Light-Duty Technology Cost Analysis Pilot Study

United States
Environmental Protection
Agency

Light-Duty Technology Cost Analysis Pilot Study

Assessment and Standards Division
Office of Transportation and Air Quality
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NOTICE

This technical report does not necessarily represent final EPA decisions or positions. It is intended to present technical analysis of issues using data that are currently available. The purpose in the release of such reports is to facilitate the exchange of technical information and to inform the public of technical developments.

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Executive Summary

The United States Environmental Protection Agency (EPA) contracted with FEV, Inc. to determine incremental direct manufacturing costs for a set of advanced light-duty vehicle technologies. The technologies selected are on the leading edge for reducing emissions of greenhouse gases in the future, primarily in the form of tailpipe carbon dioxide (CO2).

In contrast to comparable cost analyses done in the past, which rely heavily on supplier price quotes for key components, this study is based to a large degree on teardowns of vehicles or vehicle systems that employ the new technologies, and of similar vehicles or systems without the new technologies. Analysts with expertise in automotive design, materials, and manufacturing then compare the teardown components and evaluate the differences. Using databases for materials, labor, manufacturing overhead, and mark-up costs, the overall cost to manufacture individual parts are calculated and summed into final results. A model consisting of an extensive set of linked spreadsheets and associated macros has been developed to perform the calculations, to track the input data, identify sources of information, describe assumptions used in the case study, and provide analysis tools (such as forecasting to future years).

This report describes the study methodology in detail, and presents results for the first technology evaluated: stoichiometric, gasoline direct injection (GDI) with turbocharging on a downsized I4 engine, compared to an equivalent conventional I4 engine. These results are summarized in the following Table ES-1.

As shown in Table 1, the two (2) subsystems having the greatest impact on incremental costs were the air induction subsystem ($258.89) and fuel induction subsystem ($107.32). In the case of the air induction subsystem, all components included in the cost analysis were absolute component costs (i.e., there were no cost offsets from the base technology configuration). The major cost contributors to the air induction subsystem included the turbocharger assembly ($151.85), tubes and hoses ($52.21), charged air cooler assembly ($18.65), and the OEM engine and vehicle assembly of air induction components ($25.70). The major cost contributors associated with the adoption of a high pressure fuel induction subsystem included the addition of a high pressure fuel pump ($69.61), four (4) high pressure fuel injectors ($13.13/each) and a high pressure fuel rail ($20.76). These cost additions were offset by the base technology configuration costs which included four (4) low pressure fuel injectors ($8.77/each) and a low pressure fuel rail ($5.83).

Complete cost details for all subsystems referenced in Table ES-1 can be found in Appendices G.1 (individual component cost sheets), H.1 (subsystem cost roll ups) and H.2 (system cost roll up).

Table ES-1: Case Study #0101 Incremental Unit Cost Impact - Downsizing from a 2.4L I4, 16 Valve, DOHC, NA, PFI Engine to a 1.6L I4, 16 Valve, DOHC, Turbo, GDI Engine

Engine Subsystems	Net Incremental Component/Assembly Cost Impact to OEM
Engine Frames, Mountings & Brackets Subsystem	$0.00
Crank Drive Subsystem	$0.00
Counter Balance Subsystem	($35.95)
Cylinder Block Subsystem	$0.44
Cylinder Head Subsystem	$16.55
Valve Train Subsystem	$10.06
Timing Drive Subsystem	$1.60
Accessory Drive Subsystem	$0.00
Intake Subsystem	($12.73)
Fuel Induction Subsystem	$107.32
Exhaust Subsystem	$37.77
Lubrication (Oil Pans/Sumps) Subsystem	$34.46
Cooling Subsystem	$41.56
Induction Air Charging Subsystem	$258.89
Exhaust Gas Re-Circulations Subsystem	$0.00
Breather Subsystem	$4.17
Engine Management, Engine Electronic and Electrical Subsystem	$56.61
Accessory (e.g. Starter Motor, Power Steering Pump, Air Conditioning Compressor) Subsystem	$16.95
TOTAL UNIT COST	$537.70

1 Introduction

1.1 Objectives

This report describes the methodology used for the light-duty vehicle technology cost study performed for the Environmental Protection Agency (EPA) by FEV and its subcontractors. Because the methodology is most readily understood in the context of an actual case study, this report also presents details and results for the first technology studied: stoichiometric gasoline direct injection (GDI) with turbocharging on a downsized I4 engine, compared to an equivalent conventional I4 engine (Case Study #0101). Detailed analysis working documents for the case study are provided in the Appendix; however, the very large size of some of the analysis spreadsheets precludes their inclusion in the report itself and these are being made available in CD form or on EPA's website (http://www.epa/gov/otaq/). Costing results and details for additional technologies and vehicle classes will be provided in subsequent reports.

The objective of this work assignment is to determine incremental direct manufacturing costs for a set of advanced light-duty vehicle technologies. The technologies selected are on the leading edge for reducing emissions of greenhouse gases in the future, primarily in the form of tailpipe carbon dioxide (CO2). Such reductions generally correspond to fuel economy improvements. Each technology selected is evaluated against a baseline vehicle technology configuration, representative of the current state of design, and having similar overall driving performance. To obtain cost results across the diverse light-duty vehicle fleet, application of the new technologies in five (5) vehicle size classes is considered, though no costing is performed for cases in which a technology is not generally considered applicable to a vehicle class. The vehicle size classes are:

- Small car: a subcompact or compact car typically powered by an in-line 4 cylinder engine

- Midsize car: a midsize or large passenger car typically powered by a V6 engine

- Large multi-purpose vehicle: a minivan or large cross-over vehicle with a large frontal area, typically powered by a V6 engine, capable of carrying ~ 6 or more passengers

- Small truck: a small or mid-sized sports-utility or cross-over vehicle, or a small pick-up truck, powered by a V6 or V8 engine

- Large truck: large sports-utility vehicles and large pickup trucks, typically powered by a V8 engine

Currently, the new technologies under consideration for study are:

- Downsized turbocharged gasoline direct-injection (GDI) engines
- Hybrid electric vehicles
- Advanced transmissions (6-speed, dual clutch)
- High-efficiency, low-leak air conditioning
- Advanced diesel engines
- Plug-in hybrids
- Full electric vehicles
- Homogenous charge compression ignition engines
- Lean-burn GDI engines

1.2 Process Methodology and Key Supporting Documents

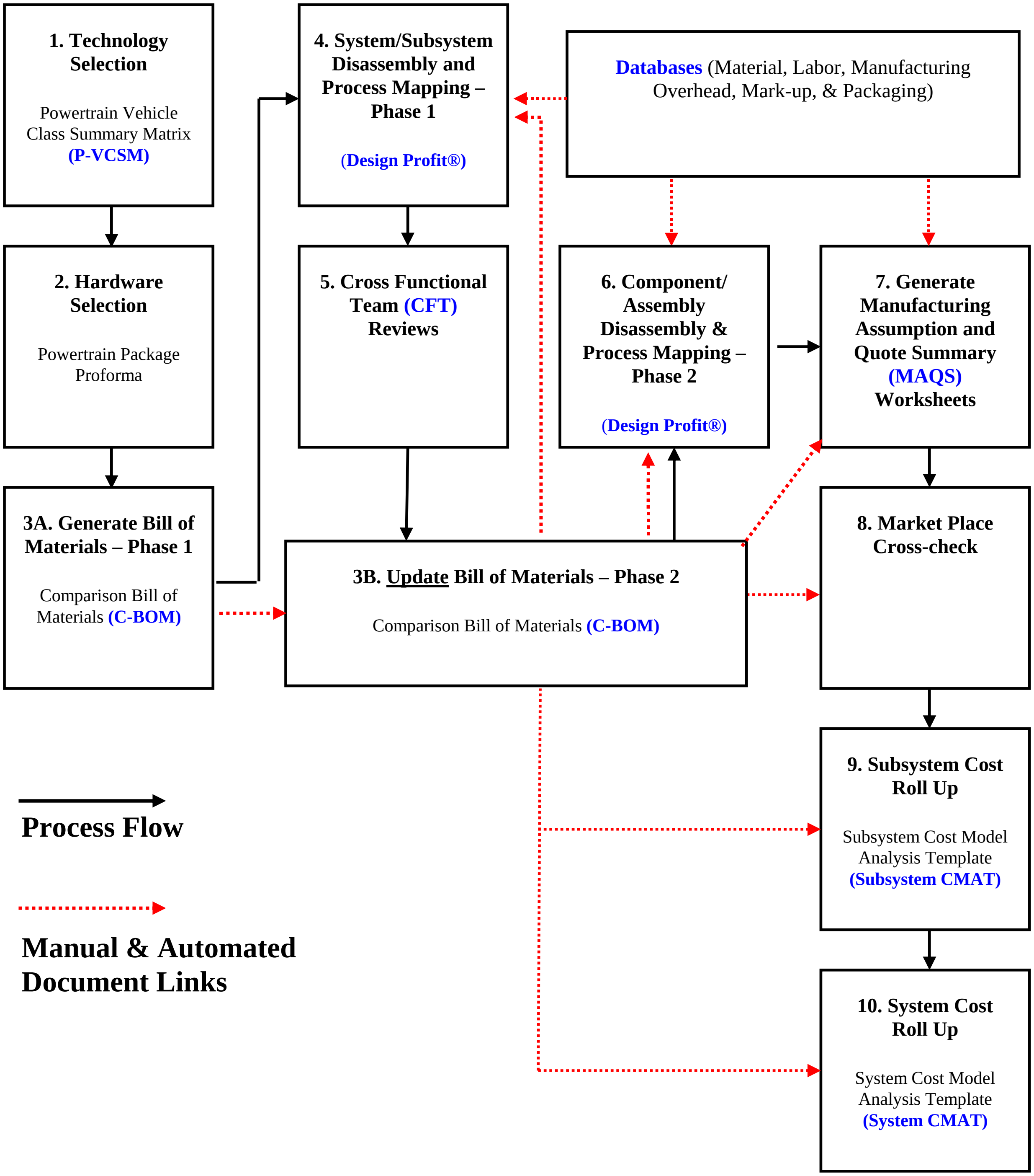


Figure 1-1: Cost Analysis Process Flow Steps & Document Interaction

The overall process methodology is comprised of ten (10) major steps, described briefly below and in Figure 1, and in more detail in subsequent sections.

Step 1: Using the Powertrain-Vehicle Class Summary Matrix (P-VCSM) a technology is selected for cost analysis.

> The ***P-VCSM*** identifies the technologies being evaluated, the applicable vehicle classes for each technology, and key parameters for vehicles or vehicle systems that have been selected to represent the new technology and baseline configurations in each vehicle class to be costed. As the defining input to the cost analysis, it is developed through extensive discussions with EPA. A portion of the P-VCSM for this case study is provided in Appendix A.1. This document may be modified as the study progresses. Note that some closely associated technologies are bundled; for example: gasoline direct injection and turbocharging.

Step 2: Existing vehicle models are identified for teardown, to provide the basis for detailed incremental cost calculations. The teardown vehicles are chosen in collaboration with EPA to represent the base and new technology cases on the P-VCSM. For many technologies being studied the vehicle systems involved are not extensive, so that entire vehicles need not be torn down or costed out, but rather engines, transmissions, or other major components are targeted instead. In doing so, close scrutiny is paid to vehicle components that might be indirectly affected by the addition of a new technology, such as those needed for noise, vibration, and harshness (NVH) mitigation. The system and performance details of the selected new and base technology configurations are recorded in the Powertrain Package Proforma.

> The ***Powertrain Package Proforma*** is a summary worksheet comparing the key physical and performance attributes of the technology under study with those of the corresponding base configuration. The Powertrain Package Proforma for case study #0101 may be found in Appendix B.1.

Step 3: Pre-teardown Comparison Bills of Materials (CBOM) are developed, covering hardware that exists in the new and base technology configurations. These high level CBOM's are informed by the team's understanding of the new and base technologies and serve to identify the major systems and components targeted for teardown.

> The ***CBOM*** is a bill of materials which lists out all the subsystems and components associated with the technology configurations under evaluation. It may include subsystems or components of the new technology vehicle that are not used on the base vehicle.
>
> The CBOM provides a means of identifying all the parts that are different between the base and new technology configurations, as a result of adoption of the new technology. Also the CBOM is the document used to capture alternative design

and manufacturing innovations, which can be binned to either material cost reduction (MCR) ideas or new technology advances (NTAs), within the technology configurations under evaluation. These ideas, if found to be of significant value, are then evaluated in terms of performance and/or cost improvements over the base assessment.

In addition, the CBOM documents sources of the quote assumptions made for the cost analysis, e.g., parts, drawings or specifications, actual parts or surrogate, make or buy (purchase), validation quote required, etc. In the context of this study, "quote" generally refers to the analytically determined cost of a part or assembly, not a price provided by a supplier. A portion of the new technology configuration CBOM for case study #0101 may be found in Appendix C.1.

Step 4: Phase 1 (high level) teardown is conducted for all subsystems identified in Step 3 and the assemblies that comprise them. Using Design Profit® software, all high level processes (e.g. assembly process of the high pressure fuel pump onto the cylinder head assembly) are mapped during the disassembly.

Process mapping is the sequential identification and orderly documentation of all the steps involved in a making an assembly or component. A single component may be manufactured using a number of processes (die casting, machining, washing, heat treating, anodizing, testing, etc). Each process may by further divided into several operations. Thus for a given assembly, often consisting of twenty (20) or more components, keeping track of processes and operations in a logical manner is very critical.

Fundamental to process mapping is identifying the materials and the primary processes required to manufacture a part. This is followed by selecting the optimal manufacturing inputs (tools, equipment, etc.) based on certain manufacturing assumptions (see Section 1.3), such that a series of operations defining the process can be mapped. All parts requiring a detailed cost analysis undergo this process.

Step 5: A cross functional team (CFT) reviews all the data generated from the high level teardown. This CFT, with an average relevant experience level of 23 years, employs technology expertise from several areas including: engine design and development, NVH and driveline subsystems, vehicle integration, production development, manufacturing engineering (supplier and OEM), cost estimating and product benchmarking. Where appropriate, personnel changes are made to the CFT to ensure matching expertise to the technology under analysis.

The CFT captures the assessments in the CBOMs, identifying the component and assembly differences between the new and base technology configurations. All components requiring cost analysis are identified, as well as any base assumptions where applicable (e.g. material selection, primary and secondary manufacturing processes).

Step 6: Phase 2 (component/assembly level) teardowns are done, based on the updated CBOM's. Components and assemblies are disassembled, and processes and operations are mapped in full detail. The process mapping generates key process information for the quote worksheets. Several databases, containing critical costing information, provide support to the mapping process.

Step 7: Manufacturing Assumption and Quote Summary (MAQS) worksheets are generated for all parts undergoing the cost analysis. The MAQS details all cost elements making up the final unit costs:

- material
- labor
- burden
- end item scrap
- selling, general & administrative (SG&A)
- profit
- engineering design & testing (ED&T)
- packaging

In addition the MAQS worksheet has active links to all key costing parameters.

> The **MAQS** worksheet is basically a standard original equipment manufacturer (OEM) quote sheet modified with some extra sections to display additional details as well as provide ease and flexibility for updating specific cost factors. The main feeder documents to the MAQS worksheet include the Design Profit® maps and costing databases.
>
> Two (2) key sections to the MAQS worksheet are the manufacturing assumption section and the quote summary section. In the manufacturing assumption section, key output variables from the process maps created by Design Profit® software are imported into the MAQS worksheets. Calculations are made with these inputs developing a mass production processing methodology.
>
> Outputs from the manufacturing assumption section of the MAQS worksheet are uploaded into the quote summary section along with various inputs from the various costing databases to arrive at a final estimated manufacturing cost.

Step 8: Parts with high or unexpected cost results are subjected to a marketplace cross-check such as comparison with supplier price quotes, or wider consultation with company and industry resources beyond the CFT.

Step 9: All costs calculated in the MAQS worksheets are automatically inputted into the Subsystem Cost Model Analysis Templates (CMAT). Some examples of subsystems, contained within the engine system, include the following: crankdrive subsystem, cylinder head subsystem, fuel induction subsystem, and air induction subsystem.

> The ***Subsystem CMAT*** is used to display and roll up all the differential costs associated with a subsystem. All parts in a subsystem that are identified for costing in the CBOM are entered into the Subsystem CMAT. Also both the base and new technology configurations are included in the same CMAT to facilitate differential cost analysis.

Step 10: The final step in the process is creating the System CMAT which rolls up all the subsystem differential costs to establish a final system unit cost. For case study #0101, the engine system was the only vehicle system requiring analysis.

> The ***System CMAT***, similar in function to the subsystem CMAT, is the document used to display and roll-up all the subsystem costs associated within a system, as defined by the CBOM. Within the scope of this cost analysis, the System CMAT provides the bottom line incremental unit cost, between the base and new technology configurations under evaluation. All Subsystem CMAT totals are linked directly to the System CMAT.

1.3 Manufacturing Assumptions

When conducting the cost analysis for the various technology configurations, a number of assumptions are made in order to establish a consistent framework for all costing. The manufacturing assumptions can be broken into generic and specific case study assumptions.

The generic manufacturing assumptions apply to all technology configurations under analysis. Listed below are the fundamental assumptions:

1) All OEM and supplier manufacturing locations are in North America, unless otherwise stated. This serves to make the resulting costs conservative to the extent that OEMs use offshore suppliers to reduce costs.

2) OEMs and suppliers have manufacturing equipment and facilities capable of handling required manufacturing processes and capacities, unless otherwise stated.

3) All manufacturing processes and operations are based on standard/mainstream industrial practices.

4) Supplier mark-up rates (End-Item Scrap, SG&A, Profit, ED&T) are based on mature technology and manufacturing methods (e.g. mature product designs, high production volumes, significant marketplace competition, established manufacturing processes) unless otherwise specified.

5) All OEM mark-up will be applied using indirect cost (IC) multipliers. These are not within the scope of this analysis, but should be separately determined and applied to the results of this analysis to obtain total (direct + indirect) manufacturing costs.

6) Manufacturing rates are considered high volume (450,000 units per year for case study #0101) and maintained throughout the product life. The engine volume assumption for case study #0101 is based on published data from Ward's Automotive Yearbook 2008, in which annual engine volumes for 2007 model year US domestic light-vehicle production ranged from 350K to 480K for moderate to high volume consumption applications.

The specific case study assumptions are those unique to a given technology configuration. These include volume assumptions, weekly operation assumptions (days, shifts, hours, etc.), packaging assumptions, and Tier 1 in-house manufacturing versus Tier 2/3 purchase part assumptions. Details on the case study specific assumptions can be found in the individual MAQS worksheets.

2 Technology Selection

The Powertrain-Vehicle Class Summary Matrix (P-VCSM) summarizes the technology configurations and vehicle classes to be evaluated. Using the design parameters listed in the P-VCSM, the best-suited hardware is chosen for the new technology and base configurations. The performance attributes being matched in these configurations, along with other pertinent vehicle/system details, are listed in the Powertrain Package Proforma for each case study.

As discussed in Section 1.1, five (5) vehicle classes were considered for this work assignment. Costing based on full teardowns in every relevant vehicle class would be prohibitively expensive and time consuming. Fortunately, reliable results can be obtained through judicious scaling of the teardown-derived costs, up or down, across the relevant vehicle classes. In some cases, teardown of a limited set of key components from a vehicle in a particular class assists in scaling costing results to that class.

Proper scaling of teardown results is a complex but critical part of the overall analysis, and the methodology for it can vary, component by component. Some parts are best scaled by engine displacement (cylinder block, turbocharger assembly, oil pump assembly, for example) and some by number count (number of pistons, for example) or other parameters. The P-VCSM identifies which case studies have been conducted using the full teardown and cost analysis method and those which have used the scaling methodology. The scaling assumptions for individual components are documented in the quote assumption section of the CBOM.

3 Comparison Bill of Materials

3.1 Overview

The CBOM's function as the case study road maps, detailing what is being quoted and why. The CBOM records all the high level details of the technology configurations under study, identifies those items which have cost implication as a result of the new versus base technology differences, documents the study assumptions, and captures input from the cross functional team.

The CBOM's are considered working documents, and as such are updated and referenced throughout the different phases of the analysis. All costing documents are referenced back to the CBOM's, linking all components of the analysis.

In addition to the manufacturing cost impact on components and assemblies directly associated with new technologies, the "ripple effect" on neighboring systems must be considered. These effects may have positive or negative consequences on the overall vehicle costs for the new technologies.

When a new case study is initiated, the cross functional team meets to discuss the primary differences between the base and new technology configurations being studied as well as the surrounding systems, which may be affected by the technology differences. A Comparison Bill of Material is generated as a starting point to track all potential system, subsystem and component/assembly costs directly or indirectly associated with the technology change. Thus, regardless of what system or subsystem an affected component or assembly resides in, it is tracked and quoted using the same costing methodology. It should be noted that in this case study, where a naturally-aspirated I-4 engine is replaced by a downsized, turbocharged I-4 engine, the team concluded that no additional costs were involved outside the engine system (e.g. the firing frequency and overall power level of the two (2) engines are similar). In future studies, where there is a quantifiable difference in NVH or other characteristics between the base case and the new technology, the components required to address them will be identified and costed.

3.2 Main Sections of Comparison Bill of Materials

The CBOM consists of the following sections:

The ***General Part Information*** section lists out all the systems, subsystems, and components potentially affected by going from the base configuration to the new technology configuration under consideration. The goal at this stage of the process is a conservative (long) list, with the expectation that detailed examination will subsequently eliminate some components from further consideration, as described below. The layout structure of the CBOM is top level down (system, subsystems, assemblies, etc.) All components and assemblies within subsystems, and all subsystems within systems, are grouped according to design function.

The ***Design Difference*** section is where parts are identified as **not** needing cost analysis. All parts initially listed in the CBOM are identified as requiring cost analysis; represented with a red check box. Only after the cross functional team has reviewed the parts and determined they can be excluded from the study is the box checked off, turning it green to indicate no cost analysis is required. If exclusion of a part is not obvious, remarks are added identifying the team's assumptions. If a checkbox is left red, identifying that the part requires cost analysis, the attribute differences are identified along with any study and costing assumptions. In several circumstances, the systems, subsystems, and components under comparison, between the base and new technology configurations, will be different in variety of ways: part existence, material selection, part geometry, manufacturing methods, etc. It is the job of the cross functional team to determine if these differences are driven by the change in technology, or are exclusive of the technology and the result of a supplier and/or OEM design and/or manufacturing preference. These decisions are documented in the CBOM.

The ***Potential Material Cost Reduction (MCR)*** section captures potential design and/or manufacturing optimization for the hardware being evaluated. These savings could potentially reduce or increase the differential costs between the new and base technology configurations, depending on whether an MCR idea is for the new or the base technology. Typically base technology MCR actions are associated with efforts to share components across common platforms.

The ***New Technology Advances (NTA)*** section captures alternative advance technology ideas which could be substituted for some of the existing hardware being evaluated. These advanced technologies, through improved function and performance, and/or cost reductions, could help increase the overall value of the technology configuration.

The MCR and NTA sections are intended to provide for cost optimization in the model from improvement opportunities explicitly identified in the teardown evaluations. However, this cost study uses these sections sparingly, emphasizing hardware "on the floor", and therefore does not negate the appropriateness of applying "learning curves" for projecting future cost reductions in maturing technologies.

The ***Quote Assumptions*** section provides the cost analysis roadmap for each part. The roadmap includes some of the following general items:

1) "Make Versus Buy" indicates if a part is quoted with a full analysis, as if it were being made by the manufacturer, or is treated as a "buy", with surrogate costs pulled from an applicable database.

2) “Marketplace Validation” identifies which components should be cross-checked with market place data.

3) “Component Information Source”, identifies what type of information is available for the quote, e.g., part, drawing, marked-up drawing/sketch, specification, or other.

4) “Component Information Requires Assumption Modifications”, identifies for a given component what modifications or assumption changes are required to the information before the item is quoted.

The ***Component Specification Assumptions*** section identifies the basic material, finish, functional and/or performance information associated with top level components where applicable. The information listed in this section facilitates the process mapping stage by identifying some of these core assumptions up front. This section is typically more beneficial for component type end items than for assemblies. For example, the material and heat treat level for a cylinder block can be identified up front, prior to the actual mapping process. In contrast, a high pressure fuel pump, which would exist in the CBOM as a complete assembly, would require disassembly so all part materials, finishes, etc., can be identified.

The ***Component Manufacturing Assumptions*** section identifies the primary and secondary manufacturing processes associated with top level components. As for the Component Specification Assumptions, this information is used to help feed the process mapping stage. In addition, this section is better suited for end-item components than for assemblies.

The ***Potential Component Suppliers*** section lists the typical suppliers who may manufacture similar types of parts as those identified in the CBOM. Understanding the typical supplier size and complexity characteristics associated with manufacturing a particular type of component facilitates the assignment of the mark-up rates to a particular component. Various mark-up rate groupings are established (methodology detailed in Section 7.5) based on supplier size and complexity. During the cost analysis suppliers are binned to these various mark-up groups which in turn define the mark-up rates for a particular component.

4 Costing Methodology - Teardown, Process Mapping, and Costing

4.1 Cost Methodology Fundamentals

The costing methodology employed in this analysis is based on two (2) primary processes: (1) the development of detailed production process flow charts (P-flows), and (2) the transferring and processing of key information, from the P-flows, into standardize quoting worksheets. Supporting these two (2) primary processes with key input data, are the costing databases (e.g. material "price/lb", labor "$/hour", manufacturing overhead "$/hour", mark-up "% of manufacturing cost" and packaging "$/packaging type"). The costing databases will be discussed in greater detail in Section 7.

Process flow charts, depending on their defined function and end user, can very widely in the level of detail they contain; ranging from simple block diagrams showing the general steps involved in the manufacturing or assembly of an item, to very detailed process flow charts breaking out each process step in finite detail capturing key manufacturing variables. For this cost analysis, detailed P-flows, which will also be referred to as process maps, are used to identify all the steps involved in manufacturing a product (e.g. assembly, machining, welding, forming), at all levels (e.g. system, subsystem, assembly and component). For example in a turbocharger scenario, process flows would exist for the following: (1) at the ***component level***, the manufacturing of every component within the turbocharger (unless considered a purchase part), (2) at the ***assembly level***, the assembly of all the individual components to produce the turbocharger, (3) at the ***subsystem level***, the assembly of the turbocharger onto the engine, and (4) at the ***system level***, the assembly of the engine into the vehicle.

In addition to detailing pictorially the process steps involved for a given manufacturing process, having key information (e.g. equipment type, material type and usage, cycle times, handling precautions, number of operators) associated with each step is imperative. Understanding the steps and the key process parameters together creates the costing roadmap for any particular manufacturing process.

Due to the vast and complex nature of P-flows associated with some of the larger system and subsystems under analysis, having specialized software which can accurately and consistently create and organize the abundant number of detailed P-flows becomes a considerable advantage. For this cost analysis Design Profit® software is utilized for producing and managing the process flows. Information regarding the details of Design Profit® software will be covered in the next section.

The second major step in the cost analysis process involves taking the key information from the process flows and uploading it into a standardized quote worksheet. The quote worksheet, referred to as the Manufacturing Assumption and Quote Summary (MAQS) worksheet, is essentially a modified generic OEM quoting template. Every assembly included in the cost analysis (excluding commodity purchased parts) has a completed MAQS worksheet capturing all the cost details for the assembly. For example all the components and their associated costs, required in the manufacturing of a turbocharger assembly, will be captured in Turbocharger Assembly MAQS worksheet. In addition, a separate MAQS worksheet detailing the cost associated with assembling the turbocharger assembly to the engine, along with any other identified air induction subsystem components, would be created.

In addition to process flow information feeding into the MAQS worksheet, data is also automatically linked in from the various costing databases. More discussion on the MAQS worksheet, interfaces, and complete function is captured in Section 9.

4.2 Serial and Parallel Manufacturing Operations and Processes

For purpose of this analysis, serial operations are defined as operations which must take place in a set sequence; one at a time. For example, fixturing metal stamped bracket components before welding can commence, both the fixturing and welding are considered serial operations within the bracket welding process. Conversely, parallel operations are defined as two (2) or more operations which can occur simultaneously on a part. An example of this would be machining multiple features into a cylinder block simultaneously.

A process is defined as one (1) or more operations (serial or parallel) coupled together to create a component, subassembly, or assembly. A serial process is defined as a process where all operations (serial and/or parallel) are completed on a part before work is initiated on the next part. For example, turning a check valve body on a single spindle, CNC screw machine, would be considered a serial process. In comparison, a parallel process is where different operations (serial and/or parallel) are taking place simultaneously at multiple stations on more than one (1) part. A multi-station final assembly line, for assembling together the various components of a vacuum pump, would be considered a parallel process.

As discussed, the intent of a process flow chart is to capture all the individual operations and details required to manufacture a part (e.g. component, subassembly, assembly). In many cases this results in a string of serial operations, generating a serial process, which requires additional analysis to develop a mainstream mass production process (i.e., inclusion of parallel operations and processing). The Manufacturing Assumption section of the MAQS worksheet, is where the base assumptions for converting serial operations and processes, into mass production operations and processes, is captured.

For example, assume “Assembly M” requires fifteen (15) operations to assembly all of its parts together; each operation on average taking approximately ten (10) seconds to complete. In a serial process (analogous to single, standalone work cell, manned by a single operator) consisting of fifteen (15) serial operations, the total process time would be 150 seconds to produce each part (15 operations x 10 second average/station). Taking this serial assembly process, and converting it into a mass production parallel process, the following scenarios could be evaluated (Note rates and assumptions applied below are fabricated for this example only):

1. Scenario #1: 15 serial operation stations, all manned, each performing a single operation in parallel.
    - Process Time 10 seconds/part, 360 parts/hour @ 100% efficiency
    - Labor Cost/Part = [(15 Direct Laborers)*(Labor Rate $30/hour)]/360 parts/hour = $1.25/part
    - Burden Cost/Part = [(15 Stations)*(Burden Rate Average (Low Complexity Line) $15/hour/station)]/360 parts/hour = $0.625/part

2. Scenario #2: 15 serial operations combined into 10 stations, 5 with 2 parallel automated operations, 5 serial manual operations.
    - Process Time 10 seconds/part, 360 parts/hour @ 100% efficiency,
    - Labor Cost/Part = [(5 Direct Laborers)*(Labor Rate $30/hour)]/360 parts/hour = $0.42/part
    - Burden Cost/Part = [(10 Stations)*(Burden Rate Average (Moderate Complexity Line) $30/hour/station)]/360 parts/hour = $0.83/part

Assuming a high production volume in a North America manufacturing base (two key study assumptions), scenario #2 would have been automatically chosen; higher level of automation offsetting higher manual assembly costs.

For components whose typical mass production process is a serial process (e.g., injection molding, stamping, die casting, selected screw machining) the manufacturing assumption section of the MAQS worksheet requires far less consideration. Analysis is usually limited to determining the total number of pieces of equipment required for the defined volume.

Figure 4-1 illustrates the fundamental steps incorporated into the cost methodology.

Costing Databases Support Process Mapping and Quote Worksheet Phases of Cost Analysis

Five (5) Databases store rates for all eight cost elements used within the cost analysis: Material, Labor, Burden, Mark-up (End-item Scrap, SG&A, Profit, and ED&T) and Packaging

1. Select **Component Assembly, Subsystem, and /or System, for cost analysis**

2. Conduct **Controlled Teardown Process**

3. Develop **Process Flow Charts (Also referred to as Process Maps)**

During all levels of the teardown, process flow charts capturing every manufacturing operation are generated, including all key variables associated with each operation.

Examples of the operations and part details include:
> operation description, equipment specification, cycle times, material composition/specification, component geometry, component mass, etc.

Tools used to create Process Maps:
> Design Profit® Software using Lean Design® Module
> Munro & Associates Cost Estimator Model/Tools

4. Populate Standardized Quote Worksheets - Two Main Functional Sections (Also referred to as Manufacturing Assumption and Quote Summary (MAQS) worksheet)

Manufacturing Assumptions (Section D of MAQS)

Using the data generated from the Process Flow Charts, multiple calculations are performed establishing the mass production manufacturing assumptions.

Examples included the following:
> OEM and Supplier classifications are selected, based on component type and processes, establishing the applicable mark-up rates
> Serial operations are combined into parallel operations where applicable
> Operations, both serial and/or parallel, are grouped into high volume parallel processes where applicable.
> Equipment numbers calculated to support capacity requirements
> Final equipment selection and associated burden rates are established
> Calculate number of operators required to support defined manufacturing process
> Piece per hours calculated

Quote Summary (Sections B,C,E & F)

Using the data generated in the Manufacturing Assumption Section of the MAQS, along with data from the Costing Databases, a net component/assembly cost impact is calculated.

Information used in final calculations includes the following:
> Calculated pieces/hour
> Material specification, quantity, and price/pound
> Labor Classification, number of operators, and cost/hour
> Burden Classification, number of machines, and cost/hour
> OEM/Supplier Classification, percent of total manufacturing costs
> Packaging Container, cost per container, number of parts per container

5. Market Place Cross-Check on Selected Assemblies through solicitation of Industry Experts

6. Roll Up costs from MAQS Assembly Worksheets into Net Incremental Subsystem Costs

7. Roll Up **each Incremental Subsystem Cost into a Net Incremental System Cost**

Figure 4-1: Fundamental Steps in Costing Process

4.3 Design Profit® Software Overview

Design Profit® software, has been chosen as the primary tool for creating detailed process flow charts, also referred to as process maps, for the cost analysis. The Design Profit® software consists of several modules each providing unique application specific functions. The process mapping module, within Design Profit® Software, is referred to as Lean Design®. Design Profit®, owned and developed by Design Profit, Inc., was started in 1995 to encompass the Lean Design® and Quality Report Card® methodologies developed by Munro & Associates, Inc.

The Design Profit® methodology is a quantitative, analytical, database-driven approach to mapping manufacturing operations and processes, providing a consistent means of capturing the essence of manufacturing. The software resides on a central server which allows for multiple users to work within the same project utilizing the exact same databases. This further ensures consistency through out the project as additional personnel can be added while minimizing the learning curve typically associated with most projects.

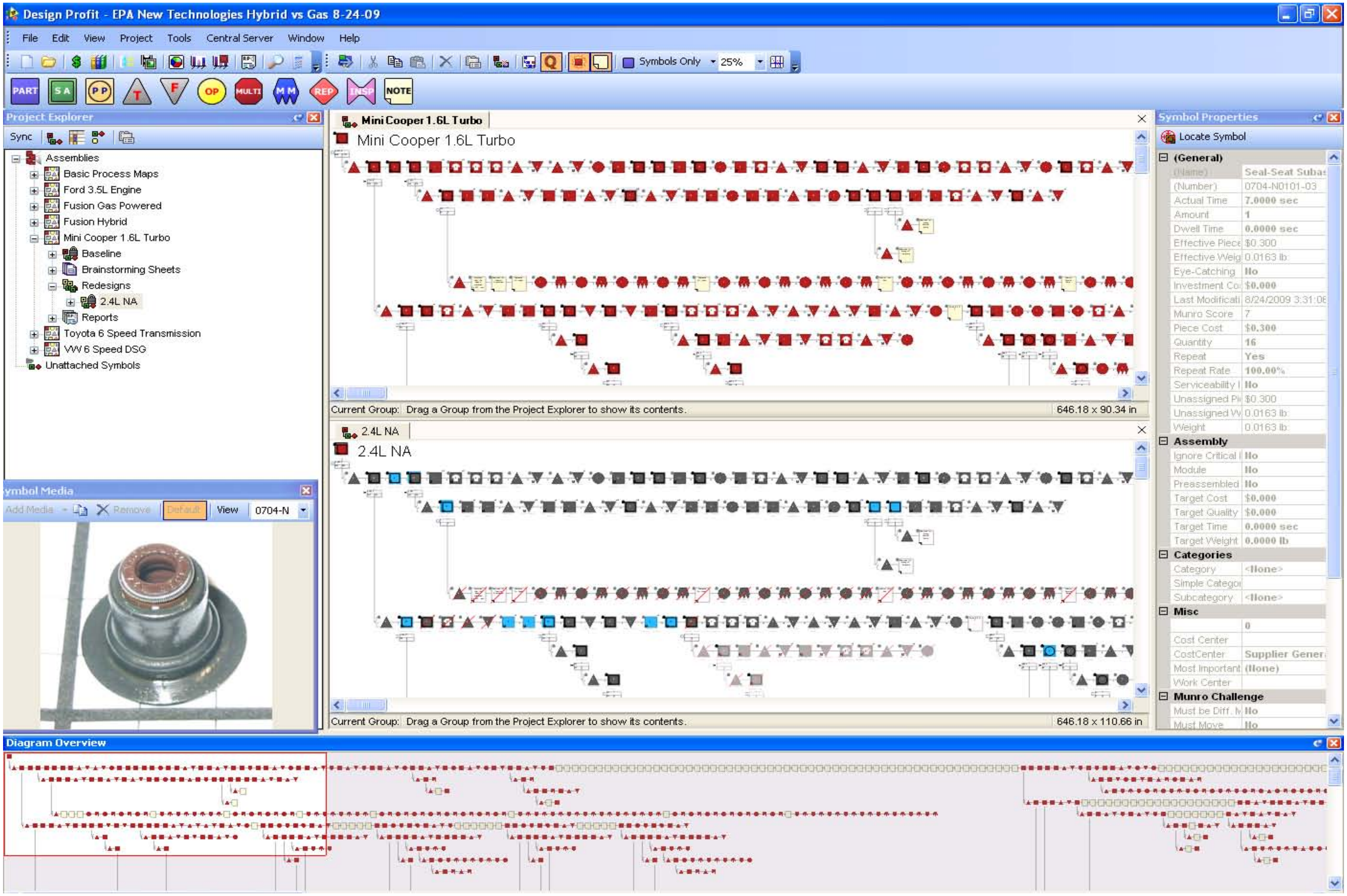
The software provides a visual representation of the product through the use of symbology depicting various assembly and manufacturing processes. Figure 4-2 is a screenshot of the Design Profit® software and the mapping process used to generate product, process and operation metrics. There are various symbols used in developing process maps, each having a unique meaning such as part type, part level, process, operation, etc. Reference Appendix D.1 for symbol examples and associated descriptions.

Each symbol is generated by filling out a properties window, which assigns key manufacturing information to the symbol. These details include operator-to-part interfaces, part-to-part interfaces, machine operations, etc., which provide the basic assembly time associated with the operation. Additional data includes part name, part number, part description, weight, quantity, material and supplier if known. Figure 4-3 is a screenshot of a part input screen.

The majority of manufacturing information/specifications uploaded during the mapping process are acquired directly from pre-established internal libraries/databases incorporated within the Design Profit® software. These internal databases have been loaded, validated and maintained by Munro & Associates Inc., a partner in the cost analysis studies.

In addition to manufacturing information inputted directly from internal Design Profit® software libraries, external costing tools are also used to generate manufacturing data for the process maps. These external cost estimating models commonly handle all the primary fabrication processes (e.g. injection molding, stamping, die casting). More details on these external cost estimating models are covered in Section 4.5.

Design Profit® uses a combination of automated testing and dedicated developers who test and develop test cases. In addition to in-house testing and validation, the metrics and algorithms in Design Profit® have gone through scrutiny over the last fifteen (15) years and have proven to be accurate for automotive volume and small to medium size parts. The customized internal libraries have been refined to include standard labor rates, assembly processes, and manufacturing processes. This level of customization provides repeatability and consistency in analysis. Design Profit® also provides the ability to input customer-known variables where component size and/or difficulty of assembly are outside the prediction abilities for Design Profit®.

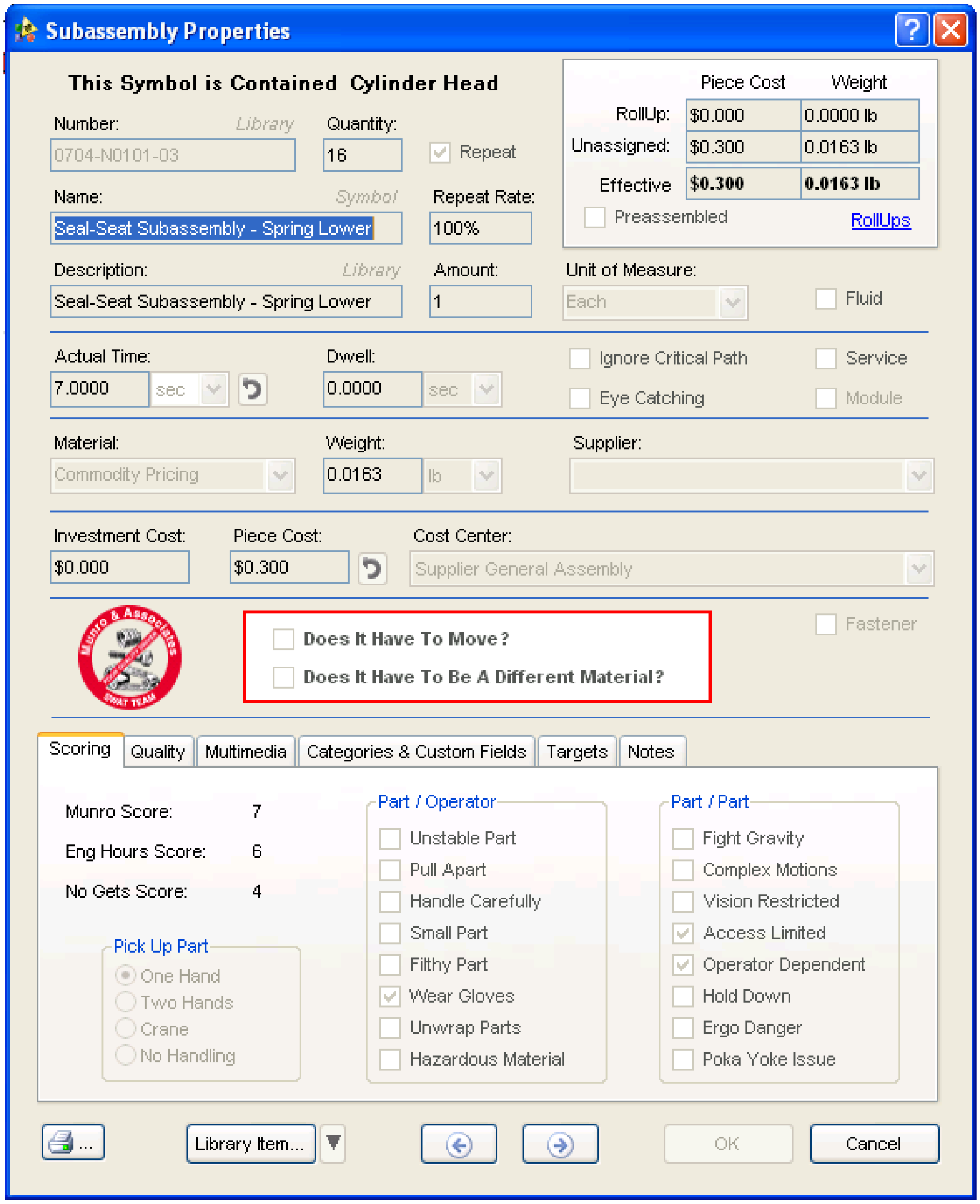


Current Group: Drag a Group from the Project Explorer to show its contents. 646.18 x 90.34 in

Current Group: Drag a Group from the Project Explorer to show its contents. 646.18 x 110.66 in

(General)	
(Name)	Seal-Seat Subas
(Number)	0704-N0101-03
Actual Time	7.0000 sec
Amount	1
Dwell Time	0.0000 sec
Effective Piece	$0.300
Effective Weig	0.0163 lb
Eye-Catching	No
Investment Co	$0.000
Last Modificati	8/24/2009 3:31:0
Munro Score	7
Piece Cost	$0.300
Quantity	16
Repeat	Yes
Repeat Rate	100.00%
Serviceability I	No
Unassigned Pi	$0.300
Unassigned W	0.0163 lb
Weight	0.0163 lb
Assembly	
Ignore Critical I	No
Module	No
Preassembled	No
Target Cost	$0.000
Target Quality	$0.000
Target Time	0.0000 sec
Target Weight	0.0000 lb
Categories	
Category	<None>
Simple Categor	
Subcategory	<None>
Misc	
	0
Cost Center	
CostCenter	Supplier Gener
Most Important	(None)
Work Center	
Munro Challenge	
Must be Diff. M	No
Must Move	No

Figure 4-2: Screen Shot of Process Mapping Using Design Profit® Software



This Symbol is Contained Cylinder Head

Number: 0704-N0101-03

Quantity: 16

☑ Repeat

Name: Seal-Seat Subassembly - Spring Lower

Repeat Rate: 100%

Description: Seal-Seat Subassembly - Spring Lower

Amount: 1

	Piece Cost	Weight
RollUp:	$0.000	0.0000 lb
Unassigned:	$0.300	0.0163 lb
Effective	**$0.300**	**0.0163 lb**

☐ Preassembled RollUps

Unit of Measure: Each

☐ Fluid

Actual Time: 7.0000 sec

Dwell: 0.0000 sec

☐ Ignore Critical Path

☐ Service

☐ Eye Catching

☐ Module

Material: Commodity Pricing

Weight: 0.0163 lb

Supplier:

Investment Cost: $0.000

Piece Cost: $0.300

Cost Center: Supplier General Assembly

☐ **Does It Have To Move?**

☐ **Does It Have To Be A Different Material?**

☐ Fastener

Munro Score: 7

Eng Hours Score: 6

No Gets Score: 4

Pick Up Part
- ● One Hand
- ○ Two Hands
- ○ Crane
- ○ No Handling

Part / Operator
- ☐ Unstable Part
- ☐ Pull Apart
- ☐ Handle Carefully
- ☐ Small Part
- ☐ Filthy Part
- ☑ Wear Gloves
- ☐ Unwrap Parts
- ☐ Hazardous Material

Part / Part
- ☐ Fight Gravity
- ☐ Complex Motions
- ☐ Vision Restricted
- ☑ Access Limited
- ☑ Operator Dependent
- ☐ Hold Down
- ☐ Ergo Danger
- ☐ Poka Yoke Issue

Figure 4-3: Property Window for a Part Symbol Used in Process Mapping

4.4 Teardown Process Overview

The teardown methodology utilized for the analysis is a multi-tiered approach. First, a high level teardown is initiated. This process consists of identifying the high level modules within each system/subsystem and mapping them in the Design Profit® software. This provides a means of determining when/where various components are assembled and to what content level, providing insight to differentiate OEM- vs. supplier-assembled components. During the high level teardown process, updates are made to the CBOM to ensure all high level assemblies and assumptions are accurately recorded. The CBOM provides the first glimpse of what the true differences are between the two vehicle technologies. At this point assemblies are identified that will require further disassembly to establish cost deltas.

After the comparison review, the second level of teardown commences. As with the high level reviews, all steps associated with the assembly of the components are captured within the Design Profit® software. Also at this point all primary manufacturing processes are captured. The vast majority of the parts identified for cost deltas are disassembled down to individual components, each manufactured from a single material.

During both the high level and the detailed teardowns, all attributes of the parts are captured, including assembly characteristics, materials, quantities, and weights; photos are also taken. Once the parts are disassembled in their entirety, they are then put through the Design Profit® costing tools to develop the serial manufacturing process times. Throughout the process a number of databases and costing tools are used to feed essential data into Design Profit® Maps. These databases include but are not limited to: raw material specifications and prices, OEM labor rates, machine burden rates, various costed BOMs, and supplier processes and operations.

4.5 Identifying Materials, Primary and Secondary Processes

Key steps in the cost analysis, for each individual part, are identifying the materials and the primary processes used in making the part. Once these have been identified, appropriate costing models are selected to calculate the primary fabrication parameters (e.g. raw material usage, cycle times, equipment size, number of cavities per tool). This is followed by capturing the secondary processes and parameters associated with manufacturing the part (e.g. machining, welding, assembly).

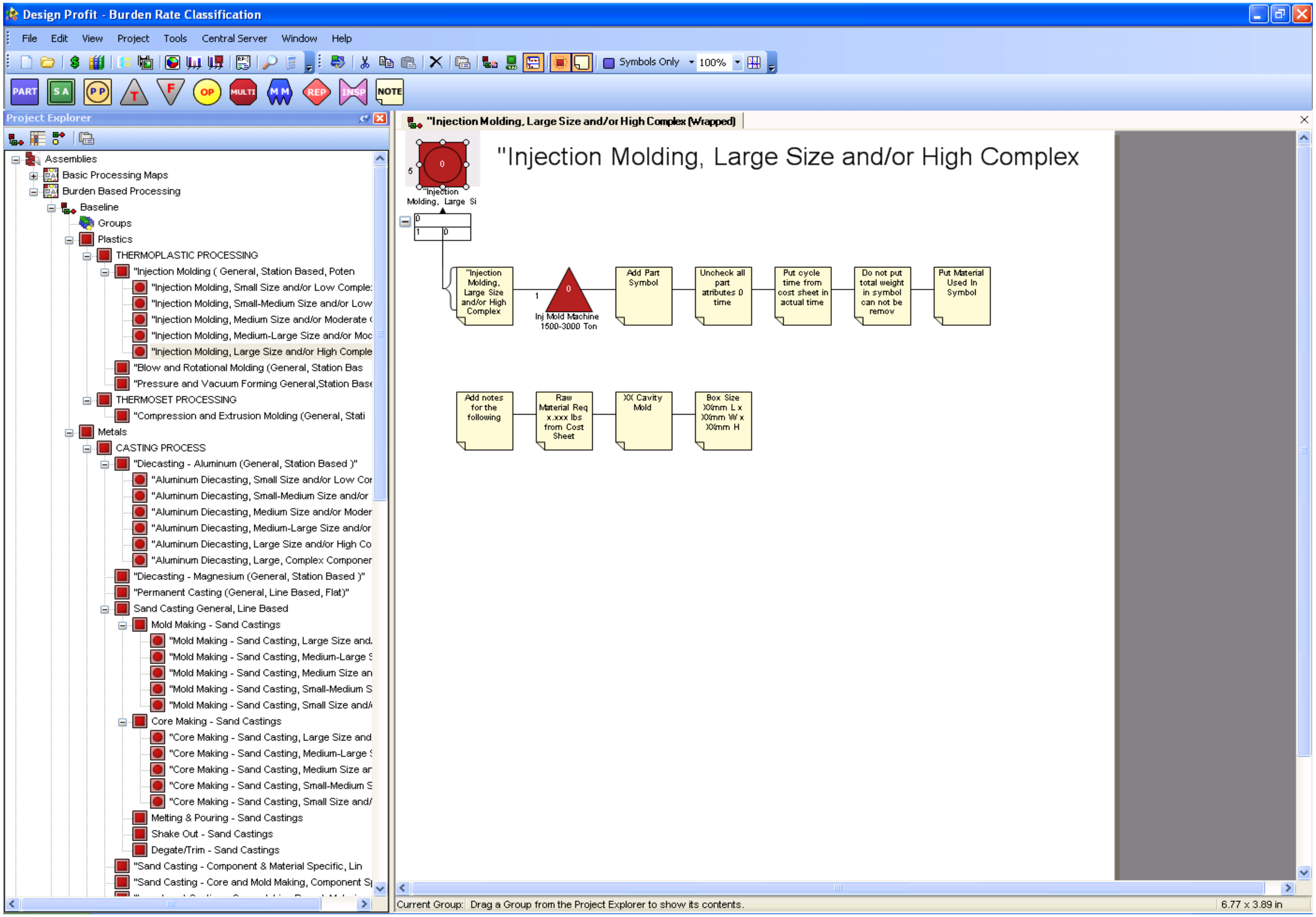
Material identification is accomplished in one of three ways. The simplest method is observing material identification markings on the part itself. Because of recyclability directives set in place in Europe, most manufactures will cast/mold in the material properties. For components which are not marked, such as pistons and crankshafts, the first approach to accessing the specific material composition is consultation with FEV’s and Munro’s CFT members. If there are still materials which cannot be identified a selection of publications are referenced, and/or manufacturers and experts within the supplier community are contacted to establish credible material choices.

Next the primary manufacturing process must be established. Most all of the processes typically leave little tell-tale signs as to how the part is manufactured. If the part is die cast, for example, there will be ejector pin marks and distinct parting lines, while sand and semi-permanent molding techniques are typically utilized when there are internal hollow sections formed by cores. A semi-permanent mold casting will have parting lines and no ejector pin markings, while a sand casting will typically have little to no signs of parting lines or ejector pin markings. In the case of no tell-tale signs (less than 2% of parts) of the primary processes, an outside subject matter expert is contacted.

Once the primary material and manufacturing processes have been identified the part can then be cost estimated. To accomplish this various cost estimating models, developed by Munro & Associates Inc are utilized. These models provide various key outputs including cycle times and equipment sizes for the particular part being cost estimated. All of the models require a number of manual input parameters which may include some or all of the following depending on the primary process selected: part length, width, height, weight (or volume), material, nominal wall thicknesses, material thickness, number of bends, number of punched holes, part projected area, part perimeter and the number of cavities. The models also account for part variability through a factoring methodology. These include tolerances, appearance, parting lines, complexity, number of planes with die lock, and profiles in the case of extrusions.

The models use these input factors within formulas to establish the output results. The fixed formulas also take into account various material and processing specifications including material density, tensile strengths, thermal diffusivity, injection pressures, die temperatures, mold temperatures, ejection temperatures, press sizes, press stroke rates, extrusion rates etc. The library of costing models used for the study includes, but not limited too, the following: aluminum (die casting, semi-permanent mold, sand casting, metal injection molding and powdered metal), plastics/composites (injection molded and extruded), and steel/iron (casting, forging, stamping, investment cast, and powdered metal). Figure 4-4 provides a snap shot of the process mapping and how the cost models are tied into the process maps for a large injection molded part.

All of the cost models are put through a validation process to ensure the results are reflective of current technologies and known costs of components. An example of this process would be validation of the injection molding module. Three (3) different size parts with assorted features are selected to ensure diversity of the model. The parts selected are typically chosen from the most recent projects that had available cost data. The part parameters are then input into the model and the results are directly compared to the actual known costs of the current parts.

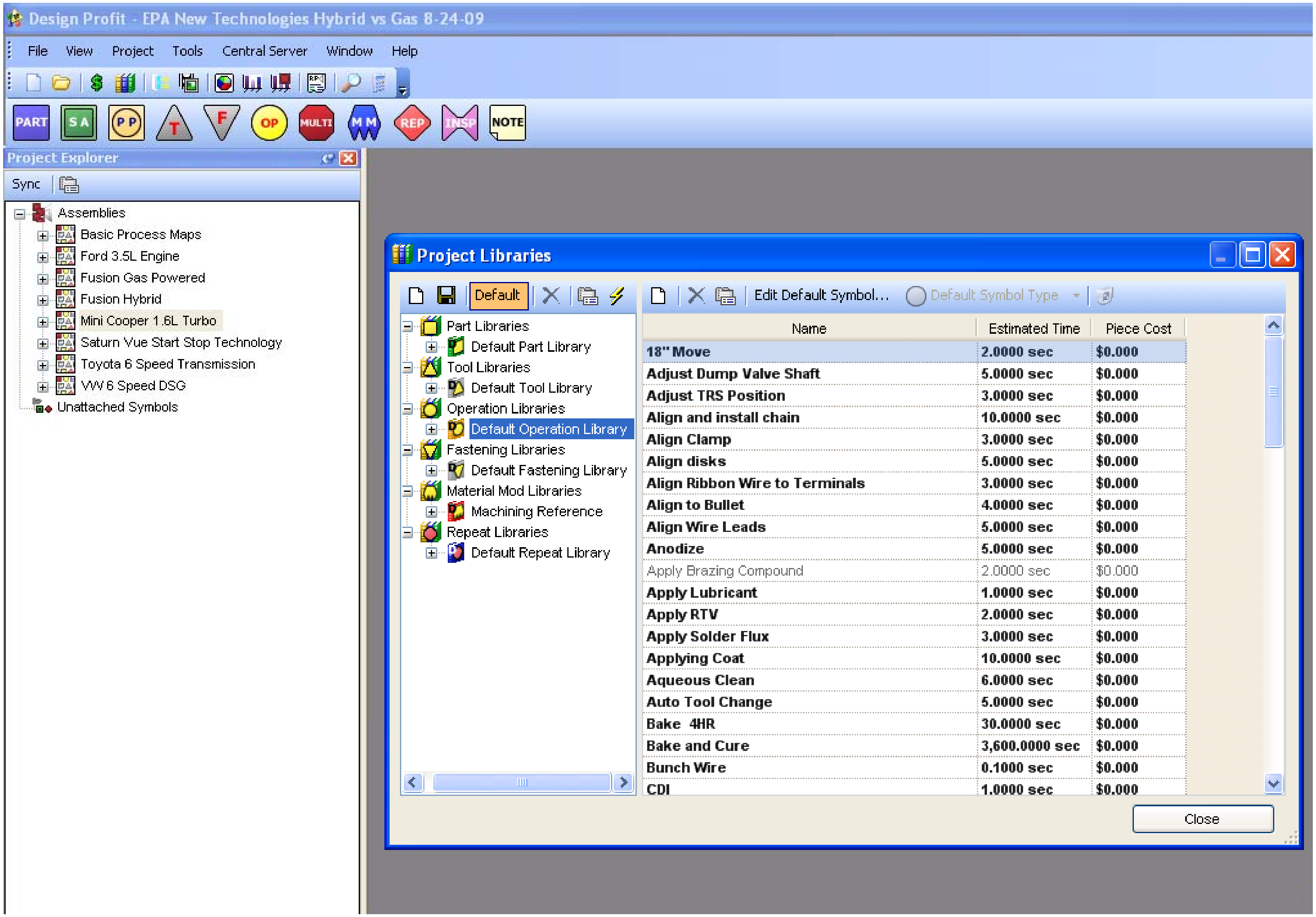


Current Group: Drag a Group from the Project Explorer to show its contents.

Figure 4-4: Injection Molded Primary Processing Map

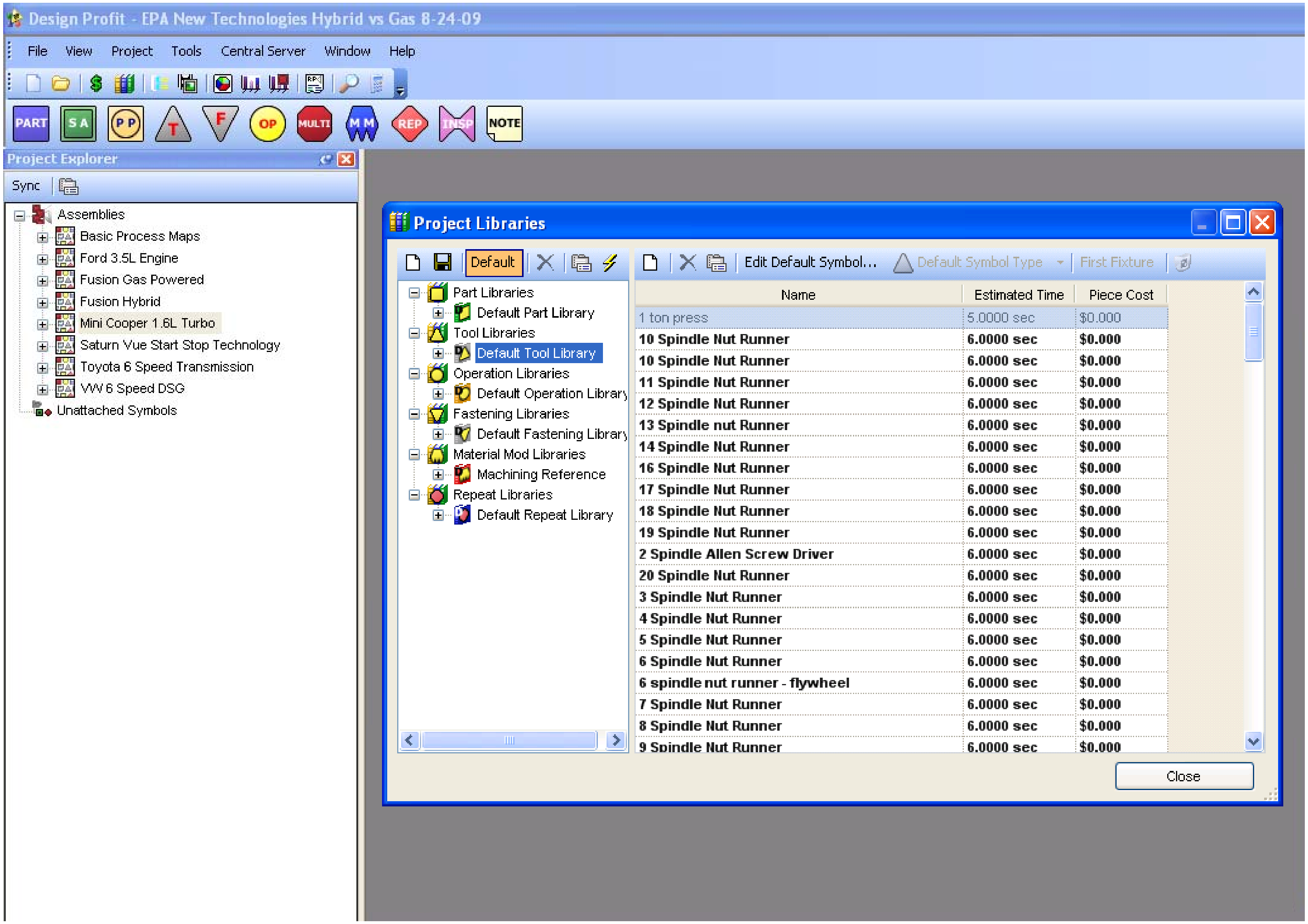
After the primary process analysis has been completed, the secondary processes are addressed. The Design Profit® software is utilized to capture all secondary operations and processes to ensure consistency throughout the costing exercise. These secondary processes include all aspects of machining, surface treatments, joining methods, etc. All operation and process details are stored in various libraries (Design Profit® databases) which are readily available for reuse in additional analyzes. For example drilled holes are categorized in the Material Modification Library by depth of hole, as this is typically the cycle time driver.

The actual cycle time, and other operation details, for items captured in the libraries are based on a number of parameters depending on the actual process being analyzed. As an example, the machining times are based on typical feeds and speeds associated with the specific material being removed, and/or based on averages from available processing data (machining bill of materials), and/or actual listed equipment capabilities. In other situations the process time may be calculated based on distance calculations i.e. applying RTV is based on seconds per inch. Each of these processes is mapped within their own string of symbols and is assigned burden rates dependent on the actual equipment required. See Figure 4-5 through 4-8 for snap shots of the actual libraries found within the Design Profit® software.



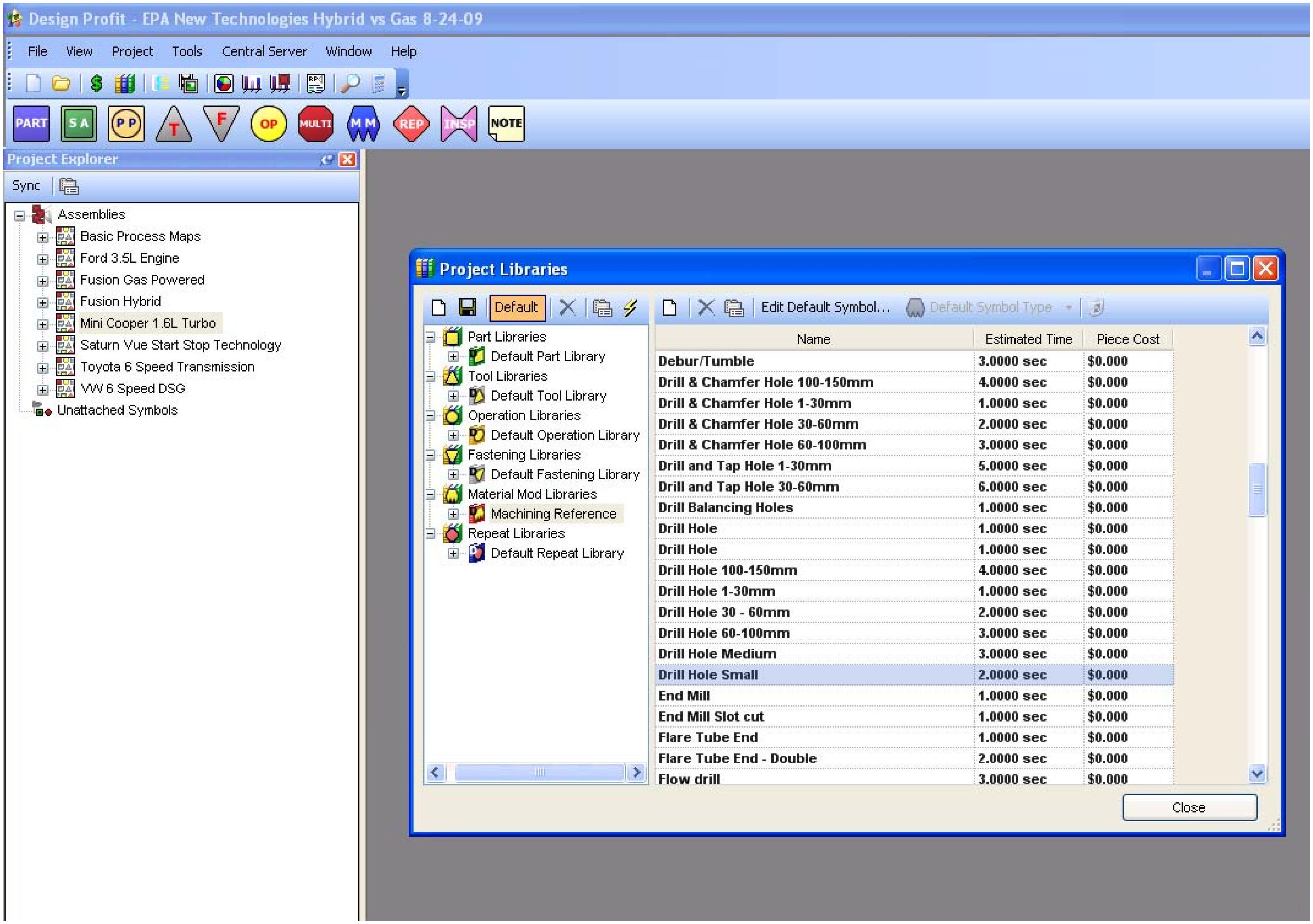
Name	Estimated Time	Piece Cost
18" Move	2.0000 sec	$0.000
Adjust Dump Valve Shaft	5.0000 sec	$0.000
Adjust TRS Position	3.0000 sec	$0.000
Align and install chain	10.0000 sec	$0.000
Align Clamp	3.0000 sec	$0.000
Align disks	5.0000 sec	$0.000
Align Ribbon Wire to Terminals	3.0000 sec	$0.000
Align to Bullet	4.0000 sec	$0.000
Align Wire Leads	5.0000 sec	$0.000
Anodize	5.0000 sec	$0.000
Apply Brazing Compound	2.0000 sec	$0.000
Apply Lubricant	1.0000 sec	$0.000
Apply RTV	2.0000 sec	$0.000
Apply Solder Flux	3.0000 sec	$0.000
Applying Coat	10.0000 sec	$0.000
Aqueous Clean	6.0000 sec	$0.000
Auto Tool Change	5.0000 sec	$0.000
Bake 4HR	30.0000 sec	$0.000
Bake and Cure	3,600.0000 sec	$0.000
Bunch Wire	0.1000 sec	$0.000
CDI	1.0000 sec	$0.000

Figure 4-5: Operations Library – Design Profit® Database



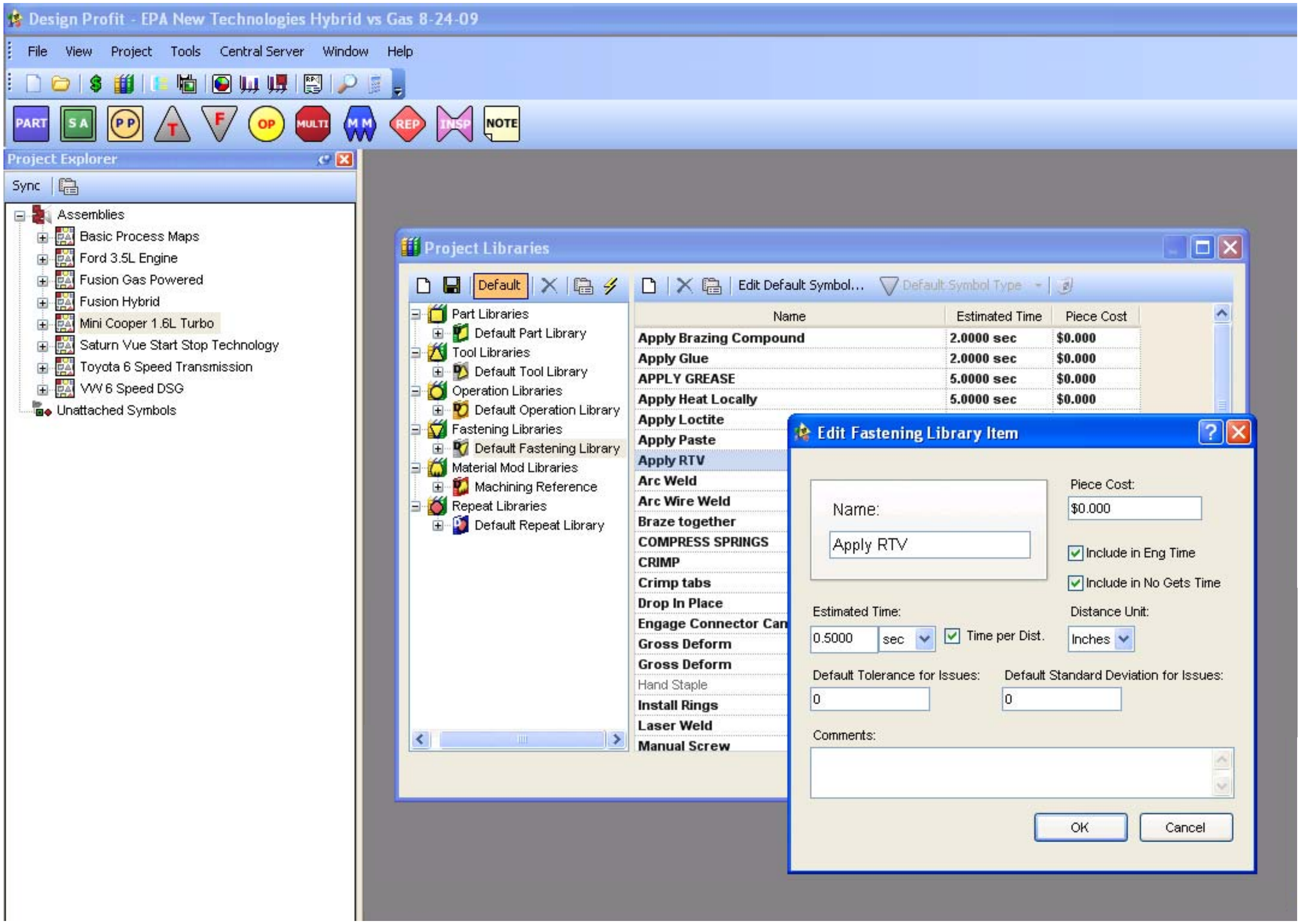
Name	Estimated Time	Piece Cost
1 ton press	5.0000 sec	$0.000
10 Spindle Nut Runner	6.0000 sec	$0.000
10 Spindle Nut Runner	6.0000 sec	$0.000
11 Spindle Nut Runner	6.0000 sec	$0.000
12 Spindle Nut Runner	6.0000 sec	$0.000
13 Spindle nut Runner	6.0000 sec	$0.000
14 Spindle Nut Runner	6.0000 sec	$0.000
16 Spindle Nut Runner	6.0000 sec	$0.000
17 Spindle Nut Runner	6.0000 sec	$0.000
18 Spindle Nut Runner	6.0000 sec	$0.000
19 Spindle Nut Runner	6.0000 sec	$0.000
2 Spindle Allen Screw Driver	6.0000 sec	$0.000
20 Spindle Nut Runner	6.0000 sec	$0.000
3 Spindle Nut Runner	6.0000 sec	$0.000
4 Spindle Nut Runner	6.0000 sec	$0.000
5 Spindle Nut Runner	6.0000 sec	$0.000
6 Spindle Nut Runner	6.0000 sec	$0.000
6 spindle nut runner - flywheel	6.0000 sec	$0.000
7 Spindle Nut Runner	6.0000 sec	$0.000
8 Spindle Nut Runner	6.0000 sec	$0.000
9 Spindle Nut Runner	6.0000 sec	$0.000

Figure 4-6: Tool Library - Design Profit® Database



Name	Estimated Time	Piece Cost
Debur/Tumble	3.0000 sec	$0.000
Drill & Chamfer Hole 100-150mm	4.0000 sec	$0.000
Drill & Chamfer Hole 1-30mm	1.0000 sec	$0.000
Drill & Chamfer Hole 30-60mm	2.0000 sec	$0.000
Drill & Chamfer Hole 60-100mm	3.0000 sec	$0.000
Drill and Tap Hole 1-30mm	5.0000 sec	$0.000
Drill and Tap Hole 30-60mm	6.0000 sec	$0.000
Drill Balancing Holes	1.0000 sec	$0.000
Drill Hole	1.0000 sec	$0.000
Drill Hole	1.0000 sec	$0.000
Drill Hole 100-150mm	4.0000 sec	$0.000
Drill Hole 1-30mm	1.0000 sec	$0.000
Drill Hole 30 - 60mm	2.0000 sec	$0.000
Drill Hole 60-100mm	3.0000 sec	$0.000
Drill Hole Medium	3.0000 sec	$0.000
Drill Hole Small	2.0000 sec	$0.000
End Mill	1.0000 sec	$0.000
End Mill Slot cut	1.0000 sec	$0.000
Flare Tube End	1.0000 sec	$0.000
Flare Tube End - Double	2.0000 sec	$0.000
Flow drill	3.0000 sec	$0.000

Figure 4-7: Material Modification Library – Design Profit® Database



Name	Estimated Time	Piece Cost
Apply Brazing Compound	2.0000 sec	$0.000
Apply Glue	2.0000 sec	$0.000
APPLY GREASE	5.0000 sec	$0.000
Apply Heat Locally	5.0000 sec	$0.000
Apply Loctite		
Apply Paste		
Apply RTV		
Arc Weld		
Arc Wire Weld		
Braze together		
COMPRESS SPRINGS		
CRIMP		
Crimp tabs		
Drop In Place		
Engage Connector Can		
Gross Deform		
Gross Deform		
Hand Staple		
Install Rings		
Laser Weld		
Manual Screw		

Name: Apply RTV

Piece Cost: $0.000

☑ Include in Eng Time

☑ Include in No Gets Time

Estimated Time: 0.5000 sec ☑ Time per Dist.

Distance Unit: Inches

Default Tolerance for Issues: 0

Default Standard Deviation for Issues: 0

Comments:

Figure 4-8: Fastening Library - Design Profit® Database

Figure 4-9 is a sample excerpt displaying the various steps associated with a vacuum pump base component and how it was mapped using the Design Profit® software. The vacuum pump is assumed to be purchased by the OEM and its' assembly to the vehicle is represented on the top line of the map (Symbols 121 thru 127). The top line is assigned a labor rate, based on OEM assembly, pulled from the labor database. The next line below the OEM is the assembly of the various parts at the supplier level and is assigned a supplier general assembly labor rate, also pulled in from the labor database (11 of 30 symbols shown). The pump base was identified as a die cast machined part based on part attributes, and was further analyzed with the third line representing the casting being machined on a CNC machine with the appropriate burden rate being selected from the burden database. The machining total time was estimated at 122 seconds based on all of its discreet features (7 of the 45 symbols shown). The last line of symbols represents the casting as its primary manufacturing method. To establish the casting cost a number of inputs are required in the cost modeling tool. In the case of the pump base the material was identified as Aluminum A380 with a raw material cost of $1.10 pulled from the material database. Additional inputs required to calculate the part cost included the following for die casting: annual volume (450,000), years of production (5), wall thickness (0.25 inches), part length (5.4 inches), part width (4.6 inches), part depth (1 inch), part projected area (24.84 square inches), part weight after machining (0.4733 pounds), number of planes with die lock features (2) and number of cavities in the tool (4). These inputs are then utilized to establish the actual material required for the casting accounting for sprue and runner lengths associated with the process; material required was estimated to be 0.542 pounds for the raw casting. The tool calculates the press size (tonnage) based on the number of parts and their total project area estimating the clamp load required to prevent die separation (~173 ton theoretical) This is then used to establish the actual equipment to determine the appropriate burden rate associated with the casting. The tool then calculates the cycle time for the machine establishing injection time (2.4 sec) cooling time (60.36 sec) resetting time (5.4 sec) and die lubricating time (10.5 sec) for a total cycle time of 78.6 seconds divided by the number of cavities resulting in 19.7 seconds per part. The cycle time is input into the Design Profit® symbols actual time cell and all others are zeroed out.

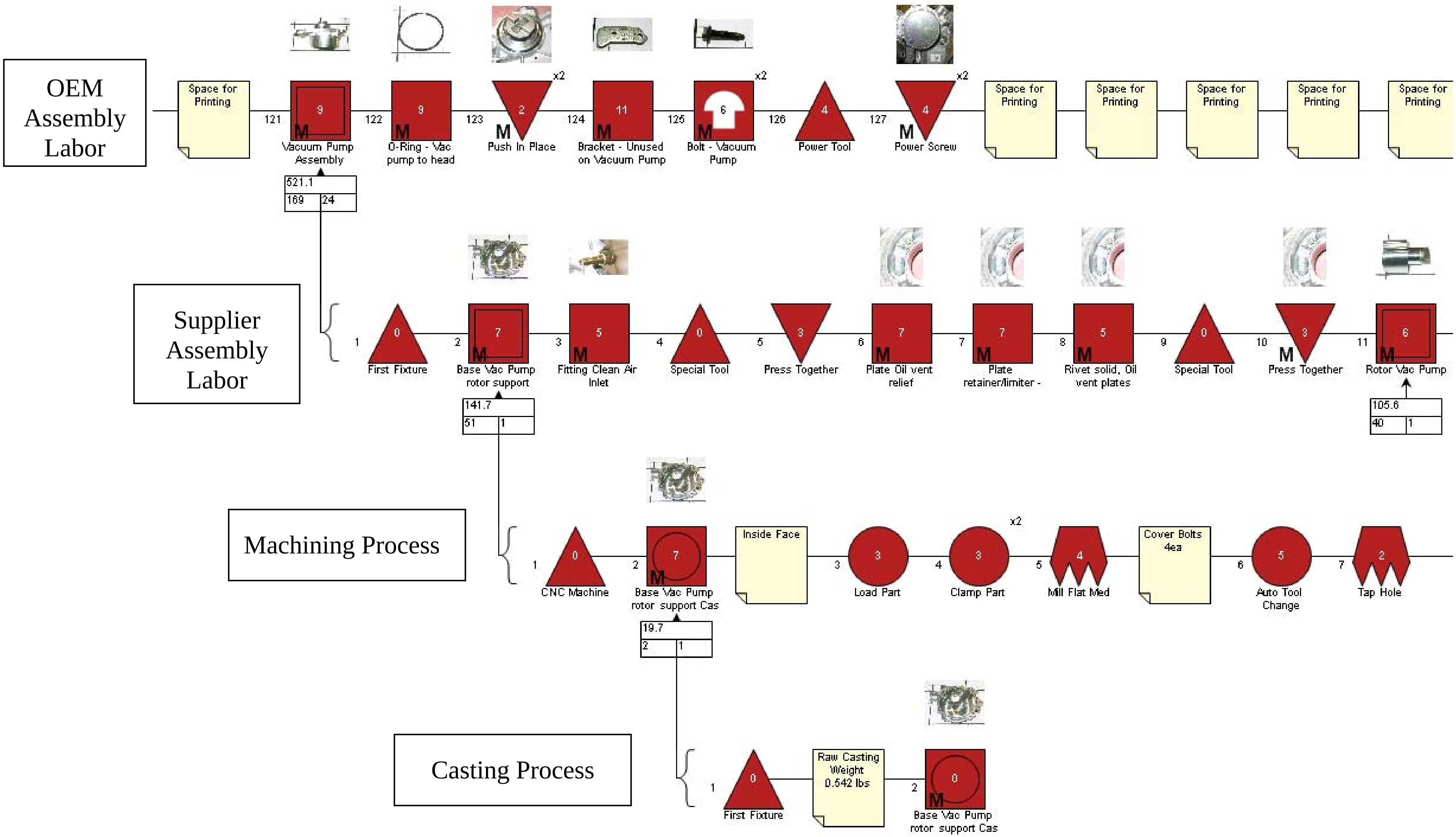


Figure 4-9: Example Illustrating the Various Levels Associated with Process Mapping a Vacuum Pump Base Support

5 Cost Model Overview

The cost parameters considered in determining the net incremental component/assembly impact to the OEM for new technologies are discussed in detail below.

Unit Cost is the sum of total manufacturing cost (TMC), mark-up costs and packaging cost associated with producing a component/assembly. It is the net component/assembly cost impact to the OEM (generally, the automobile manufacturer). Figure 5-1 shows all the factors contributing to unit cost for supplier manufactured components. Additional details on the subcategories are discussed in the sections that follow.

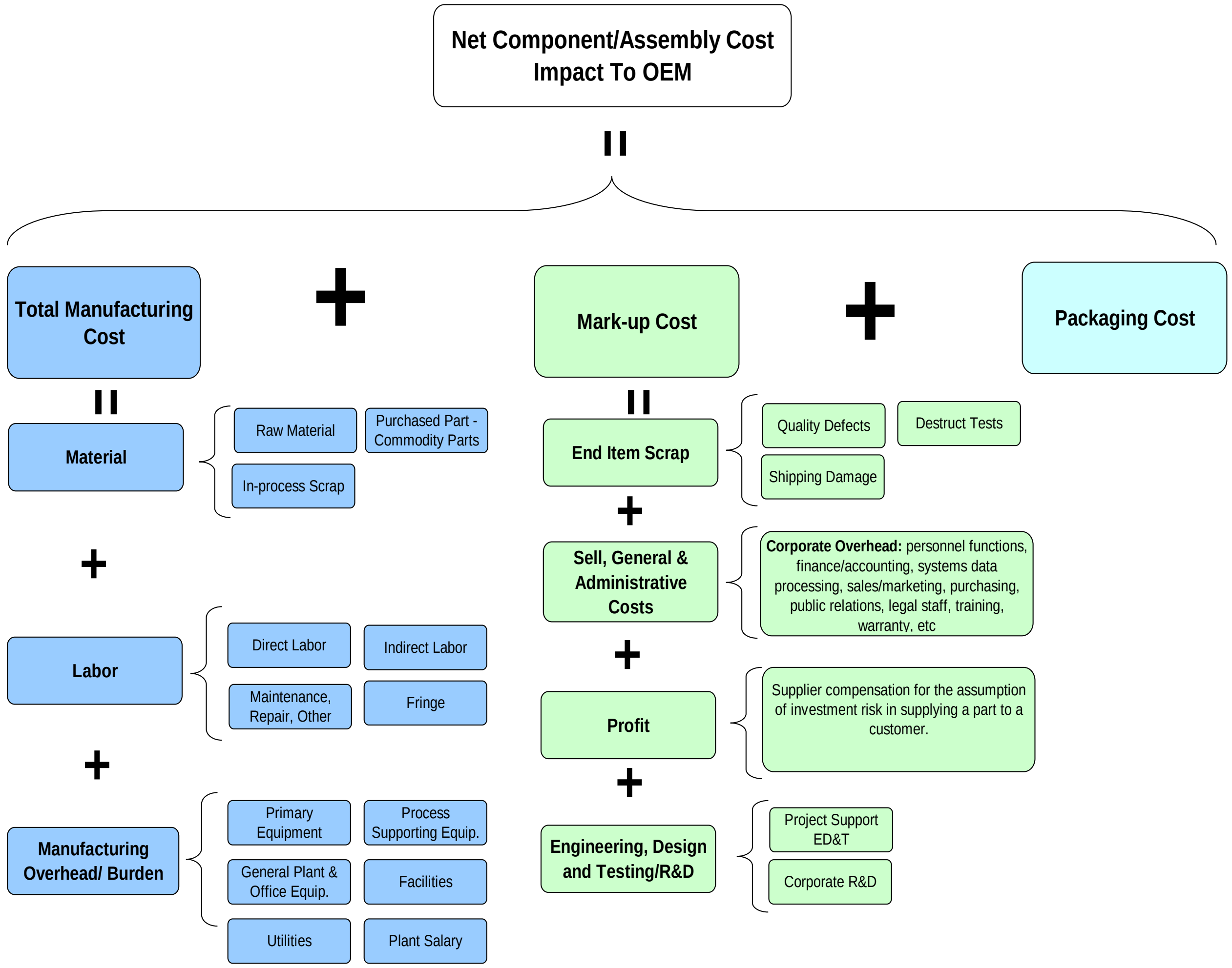


Figure 5-1: Unit Cost Model – Costing Factors Included in Analysis

For OEM manufactured components/assemblies, the unit cost is calculated in the same way, except that mark-up is addressed outside the scope of this study through application of indirect cost (IC) multipliers. The IC multiplier assigned is based on the technology complexity level and timeframe in the market place; see Section 6 for additional details.

The full report, "Automobile Industry Retail Price Equivalent and Indirect Cost Multipliers" EPA report EPA-420-R-09-003, February 2009, can be downloaded from http://www.epa.gov/OMSWWW/ld-hwy/420r09003.pdf.

Shipping Costs are those required to transport a component between dispersed manufacturing and assembly locations, including any applicable insurance, tax, or surcharge expenses. Shipping costs between T2/T3 and T1 suppliers are captured as part of the mark-up rate except where special handling measures are involved. For T1 supplier to OEM facilities, the shipping costs are captured using the IC multiplier that replaces mark-up as discussed above. Additional details on shipping costs are discussed in Section 8.

Tooling Costs are the dedicated tool, gauge and fixture costs required to manufacture a part. Examples of items covered by tooling costs are: injection molds, casting molds, stamping dies, weld fixtures, assembly fixtures, dedicated assembly and/or machining pallets, and dedicated gauging. For this analysis, all tooling is assumed to be owned by the OEM and the differential cost impact is accounted for through the application of an IC multiplier.

Investment Costs are the manufacturing facility costs, not covered as tooling, required to manufacture parts. Investment costs include manufacturing plants, manufacturing equipment (e.g. injection mold machines, die cast machines, machining and turning machines, welding equipment, assembly lines), material handling equipment (e.g. lift forks, overhead cranes, loading dock lifts, conveyor systems), paint lines, plating lines, and heat treat equipment. Investment costs are covered by manufacturing overhead rates and thus are not summed up separately in the cost analysis. Additional details on how investments expenses are accounted for through manufacturing overhead can be found in Section 7.4.

Product Development Costs are the ED&T costs incurred for development of a component or system. These costs can be associated with a vehicle specific application and/or be part of the normal research and development (R&D) performed by companies to remain competitive. In the cost analysis, the product development costs for suppliers are included in the mark-up rate as ED&T. More details are provided in Section 7.5. For the OEM, the product development costs are captured in the IC multipliers that replace mark-up, as discussed in the unit cost section above.

In summary, the two (2) main cost elements (TMC and Mark-up), in the supplier unit cost model defined in Figure 5-1 includes considerations for shipping, investment and product development costs. For the OEM, investment costs are accounted for in the OEM Unit cost model via the TMC. Shipping, tooling and product development costs are accounted for as part of the IC multiplier addressed outside the scope of this study.

Lastly, the “Net Incremental Component /Assembly Cost Impact to OEM” is defined as the summation of the supplier and OEM unit costs, for all the identified component and assembly differences, between the new and base technology configurations.

A more detailed discussion on the elements which make-up the unit cost model follows.

6 Indirect OEM Costs

In addition to the direct manufacturing costs, a manufacturer also incurs certain indirect costs. These costs may be related to production, such as research and development (R&D); tooling; corporate operations, such as salaries, pensions, and health care costs for corporate staff; or selling, such as transportation, dealer support, and marketing. Indirect costs incurred by a supplier of a component or vehicle system constitute a direct manufacturing cost to the OEM (the original equipment (vehicle) manufacturer), and thus are included in this study. The OEM's indirect costs, however, are not included and must be determined and applied separately to obtain total manufacturing costs. These indirect costs are beyond the scope of this study and are applied separately by EPA staff in their analysis. A brief discussion of this follows.

In February 2009, EPA issued a report, "Automobile Industry Retail Price Equivalent and Indirect Cost Multipliers," written by Alex Rogozhin and Michael Gallaher of RTI International and Walter McManus of the University of Michigan Transportation Research Institute. The discussion in this section is taken from that report.

The RPE/IC report provides a new calculation of the retail price equivalent (RPE) multiplier commonly used to estimate the indirect costs associated with a new technology. The RPE is a ratio of total revenue to direct manufacturing cost; put another way, it is the ratio of indirect costs plus profit to direct manufacturing costs. It is an average over all the activities of a manufacturer. However, a problem in using RPE multipliers in regulatory analysis is that some of the indirect cost components of the RPE multiplier, such as fixed depreciation costs, health care costs for retired workers, or pensions, may not be affected by all vehicle modifications resulting from regulation. In addition, RPEs assume that market prices will increase by the full cost plus constant profit of the new technology; in fact, other factors that influence price (especially consumer demand and preferences) will affect how much of those costs will be passed along into market price.

The RPE/IC report develops a modified multiplier, referred to as an IC multiplier, which specifically evaluates the components of indirect costs that are likely to be affected by vehicle modifications associated with environmental regulation. A range of IC multipliers are developed that 1) account for differences in the technical complexity of required vehicle modifications and 2) adjust over time as new technologies become assimilated into the automotive supply chain.

ICMs are calculated in the RPE/IC report to range from 1.05 to 1.45 in the short run and from 1.02 to 1.26 in the long run. The differences between the short- and long-run IC multipliers are primarily due to R&D and warranty costs, which are projected to decrease over time. R&D expenditures also vary greatly over the level of technology complexity, as does the need for dealer support. To use the multipliers in the RPE/IC *report, analysts can start by assessing the degree of complexity of the new technology under consideration. That identification process will lead to the short-run and long-run multipliers for the new technology. If an analyst has additional information about the role of indirect cost contributors for the new technology, that information can be used to develop project-specific adjustment factor.*

7 Costing Databases

7.1 Database Overview

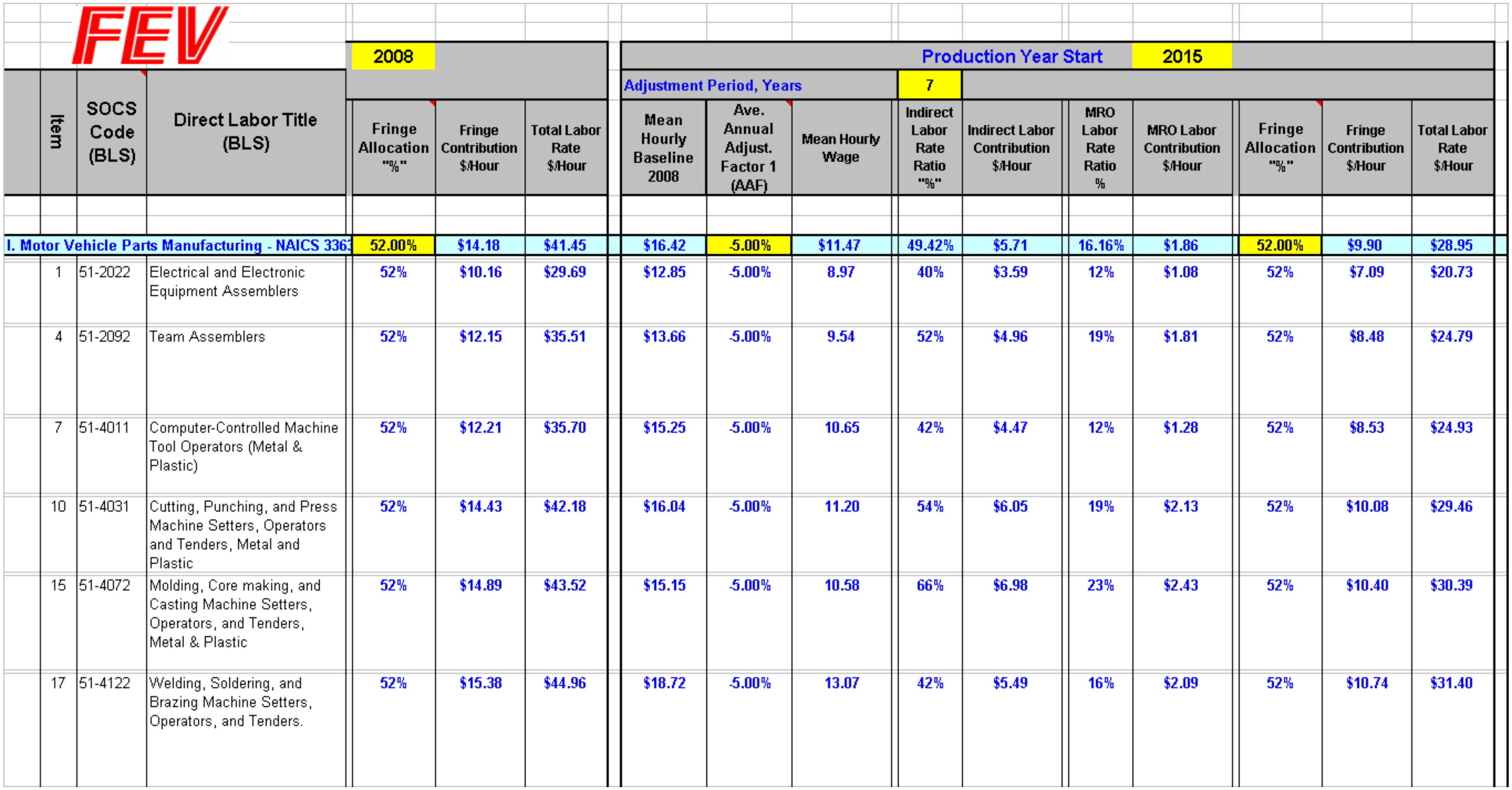
The Unit Cost Model shown in Figure 5-1 illustrates the three (3) main cost element categories, along with all the core subcategories, which make up the unit costs for all components and assemblies in the analysis.

Every cost element used throughout the analysis is extracted from one of the core databases. There are databases for material prices ($/pound), labor rates ($/hour), manufacturing overhead rates ($/hour), mark-up rates (% of TMC) and packaging ($/packaging option). The databases provide the foundation of the cost analysis, since all costs originate from them, and they are also used to document sources and supporting information for the cost numbers. Excerpts from all five (5) databases may be found in Appendix E.1-E.6.

The model allows for updates to the cost elements which automatically roll into the individual component/assembly cost models. Since all cost sheets and parameters are directly linked to the databases, changing the "Active Rate" cost elements in the applicable database automatically updates the Manufacturing Assumption Quote Summary (MAQS) worksheets. Thus if a material doubles in price, one can easily assess the impact on the technology configurations under study.

The model also includes a forecasting feature associated with each database to project changes from the baseline cost data. For each database there is a baseline data set based on 2008 figures, and two (2) additional "projected cost" data sets which reference back to this baseline dataset. The projected cost data sets can be specified either manually or by using the Annual Adjustment Factor (AAF) feature. The AAF feature is basically a depreciation/interest calculator where the user defines a period, and a percent rate of growth or decline relative to the baseline. To illustrate the AFF feature, an ***exaggerated*** gross decline of 5% per year, from 2008 through to 2015, was entered into the labor database to create a mock 2015 forecasted data set (see Figure 7-1). Changing the active rate value in the database from 2008 to 2015 loads the new dataset; all cost sheets are automatically updated with the 2015 labor projections.

Additional details are provided for each database in the following sections.



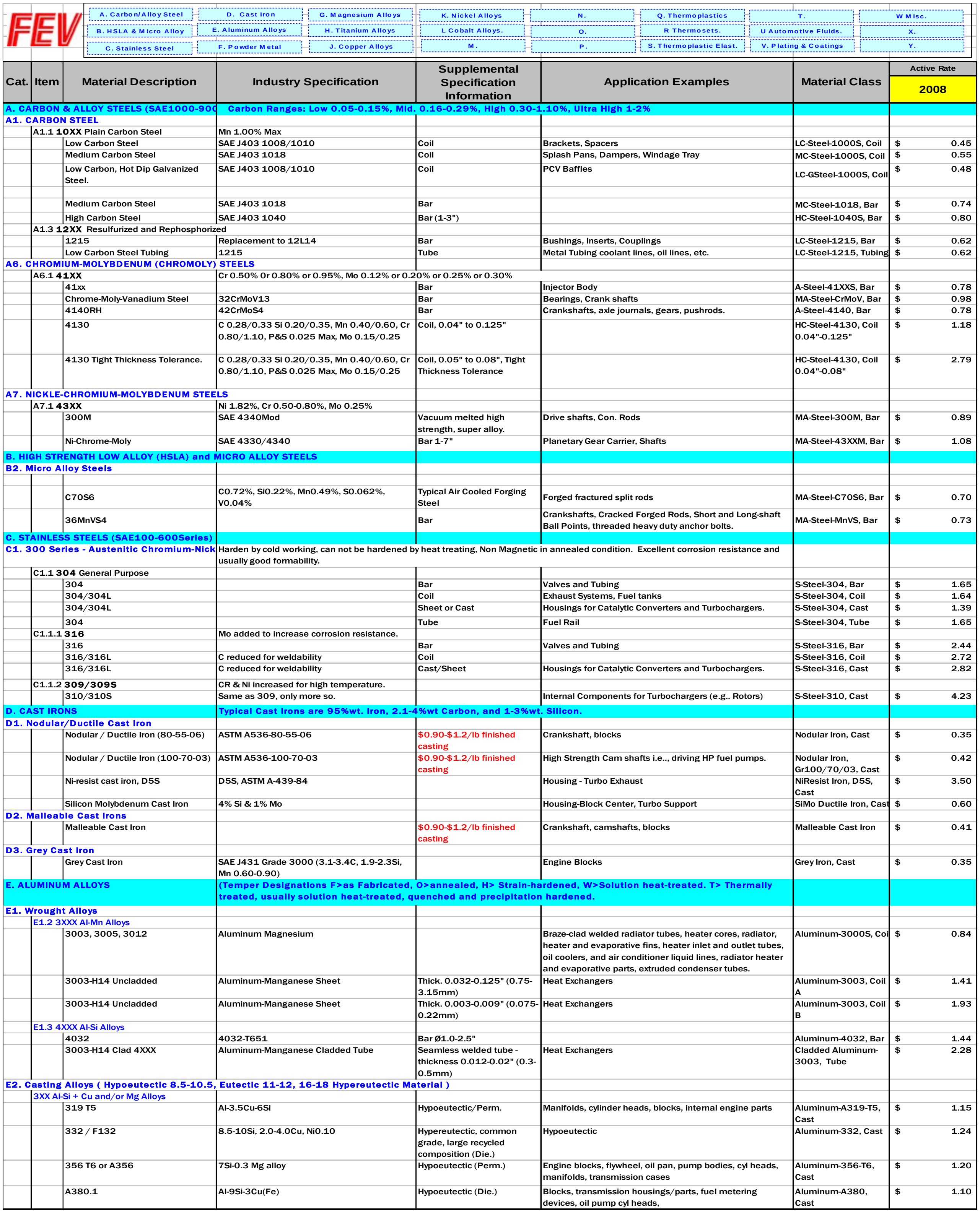
			2008							Production Year Start		2015			
						Adjustment Period, Years			7						
Item	SOCS Code (BLS)	Direct Labor Title (BLS)	Fringe Allocation "%"	Fringe Contribution $/Hour	Total Labor Rate $/Hour	Mean Hourly Baseline 2008	Ave. Annual Adjust. Factor 1 (AAF)	Mean Hourly Wage	Indirect Labor Rate Ratio "%"	Indirect Labor Contribution $/Hour	MRO Labor Rate Ratio %	MRO Labor Contribution $/Hour	Fringe Allocation "%"	Fringe Contribution $/Hour	Total Labor Rate $/Hour
I. Motor Vehicle Parts Manufacturing - NAICS 3363			52.00%	$14.18	$41.45	$16.42	-5.00%	$11.47	49.42%	$5.71	16.16%	$1.86	52.00%	$9.90	$28.95
1	51-2022	Electrical and Electronic Equipment Assemblers	52%	$10.16	$29.69	$12.85	-5.00%	8.97	40%	$3.59	12%	$1.08	52%	$7.09	$20.73
4	51-2092	Team Assemblers	52%	$12.15	$35.51	$13.66	-5.00%	9.54	52%	$4.96	19%	$1.81	52%	$8.48	$24.79
7	51-4011	Computer-Controlled Machine Tool Operators (Metal & Plastic)	52%	$12.21	$35.70	$15.25	-5.00%	10.65	42%	$4.47	12%	$1.28	52%	$8.53	$24.93
10	51-4031	Cutting, Punching, and Press Machine Setters, Operators and Tenders, Metal and Plastic	52%	$14.43	$42.18	$16.04	-5.00%	11.20	54%	$6.05	19%	$2.13	52%	$10.08	$29.46
15	51-4072	Molding, Core making, and Casting Machine Setters, Operators, and Tenders, Metal & Plastic	52%	$14.89	$43.52	$15.15	-5.00%	10.58	66%	$6.98	23%	$2.43	52%	$10.40	$30.39
17	51-4122	Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders.	52%	$15.38	$44.96	$18.72	-5.00%	13.07	42%	$5.49	16%	$2.09	52%	$10.74	$31.40

Figure 7-1: Illustrates the change in Labor Rates between 2008 and 2015, Assuming a Negative 5% Annual Adjustment Factor (AFF)

7.2 Material Database

7.2.1 Overview

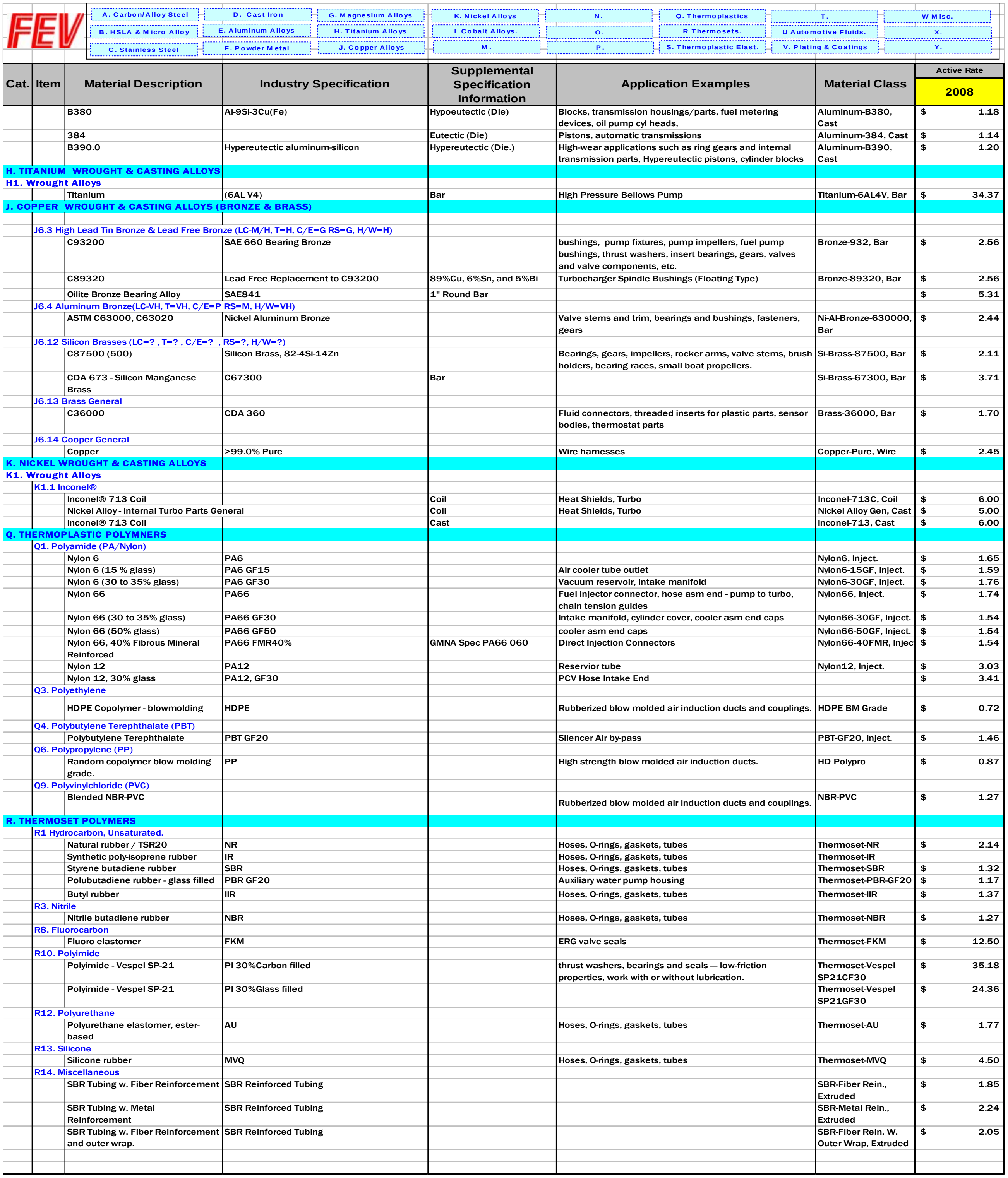
The Material Database houses specific material prices and related material information required for component cost estimating analysis. The information related to each material listed includes the material name, standard industry identification (e.g. AISI or SAE nomenclature), typical automotive applications, pricing per pound, annual consumption rates, and source references. The prices recorded in the database are in US dollars per pound. The database provides for input of forecasted future year prices; a discussion of the forecasting methodology follows. Figure 7-2 and Figure 7-3 provide the price data for significant materials identified in the cost study analysis.



A. Carbon/Alloy Steel	D. Cast Iron	G. Magnesium Alloys	K. Nickel Alloys	N.	Q. Thermoplastics	T.	W Misc.
B. HSLA & Micro Alloy	E. Aluminum Alloys	H. Titanium Alloys	L Cobalt Alloys.	O.	R Thermosets.	U Automotive Fluids.	X.
C. Stainless Steel	F. Powder Metal	J. Copper Alloys	M.	P.	S. Thermoplastic Elast.	V. Plating & Coatings	Y.

Cat.	Item	Material Description	Industry Specification	Supplemental Specification Information	Application Examples	Material Class	Active Rate
							2008
A. CARBON & ALLOY STEELS (SAE1000-900			Carbon Ranges: Low 0.05-0.15%, Mid. 0.16-0.29%, High 0.30-1.10%, Ultra High 1-2%				
A1. CARBON STEEL							
	A1.1 **10XX** Plain Carbon Steel		Mn 1.00% Max				
		Low Carbon Steel	SAE J403 1008/1010	Coil	Brackets, Spacers	LC-Steel-1000S, Coil	$ 0.45
		Medium Carbon Steel	SAE J403 1018	Coil	Splash Pans, Dampers, Windage Tray	MC-Steel-1000S, Coil	$ 0.55
		Low Carbon, Hot Dip Galvanized Steel.	SAE J403 1008/1010	Coil	PCV Baffles	LC-GSteel-1000S, Coil	$ 0.48
		Medium Carbon Steel	SAE J403 1018	Bar		MC-Steel-1018, Bar	$ 0.74
		High Carbon Steel	SAE J403 1040	Bar (1-3")		HC-Steel-1040S, Bar	$ 0.80
	A1.3 **12XX** Resulfurized and Rephosphorized						
		1215	Replacement to 12L14	Bar	Bushings, Inserts, Couplings	LC-Steel-1215, Bar	$ 0.62
		Low Carbon Steel Tubing	1215	Tube	Metal Tubing coolant lines, oil lines, etc.	LC-Steel-1215, Tubing	$ 0.62
A6. CHROMIUM-MOLYBDENUM (CHROMOLY) STEELS							
	A6.1 **41XX**		Cr 0.50% Or 0.80% or 0.95%, Mo 0.12% or 0.20% or 0.25% or 0.30%				
		41xx		Bar	Injector Body	A-Steel-41XXS, Bar	$ 0.78
		Chrome-Moly-Vanadium Steel	32CrMoV13	Bar	Bearings, Crank shafts	MA-Steel-CrMoV, Bar	$ 0.98
		4140RH	42CrMoS4	Bar	Crankshafts, axle journals, gears, pushrods.	A-Steel-4140, Bar	$ 0.78
		4130	C 0.28/0.33 Si 0.20/0.35, Mn 0.40/0.60, Cr 0.80/1.10, P&S 0.025 Max, Mo 0.15/0.25	Coil, 0.04" to 0.125"		HC-Steel-4130, Coil 0.04"-0.125"	$ 1.18
		4130 Tight Thickness Tolerance.	C 0.28/0.33 Si 0.20/0.35, Mn 0.40/0.60, Cr 0.80/1.10, P&S 0.025 Max, Mo 0.15/0.25	Coil, 0.05" to 0.08", Tight Thickness Tolerance		HC-Steel-4130, Coil 0.04"-0.08"	$ 2.79
A7. NICKLE-CHROMIUM-MOLYBDENUM STEELS							
	A7.1 **43XX**		Ni 1.82%, Cr 0.50-0.80%, Mo 0.25%				
		300M	SAE 4340Mod	Vacuum melted high strength, super alloy.	Drive shafts, Con. Rods	MA-Steel-300M, Bar	$ 0.89
		Ni-Chrome-Moly	SAE 4330/4340	Bar 1-7"	Planetary Gear Carrier, Shafts	MA-Steel-43XXM, Bar	$ 1.08
B. HIGH STRENGTH LOW ALLOY (HSLA) and MICRO ALLOY STEELS							
B2. Micro Alloy Steels							
		C70S6	C0.72%, Si0.22%, Mn0.49%, S0.062%, V0.04%	Typical Air Cooled Forging Steel	Forged fractured split rods	MA-Steel-C70S6, Bar	$ 0.70
		36MnVS4		Bar	Crankshafts, Cracked Forged Rods, Short and Long-shaft Ball Points, threaded heavy duty anchor bolts.	MA-Steel-MnVS, Bar	$ 0.73
C. STAINLESS STEELS (SAE100-600Series)							
C1. 300 Series - Austenitic Chromium-Nick			Harden by cold working, can not be hardened by heat treating, Non Magnetic in annealed condition. Excellent corrosion resistance and usually good formability.				
	C1.1 **304** General Purpose						
		304		Bar	Valves and Tubing	S-Steel-304, Bar	$ 1.65
		304/304L		Coil	Exhaust Systems, Fuel tanks	S-Steel-304, Coil	$ 1.64
		304/304L		Sheet or Cast	Housings for Catalytic Converters and Turbochargers.	S-Steel-304, Cast	$ 1.39
		304		Tube	Fuel Rail	S-Steel-304, Tube	$ 1.65
	C1.1.1 **316**		Mo added to increase corrosion resistance.				
		316		Bar	Valves and Tubing	S-Steel-316, Bar	$ 2.44
		316/316L	C reduced for weldability	Coil		S-Steel-316, Coil	$ 2.72
		316/316L	C reduced for weldability	Cast/Sheet	Housings for Catalytic Converters and Turbochargers.	S-Steel-316, Cast	$ 2.82
	C1.1.2 **309/309S**		CR & Ni increased for high temperature.				
		310/310S	Same as 309, only more so.		Internal Components for Turbochargers (e.g.. Rotors)	S-Steel-310, Cast	$ 4.23
D. CAST IRONS			Typical Cast Irons are 95%wt. Iron, 2.1-4%wt Carbon, and 1-3%wt. Silicon.				
D1. Nodular/Ductile Cast Iron							
		Nodular / Ductile Iron (80-55-06)	ASTM A536-80-55-06	$0.90-$1.2/lb finished casting	Crankshaft, blocks	Nodular Iron, Cast	$ 0.35
		Nodular / Ductile Iron (100-70-03)	ASTM A536-100-70-03	$0.90-$1.2/lb finished casting	High Strength Cam shafts i.e.., driving HP fuel pumps.	Nodular Iron, Gr100/70/03, Cast	$ 0.42
		Ni-resist cast iron, D5S	D5S, ASTM A-439-84		Housing - Turbo Exhaust	NiResist Iron, D5S, Cast	$ 3.50
		Silicon Molybdenum Cast Iron	4% Si & 1% Mo		Housing-Block Center, Turbo Support	SiMo Ductile Iron, Cast	$ 0.60
D2. Malleable Cast Irons							
		Malleable Cast Iron		$0.90-$1.2/lb finished casting	Crankshaft, camshafts, blocks	Malleable Cast Iron	$ 0.41
D3. Grey Cast Iron							
		Grey Cast Iron	SAE J431 Grade 3000 (3.1-3.4C, 1.9-2.3Si, Mn 0.60-0.90)		Engine Blocks	Grey Iron, Cast	$ 0.35
E. ALUMINUM ALLOYS			(Temper Designations F>as Fabricated, O>annealed, H> Strain-hardened, W>Solution heat-treated. T> Thermally treated, usually solution heat-treated, quenched and precipitation hardened.				
E1. Wrought Alloys							
	E1.2 3XXX Al-Mn Alloys						
		3003, 3005, 3012	Aluminum Magnesium		Braze-clad welded radiator tubes, heater cores, radiator, heater and evaporative fins, heater inlet and outlet tubes, oil coolers, and air conditioner liquid lines, radiator heater and evaporative parts, extruded condenser tubes.	Aluminum-3000S, Coi	$ 0.84
		3003-H14 Uncladded	Aluminum-Manganese Sheet	Thick. 0.032-0.125" (0.75-3.15mm)	Heat Exchangers	Aluminum-3003, Coil A	$ 1.41
		3003-H14 Uncladded	Aluminum-Manganese Sheet	Thick. 0.003-0.009" (0.075-0.22mm)	Heat Exchangers	Aluminum-3003, Coil B	$ 1.93
	E1.3 4XXX Al-Si Alloys						
		4032	4032-T651	Bar Ø1.0-2.5"		Aluminum-4032, Bar	$ 1.44
		3003-H14 Clad 4XXX	Aluminum-Manganese Cladded Tube	Seamless welded tube - thickness 0.012-0.02" (0.3-0.5mm)	Heat Exchangers	Cladded Aluminum-3003, Tube	$ 2.28
E2. Casting Alloys (Hypoeutectic 8.5-10.5, Eutectic 11-12, 16-18 Hypereutectic Material)							
	3XX Al-Si + Cu and/or Mg Alloys						
		319 T5	Al-3.5Cu-6Si	Hypoeutectic/Perm.	Manifolds, cylinder heads, blocks, internal engine parts	Aluminum-A319-T5, Cast	$ 1.15
		332 / F132	8.5-10Si, 2.0-4.0Cu, Ni0.10	Hypereutectic, common grade, large recycled composition (Die.)	Hypoeutectic	Aluminum-332, Cast	$ 1.24
		356 T6 or A356	7Si-0.3 Mg alloy	Hypoeutectic (Perm.)	Engine blocks, flywheel, oil pan, pump bodies, cyl heads, manifolds, transmission cases	Aluminum-356-T6, Cast	$ 1.20
		A380.1	Al-9Si-3Cu(Fe)	Hypoeutectic (Die.)	Blocks, transmission housings/parts, fuel metering devices, oil pump cyl heads,	Aluminum-A380, Cast	$ 1.10

Figure 7-2: Price Data for Significant Materials Identified in Case Study #0101 (Materials Database Excerpt #2A)



A. Carbon/Alloy Steel	D. Cast Iron	G. Magnesium Alloys	K. Nickel Alloys	N.	Q. Thermoplastics	T.	W Misc.
B. HSLA & Micro Alloy	E. Aluminum Alloys	H. Titanium Alloys	L Cobalt Alloys.	O.	R Thermosets.	U Automotive Fluids.	X.
C. Stainless Steel	F. Powder Metal	J. Copper Alloys	M.	P.	S. Thermoplastic Elast.	V. Plating & Coatings	Y.

Cat.	Item	Material Description	Industry Specification	Supplemental Specification Information	Application Examples	Material Class	Active Rate
							2008
		B380	Al-9Si-3Cu(Fe)	Hypoeutectic (Die)	Blocks, transmission housings/parts, fuel metering devices, oil pump cyl heads,	Aluminum-B380, Cast	$ 1.18
		384		Eutectic (Die)	Pistons, automatic transmissions	Aluminum-384, Cast	$ 1.14
		B390.0	Hypereutectic aluminum-silicon	Hypereutectic (Die.)	High-wear applications such as ring gears and internal transmission parts, Hypereutectic pistons, cylinder blocks	Aluminum-B390, Cast	$ 1.20
H. TITANIUM WROUGHT & CASTING ALLOYS							
H1. Wrought Alloys							
		Titanium	(6AL V4)	Bar	High Pressure Bellows Pump	Titanium-6AL4V, Bar	$ 34.37
J. COPPER WROUGHT & CASTING ALLOYS (BRONZE & BRASS)							
	J6.3 High Lead Tin Bronze & Lead Free Bronze (LC-M/H, T=H, C/E=G RS=G, H/W=H)						
		C93200	SAE 660 Bearing Bronze		bushings, pump fixtures, pump impellers, fuel pump bushings, thrust washers, insert bearings, gears, valves and valve components, etc.	Bronze-932, Bar	$ 2.56
		C89320	Lead Free Replacement to C93200	89%Cu, 6%Sn, and 5%Bi	Turbocharger Spindle Bushings (Floating Type)	Bronze-89320, Bar	$ 2.56
		Oilite Bronze Bearing Alloy	SAE841	1" Round Bar			$ 5.31
	J6.4 Aluminum Bronze(LC-VH, T=VH, C/E=P RS=M, H/W=VH)						
		ASTM C63000, C63020	Nickel Aluminum Bronze		Valve stems and trim, bearings and bushings, fasteners, gears	Ni-Al-Bronze-630000, Bar	$ 2.44
	J6.12 Silicon Brasses (LC=? , T=? , C/E=? , RS=?, H/W=?)						
		C87500 (500)	Silicon Brass, 82-4Si-14Zn		Bearings, gears, impellers, rocker arms, valve stems, brush holders, bearing races, small boat propellers.	Si-Brass-87500, Bar	$ 2.11
		CDA 673 - Silicon Manganese Brass	C67300	Bar		Si-Brass-67300, Bar	$ 3.71
	J6.13 Brass General						
		C36000	CDA 360		Fluid connectors, threaded inserts for plastic parts, sensor bodies, thermostat parts	Brass-36000, Bar	$ 1.70
	J6.14 Cooper General						
		Copper	>99.0% Pure		Wire harnesses	Copper-Pure, Wire	$ 2.45
K. NICKEL WROUGHT & CASTING ALLOYS							
K1. Wrought Alloys							
	K1.1 Inconel®						
		Inconel® 713 Coil		Coil	Heat Shields, Turbo	Inconel-713C, Coil	$ 6.00
		Nickel Alloy - Internal Turbo Parts General		Coil	Heat Shields, Turbo	Nickel Alloy Gen, Cast	$ 5.00
		Inconel® 713 Coil		Cast		Inconel-713, Cast	$ 6.00
Q. THERMOPLASTIC POLYMNERS							
	Q1. Polyamide (PA/Nylon)						
		Nylon 6	PA6			Nylon6, Inject.	$ 1.65
		Nylon 6 (15 % glass)	PA6 GF15		Air cooler tube outlet	Nylon6-15GF, Inject.	$ 1.59
		Nylon 6 (30 to 35% glass)	PA6 GF30		Vacuum reservoir, Intake manifold	Nylon6-30GF, Inject.	$ 1.76
		Nylon 66	PA66		Fuel injector connector, hose asm end - pump to turbo, chain tension guides	Nylon66, Inject.	$ 1.74
		Nylon 66 (30 to 35% glass)	PA66 GF30		Intake manifold, cylinder cover, cooler asm end caps	Nylon66-30GF, Inject.	$ 1.54
		Nylon 66 (50% glass)	PA66 GF50		cooler asm end caps	Nylon66-50GF, Inject.	$ 1.54
		Nylon 66, 40% Fibrous Mineral Reinforced	PA66 FMR40%	GMNA Spec PA66 060	Direct Injection Connectors	Nylon66-40FMR, Injec	$ 1.54
		Nylon 12	PA12		Reservior tube	Nylon12, Inject.	$ 3.03
		Nylon 12, 30% glass	PA12, GF30		PCV Hose Intake End		$ 3.41
	Q3. Polyethylene						
		HDPE Copolymer - blowmolding	HDPE		Rubberized blow molded air induction ducts and couplings.	HDPE BM Grade	$ 0.72
	Q4. Polybutylene Terephthalate (PBT)						
		Polybutylene Terephthalate	PBT GF20		Silencer Air by-pass	PBT-GF20, Inject.	$ 1.46
	Q6. Polypropylene (PP)						
		Random copolymer blow molding grade.	PP		High strength blow molded air induction ducts.	HD Polypro	$ 0.87
	Q9. Polyvinylchloride (PVC)						
		Blended NBR-PVC			Rubberized blow molded air induction ducts and couplings.	NBR-PVC	$ 1.27
R. THERMOSET POLYMERS							
	R1 Hydrocarbon, Unsaturated.						
		Natural rubber / TSR20	NR		Hoses, O-rings, gaskets, tubes	Thermoset-NR	$ 2.14
		Synthetic poly-isoprene rubber	IR		Hoses, O-rings, gaskets, tubes	Thermoset-IR	
		Styrene butadiene rubber	SBR		Hoses, O-rings, gaskets, tubes	Thermoset-SBR	$ 1.32
		Polubutadiene rubber - glass filled	PBR GF20		Auxiliary water pump housing	Thermoset-PBR-GF20	$ 1.17
		Butyl rubber	IIR		Hoses, O-rings, gaskets, tubes	Thermoset-IIR	$ 1.37
	R3. Nitrile						
		Nitrile butadiene rubber	NBR		Hoses, O-rings, gaskets, tubes	Thermoset-NBR	$ 1.27
	R8. Fluorocarbon						
		Fluoro elastomer	FKM		ERG valve seals	Thermoset-FKM	$ 12.50
	R10. Polyimide						
		Polyimide - Vespel SP-21	PI 30%Carbon filled		thrust washers, bearings and seals — low-friction properties, work with or without lubrication.	Thermoset-Vespel SP21CF30	$ 35.18
		Polyimide - Vespel SP-21	PI 30%Glass filled			Thermoset-Vespel SP21GF30	$ 24.36
	R12. Polyurethane						
		Polyurethane elastomer, ester-based	AU		Hoses, O-rings, gaskets, tubes	Thermoset-AU	$ 1.77
	R13. Silicone						
		Silicone rubber	MVQ		Hoses, O-rings, gaskets, tubes	Thermoset-MVQ	$ 4.50
	R14. Miscellaneous						
		SBR Tubing w. Fiber Reinforcement	SBR Reinforced Tubing			SBR-Fiber Rein., Extruded	$ 1.85
		SBR Tubing w. Metal Reinforcement	SBR Reinforced Tubing			SBR-Metal Rein., Extruded	$ 2.24
		SBR Tubing w. Fiber Reinforcement and outer wrap.	SBR Reinforced Tubing			SBR-Fiber Rein. W. Outer Wrap, Extruded	$ 2.05

Figure 7-3: Price Data for Significant Materials Identified in Case Study #0101 (Materials Database Excerpt #2B)

The applications identified for a material also help determine the annual consumption rate which impacts whether high or low volume prices are used. The annual consumption rate assigned to a particular material is determined by its weight, usage and uniqueness. For example, a single polypropylene cover on an engine assembly represents a very minor usage and weight contribution to the engine. Polypropylene, however, is a common high usage resin. Therefore, despite its limited use in this application a high annual consumption rate pricing is applied. This resin is readily available, and the part can be obtained from any number of competitive molding companies that regularly manufacture these types of components. A Viton® fluoroelastomer engine seal, on the other hand, is specified as a low annual consumption rate material. This component also represents a very minor usage and weight contribution to the engine, but, in addition, this resin is a specialty material. It is known for its excellent heat and chemical resistance, and is used sparingly for certain engine end-use applications. For case study #0101, only material pricing corresponding to high annual volume consumption was considered.

7.2.2 Material Selection Process

The materials listed in the database are resins and ferrous and non-ferrous alloys used in the products and components selected for cost analysis. The materials identification process is based on visual part markings, part appearance and part application. Material markings are the most obvious method of material identification. Resin components typically have material markings (for example, >PA66 30GF<) which are easily identified, recorded in the database and researched to establish price trends.

For components which are not marked, such as pistons and crankshafts, the FEV and Munro cross functional team members are consulted to help in the materials identification. For any materials still not identified, information published in print and on the web is researched, or primary manufacturers and experts within the Tier 1 supplier community are contacted to establish credible material choices.

The specific application and the part appearance play a role in materials identification. Steels commonly referred to as work-hardenable steels with high manganese content (13% Mn) are readily made in a casting and are not forgeable. Therefore establishing whether a component is forged or cast can narrow the materials identification process. Observing visual cues on components can be very informative. Complex part geometry alone can rule out the possibility of forgings; however more subtle differences must be considered. For example, forged components typically have a smoother appearance to the grain whereas cast components have a rougher finish, especially in the areas where machining is absent. Castings also usually display evidence of casting flash.

The component application environment will also help determine material choice. There are, for example, several conventional ductile cast iron applications found in base gasoline engines that are moving to Ductile High Silicon - Molybdenum or Ductile Ni-

Resist cast irons in downsized turbocharged engines. This is due to high temperature, thermal cycling, and corrosion resistance demands associated with elevated exhaust gas temperatures in turbocharged engines. Therefore understanding the part application and use environment can greatly assist in more accurate material determinations.

7.2.3 Pricing Sources and Considerations

The pricing data housed in the database is derived from various sources of publicly available data from which historical trend data can be derived. The objective is to find historical pricing data over as many years as possible to obtain the most accurate trend response. Ferrous and non-ferrous alloy pricing involves internet searches of several sources, including the U.S. Geological Survey (USGS), MEPS (previously Management Engineering & Production Services), Metalprices, estainlesssteel and Longbow. Figure 7-4 is a snap shot of historical steel prices for US stainless steel grade 304 sheet compiled from estainlesssteel and purchasing.com.

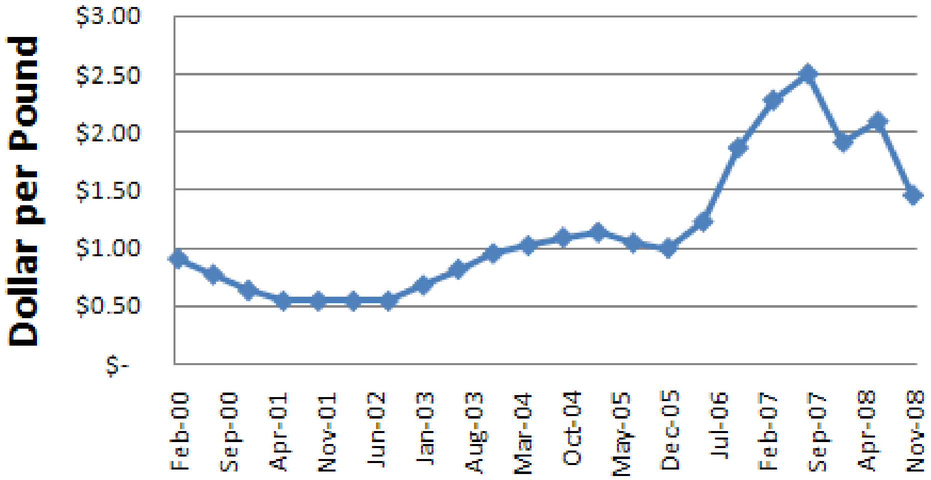


Figure 7-4: Historical 304 Stainless Steel Prices

Resin pricing is also obtained from sources such as Plastics News, Plastics Technology Online, Rubber and Plastics News and IDES (Integrated Design Engineering Systems). Several other sources are used in this research as outlined in the database.

Though material prices are often published for standard materials, prices for specialized material formulations and/or those having a nonstandard geometric configuration (e.g. length, width, thickness, cross-section), are not typically available. Where pricing is not available for a given material with a known composition, two (2) approaches are used: industry consultation and composition analysis. In cases such as Ni-Resist cast iron, which has several different possible pre-processed heat treatments, consultation with manufacturers of the component or similar components is required.

Obtaining prices for unknown proprietary material compositions, such as powder metals, necessitated a standardized industry approach. In these cases manufacturers and industry market research firms are consulted to provide generic pricing formulas and pricing trends. Their price formulas are balanced against published market trends of similar materials to establish new pricing trends. In terms of ferrous alloys, the database must also take into account unique or non-standard material thicknesses. Any specified non-standard sheet or plate thickness requires additional mill runs and must be priced accordingly. In this case, price estimations from consultations with industry manufacturers in conjunction with similar material pricing trend data are utilized.

Resin formulations are also available with a variety of fillers and filler content. Some pricing data is available for specific formulations; however pricing is not published for every variation. This variation is significant since many manufactures can easily tailor resin filler type and content to serve the specific application. Consequently, the database has been structured to group resins with a common filler, into ranges of filler content. For example, glass filled Nylon 6 is grouped into three (3) categories; 0 to 15 percent glass filled, 30 to 35 percent glass filled and 50 percent glass filled, each with their own price point. These groupings provide a single price point as the price differential within a group (0 to 15 percent glass filled) is not statistically significant

7.2.4 Material Price Forecasting, Accuracy and Variation

Though it is very difficult to accurately predict future material prices, there are statistical methods, such as regression analysis, to help predict expected pricing outcomes based on past trends. Price movements can be greatly affected over a short period of time by unpredictable global economic movements and policies such as the price of oil or embargos. In order to mitigate sporadic anomalies, these extreme peaks and valleys in the data set, which normalize within short periods of time, are disregarded.

Figure 7-5 illustrates the power curve trend line applied to historical 304 stainless steel prices. Other trend line plotting options (exponential, linear, etc.) are available; however, the power trend line obtains what is felt to be a realistic upward trend line response in this case. Each material data history is evaluated to establish the best fit line and corresponding projection. However, it should be noted that, for the case study presented in this report, a sensitivity analysis has been performed in lieu of calculating future technology cost impacts based on these data-based material-by-material price projections. Subsequent case analyses are expected to make use of these projections.

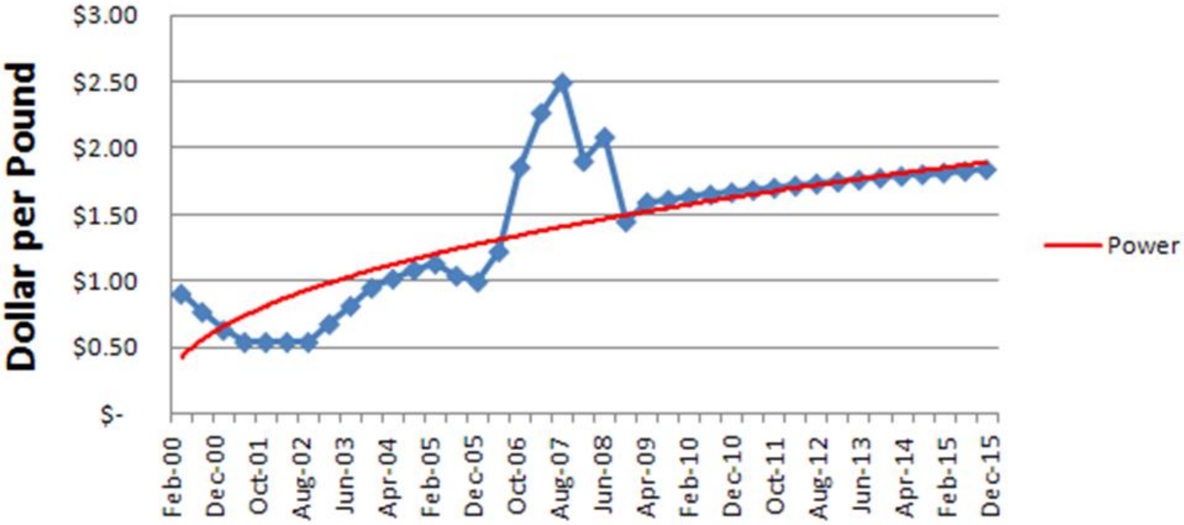


Figure 7-5: Projected Pricing for 304 Stainless Steel

7.2.5 <u>In-process Scrap</u>

In-process scrap is defined as the raw material mass, beyond the final part weight, required to manufacture a component. For example in an injection molded part, the in-process scrap is typically created from the delivery system of the molten plastic into the part cavity (e.g. sprue, runners and part gate). This additional material is trimmed off following part injection from the mold. In some cases, dependent on the material and application, a portion of this material can be ground up and returned into the virgin material mix.

In the case of screw machine parts, the in-process scrap is defined as the amount of material removed from the raw bar stock in the process of creating the part features. Generally, material removed during the various machining processes is sold at scrap value. Within this cost analysis study, no considerations were made to account for recovering scrap costs.

A second scrap parameter accounted for in the cost analysis is end-item scrap. End-item scrap is captured as a cost element within mark-up and will be discussed in more detail within the mark-up database section (Section 6.5). Although it is worth reiterating here that in-process scrap only covers the additional raw material mass required for manufacturing a part. It does not include an allowance for quality defects, rework costs and/or destructive test parts; these costs are covered by the end-item scrap allowance.

7.2.6 Purchase Part – Commodity Parts

In the quote assumption section of the CBOM, parts are identified as either “make” or “buy”. The “make” classification indicates a detailed quote is required for the applicable part, and “buy” indicates an established price based on historical data is used in place of a full quote work-up. Parts identified as a “buy” are treated as a purchased part. For the first case study, no attempt was made to split purchased part costs into material, labor, and burden components. In this case purchased part costs are binned solely as material costs.

Many of the parts considered to be purchased are simple standard fasteners (nuts, bolts, screws, washers, clips, hose clamps) and seals (gaskets, o-rings). However, in certain cases more value-added components are considered purchased when sufficient data existed supporting their cost as a commodity, that is, where competitive or other forces drive these costs to levels on the order of those expected had these parts been analyzed as “make” parts.

Purchased part costs are obtained from a variety of sources. These include FEV and Munro team members’ cost knowledge, surrogate component costing databases, Tier 1 supplier networks, published information, and service part cost information. Although an important component of the overall costing methodology, purchase part costs are used judiciously and conservatively, primarily for mature commodity parts.

7.3 Labor Database

7.3.1 Overview

The Labor Database contains all the standard occupations and associated labor rates required to manufacture automotive parts and vehicles. All labor rates referenced throughout the cost analysis are referenced from the established Labor Database.

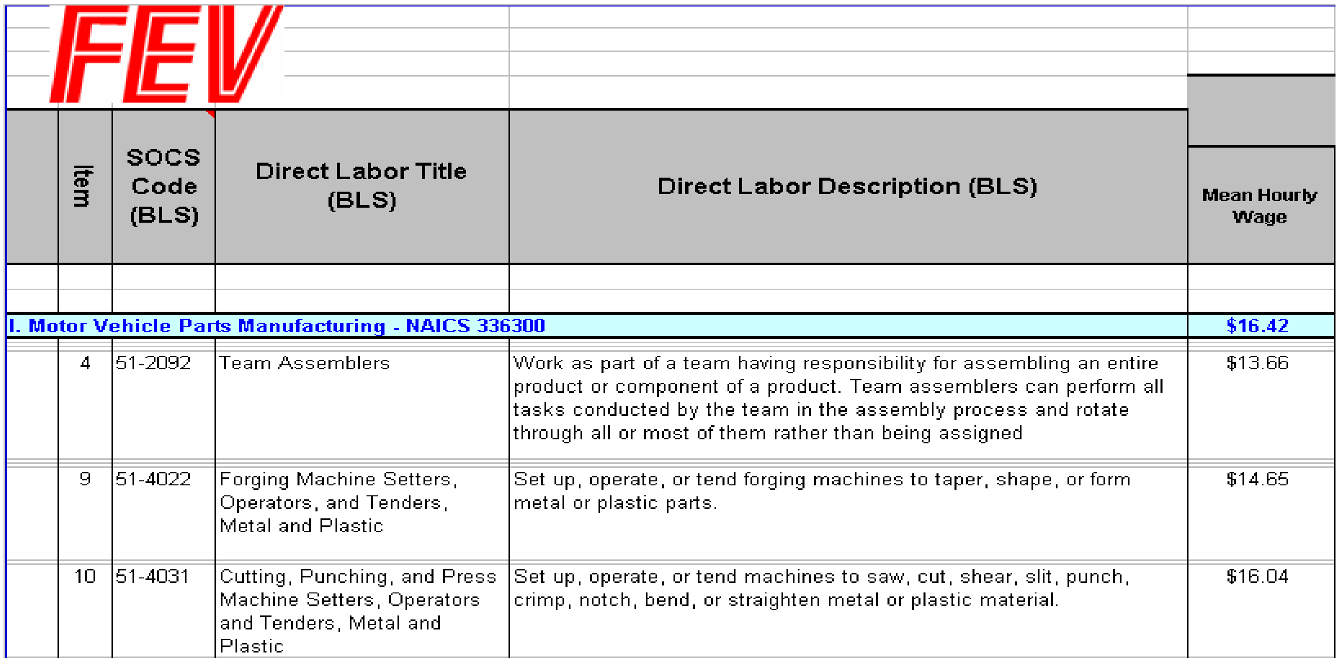
The labor classification format of the database is created using the same methodology as the Bureau of Labor Statistics (BLS). Further, the core labor wage data used throughout the study, with exception of fringe and wage projection parameters, is acquired from the BLS.

The Labor Database is broken into (2) two primary industry sections, Motor Vehicle Parts Manufacturing (supplier base) and Motor Vehicle Manufacturing (OEMs). These (2) two industry sections correspond to the BLS, North American Industry Classification System (NAICS) 336300 and 336100 respectively. Within each industry section of the database, there is a list of standard production occupations taken from the BLS Standard Occupation Classification (SOC) system. For reference, the base SOC code for production occupations within the Motor Vehicle Parts Manufacturing and Motor Vehicle Manufacturing is 51-0000. Every production occupation listed in the Labor Database has a calculated labor rate, as discussed in more detail below.

Labor rates for 2008 establish the reference baseline from which projected labor rates can be developed. An “Annual Adjustment Factor” is used to account for labor rate projections. The labor rates can be modified for each production occupation, or for the industry as a whole.

7.3.2 Direct Versus Total Labor, Wage Versus Rate

Each standard production occupation found in the Labor Database has an SOC identification number, title, labor description and mean hourly wage taken directly from the BLS. Figure 7-6 is an excerpt from the Labor Database.



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	Item	SOCS Code (BLS)	Direct Labor Title (BLS)	Direct Labor Description (BLS)	Mean Hourly Wage
I. Motor Vehicle Parts Manufacturing - NAICS 336300					**$16.42**
	4	51-2092	Team Assemblers	Work as part of a team having responsibility for assembling an entire product or component of a product. Team assemblers can perform all tasks conducted by the team in the assembly process and rotate through all or most of them rather than being assigned	$13.66
	9	51-4022	Forging Machine Setters, Operators, and Tenders, Metal and Plastic	Set up, operate, or tend forging machines to taper, shape, or form metal or plastic parts.	$14.65
	10	51-4031	Cutting, Punching, and Press Machine Setters, Operators and Tenders, Metal and Plastic	Set up, operate, or tend machines to saw, cut, shear, slit, punch, crimp, notch, bend, or straighten metal or plastic material.	$16.04

Figure 7-6: Labor Database Excerpt Highlighting Occupation Classification Codes, Descriptions, and Mean Hourly Wages

Only "direct" production occupations are listed in the database. Team assemblers and forging, cutting, punching, and press machine operators are all considered direct production occupations. There are several tiers of manufacturing personnel supporting the direct laborers that need to be accounted for in the total labor costs: quality technicians, process engineers, lift truck drivers, millwrights, electricians, etc. A method typically used by the automotive industry to account for all of these additional "indirect labor" costs, and the one chosen for this cost analysis, is to calculate the contribution of indirect labor as an average percent of direct labor, for a given production occupation, in a given industry sector. More details of this calculation are discussed in the next section.

The BLS Database provides labor wage data, rather than labor rate data. In addition to what a direct laborer is paid, there are several additional expenses the employer must cover in addition to the employee base wage. This analysis refers to these added employer expenditures as "fringe". Fringe is applicable to all employees and will be discussed in greater detail below.

It should be noted that the BLS motor vehicle and motor vehicle parts manufacturing (NAICS 336100&336300) labor rates include union and non-union labor rates, reflecting the relative mix of each in the workforce at the time the data was gathered (2007).

7.3.3 Contributors to Labor Rate and Labor Rate Equation

Summarized below are the four (4) contributors to labor costs used in this study:

Direct Labor (DIR) is the ***mean*** manufacturing labor wage directly associated with fabricating, finishing and/or assembling a physical component or assembly. Examples falling into this labor classification would include injection mold press operators, die cast press operators, heat treat equipment operators, team/general assemblers, computer numerical controlled (CNC) machine operators, and stamping press operators. The median labor wage for each direct labor title is also included in the database; these values are treated as reference only.

Indirect Labor (IND) is the manufacturing labor indirectly associated with making a physical component or assembly. Examples include material handling personnel, shipping and receiving personnel, quality control technicians, first-line supervisors, and manufacturing/process engineers. For a selected industry sector (such as injection molding, permanent casting, or metal stamping), an average ratio of indirect to direct labor costs can be derived from which the contribution of indirect labor ($/hour) can be calculated.

This ratio is calculated as follows:

1. An industry sector is chosen from the BLS, NAIC System. e.g., Plastics Product Manufacturing NAICS 326100.
2. Within the selected industry sector, occupations are sorted (using SOC codes) into one (1) of the four (4) categories, Direct Labor, Indirect Labor, MRO Labor, or Other.
3. For each category (excluding "Other") a total cost/hour is calculated by summing up the population weighted cost per hour rates, for the SOC codes within each labor category.
4. Dividing the total indirect labor costs by total direct labor costs, the industry sector ratio is calculated.
5. When multiple industries employ the same type direct laborer, as defined by NAICS, a weighted average of indirect to direct is calculated using the top three (3) industries.

Maintenance Repair and Other (MRO) is the labor required to repair and maintain manufacturing equipment and tools directly associated with manufacturing a given component or assembly. Examples falling into this labor classification include electricians, pipe fitters, millwrights, and on-site tool and die tradesmen. Similar to indirect labor, an average ratio of MRO to direct labor costs can be derived from which the contribution of MRO labor ($/hour) can be calculated. The same process used to calculate the indirect labor ratio is also used for the MRO ratio.

Fringe (FR) is all the additional expenses a company must pay for an employee above and beyond their base wage. Examples of expenses captured as part of fringe include company medical and insurance benefits, pension/retirement benefits, government directed benefits, vacation and holiday benefits, shift premiums, training, etc.

Fringe applies to all manufacturing employees. Therefore the contribution of fringe to the overall labor rate is based on a percentage of direct, indirect and MRO labor. Two (2) fringe rates are used: 52% for supplier manufacturing, and 160% for OEM manufacturing. The supplier manufacturing fringe rate is based on data aquired from the BLS; Employer Costs for Employee Compensation Historical Listings, March 2004 - 2009. Using the average 2007/2008 manufacturing sector numbers, an average fringe rate of 52% was calculated ([[$31.86-$20.95]/$20.95]*100), where average employee total compensation = $31.86/hour and wages and salaries = $20.95/hour).

The OEM fringe rate was calculated the same way as the supplier fringe rate above. Taking the 2006/2007 average North American UAW OEM hourly wage and total compensation rate of $28.18 and $73.21 respectively, a rate of 160% was calculated. Additional details on these calculations can be found in the labor database.

Taking the four (4) contributors of labor cost, the following labor rate equation for a manufacturing operation can be written:

Labor Rate ($/Hour) = DIR+ IND + MRO + FR

Where,

IND = DIR * ILRR, where ILRR = Ratio of Indirect to Direct Overall Labor Costs

MRO = DIR * MLRR, where MLRR = Ratio of MRO to Direct Overall Labor Costs

FR = {DIR + IND + MRO}*%FR, where %FR is the fringe rate

For example, to determine the applicable labor rate for a supplier injection molding facility:

DIR = $15.15/hr (SOC 51-4072)

ILRR = 66%

MLRR = 23%

%FR = 52%

First indirect and MRO labor contributions are calculated:

IND = $15.15 * 0.66 = $10.00/hr

MRO = $15.15 * 0.23 = $3.48/hr

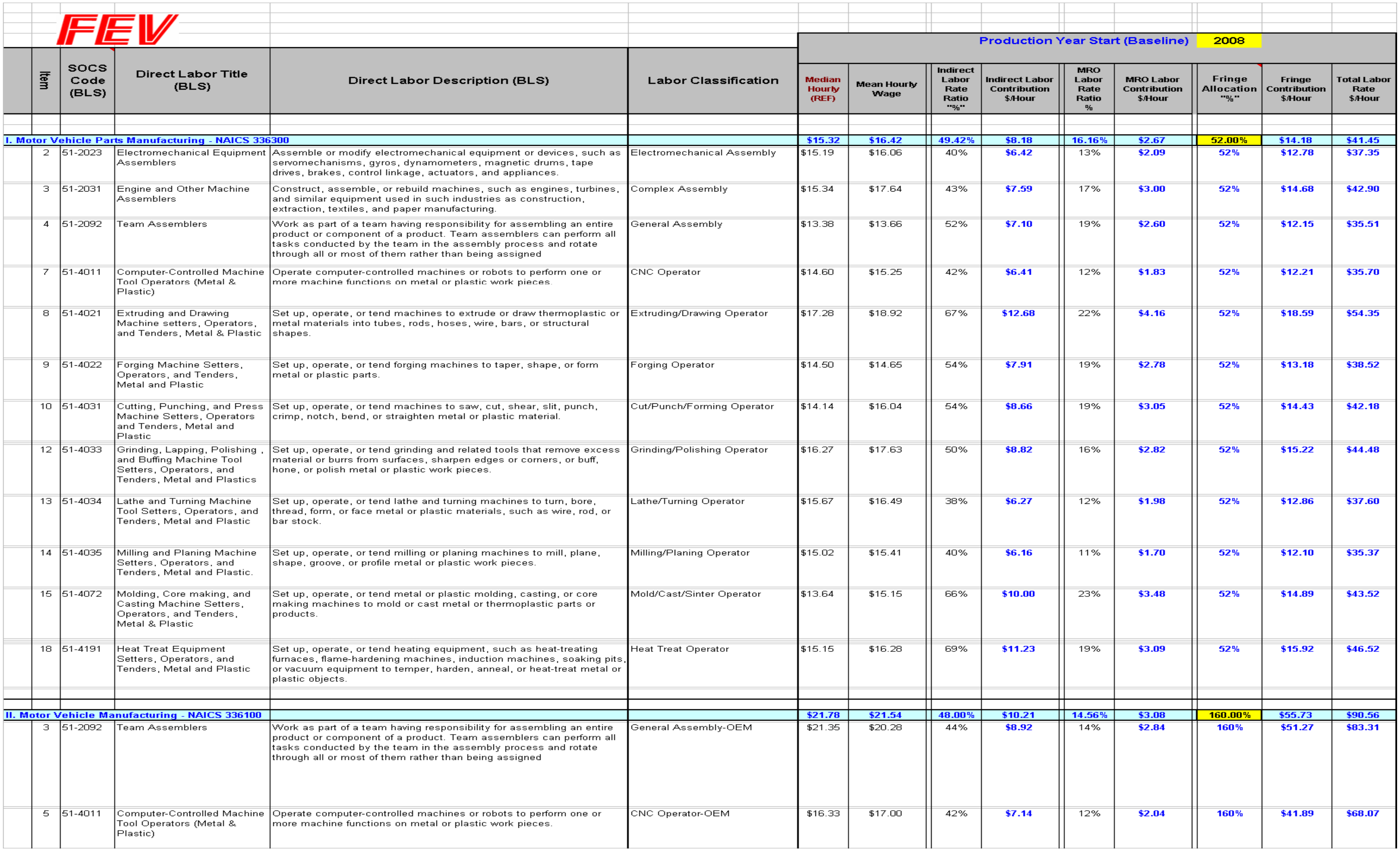
Next Fringe is calculated as a percent of direct, indirect and MRO labor:

Fringe = ($15.15 + $10.00 + $3.48) * 0.52 = $14.88/hr

Lastly, the labor rate for injection molding is calculated by summing the four (4) contributors.

Labor Rate = $15.15/hr + $10.00/hr + $3.48/hr + $14.88/hr = $43.52/hr

In Figure 7-7, some additional examples of production occupations and corresponding total labor rates are shown. Similar calculations are made for every production occupation classification found in the Labor Database.



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Item	SOCS Code (BLS)	Direct Labor Title (BLS)	Direct Labor Description (BLS)	Labor Classification	Production Year Start (Baseline)						2008		
					Median Hourly (REF)	Mean Hourly Wage	Indirect Labor Rate Ratio "%"	Indirect Labor Contribution $/Hour	MRO Labor Rate Ratio %	MRO Labor Contribution $/Hour	Fringe Allocation "%"	Fringe Contribution $/Hour	Total Labor Rate $/Hour
I. Motor Vehicle Parts Manufacturing - NAICS 336300					**$15.32**	**$16.42**	**49.42%**	**$8.18**	**16.16%**	**$2.67**	**52.00%**	**$14.18**	**$41.45**
2	51-2023	Electromechanical Equipment Assemblers	Assemble or modify electromechanical equipment or devices, such as servomechanisms, gyros, dynamometers, magnetic drums, tape drives, brakes, control linkage, actuators, and appliances.	Electromechanical Assembly	$15.19	$16.06	40%	**$6.42**	13%	**$2.09**	**52%**	**$12.78**	**$37.35**
3	51-2031	Engine and Other Machine Assemblers	Construct, assemble, or rebuild machines, such as engines, turbines, and similar equipment used in such industries as construction, extraction, textiles, and paper manufacturing.	Complex Assembly	$15.34	$17.64	43%	**$7.59**	17%	**$3.00**	**52%**	**$14.68**	**$42.90**
4	51-2092	Team Assemblers	Work as part of a team having responsibility for assembling an entire product or component of a product. Team assemblers can perform all tasks conducted by the team in the assembly process and rotate through all or most of them rather than being assigned	General Assembly	$13.38	$13.66	52%	**$7.10**	19%	**$2.60**	**52%**	**$12.15**	**$35.51**
7	51-4011	Computer-Controlled Machine Tool Operators (Metal & Plastic)	Operate computer-controlled machines or robots to perform one or more machine functions on metal or plastic work pieces.	CNC Operator	$14.60	$15.25	42%	**$6.41**	12%	**$1.83**	**52%**	**$12.21**	**$35.70**
8	51-4021	Extruding and Drawing Machine setters, Operators, and Tenders, Metal & Plastic	Set up, operate, or tend machines to extrude or draw thermoplastic or metal materials into tubes, rods, hoses, wire, bars, or structural shapes.	Extruding/Drawing Operator	$17.28	$18.92	67%	**$12.68**	22%	**$4.16**	**52%**	**$18.59**	**$54.35**
9	51-4022	Forging Machine Setters, Operators, and Tenders, Metal and Plastic	Set up, operate, or tend forging machines to taper, shape, or form metal or plastic parts.	Forging Operator	$14.50	$14.65	54%	**$7.91**	19%	**$2.78**	**52%**	**$13.18**	**$38.52**
10	51-4031	Cutting, Punching, and Press Machine Setters, Operators and Tenders, Metal and Plastic	Set up, operate, or tend machines to saw, cut, shear, slit, punch, crimp, notch, bend, or straighten metal or plastic material.	Cut/Punch/Forming Operator	$14.14	$16.04	54%	**$8.66**	19%	**$3.05**	**52%**	**$14.43**	**$42.18**
12	51-4033	Grinding, Lapping, Polishing , and Buffing Machine Tool Setters, Operators, and Tenders, Metal and Plastics	Set up, operate, or tend grinding and related tools that remove excess material or burrs from surfaces, sharpen edges or corners, or buff, hone, or polish metal or plastic work pieces.	Grinding/Polishing Operator	$16.27	$17.63	50%	**$8.82**	16%	**$2.82**	**52%**	**$15.22**	**$44.48**
13	51-4034	Lathe and Turning Machine Tool Setters, Operators, and Tenders, Metal and Plastic	Set up, operate, or tend lathe and turning machines to turn, bore, thread, form, or face metal or plastic materials, such as wire, rod, or bar stock.	Lathe/Turning Operator	$15.67	$16.49	38%	**$6.27**	12%	**$1.98**	**52%**	**$12.86**	**$37.60**
14	51-4035	Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic.	Set up, operate, or tend milling or planing machines to mill, plane, shape, groove, or profile metal or plastic work pieces.	Milling/Planing Operator	$15.02	$15.41	40%	**$6.16**	11%	**$1.70**	**52%**	**$12.10**	**$35.37**
15	51-4072	Molding, Core making, and Casting Machine Setters, Operators, and Tenders, Metal & Plastic	Set up, operate, or tend metal or plastic molding, casting, or core making machines to mold or cast metal or thermoplastic parts or products.	Mold/Cast/Sinter Operator	$13.64	$15.15	66%	**$10.00**	23%	**$3.48**	**52%**	**$14.89**	**$43.52**
18	51-4191	Heat Treat Equipment Setters, Operators, and Tenders, Metal and Plastic	Set up, operate, or tend heating equipment, such as heat-treating furnaces, flame-hardening machines, induction machines, soaking pits, or vacuum equipment to temper, harden, anneal, or heat-treat metal or plastic objects.	Heat Treat Operator	$15.15	$16.28	69%	**$11.23**	19%	**$3.09**	**52%**	**$15.92**	**$46.52**
II. Motor Vehicle Manufacturing - NAICS 336100					**$21.78**	**$21.54**	**48.00%**	**$10.21**	**14.56%**	**$3.08**	**160.00%**	**$55.73**	**$90.56**
3	51-2092	Team Assemblers	Work as part of a team having responsibility for assembling an entire product or component of a product. Team assemblers can perform all tasks conducted by the team in the assembly process and rotate through all or most of them rather than being assigned	General Assembly-OEM	$21.35	$20.28	44%	**$8.92**	14%	**$2.84**	**160%**	**$51.27**	**$83.31**
5	51-4011	Computer-Controlled Machine Tool Operators (Metal & Plastic)	Operate computer-controlled machines or robots to perform one or more machine functions on metal or plastic work pieces.	CNC Operator-OEM	$16.33	$17.00	42%	**$7.14**	12%	**$2.04**	**160%**	**$41.89**	**$68.07**

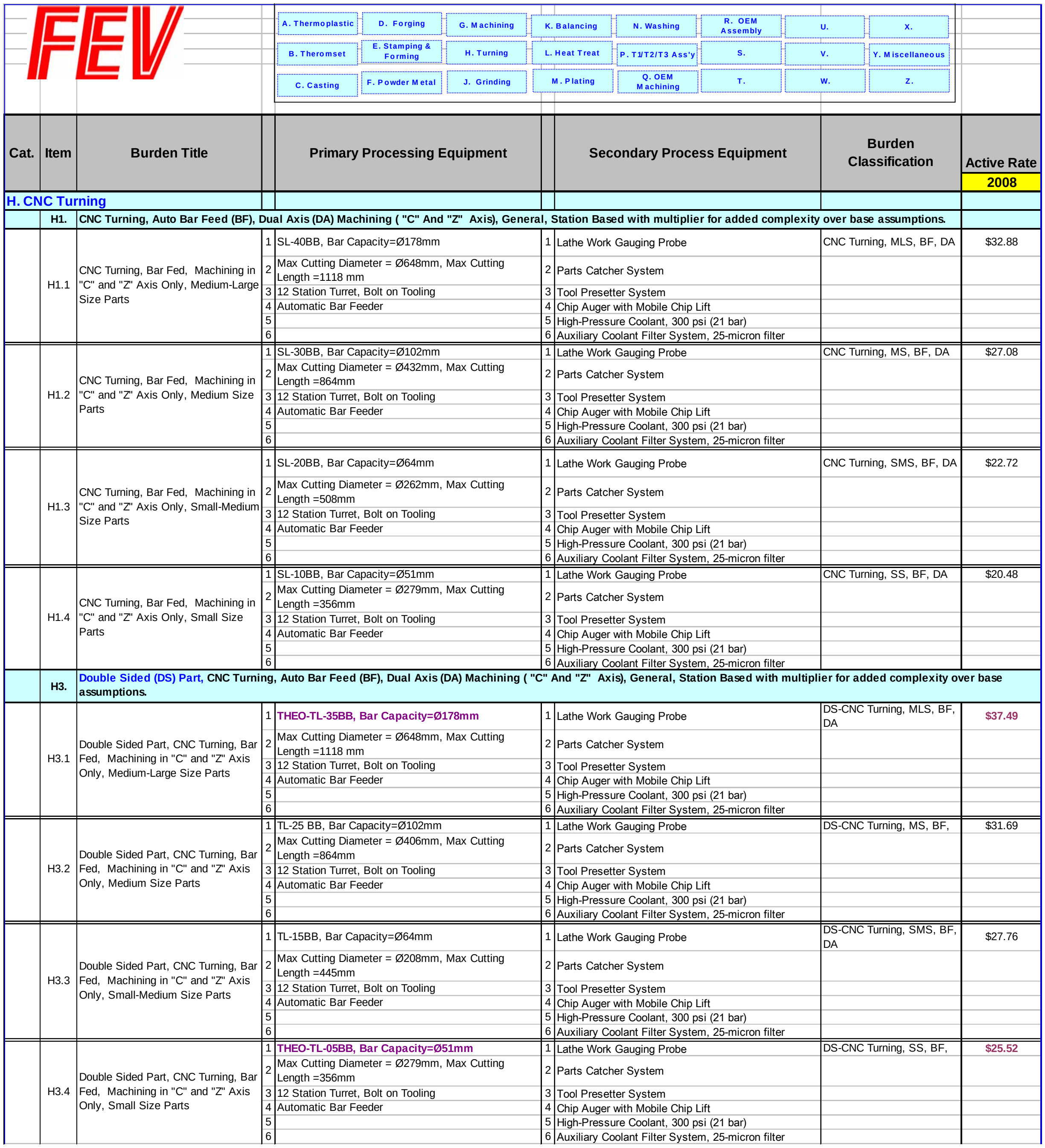
Figure 7-7: Labor Database Excerpt Showing Contributors to Total Labor Rate for Various Direct Labor Occupations

7.4 Manufacturing Overhead Database

7.4.1 Overview

The Manufacturing Overhead Database contains several manufacturing overhead rates (also sometimes referred to as burden rates, or simply burden) associated to various types of manufacturing equipment, that are required to manufacture automotive parts and vehicles. With material and labor costs, it forms the total manufacturing cost (TMC) to manufacture a component or assembly, accounting for workers, supervisors, managers, raw materials, purchased parts, production facilities, fabrication equipment, finishing equipment, assembly equipment, utilities, measurement and test equipment, handling equipment, office equipment, etc. Manufacturing equipment is typically one of the largest contributors to manufacturing overhead, and so manufacturing overhead rates are categorized according to primary manufacturing processes and the associated equipment as follows:

1. The first tier of the Manufacturing Overhead Database is arranged by the primary manufacturing process groups (e.g., thermoplastic molding, thermoset molding, castings, forgings, stamping and forming, powder metal, machining, turning, etc.)
2. The second tier subdivides the primary manufacturing process groups into primary processing equipment groups. For example the ‘turning group’ consists of several subgroups including some of the following: (1) CNC turning, auto bar fed, dual axis machining, (2) CNC turning, auto bar fed, quad axis machining, (3) double sided part, CNC turning, auto bar fed, dual axis machining, and (4) double sided part, CNC turning, auto bar fed, quad axis machining.
3. The third and final tier of the database, increases the resolution of the primary processing equipment groups, and defines the applicable manufacturing overhead rates. The added resolution is typically based on part size and complexity and the need for particular models/versions of primary and secondary processing equipment. An excerpt from the Manufacturing Overhead Database is shown in Figure 7-8. In this example, the levels of complexity in CNC equipment are described and assigned an ‘Active Rate’, which is the burden cost-per-hour for the equipment.



Cat.	Item	Burden Title		Primary Processing Equipment		Secondary Process Equipment	Burden Classification	Active Rate 2008
H. CNC Turning								
	H1.	**CNC Turning, Auto Bar Feed (BF), Dual Axis (DA) Machining ("C" And "Z" Axis), General, Station Based with multiplier for added complexity over base assumptions.**						
	H1.1	CNC Turning, Bar Fed, Machining in "C" and "Z" Axis Only, Medium-Large Size Parts	1	SL-40BB, Bar Capacity=Ø178mm	1	Lathe Work Gauging Probe	CNC Turning, MLS, BF, DA	$32.88
			2	Max Cutting Diameter = Ø648mm, Max Cutting Length =1118 mm	2	Parts Catcher System		
			3	12 Station Turret, Bolt on Tooling	3	Tool Presetter System		
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift		
			5		5	High-Pressure Coolant, 300 psi (21 bar)		
			6		6	Auxiliary Coolant Filter System, 25-micron filter		
	H1.2	CNC Turning, Bar Fed, Machining in "C" and "Z" Axis Only, Medium Size Parts	1	SL-30BB, Bar Capacity=Ø102mm	1	Lathe Work Gauging Probe	CNC Turning, MS, BF, DA	$27.08
			2	Max Cutting Diameter = Ø432mm, Max Cutting Length =864mm	2	Parts Catcher System		
			3	12 Station Turret, Bolt on Tooling	3	Tool Presetter System		
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift		
			5		5	High-Pressure Coolant, 300 psi (21 bar)		
			6		6	Auxiliary Coolant Filter System, 25-micron filter		
	H1.3	CNC Turning, Bar Fed, Machining in "C" and "Z" Axis Only, Small-Medium Size Parts	1	SL-20BB, Bar Capacity=Ø64mm	1	Lathe Work Gauging Probe	CNC Turning, SMS, BF, DA	$22.72
			2	Max Cutting Diameter = Ø262mm, Max Cutting Length =508mm	2	Parts Catcher System		
			3	12 Station Turret, Bolt on Tooling	3	Tool Presetter System		
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift		
			5		5	High-Pressure Coolant, 300 psi (21 bar)		
			6		6	Auxiliary Coolant Filter System, 25-micron filter		
	H1.4	CNC Turning, Bar Fed, Machining in "C" and "Z" Axis Only, Small Size Parts	1	SL-10BB, Bar Capacity=Ø51mm	1	Lathe Work Gauging Probe	CNC Turning, SS, BF, DA	$20.48
			2	Max Cutting Diameter = Ø279mm, Max Cutting Length =356mm	2	Parts Catcher System		
			3	12 Station Turret, Bolt on Tooling	3	Tool Presetter System		
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift		
			5		5	High-Pressure Coolant, 300 psi (21 bar)		
			6		6	Auxiliary Coolant Filter System, 25-micron filter		
	H3.	**Double Sided (DS) Part, CNC Turning, Auto Bar Feed (BF), Dual Axis (DA) Machining ("C" And "Z" Axis), General, Station Based with multiplier for added complexity over base assumptions.**						
	H3.1	Double Sided Part, CNC Turning, Bar Fed, Machining in "C" and "Z" Axis Only, Medium-Large Size Parts	1	**THEO-TL-35BB, Bar Capacity=Ø178mm**	1	Lathe Work Gauging Probe	DS-CNC Turning, MLS, BF, DA	**$37.49**
			2	Max Cutting Diameter = Ø648mm, Max Cutting Length =1118 mm	2	Parts Catcher System		
			3	12 Station Turret, Bolt on Tooling	3	Tool Presetter System		
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift		
			5		5	High-Pressure Coolant, 300 psi (21 bar)		
			6		6	Auxiliary Coolant Filter System, 25-micron filter		
	H3.2	Double Sided Part, CNC Turning, Bar Fed, Machining in "C" and "Z" Axis Only, Medium Size Parts	1	TL-25 BB, Bar Capacity=Ø102mm	1	Lathe Work Gauging Probe	DS-CNC Turning, MS, BF,	$31.69
			2	Max Cutting Diameter = Ø406mm, Max Cutting Length =864mm	2	Parts Catcher System		
			3	12 Station Turret, Bolt on Tooling	3	Tool Presetter System		
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift		
			5		5	High-Pressure Coolant, 300 psi (21 bar)		
			6		6	Auxiliary Coolant Filter System, 25-micron filter		
	H3.3	Double Sided Part, CNC Turning, Bar Fed, Machining in "C" and "Z" Axis Only, Small-Medium Size Parts	1	TL-15BB, Bar Capacity=Ø64mm	1	Lathe Work Gauging Probe	DS-CNC Turning, SMS, BF, DA	$27.76
			2	Max Cutting Diameter = Ø208mm, Max Cutting Length =445mm	2	Parts Catcher System		
			3	12 Station Turret, Bolt on Tooling	3	Tool Presetter System		
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift		
			5		5	High-Pressure Coolant, 300 psi (21 bar)		
			6		6	Auxiliary Coolant Filter System, 25-micron filter		
	H3.4	Double Sided Part, CNC Turning, Bar Fed, Machining in "C" and "Z" Axis Only, Small Size Parts	1	**THEO-TL-05BB, Bar Capacity=Ø51mm**	1	Lathe Work Gauging Probe	DS-CNC Turning, SS, BF,	**$25.52**
			2	Max Cutting Diameter = Ø279mm, Max Cutting Length =356mm	2	Parts Catcher System		
			3	12 Station Turret, Bolt on Tooling	3	Tool Presetter System		
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift		
			5		5	High-Pressure Coolant, 300 psi (21 bar)		
			6		6	Auxiliary Coolant Filter System, 25-micron filter		

Figure 7-8: Manufacturing Overhead Database Excerpt Showing Standard Overhead Rates for CNC Turning

Manufacturing overhead rates for 2008 establish the baseline from which projected rates can be developed. A single Average Annual Adjustment Factor is used to for this purpose.

7.4.2 Manufacturing Overhead Rate Contributors and Calculations

In this analysis burden is defined in terms of an "inclusion/exclusion" list as follows:

Burden costs do not include:

- manufacturing material costs
- manufacturing labor costs
    - direct labor
    - indirect labor
    - maintenance repair and other (MRO) labor
- mark-up
    - end-item scrap
    - corporate SG&A expenses
    - profit
    - ED&T/ R&D costs expenses
- tooling (e.g. mold, dies, gauges, fixtures, dedicated pallets)
- packaging costs
- shipping and handling costs

Burden costs do include:

- rented and leased equipment
- primary and process support manufacturing equipment depreciation
- plant office equipment depreciation
- utilities expense
- insurance (fire and general)
- municipal taxes
- plant floor space (equipment and plant offices)
- maintenance of manufacturing equipment - non-labor
- maintenance of manufacturing building - general, internal and external, parts, and labor
- operating supplies
- perishable and supplier-owned tooling
- all other plant wages (excluding direct, indirect and MRO labor)
- returnable dunnage maintenance
- intra-company shipping costs

As can be seen in the lists above, burden includes both fixed and variable costs. Generally, the largest contribution to the fixed burden costs are the investments associated with primary and process support equipment. The single largest contributor to the variable burden rate is typically utility usage.

In general the average burden rate for a production facility is calculated by summing up the total burden costs for the facility for a pre-defined period. This value is then divided by either the total direct labor cost, the total direct labor hours, or the total machining hours.

Since this cost analysis assumes that all production is in North America and at relatively high volumes, the standard quote assumption is that higher labor costs are offset by automation. With this assumption, there are considerably fewer direct labor hours versus machine hours, making a machine-based burden rate more applicable for this cost analysis. Thus all burden rates contained in the Manufacturing Overhead Database are considered machine based burden rates.

Depending on the mix of equipment, processes, and product variation at a given manufacturing facility, a corporation may choose to apply either a flat rate approach or an activity based approach to burden rates. The flat rate approach assumes one burden rate for the entire manufacturing facility, regardless of the types of manufacturing processes employed. (For example, stamping, welding, and general assembly would all share a common burden rate). The activity based approach applies a unique burden rate to each core manufacturing activity or process which exists within the facility. For example, stamping welding, and general assembly would each be assigned a unique burden rate.

For this cost analysis the majority of the costing is done using activity based burden rates. However, for a few components where there are some minor secondary operations performed, the flat rate approach is used for simplification.

7.4.3 Acquiring Manufacturing Overhead Data

Because there is very limited publicly available data on manufacturing overhead rates for the industry sectors included in this analysis, overhead rates have been developed from a combination of internal knowledge at FEV and Munro, supplier networks, miscellaneous publications, reverse costing exercises and “ground-up” manufacturing overhead calculations.

For ground-up calculations, a generic “Manufacturing Overhead Calculator Template” was created. The template consists of eight (8) sections: A. General Manufacturing Overhead Information, B. Primary Process Equipment, C. Process Support Equipment, D. General Plant & Office Hardware/Equipment, E. Facilities Cost, F. Utilities, G. Plant

Salaries, and H. Calculated Hourly Burden Rate. An example of the template can be found in Appendix E.4 illustrating the hourly burden rate calculation for a 500 ton (T) injection mold machine. To assist in the discussion of the various sections of the costing template, input and calculated values for this same example are captured below in parentheses.

The General Manufacturing Overhead Information section, in addition to defining the burden title (Injection Molding, Medium Size and/or Moderate Complexity) and description (Injection Molding Station, 500T Press), also defines the equipment life expectancy (12 years), yearly operating capacity (4700 hours), operation efficiency (85%), equipment utilization (81.99%) and borrowing cost of money (8%). These input variables support many of the calculations made throughout the costing template.

The Primary Process Equipment section (500T Horizontal Injection Molding Machine) calculates the annual expense ($53,139) associated with equipment depreciation over the defined life expectancy. A straight-line-depreciation method, with zero end of life value, is assumed for all equipment. Included in the cost of the base equipment are several factors including sales tax, freight, installation, insurance, maintenance-parts, etc.

The Process Support Equipment section (e.g. Chiller, Dryer, Thermal Control Unit-Mold), similar to the primary process equipment section, calculates the annual expense ($6,121) associated with process support equipment depreciation.

The General Plant and Office Hardware/Equipment section assigns an annual contribution directed towards covering a portion of the miscellaneous plant & office hardware/equipment costs (e.g. millwright, electrician, and plumbing tool crib, production/quality communication, data tracking and storage, general material handling equipment, storage, shipping and receiving equipment, general quality lab equipment, office equipment). The contribution expense ($2,607) is calculated as a percent of the annual primary and process support equipment depreciation costs.

The Facilities Cost section assigns a cost based on square footage utilization for the primary equipment ($4,807), process support equipment ($3,692), and general plant and office hardware/equipment ($6,374). The general plant and office hardware/equipment floor space allocation is a calculated percentage (default 75%) of the derived primary and process support equipment floor space. The expense per square foot is $11.50 and covers several cost categories including facility depreciation costs, property taxes, property insurance, general facility maintenance, general utilities, etc.

The Utilities section calculates a utility expense per hour for both primary equipment ($9.29/hour) and process support equipment ($3.51/hour) based on equipment utility usage specifications. Some of the utility categories covered in this section include: electricity at $0.10/Kw-hr., natural gas at $0.00664/cubic foot, and water at

$0.001/gallon. General plant and office hardware/equipment utility expenses are covered as part of the facility cost addressed above (i.e., $11.50/square foot).

The Plant Salary section estimates the contribution of manufacturing salaries (e.g. plant manager, production manager, quality assurance manager) assigned to the indirect participation of primary and process support equipment. An estimate is made on the average size of the manufacturing facility for this type of primary process equipment. There are six (6) established manufacturing facility sizes and corresponding salary payrolls to choose from; each has a calculated salary cost/square foot. Based on the combined square footage utilization of the primary, process support, and general plant and office equipment, an annual salary contribution cost is calculated ($6,625).

The final section, Calculated Hourly Burden Rate, takes the calculated values from the previous sections and calculates the hourly burden rate in three (3) steps: (1) 100% efficiency and utilization ($30.54/hour), (2) user-defined efficiency with 100% utilization ($35.12/hour), and (3) both user-defined efficiency and utilization ($38.79/hour).

The majority of primary process equipment groups (e.g. injection molding, aluminum die casting, forging, stamping and forming) in the manufacturing overhead database are broken into five (5) to ten (10) burden rate subcategories based on processing complexity and/or size, as discussed in the manufacturing overhead review. For any given category, there will often be a range of equipment sizes and associated burden rates which are averaged into a final burden rate. The goal of this averaging method is to keep the database compact while maintaining high costing resolution.

In the example of the 500T injection molding press burden rate, the calculated rate ($38.79) was averaged with three (3) other calculated rates (for 390T, 610T and 720T injection mold presses) into a final burden rate called "Injection Molding, Medium Size and/or Moderate Complexity". The final calculated burden rate of $50.58/hour is used in applications requiring injection molding presses in the range of 400-800 tons.

As discussed, multiple methods of arriving at burden rates are used within the cost analysis. Every attempt is made to acquire multiple data points for a given burden rate as a means of validating the rate. In some cases the validation is accomplished at the final rate level and in other cases multiple pieces of input data, used in the calculation of a rate, are acquired as a means of validation.

7.5 Mark-up (Scrap, SG&A, Profit, ED&T)

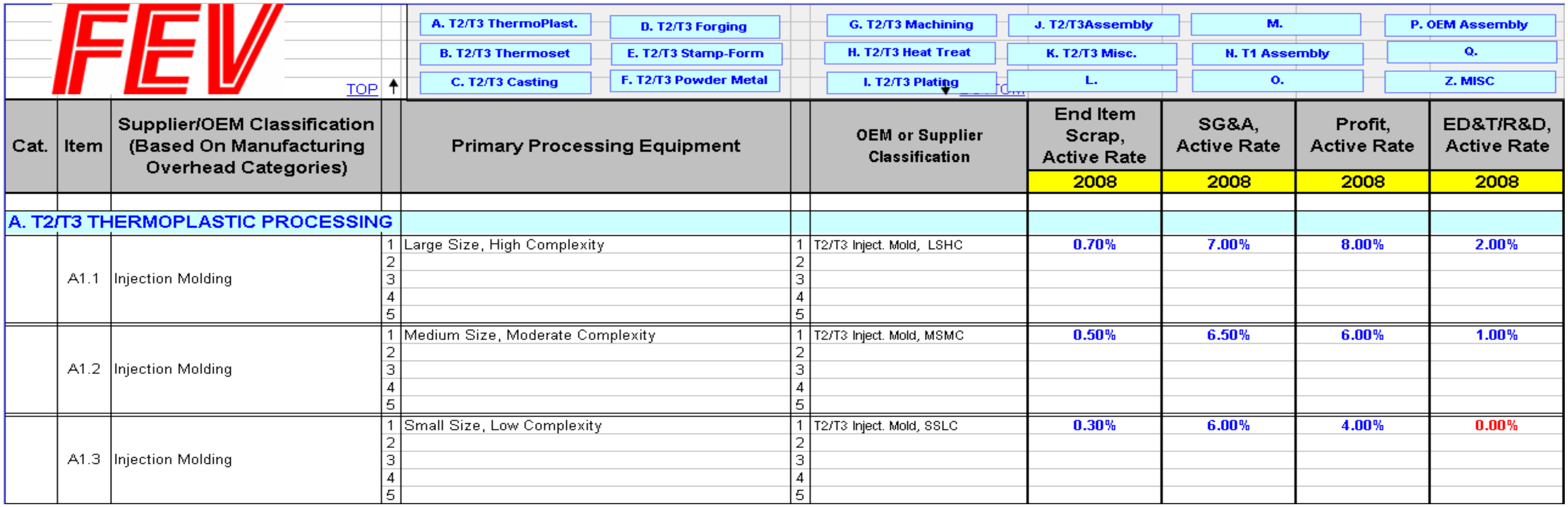
7.5.1 Overview

All mark-up rates referenced throughout the cost analysis, for Tier 1 and Tier 2/3 automotive suppliers, can be found in the Mark-up Database, except in those cases where unique component tolerances, performance requirements, or some other unique feature dictates a special rate. In cases where a mark-up rate is “flagged” within the costing worksheet, a note is included which describes the assumption differences justifying the modified rate.

For this cost analysis study, four (4) mark-up sub-categories are used in determining an overall mark-up rate: (1) end-item scrap allowance, (2) SG&A expenses, (3) profit, and (4) ED&T/ R&D expenses. Additional details for each subcategory are discussed below.

The layout of the Mark-up Database is similar to the Manufacturing Overhead Database in that the first tier of the Mark-up Database is arranged by the primary manufacturing process groups (e.g., thermoplastic processing, thermoset processing, casting, etc.). The second tier subdivides the primary manufacturing process groups into primary processing equipment groups (e.g., thermoplastic processing is subdivided into injection molding, blow or rotational molding, and pressure or vacuum form molding). The third and final tier of the database, increases the resolution of the primary processing equipment groups, and defines the applicable mark-up rates. Similar to the overhead manufacturing rates, size and complexity of the parts being manufactured will direct the process and equipment requirements, as well as investments, which in turn, will have a direct correlation to mark-up rates.

For example, a small, low complexity Tier 2/Tier 3 injection molding facility will generally have less in-process scrap (as a result of defective parts and/or destructive testing), less corporate overhead, less investment risk, and less engineering, design and testing support than a large, high complexity Tier 2/Tier 3 injection molding facility, as illustrated in Figure 7-9.



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A. T2/T3 ThermoPlast.
B. T2/T3 Thermoset
C. T2/T3 Casting
D. T2/T3 Forging
E. T2/T3 Stamp-Form
F. T2/T3 Powder Metal
G. T2/T3 Machining
H. T2/T3 Heat Treat
I. T2/T3 Plating
J. T2/T3Assembly
K. T2/T3 Misc.
L.
M.
N. T1 Assembly
O.
P. OEM Assembly
Q.
Z. MISC

Cat.	Item	Supplier/OEM Classification (Based On Manufacturing Overhead Categories)		Primary Processing Equipment		OEM or Supplier Classification	End Item Scrap, Active Rate	SG&A, Active Rate	Profit, Active Rate	ED&T/R&D, Active Rate
							2008	2008	2008	2008
A. T2/T3 THERMOPLASTIC PROCESSING										
	A1.1	Injection Molding	1	Large Size, High Complexity	1	T2/T3 Inject. Mold, LSHC	0.70%	7.00%	8.00%	2.00%
			2		2					
			3		3					
			4		4					
			5		5					
	A1.2	Injection Molding	1	Medium Size, Moderate Complexity	1	T2/T3 Inject. Mold, MSMC	0.50%	6.50%	6.00%	1.00%
			2		2					
			3		3					
			4		4					
			5		5					
	A1.3	Injection Molding	1	Small Size, Low Complexity	1	T2/T3 Inject. Mold, SSLC	0.30%	6.00%	4.00%	0.00%
			2		2					
			3		3					
			4		4					
			5		5					

Figure 7-9: Mark-up Database Excerpt Highlighting the Rate Differences (End Item Scrap, SG&A, Profit, and ED&T), for Three (3) Levels of Injection Molding, Based on Part Size and Complexity

As shown in the Figure 7-9, the Mark-up Database has a column for each category of mark-up, making it possible to modify each category independently or as a group. In addition, the mark-up rates for a particular supplier/OEM classification and/or primary processing equipment category can be modified independently.

Mark-up rates for 2008 establish the reference baseline from which projected rates can be developed. A single average Annual Adjustment Factor is used to for this purpose.

7.5.2 Mark-up Rate Contributors and Calculations

Mark-up, in general, is an added allowance to the Total Manufacturing Cost to cover end-item scrap, SG&A, profit and ED&T expenses. Below are some additional details on what is included in each mark-up category.

End-Item Scrap Mark-up: is an added allowance to cover the projected manufacturing fall-out and/or rework costs associated with producing a particular component or assembly. In addition, any costs associated with in-process destructive testing of a component or assembly would also be covered by this allowance. As a starting point, scrap allowances were estimated to be between 0.3% and 0.7% of the TMC within each primary manufacturing processing group The actual assigned value, for each category, is an estimate based on size and complexity of the primary processing equipment as shown in Table 7-2.

When published industry data or consultation with an industry expert produces more reliable estimates for scrap allowance associated with a generic manufacturing process (e.g. 5% for sand casting, investment casting), the Mark-up Database is updated accordingly. In cases where the manufacturing process is considered generic, but the component performance requirements drive a higher fall-out rate (e.g. 25% combined process fallout on turbocharger turbine wheels), then the scrap mark-up rate would only be adjusted in the Manufacturing Assumption Quote Summary (MAQS) worksheet.

Selling, General, and Administrative (SG&A) Mark-up: is also referred to as corporate overhead or non-manufacturing overhead costs, and some of the more common cost elements of SG&A are as follows:

- Non-manufacturing, corporate facilities (building, office equipment, utilities, maintenance expenses, etc.)
- Corporate salaries (President, Chief Executive Officers, Chief Financial Officers, Vice Presidents, Directors, Corporate Manufacturing, Logistics, Purchasing, Accounting, Quality, Sales, etc.)
- Insurance on non-manufacturing buildings and equipment
- Legal and public relation expenses
- Recall insurance and warranty expenses

- Patent fees
- Marketing and advertising expenses
- Corporate travel expenses

SG&A, like all mark-up rates, is an applied percentage to the Total Manufacturing Cost. The default rates for this cost analysis range between 6% to 7% within each of the primary processing groups. The actual values, as with the end-item scrap allowances, vary within these ranges based on the size and complexity of the part, which in turn is reflected in the size and complexity of the processing equipment as shown in Table 7-2. To support the estimated SG&A rates (which are based on generalized OEM data), SG&A values are extracted from publicly traded automotive supplier 10-K reports (Table 7-1).

Profit Mark-up: is the supplier's or OEM's reward for the investment risk associated with taking on a project. On average, the higher the investment risk, the larger the profit mark-up that is sought by a manufacturer.

As part of the assumptions list made for this cost analysis, it is assumed that the technology being studied is mature from the development and competition standpoint. These assumptions are reflected in the conservative profit mark-up rates which range from 4% to 8% of the Total Manufacturing Cost. The profit mark-up ranges selected from this cost analysis are based on generalized historical data from OEMs and suppliers.

As detailed with the preceding mark-up rates, the actual assigned percentage is based on the supplier processing equipment size and complexity capabilities (Table 7-2).

ED&T Mark-up: the ED&T used for this cost analysis is a combination of "Traditional ED&T" plus R&D mark-up.

Traditional ED&T may be defined as the engineering, design and testing activities required to take an "implementation ready" technology and integrate it into a specific vehicle application. The ED&T calculation is typically more straight-forward because the tasks are predefined. R&D, defined as the cost of the research and development activities required to create a new (or enhance an existing) component/system technology, is often independent of a specific vehicle application. In contrast to ED&T, pure R&D costs are very difficult to predict and are very risky from an OEM and suppliers perspective, in that these costs may or may not result in a profitable outcome.

For many automotive suppliers and OEMs, traditional ED&T and R&D are combined into one (1) cost center. For this cost analysis, the same methodology has been adopted, creating a combined traditional ED&T and R&D mark-up rate simply referred to as ED&T.

Based on the assumption stated above for this cost analysis (technology is mature from the product development and competition point-of-view), a ED&T mark-up range between 0% to 6% has been selected. The selected range is based on a combination of publications examining ED&T mark-up rates in the automotive industry, available 10K reports, and EPA's Indirect Cost Multiplier report. Table 7-1 provides some examples of Tier 1 automotive supplier SG&A and ED&T/R&D rates. These rates are based on world wide operations including automotive and non-automotive components.

Table 7-1: Tier 1 Published SG&A and ED&T/R&D Rates for 2007 and 2008

Corporation	**SG&A**		**ED&T/R&D**	
	2008	**2007**	**2008**	**2007**
Dana Holding Corp	4.2%	4.2%	2.4%	2.2%
Wescast Industries Inc.	6.5%	7.2%	2.4%	2.0%
Honeywell Internationational Inc	13.8%	13.2%	4.2%	4.2%
Delphi Corp	10.5%	9.0%	8.1%	7.2%
Federal Mogul Corp	8.8%	9.4%	2.5%	2.6%
American Axle and Manufacturing	4.8%	3.8%	4.0%	2.5%

Source: 2008 Company Annual Financial Reports

Royalty fees, as the result of employing intellectual property, are also captured in the ED&T mark-up section. When such cases exist, separate lines in the Manufacturing Assumption & Quote Summary (MAQS) worksheet are used to capture these costs. These costs are in addition to the standard ED&T rates. The calculation of the royalty fees are on a case by case basis and information regarding the calculation of each fee can be found in the individual MAQS worksheets where applicable.

As part of the costing assumptions, intellectual property is always treated as though it is purchased from a second entity.

See Table 7-2 for applicable mark-up rates based on the supplier processing equipment size and complexity capabilities.

Table 7-2: Standard Mark-up Rates Applied to Tier 1 and Tier 2/3 Suppliers Based on Size and Complexity Ratings

Primary Manufacturing Equipment Group	End Item Scrap Mark-up	SG&A Mark-up	Profit Mark-up	ED&T Mark-up	Total Mark-up
Tier 2 /3 – Large Size, High Complexity,	0.7%	7.0%	8.0%	2.0%	17.7%
Tier 2 /3 – Medium Size, Moderate Complexity,	0.5%	6.5%	6.0%	1.0%	14.0%
Tier 2 /3 – Small Size, Low Complexity	0.3%	6.0%	4.0%	0.0%	10.3%
Tier 1 Complete System/Subsystem Supplier (System/Subsystem Integrator)	0.7%	7.0%	8.0%	6.0%	21.7%
T1 High Complexity Component Supplier	0.7%	7.0%	8.0%	4.0%	19.7%
T1 Moderate Complexity Component Supplier	0.5%	6.5%	6.0%	2.5%	15.5%
T1 Low Complexity Component Supplier	0.3%	6.0%	4.0%	1.0%	11.3%

The following additional points should be noted:

For Tier 2/Tier 3 (T2/T3) suppliers, the same level of mark-up is applied regardless of the primary manufacturing process group and primary manufacturing equipment group involved. For example a T2/T3, large, high complexity thermoplastic injection molding process will have the same mark-up rates as a T2/T3, large, high complexity, stamping and forming fine blanking process; it is size and complexity capabilities which produce the different mark-up rates within the T2/T3 supplier's classifications.

- In reference to the item above, these are standard or base rates. If one of the primary manufacturing process groups and/or equipment groups requires a higher scrap, SG&A, profit and/or ED&T rate, the Mark-up Database is adjusted accordingly.
- The Tier 1 (T1) mark-up classification system is based on a component, assembly, or system complexity ranking. For example a supplier who is manufacturing complete transmissions for an OEM would charge a total mark-up rate of 21.7% on the Total Manufacturing Costs versus the Supplier who provides an oil pan directly to the OEM would only receive 11.3% in mark-up.

- All value-added operations, in addition to final assembly performed by a T1 supplier (injection molding, casting, stamping, etc.), receive the mark-up rate defined by their complexity rating.

7.5.3 Assigning Mark-up Rates

The three (3) primary steps to matching mark-up rates to a given component/assembly are as follows:

Step 1. Primary manufacturing process and equipment groupings are pre-selected as part of the process to identify the manufacturing overhead rate.

Step 2. Manufacturing facilities are identified as OEM, T1 or T2/T3 (this identification process is discussed in more detail in the Manufacturing Assumption & Quote Summary worksheet section).

Step 3. The best-fit mark-up rate is selected based on the size and complexity of the part, which in turn is reflected in the size and complexity of the processing equipment. Note that size and complexity are considered as independent parameters when reviewing a component and the equipment capabilities (with priority typically given to 'complexity')

Table 7-3 is an example of mark-up rate classifications based on size and complexity combinations for some typical stampings, castings, and injection molded parts. In addition, other attributes which are not included in the naming convention (such as component function and performance) are also considered when assigning mark-up rates.

Table 7-3: Generic Mark-Up Rate Classification Based on Component Size and Complexity

Size Attribute	Complexity Attribute	Mark-Up Rate Classification
Large	High	Large Size, High Complexity
Medium	High	Large Size, High Complexity
Small	High	Large Size, High Complexity
Large	Moderate	Large Size, High Complexity
Medium	Moderate	Medium Size, Moderate Complexity
Small	Moderate	Medium Size, Moderate Complexity
Large	Low	Medium Size, Moderate Complexity
Medium	Low	Small Size, Low Complexity
Small	Low	Small Size, Low Complexity

7.6 Packaging Database

7.6.1 Overview

The Packaging Database contains standardized packaging options available for developing packaging costs for components and assemblies. In the cost analysis only packaging costs required to transport a component/assembly from a Tier 1 to an OEM facility (or one facility to another at the same OEM) are calculated in detail. For Tier 2/3 suppliers of high- and low-impact components, as well as purchased parts, the Tier 1 mark-up is estimated to cover the packaging as well as shipping expenses. Tier 1 mark-up on incoming Tier 2/3 parts and purchase parts are discussed in more detail in Section 8.

All core packaging items (containers, pallets, totes, etc.) referenced in the database are considered returnable dunnage. Internal packaging (tier pads, dividers, formed trays, etc.) are also considered returnable with the exception of a few items that are expendable. The cost to clean and maintain returnable dunnage is assumed to be covered by the manufacturing overhead rate.

7.6.2 Types of Packaging and Selection Process

Packaging options in the database are limited to a few standard types and sizes to minimize complexity. In general, everything is tailored towards fitting onto a standard automotive pallet (as specified by the Automotive Industry Action Group), which has exterior dimensions of 48 by 45 inches and a base height assumption of 34 inches (although other standard sizes exist in 25, 33 39, 42, 48, and 50 inches in height). A standard transport trailer height of 106" is used as the guideline for overall packaging height.

When initially trying to package a component, three (3) typical packaging options are considered:

- standard 48 by 45 by 34-inch palletized container (with tier pads and dividers)
- 48 by 45-inch base pallet with stacked 21.5 by 15 by 12.5-inch totes (48 totes max – and note that totes can have specialized tier pads, dividers, etc.)
- 48 by 45-inch base pallet with vacuum formed dividers strapped together

Considering component attributes such as weight, size, shape, fragility, and cleanliness, one (1) of the packaging options above are selected, along with an internal dunnage scheme. If it is deemed impractical to package the component within one (1) of the primary options, a new package style is created and added to the Packaging Database.

Once the primary packaging type and associated internal dunnage are selected for a component, the assumptions along with the costs are entered into a Manufacturing Assumption Quote Summary (MAQS) worksheet. In the MAQS worksheet, packaging costs along with volume assumptions, pack densities, stock turn-over times, program life, packaging life, and interest expenses are used to calculate a cost-per-part for packaging. Section 9 provides more details on the calculation of packaging costs.

7.6.3 Support for Costs in Packaging Database

Primary pallet and container costs are acquired from either Tier 1 automotive suppliers or from container vendors. In some cases, scaling within container groups is performed to quantify the pricing for slightly larger or smaller containers within the same family.

Internal dunnage costs are acquired from either Tier 1 automotive suppliers or calculated based on standard material and processing estimates. When tooling costs are required for packaging, the value of that tooling is added to the total pallet container piece cost, as calculated in the MAQS worksheets. The total value is then amortized to calculate a cost-per-part for packaging.

8 Shipping Costs

In the cost analysis, shipping costs are accounted for by one of three factors: Indirect Cost multiplier, total mark-up allowance, or manufacturing overhead. Further shipping costs, with the exception of inner company transportation, are always considered freight on board (FOB) the shipper's dock. Below are the four (4) shipping scenarios encountered in the cost analysis and how each case is handled.

The first two (2) cases, OEM and supplier inner company transportation, shipping costs are accounted for as part of the manufacturing overhead rate. It is assumed that the OEM or supplier would either have their own transportation equipment and/or subcontract this service out. In either case the expense is binned to manufacturing overhead.

The third case is Tier 1 shipments to an OEM facility. As stated above the shipments are FOB the shipper's dock and thus the OEM is responsible for the shipping expense. In this case the Indirect Cost multiplier is assumed to cover the OEM's expense to have all parts delivered to the applicable OEM manufacturing facilities.

The final case is Tier 2/3 shipments to the Tier 1 facility. Generally, the Tier 1 supplier is allowed a mark-up on incoming purchased parts from Tier 2/3 suppliers. The mark-up covers many costs including the shipping expenses to have the part delivered onto the Tier 1 supplier's dock. Further, the mark-up can either be a separate mark-up only applied to incoming purchased parts, or accounted for by the mark-up applied to the TMCs. In the former, the purchase part content would not be included in the final mark-up calculation (i.e., Mark-up = (TMC -Purchase Parts cost) x Applicable Mark-up Rate).

For this cost analysis, the latter case is chosen using the same mark-up rate for all Tier 1 value-added manufacturing as well as all incoming purchase parts.

9 Manufacturing Assumption and Quote Summary Worksheet

9.1 Overview

The Manufacturing Assumption and Quote Summary (MAQS) worksheet is the document used in the cost analysis process to compile all the known cost data, add any remaining cost parameters, and calculate a final unit cost. All key manufacturing cost information can be viewed in the MAQS worksheet for any component or assembly. Additional details on the information which flows into, and out of the MAQS worksheet are discussed in more detail below. Section 11 discusses how MAQS worksheets are uploaded into subsystem and system summary templates to calculate the net component/assembly cost impact to the OEM.

The fundamental objective of the MAQS worksheet is similar to a standard quoting template used by the automotive industry. However the format has been revised to capture additional quote details and manufacturing assumptions, improve on transparency by breaking out all major cost elements, and accommodate variable data inputs for the purpose of sensitivity assessments. These features are discussed in more detail below.

For a given case study, all Tier 1 or OEM assemblies, identified in the CBOM as requiring cost analysis, will have a link to a MAQS worksheet. In some cases where high value final assembly Tier 2/3 parts are shipped to a Tier 1 supplier, a separate MAQS worksheet is created for greater transparency. These T2/3 MAQS worksheets are linked to T1/OEM MAQS worksheets, which in turn are referenced back to the CBOM.

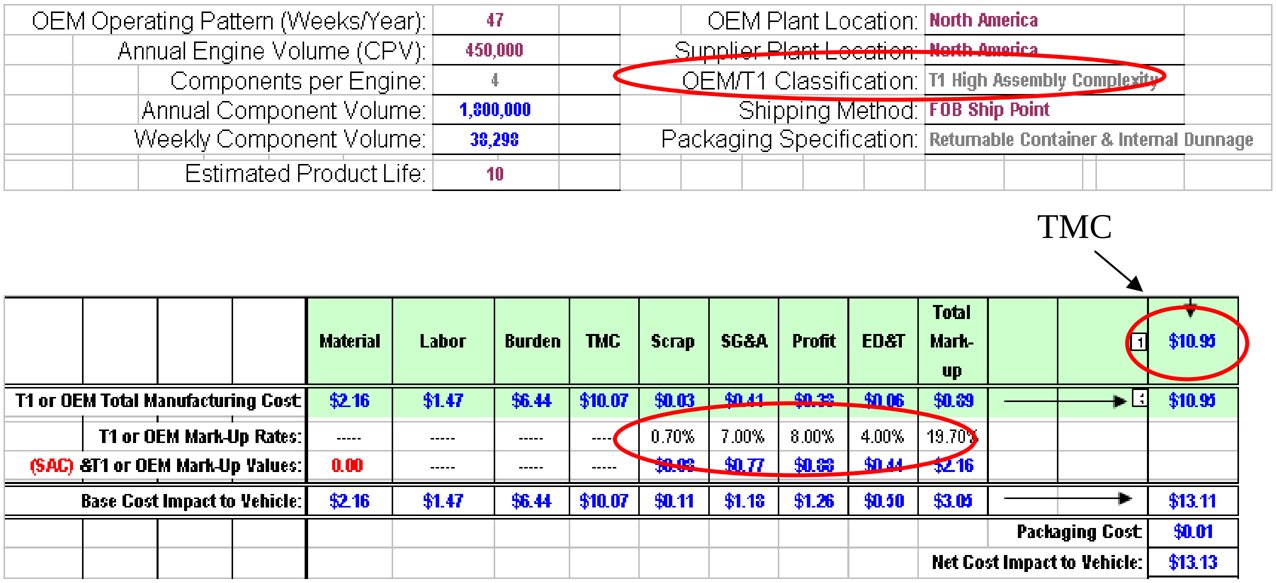
9.2 Main Sections of Manufacturing Assumption and Quote Summary Worksheet

At the top of every MAQS worksheet is an information header ***(Section A)*** which captures the basic project details along with the primary quote assumptions. The project detail section references the MAQS worksheet back to the applicable CBOM. The primary quote assumption section provides the basic information needed to put together a quote for a component/assembly. Some of the parameters in the quote assumption section are automatically referenced/linked throughout the MAQS worksheet such as capacity planning volumes, product life span, and OEM/T1 classification. The remaining parameters in this section including facility locations, shipping methods, packing specifications, and component quote level are manually considered for certain calculations. Included in Appendix F.1 is a sample MAQS worksheet identifying all the major sections.

Two (2) parameters above whose functions perhaps are not so evident from their names are the “OEM/T1 classification” and “component quote level”.

The "OEM/T1 classification" parameter addresses who is taking the lead on manufacturing the end-item component, the OEM or Tier 1 supplier. In addition, the OEM or Tier 1 level, defined by size, complexity, and expertise level is also captured. The value entered into the cell is linked to the Mark-up Database, which will up-load the corresponding mark-up values from the database into the MAQS worksheet. For example if "T1 High Assembly Complexity" is typed into the input cell, the following values for mark-up are pulled into the worksheet: Scrap = 0.70%, SG&A = 7%, Profit = 8.0% and ED&T = 4%. These rates are then multiplied by the TMC at the bottom of the MAQS worksheet to calculate the applied mark-up as shown in Figure 9-1.

The process for selecting the classification of the lead manufacturing site (OEM or T1) and corresponding complexity (e.g. High Assembly Complexity, Moderate Assembly Complexity, Low Assembly Complexity) is based on the team's knowledge of existing value chains for same or similar type components.



OEM Operating Pattern (Weeks/Year):	47	OEM Plant Location:	North America
Annual Engine Volume (CPV):	450,000	Supplier Plant Location:	North America
Components per Engine:	4	OEM/T1 Classification:	T1 High Assembly Complexity
Annual Component Volume:	1,800,000	Shipping Method:	FOB Ship Point
Weekly Component Volume:	38,298	Packaging Specification:	Returnable Container & Internal Dunnage
Estimated Product Life:	10		

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1 $10.95
T1 or OEM Total Manufacturing Cost:	$2.16	$1.47	$6.44	$10.07	$0.03	$0.41	$0.38	$0.06	$0.89	→	$10.95
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.70%	7.00%	8.00%	4.00%	19.70%		
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.08	$0.77	$0.88	$0.44	$2.16		
Base Cost Impact to Vehicle:	$2.16	$1.47	$6.44	$10.07	$0.11	$1.18	$1.26	$0.50	$3.05	→	$13.11
										Packaging Cost:	$0.01
										Net Cost Impact to Vehicle:	$13.13

Figure 9-1: Excerpt Illustrating Automated Link between OEM/T1 Classification Input in MAQS Worksheet and the Corresponding Mark-up Percentages Uploaded from the Mark-up Database

The "component quote level" identifies what level of detail is captured in the MAQS worksheet for a particular component/assembly, full quote, modification quote, or differential quote. When the "full quote" box is checked off, it indicates all manufacturing costs are captured for the component/assembly. When the "modification quote" box is checked off, it indicates only the changed portion of the component/assembly, has been quoted. A differential quote is similar to a modification quote with the exception that information from both technology configurations, is brought into the same MAQS worksheet, and a differential analysis is conducted on the input cost attributes versus the output cost attributes. For example, if two (2) engine cylinder heads are being compared for cost, each head can have its' differences quoted in a separate MAQS worksheet (modification quote) and the total cost outputs for each can be subtracted to acquire the differential cost. Alternatively in a single MAQS worksheet the cost driving attributes for the differences between the head's (e.g., weight, material type, machining time, heat treat processes, etc.) can be offset, and the differential cost calculated in a single worksheet. The differential quote method is typically employed with those components with low differential cost impact to help minimize the number of MAQS worksheets being generated.

From left to right, the MAQS worksheet is broken into two (2) main sections as the name suggests, a quote summary ***(Section B)*** and manufacturing assumption section ***(Section D).*** The manufacturing assumption section, positioned to the right of the quote summary section, is where the additional assumptions and calculations are made to convert the serial processing operations from Lean Design® into mass production operations. Calculations made in this section are automatically loaded into the quote summary section. The quote summary section, utilizes this data, along with other costing database data, to calculate the total cost for each defined operation in the MAQS worksheet.

Note "defined operations" are all the value-added operations required to make a component or assembly. For example, a high pressure fuel injector may have twenty (20) base level components which all need to be assembled together. To manufacture one (1) of the base level components there may be as many as two (2) or three (3) value-added process operations (e.g., cast, heat treat, machine). In the MAQS worksheet each of these process operations has an individual line summarizing the manufacturing assumptions and costs for the defined operation. For a case with two (2) defined operations per base level component, plus two (2) subassembly and final assembly operations, there could be as many as forty (40) defined operations detailed out in the MAQS worksheet. For ease of viewing all the costs associated with a part, with multiple value-added operations, the operations are grouped together in the MAQS worksheet.

Commodity based purchased parts are also included as a separate line code in the MAQS worksheet. Although there are no supporting manufacturing assumptions and/or calculations required since the costs are provided as total costs.

From top to bottom, the MAQS worksheet is divided into four (4) quoting levels in which both the value-added operations and commodity based purchase parts are grouped: (1) Tier 1 Supplier or OEM Processing and Assembly, (2) Purchase Part – High Impact Items, (3) Purchase Part – Low Impact Items, and (4) Purchase Part – Commodity. Each quoting level has different rules relative to what cost elements are applicable, how cost elements are binned, and how they are calculated.

Items listed in the ***Tier 1 Supplier or OEM Processing and Assembly*** section are all the assembly and subassembly manufacturing operations assumed to be performed at the main OEM or T1 manufacturing facility. Included in manufacturing operations, would be any on-line attribute and/or variable product engineering characteristic checks. For this quote level full detailed cost analysis is performed, with the exception of mark-up which is applied to the TMC at the bottom of the worksheet.

Purchase Part – High Impact Items include all the operations assumed to be performed at Tier 2/3 (T2/3) supplier facilities and/or T1 internal supporting facilities. For this quote level, detailed cost analysis is performed including mark-up calculations for those components/operations considered to be supplied by T2/3 facilities. T1 internal supporting facilities included in this category do not include mark-up calculations. As mentioned above, the T1 mark-up (for main and supporting facilities), is applied to the TMC at the bottom of the worksheet.

Purchase Part – Low Impact Items are for *higher priced* commodity based items which need to have their manufacturing cost elements broken out and presented in the MAQS sheet similar to high impact purchase parts. If not, the material cost group in the MAQS worksheet may become distorted since commodity based purchase part costs are binned to material costs. The cost estimating methodology used is basically a reverse costing process, where the total cost is known and estimates are required to divide the costs into material, labor, burden and mark-up. This level of quoting was not frequently used in the first case study (#0101).

Purchase Part – Commodity parts are represented in the MAQS worksheet as a single cost and are binned to material costs.

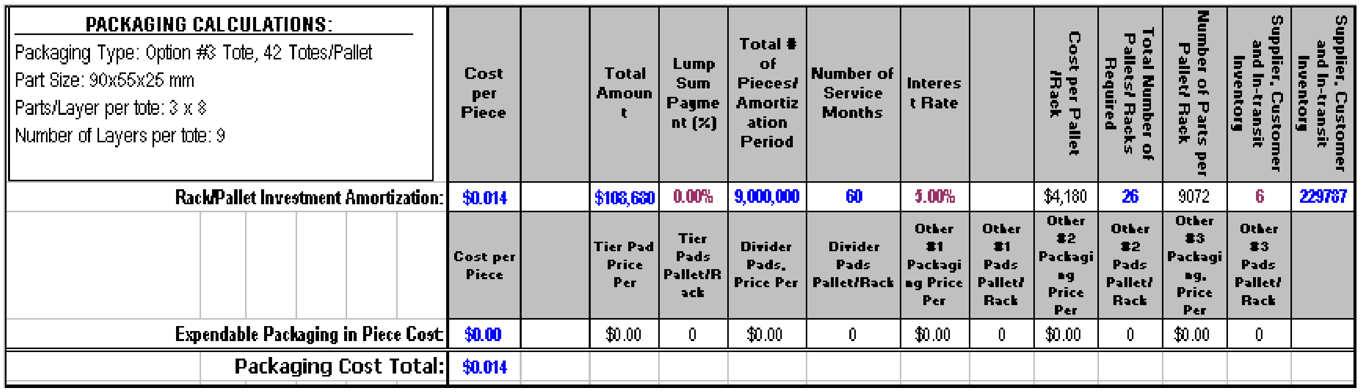
At the bottom of the MAQS worksheet ***(Section F)***, all the value-added operations and commodity based purchase part costs, recorded in the four (4) quote levels, are automatically added together to obtain the TMC. The applicable mark-up rates based on the T1 or OEM classification recorded in the MAQS header are then multiplied by the TMC to obtain the mark-up contribution. Adding the TMC and mark-up contribution together a subtotal unit cost is calculated.

Important to note is that throughout the MAQS worksheet, all seven (7) cost element categories (material, labor, burden, scrap, SG&A, profit, and ED&T) are maintained in the analysis. ***Section C***, MAQS breakout calculator, which resides between the quote summary and manufacturing assumption sections, exists primarily for this function.

The last major section of the MAQS worksheet is the packaging calculation, ***Section E***. In this section of the MAQS worksheet a packaging cost contribution is calculated for each part based on packaging requirements, pack densities, volume assumptions, stock and transit lead times, etc.

The sample packaging calculation (Figure 9-2) is taken from the high pressure fuel injector MAQS worksheet, Case Study #N0101. In this example, six (6) weeks (which is the default value) of packaging is required to support inventory and transit lead times. This equates to packaging for 229,787 parts, over the six (6) weeks, based off the weekly capacity planning rates. There are 9,072 pieces per pallet at a packaging hardware cost of $4180 per pallet (container and internal dunnage costs are from the Packaging Database). From the above information, twenty (26) pallet sets are required @ $4180/set equaling a total of $108,680 in packaging costs. Packaging is estimated to last sixty (60) months. Thus applying the amortization formula based on sixty (60) months, 5% interest, and 9M parts/ 60 months yields $0.014/part. This cost is added to the subtotal unit cost (TMC + mark-up) to obtain the Total Unit Cost.

Note in this case both the container and dunnage are assumed returnable. Thus the bottom section of the packaging calculator is not used.



PACKAGING CALCULATIONS: Packaging Type: Option #3 Tote, 42 Totes/Pallet Part Size: 90x55x25 mm Parts/Layer per tote: 3 x 8 Number of Layers per tote: 9	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces/ Amortization Period	Number of Service Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory	Supplier, Customer and In-transit Inventory
Rack/Pallet Investment Amortization:	$0.014		$108,680	0.00%	9,000,000	60	5.00%		$4,180	26	9072	6	229787
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/ Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/ Rack	Other #3 Packaging. Price Per	Other #3 Pads Pallet/ Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.014												

Figure 9-2: Example of Packaging Cost Calculation for a High Pressure Fuel Injector

9.3 Manufacturing Assumption and Quote Summary Detail Review

Although simple in function, the MAQS worksheet appears rather complex due to the amount of information imported, referenced, analyzed, and exported. To help describe this information flow into and out of the MAQS worksheet, as well as the internal interactions taking place, a detailed reference table has been created.

In Appendix F.1, the main tasks for each section of the MAQS worksheet have been listed, along with the input sources, reference sources and output sources of information and data exchange associated with each task. In addition, key sources of interaction and data exchanges have been identified with special text formatting to help highlight these key interaction sources. For example two (2) of the major sources of data into the MAQS worksheet come from Lean Design® process maps/exports and databases (five (5) databases in total). Thus, both these sources are highlighted through the table. Lastly, in the task description column, the word “Enter” or “Automatically” have been highlighted to give the reader a sense of how much data is manually entered versus automatically loaded for each MAQS worksheet.

Note, revisions were made to the MAQS worksheet template as the cost study analysis progressed. As such, the information shown in Appendix F.1, MAQS Worksheet Task Reference Guide and accompanying MAQS worksheet template, will exist at a higher revision level than a few of the case study MAQS worksheets found in Appendix G.1. Only components which required the latest revision level MAQS template features were updated during the first cost analysis.

10 Marketplace Validation

Marketplace validation is the process by which individual parts, components and/or assemblies are cross-checked with costing data developed by entities and processes external to the team responsible for the cost analysis. This process occurs at all stages of the cost analysis; special emphasis is placed on cross-checking in-process costs (e.g. material costs, material selection, labor costs, manufacturing overhead costs, scrap rates, and individual component costs within an assembly).

In-process cost validation occurs when a preliminary cost has been developed for a particular part within an assembly, and the cost is significantly higher or lower than expected based on the team’s technical knowledge, or on pricing from similar components. In this circumstance the cost analysis team would first revisit the costs, drawing in part/process-specific internal expertise and checking surrogate parts from previously costed bills of materials where available. If the discrepancy is still unresolved, the team would rely on automotive supplier networks, industry experts, and/or publicly available publications to validate the cost assumptions, making changes where warranted.

Cross-checking on final assembly costs (e.g. turbochargers, direct injectors, high pressure fuel pumps) also occurs within the scope of the cost analysis, mainly as a “big picture” check. In general cross-checking final assembly costs are typically achieved through solicitation of industry experts. The depth of cross-checking ranges from simple comparison of cost data on surrogate assemblies to full Manufacturing Assumption and Quote Summary (MAQS) worksheet reviews.

11 Cost Model Analysis Templates

11.1 Subsystem Cost Model Analysis Templates

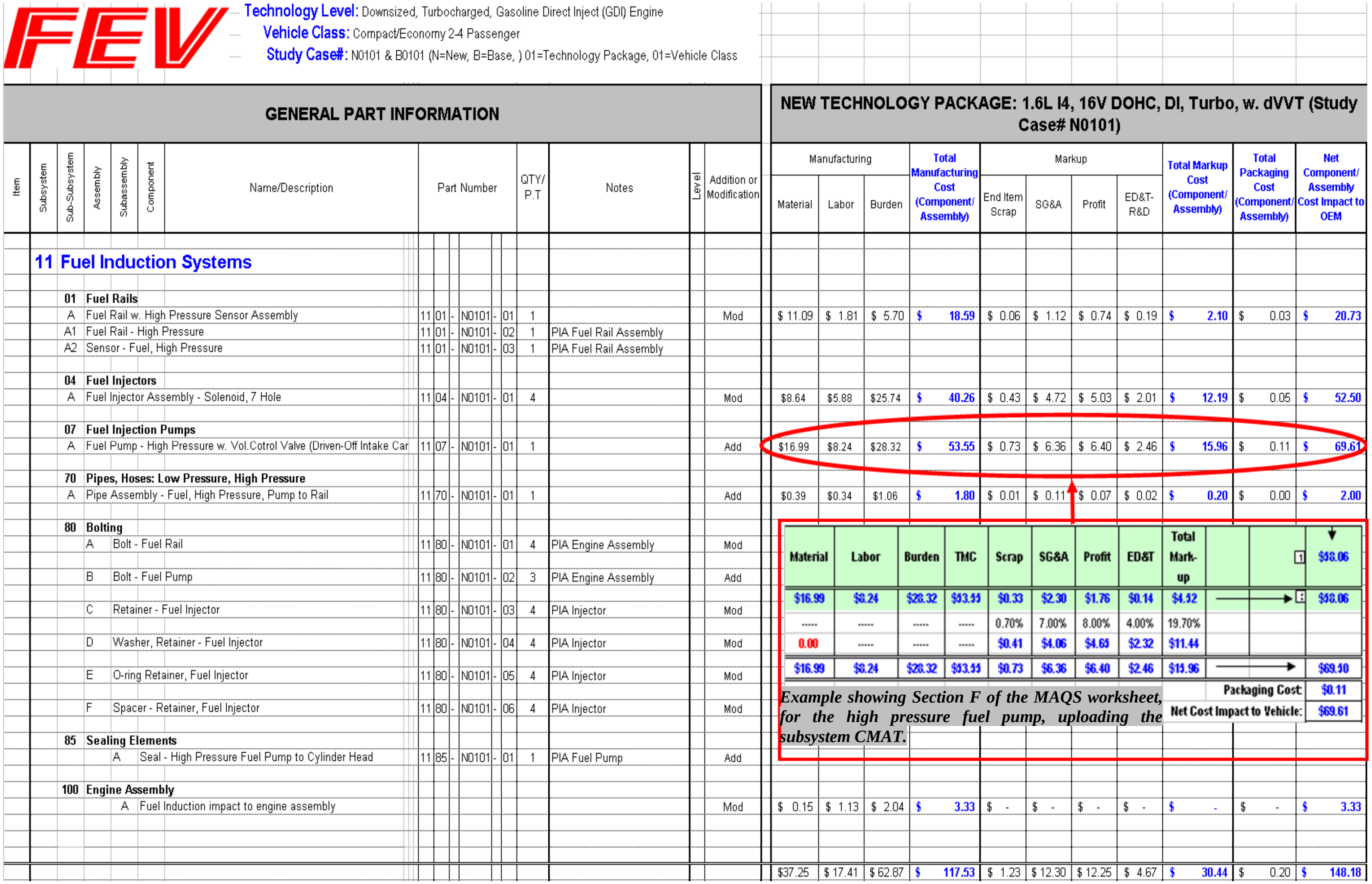
The Subsystem Cost Model Analysis Template (CMAT) is the document used to display and roll-up all the costs associated with a subsystem (fuel induction, air induction, exhaust, etc.) as defined by the CBOM. All parts identified, within the applicable subsystem of the CBOM, as requiring cost analysis, are entered into the CMAT. Also both the base and new technology configurations are included in the same CMAT to facilitate the differential cost analysis.

The cost inputs for the Subsystem CMAT are the MAQS worksheets. As discussed previously, generally every component and assembly identified in the CBOM, as requiring cost analysis will have a MAQS worksheet. However, there are a few key exceptions to this rule, listed below, worth pointing out.

1. Because the basis of the analysis is a differential analysis, the base technology configuration is assumed "Zero Cost" and everything is quoted as a differential to this zero baseline. Thus in many case studies there are very few MAQS worksheets for the baseline configuration. Note that in the CMAT, "$ 0" or "$ -" indicates that no MAQS worksheets exists.
2. In those cases where the baseline configuration has identified differences requiring costing, two (2) potential paths are possible.
    a. A Full or Modified Quote level MAQS worksheet (pending situation) is created for both the new and base technology components and/or assemblies, and the totals are subtracted out in the CMAT.
    b. A Differential Quote level MAQS worksheet is created where both the baseline and new technology components or assemblies are pulled into the same MAQS worksheet for differential cost analysis. In this case the costs are binned to either the base or new technology configuration (case dependent) and the technology configuration showing zero costs is highlighted yellow (i.e., "$ 0" or "$ - ") in the CMAT.

The MAQS worksheets are automatically linked to the CMAT templates to facilitate automatic updating for assumption changes and/or sensitivity studies. This includes uploading all eight (8) unit cost elements including packaging. Figure 11-1 and Figure 11-2 are samples excerpts of the CMAT taken from the Fuel Induction Subsystem, Case Study #0101 (Base 2.4L I4, Naturally Aspirated, Port Fuel Injected (PFI) downsized to a new 1.6L, I4 Turbo, Direct Injection (DI). Included in Figure 11-1, is an overlay of the Unit Cost Summary section, taken from the MAQS worksheet for the high pressure fuel Pump, highlighting the link between the documents. For this particular Fuel Induction Subsystem example, the Net Component Assembly Cost Impact to the OEM is $148.18, for the new technology configuration, and $40.84 for the base technology configuration.

Thus $107.34 ($148.18-$40.84) is the pre-estimated cost impact to add DI over PFI. Pre-estimated indicating that there are other potentially cost factors for adding DI which are not included in the Fuel Induction Subsystem classification. For example additional machining of the cylinder head for mounting the injectors would be an added cost addressed in the Head Subsystem.



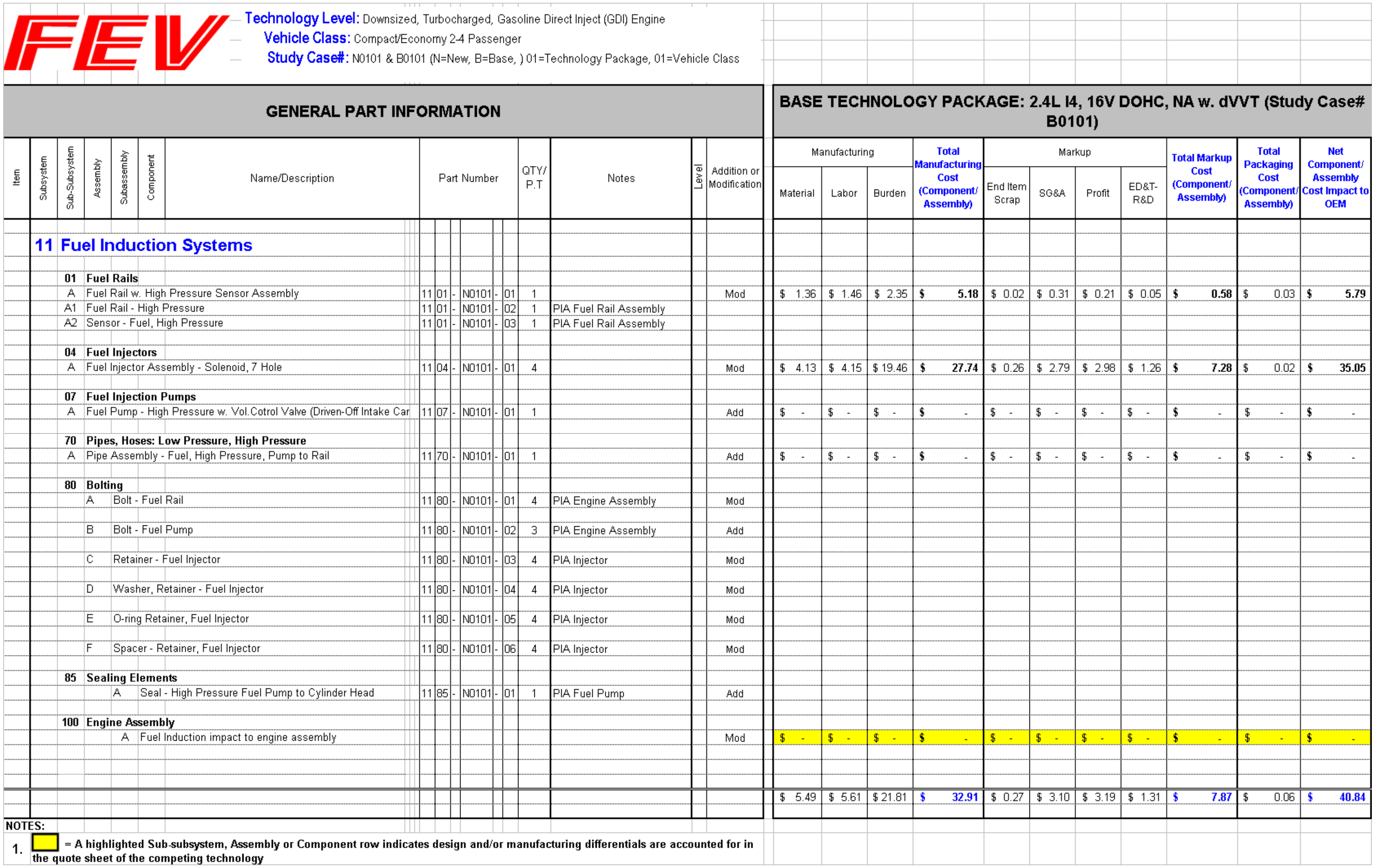
Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Addition or Modification	Material	Labor	Burden	Total Manufacturing Cost (Component/ Assembly)	End Item Scrap	SG&A	Profit	ED&T- R&D	Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
GENERAL PART INFORMATION												NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo, w. dVVT (Study Case# N0101)										
												Manufacturing				Markup						
	11	Fuel Induction Systems																				
		01	Fuel Rails																			
		A				Fuel Rail w. High Pressure Sensor Assembly	11 01 - N0101 - 01	1			Mod	$ 11.09	$ 1.81	$ 5.70	$ 18.59	$ 0.06	$ 1.12	$ 0.74	$ 0.19	$ 2.10	$ 0.03	$ 20.73
		A1				Fuel Rail - High Pressure	11 01 - N0101 - 02	1	PIA Fuel Rail Assembly													
		A2				Sensor - Fuel, High Pressure	11 01 - N0101 - 03	1	PIA Fuel Rail Assembly													
		04	Fuel Injectors																			
		A				Fuel Injector Assembly - Solenoid, 7 Hole	11 04 - N0101 - 01	4			Mod	$8.64	$5.88	$25.74	$ 40.26	$ 0.43	$ 4.72	$ 5.03	$ 2.01	$ 12.19	$ 0.05	$ 52.50
		07	Fuel Injection Pumps																			
		A				Fuel Pump - High Pressure w. Vol.Cotrol Valve (Driven-Off Intake Car	11 07 - N0101 - 01	1			Add	$16.99	$8.24	$28.32	$ 53.55	$ 0.73	$ 6.36	$ 6.40	$ 2.46	$ 15.96	$ 0.11	$ 69.61
		70	Pipes, Hoses: Low Pressure, High Pressure																			
		A				Pipe Assembly - Fuel, High Pressure, Pump to Rail	11 70 - N0101 - 01	1			Add	$0.39	$0.34	$1.06	$ 1.80	$ 0.01	$ 0.11	$ 0.07	$ 0.02	$ 0.20	$ 0.00	$ 2.00
		80	Bolting																			
			A			Bolt - Fuel Rail	11 80 - N0101 - 01	4	PIA Engine Assembly		Mod											
			B			Bolt - Fuel Pump	11 80 - N0101 - 02	3	PIA Engine Assembly		Add											
			C			Retainer - Fuel Injector	11 80 - N0101 - 03	4	PIA Injector		Mod											
			D			Washer, Retainer - Fuel Injector	11 80 - N0101 - 04	4	PIA Injector		Mod											
			E			O-ring Retainer, Fuel Injector	11 80 - N0101 - 05	4	PIA Injector		Mod											
			F			Spacer - Retainer, Fuel Injector	11 80 - N0101 - 06	4	PIA Injector		Mod											
		85	Sealing Elements																			
				A		Seal - High Pressure Fuel Pump to Cylinder Head	11 85 - N0101 - 01	1	PIA Fuel Pump		Add											
		100	Engine Assembly																			
				A		Fuel Induction impact to engine assembly					Mod	$ 0.15	$ 1.13	$ 2.04	$ 3.33	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.33
												$37.25	$ 17.41	$ 62.87	$ 117.53	$ 1.23	$ 12.30	$ 12.25	$ 4.67	$ 30.44	$ 0.20	$ 148.18

Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up			$58.06
$16.99	$8.24	$28.32	$53.55	$0.33	$2.30	$1.76	$0.14	$4.52	→		$58.06
-----	-----	-----	-----	0.70%	7.00%	8.00%	4.00%	19.70%			
0.00	-----	-----	-----	$0.41	$4.06	$4.65	$2.32	$11.44			
$16.99	$8.24	$28.32	$53.55	$0.73	$6.36	$6.40	$2.46	$15.96	→		$69.50
										Packaging Cost:	$0.11
										Net Cost Impact to Vehicle:	$69.61

Example showing Section F of the MAQS worksheet, for the high pressure fuel pump, uploading the subsystem CMAT.

Figure 11-1: Excerpt from Subsystem Cost Model Analysis Template Illustrating Subsystem Cost Roll Up for the Fuel Induction Subsystem - New Technology Configuration - Case Study #N0101



FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

GENERAL PART INFORMATION												BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT (Study Case# B0101)										
												Manufacturing				Markup						
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Addition or Modification	Material	Labor	Burden	Total Manufacturing Cost (Component/ Assembly)	End Item Scrap	SG&A	Profit	ED&T-R&D	Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
	11					**Fuel Induction Systems**																
		01				**Fuel Rails**																
		A				Fuel Rail w. High Pressure Sensor Assembly	11 01 - N0101 - 01	1			Mod	$ 1.36	$ 1.46	$ 2.35	$ **5.18**	$ 0.02	$ 0.31	$ 0.21	$ 0.05	$ **0.58**	$ 0.03	$ **5.79**
		A1				Fuel Rail - High Pressure	11 01 - N0101 - 02	1	PIA Fuel Rail Assembly													
		A2				Sensor - Fuel, High Pressure	11 01 - N0101 - 03	1	PIA Fuel Rail Assembly													
		04				**Fuel Injectors**																
		A				Fuel Injector Assembly - Solenoid, 7 Hole	11 04 - N0101 - 01	4			Mod	$ 4.13	$ 4.15	$ 19.46	$ **27.74**	$ 0.26	$ 2.79	$ 2.98	$ 1.26	$ **7.28**	$ 0.02	$ **35.05**
		07				**Fuel Injection Pumps**																
		A				Fuel Pump - High Pressure w. Vol.Cotrol Valve (Driven-Off Intake Car	11 07 - N0101 - 01	1			Add	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		70				**Pipes, Hoses: Low Pressure, High Pressure**																
		A				Pipe Assembly - Fuel, High Pressure, Pump to Rail	11 70 - N0101 - 01	1			Add	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		80				**Bolting**																
			A			Bolt - Fuel Rail	11 80 - N0101 - 01	4	PIA Engine Assembly		Mod											
			B			Bolt - Fuel Pump	11 80 - N0101 - 02	3	PIA Engine Assembly		Add											
			C			Retainer - Fuel Injector	11 80 - N0101 - 03	4	PIA Injector		Mod											
			D			Washer, Retainer - Fuel Injector	11 80 - N0101 - 04	4	PIA Injector		Mod											
			E			O-ring Retainer, Fuel Injector	11 80 - N0101 - 05	4	PIA Injector		Mod											
			F			Spacer - Retainer, Fuel Injector	11 80 - N0101 - 06	4	PIA Injector		Mod											
		85				**Sealing Elements**																
				A		Seal - High Pressure Fuel Pump to Cylinder Head	11 85 - N0101 - 01	1	PIA Fuel Pump		Add											
		100				**Engine Assembly**																
				A		Fuel Induction impact to engine assembly					Mod	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$ 5.49	$ 5.61	$ 21.81	$ **32.91**	$ 0.27	$ 3.10	$ 3.19	$ 1.31	$ **7.87**	$ 0.06	$ **40.84**

NOTES:

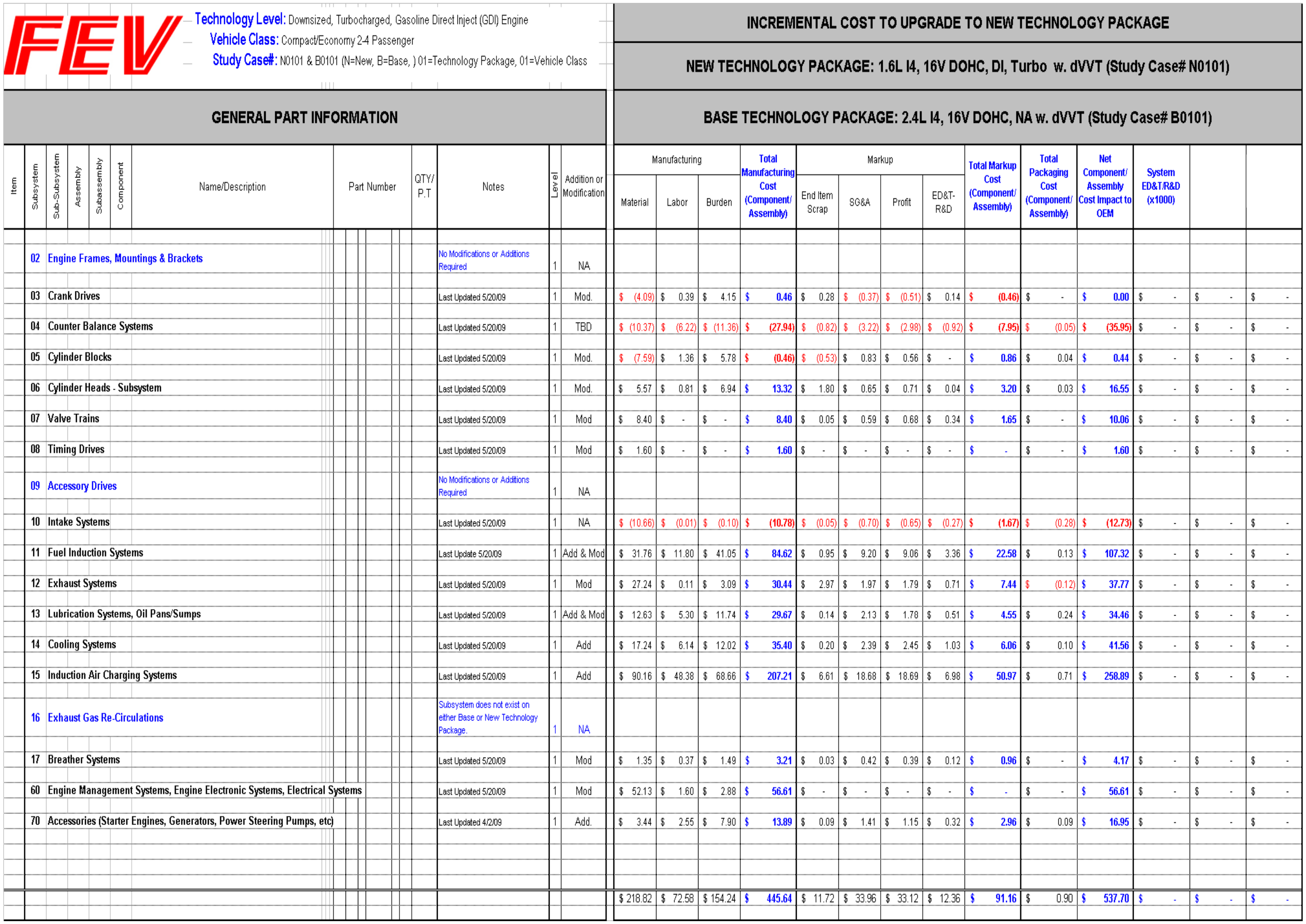
1. 🟨 = **A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology**

Figure 11-2: Excerpt from Subsystem Cost Model Analysis Template Illustrating Subsystem Cost Roll Up for the Fuel Induction Subsystem - Base Technology Package - Case Study #B0101

11.2 System Cost Model Analysis Template

The System CMAT, similar in function to the Subsystem CMAT, is the document used to display and roll-up all the subsystem costs associated within a system, as defined by the Comparison Bill of Materials. Within the scope of this cost analysis, the System CMAT provides the bottom line unit cost, between the base and new technology configurations under evaluation.

As evident in Figure 11-3, the same level of cost detail is maintained throughout all documents providing optimal transparency up to the concluding cost worksheet. In addition, all Subsystem CMAT totals are linked directly to the System CMAT supporting automatic updates due to assumption changes and/or sensitivity studies.



FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine

Vehicle Class: Compact/Economy 2-4 Passenger

Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT (Study Case# N0101)

GENERAL PART INFORMATION

BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT (Study Case# B0101)

Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Addition or Modification	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM	System ED&T/R&D (x1000)		
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D						
	02					Engine Frames, Mountings & Brackets			No Modifications or Additions Required	1	NA														
	03					Crank Drives			Last Updated 5/20/09	1	Mod.	$ (4.09)	$ 0.39	$ 4.15	$ 0.46	$ 0.28	$ (0.37)	$ (0.51)	$ 0.14	$ (0.46)	$ -	$ 0.00	$ -	$ -	$ -
	04					Counter Balance Systems			Last Updated 5/20/09	1	TBD	$ (10.37)	$ (6.22)	$ (11.36)	$ (27.94)	$ (0.82)	$ (3.22)	$ (2.98)	$ (0.92)	$ (7.95)	$ (0.05)	$ (35.95)	$ -	$ -	$ -
	05					Cylinder Blocks			Last Updated 5/20/09	1	Mod.	$ (7.59)	$ 1.36	$ 5.78	$ (0.46)	$ (0.53)	$ 0.83	$ 0.56	$ -	$ 0.86	$ 0.04	$ 0.44	$ -	$ -	$ -
	06					Cylinder Heads - Subsystem			Last Updated 5/20/09	1	Mod.	$ 5.57	$ 0.81	$ 6.94	$ 13.32	$ 1.80	$ 0.65	$ 0.71	$ 0.04	$ 3.20	$ 0.03	$ 16.55	$ -	$ -	$ -
	07					Valve Trains			Last Updated 5/20/09	1	Mod	$ 8.40	$ -	$ -	$ 8.40	$ 0.05	$ 0.59	$ 0.68	$ 0.34	$ 1.65	$ -	$ 10.06	$ -	$ -	$ -
	08					Timing Drives			Last Updated 5/20/09	1	Mod	$ 1.60	$ -	$ -	$ 1.60	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.60	$ -	$ -	$ -
	09					Accessory Drives			No Modifications or Additions Required	1	NA														
	10					Intake Systems			Last Updated 5/20/09	1	NA	$ (10.66)	$ (0.01)	$ (0.10)	$ (10.78)	$ (0.05)	$ (0.70)	$ (0.65)	$ (0.27)	$ (1.67)	$ (0.28)	$ (12.73)	$ -	$ -	$ -
	11					Fuel Induction Systems			Last Update 5/20/09	1	Add & Mod	$ 31.76	$ 11.80	$ 41.05	$ 84.62	$ 0.95	$ 9.20	$ 9.06	$ 3.36	$ 22.58	$ 0.13	$ 107.32	$ -	$ -	$ -
	12					Exhaust Systems			Last Updated 5/20/09	1	Mod	$ 27.24	$ 0.11	$ 3.09	$ 30.44	$ 2.97	$ 1.97	$ 1.79	$ 0.71	$ 7.44	$ (0.12)	$ 37.77	$ -	$ -	$ -
	13					Lubrication Systems, Oil Pans/Sumps			Last Updated 5/20/09	1	Add & Mod	$ 12.63	$ 5.30	$ 11.74	$ 29.67	$ 0.14	$ 2.13	$ 1.78	$ 0.51	$ 4.55	$ 0.24	$ 34.46	$ -	$ -	$ -
	14					Cooling Systems			Last Updated 5/20/09	1	Add	$ 17.24	$ 6.14	$ 12.02	$ 35.40	$ 0.20	$ 2.39	$ 2.45	$ 1.03	$ 6.06	$ 0.10	$ 41.56	$ -	$ -	$ -
	15					Induction Air Charging Systems			Last Updated 5/20/09	1	Add	$ 90.16	$ 48.38	$ 68.66	$ 207.21	$ 6.61	$ 18.68	$ 18.69	$ 6.98	$ 50.97	$ 0.71	$ 258.89	$ -	$ -	$ -
	16					Exhaust Gas Re-Circulations			Subsystem does not exist on either Base or New Technology Package.	1	NA														
	17					Breather Systems			Last Updated 5/20/09	1	Mod	$ 1.35	$ 0.37	$ 1.49	$ 3.21	$ 0.03	$ 0.42	$ 0.39	$ 0.12	$ 0.96	$ -	$ 4.17	$ -	$ -	$ -
	60					Engine Management Systems, Engine Electronic Systems, Electrical Systems			Last Updated 5/20/09	1	Mod	$ 52.13	$ 1.60	$ 2.88	$ 56.61	$ -	$ -	$ -	$ -	$ -	$ -	$ 56.61	$ -	$ -	$ -
	70					Accessories (Starter Engines, Generators, Power Steering Pumps, etc)			Last Updated 4/2/09	1	Add.	$ 3.44	$ 2.55	$ 7.90	$ 13.89	$ 0.09	$ 1.41	$ 1.15	$ 0.32	$ 2.96	$ 0.09	$ 16.95	$ -	$ -	$ -
												$ 218.82	$ 72.58	$ 154.24	$ 445.64	$ 11.72	$ 33.96	$ 33.12	$ 12.36	$ 91.16	$ 0.90	$ 537.70	$ -	$ -	$ -

Figure 11-3: Excerpt from System Cost Model Analysis Template Illustrating the Incrmental Subystem Cost Roll Up for Case Study #0101 - 2.4L I4, 16 Valve, DOHC, NA, PFI downsized to 1.6L I4, DOHC, Turbo GDI

12 Operating and End-of-Life Costs

Some of the technologies being analyzed may involve additional maintenance or a change in existing maintenance. Some may also involve additional vehicle scrappage costs or salvage value. These incremental costs and savings are evaluated and presented separately from the new vehicle unit costs.

The maintenance and end-of-life cost calculations are performed on a case basis, using methodologies developed and documented specifically for the relevant technology case. The general methodology for maintenance calculations is the following:

1. Identify a new or altered maintenance practice based on owner's manuals, service instructions, and the team's engineering knowledge of how the technology affects vehicle operation.

2. Calculate the differential cost of the identified maintenance practice.

3. Calculate the number of corresponding maintenance cycles over the expected service life of the vehicle.

4. Calculate an incremental cost (or savings) per year and a net present value of the cumulative costs.

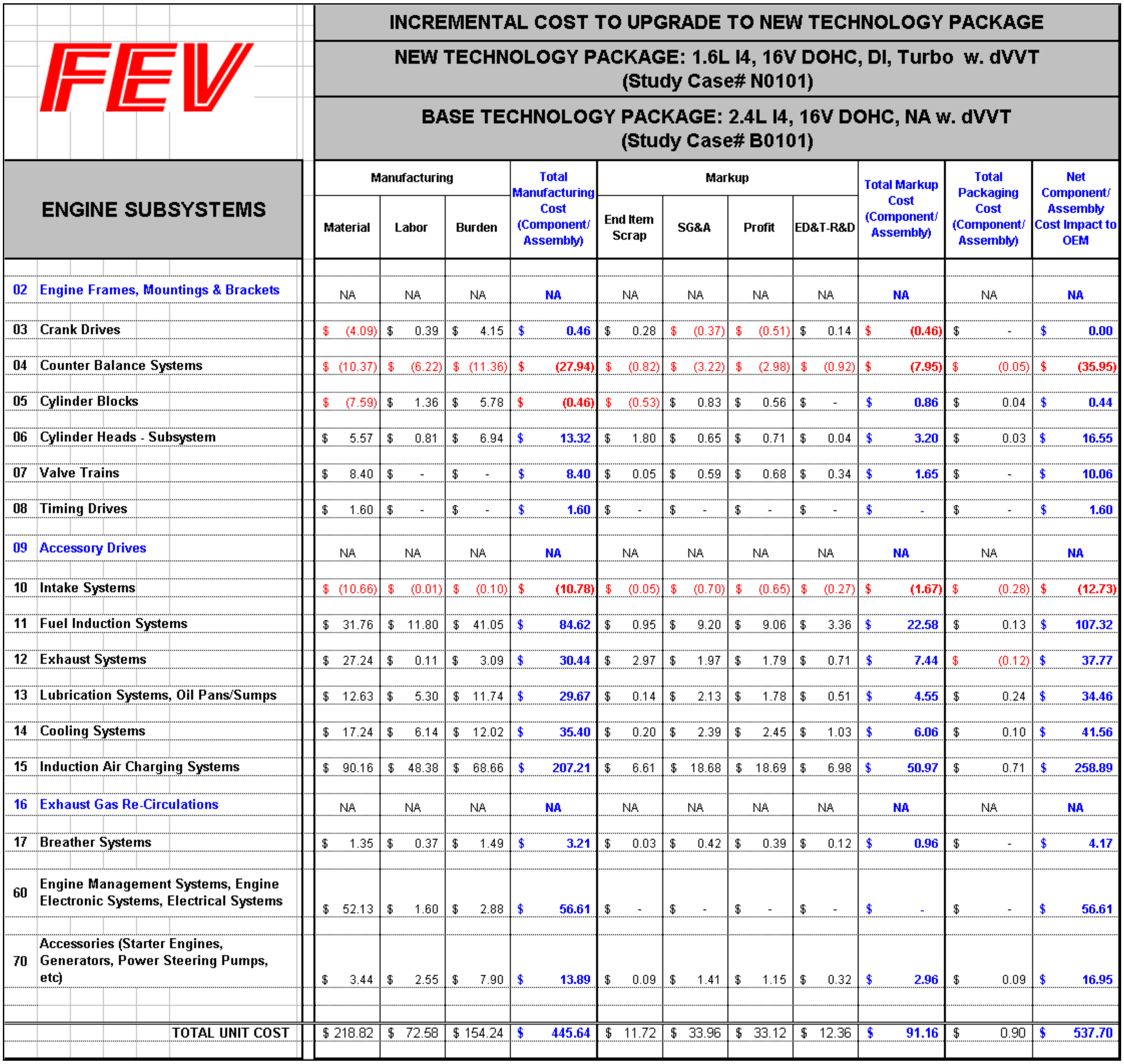
A similar approach is used for the differential salvage value and disposal costs. The #0101 case study documented in this report has identified no new or modified maintenance or end-of-life costs.

13 Results for Case Study #0101

Using the established study methodology detailed in the previous sections, the first cost study analysis was conducted: stoichiometric, gasoline direct injection (GDI) with turbocharging on a downsized I4 engine, compared to an equivalent conventional I4 engine. The hardware chosen to represent the new technology configuration was the 2007 Mini Cooper S, 1.6L I4, four (4) valve, dual overhead cam, turbocharged, direct injection engine (172 hp). The engine selected to represent the baseline configuration was the 2007 Chrysler GEMA 2.4L I4, four (4) valve, dual overhead cam, naturally aspirated, port fuel injected engine (173 hp).

Figure 13-1 is an excerpt from the System CMAT showing the incremental cost impact for each subsystem for Case Study #0101. For Case Study #0101, condensed versions of all supporting MAQS worksheets can be found in Appendix G.1. In addition the Subsystem CMATs and the System CMAT may be found in Appendix H.1 and H.2 respectively. Table 13-1, captures some of the basic cost analysis assumptions made for this first case study (#0101).

Because many of the documents referenced within this report are too large to be shown in their entirety (e.g. MAQS worksheets, CMATs, Costing Databases), electronic copies can be accessed at **http://www.epa.gov/otaq/**.



FEV

INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT
(Study Case# N0101)

BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT
(Study Case# B0101)

ENGINE SUBSYSTEMS		Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
		Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
02	Engine Frames, Mountings & Brackets	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
03	Crank Drives	$ (4.09)	$ 0.39	$ 4.15	$ 0.46	$ 0.28	$ (0.37)	$ (0.51)	$ 0.14	$ (0.46)	$ -	$ 0.00
04	Counter Balance Systems	$ (10.37)	$ (6.22)	$ (11.36)	$ (27.94)	$ (0.82)	$ (3.22)	$ (2.98)	$ (0.92)	$ (7.95)	$ (0.05)	$ (35.95)
05	Cylinder Blocks	$ (7.59)	$ 1.36	$ 5.78	$ (0.46)	$ (0.53)	$ 0.83	$ 0.56	$ -	$ 0.86	$ 0.04	$ 0.44
06	Cylinder Heads - Subsystem	$ 5.57	$ 0.81	$ 6.94	$ 13.32	$ 1.80	$ 0.65	$ 0.71	$ 0.04	$ 3.20	$ 0.03	$ 16.55
07	Valve Trains	$ 8.40	$ -	$ -	$ 8.40	$ 0.05	$ 0.59	$ 0.68	$ 0.34	$ 1.65	$ -	$ 10.06
08	Timing Drives	$ 1.60	$ -	$ -	$ 1.60	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.60
09	Accessory Drives	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10	Intake Systems	$ (10.66)	$ (0.01)	$ (0.10)	$ (10.78)	$ (0.05)	$ (0.70)	$ (0.65)	$ (0.27)	$ (1.67)	$ (0.28)	$ (12.73)
11	Fuel Induction Systems	$ 31.76	$ 11.80	$ 41.05	$ 84.62	$ 0.95	$ 9.20	$ 9.06	$ 3.36	$ 22.58	$ 0.13	$ 107.32
12	Exhaust Systems	$ 27.24	$ 0.11	$ 3.09	$ 30.44	$ 2.97	$ 1.97	$ 1.79	$ 0.71	$ 7.44	$ (0.12)	$ 37.77
13	Lubrication Systems, Oil Pans/Sumps	$ 12.63	$ 5.30	$ 11.74	$ 29.67	$ 0.14	$ 2.13	$ 1.78	$ 0.51	$ 4.55	$ 0.24	$ 34.46
14	Cooling Systems	$ 17.24	$ 6.14	$ 12.02	$ 35.40	$ 0.20	$ 2.39	$ 2.45	$ 1.03	$ 6.06	$ 0.10	$ 41.56
15	Induction Air Charging Systems	$ 90.16	$ 48.38	$ 68.66	$ 207.21	$ 6.61	$ 18.68	$ 18.69	$ 6.98	$ 50.97	$ 0.71	$ 258.89
16	Exhaust Gas Re-Circulations	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17	Breather Systems	$ 1.35	$ 0.37	$ 1.49	$ 3.21	$ 0.03	$ 0.42	$ 0.39	$ 0.12	$ 0.96	$ -	$ 4.17
60	Engine Management Systems, Engine Electronic Systems, Electrical Systems	$ 52.13	$ 1.60	$ 2.88	$ 56.61	$ -	$ -	$ -	$ -	$ -	$ -	$ 56.61
70	Accessories (Starter Engines, Generators, Power Steering Pumps, etc)	$ 3.44	$ 2.55	$ 7.90	$ 13.89	$ 0.09	$ 1.41	$ 1.15	$ 0.32	$ 2.96	$ 0.09	$ 16.95
	TOTAL UNIT COST	$ 218.82	$ 72.58	$ 154.24	$ 445.64	$ 11.72	$ 33.96	$ 33.12	$ 12.36	$ 91.16	$ 0.90	$ 537.70

Figure 13-1: System Cost Model Analysis Template Illustrating the Incremental Subsytem Costs Roll Up for I4, Turbo, GDI Downsizing, Case Study #0101

Table 13-1: Summary of Cost Analysis Assumptions for Case Study #0101

Description	Case Study Assumption
Annual Volume	450,000 units
Supplier Manufacturing Locations	North America
OEM Manufacturing Locations	North America
Manufacturing Cost Structure: (e.g. Material Costs, Labor Rates, Manufacturing Overhead Rates)	2008 production year rates
Supplier Mark-up Rate Structure:	2008 production year rates, based on mature technology assumptions
Manufacturing Process and Operation Considerations	Based on standard/mainstream industrial practices
Intellectual Property Cost Considerations	No special cases of intellectual property were identified and costed within the analysis.
Cost analysis identified and assigned costs to neighboring systems as a result of new technology adaptation.	No neighboring system (e.g. Engine Mounting, NVH Packages) upgrades were considered in analysis. Assumed that the engine mounts and NVH packages were of reasonable quality for the PFI engine. As such, no changes would be required for the adaptation of turbo DI
Operating and End-of Life Costs	No new, or modified, maintenance or end-of-life costs, were identified in this analysis.
Material Cost Reductions (MCRs) on analyzed hardware.	Potential MCRs were identified and evaluated, but not found to be of great significance to the incremental cost. As representative hardware is acquired, the potential exists to create MCR costing scenarios based on the initial cost analysis work.
New Technology Advances (NTAs) on analyzed hardware	Potential NTAs were identified and evaluated, but not found to be of great significance to the incremental cost. As representative hardware is acquired, the potential exists to create NTA costing scenarios based on the initial cost analysis work.
Costs elements not handle within the scope of this cost analysis.	Several cost elements (e.g. OEM mark-up, vehicle and system engineering, design and testing costs, dedicated production tooling costs) are handled through the application of an Indirect Cost Multiplier. See EPA report EPA-420-R-09-003, February 2009, “Automobile Industry Retail Price Equivalent and Indirect Cost Multipliers” for additional details.

14 Sensitivity Analysis

For this case study, it was necessary to understand how sensitive the incremental unit cost impact ($537.70) was to any future changes in the cost of materials, labor, burden or mark-up. The following scenarios were modeled relative to 2008 dollars: supplier and OEM labor cost -20%; OEM labor rate fringe contribution reduced from 160% to 52% (matching supplier rate); burden cost -20%; material cost +/- 20%; mark-up +/- 20%. Given the clear trends in North American manufacturing, only declines were considered for the labor and burden rates within this sensitivity analysis. The percent change in cost for each of these categories was modeled independently, and the results for each scenario are shown in Table 14-1.

Table 14-1: Cost Model Sensitivity Study Results

Model Description	Net Component /Assembly Cost Impact to OEM
Baseline, Case Study #0101	$537.70
20% average decrease in labor rates	$520.16 (-3%)
OEM fringe reduced from 160% to 52%	$530.28 (-1%)
20% average decrease in burden rates	$498.59 (-7%)
20% average decrease in raw material costs(1)	$493.94 (-8%)
20% average increase in raw material costs(1)	$581.46 (+8%)
20% average decrease in mark-up rates	$519.47 (-3%)
20% average increase in mark-up rates	555.93 (+3%)

[1] Both raw material and commodity purchased components are grouped together in the above sensitivity analysis. Total Incremental Material Costs = $218.82 of which $160.37 are commodity purchased parts and $58.45 are raw material costs including in-process scrap.

As discussed in Section 5.0, material costs include a combination of raw materials, material processing scrap, and commodity purchased parts. The value of commodity purchase parts, if excessive, can prove misleading relative to the contribution of each cost element within the cost model. In case studies which follow, greater efforts are being employed on binning unit costs, for those higher price commodities, into defined cost element categories. This is accomplished by using surrogate costing data for like components and developing standardized cost models (e.g., the Total Manufacturing Cost for a electromechanical device type “X” would have the predefined cost model - 35% material, 15% labor and 50% burden). Because surrogate costing data for the commodity purchase parts were not used in this case study, there will be a modest effect on the above sensitivity results (i.e., somewhat lower labor, burden, and somewhat higher material).

15 GLOSSARY OF TERMS

Assembly: generally refers to a group of interdependent components joined together to perform a defined function (e.g. turbocharger assembly, high pressure fuel pump assembly, high pressure fuel injector assembly).

Buy: is the terminology used to identify those components or assemblies as ones in which a manufacturer would purchase versus manufacture. All parts designated as a "buy" part, within the analysis, only have a net component cost presented. Typically these types of parts are considered commodity purchase parts having industry established pricing.

CBOM (Comparison Bill of Materials): is a system bill of materials, identifying all the subsystems, assemblies and components associated with the technology configurations under evaluation. The CBOM records all the high level details of the technology configurations under study, identifies those items which have cost implication as a result of the new versus base technology differences, documents the study assumptions, and is the primary document for capturing input from the cross functional team.

Component: is the lowest level part within the cost analysis. An assembly is typically made up of several components acting together to perform a function (e.g. the turbine wheel in a turbocharger assembly). However, in some cases a component can act independently performing a function within a sub-subsystem or subsystem (e.g. exhaust manifold within the exhaust subsystem).

Cost Estimating Models: are cost estimating tools, external to the Design Profit® software, used to calculate operation and process parameters for primary manufacturing processes (e.g. injection molding, die casting, metal stamping, forging). Key information calculated from the costing estimating tools (e.g. cycle times, raw material usage, equipment size) is inputted into the Lean Design® process maps supporting the cost analysis. The Excel base cost estimating models are developed and validated by Munro & Associates.

Costing Databases: refer to the five (5) core databases which contain all the cost rates for the analysis. The material database lists out all the materials used throughout the analysis along with the estimated price/pound for each. The labor database captures various automotive, direct labor, manufacturing jobs (supplier and OEM), along with the associated mean hourly labor rates. The manufacturing overhead rate database contains the cost/hour for the various pieces of manufacturing equipment assumed in the analysis. A mark-up database assigns a percentage of mark-up for each of the four (4) main mark-up categories (i.e. end-item scrap, SG&A, profit, and ED&T), based on the industry, supplier size, and complexity classification. The fifth database, the packaging database, contains packaging options and costs for each case.

Lean Design® (a module within the *Design Profit® software*): is used to create detailed process flow charts/process maps. Lean Design® uses a series of standardized symbols, each base symbol representing a group of similar manufacturing procedures (e.g. fastening, material modifications, inspection). For each group, a Lean Design® library/database exists containing standardized operations along with the associated manufacturing information and specifications for each operation. The information and specifications are used to generate a net operation cycle time. Each operation on a process flow chart is represented by a base symbol, operation description, and operation time, all linked to a Lean Design® library/database.

Make: is the terminology used to identify those components or assemblies as ones in which a manufacturer would produce internally versus purchase. All parts designated as a "make" part, within the analysis, are costed in full detail.

MAQS (Manufacturing Assumption and Quote Summary) worksheet: is the standardized template used in the analysis to calculate the mass production manufacturing cost, including supplier mark-up, for each system, subsystem and assembly quoted in the analysis. Every component and assembly costed in the analysis will have a MAQS worksheet. The worksheet is based on a standard OEM (original equipment manufacturer) quote sheet modified for improved costing transparency and flexibility in sensitivity studies. The main feeder documents to the MAQS worksheets are process maps and the costing databases.

MCRs (Material Cost Reductions): is a process employed to identify and capture potential design and/or manufacturing optimization ideas with the hardware under evaluation. These savings could potentially reduce or increase the differential costs between the new and base technology configurations, depending on whether an MCR idea is for the new or the base technology.

Net Component/Assembly Cost Impact to OEM: is defined as the net manufacturing cost impact per unit, to the OEM, for a defined component, assembly, subsystem or system. For components produced by the supplier base, the net manufacturing cost impact to the OEM includes total manufacturing costs (material, labor, and manufacturing overhead), mark-up (end-item scrap costs, selling, general and administrative costs, profit, and engineering design and testing costs) and packaging costs. For OEM internally manufactured components, the net manufacturing cost impact to the OEM includes total manufacturing costs and packaging costs; mark-up costs are addressed through the application of an indirect cost multiplier.

NTAs (New Technology Advances): is a process employed to identify and capture alternative advance technology ideas which could be substituted in for some of the existing hardware under evaluation. These advanced technologies, through improved function and performance, and/or cost reductions, could help increase the overall value of the technology configuration.

Powertrain Package Proforma: is a summary worksheet comparing the key physical and performance attributes of the technology under study with those of the corresponding base configuration.

Process Maps: are detailed process flow charts used to capture the operations and processes, and associated key manufacturing variables, involved in manufacturing products at any level (e.g. vehicle, system, subsystem, assembly, component).

P-VCSM (Powertrain–Vehicle Class Summary Matrix): records the technologies being evaluated, the applicable vehicle classes for each technology, and key parameters for vehicles or vehicle systems that have been selected to represent the new technology and baseline configurations in each vehicle class to be costed.

Quote: refers to the analytical process of establishing a cost for a component or assembly.

Sub-subsystem: refers to a group of interdependent assemblies and/or components, required to create a functioning sub-subsystem. For example, the air induction subsystem contains several sub-subsystems including the following: turbocharging, heat exchangers, and pipes, hoses and ducting.

Subsystem: refers to a group of interdependent sub-subsystems, assemblies and/or components, required to create a functioning subsystem. For example, the engine system contains several subsystems including the following: crank drive subsystem, cylinder block subsystem, cylinder head subsystem, fuel induction subsystem, and air induction subsystem.

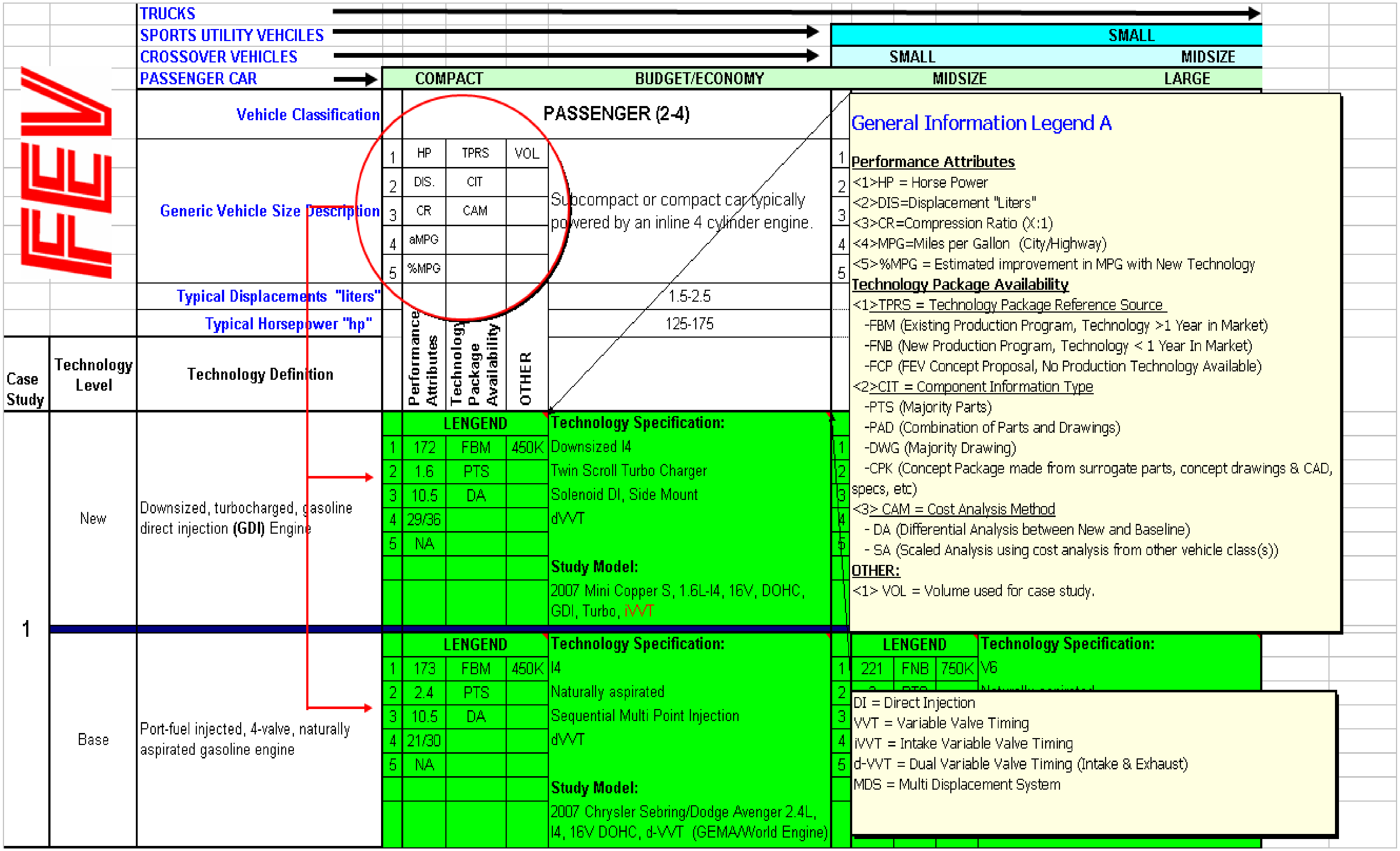
Subsystem CMAT (Cost Model Analysis Templates): is the document used to display and roll up all the sub-subsystem, assembly and component incremental costs associated with a subsystem (e.g. fuel induction, air induction, exhaust), as defined by the Comparison Bill of Material (CBOM).

Surrogate part: refers to a part similar in fit, form and function as the part required for the cost analysis. Surrogate parts are sometimes used in the cost analysis when actual parts are unavailable. The cost of a surrogate part is considered equivalent to the cost of the actual part.

System: refers to a group of interdependent subsystems, sub-subsystems, assemblies and/or components, working together to create a vehicle primary function (e.g. engine system, transmission system, brake system, fuel system, suspension system).

System CMAT (Cost Model Analysis Template): is the document used to display and roll up all the subsystem incremental costs associated with a system (e.g. engine, transmission, steering), as defined by the CBOMs.

APPENDIX A.1 Powertrain-Vehicle Class Summary Matrix Excerpt – Case Study #0101



TRUCKS
SPORTS UTILITY VEHICLES → SMALL
CROSSOVER VEHICLES → SMALL | MIDSIZE
PASSENGER CAR → COMPACT | BUDGET/ECONOMY | MIDSIZE | LARGE

Vehicle Classification	PASSENGER (2-4)
Generic Vehicle Size Description	Subcompact or compact car typically powered by an inline 4 cylinder engine.
Typical Displacements "liters"	1.5-2.5
Typical Horsepower "hp"	125-175

	Performance Attributes	Technology Package Availability	OTHER
1	HP	TPRS	VOL
2	DIS.	CIT	
3	CR	CAM	
4	aMPG		
5	%MPG		

Case Study	Technology Level	Technology Definition		Performance Attributes	Technology Package Availability	OTHER	
1	New	Downsized, turbocharged, gasoline direct injection **(GDI)** Engine		LENGEND			**Technology Specification:**
			1	172	FBM	450K	Downsized I4
			2	1.6	PTS		Twin Scroll Turbo Charger
			3	10.5	DA		Solenoid DI, Side Mount
			4	29/36			dVVT
			5	NA			
							Study Model:
							2007 Mini Copper S, 1.6L-I4, 16V, DOHC, GDI, Turbo, iVVT
	Base	Port-fuel injected, 4-valve, naturally aspirated gasoline engine		LENGEND			**Technology Specification:**
			1	173	FBM	450K	I4
			2	2.4	PTS		Naturally aspirated
			3	10.5	DA		Sequential Multi Point Injection
			4	21/30			dVVT
			5	NA			
							Study Model:
							2007 Chrysler Sebring/Dodge Avenger 2.4L, I4, 16V DOHC, d-VVT (GEMA/World Engine)

	LENGEND			**Technology Specification:**
1	221	FNB	750K	V6
2				
3				
4				
5				

General Information Legend A

Performance Attributes

<1>HP = Horse Power
<2>DIS=Displacement "Liters"
<3>CR=Compression Ratio (X:1)
<4>MPG=Miles per Gallon (City/Highway)
<5>%MPG = Estimated improvement in MPG with New Technology

Technology Package Availability

<1>TPRS = Technology Package Reference Source
-FBM (Existing Production Program, Technology >1 Year in Market)
-FNB (New Production Program, Technology < 1 Year In Market)
-FCP (FEV Concept Proposal, No Production Technology Available)
<2>CIT = Component Information Type
-PTS (Majority Parts)
-PAD (Combination of Parts and Drawings)
-DWG (Majority Drawing)
-CPK (Concept Package made from surrogate parts, concept drawings & CAD, specs, etc)
<3> CAM = Cost Analysis Method
- DA (Differential Analysis between New and Baseline)
- SA (Scaled Analysis using cost analysis from other vehicle class(s))

OTHER:

<1> VOL = Volume used for case study.

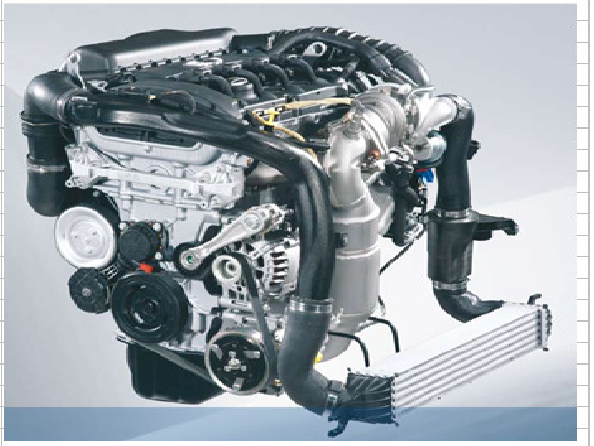
DI = Direct Injection
VVT = Variable Valve Timing
iVVT = Intake Variable Valve Timing
d-VVT = Dual Variable Valve Timing (Intake & Exhaust)
MDS = Multi Displacement System

APPENDIX B.1 Powertrain Package Proforma - Case Study #0101

CASE STUDY: 0101

TECHNOLOGY:
Downsized, turbocharged, gasoline direct injection (GDI) Engine versus Port-fuel injected, 4-valve, naturally aspirated gasoline engine.

VEHICLE CLASS:
Compact/Budget/Economy,
Passenger Seating: 2-4
Displacement: 1.5-2.4L
Horsepower: 125-175



Item	Characteristics	Baseline Technology Package	New Technology Package
1	Engine Name/Code	GEMA 2.4L	Prince/N14B16
2	Engine Type	2.4L DOHC, I4, 16V	1.6L DOHC I4, 16V
3	Displacement (cc)	2360	1598
4	Aspiration	Naturally Aspirated	Turbocharged (Twin Scroll, Wastegate)
5	Compression Ratio	10.5:1	10.5:1
6	Fuel Management	-	MED 17.2
7	Variable Valve Timing	Intake and Exhaust	Intake Only
8	Variable Valve Lift	No	No
9	Multi Displacement System	No	No
10	Variable Intake Manifold	No	No
11	Bore (mm)	88	77
12	Stroke (mm)	97	85.9
13	Fuel System	Sequential Electronic Port Fuel Injection	Direct Injection, Side Mounted Solenoid (7 Hole)
14	Block Material	Aluminum	Aluminum
15	Cylinder Head Material	Aluminum	Aluminum
16	Cylinder Liner Material	Cast Iron	Cast Iron
17	Connecting Rod Material	Forged Steel	Forged Steel
18	Intake Manifold Material	Composite	Composite
19	Horse Power @ RPM	173 HP @ 6000 rpm	172 hp @ 5500 rpm
20	Torque (lb.ft) @ rpm (normal)	166 lb.-ft. @ 4400 rpm	177 lb.-ft. @ 1600-5000 rpm
21	Torque (lb.ft) @ rpm (over boost)	N/A	192 lb.-ft. @ 1600-5000 rpm
22	Transmission	4 Speed Automatic (Sebring)	6 Speed Auto or Manual
23	Curb Weight	3310 (Sebring LX -2008)	2668 (Manual)
24	Fuel Economy (City/Highway)	21/30 (Sebring-LX-2008)	29/36 (Manual)
25	Emission Certification	PZEV	Tier 2, Bin 5 / LEV-2
26	Fuel Octane	87	87/91
27	Application(s)	Chrysler Sebring, Dodge Avenger, Caliber R/T & Journey, Jeep Compass & Patriot	Mini Cooper S, Hard Top
28	Manufacturer	Chrysler (Hyundai & Mitsubishi)	PSA Peugeot - Citroen
29	Plant Locations	x2 Dundee Michigan, (x2 South Korea, 1 Shiga Japan)	Warwickshire, UK
30	Engine Volume	Chrysler Projections: 840K	20K

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101, 2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

GENERAL PART INFORMATION

Powertrain Description: 2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp
Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine **Vehicle Class:** Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)

🟥 Default, indicates cost study required for identified item.
? Indicates cost analysis potentially required, additional details required.
X Indicates common item/cost factor found in both baseline and new technology package, no cost analysis required.
▨X Same as above, however with potential MCR or Technology Advance Considerations

<NR> = Item cost impact assumed unaffected or negligibly affected by technology differences

ITEM	ASY LVL	SUBSYSTEM	SUB-SUBSYSTEM	ASSEMBLY	SUBASSEMBLY	COMPONENT	NAME/DECRIPTION		PART NUMBER	QTY/ P.T.	Label #	Part Existence	Material/Finish(s)	Weight/ Size	Function	Performance	QTY/P.T.	Royalty	BRIEF EXPLANATION OF DIFFERENCES	Notes: Addititional Items Requiring Investigation.	Design modifications for Material Cost Reductions (MCR's).	Additional Technology Advances or Performance Upgrades
	X	02	**Engine Frames, Mountings & Brackets**																Assumed the engine mounts are of reasonable quality for the Base Engine (NA PFI). As such, no changes would be required for Turbo DI			
		X	02	**Engine Mountings**																		
					A	Bracket - Engine Mount, Front		X	02 01 - N0101 - 01	1	MT								NR			
		X	10	**Hanging-up Eye**																		
			A	Bracket - Engine Lift				X	02 10 - N0101 - 01	1	MT								NR			
		X	75	**Engine Brackets**																		
					A	Bracket- Wire/Belt Guide (Front of Crank Damper)		X	02 75 - N0101 - 01	1	MT								NR			
		X	80	**Boltings**																		
					A	Bolt- Bracket, Engine Mount, Front		X	02 80 - N0101 - 01	4	MT								NR			
					B	Bolt - Bracket, Engine Mount, Front of Crank Damper		X	02 80 - N0101 - 02	1	MT								NR			
					C	Bolt - Lift Eye		X	02 80 - N0101 - 03	2	MT								NR			
	🟥	03	**Crank Drives**																			
		🟥	01	**Crank Shaft**																		
					A.	Shaft - Crank		🟥	03 01 - N0101 - 01	1	1			X		X			Assumption: both shafts are made from Micro-Alloyed Steel such as C38N2 or C38Mod(+Vanadium). Due to reduced stroke and overall crankshaft length expect cost reduction.	Need to ensure additional features are equal between New and Base such as Rolled Fillets.	Potential for Base Engine Crank Shaft to be made from Nodular Cast Iron as cost save.	NA
		X	02	**Flywheels**																		
			A	Flywheel Assembly - Engine				X	03 02 - N0101 - 01	1	2								Single Mode Fly Wheel on Mini Cooper. Potentially twisting pulsations handled through Torque Converter tuning. Would not be able to tune out any degradation due to bending vibration.	May not need to consider for smaller displacements, but will be mandatory with higher displacement Turbo DI Engines.	Dual Mass Fly Wheel Required for DI Engine? Track as cost Risk?	NA
		🟥	03	**Connect Rods (Assemblies:Connecting Rod, Connecting Rod Cap)**																		
				A	Rod Subassembly - Connecting			🟥	03 03 - N0101 - 01	4												
					A1	Bushing - Connecting Rod		🟥	03 03 - N0101 - 02	4	MP-3	X				X			Bushing required to accommodate higher loading at pin to connecting rod interface.			Connecting rod bushing typical may be replaced with phosphate coated road end which is a newer process which offers less design margin. What is cost delta???
					A2	Rod - Connecting		🟥	03 03 - N0101 - 03	4	MP-3			X		X			Assumption: both have forged connecting rods made from either C70 or 36MnVS4 Micro Alloy Steel or equivalent. The connecting rods are approx. same length for both packages, however Turbo DI rods have thicker cross section to handle higher loads.		To equalize the connecting rods for cost comparison, the rod length to crank radius (L/R) ratio should be assumed common for both designs. Ideal range is between 3-4; most production engines are between 3-3.6. The Chrysler GEMA engine is designed to use a common connecting rod for all three engines on same platform. Thus the L/R ratios are as follows: 2.4L = 2.964, 2.0L = 3.471 and 1.8L is 3.968. Calculate cost impact assuming common Mini Cooper L/R ratio.	
					B	Cap- Connecting Rod		🟥	03 03 - N0101 - 04	4	4			X		X			Assumption: both have forged connecting rods made from either C70 or 36MnVS4 Micro Alloy Steel.			
		🟥	04	**Pistons (Assemblies, Including Pistons, Ring Packs, Piston Pins, Circlips)**																		

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101, 2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

GENERAL PART INFORMATION

Powertrain Description: 2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp
Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine **Vehicle Class:** Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)

ITEM	ASY LVL	NAME/DECRIPTION						PART NUMBER	QTY/ P.T.	Label #	CHECK OFF ATTRIBUTES WHICH ARE DIFFERENT BETWEEN COMPARISON TECHNOLOGY PACKAGES							BRIEF EXPLANATION OF DIFFERENCES	Notes: Addititional Items Requiring Investigation.	Design modifications for Material Cost Reductions (MCR's).	Additional Technology Advances or Performance Upgrades
		SUBSYSTEM	SUB-SUBSYSTEM	ASSEMBLY	SUBASSEMBLY	COMPONENT	🟥 Default, indicates cost study required for identified item. ? Indicates cost analysis potentially required, additional details required. X Indicates common item/cost factor found in both baseline and new technology package, no cost analysis required. ▨ Same as above, however with potential MCR or Technology Advance Considerations				Part Existence	Material/Finish(s)	Weight/ Size	Function	Performance	QTY/P.T.	Royalty	<NR> = Item cost impact assumed unaffected or negligibly affected by technology differences			
					A	Piston - Engine, Machined	🟥	03 04 - N0101 - 01	4	**5**		X	X		X			Less mass, additional machining at piston crown and for piston pin clips. Top ring groove anodized for improved durability and reduction in the potential of micro welding the top compression ring in the groove. Assume same anti friction skirt coating on both New and Base Pistons. Post heat treat and machining premium on hypereutectic material.			Neither design has piston cooling channels. Benchmarking is split, for example BMW 3.0L DI Turbo has cooling channels and the 2.0L GM Ecotec does not. On a current Turbo DI project, FEV is evaluating if there is notable spark timing advantage with the addition of piston cooling channels.
					B	Ring/Clip - Piston Pin Retainer	🟥	03 04 - N0101 - 02	8	**6**	X							Clips required for dual bearing slip fit design of pin to connecting rod & piston.			
					C	Pin- Piston	🟥	03 04 - N0101 - 03	4	**7**			X		X			Assume same material, Chromium Steel SAE 5115 (16MnCr5). Quote mass difference only.			
					D	Compression Ring - Piston, Top	🟥	03 04 - N0101 - 04	4	**8**					X			Assume that the Turbo DI will use a more durable, low friction ring pack versus base. For Example, top compression ring, might be Silicon Manganese Spring Steel or Chrome Versus Cast or Nodular Iron. Coating may be Metallized Molybdenum versus a standard Manganese Phosphate.	Estimated to be Approx. $1.00 hit per ring pack (Top, Second and Oil Ring). Confirm with Tech. Specialist		
					E	Compression Ring - Piston, 2nd	🟥	03 04 - N0101 - 05	4	**9**					X			Similar to Top Compression Ring			
				F	Oil Ring Subassembly																
					F1	Spacer/Expander/Coil Spring - Oil Ring, Piston	🟥	03 04 - N0101 - 07	4	**10**					X			Assumption is higher end performing Oil Ring Assembly on Turbo DI versus NA PFI.			
					F2	Rail(s) - Oil Ring, Piston	🟥	03 04 - N0101 - 08	4	**11**					X			Assumption is higher end performing Oil Ring Assembly on Turbo DI versus NA PFI.			
		X	**80**	**Boltings: Connecting-Rod Bolts**																	
					A	Bolt -Connector Rod Cap to Connecting Rod	X	03 80 - N0101 - 01	8	**12**								NR			
					B	Screw - Sensor Crankshaft to Block	X	03 80 - N0101 - 02	1	**13**								NR			
					C	Bolt -Flywheel to Crankshaft	X	03 80 - N0101 - 03	6	**14**								NR			
					D	Dowel/Pin - Flywheel to Crankshaft	X	03 80 - N0101 - 04	1									NR			
		X	**85**	**Sealing Elements**																	
							X														
		🟥	**90**	**Bearing Elements: Connecting Rod Bearing Shells, Connecting Rod**																	
					A	Bearing - Connecting Rod to Crank Shaft	🟥	03 90 - N0101 - 01	8	**17**					X			For Turbo DI, Rod Bearings would be upgraded from AlSn20Mn (Federal Mogul A-370) to a AlSn10Ni (Federal Mogul A-273)			
		X	**99**	**Miscellaneous**																	
			A	Sensor - Crankshaft			X	03 99 - N0101 - 01	1	**19**								NR			
			B	Encoder Wheel Assembly - Crankshaft Sensor			X	03 99 - N0101 - 02	1	**20**								NR		Manufacturing process differences between Turbo DI and NA PFI Engines. Encoder design has no association with technology upgrade; purely a MCR idea regardless of technology.	
			C	Cover - Sensor Crankshaft			X	03 99 - N0101 - 03	1	**MP-20**								NR			
	X	**04**	**Counter Balance Systems**																		
		🟥	**01**	**Moved Parts**																	
							🟥											Balancer shafts are not required on Turbo DI due to smaller engine size. However they are incorporated in the Base NA PFI Engine. In this application, the balance shafts are integrated into the oil pump.	Oil pump integration isn't typical, may need access cost risk.		
		X	**02**	**Static Parts**																	
							X														
		X	**03**	**Drives**																	

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101, 2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

FEV

GENERAL PART INFORMATION

Powertrain Description: 2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp
Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)

- 🟥 Default, indicates cost study required for identified item.
- ? Indicates cost analysis potentially required, additional details required.
- X Indicates common item/cost factor found in both baseline and new technology package, no cost analysis required.
- X Same as above, however with potential MCR or Technology Advance Considerations

<NR> = Item cost impact assumed unaffected or negligibly affected by technology differences

ITEM	ASY LVL	SUBSYSTEM	SUB-SUBSYSTEM	ASSEMBLY / SUBASSEMBLY / COMPONENT – NAME/DECRIPTION		PART NUMBER	QTY/ P.T.	Label #	Part Existence	Material/ Finish(s)	Weight/ Size	Function	Performance	QTY/P.T.	Royalty	BRIEF EXPLANATION OF DIFFERENCES	Notes: Addititional Items Requiring Investigation.	Design modifications for Material Cost Reductions (MCR's).	Additional Technology Advances or Performance Upgrades
					X														
		X	65	Adapters															
					X														
		X	70	Pipes, Hoses, Ducting															
					X														
		X	75	Brackets															
					X														
		X	80	Connecting Elements															
					X														
		X	85	Sealing Elements															
					X														
		X	90	Bearing Elements															
					X														
		X	95	Tools															
					X														
		X	99	Misc															
					X														
	🟥	05		Cylinder Blocks															
		🟥	01	Cylinder Block															
			A	Cylinder Block Assembly - Machined w. Studs, Plugs, etc.	🟥	05 01 - N0101 - 01	1	1			X	X	X			Cost drivers between Turbo DI and NA PFI Engines 1. Assume material for Turbo and Base Block are same and made from Diecast Hypereutectic Aluminum (B390) 2. Turbo block smaller overall due to smaller bore size. Using CAE tools, a 11 mm reduction in bore size on the Base NA PFI (Base Bore 88, Turbo GDI Bore 77), would yield a weight savings of approx. 3.5kg. Will confirm with weight measurements on physical parts. 3. Added diecast complexity and machining to incorporate features such as inter-bore cooling, Turbo cooling & oil supply and return lines, piston cooling jets, etc.	Industry trend in North America is moving away from sand cast blocks to diecast block. Initially higher investment due to tooling complexity, but over time pays for itself. Need to verify material of block.		
				A1 Cylinder Block Subassembly - Machined w/o Studs/Plugs, etc	🟥	05 01 - N0101 - 02	1									Reference Cylinder Block Assembly			
				A1.1 Cylinder Block Subassembly - Cast	🟥	05 01 - N0101 - 03	1									Reference Cylinder Block Assembly			
				A1.1.1 Cylinder Liners - Cast Iron	🟥	05 01 - N0101 - 04	1				X					Both Engines have Cast cylinder liners. Calculate cost differential as a result of smaller liners for Turbo DI.	Assume Nodular Cast Iron for both Engines, Spec?		
		🟥	02	Crankshaft Bearing Caps															
					🟥											Captured below in Bed Plate Assembly			
		🟥	03	Bedplates															
			A	Bed Plate Assembly - Machined w. Studs, Plugs, etc.	🟥	05 03 - N0101 - 01	1	2			X		X			Both Engines Can operate using either a bedplate, cross-bolted mains (rare on in-line engines), ladder caps, and two-bolted main bearing caps. The NVH characteristics degrade in the same order as above. For a clean sheet I4, bedplate construction would likely be the best option for both the NA PFI and Turbo DI engines. For cost analysis, will assume both engines have bed plate design and thus only compare size/weight difference. Material Diecast Hypereutectic Aluminum (B390)	Need to verify material spec of bedplate and caps.		
				A1 Bed Plate Assembly - Machined w/o. Studs, Plugs, etc.	🟥	05 03 - N0101 - 02	1									Reference Bed Plate Assembly			

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101, 2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

FEV

GENERAL PART INFORMATION

Powertrain Description: 2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp
Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine **Vehicle Class:** Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)

ITEM	ASY LVL						NAME/DECRIPTION		PART NUMBER	QTY/ P.T.	Label #	CHECK OFF ATTRIBUTES WHICH ARE DIFFERENT BETWEEN COMPARISON TECHNOLOGY PACKAGES							BRIEF EXPLANATION OF DIFFERENCES	Notes: Addititional Items Requiring Investigation.	Design modifications for Material Cost Reductions (MCR's).	Additional Technology Advances or Performance Upgrades
		SUBSYSTEM	SUB-SUBSYSTEM	ASSEMBLY	SUBASSEMBLY	COMPONENT	🟥 Default, indicates cost study required for identified item. ? Indicates cost analysis potentially required, additional details required. X Indicates common item/cost factor found in both baseline and new technology package, no cost analysis required. X Same as above, however with potential MCR or Technology Advance Considerations					Part Existence	Material/Finish(s)	Weight/ Size	Function	Performance	QTY/P.T.	Royalty	<NR> = Item cost impact assumed unaffected or negligibly affected by technology differences			
				A1.1			Bed Plate Subassembly - Cast	🟥	05 03 - N0101 - 02	1									Reference Bed Plate Assembly			
					A1.1.1		Bearing - Bolt Through - Insert, Steel	🟥	05 03 - N0101 - 03	5				X					Assume same material only, size /weight difference only.	Need material spec of inserted bearing caps.		
		🟥	04				**Piston Cooling**															
					A		Squirter - Oil, Piston Cooler	🟥	05 04 - N0101 - 01	4	3	X			X				Required for Turbo DI			
					B		Bolt - Piston Cooler Valve/Retainer (Check Valve?)	🟥	05 04 - N0101 - 02	4	4	X			X				Required for Turbo DI			
		X	80				**Boltings/Dowel Pins/Plugs/Studs Etc**															
							Boltings & Screws General															
					A		Screw - Windage Tray to Bed Plate	X	05 80 - N0101 - 01	4	5								NR			
					B		Bolt - Bed Plate to Block, Main (Crank Bearings Approx 3.5")	X	05 80 - N0101 - 02	10	6								Assuming both engines would have Bed Plate design with same amount of main bear cap thru bolts.	Check to see if size and grade are compatible between two engines.		
					C		Bolt - Bed Plate to Block (Perimeter Approx. 1.5")	X	05 80 - N0101 - 03	16	7								Assuming both engines would have Bed Plate design will make assumption same number of perimeter bolts required. Any difference would have negligible cost impact.	Reasoning larger perimeter on base versus Turbo DI, however greater loading on Turbo DI versus base, thus number of fasteners could potentially be equivalent.		
					D		Bolt - Bed Plate to Block (Perimeter Approx 2.5")	X	05 80 - N0101 - 04	2	8								Assuming both engines would have Bed Plate design will make assumption same number of perimeter bolts required. Any difference would have negligible cost impact.	Reasoning larger perimeter on base versus Turbo DI, however greater loading on Turbo DI versus base, thus number of fasteners could potentially be equivalent.		
					E		Screw - Sensor, Knock	X	05 80 - N0101 - 05	1	9								NR			
								X														
							Dowel Pins/Plugs/Studs - Cylinder Block															
					A		Plugs - Oil Galley	X	05 80 - N0101 - 10	2									NR			
					B		Pin/Dowel - Locator Cylinder Block to Head	X	05 80 - N0101 - 11	2									NR			
					C		Pin/Dowel - Locator Cylinder Block to Bedplate	X	05 80 - N0101 - 12	2									NR			
					D		Pin/Dowel - Block & Bed Plate (Flywheel Side), Accessory	X	05 80 - N0101 - 13	2									NR			
							Dowel Pins/Plugs/Studs - Bed Plate															
					A		Plug - Non Turbo Oil Indicator, Bedplate	X	05 80 - N0101 - 20	1									Clean sheet design could eliminate.			
					B		Stud #1 - Accessory, Bed Plate (CC. Cat. Conv. Mnt)	X	05 80 - N0101 - 21	2									NR			
					C		Stud #2 - Accessory, Bed Plate	X	05 80 - N0101 - 22	2									NR			
		X	85				**Sealing Elements**															
					A		Seal - Crankshaft Front	X	05 85 - N0101 - 01	1	10								NR			
					B		Seal - Crankshaft Rear	X	05 85 - N0101 - 02	1	11								NR			
					C		Gasket/Seal - Block to Bed Plate (Deposit)	X	05 85 - N0101 - 03	1									NR			
		🟥	90				**Bearing Elements: Crankshaft bearing shells**															
					A		Bearing - Crankshaft, Block 1/2 Bearing (Top w. Lub. Pass.)	🟥	05 90 - N0101 - 01	5	13								For Turbo DI, main bearings would be upgraded from AlSn20Mn (Federal Mogul A-370) to a AlSn6Si4 (Federal Mogul A-590)			
					B		Bearing/Shim - Crankshaft Thrust	🟥	05 90 - N0101 - 02	2	14								Material Upgrade - TBD	Talk to Steve on possible material options.		
					C		Bearing - Crankshaft, Block 1/2 Bearing (Bottom)	🟥	05 90 - N0101 - 03	5	13								For Turbo DI, main bearings would be upgraded from AlSn20Mn (Federal Mogul A-370) to a AlSn6Si4 (Federal Mogul A-590)			
		X	99				**Miscellaneous**															
				A			Windage Tray - Bed Plate	X	05 99 - N0101 - 01	1	15								NR			
				B			Sensor - Knock	X	05 99 - N0101 - 02	1	16								NR			
					C		Cap - Bed Plate Rear Main Bolts	X	05 99 - N0101 - 04	1	MP-16								NR			

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101, 2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

GENERAL PART INFORMATION

Powertrain Description: 2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp
Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine **Vehicle Class:** Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)

ITEM	ASY LVL	NAME/DECRIPTION							PART NUMBER	QTY/ P.T.	Label #	CHECK OFF ATTRIBUTES WHICH ARE DIFFERENT BETWEEN COMPARISON TECHNOLOGY PACKAGES							BRIEF EXPLANATION OF DIFFERENCES	Notes: Addititional Items Requiring Investigation.	Design modifications for Material Cost Reductions (MCR's).	Additional Technology Advances or Performance Upgrades
		SUBSYSTEM	SUB-SUBSYSTEM	ASSEMBLY	SUBASSEMBLY	COMPONENT	🟥 Default, indicates cost study required for identified item. ? Indicates cost analysis potentially required, additional details required. X Indicates common item/cost factor found in both baseline and new technology package, no cost analysis required. X Same as above, however with potential MCR or Technology Advance Considerations					Part Existence	Material/Finish(s)	Weight/ Size	Function	Performance	QTY/P.T.	Royalty	<NR> = Item cost impact assumed unaffected or negligibly affected by technology differences			
								X														
	🟥	06	**Cylinder Heads - Subsystem**																			
		🟥	01				**Cylinder Head**															
			A				Cylinder Head Assembly - Machined w. Studs, Valves, etc.	🟥	06 01 - N0101 - 01	1	1			X	X	X			Cost drivers between Turbo DI and NA PFI Engines 1. Assume material for Turbo head A356 T6 versus Base A319 T7. A356 is required for high temperature strength and heat conductivity (better spark timing). 2. Turbo head smaller overall due to smaller bore size. Approx 46 mm shorter in length. 3. Added diecast complexity and machining to incorporate features such as inter-bore cooling, side mount injectors, HP fuel rail and fuel pump mounting etc.			
					A1		Cylinder Head - Machined w/o. Studs, Valves, etc.	🟥	06 01 - N0101 - 02	1									Reference Cylinder Head Assembly			
					A1.1		Cylinder Head Subassembly - Cast	🟥	06 01 - N0101 - 03	1									Reference Cylinder Head Assembly			
		🟥	02				**Valve Guides. Valve Seats**															
					A		Guide - Intake Valve	X	06 02 - N0101 - 01	8	MT								NR			
					B		Guide - Exhaust Valve	X	06 02 - N0101 - 02	8	MT								NR			
					C		Seat - Intake Valve	🟥	06 02 - N0101 - 03	8	MT								Intake Seats would need to be upgraded - typical upgrade would be from Brico 310 to Como1207.			
					D		Seat - Exhaust Valve	🟥	06 02 - N0101 - 04	8	MT								Exhaust seats would need to be upgraded - typical upgrade would be from MS25Cu to AR20.			
		X	03				**Guides for Valve Train**															
								X														
		🟥	06				**Camshaft Bearing Housing**															
					A		Cap-Bearing Camshaft, Intake, Phaser Type	X	06 06 - N0101 - 01	1	2		X	X					Cost drivers between Turbo DI and NA PFI Engines 1. Assume both Base and Turbo are made from same material, either Diecast Aluminum or Power Metal. 2. Compare mass difference between both sets of caps. 3. Machining considered equivalent, assumption both engines have dVVT.	Negligible Weight Difference		
					B		Cap-Bearing Camshaft, Intake Standard	X	06 06 - N0101 - 02	9	3		X	X					Cost drivers between Turbo DI and NA PFI Engines 1. Assume both Base and Turbo are made from same material, either Diecast Aluminum or Power Metal. 2. Compare mass difference between both sets of caps.	Negligible Weight Difference		
					C		Cap, Head (Fuel Pump & Vacum Mount)	🟥	06 06 - N0101 - 03	1	4	X							Cap unique to Turbo DI, required for HP fuel pump and Vacuum pump mounting and driving.	Same as above		
		X	07				**Cam Shaft Speed Sensor**															

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101, 2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

GENERAL PART INFORMATION

Powertrain Description: 2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp
Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)

ITEM	ASY LVL						NAME/DECRIPTION		PART NUMBER	QTY/ P.T.	Label #	CHECK OFF ATTRIBUTES WHICH ARE DIFFERENT BETWEEN COMPARISON TECHNOLOGY PACKAGES							BRIEF EXPLANATION OF DIFFERENCES	Notes: Addititional Items Requiring Investigation.	Design modifications for Material Cost Reductions (MCR's).	Additional Technology Advances or Performance Upgrades
		SUBSYSTEM	SUB-SUBSYSTEM	ASSEMBLY	SUBASSEMBLY	COMPONENT	🟥 Default, indicates cost study required for identified item. ? Indicates cost analysis potentially required, additional details required. X Indicates common item/cost factor found in both baseline and new technology package, no cost analysis required. X Same as above, however with potential MCR or Technology Advance Considerations					Part Existence	Material/Finish(s)	Weight/ Size	Function	Performance	QTY/P.T.	Royalty	<NR> = Item cost impact assumed unaffected or negligibly affected by technology differences			
			A				Sensor - Cam Shaft, Speed	X	06 07 - N0101 - 01	1	5								NR			
		🟥	20				**Cylinder Head Covers**															
			A				Cover Assembly- Cylinder Head Assembly	X	06 20 - N0101 - 01	1	6											
				A1			**PCV Subassembly (Built into cover)**	🟥	06 20 - N0101 - 02	1									Crankcase vent system for DI engine is more difficult and requires better oil separation. The cost associated with upgraded PCV system is addressed in section 17 below.			
					A2		Cap - Oil Fill	X	06 20 - N0101 - 03	1												
					A3		Insert - Fastener, Torque Loss	X	06 20 - N0101 - 04	13												
					A4		Insert - Threaded, Brass	X	06 20 - N0101 - 05	3												
		🟥	80				**Boltings: Cylinder Head, Cylinder Head Cover, Manifold**															
							Boltings & Screws General															
					A		Bolt - Cap Bearing, Camshaft	🟥	06 80 - N0101 - 01	23	7								4 Extra Required for Extra Cap			
					B		Bolt & Washer Assembly - Cylinder Head to Block M10X150	X	06 80 - N0101 - 02	10	8								NR: Same QTY, Size and Property Class used in both Engine Designs.			
					C		Bolt & Washer Assembly - Cylinder Head to Block M8x96	X	06 80 - N0101 - 03	2	9								NR - Design choice based on integrating timing cover into block and head versus stand alone cover.			
					D		Bolt & Washer Assembly - Cylinder Head to Block M8x35	X	06 80 - N0101 - 04	1	10								NR - Design choice based on integrating timing cover into block and head versus stand alone cover.			
					E		Bolt - Cam Sensor	X	06 80 - N0101 - 05	1	11								NR			
							Dowel Pins/Plugs/Studs - Cylinder Head															
					A		Bolt - Manifold, Exhaust	🟥	06 80 - N0101 - 10	10									Material upgrade on fasteners to stainless steal.			
					B		Bolt - Manifold, Intake	X	06 80 - N0101 - 11	5									NR			
					C		Pipe Plug -	X	06 80 - N0101 - 12	1									NR			
					D		Core Plug - Press Fit (Φ18.5 Top)	X	06 80 - N0101 - 13	1									NR			
					E		Core Plug - Torx (Φ15)	X	06 80 - N0101 - 14	1									NR			
					F		Cup Plug - Press Fit (Φ40)	X	06 80 - N0101 - 15	1									NR			
					G		Core Plug - Press Fit (Φ36 Top)	X	06 80 - N0101 - 16	1									NR			
					H		Core Plug - Ball, Adjuster	X	06 80 - N0101 - 17	1									NR			
					I		Dowel - Cap, Bearing Camshaft	X	06 80 - N0101 - 18	??									NR			
		🟥	85				**Sealing Elements: Cylinder Head, Cylinder Head Cover, ...**															
					A		Gasket - Cylinder Head to Block	🟥	06 85 - N0101 - 01	1	12			X		X			Base Engine 2 layer MLS gasket for standard engine. Turbo DI would require 3 layer MLS gasket.			
					B		Seal - Cover to Cylinder Head, Perimeter	X	06 85 - N0101 - 02	1	13								NR			
					C		Seal - Cover to Cylinder Head, Inner	X	06 85 - N0101 - 03	1	14								NR			
	🟥	07					**Valve Trains**															
		🟥	01				**Inlet Valves**															
					A		Valve - Intake	🟥	07 01 - N0101 - 01	8	1		X			X			Intake valves would need to be upgraded - typical upgrade would be from nitrided JIS SUH11 (Fe-1.5Si, 8.5Cr, 0.5C) to Silichrome			

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101, 2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

FEV

GENERAL PART INFORMATION

Powertrain Description: 2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine **Vehicle Class:** Compact/Economy 2-4 Passenger

Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)

ITEM	ASY LVL						NAME/DECRIPTION		PART NUMBER	QTY/ P.T.	Label #	CHECK OFF ATTRIBUTES WHICH ARE DIFFERENT BETWEEN COMPARISON TECHNOLOGY PACKAGES							BRIEF EXPLANATION OF DIFFERENCES	Notes: Addititional Items Requiring Investigation.	Design modifications for Material Cost Reductions (MCR's).	Additional Technology Advances or Performance Upgrades
		SUBSYSTEM	SUB-SUBSYSTEM	ASSEMBLY	SUBASSEMBLY	COMPONENT	🟥 Default, indicates cost study required for identified item. ? Indicates cost analysis potentially required, additional details required. X Indicates common item/cost factor found in both baseline and new technology package, no cost analysis required. X Same as above, however with potential MCR or Technology Advance Considerations					Part Existence	Material/Finish(s)	Weight/ Size	Function	Performance	QTY/P.T.	Royalty	<NR> = Item cost impact assumed unaffected or negligibly affected by technology differences			
		🟥	02	**Outlet Valves**																		
					A	Valve - Exhaust		🟥	07 02 - N0101 - 01	8	2		X			X			Exhaust valves would need to be upgraded - typical upgrade would be from nitrided JIS SUH 35 (Fe, 9Mn, 21Cr 4Ni, 0.5C and 0.4N) to Inconel head and Silichrome stem. Exhaust valves on Mini Cooper Turbo DI are Sodium filled as well. This design approach is not considered preferred and thus will note be included in cost analysis.			
		X	03	**Valve Springs**																		
					A	Spring - Valve		X	07 03 - N0101 - 01	16	3								NR			
		X	04	**Spring Retainers, Cotters, Spring Seats**																		
					A	Seat - Spring Upper		X	07 04 - N0101 - 01	16	4								NR			
					B	Retainer - Valve Spring		X	07 04 - N0101 - 02	32	5								NR			
			C	Seal-Seat Subassembly - Spring Lower (Seat, Seal and Coil Spring)				X	07 04 - N0101 - 03	16	6								NR			
		X	05	**Valve Actuation Elements: Rockers, Finger Followers, Hydraulic Lash Adjusters,...**																		
			A	Adjuster - Hydraulic,				X	07 05 - N0101 - 01	16	7								NR			
			B	Follower- Roller Finger				X	07 05 - N0101 - 02	16	8								NR			
		🟥	06	**Camshafts**																		
			A	Camshaft Assembly - Intake Machined				🟥	07 06 - N0101 - 01	1	9			X	X				1. Length of Camshaft reduced, mass reduction. 2.Feature required to drive high pressure fuel pump for DI. 3. Material Assumption, both Base and Turbo DI made from Nodular Cast Iron, Chilled			
					A1	Camshaft - Intake Machined		🟥	07 06 - N0101 - 02	1									Reference Camshaft Assembly-Intake			
					A2	Encoder Wheel - Intake		X	07 06 - N0101 - 03	1									NR			
			B	Camshaft Assembly - Exhaust Machined				🟥	07 06 - N0101 - 10	1	10			X	X				1. Length of Camshaft reduced, mass reduction. 2.Feature required to drive high pressure fuel pump for DI. 3. Material Assumption, both Base and Turbo DI made from Nodular Cast Iron, Chilled			
					B1	Camshaft - Exhaust Machine		🟥	07 06 - N0101 - 11	1									Reference Camshaft Assembly-Exhaust			
					B2	Encoder Wheel - Exhaust		X	07 06 - N0101 - 12	1									NR			
		x	08	**Camshaft Phaser and/or Cam Sprockets**																		
			A	Cam Phaser Assembly- Intake				X	07 08 - N0101 - 01	1	11								Assumption Base and New Technology Packages have Dual VVT.			

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101, 2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

FEV

GENERAL PART INFORMATION

Powertrain Description: 2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine **Vehicle Class:** Compact/Economy 2-4 Passenger

Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)

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			B			Sprocket - Cam, Exhaust (Replaced with Exhaust Cam Phaser for Analysis)	X	07 08 - N0101 - 20	1	12								NR - Assumption Base and New Technology Packages have Dual VVT. Thus exhaust sprocket is replaced with cam phaser assembly.			
		X	80			Boltings															
					A	Bolt - Cam Phaser, Camshaft, Intake	X	07 80 - N0101 - 01	1	13								NR			
					B	Bolt - Sprocket, Camshaft, Exhaust	X	07 80 - N0101 - 02	1	14								NR			
							X			15											
							X			16											
					E	Bolt-Flange -Control Valve Oil To Cylinder Head	X	07 80 - N0101 - 20	1	17								NR			
		X	99			Miscellaneous															
			A			Control Valve - Oil, Intake VVT	X	07 99 - N0101 - 01	1	18								NR			
			B			Control Valve - Oil, Exhaust VVT (Added into assumption for cost analysis)	X	07 99 - N0101 - 02	1									NR			
							X														
	X	08				Timing Drives															
		🟥	01			Timing Wheels (Sprockets)															
					A	Sprocket - Crankshaft, Timing Drive	🟥	08 01 - N0101 - 01	1	1					X		X	Smart sprocket required to help counter act cyclic loading effects from Vacuum Pump and High Pressure Pump.	Cost impact approx. $1-$2/Engine. Note, cost impact is associated with royalty fee; no manufacturing cost impact.		
					B	Sprocket - Crankshaft, Oil Pump Drive	X	08 01 - N0101 - 02	1	2								Surrogate Design			
		X	02			Tensioners															
			A			Tensioner - Camshaft Timing	X	08 02 - N0101 - 01	1	3								NR			
		X	03			Guides															
			A			Tensioner Arm Assembly - Timing Chain, Lower	X	08 03 - N0101 - 01	1	4								NR			
					A1	Tensioner Arm - RHS															
					A2	Tensioner Arm - LHS															
			B			Guide Assembly - Timing Chain, Upper Cam to Cam	X	08 03 - N0101 - 10	1	5								NR			
					B1	Bracket - Mounting															
					B2	Guide Rail -Upper															
		X	05			Belts, Chains															
					A	Chain Assembly - Timing	X	08 05 - N0101 - 01	1	6			X		X			May require heavier chain to handle additional timing drive load created by the vacuum pump and high pressure fuel pump.	Turbo DI has Roller Chain and NA PFI Engine has Inverted Tool/Silent Chain? Verify and determine if there is cost impact. Perhaps MCR on Base?		
		X	06			Covers															
							X														
		X	65			Adaptors															
					A	Nose - Crankshaft, Timing Sprocket & Accessory Pulley	X	08 65 - N0101 - 01	1	7								NR			
		X	80			Boltings															

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101, 2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

FEV

GENERAL PART INFORMATION

Powertrain Description: 2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine **Vehicle Class:** Compact/Economy 2-4 Passenger

Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)

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												Part Existence	Material/Finish(s)	Weight/ Size	Function	Performance	QTY/P.T.	Royalty	<NR> = Item cost impact assumed unaffected or negligibly affected by technology differences			
					A		Bolt - Crankshaft Nose	X	08 80 - N0101 - 01	1	8								NR			
					B		Washer - Crankshaft Nose	X	08 80 - N0101 - 02	1	9								NR			
					C		Bolt - Guide, Timing Chain Upper to cylinder head.	X	08 80 - N0101 - 03	1	10								NR			
					D		Bolt - Tension Arm Subassembly to Block	X	08 80 - N0101 - 04	3	11								NR			
								X														
	X	09					Accessory Drives															
		X	01				Pulleys															
					A		Pulley/Damper Assembly - Crankshaft	X	09 01 - N0101 - 01	1	1			X		X			NR - Turbo DI has single mode damper similar to Base NA PFI Engine	Dual mode dampers (DMD) reduce vibration in two directions. DMD's are typical for Turbo DI Engines. DMDs contain two separate dampers, one is for torsional crankshaft vibration (twisting) and the other is for bending vibration (bending up and down).		
					B		Wheel - Drive, Coolant Pump (Friction Driven)	X	09 01 - N0101 - 02	1	2								NR			If mechanical water pump + small auxiliary Turbo pump was replaced with single larger electric water , this item would be removed and cost savings put towards electric pump.
			C				Actuating Drive Assembly - Drive Pulley & Water Pump	X	09 01 - N0101 - 03	1	3								NR			If mechanical water pump + small auxiliary Turbo pump was replaced with single larger electric water , this item would be removed and cost savings put towards electric pump.
		X	02				Tensioners															
			A				Tensioner Assembly - Accessory Drive	X	09 02 - N0101 - 01	1	4								NR			
		X	03				Guides															
								X														
		X	05				Belts															
					A		Belt - Accessory Drive	X	09 05 - N0101 - 01	1	5								NR			
		X	65				Adaptors															
								X														
		X	70				Pipes, Hoses, Ducting															
								X														
		X	75				Brackets															
								X														
		X	80				Bolting															
					A		Bolts - Pulley Crankshaft	X	09 80 - N0101 - 01	3	6								NR			
					B		Bolts - Drive Gear/Wheel Coolant Pump	X	09 80 - N0101 - 02	3	7								NR			If mechanical water pump + small auxiliary Turbo pump was replaced with single larger electric water , this item would be removed and cost savings put towards electric pump.
					C		Bolt - Tensioner Assembly (Secures to Alternator)	X	09 80 - N0101 - 03	1	8								NR			
					D		Bolt - Actuating Drive Assembly - Drive Pulley & Water Pump	X	09 80 - N0101 - 04	3	9								NR			If mechanical water pump + small auxiliary Turbo pump was replaced with single larger electric water , this item would be removed and cost savings put towards electric pump.

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101, 2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

GENERAL PART INFORMATION

Powertrain Description: 2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp
Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)

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												Part Existence	Material/Finish(s)	Weight/ Size	Function	Performance	QTY/P.T.	Royalty				
	🟥	10					**Intake Systems**															
		🟥	01				**Intake Manifolds**															
			A				Manifold Assembly - Intake	🟥	10 01 - N0101 - 01	1	**1**			X	X	X			Assumptions: Intake manifold of Turbo DI is approximately half size of NA PFI Engine. Also base engine has intake tumbler to improve fuel atomization which helps meet cold start and idling targets. Although FEV feels additional tumbler device may be avoided with proper intake manifold design and head design.	Long runner intake manifolds are required in NA engines for tuning pressure wave. Want to make sure peak pressure hits at intake valve.		
		X	02				**Air Filter Box**															
			A				Air Filter Box Assembly	X	10 02 - N0101 - 01	1	**2**								NR			
		X	03				**Air Filters**															
					A		Air Filter	X	10 03 - N0101 - 01	1	**3**								NR			
		X	05				**Throttle Housing Assembly; including Supplies**															
			A				Throttle Body Assembly - Electronically Controlled	X	10 05 - N0101 - 01	1	**4**								NR			
		X	65				**Adapters: Flanges for Port Shut-off**															
								X														
		X	70				**Pipes, Hoses, Ducting**															
						A	Tube - Elbow, Air Intake to Filter Box	X	10 70 - N0101 - 01	1	**5**								NR			
						B	Tube - Flex, Air Intake to Elbow	X	10 70 - N0101 - 02	1	**6**								NR			
						C	Coupler - Tube Flex to Vehicle Mount	X	10 70 - N0101 - 03	1	**7**								NR			
						D	Tube - Air Filter Box via MFS to Turbo Inlet	X	10 70 - N0101 - 04	1	**8**								NR - This would go direct to ETB on Base Engine			
		X	75				**Brackets**															
					A		Bracket - Support, Intake Manifold	X	10 75 - N0101 - 01	1	**9**								NR			
		X	80				**Bolting & Clamps**															
					A		Nut - Intake Manifold Assembly to Cylinder Head	X	10 80 - N0101 - 01	5	**10**								NR			
					B		Nut- Bracket, Intake Manifold Support	X	10 80 - N0101 - 02	2	**11**								NR			
					C		Bolt- Bracket, Intake Manifold Support	X	10 80 - N0101 - 03	1	**12**								NR			
					D		Bolt- Throttle Body to Intake Manifold	X	10 80 - N0101 - 04	3	**13**								NR			
					E		Bolt - Manifold Absolute Pressure	X	10 80 - N0101 - 05	1	**14**								NR			
					F		Grommet - Air Filter Box to Intake Manifold Mounting	X	10 80 - N0101 - 06	3	**15**								NR			
					G		Bolt - Air Filter Box To Intake Manifold	X	10 80 - N0101 - 07	1	**16**								NR			
					H		Duplicate Part to "F"	X			**17**											
					I		Insert - Air Filter - Intake Torque Loss Prevention	X	10 80 - N0101 - 09	1	**18**								NR			
					J		Clamp - Tube, Mass Air Flow Outlet	X	10 80 - N0101 - 10	1	**19**								NR			
					K		Clamp - Tube, Turbo Inlet	X	10 80 - N0101 - 11	1	**20**								NR - This would clamp would be used to secure inlet tube directly to ETB			
		(Move to PCV)			~~L~~		~~Retainer - Turbo Intake Pipe to PCV Subassembly~~	X	~~10~~ ~~80~~ - ~~N0101~~ - ~~12~~	1	**21**											
		X	85				**Sealing Elements**															
					A		Gasket-Intake Manifold, Main Flange to Cylinder Head	X	10 85 - N0101 - 01	1	**22**								NR			

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101, 2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

GENERAL PART INFORMATION

Powertrain Description:	2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp
Technology Level:	Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class:	Compact/Economy 2-4 Passenger
Study Case#:	N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)

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					B		Gasket-Electronic Throttle Body to Intake Manifold	X	10 85 - N0101 - 02	4	23								NR			
					C		Gasket - Mass Flow Sensor (MFS) - Air Filter Box	X	10 85 - N0101 - 03	1	24								NR			
		X	99				**Miscellaneous**															
			A				Sensor - Mass Flow Meter, Hot Wire	X	10 99 - N0101 - 01	1	25								NR			
			B				Sensor - Manifold Absolute Pressure (MAP)	X	10 99 - N0101 - 02	1	26								NR			
	🟥	11					**Fuel Induction Systems**															
		🟥	01				**Fuel Rails**															
			A				Fuel Rail w. High Pressure Sensor Assembly	🟥	11 01 - N0101 - 01	1												
			A1				Fuel Rail - High Pressure	🟥	11 01 - N0101 - 02	1	MP-1		X	X		X			As a result of higher fuel pressures (approx. 1200 psi), the following upgrades are required for DI versus PFI. 1. Enhanced material grade. 2. Thicker gauge material and structural enhancements. 3. Additional attachment points.			
			A2				Sensor - Fuel, High Pressure	🟥	11 01 - N0101 - 03	1	MP-1	X							1 . Require pressure senor on fuel rail for DI; not required for PFI engine.			
		🟥	04				**Fuel Injectors**															
			A				Fuel Injector Assembly - Solenoid, 7 Hole	🟥	11 04 - N0101 - 01	4	2		X	X	X	X			1. Replaces Low Pressure Port Injectors			
		🟥	07				**Fuel Injection Pumps**															
			A				Fuel Pump - High Pressure w. Vol.Cotrol Valve (Driven-Off Intake Cam)	🟥	11 07 - N0101 - 01	1	3	X							1, Required for DI system, not required PFI system.		Look at cost Delta for Rotary pump which is driven off back of intake Cam versus Cam Lobe driven pump. Rotary pump assembly more expensive. However, need to consider entire subsystem which includes head changes [additional cast material (Approx. 1 kg) and added precision machining (Especially tappet bore and flange face)], cam changes (Additional lobe on intake cam), and a few others.	
		🟥	70				**Pipes, Hoses: Low Pressure, High Pressure**															
			A				Pipe Assembly - Fuel, High Pressure, Pump to Rail	🟥	11 70 - N0101 - 01	1	4	X							1. Connects High Pressure Pump to Fuel Rail on DI Engine; not required for PFI system.			
			B				Tube & Hose Fuel LP & Purge Assembly	X	11 70 - N0101 - 02	1	MP-4								NR			
			B1				Hose - Fuel Feed, Low Pressure	X	11 70 - N0101 - 03	1	MP-4								NR			
			B2				Hose - Fuel, Purge	X	11 70 - N0101 - 04	1	MP-4								NR			
					B3		Retainer - Fuel Hoses to Bracket, LP & Purge	X	11 70 - N0101 - 05	1	MP-4								NR			
					B4		Retainer- Fuel Hose, LP & Purge	X	11 70 - N0101 - 06	1	MP-4								NR			
		X	75				**Brackets**															
			D				Bracket Assembly - Tube, Fuel Low Pressure and Purge	X	11 75 - N0101 - 01	1	MP-4								NR			
		🟥	80				**Bolting**															
				A			Bolt - Fuel Rail	🟥	11 80 - N0101 - 01	4	5					X	X		DI has increased fastener quantity and size for securing fuel rail.			
				B			Bolt - Fuel Pump	🟥	11 80 - N0101 - 02	3	6	X							Added for DI			
				C			Retainer - Fuel Injector	🟥	11 80 - N0101 - 03	4	7	X							Added for DI			
				D			Washer, Retainer - Fuel Injector	🟥	11 80 - N0101 - 04	4	8	X							Added for DI			
				E			O-ring Retainer, Fuel Injector	🟥	11 80 - N0101 - 05	4	9	X							Added for DI			
				F			Spacer - Retainer, Fuel Injector	🟥	11 80 - N0101 - 06	4	10	X							Added for DI			

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101, 2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

GENERAL PART INFORMATION

Powertrain Description: 2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine **Vehicle Class:** Compact/Economy 2-4 Passenger

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		🟥	**85 Sealing Elements**															
			A Seal - High Pressure Fuel Pump to Cylinder Head	🟥	11 85 - N0101 - 01	1	11	X							Added for DI			
	🟥		**12 Exhaust Systems**															
		🟥	**01 Exhaust Manifold**															
			A Manifold - Exhaust, Dual Wall	🟥	12 01 - N0101 - 01	1	1		X						Material upgrade required to a stainless steel capable of operating @ 1050C. Recommendation DIN 14826 Stainless Material.		Fabricated dual wall manifolds may offer a 30% cost reduction over the cast manifold but these designs are package specific and require a significant amount of engineering development.	Nodular Cast Iron
		X	**04 Collector Pipes**															
				X														
		X	**05 Catalysts**															
			A Close Couple Catalytic Converter Subass'y- 3 Way (Exhaust Pipe Ass'Y)	X	12 05 - N0101 - 01	1									NR - Estimate close coupled catalytic converter subsystem for Turbo DI technology and NA PFI engine approximately equivalent in cost for this study based on similar power flows.	Consider higher temperatures and quicker light-off with direct injection offset by heat sink from turbo assembly hardware.		
			B Underbody Catalytic Converter Subass'y - ? Way (Under Body Ass'y)	X	12 05 - N0101 - 02	1									NR			
		X	**07 Silencers (Mufflers)**															
			A Resonator Subassembly (Under Body Ass'y)	X	12 07 - N0101 - 01	1									NR			
			B Muffler & Tail Pipe Subassembly (Under Body Ass'y)	X	12 07 - N0101 - 02	1									NR			
		X	**08 Oxygen Sensors**															
			A Sensor Assembly - Oxygen/Lambda Before Catalyst	X	12 08 - N0101 - 01	1	2								NR			
			B Sensor Assembly - Oxygen/Lambda After Catalyst	X	12 08 - N0101 - 02	1	3								NR			
		X	**65 Adapters**															
			A Flex Pipe Subass'y - Under Body Exhaust Ass'y to Exhaust Pipe Ass'y	X	12 65 - N0101 - 01	1	4								NR			
		X	**70 Pipes, Hoses: Low Pressure, High Pressure**															
			A Exhaust Pipe Assembly	X	12 70 - N0101 - 01	1	5								NR			
			B Underbody Exhaust Pipe Assembly	X	12 70 - N0101 - 02	1	6								NR			
		🟥	**75 Brackets**															
			A Bracket Subassembly - Exhaust Manifold w. Integrated Gasket	🟥	12 75 - N0101 - 01	1	7		X		X				1. 3 layer sealing Turbo, 2 layer base NA PFI			
			B Bracket Subassembly- Heat Shield, Top, Turbo	🟥	12 75 - N0101 - 02	1	8	X							Required to cover Turbo Assembly			
			C Bracket Subassembly - Heat Shield, Exhaust Outlet to Block	X	12 75 - N0101 - 03	1	9								NR			As Turbo DI becomes more main stream, prediction is that heat shields will not only be used for heat control, but also be required to dampen and absorb combustion noise. Investigate cost impact for composite type structures.
			D Bracket Subassembly - Exhaust Lower - CC. Cat. Conv.	X	12 75 - N0101 - 05	1	MP-9								NR			As Turbo DI becomes more main stream, prediction is that heat shields will not only be used for heat control, but also be required to dampen and absorb combustion noise. Investigate cost impact for composite type structures.

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101, 2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

GENERAL PART INFORMATION

Powertrain Description: 2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp
Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)

ITEM	ASY LVL						NAME/DECRIPTION		PART NUMBER	QTY/ P.T.	Label #	CHECK OFF ATTRIBUTES WHICH ARE DIFFERENT BETWEEN COMPARISON TECHNOLOGY PACKAGES							BRIEF EXPLANATION OF DIFFERENCES	Notes: Addititional Items Requiring Investigation.	Design modifications for Material Cost Reductions (MCR's).	Additional Technology Advances or Performance Upgrades
		SUBSYSTEM	SUB-SUBSYSTEM	ASSEMBLY	SUBASSEMBLY	COMPONENT	🟥 Default, indicates cost study required for identified item. ? Indicates cost analysis potentially required, additional details required. 🟩X Indicates common item/cost factor found in both baseline and new technology package, no cost analysis required. ▨X Same as above, however with potential MCR or Technology Advance Considerations					Part Existence	Material/Finish(s)	Weight/ Size	Function	Performance	QTY/P.T.	Royalty	<NR> = Item cost impact assumed unaffected or negligibly affected by technology differences			
					E		Strap - Manifold Mount Face (Torque Loss)	🟩X	12 75 - N0101 - 06	1	MP-10								NR - Components not industry standard for Base or Turbo DI			
					F		Strap - Manifold Mount Face (Torque Loss)	🟩X	12 75 - N0101 - 07	1	MP-10								NR - Components not industry standard for Base or Turbo DI			
					G		Strap - Manifold Mount Face (Toque Loss)	🟩X	12 75 - N0101 - 08	1	MP-10								NR - Components not industry standard for Base or Turbo DI			
				H			Bracket Subassembly #1 - C.C. Catalytic Con. To Bed Plate	🟩X	12 75 - N0101 - 09	1	MP-10								NR			
				I			Bracket Subassembly #2 - C.C. Catalytic Con. To Bed Plate	🟩X	12 75 - N0101 - 10	1	MP-10								NR			
				J			Bracket Subassembly - O2 Sensor (Before CC Cat. Conv.)	🟩X	12 75 - N0101 - 11	1	MP-10								NR			
				K			Fixturing Hardware General - Exhaust Underbody Assembly	🟩X	12 75 - N0101 -	NA									NR			
		🟥	80				**Bolting**															
					A		Nut- Manifold Exhaust to Cylinder Head	🟥	12 80 - N0101 - 01	10	11		X			X			Material upgrade to stainless to handle higher exhaust temperatures			
					B		Bolt - BRKT Heat Shield Turbo to Exhaust Manifold BRKT	🟩X	12 80 - N0101 - 02	12	12								NR - Similar fasteners exist for both designs			
					D		Nut - BRKT Heat Shield Exhaust to Exhaust Manifold BRKT	🟩X	12 80 - N0101 - 04	1	14								NR - Similar fasteners exist for both designs			
					E		Nut - C.C. Catalytic Converter to Bed Plate (Copper Nut)	🟩X	12 80 - N0101 - 05	2	MP-14								NR			
					F		Nut - Turbo to C.C. Catalytic Converter	🟥	12 80 - N0101 - 06	3	MP-14	X							Add for Turbo, Stainless Material?			
					G		Nut - Exhaust Manifold to Turbo	🟥	12 80 - N0101 - 07	4	MP-14		X			X			If there was no Turbo, assume same four nuts would be required to mount directly between manifold and exhaust pipe or Catalytic Converter Subassembly. However in Turbo DI case need to cover cost impact of Stainless Steel Nuts Versus Standard.			
					H		Nut - Bracket, C.C. Catalytic Converter to Bed Plate	🟩X	12 80 - N0101 - 08	2	MP-14								NR			
			I				Clamp Assembly - CC Catalytic Converter to Exhaust Pipe	🟩X	12 80 - N0101 - 09	1	MP-14								NR			
					J		Fastening Hardware General - Exhaust Underbody Assembly	🟩X	12 80 - N0101 -	TBD												
								🟩X														
		🟥	85				**Sealing Elements**															
					A		Gasket - Turbo Inlet to Exhaust Manifold	🟥	12 85 - N0101 - 01	1	15	X							Required with Turbo			
					B		Gasket - Turbo Outlet to Catalytic Converter	🟩X	12 85 - N0101 - 02	1	MP-15								If there was no Turbo, assume gasket would be used to mount directly between manifold and exhaust pipe or Catalytic Converter Subassembly.			
	🟥	13					**Lubrication Systems, Oil Pans/Sumps**															
		🟩X	01				**Oil Pans (Oil Sump)**															
					A		Pan -Oil	🟩X	13 01 - N0101 - 01	1	1								NR			
		🟥	02				**Oil Pumps**															
			A				Oil Pump Assembly	🟥	13 02 - N0101 - 01	1	2					X			Piston Cooling Jets, Turbo Charge lubrication and External Oil cooler will require increased oil capacity. Will need to access cost impact to moving to higher flow pump.	Typical oil pump pressure 50-60psi (10psi/1000rpm). High volume pump typical has flow 20-25% higher. The physically larger surface area of the gears pushes more oil through the pump at the same rpm than a stock pump.		
		🟥	06				**Oil Filter**															

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101, 2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

GENERAL PART INFORMATION

Powertrain Description: 2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp
Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)

ITEM	ASY LVL						NAME/DECRIPTION		PART NUMBER	QTY/ P.T.	Label #	CHECK OFF ATTRIBUTES WHICH ARE DIFFERENT BETWEEN COMPARISON TECHNOLOGY PACKAGES							BRIEF EXPLANATION OF DIFFERENCES	Notes: Addititional Items Requiring Investigation.	Design modifications for Material Cost Reductions (MCR's).	Additional Technology Advances or Performance Upgrades
		SUBSYSTEM	SUB-SUBSYSTEM	ASSEMBLY	SUBASSEMBLY	COMPONENT	🟥 Default, indicates cost study required for identified item. ? Indicates cost analysis potentially required, additional details required. X Indicates common item/cost factor found in both baseline and new technology package, no cost analysis required. X Same as above, however with potential MCR or Technology Advance Considerations					Part Existence	Material/Finish(s)	Weight/ Size	Function	Performance	QTY/P.T.	Royalty	<NR> = Item cost impact assumed unaffected or negligibly affected by technology differences			
			A				Filter Cooler Assembly - Oil (Includes Seals)	🟥	13 06 - N0101 - 01	1	3	X							Require oil cooler in circuit to help cool oil going into Turbo assembly.			
		🟥	70				**Pipes, Hoses: Suction Pipe for Oil Pump, Oil Return, High Pressure, Low Pressure.**															
			A				Tube Assembly- Oil, Cooler/Filter Ass'y Outlet to Turbocharger	🟥	13 70 - N0101 - 01	1	4	X							Required with Turbo			
			B				Tube Assembly - Oil, Turbo to Engine Block (Piston Squirter's)	🟥	13 70 - N0101 - 02	1	5	X							Required with Turbo			
		🟥	80				**Boltings & Clamps**															
					A		Screw - Oil Pan to Bed Plate	X	13 80 - N0101 - 01	16	6								NR			
					B		Bolt - Oil Pump Assembly	X	13 80 - N0101 - 02	3	7								NR			
					C		Bolt - Filter Cooler Assembly	🟥	13 80 - N0101 - 03	4	8	X							Required with Turbo			
					D		Bolt - Tube Assembly , Oil, Turbo Inlet	🟥	13 80 - N0101 - 09	1	9	X							Required with Turbo			
					E		Clamp - Tube Assembly, Oil, Cooler/Filter Outlet	🟥	13 80 - N0101 - 05	1	10	X							Required with Turbo			
					F		Bolt - Tube Assembly , Oil, Turbo Outlet & Block Inlet	🟥	13 80 - N0101 - 06	2	11	X							Required with Turbo			
					G		Screw - Tube assembly Oil level Indicator	X	13 80 - N0101 - 07	1	12								NR			
		🟥	85				**Sealing Elements: Oil Pan Gasket,...**															
					A		Gasket - Oil Pan (Deposit)	X	13 85 - N0101 - 01	1									NR			
				B			Plug & Gasket Subassembly - Oil Pan, Drain	X	13 85 - N0101 - 02	1									NR			
					C		Seal - Tube Assembly, Oil, Turbo Inlet	🟥	13 85 - N0101 - 03	1	15	X							Required for Turbo			
					D		Compression Seal-Tube Ass'y, Oil Turbo Outlet & Block Inlet	🟥	13 85 - N0101 - 04	4	16	X							Required for Turbo			
		🟥	99				**Miscellaneous**															
					A		Chain - Crank Shaft to Oil Pump	X	13 99 - N0101 - 01	1	17								NR			
			B				Tube Assembly - Oil Level Indicator	X	13 99 - N0101 - 02	1	18								NR			
			C				Sensor - Oil Pressure	X	13 99 - N0101 - 03	1	19								NR			
			D				Cover - Oil Pump Chain	X	13 99 - N0101 - 06	1	MP								NR			
			E				Sensor - Oil Temperature	X	13 99 - N0101 - 04	1	20								NR			
			F				Oil - Synthetic	🟥	13 99 - N0101 - 08	1			X			X			Synthetic oil required for turbocharged applications. Need to consider cost of initial factory fill.			
	🟥	14					**Cooling Systems**															
		🟥	01				**Water Pumps**															
			A				Pump Assembly - Coolant (Primary Mechanical)	X	14 01 - N0101 - 01	1	1								NR			Upgrade system from mechanical pump + smaller auxiliary to single larger electric water pump for reduced parasitic losses and I improved friction characteristics. Need to investigate cost impact (Conventional Water Pump $25.50) . Need to consider other H/W which can be removed if single electric water pump is utilized.
			B				Pump- Auxiliary Coolant, Electric	🟥	14 01 - N0101 - 02	1	2	X							Required for Turbo Cooling following engine shut down.			
		X	02				**Thermostat Housing**															
			A				Thermostat/Coolant Flow Valve Assembly -Coolant	X	14 02 - N0101 - 01	1	3								NR - Today having Integrated Electric Thermostat on Turbo DI and a conventional mechanical thermostat on the NA PFI is more typical. However I industry trend is moving towards electric thermostats for both technology levels. Thus assumption is same technology would exist in both applications.			

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101, 2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

GENERAL PART INFORMATION

Powertrain Description: 2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine **Vehicle Class:** Compact/Economy 2-4 Passenger

Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)

ITEM	ASY LVL	NAME/DECRIPTION							PART NUMBER	QTY/ P.T.	Label #	CHECK OFF ATTRIBUTES WHICH ARE DIFFERENT BETWEEN COMPARISON TECHNOLOGY PACKAGES							BRIEF EXPLANATION OF DIFFERENCES	Notes: Addititional Items Requiring Investigation.	Design modifications for Material Cost Reductions (MCR's).	Additional Technology Advances or Performance Upgrades
		SUBSYSTEM	SUB-SUBSYSTEM	ASSEMBLY	SUBASSEMBLY	COMPONENT	🟥 Default, indicates cost study required for identified item. ? Indicates cost analysis potentially required, additional details required. X Indicates common item/cost factor found in both baseline and new technology package, no cost analysis required. X Same as above, however with potential MCR or Technology Advance Considerations					Part Existence	Material/Finish(s)	Weight/ Size	Function	Performance	QTY/P.T.	Royalty	<NR> = Item cost impact assumed unaffected or negligibly affected by technology differences			
							Sensor - Thermostat (Integrated into Housing?)	X	14 02 - N0101 - 02	1									Same as above			
							Sensor - Engine Temperature (Includes O-ring and Clip)	X	14 02 - N0101 - 03	1	4								NR			
		🟥	70				**Pipes, Hoses, Ducting**															
			A				Tube - Mech. Pump to Thermostat/Coolant Valve Ass'y	X	14 70 - N0101 - 01	1	5								NR			
			B				Hose Assembly - Turbo Assembly to Thermostat/Coolant Valve	🟥	14 70 - N0101 - 02	1	6	X							Required for Turbo Cooling			
			C				Hose Assembly - Auxiliary Pump to Turbo	🟥	14 70 - N0101 - 03	1	7	X							Required for Turbo Cooling			
					D		Hose Assembly - Oil Filer/Cooler Ass'y to Auxiliary Pump	🟥	14 70 - N0101 - 04	1	8	X							Required for Turbo Cooling			
					E		Hose - Radiator to Thermostat/Coolant Valve Assembly	X	14 70 - N0101 - 05	1									NR			
					F		Hose - Thermostat/Coolant Valve Assembly to Radiator	X	14 70 - N0101 - 06	1									NR			
					G		Hose - Heater Core to Thermostat/Coolant Valve Assembly	X	14 70 - N0101 - 07	1									NR			
					H		Hose - Thermostat/Coolant Valve Assembly to Heater Core	X	14 70 - N0101 - 08	1									NR			
		🟥	75				**Brackets**															
				A			Bracket Subassembly - Auxiliary Pump to Oil Filter/Cooler Ass'y	🟥	14 75 - N0101 - 01	1	MP	X							Required to secure auxiliary electric pump for cooling turbo.			
		🟥	80				**Boltings & Clamps**															
					A		Bolt - Water Pump, Mechanical	X	14 80 - N0101 - 01	5	13								NR			
					B		Bolt - Thermostat/Coolant Flow Valve Assembly	X	14 80 - N0101 - 02	3	14								NR			
					C		Retainer(s) - Tube, Mech Pump to Thermostat Valve Ass'y	X	14 80 - N0101 - 03	??	15								NR			
					D		Clamp-Hose Thermo/Coolant Valve Ass'y to Turbo @ Thermo	🟥	14 80 - N0101 - 04	1	16	X							Required for Turbo Cooling			
					E		Bolt-Hose Ass'yThermo/Coolant Valve to Turbo, BRKT Mount	🟥	14 80 - N0101 - 05	1		X							Required for Turbo Cooling			
					F		Bolt-Hose, Inlet and Outlet @ Turbo	🟥	14 80 - N0101 - 06	2	18	X							Required for Turbo Cooling			
					G		Bolt - Auxiliary Pump to Oil Filter Cooler Bracket Assembly	🟥	14 80 - N0101 - 07	2	19	X							Required for Turbo Cooling			
					I		Clamp - Hose, Auxiliary Pump to Turbo	🟥	14 80 - N0101 - 09	1	21	X							Required for Turbo Cooling			
					J		Clamp - Hose, Oil Filter Cooler Assembly to Auxiliary Pump	🟥	14 80 - N0101 - 10	2	22	X							Required for Turbo Cooling			
					K		Clamp - Inlet and Outlet Radiator Hoses	X	14 80 - N0101 - 11	4									NR			
					L		Clamp - Inlet and Outlet Heater Core Hoses	X	14 80 - N0101 - 12	4									NR			
					M		Washer Banjo Bolt - Hose Coolant Inlet & Outlet Turbo	🟥	14 80 - N0101 - 13	4	MP-24	X							Required for Turbo Cooling			
		X	85				**Sealing Elements**															
					A		Seal - Water Pump Mechanical	X	14 85 - N0101 - 01	1	25								NR			
					B		Seal - Thermostat/Coolant Flow Valve Assembly	X	14 85 - N0101 - 02	1	26								NR			
	🟥	15					**Induction Air Charging Systems**															
		🟥	01				**Turbo Chargers (Assemblies)**															
			A				Turbo Charger Assembly	🟥	15 01 - N0101 - 01	1	1	X							Require for Turbo System Twin Scroll turbocharger capable of operating at 1050C EGT (Exhaust Gas Temperature) is currently the best option for transient operation.		Future cost reduction may include fabricated exhaust manifold scrolls integrated with the exhaust manifold.	Future technology advances may include a variable geometry turbo, but there are non in existence today capable of operating above 950C EGT.
				A1			Waste Gate Anti Surge Control Valve	🟥	15 01 - N0101 - 02	1		X							Same as above			
		🟥	05				**Heat Exchanger**															

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101,
2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

FEV

GENERAL PART INFORMATION

Powertrain Description: 2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp
Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine **Vehicle Class:** Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)

🟥 Default, indicates cost study required for identified item.
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X Same as above, however with potential MCR or Technology Advance Considerations

<NR> = Item cost impact assumed unaffected or negligibly affected by technology differences

ITEM	ASY LVL	SUBSYSTEM	SUB-SUBSYSTEM	ASSEMBLY	SUBASSEMBLY	COMPONENT	NAME/DECRIPTION		PART NUMBER	QTY/ P.T.	Label #	CHECK OFF ATTRIBUTES WHICH ARE DIFFERENT BETWEEN COMPARISON TECHNOLOGY PACKAGES: Part Existence	Material/Finish(s)	Weight/ Size	Function	Performance	QTY/P.T.	Royalty	BRIEF EXPLANATION OF DIFFERENCES	Notes: Addititional Items Requiring Investigation.	Design modifications for Material Cost Reductions (MCR's).	Additional Technology Advances or Performance Upgrades
			A				Cooler Assembly - Charged Air	🟥	15 05 - N0101 - 01	1	2	X							Charged air cooler required for Turbo System			Estimated unit cost savings to move from conventional air to air charge air cooler to water to air charge air cooling subsystem. Note that the tooling bill is higher but the A-ACAC tooling needs to be completely duplicated for a new vehicle application whereas the W-ACAC is only partially duplicated. Improved performance for stop and go city driving.
		🟥	65				**Adapters**															
								🟥														
		🟥	70				**Pipes, Hoses, Ducting**															
			A				Tube Assembly - Turbo Waste Gate Pneumatic Control	🟥	15 70 - N0101 - 03	1	3	X							Required for Turbo System			
			B				Tube Ass'y w. Vehicle Tie Down Resonator, Air Cooler Inlet		15 70 - N0101 - 19	1												
					BI		Tube - Turbo Outlet to Vehicle Mount Coupler	🟥	15 70 - N0101 - 20	1	4	X							Part of air charge air cooling & delivery subsystem			
					B2		Coupler - Turbo Outlet Tube to Cooler Intake Tube	🟥	15 70 - N0101 - 21	1	5	X							Part of air charge air cooling & delivery subsystem			
					B3		Tube - Coupler to Charge Air Cooler	🟥	15 70 - N0101 - 22	1	6	X							Part of air charge air cooling & delivery subsystem			
			C				Tube Ass'y w. Vehicle Tie Down, Air Cooler Outlet					X							Part of air charge air cooling & delivery subsystem			
					C1		Tube - Charge Air Cooler Outlet	🟥	15 70 - N0101 - 01	1	7	X							Part of air charge air cooling & delivery subsystem			
					C2		Tube - Formed, Charge Air Cooler Tube Outlet	🟥	15 70 - N0101 - 31	1	8	X							Part of air charge air cooling & delivery subsystem			
					D		Tube - Elbow, Upper to Charged Air Coupler By-Pass	🟥	15 70 - N0101 - 40	1	9	X							Part of air charge air cooling & delivery subsystem			
					E		Tube - Coupler Y Branch to By-Pass	🟥	15 70 - N0101 - 41	1	10	X							Part of air charge air cooling & delivery subsystem			
					F		Tube - Elbow Coupler By-Pass to Throttle Body	🟥	15 70 - N0101 - 42	1	11	X							Part of air charge air cooling & delivery subsystem			
					G		Tube - Charged Air Bypass to Silencer	🟥	15 70 - N0101 - 43	1	12	X							Part of air charge air cooling & delivery subsystem			
					H		Tube - Flex Elbow, Silencer to Environment	🟥	15 70 - N0101 - 44	1	13	X							Part of air charge air cooling & delivery subsystem			
		🟥	75				**Brackets**															
					A		Bracket - Support, Turbo Assembly	🟥	15 75 - N0101 - 01	1	14	X							Required to support mass of Turbo assembly hanging off Exhaust Manifold.			
		🟥	80				**Boltings, Clamps, Misc Fastening**															
					A		**Bolt - Turbo Assembly to Exhaust Manifold (Moved-12)**	🟥	15 80 - N0101 -													
					B		**Bolt - Turbo Assembly to Exhaust Pipe (Moved-12)**	🟥	15 80 - N0101 -													
					C		Bolt - Bracket Support, Turbo Assembly	🟥	15 80 - N0101 - 03	1	17	X							Required to support Turbo Assembly			
					D		Bolt - Bracket Support, Turbo Assembly	🟥	15 80 - N0101 - 04	1	18	X							Required to support Turbo Assembly			
					E		Bolt - Pressure Reservoir, Turbo Waste Gate	🟥	15 80 - N0101 - 05	2	19	X							Required for Turbo Assembly Subsystem			
					F		Nut - Pressure Reservoir, Turbo Waste Gate	🟥	15 80 - N0101 - 06	1	20	X							Required for Turbo Assembly Subsystem			
								🟥														
					H		Clamp - Tube, Large, Turbo to Throttle Body	🟥	15 80 - N0101 - 08	9	22	X							Part of air charge air cooling & delivery subsystem. Note one clamp is accounted for in intake subsystem which would connect intake tube directly to ETB in base systems.			
					I		Bolt - Tube, Charge Air Cooler to Vehicle	🟥	15 80 - N0101 - 09	2		X							Part of air charge air cooling & delivery subsystem			
					J		Screw - Sensor, Charge Air Temperature	🟥	15 80 - N0101 - 10	1	24	X							Part of air charge air cooling & delivery subsystem			
					L		Clamp - Tubing Charged Air By-Pass	🟥	15 80 - N0101 - 12	3	26	X							Part of air charge air cooling & delivery subsystem			
					M		Retainer - Vehicle, Charged Air By-Pass Elbow	🟥	15 80 - N0101 - 13	1		X							Part of air charge air cooling & delivery subsystem			
		🟥	99				**Miscellaneous**															
			A				Vacuum Reservoir - Turbo Waste Gate	🟥	15 99 - N0101 - 01	1	29	X							Required for Turbo Assembly Subsystem			
			B				Value - Thrust Control, Turbo Waste Gate Pneumatic Control	🟥	15 99 - N0101 - 02	1	30	X							Required for Turbo Assembly Subsystem			

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101, 2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

FEV

GENERAL PART INFORMATION

Powertrain Description: 2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine **Vehicle Class:** Compact/Economy 2-4 Passenger

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			C				Sensor - Intake Temperature, Outlet Charged Air Cooler	🟥	15 99 - N0101 - 03	1	31	X							Part of air charge air cooling & delivery subsystem			
			D				Baffle - Charge Air By-Pass	🟥	15 99 - N0101 - 04	1	32	X							Part of air charge air cooling & delivery subsystem			
	🟥	17					**Breather Systems**															
		🟥	02				**Oil/Air Separator**															
			A				PCV ASSEMBLY - (Built into Cylinder Head Cover)						X			X			• The crankcase vent system for a DI engine is more difficult and requires better oil separation. This may drive some additional cost into the system if a good result can not be engineered from a separator internal to the cam cover.			
				A1			Valve - Non Return Intake Hose Side	🟥	17 02 - N0101 - 01	1									Evaluate upon teardown of PCV Subsystem			
				A2			Separator - Cyclone	🟥	17 02 - N0101 - 10	1									Evaluate upon teardown of PCV Subsystem			
				A3			Valve - Pressure Control	🟥	17 02 - N0101 - 20	1									Evaluate upon teardown of PCV Subsystem			
				A4			Valve - Oil Drain	🟥	17 02 - N0101 - 30	1									Evaluate upon teardown of PCV Subsystem			
				A5			Valve - Non Return Intake Manifold Side	🟥	17 02 - N0101 - 40	1									Evaluate upon teardown of PCV Subsystem			
		X	70				**Pipes, Hoses, Ducting**															
			A				Hose Assembly- PCV H/W to Intake Manifold	X	17 70 - N0101 - 01	1	6								NR			
			B				Hose Assembly- Air Intake to PCV H/W (With Valve or Sensor??)	X	17 70 - N0101 - 02	1	MP-6								NR			
		X	75				**Brackets**															
								X														
		X	80				**Boltings**															
								X														
		X	85				**Sealing Elements**															
								X														
		X	90				**Bearing Elements**															
								X														
		X	95				**Tools**															
								X														
		X	99				**Miscellaneous**															
					A		Retainer - Hose Assembly - Air Intake to PCV H/W	X	17 99 - N0101 - 01	1	6								NR			
	🟥	60					**Engine Management Systems, Engine Electronic Systems, Electrical Systems**															
		X	01				**Spark Plugs, Glow Plugs**															
			A				Spark Plug	X	60 01 - N0101 - 01	4	1								NR			
		🟥	02				**Engine Management Systems, Engine Electronic Systems**															
			A				Power Train Control Module (PCM) Assembly - Hardware	🟥	60 02 - N0101 - 01						X	X			The PCM H/W is carry over except for the PFI drivers. GDI drivers use a 75-80VDC Boost Circuit and 25A Peak/Hold Drivers. The turbo is just another low-side driver really no cost.	Estimated cost from Tech Team on GDI PCM may cost $40-45 more than a PFI PCM.		
			B				Power Train Control Module (PCM) Assembly - Software	🟥	60 02 - N0101 - 50						X	X			• Control system is much more complicated in order to control injection timing, split injections, fuel rail pressure, electric water pump, electric thermostat, etc.	Costs covered by Indirect Cost Multiplier		
		🟥	03				**Engine Electrical Systems (including Wiring Harnesses, Earth Straps, Ignition Harness, Coils, Sockets)**															

APPENDIX C.1 Comparison Bill of Materials Excerpt - Case Study #0101, 2007 Mini Cooper 1.6L I4, Turbo, Direct Injection

GENERAL PART INFORMATION

Powertrain Description: 2007 Mini Cooper, 1.6L I4, 16V DOHC, DI, Turbo, iVVT, 173hp
Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine **Vehicle Class:** Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)

🟥 Default, indicates cost study required for identified item.
? Indicates cost analysis potentially required, additional details required.
X Indicates common item/cost factor found in both baseline and new technology package, no cost analysis required.
X Same as above, however with potential MCR or Technology Advance Considerations

ITEM	ASY LVL	NAME/DECRIPTION						PART NUMBER	QTY/ P.T.	Label #	CHECK OFF ATTRIBUTES WHICH ARE DIFFERENT BETWEEN COMPARISON TECHNOLOGY PACKAGES							BRIEF EXPLANATION OF DIFFERENCES	Notes: Addititional Items Requiring Investigation.	Design modifications for Material Cost Reductions (MCR's).	Additional Technology Advances or Performance Upgrades
		SUBSYSTEM	SUB-SUBSYSTEM	ASSEMBLY	SUBASSEMBLY	COMPONENT					Part Existence	Material/Finish(s)	Weight/ Size	Function	Performance	QTY/P.T.	Royalty	<NR> = Item cost impact assumed unaffected or negligibly affected by technology differences			
			A	Ignition Coil Assembly - Single Spark			🟥	60 03 - N0101 - 01	4	2					X			Require upgrade in ignition coils, Turbo typically 75-100 mJ, Base NAPFI 40-45mJ.	Need to order ignition coil assembly		
			B	Battery Assembly			X	60 03 - N0101 - 20	1									NR			
			C	Wire Harness Assembly #1 - Engine, Main			🟥	60 03 - N0101 - 30	1	3	X		X	X				Added wiring complexity due to more sensors and actuators.			
		X	80	Boltings																	
					A	Cover - COP harness	X	60 80 - N0101 - 01	1	MP								NR			
	🟥	70	Accessories (Starter Engines, Generators, Power Steering Pumps, etc)																		
		X	01	Starter Engines																	
			A	Starter Motor Assembly			X	70 01 - N0101 - 01	1	1								NR			
		X	02	Generators																	
			A	Alternator Assembly			X	70 02 - N0101 - 01	1	2								NR			
		X	03	Power Steering Pumps																	
			A	Power Steering Pump Assembly -Electronic			X	70 03 - N0101 - 01	1	3								NR		In future the electric steering pump will become more of a standard on both Turbo DI as well as Base. Should include in second case cost model.	
		🟥	04	Vacuum Pumps																	
			A	Vacuum Pump Assembly			🟥	70 04 - N0101 - 01	1	4	X							On Turbo DI Vacuum pump required for brakes and accessories.			
		X	05	Air Conditioning Compressors																	
			A	Air Conditioning Compressor Assembly			X	70 05 - N0101 - 01	1	5								NR			
		X	70	Pipes, Hoses, Ducting																	
					A	Hose - Vacuum Pump, Brake Booster	X	70 70 - N0101 - 01	1	6								NR			
		X	75	Brackets																	
					A	Bracket - AC Compressor Mount	X	70 75 - N0101 - 01	1	7								NR			
					B	Bracket - Retention tube and wire harness	X	70 75 - N0101 - 03	1	MP								NR			
		🟥	80	Boltings																	
					A	Bolt - Vacuum Pump	🟥	70 80 - N0101 - 01	2	8	X							Required to mount vacuum pump to head.			
					B	Bolt - Starter Motor Assembly to Block	X	70 80 - N0101 - 02	3	9								NR			
					D	Bolt - Alternator Assembly to Block	X	70 80 - N0101 - 03	3	10								NR			
					E	Bolt - AC Comp. Mounting Bracket to Block & Bed Plate	X	70 80 - N0101 - 04	4	11								NR			
					F	Bolt - AC Compressor Assembly to Mounting Bracket	X	70 80 - N0101 - 05	3	12								NR			
					G	Fastener - Steering Pump Assembly to Vehicle	X	70 80 - N0101 - 06	??	13								NR			

APPENDIX D.1 Design Profit® Mapping Symbols

Examples of symbols used in the Design Profit® Mapping Process:

PART

Part: Solid objects that are single entities. They have no other components attached or inside them, i.e. flange head bolt, one piece stamped bracket, single plastic injected molding.

SA

Sub Assembly: As the symbol implies, are parts inside or attached to other parts or products which have components inside them, i.e. bolts with captured washers, welded brackets, insert molded parts, purchased assemblies.

PP

Pre-processed Part: Are parts that have undergone additional processes before they can be used, i.e. Anodizing, powder coat, or paint. They typically contain a single part and one or more manufacturing processes.

MULTI

Multiple Touch Part: If a part or subassembly is handled more than once in the assembly of the product this stop sign symbol should be used in order to:

- Ensure our part count is still correct.
- Highlight the fact we are violating a good design principle

T

Tool: Not all screwing operations can be done by hand like a jar lid; sometimes a tool will be needed.

F

Fasten: Not all products and parts can be assembled right away. Some need an extra step like screwing. Get the part, put the part, and then fasten the part.

OP

Operation: Operations such as moving the product, operator movement, or changes to the direction of insertion, part manipulation, etc. In many cases, Operations are non value added (NVA) activities.

M M

Material Modification: Anytime the physical characteristics of a part are changed, such as heat treating, and freezing, or, anytime material is removed, as in machining operations such as milling, boring, punching, drilling, etc.

INSP

Inspect: Represents inspection steps in an assembly. Inspections are non-value added processes that should be eliminated or automated.

In addition to the standard part symbols, parts are also further identified for fasteners and fluids:

Fastener*:* Used to join two or more parts.
Includes threaded and non-threaded fasteners, i.e. screws, washers, and glue.

Fluid*:* Anything that is measured by volume rather than count. Includes oil, grease, coolant, and glue.

APPENDIX E.1 Material Costing Database Excerpt

A. Carbon/Alloy Steel	D. Cast Iron	G. Magnesium Alloys	K. Nickel Alloys	N.	Q. Thermoplastics	T.	W Misc.
B. HSLA & Micro Alloy	E. Aluminum Alloys	H. Titanium Alloys	L Cobalt Alloys.	O.	R Thermosets.	U Automotive Fluids.	X.
C. Stainless Steel	F. Powder Metal	J. Copper Alloys	M.	P.	S. Thermoplastic Elast.	V. Plating & Coatings	Y.

Cat.	Item	Material Description	Industry Specification	Supplemental Specification Information	Application Examples	Material Class	Active Rate 2008	Information Reference Source
A. CARBON & ALLOY STEELS (SAE1000-9000			Carbon Ranges: Low 0.05-0.15%, Mid. 0.16-0.29%, High 0.30-1.10%, Ultra High 1-2%					
A1. CARBON STEEL								
	A1.1 **10XX** Plain Carbon Steel		Mn 1.00% Max					
		Low Carbon Steel	SAE J403 1008/1010	Coil	Brackets, Spacers	LC-Steel-1000S, Coil	$ 0.45	AMM Reference, MEPS, USGS
		Medium Carbon Steel	SAE J403 1018	Coil	Splash Pans, Dampers, Windage Tray	MC-Steel-1000S, Coil	$ 0.55	Online Metals, Metals Depot, Speedy Metals, All Metals, Industrial Metal Sales w/ AMM spot check
		Low Carbon, Hot Dip Galvanized Steed.	SAE J403 1008/1010	Coil	PCV Baffles	LC-GSteel-1000S, Coil	$ 0.48	Premium Steel
		Medium Carbon Steel	SAE J403 1018	Bar		MC-Steel-1018, Bar	$ 0.74	Metals Express, Industrial Metal, Online Metals, Metals Depot
		High Carbon Steel	SAE J403 1040	Bar (1-3")		HC-Steel-1040S, Bar	$ 0.80	Online Metals, Speedy Metals, All Metals
	A1.3 **12XX** Resulfurized and Rephosphorized							
		12L14	Leaded Bar	Bar	Bushings, Inserts, Couplings	LC-Steel-1214, Bar	$ 0.62	Online Metals, Speedy Metals, All Metals
		1215	Replacement to 12L14	Bar	Bushings, Inserts, Couplings	LC-Steel-1215, Bar	$ 0.62	Purchasing Magazine
		Low Carbon Steel Tubing	1215	Tube	Metal Tubing coolant lines, oil lines, etc.	LC-Steel-1215, Tubing	$ 0.62	Estimated same pricing as 1215 bar.
A6. CHROMIUM-MOLYBDENUM (CHROMOLY) STEELS								
	A6.1 **41XX**		Cr 0.50% 0r 0.80% or 0.95%, Mo 0.12% or 0.20% or 0.25% or 0.30%					
		41xx		Bar	Injector Body	A-Steel-41XXS, Bar	$ 0.78	Assigned same rate as A-Steel-4140, Bar 0.875-2.75"
		Chrome-Moly-Vanadium Steel	32CrMoV13	Bar	Bearings, Crank shafts	MA-Steel-CrMoV, Bar	$ 0.98	Composition analysis plus surcharge
		4140RH	42CrMoS4	Bar	Crankshafts, axle journals, gears, pushrods.	A-Steel-4140, Bar	$ 0.78	Composition analysis plus surcharge
		4130 Spring Steel Heat-Treatable	C 0.28/0.33 Si 0.20/0.35, Mn 0.40/0.60, Cr 0.80/1.10, P&S 0.025 Max, Mo 0.15/0.25	Coil	Direct Injector Spring Clips	HC-Steel-4130, Coil	$ 1.18	Surrogate pricing based on 4130 0.040"-0.125"
		4130	C 0.28/0.33 Si 0.20/0.35, Mn 0.40/0.60, Cr 0.80/1.10, P&S 0.025 Max, Mo 0.15/0.25	Coil, 0.04" to 0.125"		HC-Steel-4130, Coil 0.04"-0.125"	$ 1.18	Online Metals, Aircraft Spruce & Specialty Co. & Specialty Co.
		4130 Tight Thickness Tolerance.	C 0.28/0.33 Si 0.20/0.35, Mn 0.40/0.60, Cr 0.80/1.10, P&S 0.025 Max, Mo 0.15/0.25	Coil, 0.05" to 0.08", Tight Thickness Tolerance		HC-Steel-4130, Coil 0.04"-0.08"	$ 2.79	Kmac
A7. NICKLE-CHROMIUM-MOLYBDENUM STEELS								
	A7.1 **43XX**		Ni 1.82%, Cr 0.50-0.80%, Mo 0.25%					
		300M	SAE 4340Mod	Vacuum melted high strength, super alloy.	Drive shafts, Con. Rods	MA-Steel-300M, Bar	$ 0.89	Composition analysis plus surcharge
		Ni-Chrome-Moly	SAE 4330/4340	Bar 1-7"	Planetary Gear Carrier, Shafts	MA-Steel-43XXM, Bar	$ 1.08	Online Metals, Metals Express, Hi Tech Metals quote
	A7.4 86XX		Ni 0.55%, Cr 0.50 Mo 0.20%					
		8620, Case Hardening Steel	SAE 8620, 21NiCrMoS5	Bar	Driving Bevel Gears, Crown Wheels, Gears, Shafts, Bolts for automotive and gear components.	A-Steel-8620, Bar	$ 0.70	Composition analysis plus surcharge
A9. CHROMIUM STEELS								
	A9.4 **51XX**		Cr 0.80% or 0.87% or 0.92% or 1.00% or 1.05%.					
		SAE 5115	C0.15, Si0.25, Mn0.50, Cr0.60,	Bar		A-Steel-51XX, Bar	$ 1.00	Surrogate pricing based on "A-Steel-5140, Bar"
		SAE 5140/5145		Bar	Gears, Shafts	A-Steel-5140, Bar	$ 1.00	Kmac, Raker, Continental Steel Quote
	A9.5 **51XXX**		Cr 1.02%, C 1.00% Min.					
		Chromium Steel, High Carbon, Bearing Grade, Unpolished Mill Finished, Annealed	SAE 52100	Bar >0.5"	Bearing Races	A-Steel-52100 Bar	$ 1.00	Kmac, Raker, Continental Steel Quote
A10. CHROMIUM-VANADIUM STEELS								
	A10.1 **61XX**		Cr 0.60% or 0.80% or 0.95%, V 0.10% or 0.15%					
		SAE 6150		Bar 1-8"	Park pawl, park gear		$ 0.67	Kmac

APPENDIX E.1 Material Costing Database Excerpt

A. Carbon/Alloy Steel	D. Cast Iron	G. Magnesium Alloys	K. Nickel Alloys	N.	Q. Thermoplastics	T.	W Misc.
B. HSLA & Micro Alloy	E. Aluminum Alloys	H. Titanium Alloys	L Cobalt Alloys.	O.	R Thermosets.	U Automotive Fluids.	X.
C. Stainless Steel	F. Powder Metal	J. Copper Alloys	M.	P.	S. Thermoplastic Elast.	V. Plating & Coatings	Y.

Cat.	Item	Material Description	Industry Specification	Supplemental Specification Information	Application Examples	Material Class	Active Rate	Information Reference Source
							2008	
B. HIGH STRENGTH LOW ALLOY (HSLA) and MICRO ALLOY STEELS								
B2. Micro Alloy Steels								
	A2.1		Mn 1.75%					
		C70S6	C0.72%, Si0.22%, Mn0.49%, S0.062%, V0.04%	Typical Air Cooled Forging Steel	Forged fractured split rods	MA-Steel-C70S6, Bar	$ 0.70	Composition analysis plus surcharge
		36MnVS4		Bar	Crankshafts, Cracked Forged Rods, Short and Long-shaft Ball Points, threaded heavy duty anchor bolts.	MA-Steel-MnVS, Bar	$ 0.73	Composition analysis plus surcharge
C. STAINLESS STEELS (SAE100-600Series)								
C1. 300 Series - Austenitic Chromium-Nickel All			Harden by cold working, can not be hardened by heat treating, Non Magnetic in annealed condition. Excellent corrosion resistance and usually good formability.					
	C1.1 **304** General Purpose							
		304		Bar	Valves and Tubing	S-Steel-304, Bar	$ 1.65	MEPS, stainlesssteel.com, purchasing.com
		304/304L		Coil	Exhaust Systems, Fuel tanks	S-Steel-304, Coil	$ 1.64	MEPS, stainlesssteel.com, purchasing.com
		304/304L		Sheet or Cast	Housings for Catalytic Converters and Turbochargers.	S-Steel-304, Cast	$ 1.39	MEPS, stainlesssteel.com, purchasing.com
		304		Tube	Fuel Rail	S-Steel-304, Tube	$ 1.65	Estimate, same pricing as 304Bar
	C1.1.1 **316**		Mo added to increase corrosion resistance.					
		316		Bar	Valves and Tubing	S-Steel-316, Bar	$ 2.44	MEPS, stainlesssteel.com, purchasing.com
		316/316L	C reduced for weldability	Coil		S-Steel-316, Coil	$ 2.72	MEPS, stainlesssteel.com, purchasing.com
		316/316L	C reduced for weldability	Cast/Sheet	Housings for Catalytic Converters and Turbochargers.	S-Steel-316, Cast	$ 2.82	MEPS, stainlesssteel.com, purchasing.com
	C1.1.2 **309/309S**		CR & Ni increased for high temperature.					
		310/310S	Same as 309, only more so.		Internal Components for Turbochargers (e.g.. Rotors)	S-Steel-310, Cast	$ 4.23	Place Holder 1.5 x $ "S-Steel-316, Cast"
	C1.1.5 **303**		S added to improve machining.					
		303Se	Se (Selenium) added for better machined surfaces.					
		303		Bar	Valves and Tubing	S-Steel-303, Bar	$ 1.55	MEPS, stainlesssteel.com, purchasing.com
		303L		Bar	Valves and Tubing	S-Steel-303L, Bar	$ 1.65	MEPS, stainlesssteel.com, purchasing.com
	C1.1.6 **301**		Cr and Ni lowered to increase work hardening.					
	C1.1.7 MISC.							
		21-2N/21/4N (EV8)	Austenitic Precipitation Hardening Chrome Manganese Nickel Steel: Cr:23/20%, Ni4.50/3.25%, Mn: 10/8% etc.	Bar	Intake & Exhaust Valves	S-Steel-21_14N, Bar	$ 7.56	Point Price from Bundy with trend analysis.
C2. 400 Series Ferritic Chromium Alloys			Can not be hardened through heat treatment and only moderately hardened by cold working. The are magnetic, have good ductility and resistance to corrosion and oxidation.					
	C.2.1.1 **442**		Cr Increased to improve scaling resistance,					
		422		Bar	Intake & Exhaust Valves	S-Steel-422, Bar	$ 7.56	Point Price from Power Plant Services with trend analysis.

APPENDIX E.1 Material Costing Database Excerpt

FEV

A. Carbon/Alloy Steel	D. Cast Iron	G. Magnesium Alloys	K. Nickel Alloys	N.	Q. Thermoplastics	T.	W Misc.
B. HSLA & Micro Alloy	E. Aluminum Alloys	H. Titanium Alloys	L Cobalt Alloys.	O.	R Thermosets.	U Automotive Fluids.	X.
C. Stainless Steel	F. Powder Metal	J. Copper Alloys	M.	P.	S. Thermoplastic Elast.	V. Plating & Coatings	Y.

Cat.	Item	Material Description	Industry Specification	Supplemental Specification Information	Application Examples	Material Class	Active Rate 2008	Information Reference Source
C3. 400 Series Martensitic Chromium Alloys			Are hardenable through heat treatment. They are magnetic. The resistance corrosion in mild environments. They have fairly good ductility, and some can be heat treated to Tensile Strengths exceeding 200kpsi.					
	C3.1.5	**440C**	C increased for highest hardness. Cr increased for corrosion resistance.	Bar	Intake & Exhaust Valves	S-Steel-440C, Bar	$ 4.56	Point Price from AK Steel with trend analysis.
		440B	C decreases slightly to improve toughness.					
		440A	Same as 440B, only more so.					
D. CAST IRONS			Typical Cast Irons are 95%wt. Iron, 2.1-4%wt Carbon, and 1-3%wt. Silicon.					
D1. Nodular/Ductile Cast Iron								
		Nodular / Ductile Iron (80-55-06)	ASTM A536-80-55-06	$0.90-$1.2/lb finished casting	Crankshaft, blocks	Nodular Iron, Cast	$ 0.35	AISI, MEPS
		Nodular / Ductile Iron (100-70-03)	ASTM A536-100-70-03	$0.90-$1.2/lb finished casting	High Strength Cam shafts i.e.., driving HP fuel pumps.	Nodular Iron, Gr100/70/03, Cast	$ 0.42	Estimate base on ASTM A536-80-55-06
		Ni-resist cast iron, D5S	D5S, ASTM A-439-84		Housing - Turbo Exhaust	NiResist Iron, D5S, Cast	$ 3.50	Estimate from Turbocharger Industry Expert
		Silicon Molybdenum Cast Iron	4% Si & 1% Mo		Housing-Block Center, Turbo Support	SiMo Ductile Iron, Cast	$ 0.60	Estimate from Turbocharger Industry Expert
D2. Malleable Cast Irons								
		Malleable Cast Iron		$0.90-$1.2/lb finished casting	Crankshaft, camshafts, blocks	Malleable Cast Iron	$ 0.41	AISI, MEPS
D3. Grey Cast Iron								
		Grey Cast Iron	SAE J431 Grade 3000 (3.1-3.4C, 1.9-2.3Si, Mn 0.60-0.90)		Engine Blocks	Grey Iron, Cast	$ 0.35	Estimate same pricing as ASTM A536-80-55-06
E. ALUMINUM ALLOYS			(Temper Designations F>as Fabricated, O>annealed, H> Strain-hardened, W>Solution heat-treated. T> Thermally treated, usually solution heat-treated, quenched and precipitation hardened.					
E1. Wrought Alloys								
	E1.1 2XXX Al-Cu Alloys							
		2024	2024-T3/T4/T351	Bar Ø0.5-2.5"		Aluminum-2024, Bar	$ 2.38	Aircraft Spruce & Specialty Co. & Specialty Co., Online Metals, Industrial Metal
		2024	2024-T3/T4/T351	Sheet, 0.032"-0.125"		Aluminum-2024, Sheet	$ 3.41	Online Metals, Kmac, Airparts
	E1.2 3XXX Al-Mn Alloys							
		3003, 3005, 3012	Aluminum Magnesium		Braze-clad welded radiator tubes, heater cores, radiator, heater and evaporative fins, heater inlet and outlet tubes, oil coolers, and air conditioner liquid lines, radiator heater and evaporative parts, extruded condenser tubes.	Aluminum-3000S, Coil	$ 0.84	Aluminum.com, AMM reference.
		3003-H14 Uncladded	Aluminum-Manganese Sheet	Thick. 0.032-0.125" (0.75-3.15mm)	Heat Exchangers	Aluminum-3003, Coil A	$ 1.41	Aluminum.com, AMM reference.
		3003-H14 Uncladded	Aluminum-Manganese Sheet	Thick. 0.003-0.009" (0.075-0.22mm)	Heat Exchangers	Aluminum-3003, Coil B	$ 1.93	Lynch Estimate
	E1.3 4XXX Al-Si Alloys							
		4032	4032-T651	Bar Ø1.0-2.5"		Aluminum-4032, Bar	$ 1.44	Kmac
	E1.4 5XXX Al-Mg Alloys							
		5052H32	5052 H32	Coil 0.025-0.125"		Aluminum-5052, Coil	$ 1.52	Online Metals, Metal Depot, Airparts, Enco, All Metals
	E1.5 6XXX Al-Mg-Si Alloys							
		6062	6062-T6511	Bar Ø0.5-1.5"	Spool valves	Aluminum-6062, Bar	$ 1.45	Online Metals
		6061	6061-T6511	Bar Ø0.5-3.0"		Aluminum-6061, Bar	$ 1.50	Metals Express, Aircraft Spruce & Specialty Co., All Metals, Metal Connection
	E1.8 Misc							
		3003-H14 Clad 4XXX	Aluminum-Manganese Cladded Tube	Seamless welded tube - thickness 0.012-0.02" (0.3-0.5mm)	Heat Exchangers	Cladded Aluminum-3003, Tube	$ 2.28	Lynch Estimate

APPENDIX E.1 Material Costing Database Excerpt

A. Carbon/Alloy Steel | D. Cast Iron | G. Magnesium Alloys | K. Nickel Alloys | N. | Q. Thermoplastics | T. | W Misc.
B. HSLA & Micro Alloy | E. Aluminum Alloys | H. Titanium Alloys | L Cobalt Alloys. | O. | R Thermosets. | U Automotive Fluids. | X.
C. Stainless Steel | F. Powder Metal | J. Copper Alloys | M. | P. | S. Thermoplastic Elast. | V. Plating & Coatings | Y.

Cat.	Item	Material Description	Industry Specification	Supplemental Specification Information	Application Examples	Material Class	Active Rate 2008	Information Reference Source
E2. Casting Alloys (Hypoeutectic 8.5-10.5, Eutectic 11-12, 16-18 Hypereutectic Material)								
	2XX Al-Cu Alloys							
	3XX Al-Si + Cu and/or Mg Alloys							
		319 T5	Al-3.5Cu-6Si	Hypoeutectic/Perm.	Manifolds, cylinder heads, blocks, internal engine parts	Aluminum-A319-T5, Cas	$ 1.15	CRU group, AMM reference
		332 / F132	8.5-10Si, 2.0-4.0Cu, Ni0.10	Hypereutectic, common grade, large recycled composition (Die.)	Hypoeutectic	Aluminum-332, Cast	$ 1.24	CRU group, AMM reference
		356 T6 or A356	7Si-0.3 Mg alloy	Hypoeutectic (Perm.)	Engine blocks, flywheel, oil pan, pump bodies, cyl heads, manifolds, transmission cases	Aluminum-356-T6, Cast	$ 1.20	CRU group, AMM reference
		A380.1	Al-9Si-3Cu(Fe)	Hypoeutectic (Die.)	Blocks, transmission housings/parts, fuel metering devices, oil pump cyl heads,	Aluminum-A380, Cast	$ 1.10	CRU group, AMM reference
		B380	Al-9Si-3Cu(Fe)	Hypoeutectic (Die)	Blocks, transmission housings/parts, fuel metering devices, oil pump cyl heads,	Aluminum-B380, Cast	$ 1.18	CRU group, AMM reference
		384		Eutectic (Die)	Pistons, automatic transmissions	Aluminum-384, Cast	$ 1.14	CRU group, AMM reference
		B390.0	Hypereutectic aluminum-silicon	Hypereutectic (Die.)	High-wear applications such as ring gears and internal transmission parts, Hypereutectic pistons, cylinder blocks	Aluminum-B390, Cast	$ 1.20	CRU group, AMM reference
		A383	AlSi10Cu2	Hypoeutectic (Die.)	Blocks			
		3HA Piston Alloy	AlSi12Cu4Ni2Mg					
F. POWDER METALS (Classification per MPIF Standard 35)								
F1. PM Structural Materials: Ferrous and Non-ferrous					Crank timing sprockets or gears, cam shaft timing sprocket or gears, Transmission clutch hubs, ATM planetary ring gear, Cam lobe on composite cam shaft, impellers.			
	Ferrous Materials							
	F1.1 Iron and Carbons Steel							
		Sintered Powdered Metal (Iron base powder alloy)	SAE 1541			PM-SMF-Iron Base	$ 1.00	
	F1.10 Stainless Steel - 300 Series Alloy							
		304/304L				PM-SMF-SS304	$ 4.92	3x Cost of 304 Coil - reference above
		316 Stainless	SS-316N2, 17Cr,12Ni,2.5Mo	ρ=6.5g/cm^3,UTS=60ksi	Good Corrosion Resistance, Appearance	PM-SMF-SS316	$ 8.16	3x Cost of 316 Coil - reference above
	F1.11 Stainless Steel - 400 Series Alloy							
		430 Stainless	SS-430N2, 17Cr	ρ=7.1g/cm^3,UTS=60ksi	Good Corrosion Resistance, Appearance			
		410 Stainless	SS-41, 13Cr, 0.8Si, 0.8Mn	ρ=6.1g/cm^3,UTS=66.7 ksi	DI Solenoids	PM-SMF-SS410	$ 4.50	Need Pricing Confirmation
	F1.12 Miscellaneous							
	Non-Ferrous Materials							
	F1.21 Aluminum and Aluminum Alloys							
		PM Aluminum - Structural Components	4.4Cu/0.5Mg/0.6Si	Ys/UTS in ksi: w. T4 HT, 31/38 w. T6 HT 47.5/48.1	Cam Caps	PM-SMNF-Aluminum	$ 3.50	
F2. P/F Steel Part Materials								
	F2.0 Carbon Steel							
		Powdered forged	HS150/160		Connecting Rods	PF-SMF-HS150/160	$ 0.70	Composition analysis plus surcharge

APPENDIX E.1 Material Costing Database Excerpt

A. Carbon/Alloy Steel	D. Cast Iron	G. Magnesium Alloys	K. Nickel Alloys	N.	Q. Thermoplastics	T.	W Misc.
B. HSLA & Micro Alloy	E. Aluminum Alloys	H. Titanium Alloys	L Cobalt Alloys.	O.	R Thermosets.	U Automotive Fluids.	X.
C. Stainless Steel	F. Powder Metal	J. Copper Alloys	M.	P.	S. Thermoplastic Elast.	V. Plating & Coatings	Y.

Cat.	Item	Material Description	Industry Specification	Supplemental Specification Information	Application Examples	Material Class	Active Rate 2008	Information Reference Source
G. MAGNESIUM WROUGHT & CASTING ALLOYS								
G2. Cast Alloys								
G2.1	AZ91							
	AZ91	AZ91D	Mg Al9 Zn1		Valve Covers	Magnesium-AZ91D, Cast	$ 2.42	USGS, AMM Reference, Purchasing Centracore, Mark Luchese (09/1709) Low Volume Rate
H. TITANIUM WROUGHT & CASTING ALLOYS								
H1. Wrought Alloys								
		Titanium (Sponge Only)				Titanium-Sponge, Cast	$ 4.71	USGS
		Titanium	(6AL V4)	Bar	High Pressure Bellows Pump	Titanium-6AL4V, Bar	$ 34.37	Longbow
		Titanium	(6AL V4)	Plate		Titanium-6AL4V, Plate	$ 43.91	Longbow
H2. Cast Alloys								
		Titanium	(6AL V4)	Ingot		Titanium-6AL4V, Cast	$ 21.30	Longbow
J. COPPER WROUGHT & CASTING ALLOYS (BRONZE & BRASS)								
	J6.3 High Lead Tin Bronze & Lead Free Bronze (LC-M/H, T=H, C/E=G RS=G, H/W=H)							
		C93200	SAE 660 Bearing Bronze		bushings, pump fixtures, pump impellers, fuel pump bushings, thrust washers, insert bearings, gears, valves and valve components, etc.	Bronze-932, Bar	$ 2.56	InfoMine for copper plus composition analysis
		C89320	Lead Free Replacement to C93200	89%Cu, 6%Sn, and 5%Bi	Turbocharger Spindle Bushings (Floating Type)	Bronze-89320, Bar	$ 2.56	Estimate based on C93200
		Oilite Bronze Bearing Alloy	SAE841	1" Round Bar			$ 5.31	Wisco Alloys
	J6.4 Aluminum Bronze(LC-VH, T=VH, C/E=P RS=M, H/W=VH)							
		ASTM C63000, C63020	Nickel Aluminum Bronze		Valve stems and trim, bearings and bushings, fasteners, gears	Ni-Al-Bronze-630000, Bar	$ 2.44	InfoMine for copper plus composition analysis
	J6.12 Silicon Brasses (LC=? , T=? , C/E=? , RS=?, H/W=?)							
		C87500 (500)	Silicon Brass, 82-4Si-14Zn		Bearings, gears, impellers, rocker arms, valve stems, brush holders, bearing races, small boat propellers.	Si-Brass-87500, Bar	$ 2.11	InfoMine for copper plus composition analysis
		CDA 673 - Silicon Manganese Brass	C67300	Bar		Si-Brass-67300, Bar	$ 3.71	Atlas Bronze Quote (quote price plus copper trend line)
	J6.13 Brass General							
		C36000	CDA 360		Fluid connectors, threaded inserts for plastic parts, sensor bodies, thermostat parts	Brass-36000, Bar	$ 1.70	InfoMine for copper plus composition analysis
	J6.14 Cooper General							
		Copper	>99.0% Pure		Wire harnesses	Copper-Pure, Wire	$ 2.45	InfoMine
K. NICKEL WROUGHT & CASTING ALLOYS								
K1. Wrought Alloys								
	K1.1 Inconel®							
		Inconel® 751/HEV3		Bar	Exhaust Valves	Inconel-751, Bar	$ 12.22	Point price from Special Metals WV with trend analysis.
		Inconel® 713 Coil		Coil	Heat Shields, Turbo	Inconel-713C, Coil	$ 6.00	Estimate from Turbocharger Industry Expert
		Nickel Alloy - Internal Turbo Parts General		Coil	Heat Shields, Turbo	Nickel Alloy Gen, Cast	$ 5.00	Need Material and Pricing Confirmation
		Inconel® 713 Coil		Cast		Inconel-713, Cast	$ 6.00	Estimate from Turbocharger Industry Expert

APPENDIX E.1 Material Costing Database Excerpt

A. Carbon/Alloy Steel	D. Cast Iron	G. Magnesium Alloys	K. Nickel Alloys	N.	Q. Thermoplastics	T.	W Misc.
B. HSLA & Micro Alloy	E. Aluminum Alloys	H. Titanium Alloys	L Cobalt Alloys.	O.	R Thermosets.	U Automotive Fluids.	X.
C. Stainless Steel	F. Powder Metal	J. Copper Alloys	M.	P.	S. Thermoplastic Elast.	V. Plating & Coatings	Y.

Cat.	Item	Material Description	Industry Specification	Supplemental Specification Information	Application Examples	Material Class	Active Rate 2008	Information Reference Source
L. COBALT WROUGHT & CASTING ALLOYS								
L1. Wrought Alloys								
	L1.1 Stellite®							
		Stellite® 6	Base Co, Cr 27-32%, W4-6%, C0.9-1.4%, Others Ni, Fe, Si, Mn, Mo	Bar	Exhaust Valves	Stellite	$ 21.00	
Q. THERMOPLASTIC POLYMNERS								
	Q1. Polyamide (PA/Nylon)							
		Nylon 6	PA6			Nylon6, Inject.	$ 1.65	IDES, Plastic News
		Nylon 6 (15 % glass)	PA6 GF15		Air cooler tube outlet	Nylon6-15GF, Inject.	$ 1.59	IDES, Plastic News, Plastic Technology
		Nylon 6 (30 to 35% glass)	PA6 GF30		Vacuum reservoir, Intake manifold	Nylon6-30GF, Inject.	$ 1.76	IDES, Plastic News, Plastic Technology
		Nylon 66	PA66		Fuel injector connector, hose asm end - pump to turbo, chain tension guides	Nylon66, Inject.	$ 1.74	IDES, Plastic News
		Nylon 66 (30 to 35% glass)	PA66 GF30		Intake manifold, cylinder cover, cooler asm end caps	Nylon66-30GF, Inject.	$ 1.54	IDES, Plastic News
		Nylon 66 (50% glass)	PA66 GF50		cooler asm end caps	Nylon66-50GF, Inject.	$ 1.54	IDES, Plastic News
		Nylon 66, 40% Fibrous Mineral Reinforced	PA66 FMR40%	GMNA Spec PA66 060	Direct Injection Connectors	Nylon66-40FMR, Inject.	$ 1.54	Estimate based on PA
		Nylon 12	PA12		Reservior tube	Nylon12, Inject.	$ 3.03	IDES, Plastic News, Plastic Technology
		Nylon 12, 30% glass	PA12, GF30		PCV Hose Intake End		$ 3.41	IDES, Plastic News, Plastic Technology
	Q3. Polyethylene							
		HDPE Copolymer - blowmolding	HDPE		Rubberized blow molded air induction ducts and couplings.	HDPE BM Grade	$ 0.72	
	Q4. Polybutylene Terephthalate (PBT)							
		Polybutylene Terephthalate	PBT GF20		Silencer Air by-pass	PBT-GF20, Inject.	$ 1.46	IDES, Plastic News
	Q5. Acrylonitrile Butadiene Styrene (ABS)							
		ABS			Beta patch for battery closeout		$ 0.72	Plastic News
	Q6. Polypropylene (PP)							
		Random copolymer blow molding grade.	PP		High strength blow molded air induction ducts.	HD Polypro	$ 0.87	
	Q9. Polyvinylchloride (PVC)							
		Blended NBR-PVC			Rubberized blow molded air induction ducts and couplings.	NBR-PVC	$ 1.27	
	Q9. Miscellaneous							
		Teflon® Polytetrafluoroethylene				PTFE, Inject.	$ 6.70	IDES, Plastic News
R. THERMOSET POLYMERS								
	R1 Hydrocarbon, Unsaturated.							
		Natural rubber / TSR20	NR		Hoses, O-rings, gaskets, tubes	Thermoset-NR	$ 2.14	CMAI, Rubber Statistical Bulletin
		Synthetic poly-isoprene rubber	IR		Hoses, O-rings, gaskets, tubes	Thermoset-IR		
		Styrene butadiene rubber	SBR		Hoses, O-rings, gaskets, tubes	Thermoset-SBR	$ 1.32	CMAI, Rubber Statistical Bulletin
		Butadiene rubber	BR		Hoses, O-rings, gaskets, tubes	Thermoset-BR	$ 0.65	CMAI
		Polubutadiene rubber	PBR		Hoses, O-rings, gaskets, tubes	Thermoset-PBR	$ 0.82	The Innovation Group
		Polubutadiene rubber - glass filled	PBR GF20		Auxiliary water pump housing	Thermoset-PBR-GF20	$ 1.17	The Innovation Group, Plastics News (for delta)
		Butyl rubber	IIR		Hoses, O-rings, gaskets, tubes	Thermoset-IIR	$ 1.37	The Innovation Group
		Chloro- and bromo- butyl rubber	CIIR, BIIR		Hoses, O-rings, gaskets, tubes			

APPENDIX E.1 Material Costing Database Excerpt

FEV

A. Carbon/Alloy Steel	D. Cast Iron	G. Magnesium Alloys	K. Nickel Alloys	N.	Q. Thermoplastics	T.	W Misc.
B. HSLA & Micro Alloy	E. Aluminum Alloys	H. Titanium Alloys	L Cobalt Alloys.	O.	R Thermosets.	U Automotive Fluids.	X.
C. Stainless Steel	F. Powder Metal	J. Copper Alloys	M.	P.	S. Thermoplastic Elast.	V. Plating & Coatings	Y.

Cat.	Item	Material Description	Industry Specification	Supplemental Specification Information	Application Examples	Material Class	Active Rate 2008	Information Reference Source
	R2. Hydrocarbon Saturated							
		Ethylene propylene (diene) rubber	EPM/EPDM		Hoses, O-rings, gaskets, tubes	Thermoset-EPDM	$ 1.83	The Innovation Group
	R3. Nitrile							
		Nitrile butadiene rubber	NBR		Hoses, O-rings, gaskets, tubes	Thermoset-NBR	$ 1.27	The Innovation Group
	R8. Fluorocarbon							
		Fluoro elastomer	FKM		ERG valve seals	Thermoset-FKM	$ 12.50	Plastics News
	R10. Polyimide							
		Polyimide - Vespel SP-21	PI 30%Carbon filled		thrust washers, bearings and seals — low-friction properties, work with or without lubrication.	Thermoset-Vespel SP21CF30	$ 35.18	PT online, Plastic News - Trend line from surrogate materials
		Polyimide - Vespel SP-21	PI 30%Glass filled			Thermoset-Vespel SP21GF30	$ 24.36	PT online, Plastic News - Trend line from surrogate materials
	R12. Polyurethane							
		Polyurethane elastomer, ester-based	AU		Hoses, O-rings, gaskets, tubes	Thermoset-AU	$ 1.77	Rubber and Plastics News
	R13. Silicone							
		Silicone rubber	MVQ		Hoses, O-rings, gaskets, tubes	Thermoset-MVQ	$ 4.50	
	R14. Miscellaneous							
		SBR Tubing w. Fiber Reinforcement	SBR Reinforced Tubing			SBR-Fiber Rein., Extruded	$ 1.85	1.40 x $SBR
		SBR Tubing w. Metal Reinforcement	SBR Reinforced Tubing			SBR-Metal Rein., Extruded	$ 2.24	1.70 x $SBR
		SBR Tubing w. Fiber Reinforcement and outer wrap.	SBR Reinforced Tubing			SBR-Fiber Rein. W. Outer Wrap, Extruded	$ 2.05	1.55 x $SBR
S. THERMOPLASTIC ELASTOMERS								
		Olefinic	Syn Rubber	M-group Synthetic	Hoses, O-rings, gaskets, tubes	TPE-PP/EPDM, Inject.	$ 0.99	Plastics News
		Olefinic	TPE+TD33		Cooling Fan Shroud		$ 1.04	Plastics News, Hutsmann
U. AUTOMOTIVE FLUIDS								
		Engine Oil - Synthetic	(Price/Quart)			Engine Oil-Synthetic	$ 1.40	Need Pricing Confirmation Source
		Engine Oil - Regular	(Price/Quart)			Engine Oil-Regular	$ 0.60	Need Pricing Confirmation Source
V. PLATINGS & COATINGS								
	V.1 Aluminum Cladding							
		Aluminum-Silicon Cladding	3003 Sheet w. 4047 Cladding Single Cladding, Combined Material Thickness <0.060"	Thickness tolerance 10% Base Material Thickness	Oil Coolers, Radiators, etc	Aluminum-3003/4047A, Cladding	$ 1.65	Sue received feedback from Alcoa (3/27/09)
		Aluminum-Silicon Cladding	3003 Sheet w. 4047 Cladding Single Cladding, Combined Material Thickness >0.060"	Thickness tolerance 10% Base Material Thickness	Oil Coolers, Radiators, etc	Aluminum-3003/4047B, Cladding	$ 2.10	Sue received feedback from Alcoa (3/27/09)
		Brake and Oil Line Platings	GALFAN Hot Dipped	Thickness 4mil or 0.1 mm		GALFAN	$ 0.56	http://metalprices.com/

Notes
1. Material composition analysis was used when published data on specific materials was not available. Materials in related categories with similar compositions and established price points were compared to the material under investigation. Elemental compositions were then compared and deltas defined to determine cost differences. Since the cost differences are calculated from the elemental deltas, it was necessary to obtain the cost of the base elements. The costs of base elements such as zinc, copper and magnesium are readily available and published in several websites. Next, the cost per pound for each element that varied was multiplied by the delta percentage difference. These incremental elemental cost differences (plus/minus) were added to the base price point to establish a price per pound of the material under investigation. Lastly the surcharge was added to the cost to obtain the final alloy price per pound. A surcharge is a special charge to cover unexpected or temporary costs in the production of alloys. Surcharges are also posted on various manufacturers websites to alert their customers of pending price fluctuations.

APPENDIX E.2 Labor Costing Database Excerpt

						Active Rate	Production Year Start (Baseline) 2008								
Item	SOCS Code (BLS)	Direct Labor Title (BLS)	Direct Labor Description (BLS)	Typical Application Association	Labor Classification	2008	Mean Hourly Wage	Indirect Labor Rate Ratio ILRR "%"	Indirect Labor Contribution $/Hour	MRO Labor Rate Ratio MLRR "%"	MRO Labor Contribution $/Hour	Fringe Allocation "%"	Fringe Contribution $/Hour	Total Labor Rate $/Hour	Information Source
I. Motor Vehicle Parts Manufacturing - NAICS 336300					Default or Average Rate	→	$16.42	49.42%	$8.18	16.16%	$2.67	52.00%	$14.18	$41.45	
1	51-2022	Electrical and Electronic Equipment Assemblers	Assemble or modify electrical or electronic equipment, such as computers, test equipment telemetering systems, electric motors, and batteries.	Sensors, Controllers, PCM	Electrical Assembly	$29.69	$12.85	40%	$5.14	12%	$1.54	52%	$10.16	$29.69	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm
2	51-2023	Electromechanical Equipment Assemblers	Assemble or modify electromechanical equipment or devices, such as servomechanisms, gyros, dynamometers, magnetic drums, tape drives, brakes, control linkage, actuators, and appliances.	Electro Mechanical Assemblies, Motors, Actuators, etc.	Electromechanical Assembly	$37.35	$16.06	40%	$6.42	13%	$2.09	52%	$12.78	$37.35	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm
3	51-2031	Engine and Other Machine Assemblers	Construct, assemble, or rebuild machines, such as engines, turbines, and similar equipment used in such industries as construction, extraction, textiles, and paper manufacturing.	Complex Assembly	Complex Assembly	$42.90	$17.64	43%	$7.59	17%	$3.00	52%	$14.68	$42.90	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm
4	51-2092	Team Assemblers	Work as part of a team having responsibility for assembling an entire product or component of a product. Team assemblers can perform all tasks conducted by the team in the assembly process and rotate through all or most of them rather than being assigned	General Assembly	General Assembly	$35.51	$13.66	52%	$7.10	19%	$2.60	52%	$12.15	$35.51	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm
5	51-2093	Timing Device Assemblers, Adjusters and Calibrators	Perform precision assembling or adjusting, within narrow tolerances, of timing devices, such as watches, clocks, or chronometers. Exclude "Watch Repairers" (49-9064).	Assembly operations requiring feedback during assembly	Precision Assembly	$25.74	$11.07	40%	$4.43	13%	$1.44	52%	$8.81	$25.74	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm
6	51-2099	Assemblers and Fabricators, All Other	All assemblers and fabricators not listed separately.	Stand alone complete assembly stations.	Work Cell Assembly	$49.78	$19.38	50%	$9.69	19%	$3.68	52%	$17.03	$49.78	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm
7	51-4011	Computer-Controlled Machine Tool Operators (Metal & Plastic)	Operate computer-controlled machines or robots to perform one or more machine functions on metal or plastic work pieces.	CNC Stations,	CNC Operator	$35.70	$15.25	42%	$6.41	12%	$1.83	52%	$12.21	$35.70	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm
8	51-4021	Extruding and Drawing Machine setters, Operators, and Tenders, Metal & Plastic	Set up, operate, or tend machines to extrude or draw thermoplastic or metal materials into tubes, rods, hoses, wire, bars, or structural shapes.	Extrusion, Seals, Gaskets, Grommets, etc. (Considered to be mostly polymer materials with exception of some very ductile metals)	Extruding/Drawing Operator	$54.35	$18.92	67%	$12.68	22%	$4.16	52%	$18.59	$54.35	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm
9	51-4022	Forging Machine Setters, Operators, and Tenders, Metal and Plastic	Set up, operate, or tend forging machines to taper, shape, or form metal or plastic parts.	Cold or Hot Forgings (Majority Metals).	Forging Operator	$38.52	$14.65	54%	$7.91	19%	$2.78	52%	$13.18	$38.52	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm
10	51-4031	Cutting, Punching, and Press Machine Setters, Operators and Tenders, Metal and Plastic	Set up, operate, or tend machines to saw, cut, shear, slit, punch, crimp, notch, bend, or straighten metal or plastic material.	Stamping & Forming, Metal or Plastic	Cut/Punch/Forming Operator	$42.18	$16.04	54%	$8.66	19%	$3.05	52%	$14.43	$42.18	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm
11	51-4032	Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic	Set up, operate, or tend drilling machines to drill, bore, ream, mill, or countersink metal or plastic work pieces.	Smaller Machining Stations and/or with less automation	Drilling/Boring Operator	$43.35	$18.52	40%	$7.41	14%	$2.59	52%	$14.83	$43.35	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm
12	51-4033	Grinding, Lapping, Polishing , and Buffing Machine Tool Setters, Operators, and Tenders, Metal and Plastics	Set up, operate, or tend grinding and related tools that remove excess material or burrs from surfaces, sharpen edges or corners, or buff, hone, or polish metal or plastic work pieces.	Smaller Grinding/Honing Stations and/or with less automation	Grinding/Polishing Operator	$44.48	$17.63	50%	$8.82	16%	$2.82	52%	$15.22	$44.48	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm
13	51-4034	Lathe and Turning Machine Tool Setters, Operators, and Tenders, Metal and Plastic	Set up, operate, or tend lathe and turning machines to turn, bore, thread, form, or face metal or plastic materials, such as wire, rod, or bar stock.	Smaller Turning Station and/or with less automation	Lathe/Turning Operator	$37.60	$16.49	38%	$6.27	12%	$1.98	52%	$12.86	$37.60	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm
14	51-4035	Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic.	Set up, operate, or tend milling or planing machines to mill, plane, shape, groove, or profile metal or plastic work pieces.	Milling Operations	Milling/Planing Operator	$35.37	$15.41	40%	$6.16	11%	$1.70	52%	$12.10	$35.37	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm

APPENDIX E.2 Labor Costing Database Excerpt

Production Year Start (Baseline) 2008

Item	SOCS Code (BLS)	Direct Labor Title (BLS)	Direct Labor Description (BLS)	Typical Application Association	Labor Classification	Active Rate 2008	Mean Hourly Wage	Indirect Labor Rate Ratio ILRR "%"	Indirect Labor Contribution $/Hour	MRO Labor Rate Ratio MLRR "%"	MRO Labor Contribution $/Hour	Fringe Allocation "%"	Fringe Contribution $/Hour	Total Labor Rate $/Hour	Information Source
15	51-4072	Molding, Core making, and Casting Machine Setters, Operators, and Tenders, Metal & Plastic	Set up, operate, or tend metal or plastic molding, casting, or core making machines to mold or cast metal or thermoplastic parts or products.	Molding and Casting Operators	Mold/Cast/Sinter Operator	$43.52	$15.15	66%	**$10.00**	23%	**$3.48**	**52%**	**$14.89**	**$43.52**	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm
16	51-4081	Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic.	Set up, operate, or tend to more than one type of cutting or forming machine tool or robot.		Will not use, too general and overlap with other categories.	$44.85	$17.46	52%	**$9.08**	17%	**$2.97**	**52%**	**$15.34**	**$44.85**	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm
17	51-4122	Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders.	Set up, operate, or tend welding, soldering, or brazing machines or robots that weld, braze, solder, or heat treat metal products, components, or assemblies. Include workers who operate laser cutters or laser-beam machines.	Various Welding Operations	Welding/Soldering Operator	$44.96	$18.72	42%	**$7.86**	16%	**$3.00**	**52%**	**$15.38**	**$44.96**	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm
18	51-4191	Heat Treat Equipment Setters, Operators, and Tenders, Metal and Plastic	Set up, operate, or tend heating equipment, such as heat-treating furnaces, flame-hardening machines, induction machines, soaking pits, or vacuum equipment to temper, harden, anneal, or heat-treat metal or plastic objects.	Heat Treat	Heat Treat Operator	$46.52	$16.28	69%	**$11.23**	19%	**$3.09**	**52%**	**$15.92**	**$46.52**	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm
19	51-4193	Plating and Coating Machine Setters, Operators, and Tenders, Metal and Plastic	Set up, operate, or tend plating or coating machines to coat metal or plastic products with chromium, zinc, copper, cadmium, nickel, or other metal to protect or decorate surfaces. Include electrolytic processes.	Plating & Finishes	Plating/Coating Operator	$55.17	$20.86	60%	**$12.52**	14%	**$2.92**	**52%**	**$18.87**	**$55.17**	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336300 - Motor Vehicle Parts Manufacturing http://www.bls.gov/oes/current/naics4_336300.htm

FEV

APPENDIX E.2 Labor Costing Database Excerpt

						Active Rate	Production Year Start (Baseline) 2008								
Item	SOCS Code (BLS)	Direct Labor Title (BLS)	Direct Labor Description (BLS)	Typical Application Association	Labor Classification	2008	Mean Hourly Wage	Indirect Labor Rate Ratio ILRR "%"	Indirect Labor Contribution $/Hour	MRO Labor Rate Ratio MLRR "%"	MRO Labor Contribution $/Hour	Fringe Allocation "%"	Fringe Contribution $/Hour	Total Labor Rate $/Hour	Information Source
II. Motor Vehicle Manufacturing - NAICS 336100					Default or Average Rate	→	$21.54	48.00%	$10.21	14.56%	$3.08	160.00%	$55.73	$90.56	
1	51-2022	Electrical and Electronic Equipment Assemblers	Assemble or modify electrical or electronic equipment, such as computers, test equipment telemetering systems, electric motors, and batteries.	Electronic Subassembly Build-Up/Assembly	Electrical Assembly-OEM	$71.82	$18.54	38%	$7.05	11%	$2.04	160%	$44.20	$71.82	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336100 - Motor Vehicle Manufacturing http://www.bls.gov/oes/current/naics4_336100.htm
2	51-2031	Engine and Other Machine Assemblers	Construct, assemble, or rebuild machines, such as engines, turbines, and similar equipment used in such industries as construction, extraction, textiles, and paper manufacturing.	Complex Assembly: Engines, Transmissions	Complex Assembly-OEM	$97.34	$26.18	34%	$8.90	9%	$2.36	160%	$59.90	$97.34	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336100 - Motor Vehicle Manufacturing http://www.bls.gov/oes/current/naics4_336100.htm
3	51-2092	Team Assemblers	Work as part of a team having responsibility for assembling an entire product or component of a product. Team assemblers can perform all tasks conducted by the team in the assembly process and rotate through all or most of them rather than being assigned	General Assembly	General Assembly-OEM	$83.31	$20.28	44%	$8.92	14%	$2.84	160%	$51.27	$83.31	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336100 - Motor Vehicle Manufacturing http://www.bls.gov/oes/current/naics4_336100.htm
4	51-2099	Assemblers and Fabricators, All Other	All assemblers and fabricators not listed separately.	Stand alone complete assembly stations.	Work Cell Operator-OEM	$95.87	$24.42	38%	$9.28	13%	$3.17	160%	$59.00	$95.87	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336100 - Motor Vehicle Manufacturing http://www.bls.gov/oes/current/naics4_336100.htm
5	51-4011	Computer-Controlled Machine Tool Operators (Metal & Plastic)	Operate computer-controlled machines or robots to perform one or more machine functions on metal or plastic work pieces.	CNC Stations,	CNC Operator-OEM	$68.07	$17.00	42%	$7.14	12%	$2.04	160%	$41.89	$68.07	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336100 - Motor Vehicle Manufacturing http://www.bls.gov/oes/current/naics4_336100.htm
6	51-4022	Forging Machine Setters, Operators, and Tenders, Metal and Plastic	Set up, operate, or tend forging machines to taper, shape, or form metal or plastic parts.	Cold or Hot Forgings, Metal or Plastic	Forging Operator-OEM	$58.96	$12.74	58%	$7.39	20%	$2.55	160%	$36.28	$58.96	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336100 - Motor Vehicle Manufacturing http://www.bls.gov/oes/current/naics4_336100.htm
7	51-4031	Cutting, Punching, and Press Machine Setters, Operators and Tenders, Metal and Plastic	Set up, operate, or tend machines to saw, cut, shear, slit, punch, crimp, notch, bend, or straighten metal or plastic material.	Stamping & Forming, Metal or Plastic	Cut/Punch/Forming Operator-OEM	$96.00	$20.86	58%	$12.10	19%	$3.96	160%	$59.08	$96.00	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336100 - Motor Vehicle Manufacturing http://www.bls.gov/oes/current/naics4_336100.htm
8	51-4032	Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic	Set up, operate, or tend drilling machines to drill, bore, ream, mill, or countersink metal or plastic work pieces.	Smaller Machining Stations and/or with less automation	Drilling/Boring Operator-OEM	$112.19	$28.02	40%	$11.21	14%	$3.92	160%	$69.04	$112.19	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336100 - Motor Vehicle Manufacturing http://www.bls.gov/oes/current/naics4_336100.htm
9	51-4033	Grinding, Lapping, Polishing , and Buffing Machine Tool Setters, Operators, and Tenders, Metal and Plastics	Set up, operate, or tend grinding and related tools that remove excess material or burrs from surfaces, sharpen edges or corners, or buff, hone, or polish metal or plastic work pieces.	Smaller Grinding/Honing Stations and/or with less automation	Grinding/Polishing Operator-OEM	$98.71	$22.87	50%	$11.44	16%	$3.66	160%	$60.74	$98.71	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336100 - Motor Vehicle Manufacturing http://www.bls.gov/oes/current/naics4_336100.htm
10	51-4034	Lather and Turning Machine Tool Setters, Operators, and Tenders, Metal and Plastic	Set up, operate, or tend lathe and turning machines to turn, bore, thread, form, or face metal or plastic materials, such as wire, rod, or bar stock.	Smaller Turning Station and/or with less automation	Lathe/Turning Operator-OEM	$83.05	$21.73	37%	$8.04	10%	$2.17	160%	$51.11	$83.05	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336100 - Motor Vehicle Manufacturing http://www.bls.gov/oes/current/naics4_336100.htm
11	51-4035	Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic.	Set up, operate, or tend milling or planing machines to mill, plane, shape, groove, or profile metal or plastic work pieces.	Milling Operations	Milling/Planing Operator-OEM	$71.22	$18.02	41%	$7.39	11%	$1.98	160%	$43.82	$71.22	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336100 - Motor Vehicle Manufacturing http://www.bls.gov/oes/current/naics4_336100.htm
12	51-4072	Molding, Core making, and Casting Machine Setters, Operators, and Tenders, Metal & Plastic	Set up, operate, or tend metal or plastic molding, casting, or core making machines to mold or cast metal or thermoplastic parts or products.	Molding and Casting Operators	Mold/Cast/Sinter Operator-OEM	$77.92	$15.69	68%	$10.67	23%	$3.61	160%	$47.95	$77.92	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336100 - Motor Vehicle Manufacturing http://www.bls.gov/oes/current/naics4_336100.htm
13	51-4081	Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic.	Set up, operate, or tend more than one type of cutting or forming machine tool or robot.	Smaller Machines and/or with High Automation for Injection Molding or Casting	Will not use, too general and overlap with other categories.	$87.55	$19.47	56%	$10.90	17%	$3.31	160%	$53.88	$87.55	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336100 - Motor Vehicle Manufacturing http://www.bls.gov/oes/current/naics4_336100.htm
14	51-4122	Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders.	Set up, operate, or tend welding, soldering, or brazing machines or robots that weld, braze, solder, or heat treat metal products, components, or assemblies. Include workers who operate laser cutters or laser-beam machines.	Various Welding Operations	Welding/Soldering Operator-OEM	$103.78	$27.34	35%	$9.57	11%	$3.01	160%	$63.87	$103.78	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336100 - Motor Vehicle Manufacturing http://www.bls.gov/oes/current/naics4_336100.htm

APPENDIX E.2 Labor Costing Database Excerpt

Production Year Start (Baseline) 2008

Item	SOCS Code (BLS)	Direct Labor Title (BLS)	Direct Labor Description (BLS)	Typical Application Association	Labor Classification	Active Rate 2008	Mean Hourly Wage	Indirect Labor Rate Ratio ILRR "%"	Indirect Labor Contribution $/Hour	MRO Labor Rate Ratio MLRR "%"	MRO Labor Contribution $/Hour	Fringe Allocation "%"	Fringe Contribution $/Hour	Total Labor Rate $/Hour	Information Source
15	51-4191	Heat Treat Equipment Setters, Operators, and Tenders, Metal and Plastic	Set up, operate, or tend heating equipment, such as heat-treating furnaces, flame-hardening machines, induction machines, soaking pits, or vacuum equipment to temper, harden, anneal, or heat-treat metal or plastic objects.	Heat Treat	Heat Treat Operator-OEM	$137.35	$28.10	69%	$19.39	19%	$5.34	160%	$84.52	$137.35	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336100 - Motor Vehicle Manufacturing http://www.bls.gov/oes/current/naics4_336100.htm
16	51-9122	Painters, Transportation Equipment	Operate or tend painting machines to paint surfaces of transportation equipment, such as automobiles, buses, trucks, trains, boats, and airplanes. Include painters in auto body repair facilities.	Painting	Painter Operator-OEM	$105.77	$23.38	60%	$14.03	14%	$3.27	160%	$65.09	$105.77	US Department of Labor, May 20007 National Industry-Specific Occupational Employment and Wage Estimates NAICS 336100 - Motor Vehicle Manufacturing http://www.bls.gov/oes/current/naics4_336100.htm
III. Miscellaneous															
1	NA	Not Applicable	Category to be referenced when there is no impact on Labor associated with technology change.		Not Applicable	$0.00								$0.00	

APPENDIX E.3 Manufacturing Overhead Costing Database Excerpt

A. Thermoplastic	D. Forging	G. Machining	K. Balancing	N. Washing	R. OEM Assembly	U.	X.
B. Thermoset	E. Stamping & Forming	H. Turning	L. Heat Treat	P. T1/T2/T3 Ass'y	S.	V.	Y. Miscellaneous
C. Casting	F. Powder Metal	J. Grinding	M. Plating	Q. OEM Machining	T.	W.	Z.

Cat.	Item	Burden Title		Primary Processing Equipment		Secondary Process Equipment	Product Examples	Burden Classification	Active Rate 2008	Information Source
A. THERMOPLASTIC PROCESSING										
	A1.	Injection Molding (General, Station Based, Potential for Material Considerations)								
	A1.1	Injection Molding, Large Size and/or High Complexity	1 2 3 4 5	Injection Molding Machines (1500-3000 Ton)	1 2 3 4 5	Chiller Dryer Mold Temperature Control Unit Basic Material Handling Equipment		Inject. Mold, LS	$151.77	Harry Manvel-Mitsubishi Sales>harry@towerklean.com Rates calculated using acquired data and Burden Calculator Template. Where possible, rates were validated with T1/T2 supplier data.
	A1.2	Injection Molding, Medium-Large Size and/or Moderate-High Complexity	1 2 3 4 5	Injection Molding Machines (800-1500 Ton)	1 2 3 4 5	Chiller Dryer Temperature Control Unit Basic Material Handling Equipment	Intake Manifolds,	Inject. Mold, MLS	$90.59	Same as above
	A1.3	Injection Molding, Medium Size and/or Moderate Complexity	1 2 3 4 5	Injection Molding Machines (400-800 Ton)	1 2 3 4 5	Chiller Dryer Mold Temperature Control Unit Basic Material Handling Equipment		Inject. Mold, LS	$50.58	Same as above
	A1.4	Injection Molding, Small-Medium Size and/or Low-Moderate Complexity	1 2 3 4 5	Injection Molding Machines (200-400 Ton)	1 2 3 4 5	Chiller Dryer Mold Temperature Control Unit Basic Material Handling Equipment	Timing Chain Tensioner, Guides,	Inject. Mold, SMS	$28.80	Same as above
	A1.5	Injection Molding, Small Size and/or Low Complexity	1 2 3 4 5	Injection Molding Machines (55-150 Ton)	1 2 3 4 5	Chiller Dryer Mold Temperature Control Unit Basic Material Handling Equipment		Inject. Mold, SS	$16.39	Same as above
C. CASTING PROCESS										
	C1.	Diecasting - Aluminum (General, Station Based)								
	C1.1	Aluminum Diecasting, Large, Complex Components with Inserts	1 2 3 4 5	Cold Chamber Die Casting Machine (2600-3800 Ton)	1 2 3 4 5	Melting Equipment Automation for applying mold release agents, removing cast parts, etc. Die Cast Mold Temperature Control Unit ***Robotic equipment for loading inserts into the tool.***	Engine Blocks, Bed Plates, etc	Diecast, LS, HC, w. Inserts	$318.10	Die casting equipment source: Buhler Prince Mark.Los@Buhlerprince.com Rates calculated using acquired data and Burden Calculator Template. When possible, rates were validated with T1/T2 supplier data.
	C1.2	Aluminum Diecasting, Large Size and/or High Complexity.	1 2 3 4 5	Cold Chamber Die Casting Machine (2600-3800 Ton)	1 2 3 4 5	Melting Equipment Automation for applying mold release agents, removing cast parts, etc. Die Cast Mold Temperature Control Unit		Diecast, LS Diecast, LS, HC	$301.91 $301.91	Same as above
	C1.3	Aluminum Diecasting, Medium-Large Size and/or Moderate-High Complexity.	1 2 3 4 5	Cold Chamber Die Casting Machine (1800-2600 Ton)	1 2 3 4 5	Melting Equipment Automation for applying mold release agents, removing cast parts, etc. Die Cast Mold Temperature Control Unit		Diecast, MLS Diecast, MHC	$247.89 $247.89	Same as above
	C1.4	Aluminum Diecasting, Medium Size and/or Moderate Complexity.	1 2 3 4 5	Cold Chamber Die Casting Machine (1000-1800 Ton)	1 2 3 4 5	Melting Equipment Automation for applying mold release agents, removing cast parts, etc. Die Cast Mold Temperature Control Unit		Diecast, MS	$197.05 $197.05	Same as above
	C1.5	Aluminum Diecasting, Small-Medium Size and/or Low-Moderate Complexity	1 2 3 4 5	Cold Chamber Die Casting Machine (500-1000 Ton)	1 2 3 7	Melting Equipment Automation for applying mold release agents, removing cast parts, etc. Die Cast Mold Temperature Control Unit		Diecast, SMS Diecast, LMC	$116.73 $116.73	Same as above

APPENDIX E.3 Manufacturing Overhead Costing Database Excerpt

A. Thermoplastic	D. Forging	G. Machining	K. Balancing	N. Washing	R. OEM Assembly	U.	X.
B. Thermoset	E. Stamping & Forming	H. Turning	L. Heat Treat	P. T1/T2/T3 Ass'y	S.	V.	Y. Miscellaneous
C. Casting	F. Powder Metal	J. Grinding	M. Plating	Q. OEM Machining	T.	W.	Z.

Cat.	Item	Burden Title		Primary Processing Equipment		Secondary Process Equipment	Product Examples	Burden Classification	Active Rate 2008	Information Source
	C1.6	Aluminum Diecasting, Small Size and/or Low Complexity	1 2 3 4 5	Cold Chamber Die Casting Machine (0-500 Ton)	1 2 3 4 7	Melting Equipment Automation for applying mold release agents, removing cast parts, etc. Die Cast Mold Temperature Control Unit		Diecast, SS	$70.80	Same as above
E. Stamping & Forming Processes										
	E1.	Stamping & Forming, General, Station Based								
	E1.1	Stamping & Forming, 2X Large Size	1 2 3 4 5	Vertical Stamping Press, Tonnage 2000-3000	1 2 3 4 5	Uncoiler & Straightener		Stamp/Form, 2XLS	$281.92	Pricing information from Emprotech and Confidential Business Information (CBI) source. Rates calculated using acquired data and Burden Calculator Template. Where possible, rates were validated with T1/T2 supplier data.
	E1.2	Stamping & Forming, Extra Large Size,	1 2 3 4 5	Vertical Stamping Press, Tonnage 1500-2000	1 2 3 4 5	Uncoiler & Straightener		Stamp/Form, XLS	$199.37	Same as above
	E1.3	Stamping & Forming, Large Size	1 2 3 4 5	Vertical Stamping Press, Tonnage 1000-1500	1 2 3 4 5	Uncoiler & Straightener		Stamp/Form, LS Stamp/Form, MLS, MHC	$141.76 $141.76	Same as above
	E1.4	Stamping & Forming, Medium-Large Size	1 2 3 4 5	Vertical Stamping Press, Tonnage 800-1000	1 2 3 4 5	Uncoiler & Straightener		Stamp/Form, MLS Stamp/Form, SMS, MHC	$106.69 $0.00	Same as above
	E1.5	Stamping & Forming, Medium Size	1 2 3 4 5	Vertical Stamping Press, Tonnage 600-800	1 2 3 4 5	Uncoiler & Straightener		Stamp/Form, MS	$83.80	Same as above
	E1.6	Stamping & Forming, Small-Medium Size	1 2 3 4 5	Vertical Stamping Press, Tonnage 400-600	1 2 3 4 5	Uncoiler & Straightener		Stamp/Form, SMS Stamp/Form, SMS, LMC	$60.65 $60.65	Same as above
	E1.7	Stamping & Forming, Small Size	1 2 3 4 5	Vertical Stamping Press, Tonnage 200-400	1 2 3 4 5	Uncoiler & Straightener		Stamp/Form, SS	$42.91	Same as above
	E1.8	Stamping & Forming, Extra Small Size	1 2 3 4 5	Vertical Stamping Press, Tonnage 60-200	1 2 3 4 5	Uncoiler & Straightener		Stamp/Form, XSS	$24.60	Same as above
	E1.9	Stamping & Forming, Terminals	1 2 3 4 5	Vertical Stamping Press, Tonnage 0-60	1 2 3 4 5	Uncoiler & Straightener	Electrical Terminals	Stamp/Form, Terminals	$15.50	Same as above

APPENDIX E.3 Manufacturing Overhead Costing Database Excerpt

A. Thermoplastic	D. Forging	G. Machining	K. Balancing	N. Washing	R. OEM Assembly	U.	X.
B. Thermoset	E. Stamping & Forming	H. Turning	L. Heat Treat	P. T1/T2/T3 Ass'y	S.	V.	Y. Miscellaneous
C. Casting	F. Powder Metal	J. Grinding	M. Plating	Q. OEM Machining	T.	W.	Z.

Cat.	Item	Burden Title	Primary Processing Equipment	Secondary Process Equipment	Product Examples	Burden Classification	Active Rate 2008	Information Source
G. Machining								
	G1.	**≤4 Axis, Manual Load, CNC Horizontal Machining Center (X,Y,Z and Rotation "B"), General, Station Based**						
	G1.1	CNC Machining, Large Size and/or High Complexity **(7.5% Premium paid for machining aggressive materials, i.e., Hypereutectic Aluminums)**	1 HS-7R - Pallet Size 2032X1016 mm, 10,000 lb Capacity (PC: 2 Work piece Envelop (Ø2450 x 1000 mm) 3 Travel X,Y,Z (2134, 1676, 1524) & 360 Rotation 4 Dual Pallet Changer 5 38 Tool, Tool changer	1 Chip Removal 2 Self-contained Coolant Delivery & Filtration 3 4 5	Supplier Machining of large complex castings, e.g. Engine Blocks	CNC Machining, LS, HC **CNC Machining, LS, HC, PREM.**	$68.33 **$73.45**	Primary cost data acquired from HAAS website, http://www.haascnc.com/home.asp (10/09) Pricing information was also acquired from Precision Machining Technology Show 04/09). Rates calculated using acquired data and Burden Calculator Template. Where possible, rates were validated with T1/T2 supplier data.
	G1.2	CNC Machining, Medium-Large Size and/or Moderate-High Complexity. **(7.5% Premium paid for machining aggressive materials)**	1 EC-630 - Pallet Size 630 mm square, 2645 lb Capacity 2 Workpiece Envelop (Ø891 x 798mm) 3 Travel X,Y,Z (1016, 838, 889) & 360 Rotation 4 Dual Pallet Changer 5 50 Tool, Tool changer	1 Chip Removal 2 Self-contained Coolant Delivery & Filtration 3 4 5	Exhaust Manifolds, Cylinder Head Covers, Front Cover	CNC Machining, MHC **CNC Machining, MHC, PREM.**	$54.19 **$58.25**	Same as above
	G1.3	CNC Machining, Medium Size and/or Moderate Complexity **(7.5% Premium paid for machining aggressive materials)**	1 EC-550 - Pallet Size 550 mm square, 2205 lb Capacity 2 Workpiece Envelop (Ø778 x 798mm) 3 Travel X,Y,Z (762, 864, 813) & 360 Rotation 4 Dual Pallet Changer 5 40 Tool, Tool changer	1 Chip Removal 2 Self-contained Coolant Delivery & Filtration 3 4 5		CNC Machining, MC **CNC Machining, MC, PREM.**	$46.31 **$49.78**	Same as above
	G1.4	CNC Machining, Small-Medium Size and/or Low-Moderate Complexity. **(7.5% Premium paid for machining aggressive materials)**	1 EC-400 - Pallet Size 400 mm square, 1000 lb Capacity 2 Workpiece Envelop (Ø500 x 762mm) 3 Travel X,Y,Z (508,508,508) & 360 Rotation 4 Dual Pallet Changer 5 24 Tool, Tool changer	1 Chip Removal 2 Self-contained Coolant Delivery & Filtration 3 4 5	Rear Covers - Block, Main Bearing Cap Brace	CNC Machining, LMC **CNC Machining, LMC,**	$35.42 **$38.08**	Same as above
	G1.5	CNC Machining, Small Size and/or Low Complexity **(7.5% Premium paid for machining aggressive materials)**	1 EC-300 - Pallet Size 300 mm square, 550 lb Capacity 2 Workpiece Envelop (Ø381 x 572mm) 3 Travel X,Y,Z (508,457,356) & 360 Rotation 4 Dual Pallet Changer 5 24 Tool, Tool changer	1 Chip Removal 2 Self-contained Coolant Delivery & Filtration 3 Hydraulic Clamping 4 Tool Probing System 5		CNC Machining, LC **CNC Machining, LC, PREM.**	$31.33 **$33.68**	Same as above
	G2.	**5 Axis and/or Automatic Load CNC Horizontal Machining Center (X,Y,Z and Rotation "B", Tilt "A"), General, Station Based**						
	G2.1	5 Axis and/or Auto Load, CNC Machining, Large Size and/or High Complexity **(7.5% Premium paid for machining aggressive materials, i.e., Hypereutectic Aluminums)**	1 HS-7R - Pallet Size 2032X1016 mm, 10,000 lb Capacity (PC: 2 Workpiece Envelop (Ø2450 x 1000 mm) 3 Travel X,Y,Z (2134, 1676, 1524), Rotation & Tilt 4 Dual Pallet Changer 5 38 Tool, Tool changer	1 Chip Removal 2 Self-contained Coolant Delivery & Filtration 3 Hydraulic Clamping 4 Tool Probing System 5 Robotic Part Load/Unload		CNC Machining, LS, HC, Automatic Load **CNC Machining, LS, HC, Automatic Load, PREM.**	$91.21 **$98.05**	Primary cost data acquired from HAAS website, http://www.haascnc.com/home.asp (10/09) Pricing information was also acquired from Precision Machining Technology Show 04/09). Rates calculated using acquired data and Burden Calculator Template. Where possible, rates were validated with T1/T2 supplier data.
	G2.2	5 Axis and/or Auto Load, CNC Machining, Auto Load, Medium-Large Size and/or Moderate-High Complexity. **(7.5% Premium paid for machining aggressive materials)**	1 EC-630 - Pallet Size 630 mm square, 2645 lb Capacity 2 Workpiece Envelop (Ø891 x 798mm) 3 Travel X,Y,Z (1016, 838, 889), Rotation & Tilt 4 Dual Pallet Changer 5 50 Tool, Tool changer	1 Chip Removal 2 Self-contained Coolant Delivery & Filtration 3 Hydraulic Clamping 4 Tool Probing System 5 Robotic Part Load/Unload		CNC Machining, MHC, Automatic Load **CNC Machining, MHC, Automatic Load, PREM.**	$69.96 **$75.21**	Same as above
	G2.3	5 Axis and/or Auto Load, 5 Axis CNC Machining, Auto Load, Medium Size and/or Moderate Complexity **(7.5% Premium paid for machining aggressive materials)**	1 EC-550 - Pallet Size 550 mm square, 2205 lb Capacity 2 Workpiece Envelop (Ø778 x 798mm) 3 Travel X,Y,Z (762, 864, 813), Rotation & Tilt 4 Dual Pallet Changer 5 40 Tool, Tool changer	1 Chip Removal 2 Self-contained Coolant Delivery & Filtration 3 Hydraulic Clamping 4 Tool Probing System 5 Robotic Part Load/Unload		CNC Machining, MC, Automatic Load **CNC Machining, MC, Automatic Load, PREM.**	$59.86 **$64.35**	Same as above

APPENDIX E.3 Manufacturing Overhead Costing Database Excerpt

FEV

A. Thermoplastic	D. Forging	G. Machining	K. Balancing	N. Washing	R. OEM Assembly	U.	X.
B. Thermoset	E. Stamping & Forming	H. Turning	L. Heat Treat	P. T1/T2/T3 Ass'y	S.	V.	Y. Miscellaneous
C. Casting	F. Powder Metal	J. Grinding	M. Plating	Q. OEM Machining	T.	W.	Z.

Cat.	Item	Burden Title		Primary Processing Equipment		Secondary Process Equipment	Product Examples	Burden Classification	Active Rate 2008	Information Source
	G2.4	5 Axis and/or Auto Load, CNC Machining, Small-Medium Size and/or Low-Moderate Complexity. **(7.5% Premium paid for machining aggressive materials)**	1 2 3 4 5	EC-400 - Pallet Size 400 mm square, 1000 lb Capacity Workpiece Envelop (Ø500 x 762mm) Travel X,Y,Z (508,508,508), Rotation & Tilt Dual Pallet Changer 24 Tool, Tool changer	1 2 3 4 5	Chip Removal Self-contained Coolant Delivery & Filtration Hydraulic Clamping Tool Probing System Robotic Part Load/Unload		CNC Machining, LMC, Automatic Load **CNC Machining, LMC, Automatic Load, PREM.**	$43.09 **$46.32**	Same as above
	G2.5	5 Axis and/or Auto Load, CNC Machining, Small Size and/or Low Complexity **(7.5% Premium paid for machining aggressive materials)**	1 2 3 4 5	EC-300 - Pallet Size 300 mm square, 550 lb Capacity Workpiece Envelop (Ø381 x 572mm) Travel X,Y,Z (508,457,356), Rotation & Tilt Dual Pallet Changer 24 Tool, Tool changer	1 2 3 4 5	Chip Removal Self-contained Coolant Delivery & Filtration Hydraulic Clamping Tool Probing System Robotic Part Load/Unload		CNC Machining, LC, Automatic Load **CNC Machining, LC, Automatic Load, PREM.**	$37.95 **$40.80**	Same as above
	G3.	**CNC Rotary or Linear Transfer Machining Centers, Option #1 -> Stationary Part, Option #2 - Part Indexing Stations, Option #3 - Part Turning Stations, General, Station Based**								
	G3.1	Automated Rotary or Linear Semi dedicated transfer machines. **Part stationary fixtured/chucked** **(7.5% Premium paid for machining aggressive materials)**	1 2 3 4 5 6	Hydromat Trunnion V8 or V12 Type Equipment Max 12 Stations 12 Max Horizontal & 6 Max Vertical Tooling Spindle Automated Part Flipping Part is stationary fixtured/chucked, thus no indexing. **(Base Machine Cost 6 or less Stations, +5% Station)**	1 2 3 4 5 6 7		Small Casting Applications, Forgings, Irregular Bar Stock Components, etc. Custom application, fittings for brake tubes, oil lines etc	Rot./Lin. Trans. Machining Line, SP **Rot./Lin. Trans. Machining Line, SP, PREM.** CNC Milling, LMC CNC Milling, SMS, LC	$125.00 **$181.25** $125.00 $100.00	T1/T2 supplier data.
	G3.2	Automated Rotary or Linear Semi dedicated transfer machines. **Part Indexing capability @ each machining station.** **(7.5% Premium paid for machining aggressive materials)**	1 2 3 4 5 6 7	Hydromat Index Chuck Machine V12 or V16 Type Equipment Max 16 Stations Horizontal & Vertical Tooling Spindle Automated Part Flipping Part Indexing Capabilities @ each machining station. **(Base Machine Cost 8 or less Stations, +5% Station)**	1 2 3 4 5 6 7		Small Casting Applications, Forgings, Irregular Bar Stock Components, etc.	Rot./Lin. Trans. Machining Line, IP **Rot./Lin. Trans. Machining Line, IP, PREM.**	$175.00 **$280.00**	T1/T2 supplier data.
	G3.3	Automated Rotary or Linear Semi dedicated transfer machines. **Part Turning or Indexing capability @ each machining station.** **(7.5% Premium paid for machining aggressive materials)**	1 2 3 4 5 6 7	Hydromat AT Advanced Technology Type Equipment Max 10 Stations Horizontal & Vertical Tooling Spindle Automated Part Flipping Part Turning Capabilities @ each machining station. **(Base Machine Cost 6 or less Stations, +5% Station)**	1 2 3 4 5 6 7		Small Casting Applications, Forgings, Irregular Bar Stock Components, etc. (Pistons)	Rot./Lin. Trans. Machining Line, TP **Rot./Lin. Trans. Machining Line, TP, PREM.** CNC Milling, LS, HC	$250.00 **$362.50** $250.00	T1/T2 supplier data.
	G4.	**Customized Machining Equipment, High Volume, Finite Repetitive Operation, General, Station Based (Categorized on Cost)**								
	G4.1	Tier 1/2 Dedicated Machining Station, Large Size and/or High Complexity	1 2 3 4 5	Rate based on $/Hour for a average station in a High Complexity Machining Center (i.e. 4 Axis). Add Number of stations in Manufacturing Assumption - Quote Summary Worksheet to calculate Burden Rate. **Total Value of Equipment: $400-500K** Stations could be linked with additional machining and/or other assembly stations.	1 2 3 4 5			Dedicated Machining Center - Single Station, HC, Base	$68.33	Surrogate rate to 4 Axis CNC machining, large size.
	G4.2	Tier 1/2 Dedicated Machining Station, Medium-Large Size and/or Moderate-High Complexity	1 2 3 4 5	Rate based on $/Hour for a average station in a High Complexity Machining Center (i.e. 4 Axis). Add Number of stations in Manufacturing Assumption - Quote Summary Worksheet to calculate Burden Rate. **Total Value of Equipment: $300K-$400K** Stations could be linked with additional machining and/or other assembly stations.	1 2 3 4 5			Dedicated Machining Center - Single Station, MHC, Base	$54.19	Surrogate rate to 4 Axis CNC machining, medium-large size.

APPENDIX E.3 Manufacturing Overhead Costing Database Excerpt

A. Thermoplastic	D. Forging	G. Machining	K. Balancing	N. Washing	R. OEM Assembly	U.	X.
B. Thermoset	E. Stamping & Forming	H. Turning	L. Heat Treat	P. T1/T2/T3 Ass'y	S.	V.	Y. Miscellaneous
C. Casting	F. Powder Metal	J. Grinding	M. Plating	Q. OEM Machining	T.	W.	Z.

Cat.	Item	Burden Title	Primary Processing Equipment	Secondary Process Equipment	Product Examples	Burden Classification	Active Rate 2008	Information Source
	G4.3	Tier 1/2 Dedicated Machining Station, Medium Size and/or Moderate Complexity	1 Rate based on $/Hour for a average station in a High Complexity Machining Center (i.e. 4 Axis). Add Number of stations in Manufacturing Assumption - Quote Summary Worksheet to calculate Burden Rate. 2 **Total Value of Equipment: $200K-300K** 3 Stations could be linked with additional machining and/or other assembly stations. 4 5	1 2 3 4 5	Connecting Rods, Head Riser & Gate Cut-off and Debarring	Dedicated Machining Center - Single Station, MC, Base	$46.31	Surrogate rate to 4 Axis CNC machining, medium size.
	G4.4	Tier 1/2 Dedicated Machining Station, Small-Medium Size and/or Low-Moderate Complexity	1 Rate based on $/Hour for a average station in a High Complexity Machining Center (i.e. 4 Axis). Add Number of stations in Manufacturing Assumption - Quote Summary Worksheet to calculate Burden Rate. 2 **Total Value of Equipment: $100K-200K** 3 Stations could be linked with additional machining and/or other assembly stations. 4 5	1 2 3 4 5		Dedicated Machining Center - Single Station, LMC, Base	$35.42	Surrogate rate to 4 Axis CNC machining, small-medium size.
	G4.5	Tier 1/2 Dedicated Machining Station, Small Size and/or Low Complexity	1 Rate based on $/Hour for a average station in a High Complexity Machining Center (i.e. 4 Axis). Add Number of stations in Manufacturing Assumption - Quote Summary Worksheet to calculate Burden Rate. 2 **Total Value of Equipment: $0-$100K** 3 Stations could be linked with additional machining 4 5	1 2 3 4 5		Dedicated Machining Center - Single Station, LC, Base	$31.33	Surrogate rate to 4 Axis CNC machining, small size.
	G5.	**Machining, Component Specific, Line Base Rate per Primary Equipment Count**						
	G5.1	Average Cost per Hour per Piece of primary Camshaft Machining Equipment	1 Average cost per primary equipment using in machining process of Camshaft (e.g. establishing camshaft datum's, turning journals and grinding lobes) 2 3 4 5	1 Calculated using(H.7.3) CNC Turning, Auto Load, Machining in "C","X", "Y" and "Z" Axis Only, Automated Unload, Small-Medium Size Parts ($32.17/Hour) * 1.70 Factor (Ratio of primary to secondary support equipment costs for cylinder head line) 2 3 4 5	Camshafts	Camshaft Machining Equipment	$54.69	Calculated using(H.7.3) CNC Turning, Auto Load, Machining in "C","X", "Y" and "Z" Axis Only, Automated Unload, Small-Medium Size Parts ($32.17/Hour) * 1.70 Factor (Ratio of primary to secondary support equipment costs for cylinder head line)
H. CNC Turning								
	H1.	**CNC Turning, Auto Bar Feed (BF), Dual Axis (DA) Machining ("C" And "Z" Axis), General, Station Based with multiplier for added complexity over base assumptions.**						
	H1.1	CNC Turning, Bar Fed, Machining in "C" and "Z" Axis Only, Medium-Large Size Parts	1 SL-40BB, Bar Capacity=Ø178mm 2 Max Cutting Diameter = Ø648mm, Max Cutting Length =1118 mm 3 12 Station Turret, Bolt on Tooling 4 Automatic Bar Feeder 5 6	1 Lathe Work Gauging Probe 2 Parts Catcher System 3 Tool Presetter System 4 Chip Auger with Mobile Chip Lift 5 High-Pressure Coolant, 300 psi (21 bar) 6 Auxiliary Coolant Filter System, 25-micron filter		CNC Turning, MLS, BF, DA	$33.30	Primary cost data acquired from HAAS website, http://www.haascnc.com/home.asp (10/09) Pricing information was also acquired from Precision Machining Technology Show 04/09). Rates calculated using acquired data and Burden Calculator Template. Where possible, rates were validated with T1/T2 supplier data.
	H1.2	CNC Turning, Bar Fed, Machining in "C" and "Z" Axis Only, Medium Size Parts	1 SL-30BB, Bar Capacity=Ø102mm 2 Max Cutting Diameter = Ø432mm, Max Cutting Length =864mm 3 12 Station Turret, Bolt on Tooling 4 Automatic Bar Feeder 5 6	1 Lathe Work Gauging Probe 2 Parts Catcher System 3 Tool Presetter System 4 Chip Auger with Mobile Chip Lift 5 High-Pressure Coolant, 300 psi (21 bar) 6 Auxiliary Coolant Filter System, 25-micron filter		CNC Turning, MS, BF, DA	$27.50	Same as above
	H1.3	CNC Turning, Bar Fed, Machining in "C" and "Z" Axis Only, Small-Medium Size Parts	1 SL-20BB, Bar Capacity=Ø64mm 2 Max Cutting Diameter = Ø262mm, Max Cutting Length =508mm 3 12 Station Turret, Bolt on Tooling 4 Automatic Bar Feeder 5 6	1 Lathe Work Gauging Probe 2 Parts Catcher System 3 Tool Presetter System 4 Chip Auger with Mobile Chip Lift 5 High-Pressure Coolant, 300 psi (21 bar) 6 Auxiliary Coolant Filter System, 25-micron filter		CNC Turning, SMS, BF, DA	$23.14	Same as above

APPENDIX E.3 Manufacturing Overhead Costing Database Excerpt

FEV

A. Thermoplastic	D. Forging	G. Machining	K. Balancing	N. Washing	R. OEM Assembly	U.	X.
B. Thermoset	E. Stamping & Forming	H. Turning	L. Heat Treat	P. T1/T2/T3 Ass'y	S.	V.	Y. Miscellaneous
C. Casting	F. Powder Metal	J. Grinding	M. Plating	Q. OEM Machining	T.	W.	Z.

Cat.	Item	Burden Title		Primary Processing Equipment		Secondary Process Equipment	Product Examples	Burden Classification	Active Rate	Information Source
									2008	
	H1.4	CNC Turning, Bar Fed, Machining in "C" and "Z" Axis Only, Small Size Parts	1	SL-10BB, Bar Capacity=Ø51mm	1	Lathe Work Gauging Probe		CNC Turning, SS, BF, DA	$20.90	Same as above
			2	Max Cutting Diameter = Ø279mm, Max Cutting Length =356mm	2	Parts Catcher System		CNC Turning, LC	$20.90	
			3	12 Station Turret, Bolt on Tooling	3	Tool Presetter System				
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift				
			5		5	High-Pressure Coolant, 300 psi (21 bar)				
			6		6	Auxiliary Coolant Filter System, 25-micron filter				
	H2.	**CNC Turning, Auto Bar Feed (BF), Quad Axis (QA) Machining ("C" , "X", "Y" and "Z" Axis), Automated Unload, General, Station Based with multiplier for added complexity over base assumptions.**								
	H2.1	CNC Turning, Bar Fed, Machining in "C" ,"X", "Y" and "Z" Axis Only, Automated Unload, Medium-Large Size Parts	1	SL-40BB, Bar Capacity=Ø178mm	1	Lathe Work Gauging Probe		CNC Turning, MLS, BF, QA	$52.75	Primary cost data acquired from HAAS website, http://www.haascnc.com/home.asp (10/09) Pricing information was also acquired from Precision Machining Technology Show 04/09). Rates calculated using acquired data and Burden Calculator Template. Where possible, rates were validated with T1/T2 supplier data.
			2	Max Cutting Diameter = Ø648mm, Max Cutting Length =1118 mm	2	Automated part unload				
			3	12 Station Turret: Average (6 Fixed, 3 Axial Live Tools and 3 Radial Live Tools)	3	Tool Presetter System				
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift				
			5		5	High-Pressure Coolant, 1000 psi (21 bar)				
			6		6	Auxiliary Coolant Filter System, 25-micron filter				
	H2.2	CNC Turning, Bar Fed, Machining in "C" ,"X", "Y"and "Z" Axis Only, Automated Unload, Medium Size Parts	1	SL-30BB, Bar Capacity=Ø102mm	1	Lathe Work Gauging Probe		CNC Turning, MS, BF, QA	$43.29	Same as above
			2	Max Cutting Diameter = Ø432mm, Max Cutting Length =864mm	2	Automated part unload				
			3	12 Station Turret: Average (6 Fixed, 3 Axial Live Tools and 3 Radial Live Tools)	3	Tool Presetter System				
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift				
			5		5	High-Pressure Coolant, 1000 psi (21 bar)				
			6		6	Auxiliary Coolant Filter System, 25-micron filter				
	H2.3	CNC Turning, Bar Fed, Machining in "C","X", "Y" and "Z" Axis Only, Automated Unload, Small-Medium Size Parts	1	SL-20BB, Bar Capacity=Ø64mm	1	Lathe Work Gauging Probe		CNC Turning, SMS, BF, QA	$34.77	Same as above
			2	Max Cutting Diameter = Ø262mm, Max Cutting Length =508mm	2	Automated part unload				
			3	12 Station Turret: Average (6 Fixed, 3 Axial Live Tools and 3 Radial Live Tools)	3	Tool Presetter System				
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift				
			5		5	High-Pressure Coolant, 1000 psi (21 bar)				
			6		6	Auxiliary Coolant Filter System, 25-micron filter				
	H2.4	CNC Turning, Bar Fed, Machining in "C","X", "Y" and "Z" Axis Only, Automated Unload, Small Size Parts	1	SL-10BB, Bar Capacity=Ø51mm	1	Lathe Work Gauging Probe		CNC Turning, SS, BF, QA	$30.84	Same as above
			2	Max Cutting Diameter = Ø279mm, Max Cutting Length =356mm	2	Automated part unload.		CNC Turning, MC	$30.84	
			3	12 Station Turret: Average (6 Fixed, 3 Axial Live Tools and 3 Radial Live Tools)	3	Tool Presetter System		CNC Turning, HC	No Longer Valid	
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift				
			5		5	High-Pressure Coolant, 1000 psi (21 bar)				
			6		6	Auxiliary Coolant Filter System, 25-micron filter				
	H3.	**Double Sided (DS) Part, CNC Turning, Auto Bar Feed (BF), Dual Axis (DA) Machining ("C" And "Z" Axis), General, Station Based with multiplier for added complexity over base assumptions.**								
	H3.1	Double Sided Part, CNC Turning, Bar Fed, Machining in "C" and "Z" Axis Only, Medium-Large Size Parts	1	**THEO-TL-35BB, Bar Capacity=Ø178mm**	1	Lathe Work Gauging Probe		DS-CNC Turning, MLS, BF, DA	$37.91	Primary cost data acquired from HAAS website, http://www.haascnc.com/home.asp (10/09) Pricing information was also acquired from Precision Machining Technology Show 04/09). Rates calculated using acquired data and Burden Calculator Template. Where possible, rates were validated with T1/T2 supplier data.
			2	Max Cutting Diameter = Ø648mm, Max Cutting Length =1118 mm	2	Parts Catcher System				
			3	12 Station Turret, Bolt on Tooling	3	Tool Presetter System				
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift				
			5		5	High-Pressure Coolant, 300 psi (21 bar)				
			6		6	Auxiliary Coolant Filter System, 25-micron filter				
	H3.2	Double Sided Part, CNC Turning, Bar Fed, Machining in "C" and "Z" Axis Only, Medium Size Parts	1	TL-25 BB, Bar Capacity=Ø102mm	1	Lathe Work Gauging Probe		DS-CNC Turning, MS, BF, DA	$32.11	Same as above
			2	Max Cutting Diameter = Ø406mm, Max Cutting Length =864mm	2	Parts Catcher System				
			3	12 Station Turret, Bolt on Tooling	3	Tool Presetter System				
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift				
			5		5	High-Pressure Coolant, 300 psi (21 bar)				
			6		6	Auxiliary Coolant Filter System, 25-micron filter				
	H3.3	Double Sided Part, CNC Turning, Bar Fed, Machining in "C" and "Z" Axis Only, Small-Medium Size Parts	1	TL-15BB, Bar Capacity=Ø64mm	1	Lathe Work Gauging Probe		DS-CNC Turning, SMS, BF, DA	$28.18	Same as above
			2	Max Cutting Diameter = Ø208mm, Max Cutting Length =445mm	2	Parts Catcher System				
			3	12 Station Turret, Bolt on Tooling	3	Tool Presetter System				
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift				
			5		5	High-Pressure Coolant, 300 psi (21 bar)				
			6		6	Auxiliary Coolant Filter System, 25-micron filter				

APPENDIX E.3 Manufacturing Overhead Costing Database Excerpt

A. Thermoplastic	D. Forging	G. Machining	K. Balancing	N. Washing	R. OEM Assembly	U.	X.
B. Thermoset	E. Stamping & Forming	H. Turning	L. Heat Treat	P. T1/T2/T3 Ass'y	S.	V.	Y. Miscellaneous
C. Casting	F. Powder Metal	J. Grinding	M. Plating	Q. OEM Machining	T.	W.	Z.

Cat.	Item	Burden Title		Primary Processing Equipment		Secondary Process Equipment	Product Examples	Burden Classification	Active Rate 2008	Information Source
	H3.4	Double Sided Part, CNC Turning, Bar Fed, Machining in "C" and "Z" Axis Only, Small Size Parts	1	**THEO-TL-05BB, Bar Capacity=Ø51mm**	1	Lathe Work Gauging Probe		DS-CNC Turning, SS, BF, DA	$25.94	Same as above
			2	Max Cutting Diameter = Ø279mm, Max Cutting Length =356mm	2	Parts Catcher System		S-CNC Turning, LC	$25.94	
			3	12 Station Turret, Bolt on Tooling	3	Tool Presetter System				
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift				
			5		5	High-Pressure Coolant, 300 psi (21 bar)				
			6		6	Auxiliary Coolant Filter System, 25-micron filter				
	H4.	**Double Sided (DS) Part, CNC Turning, Auto Bar Feed (BF), Quad Axis (QA) Machining ("C" , "X", "Y" and "Z" Axis), Automated Unload, General, Station Based with multiplier for added complexity over base assumptions.**								
	H4.1	Double Sided Part, CNC Turning, Bar Fed, Machining in "C" ,"X", "Y" and "Z" Axis Only, Automated Unload, Medium-Large Size Parts	1	**THEO-TL-35BB, Bar Capacity=Ø178mm**	1	Lathe Work Gauging Probe		DS-CNC Turning, MLS, BF, QA	$56.00	Primary cost data acquired from HAAS website, http://www.haascnc.com/home.asp (10/09) Pricing information was also acquired from Precision Machining Technology Show 04/09). Rates calculated using acquired data and Burden Calculator Template. Where possible, rates were validated with T1/T2 supplier data.
			2	Max Cutting Diameter = Ø648mm, Max Cutting Length =1118 mm	2	Automated part unload				
			3	12 Station Turret: Average (6 Fixed, 3 Axial Live Tools and 3 Radial Live Tools)	3	Tool Presetter System				
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift				
			5		5	High-Pressure Coolant, 1000 psi (21 bar)				
			6		6	Auxiliary Coolant Filter System, 25-micron filter				
	H4.2	Double Sided Part, CNC Turning, Bar Fed, Machining in "C" ,"X", "Y"and "Z" Axis Only, Automated Unload, Medium Size Parts	1	TL-25 BB, Bar Capacity=Ø102mm	1	Lathe Work Gauging Probe		DS-CNC Turning, MS, BF, QA	$46.54	Same as above
			2	Max Cutting Diameter = Ø406mm, Max Cutting Length =864mm	2	Automated part unload				
			3	12 Station Turret: Average (6 Fixed, 3 Axial Live Tools and 3 Radial Live Tools)	3	Tool Presetter System				
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift				
			5	Transfer Time to Sub-spindle 8 Seconds	5	High-Pressure Coolant, 1000 psi (21 bar)				
			6		6	Auxiliary Coolant Filter System, 25-micron filter				
	H4.3	Double Sided Part, CNC Turning, Bar Fed, Machining in "C","X", "Y" and "Z" Axis Only, Automated Unload, Small-Medium Size Parts	1	TL-15BB, Bar Capacity=Ø64mm	1	Lathe Work Gauging Probe		DS-CNC Turning, SMS, BF, QA	$42.28	Same as above
			2	Max Cutting Diameter = Ø208mm, Max Cutting Length =445mm	2	Automated part unload				
			3	12 Station Turret: Average (6 Fixed, 3 Axial Live Tools and 3 Radial Live Tools)	3	Tool Presetter System				
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift				
			5	Transfer Time to Sub-spindle 8 Seconds	5	High-Pressure Coolant, 1000 psi (21 bar)				
			6		6	Auxiliary Coolant Filter System, 25-micron filter				
	H4.4	Double Sided Part CNC Turning, Bar Fed, Machining in "C","X", "Y" and "Z" Axis Only, Automated Unload, Small Size Parts	1	**THEO-TL-05BB, Bar Capacity=Ø51mm**	1	Lathe Work Gauging Probe		DS-CNC Turning, SS, BF, QA	$38.35	Same as above
			2	Max Cutting Diameter = Ø279mm, Max Cutting Length =356mm	2	Automated part unload.		S-CNC Turning, MC	$38.35	
			3	12 Station Turret: Average (6 Fixed, 3 Axial Live Tools and 3 Radial Live Tools)	3	Tool Presetter System		S-CNC Turning, HC	No Longer Valid	
			4	Automatic Bar Feeder	4	Chip Auger with Mobile Chip Lift				
			5		5	High-Pressure Coolant, 1000 psi (21 bar)				
			6		6	Auxiliary Coolant Filter System, 25-micron filter				
	H5.	**Multi Station (MS), CNC Turning, Auto Bar Feed (BF), Quad Axis (QA) Machining ("C" , "X", "Y" and "Z" Axis), Double Sided (DS) Part, Automated Unload, General, Station Based with multiplier for added complexity over base assumptions.**								
	H5.1	Multi Station -16, CNC Turning, Auto Bar Fed, Machining in "C" ,"X", "Y" and "Z" Axis Only, Double Sided, Automated Unload, Small-Medium Size Parts	1	Hydromat Rotary Transfer Machine - Max 16 Station	1			MS-16Max, CNC Turning, SMS, BF, QA	$240.00	Estimated based equipment investment and surrogate equipment overhead rates..
			2	Bar Size = Ø44 and Length 150 mm	2			RTM Turning, HC, PP, Base	$240.00	
			3	Up to 16 Horizontal & 8 Vertical Tooling Spindle	3					
			4	Automated Part Flipping	4					
			5	**(Base Machine Cost 12 Stations, +10% Station)**	5					
			6		6					
			7		7					
	H5.2	Multi Station -12, CNC Turning, Auto Bar Fed, Machining in "C" ,"X", "Y" and "Z" Axis Only, Double Sided, Automated Unload, Small-Medium Size Parts	1	Hydromat Rotary Transfer Machine - Max 12 Station	1			MS-12Max, CNC Turning, SMS, BF, QA	$180.00	Estimated based equipment investment and surrogate equipment overhead rates..
			2	Bar Size = Ø25 and Length 100 mm	2			RTM Turning, MC, PP, Base	$180.00	
			3	Up to 12 Horizontal & 6 Vertical Tooling Spindle	3					
			4	Automated Part Flipping	4					
			5	**(Base Machine Cost 8 Stations, +10% Station)**	5					
			6		6					
			7		7					

APPENDIX E.3 Manufacturing Overhead Costing Database Excerpt

A. Thermoplastic	D. Forging	G. Machining	K. Balancing	N. Washing	R. OEM Assembly	U.	X.
B. Thermoset	E. Stamping & Forming	H. Turning	L. Heat Treat	P. T1/T2/T3 Ass'y	S.	V.	Y. Miscellaneous
C. Casting	F. Powder Metal	J. Grinding	M. Plating	Q. OEM Machining	T.	W.	Z.

Cat.	Item	Burden Title	Primary Processing Equipment	Secondary Process Equipment	Product Examples	Burden Classification	Active Rate 2008	Information Source
	H5.3	Multi Station -8, **Long Part,** CNC Turning, Auto Bar Fed, Machining in "C" ,"X", "Y" and "Z" Axis Only, Double Sided, Automated Unload, Small-Medium Size Parts	1 Hydromat Inline Standard 8 - Max 8 Stations 2 Bar Size = Ø25 and Length 550 mm 3 Bar Stock or Blanks 4 5 6 7	1 2 3 4 5 6 7			$0.00	
	H5.4	Multi Station -8, CNC Turning, Auto Bar Fed, Machining in "C" ,"X", "Y" and "Z" Axis Only, Double Sided, Automated Unload, Small-Medium Size Parts	1 **THEO-ZPS 842, 8 Station Turning Machine** 2 Bar Size = Ø42 and Length 125 mm 3 16 Station Turret: Average (8 Fixed, 4 Axial Live Tools and 4 Radial Live Tools) 4 Automatic Bar Feeder 5 6	1 Lathe Work Gauging Probe 2 Automated part unload 3 Tool Presetter System 4 Chip Auger with Mobile Chip Lift 5 High-Pressure Coolant, 1000 psi (21 bar) 6 Auxiliary Coolant Filter System, 25-micron filter		MS-8Max, CNC Turning, SMS, BF, QA	$213.49	Primary pricing information was also acquired from Precision Machining Technology Show 04/09). Secondary cost data came from HAAS website, http://www.haascnc.com/home.asp (10/09) Rates calculated using acquired data and Burden Calculator Template. Where possible, rates were validated with T1/T2 supplier data.
	H5.5	Multi Station-6, CNC Turning, Auto Bar Fed, Machining in "C" ,"X", "Y" and "Z" Axis Only, Double Sided, Automated Unload, Small-Medium Size Parts	1 **THEO-ZPS 642, 6 Station Turning Machine** 2 Bar Size = Ø42 and Length 125 mm 3 12 Station Turret: Average (6 Fixed, 3 Axial Live Tools and 3 Radial Live Tools) 4 Automatic Bar Feeder 5 6	1 Lathe Work Gauging Probe 2 Automated part unload. 3 Tool Presetter System 4 Chip Auger with Mobile Chip Lift 5 High-Pressure Coolant, 1000 psi (21 bar) 6 Auxiliary Coolant Filter System, 25-micron filter		MS-6Max, CNC Turning, SMS, BF, QA	$161.86	Same as above
H6.		**Odd Form Part, CNC Turning, Manual Load (ML), Axis (DA) Machining ("C" And "Z" Axis), General, Station Based with multiplier for added complexity over base assumptions. Category for odd form components, e.g. pre-machine bar stock, forged parts, diecast**						
	H6.1	CNC Turning, Manual Load, Machining in "C" and "Z" Axis Only, Medium-Large Size Parts	1 SL-40BB, Chuck Capacity=Ø178mm 2 Max Cutting Diameter = Ø648mm, Max Cutting Length =1118 mm 3 12 Station Turret, Bolt on Tooling 4 5 6	1 Lathe Work Gauging Probe 2 Parts Catcher System 3 Tool Presetter System 4 Chip Auger with Mobile Chip Lift 5 High-Pressure Coolant, 300 psi (21 bar) 6 Auxiliary Coolant Filter System, 25-micron filter		CNC Turning, MLS, ML, DA	$31.74	Primary cost data came from HAAS website, http://www.haascnc.com/home.asp (10/09) Pricing information was also acquired from Precision Machining Technology Show 04/09). Rates calculated using acquired data and Burden Calculator Template. Where possible, rates were validated with T1/T2 supplier data.
	H6.2	CNC Turning, Manual Load, Machining in "C" and "Z" Axis Only, Medium Size Parts	1 SL-30BB, Chuck Capacity=Ø102mm 2 Max Cutting Diameter = Ø432mm, Max Cutting Length =864mm 3 12 Station Turret, Bolt on Tooling 4 5 6	1 Lathe Work Gauging Probe 2 Parts Catcher System 3 Tool Presetter System 4 Chip Auger with Mobile Chip Lift 5 High-Pressure Coolant, 300 psi (21 bar) 6 Auxiliary Coolant Filter System, 25-micron filter		CNC Turning, ML, ML, DA	$25.79	Same as above
	H6.3	CNC Turning, Manual Load, Machining in "C" and "Z" Axis Only, Small-Medium Size Parts	1 SL-20BB, Chuck Capacity=Ø64mm 2 Max Cutting Diameter = Ø262mm, Max Cutting Length =508mm 3 12 Station Turret, Bolt on Tooling 4 5 6	1 Lathe Work Gauging Probe 2 Parts Catcher System 3 Tool Presetter System 4 Chip Auger with Mobile Chip Lift 5 High-Pressure Coolant, 300 psi (21 bar) 6 Auxiliary Coolant Filter System, 25-micron filter		CNC Turning, SMS, ML, DA	$21.43	Same as above
	H6.4	CNC Turning, Manual Load, Machining in "C" and "Z" Axis Only, Small Size Parts	1 SL-10BB, Chuck Capacity=Ø51mm 2 Max Cutting Diameter = Ø279mm, Max Cutting Length =356mm 3 12 Station Turret, Bolt on Tooling 4 5 6	1 Lathe Work Gauging Probe 2 Parts Catcher System 3 Tool Presetter System 4 Chip Auger with Mobile Chip Lift 5 High-Pressure Coolant, 300 psi (21 bar) 6 Auxiliary Coolant Filter System, 25-micron filter		CNC Turning, SS, ML, DA	$19.15	Same as above

APPENDIX E.3 Manufacturing Overhead Costing Database Excerpt

A. Thermoplastic	D. Forging	G. Machining	K. Balancing	N. Washing	R. OEM Assembly	U.	X.
B. Thermoset	E. Stamping & Forming	H. Turning	L. Heat Treat	P. T1/T2/T3 Ass'y	S.	V.	Y. Miscellaneous
C. Casting	F. Powder Metal	J. Grinding	M. Plating	Q. OEM Machining	T.	W.	Z.

Cat.	Item	Burden Title		Primary Processing Equipment		Secondary Process Equipment	Product Examples	Burden Classification	Active Rate 2008	Information Source
	H7.	**Odd Form, CNC Turning, Auto Load (AL) and Unload, Quad Axis (QA) Machining ("C" , "X", "Y" and "Z" Axis), General, Station Based with multiplier for added complexity over base assumptions.** **Category for odd form components, e.g. pre-machine bar stock, for**								
	H7.1	CNC Turning, Auto Load, Machining in "C" ,"X", "Y" and "Z" Axis Only, Automated Unload, Medium-Large Size Parts	1 2 3 4 5 6	SL-40BB, Chuck Capacity=Ø178mm Max Cutting Diameter = Ø648mm, Max Cutting Length =1118 mm 12 Station Turret: Average (6 Fixed, 3 Axial Live Tools and 3 Radial Live Tools) Automatic Part Load & Unload System	1 2 3 4 5 6	Lathe Work Gauging Probe Tool Presetter System Chip Auger with Mobile Chip Lift High-Pressure Coolant, 1000 psi (21 bar) Auxiliary Coolant Filter System, 25-micron filter		CNC Turning, MLS, AL, QA	$48.72 $82.82	Primary cost data came from HAAS website, http://www.haascnc.com/home.asp (10/09) Pricing information was also acquired from Precision Machining Technology Show 04/09). Rates calculated using acquired data and Burden Calculator Template. Where possible, rates were validated with T1/T2
	H7.2	CNC Turning, Auto Load, Machining in "C" ,"X", "Y"and "Z" Axis Only, Automated Unload, Medium Size Parts	1 2 3 4 5 6	SL-30BB, Chuck Capacity=Ø102mm Max Cutting Diameter = Ø432mm, Max Cutting Length =864mm 12 Station Turret: Average (6 Fixed, 3 Axial Live Tools and 3 Radial Live Tools) Automatic Part Load & Unload System	1 2 3 4 5 6	Lathe Work Gauging Probe Tool Presetter System Chip Auger with Mobile Chip Lift High-Pressure Coolant, 1000 psi (21 bar) Auxiliary Coolant Filter System, 25-micron filter		CNC Turning, MS, AL, QA	$39.48	Same as above
	H7.3	CNC Turning, Auto Load, Machining in "C","X", "Y" and "Z" Axis Only, Automated Unload, Small-Medium Size Parts	1 2 3 4 5 6	SL-20BB, Chuck Capacity=Ø64mm Max Cutting Diameter = Ø262mm, Max Cutting Length =508mm 12 Station Turret: Average (6 Fixed, 3 Axial Live Tools and 3 Radial Live Tools) Automatic Part Load & Unload System	1 2 3 4 5 6	Lathe Work Gauging Probe Tool Presetter System Chip Auger with Mobile Chip Lift High-Pressure Coolant, 1000 psi (21 bar) Auxiliary Coolant Filter System, 25-micron filter		CNC Turning, SMS, AL, QA	$32.17	Same as above
	H7.4	CNC Turning, Auto Load, Machining in "C","X", "Y" and "Z" Axis Only, Automated Unload, Small Size Parts	1 2 3 4 5 6	SL-10BB, Chuck Capacity=Ø51mm Max Cutting Diameter = Ø279mm, Max Cutting Length =356mm 12 Station Turret: Average (6 Fixed, 3 Axial Live Tools and 3 Radial Live Tools) Automatic Part Load & Unload System	1 2 3 4 5 6	Lathe Work Gauging Probe Tool Presetter System Chip Auger with Mobile Chip Lift High-Pressure Coolant, 1000 psi (21 bar) Auxiliary Coolant Filter System, 25-micron filter		CNC Turning, SS, AL, QA	$27.47	Same as above
Q. OEM Machining										
	Q1.	**OEM Machining, Component Specific, Line Based using Multiplier X number of pieces of primary equipment**								
	Q1.1	Crankshaft Machining	1 2 3 4 5	Average cost per primary equipment using in machining process of crankshaft (e.g. Machining Center for Datums, Turn-Turn broach, OD Mill, Multi-wheel Main Grinder, Pin Grinder etc)	1 2 3 4 5	Calculated using(H.7.3) CNC Turning, Auto Load, Machining in "C","X", "Y" and "Z" Axis Only, Automated Unload, Medium Size Parts ($39.48/Hour) * 1.70 Factor (Ratio of primary to secondary support equipment costs for cylinder head line)		CNC Machining, Crankshafts, OEM	$67.12	Calculated using(H.7.3) CNC Turning, Auto Load, Machining in "C","X", "Y" and "Z" Axis Only, Automated Unload, Medium Size Parts ($39.48/Hour) * 1.70 Factor (Ratio of primary to secondary support equipment costs for cylinder head line)
	Q1.2	Cylinder Block Machining Line (Average cost per primary piece of manufacturing equipment on a cylinder block machining line)	1 2 3 4 5	4 & 5 Axis CNC Machines, **or** Custom Machining Centers, **or** In-line Washers, **or** In-Line Inspection & Gauging	1 2 3 4 5	Automation (Gantry robot w/automation) per CNC machining operation Main Line automation (gantry robot & automation) per operation Coolant System, Mist Collection, Process Water & Waste, Misc. Department Equipment Production Floor CMM		CNC Machining, Cylinder Block, OEM	$81.11	Average rate per primary piece of equipment is calculated by dividing the total estimated facility costs (primary and ancillary tracked separately), by the total primary equipment quantity, to establish an average primary and ancillary investment cost per unit of primary equipment. These average costs, along with supporting cost and specification data from surrogate equipment, are fed into the burden calculator to establish a manufacturing overhead rate.
	Q1.3	Cylinder Head Machining Line (Average cost per primary piece of manufacturing equipment on a cylinder head machining line)	1 2 3 4 5	4 & 5 Axis CNC Machines, **or** Custom Machining Centers, **or** Head Assembly Equipment (on Machining line), **or** In-line Washers, **or** In-Line Inspection & Gauging	1 2 3 4 5	Automation (Gantry robot w/automation) per CNC machining operation Main Line automation (gantry robot & automation) per operation Coolant System, Mist Collection, Process Water & Waste, Misc. Department Equipment Production Floor CMM		CNC Machining, Cylinder Head, OEM	$79.05	Average rate per primary piece of equipment is calculated by dividing the total estimated facility costs (primary and ancillary tracked separately), by the total primary equipment quantity, to establish an average primary and ancillary investment cost per unit of primary equipment. These average costs, along with supporting cost and specification data from surrogate equipment, are fed into the burden calculator to establish a manufacturing overhead rate.

APPENDIX E.4
Manufacturing Overhead Calculator Template

A. General Manufacturing Overhead Information

Burden Title:	Burden Classification: Injection Molding, Medium Size and/or Moderate Complexity	
Burden Primary Process Equipment Description:	Injection Molding Station, 500T Press	
Estimated Production Facility Size:	1.50E+05	Square Footage Options (1.5E5, 2.5E5, 5.0E5, 7.5E5, 10E5, 20E5)
Primary Process Equipment Life Expectancy:	12	Years
Process Support Equipment Life Expectancy:	12	Years
General Plant & Office Life Expectancy:	10	Years
Yearly Operating Capacity:	4700	Hours
Operation Efficiency	85.00%	Percent
Production Usage Efficiency	81.99%	Percent
Cost To Borrow Money/Annual	8.00%	Percent

Utilization Rates Fed Reserve Rate by NAIC (2002-2007):
>Primary metal 79.87%,
>Fabricate Metal Products 75.19%,
>Electrical 78.99%,
>Motor Vehicle Parts 75.66%,
>Chemical (paints resins) 76.63%,
>Plastic & Rubbers 81.99%

B.	**Primary Processing Equipment**	**Yearly Rate**	**Expense Frequency**	**% of Primary Equip. Exp.**	**Value**
B.1	Primary Process Equipment Build				$ 260,000.00
B.2	Primary Process Equipment Design (Customized equipment/machinery or highly complex integration of commodity based equipment)				$ -
B.3	Primary Process Equipment Cost (B.1+B.2)				$ 260,000.00
B.4	Sales Tax (B.4*Rate)	5.57%	1	5.57%	$ 14,482.00
B.5	Primary Process Equipment Cost Including Sales Tax				$ 274,482.00
B.6	Freight (one time expense)	1.00%	1	1.00%	$ 2,600.00
B.7	Installation (one time expense)	12.00%	1	12.00%	$ 31,200.00
B.8	Installation to Power On (one time expense)	1.00%	1	1.00%	$ 2,600.00
B.9	Set-up & Run-offs (Power on to Production Part Approval Process PPAP) (**one time expense, value default 5%**)	5.00%	1	5.00%	$ 13,000.00
B.10	Primary Process Equipment Sub-total Including Freight, Installation, Set-up and Run-off. (B.5+B.6+B.7+B.8+B.9)				$ 323,882.00
B.11	Annual Financing Expense for Primary Process Equipment Sub-total (B.10)	8%	1	NA	$ 42,070.43
B.12	Personal Property Tax	0.66%	12	0.66%	$ 1,708.31
B.13	Equipment Insurance Cost - Fire and General	0.60%	12	0.60%	$ 1,560.00
B.14	Spare Parts-Maintenance & Repair, includes perishable goods (**default 3%/year**)	3.00%	12	3.00%	$ 7,800.00
B.15	**Total Primary Equipment Costs per Annum**				$ 53,138.74

C.	**Process Support Equipment - Process Dependent (Required to carry-out primary process)**	**Yearly Rate**	**Expense Frequency**	**% of Primary Equip. Exp.**	**Value**
C.1	Process Support Equipment Build				$ 29,950.00
C.2	Process Support Equipment Design (Customized equipment/machinery or highly complex integration of commodity based equipment)				$ -
C.3	Process Support Equipment Cost (C.1+C.2)				$ 29,950.00
C.4	Sales Tax (C.4*Rate)	5.57%	1	5.57%	$ 1,668.22
C.5	Process Support Equipment Cost Including Sales Tax				$ 31,618.22
C.6	Freight (one time expense)	1.00%	1	1.00%	$ 299.50
C.7	Installation (one time expense)	12.00%	1	12.00%	$ 3,594.00
C.8	Installation to Power On (one time expense)	1.00%	1	1.00%	$ 299.50
C.9	Set-up & Run-offs (Power on to Production Part Approval Process PPAP) (**one time expense, value default 5%**)	5.00%	1	5.00%	$ 1,497.50
C.10	Process Support Equipment Sub-total Including Freight, Installation, Set-up and Run-off. (C.5+C.6+C.7+C.8+C.9)				$ 37,308.72
C.11	Annual Financing Expense for Process Support Equipment Sub-total (C.10)	8%	1	NA	$ 4,846.19
C.12	Personal Property Tax	0.66%	12	0.66%	$ 196.78
C.13	Equipment Insurance Cost - Fire and General	0.60%	12	0.60%	$ 179.70
C.14	Spare Parts-Maintenance & Repair, includes perishable goods (**default 3%/year**)	3.00%	12	3.00%	$ 898.50
C.15	**Total Process Support Equipment Costs per Annum**				$ 6,121.17

D.	**General Plant & Office Hardware/Equipment**	**% of Primary & Process Support Equipment Costs**	**Value**
D.1	Sum of Total Primary Process Equipment Costs/Year (B.15) & Process Support Equipment Costs/Year (C.15)	NA	$ 59,259.91
D.2	Millwright, Electrician, Plumbing Tool Crib	2.00%	$ 1,185.20
D.3	Production/Quality Communication and Data Tracking & Storage	0.40%	$ 237.04
D.4	General Material Handling Equipment (e.g. Tow-Motors, Cranes, Fork Lifts)	0.20%	$ 118.52
D.5	Storage, Shipping and Receiving Equipment	0.20%	$ 118.52
D.6	Plant Cleaning Equipment	0.20%	$ 118.52
D.7	General Quality Lab Equipment	0.40%	$ 237.04
D.8	Office Equipment	1.00%	$ 592.60
D.9	**Total General Plant & Office Hardware/Equipment Costs per Year**	4.40%	$ 2,607.44

APPENDIX E.4
Manufacturing Overhead Calculator Template

A. General Manufacturing Overhead Information

Burden Title:	**Burden Classification: Injection Molding, Medium Size and/or Moderate Complexity**	
Burden Primary Process Equipment Description:	**Injection Molding Station, 500T Press**	
Estimated Production Facility Size:	**1.50E+05**	**Square Footage Options (1.5E5, 2.5E5, 5.0E5, 7.5E5, 10E5, 20E5)**
Primary Process Equipment Life Expectancy:	**12**	**Years**
Process Support Equipment Life Expectancy:	**12**	**Years**
General Plant & Office Life Expectancy:	**10**	**Years**
Yearly Operating Capacity:	**4700**	**Hours**
Operation Efficiency	**85.00%**	**Percent**
Production Usage Efficiency	**81.99%**	**Percent**
Cost To Borrow Money/Annual	**8.00%**	**Percent**

Utilization Rates Fed Reserve Rate by NAIC (2002-2007):
>Primary metal 79.87%,
>Fabricate Metal Products 75.19%,
>Electrical 78.99%,
>Motor Vehicle Parts 75.66%,
>Chemical (paints resins) 76.63%
>Plastic & Rubbers 81.99%

E.	**Facilities Cost/Floor Space Includes (Cost/Square Foot) -> Primary Process Equipment, Process Support Equipment, & General Plant Office Hardware/Equipment**	**(Cost/ Square Foot)/ year**	**% of Primary & Process Support Equipment Area**	**Total Square Feet**	**Value**
E.1	Total Primary Processing Equipment Floor Space Allocation (Equipment Foot Print + 3 ft each side)	$ 11.50	NA	418	$ 4,807.00
E.2	Total Process Support Equipment Floor Space Allocation: (Equipment Foot Print + 3 ft each side)	$ 11.50	NA	321	$ 3,691.50
E.3	General Plant & Office Equipment/Hardware Floor Space	$ 11.50	75%	554.25	$ 6,373.88
E.4	**Total Facilities Costs per Year**			1293.25	$ 14,872.38

F. Utilities for Primary Process Equipment, Process Support Equipment & General Plant and Office Hardware/Equipment.

	Utility	**Units**	**Unit Cost**	**Primary Process Equipment Usage**		**Supporting Process Equipment Utility Usage**		**General Plant & Office Utility Usage**	
				Input	**Cost/Hour**	**Input**	**Cost/Hour**	**Percent Contribution**	**Cost/Hour**
F.1	Electricity	Kilowatt Hour	$ 0.0717	129.5	$9.29	49	$3.51	Facility costs in Section D cover general plant and office utility usage expenses.	
F.2	Natural Gas	Cubic Feet	$ 0.01	0	$0.00	0	$0.00		
F.3	Coke	Ton	$ 190.00	0	$0.00	0	$0.00		
F.4	Fuel Oil	Barrel	$ 46.40	0	$0.00	0	$0.00		
F.5	Water	Gallons	$ 0.00	0	$0.00	0	$0.00		
F.6	Compressed Air	CFM	$ 0.025	0	$0.00	0	$0.00		
F.7	Subtotals				$9.29		$3.51		$0.00
F.8	**Total utilities expense/hour for all Primary and Supporting Process Equipment**								$12.80

G. Plant Salary Contribution to Manufacturing Overhead (Note, does not include, direct, indirect or Maintenance, Repair or Other Labor)

	Estimated Facility Square Footage	**Est. Hourly Employees**	**Est. Salary Employees**	**Average Salary Contribution per Square Foot**	**Enter equipment square footage usage (E.4) in corresponding overall estimated facility square**	
G.1	150,000	109	13	$5.12	1293	$ 6,625.15
G.2	250,000	182	22	$6.00	0	$ -
G.3	500,000	365	44	$7.05	0	$ -
G.4	750,000	547	66	$8.16	0	$ -
G.5	1,000,000	730	88	$9.29	0	$ -
G.6	2,000,000	1460	175	$13.76	0	$ -
G.7	**Total Plant Salary Contribution to Manufacturing Overhead/Year**					$ 6,625.15

APPENDIX E.4
Manufacturing Overhead Calculator Template

A. General Manufacturing Overhead Information

Burden Title: Burden Classification: Injection Molding, Medium Size and/or Moderate Complexity

Burden Primary Process Equipment Description: Injection Molding Station, 500T Press

Estimated Production Facility Size:	1.50E+05	Square Footage Options (1.5E5, 2.5E5, 5.0E5, 7.5E5, 10E5, 20E5)
Primary Process Equipment Life Expectancy:	12	Years
Process Support Equipment Life Expectancy:	12	Years
General Plant & Office Life Expectancy:	10	Years
Yearly Operating Capacity:	4700	Hours
Operation Efficiency	85.00%	Percent
Production Usage Efficiency	81.99%	Percent
Cost To Borrow Money/Annual	8.00%	Percent

Utilization Rates Fed Reserve Rate by NAIC (2002-2007):
>Primary metal 79.87%,
>Fabricate Metal Products 75.19%,
>Electrical 78.99%,
>Motor Vehicle Parts 75.66%,
>Chemical (paints resins) 76.63%
>Plastic & Rubbers 81.99%

H. Calculated Hourly Burden Rate at defined Efficiency and Utilization	Burden Rate "Minus" Utility Rate Contribution	Utility Rate Contribution (F.8)	Total
H.1 Total Hourly Rate based on 100% efficiency and utilization	$17.74	12.798	$ 30.54
H.2 Total Hourly Rate base on defined efficiency and 100% utilization	$20.40	14.718	$ 35.12
H.3 Total Hourly Rate base on defined efficiency and utilization	$24.07	14.718	$ 38.79
H.4 **Hourly Burden Rate loaded in Burden Database**			$ 38.79

Note: The final rate for "Injection Molding, Medium Size and/or Moderate Complexity" is calculated by taking the hourly rates for equipment within this grouping (i.e.400-800 Ton Presses) and calculating the group average.

APPENDIX E.5 Mark-up Rate Database Excerpt

A. T2/T3 ThermoPlast.	D. T2/T3 Forging	G. T2/T3 Machining	J. T2/T3Assembly	M.	P. OEM Assembly
B. T2/T3 Thermoset	E. T2/T3 Stamp-Form	H. T2/T3 Heat Treat	K. T2/T3 Misc.	N. T1 Assembly	Q.
C. T2/T3 Casting	F. T2/T3 Powder Metal	I. T2/T3 Plating	L.	O.	Z. MISC

Production Year/Case Study	2008
End Item Scrape Average Annual Adjustment Factor (AAF)	0.00%
Selling, General, and Administrative (SG&A), Average Annual Adjustment Factor (AAF)	0.00%
Profit, Average Annual Adjustment Factor (AAF)	0.00%
ED&T/R&D, Average Annual Adjustment Factor (AAF)	0.00%

Cat.	Item	Supplier/OEM Classification (Based On Manufacturing Overhead Categories)		Supplier/OEM Size & Complexity Description		OEM or Supplier Classification	End Item Scrap, Active Rate 2020	SG&A, Active Rate 2008	Profit, Active Rate 2008	ED&T/ R&D, Active Rate 2008	End Item Scrap Rate, Baseline	SG&A Rate, Baseline	Profit Rate, Baseline	ED&T/ R&D Rate, Baseline	End Item Scrap, AAF	SG&A, AAF	Profit, AAF	ED&T/ R&D, AAF	End Item Scrap Rate, Adjusted	SG&A Rate, Adjusted	Profit Rate, Adjusted	ED&T/ R&D Rate, Adjusted	Notes
A. T2/T3 THERMOPLASTIC PROCESSING																							
	A1.1	Injection Molding	1 2 3 4 5	Large Size, High Complexity	1 2 3 4 5	T2/T3 Inject. Mold, LSHC	0.70%	7.00%	8.00%	2.00%	0.70%	7.00%	8.00%	2.00%	0.00%	0.00%	0.00%	0.00%	0.70%	7.00%	8.00%	2.00%	
	A1.2	Injection Molding	1 2 3 4 5	Medium Size, Moderate Complexity	1 2 3 4 5	T2/T3 Inject. Mold, MSMC	0.50%	6.50%	6.00%	1.00%	0.50%	6.50%	6.00%	1.00%	0.00%	0.00%	0.00%	0.00%	0.50%	6.50%	6.00%	1.00%	
	A1.3	Injection Molding	1 2 3 4 5	Small Size, Low Complexity	1 2 3 4 5	T2/T3 Inject. Mold, SSLC	0.30%	6.00%	4.00%	0.00%	0.30%	6.00%	4.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.30%	6.00%	4.00%	0.00%	
B. T2/T3 THERMOSET PROCESSING																							
	B1.1	Compression and Extrusion Molding of Thermosetting Polymers	1 2 3 4 5	Large Size, High Complexity	1 2 3 4 5	T2/T3 Comp./Ext. Mold, LSHC	0.70%	7.00%	8.00%	2.00%	0.70%	7.00%	8.00%	2.00%	0.00%	0.00%	0.00%	0.00%	0.70%	7.00%	8.00%	2.00%	
	B1.2	Compression and Extrusion Molding of Thermosetting Polymers	1 2 3 4 5	Medium Size, Moderate Complexity	1 2 3 4 5	T2/T3 Comp./Ext. Mold, MSMC	0.50%	6.50%	6.00%	1.00%	0.50%	6.50%	6.00%	1.00%	0.00%	0.00%	0.00%	0.00%	0.50%	6.50%	6.00%	1.00%	
	B1.3	Compression and Extrusion Molding of Thermosetting Polymers	1 2 3 4 5	Small Size, Low Complexity	1 2 3 4 5	T2/T3 Comp./Ext. Mold, SSLC	0.30%	6.00%	4.00%	0.00%	0.30%	6.00%	4.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.30%	6.00%	4.00%	0.00%	
C. T2/T3 CASTING PROCESS																							
	C1.1	Diecasting (Aluminum, Magnesium, Zinc)	1 2 3 4 5	Large Size, High Complexity	1 2 3 4 5	T2/T3 Diecast, LSHC	5.00%	7.00%	8.00%	2.00%	5.00%	7.00%	8.00%	2.00%	0.00%	0.00%	0.00%	0.00%	5.00%	7.00%	8.00%	2.00%	
	C1.2	Diecasting (Aluminum, Magnesium, Zinc)	1 2 3 4 5	Medium Size, Moderate Complexity	1 2 3 4 5	T2/T3 Diecast, MSMC	5.00%	6.50%	6.00%	1.00%	5.00%	6.50%	6.00%	1.00%	0.00%	0.00%	0.00%	0.00%	5.00%	6.50%	6.00%	1.00%	
	C1.3	Diecasting (Aluminum, Magnesium, Zinc)	1 2 3 4 5	Small Size, Low Complexity	1 2 3 4 5	T2/T3 Diecast, SSLC	5.00%	6.00%	4.00%	0.00%	5.00%	6.00%	4.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	6.00%	4.00%	0.00%	
	C3.1	Sand Casting, (Gravity and Low Pressure Casting) (Cast Iron(s), Steel, Aluminum)	1 2 3 4 5	Large Size, High Complexity	1 2 3 4 5	T2/T3 Sand Cast, LSHC	5.00%	7.00%	8.00%	2.00%	5.00%	7.00%	8.00%	2.00%	0.00%	0.00%	0.00%	0.00%	5.00%	7.00%	8.00%	2.00%	
	C3.2	Sand Casting, (Gravity and Low Pressure Casting) (Cast Iron(s), Steel, Aluminum)	1 2 3 4 5	Medium Size, Moderate Complexity	1 2 3 4 5	T2/T3 Sand Cast, MSMC	5.00%	6.50%	6.00%	1.00%	5.00%	6.50%	6.00%	1.00%	0.00%	0.00%	0.00%	0.00%	5.00%	6.50%	6.00%	1.00%	
	C3.3	Sand Casting, (Gravity and Low Pressure Casting) (Cast Iron(s), Steel, Aluminum)	1 2 3 4 5	Small Size, Low Complexity	1 2 3 4 5	T2/T3 Sand Cast, SSLC	5.00%	6.00%	4.00%	0.00%	5.00%	6.00%	4.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	6.00%	4.00%	0.00%	

APPENDIX E.5 Mark-up Rate Database Excerpt

FEV

A. T2/T3 ThermoPlast.	D. T2/T3 Forging	G. T2/T3 Machining	J. T2/T3Assembly	M.	P. OEM Assembly
B. T2/T3 Thermoset	E. T2/T3 Stamp-Form	H. T2/T3 Heat Treat	K. T2/T3 Misc.	N. T1 Assembly	Q.
C. T2/T3 Casting	F. T2/T3 Powder Metal	I. T2/T3 Plating	L.	O.	Z. MISC

Production Year/Case Study	2008
End Item Scrape Average Annual Adjustment Factor (AAF)	0.00%
Selling, General, and Administrative (SG&A), Average Annual Adjustment Factor (AAF)	0.00%
Profit, Average Annual Adjustment Factor (AAF)	0.00%
ED&T/R&D, Average Annual Adjustment Factor (AAF)	0.00%

Cat.	Item	Supplier/OEM Classification (Based On Manufacturing Overhead Categories)		Supplier/OEM Size & Complexity Description		OEM or Supplier Classification	End Item Scrap, Active Rate	SG&A, Active Rate	Profit, Active Rate	ED&T/ R&D, Active Rate	End Item Scrap Rate, Baseline	SG&A Rate, Baseline	Profit Rate, Baseline	ED&T/ R&D Rate, Baseline	End Item Scrap, AAF	SG&A, AAF	Profit, AAF	ED&T/ R&D, AAF	End Item Scrap Rate, Adjusted	SG&A Rate, Adjusted	Profit Rate, Adjusted	ED&T/ R&D Rate, Adjusted	Notes
							2020	2008	2008	2008													
	C4.1	Investment Casting, Great for Casting High Temp, Complex parts in aluminum alloys, bronze alloys, magnesium alloys, cast iron, stainless steel and tool steel.	1 2 3 4 5	Large Size, High Complexity	1 2 3 4 5	T2/T3 Invest. Cast, LSHC	5.00%	7.00%	8.00%	2.00%	5.00%	7.00%	8.00%	2.00%	0.00%	0.00%	0.00%	0.00%	5.00%	7.00%	8.00%	2.00%	
	C4.2	Investment Casting, Great for Casting High Temp, Complex parts in aluminum alloys, bronze alloys, magnesium alloys, cast iron, stainless steel and tool steel.	1 2 3 4 5	Medium Size, Moderate Complexity	1 2 3 4 5	T2/T3 Invest. Cast, MSMC	5.00%	6.50%	6.00%	1.00%	5.00%	6.50%	6.00%	1.00%	0.00%	0.00%	0.00%	0.00%	5.00%	6.50%	6.00%	1.00%	
	C4.3	Investment Casting, Great for Casting High Temp, Complex parts in aluminum alloys, bronze alloys, magnesium alloys, cast iron, stainless steel and tool steel.	1 2 3 4 5	Small Size, Low Complexity	1 2 3 4 5	T2/T3 Invest. Cast, SSLC	5.00%	6.00%	4.00%	0.00%	5.00%	6.00%	4.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	6.00%	4.00%	0.00%	
D. T2/T3 FORGING PROCESS																							
	D1.1	Impression/Close Die Forging,	1 2 3 4 5	Large Size, High Complexity	1 2 3 4 5	T2/T3 Forge, LSHC	0.70%	7.00%	8.00%	2.00%	0.70%	7.00%	8.00%	2.00%	0.00%	0.00%	0.00%	0.00%	0.70%	7.00%	8.00%	2.00%	
	D1.2	Impression/Close Die Forging,	1 2 3 4 5	Medium Size, Moderate Complexity	1 2 3 4 5	T2/T3 Forge, MSMC	0.50%	6.50%	6.00%	1.00%	0.50%	6.50%	6.00%	1.00%	0.00%	0.00%	0.00%	0.00%	0.50%	6.50%	6.00%	1.00%	
	D1.3	Impression/Close Die Forging,	1 2 3 4 5	Small Size, Low Complexity	1 2 3 4 5	T2/T3 Forge, SSLC	0.30%	6.00%	4.00%	0.00%	0.30%	6.00%	4.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.30%	6.00%	4.00%	0.00%	
			1 2 3 4 5		1 2 3 4 5																		
	D2.1	Cold Forgings, Includes Cold Bending, Cold Drawing, Extrusions, Etc.,	1 2 3 4 5	Large Size, High Complexity	1 2 3 4 5	T2/T3 Cold Forge, LSHC	0.70%	7.00%	8.00%	2.00%	0.70%	7.00%	8.00%	2.00%	0.00%	0.00%	0.00%	0.00%	0.70%	7.00%	8.00%	2.00%	
	D2.2	Cold Forgings, Includes Cold Bending, Cold Drawing, Extrusions, Etc.,	1 2 3 4 5	Medium Size, Moderate Complexity	1 2 3 4 5	T2/T3 Cold Forge, MSMC	0.50%	6.50%	6.00%	1.00%	0.50%	6.50%	6.00%	1.00%	0.00%	0.00%	0.00%	0.00%	0.50%	6.50%	6.00%	1.00%	
	D2.3	Cold Forgings, Cold Heading, Coining, Thread Rolling, etc.,	1 2 3 4 5	Small Size, Low Complexity	1 2 3 4 5	T2/T3 Cold Forge, SSLC	0.30%	6.00%	4.00%	0.00%	0.30%	6.00%	4.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.30%	6.00%	4.00%	0.00%	
E. T2/T3 STAMPING & FORMING PROCESS																							
	E1.1	Stamping & Forming,	1 2 3 4 5	Large Size, High Complexity	1 2 3 4 5	T2/T3 Stamp/Form, LSHC	0.70%	7.00%	8.00%	2.00%	0.70%	7.00%	8.00%	2.00%	0.00%	0.00%	0.00%	0.00%	0.70%	7.00%	8.00%	2.00%	
	E1.2	Stamping & Forming,	1 2 3 4 5	Medium Size, Moderate Complexity	1 2 3 4 5	T2/T3 Stamp/Form, MSMC	0.50%	6.50%	6.00%	1.00%	0.50%	6.50%	6.00%	1.00%	0.00%	0.00%	0.00%	0.00%	0.50%	6.50%	6.00%	1.00%	
	E1.3	Stamping & Forming,	1 2 3 4 5	Small Size, Low Complexity	1 2 3 4 5	T2/T3 Stamp/Form, SSLC	0.30%	6.00%	4.00%	0.00%	0.30%	6.00%	4.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.30%	6.00%	4.00%	0.00%	

APPENDIX E.5 Mark-up Rate Database Excerpt

A. T2/T3 ThermoPlast.	D. T2/T3 Forging	G. T2/T3 Machining	J. T2/T3Assembly	M.	P. OEM Assembly
B. T2/T3 Thermoset	E. T2/T3 Stamp-Form	H. T2/T3 Heat Treat	K. T2/T3 Misc.	N. T1 Assembly	Q.
C. T2/T3 Casting	F. T2/T3 Powder Metal	I. T2/T3 Plating	L.	O.	Z. MISC

Production Year/Case Study	2008
End Item Scrape Average Annual Adjustment Factor (AAF)	0.00%
Selling, General, and Administrative (SG&A), Average Annual Adjustment Factor (AAF)	0.00%
Profit, Average Annual Adjustment Factor (AAF)	0.00%
ED&T/R&D, Average Annual Adjustment Factor (AAF)	0.00%

Cat.	Item	Supplier/OEM Classification (Based On Manufacturing Overhead Categories)		Supplier/OEM Size & Complexity Description		OEM or Supplier Classification	End Item Scrap, Active Rate	SG&A, Active Rate	Profit, Active Rate	ED&T/ R&D, Active Rate	End Item Scrap Rate, Baseline	SG&A Rate, Baseline	Profit Rate, Baseline	ED&T/ R&D Rate, Baseline	End Item Scrap, AAF	SG&A, AAF	Profit, AAF	ED&T/ R&D, AAF	End Item Scrap Rate, Adjusted	SG&A Rate, Adjusted	Profit Rate, Adjusted	ED&T/ R&D Rate, Adjusted	Notes
							2020	2008	2008	2008													
F. T2/T3 POWDER METAL PROCESS																							
	F1.1	Powder Metal, Structural Components	1 2 3 4 5	Large Size, High Complexity	1 2 3 4 5	T2/T3 Powder Metal, LSHC	0.70%	7.00%	8.00%	2.00%	0.70%	7.00%	8.00%	2.00%	0.00%	0.00%	0.00%	0.00%	0.70%	7.00%	8.00%	2.00%	
	F1.2	Powder Metal, Structural & Bearing Components,	1 2 3 4 5	Medium Size, Moderate Complexity	1 2 3 4 5	T2/T3 Powder Metal, MSMC	0.50%	6.50%	6.00%	1.00%	0.50%	6.50%	6.00%	1.00%	0.00%	0.00%	0.00%	0.00%	0.50%	6.50%	6.00%	1.00%	
	F1.3	Powder Metal, Structural & Bearing Components,	1 2 3 4 5	Small Size, Low Complexity	1 2 3 4 5	T2/T3 Powder Metal, SSLC	0.30%	6.00%	4.00%	0.00%	0.30%	6.00%	4.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.30%	6.00%	4.00%	0.00%	
			1 2 3 4 5		1 2 3 4 5																		
G. T2/T3 MACHINING PROCESS																							
	G1.1	CNC and Rotary & Linear Transfer Machining	1 2 3 4 5	Large Size, High Complexity	1 2 3 4 5	T2/T3 CNC Milling, LSHC	0.70%	7.00%	8.00%	2.00%	0.70%	7.00%	8.00%	2.00%	0.00%	0.00%	0.00%	0.00%	0.70%	7.00%	8.00%	2.00%	
	G1.2	CNC and Rotary & Linear Transfer Machining	1 2 3 4 5	Medium Size, Moderate Complexity	1 2 3 4 5	T2/T3 CNC Milling, MSMC	0.50%	6.50%	6.00%	1.00%	0.50%	6.50%	6.00%	1.00%	0.00%	0.00%	0.00%	0.00%	0.50%	6.50%	6.00%	1.00%	
	G1.3	CNC and Rotary & Linear Transfer Machining	1 2 3 4 5	Small Size, Low Complexity	1 2 3 4 5	T2/T3 CNC Milling, SSLC	0.30%	6.00%	4.00%	0.00%	0.30%	6.00%	4.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.30%	6.00%	4.00%	0.00%	
			1 2 3 4 5		1 2 3 4 5																		
	G2.1	CNC Turning	1 2 3 4 5	Large Size, High Complexity	1 2 3 4 5	T2/T3 CNC Turning, LSHC	0.70%	7.00%	8.00%	2.00%	0.70%	7.00%	8.00%	2.00%	0.00%	0.00%	0.00%	0.00%	0.70%	7.00%	8.00%	2.00%	
	G2.2	CNC Turning	1 2 3 4 5	Medium Size, Moderate Complexity	1 2 3 4 5	T2/T3 CNC Turning, MSMC	0.50%	6.50%	6.00%	1.00%	0.50%	6.50%	6.00%	1.00%	0.00%	0.00%	0.00%	0.00%	0.50%	6.50%	6.00%	1.00%	
	G2.3	CNC Turning	1 2 3 4 5	Small Size, Low Complexity	1 2 3 4 5	T2/T3 CNC Turning, SSLC	0.30%	6.00%	4.00%	0.00%	0.30%	6.00%	4.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.30%	6.00%	4.00%	0.00%	
			1 2 3 4 5		1 2 3 4 5																		
H. T2/T3 HEAT TREATING PROCESS																							
	H1.1	Heat Treating,	1 2 3 4 5	Large Size, High Complexity	1 2 3 4 5	T2/T3 Heat Treat, LSHC	0.70%	7.00%	8.00%	2.00%	0.70%	7.00%	8.00%	2.00%	0.00%	0.00%	0.00%	0.00%	0.70%	7.00%	8.00%	2.00%	
	H1.2	Heat Treating,	1 2 3 4 5	Medium Size, Moderate Complexity	1 2 3 4 5	T2/T3 Heat Treat, MSMC	0.50%	6.50%	6.00%	1.00%	0.50%	6.50%	6.00%	1.00%	0.00%	0.00%	0.00%	0.00%	0.50%	6.50%	6.00%	1.00%	

APPENDIX E.5 Mark-up Rate Database Excerpt

FEV

A. T2/T3 ThermoPlast.	D. T2/T3 Forging	G. T2/T3 Machining	J. T2/T3Assembly	M.	P. OEM Assembly
B. T2/T3 Thermoset	E. T2/T3 Stamp-Form	H. T2/T3 Heat Treat	K. T2/T3 Misc.	N. T1 Assembly	Q.
C. T2/T3 Casting	F. T2/T3 Powder Metal	I. T2/T3 Plating	L.	O.	Z. MISC

Production Year/Case Study	2008
End Item Scrape Average Annual Adjustment Factor (AAF)	0.00%
Selling, General, and Administrative (SG&A), Average Annual Adjustment Factor (AAF)	0.00%
Profit, Average Annual Adjustment Factor (AAF)	0.00%
ED&T/R&D, Average Annual Adjustment Factor (AAF)	0.00%

Cat.	Item	Supplier/OEM Classification (Based On Manufacturing Overhead Categories)		Supplier/OEM Size & Complexity Description		OEM or Supplier Classification	End Item Scrap, Active Rate	SG&A, Active Rate	Profit, Active Rate	ED&T/ R&D, Active Rate	End Item Scrap Rate, Baseline	SG&A Rate, Baseline	Profit Rate, Baseline	ED&T/ R&D Rate, Baseline	End Item Scrap, AAF	SG&A, AAF	Profit, AAF	ED&T/ R&D, AAF	End Item Scrap Rate, Adjusted	SG&A Rate, Adjusted	Profit Rate, Adjusted	ED&T/ R&D Rate, Adjusted	Notes
							2020	2008	2008	2008													
	H1.3	Heat Treating,	1 2 3 4 5	Small Size, Low Complexity	1 2 3 4 5	T2/T3 Heat Treat, SSLC	0.30%	6.00%	4.00%	0.00%	0.30%	6.00%	4.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.30%	6.00%	4.00%	0.00%	
J. T2/T3 ASSEMBLY PROCESS																							
	J1.1	General Mechanical Assembly	1 2 3 4 5	Large Size, High Complexity	1 2 3 4 5	T2/T3 Mech. Assembly, LSHC	0.70%	7.00%	8.00%	2.00%	0.70%	7.00%	8.00%	2.00%	0.00%	0.00%	0.00%	0.00%	0.70%	7.00%	8.00%	2.00%	
	J1.2	General Mechanical Assembly	1 2 3 4 5	Medium Size, Moderate Complexity	1 2 3 4 5	T2/T3 Mech. Assembly, MSMC	0.50%	6.50%	6.00%	1.00%	0.50%	6.50%	6.00%	1.00%	0.00%	0.00%	0.00%	0.00%	0.50%	6.50%	6.00%	1.00%	
	J1.3	General Mechanical Assembly	1 2 3 4 5	Small Size, Low Complexity	1 2 3 4 5	T2/T3 Mech. Assembly, SSLC	0.30%	6.00%	4.00%	0.00%	0.30%	6.00%	4.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.30%	6.00%	4.00%	0.00%	
			1 2 3 4 5		1 2 3 4 5																		
	J2.1	General Electrical Assembly	1 2 3 4 5	Large Size, High Complexity	1 2 3 4 5	T2/T3 Elect. Assembly, LSHC	0.70%	7.00%	8.00%	2.00%	0.70%	7.00%	8.00%	2.00%	0.00%	0.00%	0.00%	0.00%	0.70%	7.00%	8.00%	2.00%	
	J2.2	General Electrical Assembly	1 2 3 4 5	Medium Size, Moderate Complexity	1 2 3 4 5	T2/T3 Elect. Assembly, MSMC	0.50%	6.50%	6.00%	1.00%	0.50%	6.50%	6.00%	1.00%	0.00%	0.00%	0.00%	0.00%	0.50%	6.50%	6.00%	1.00%	
	J2.3	General Electrical Assembly	1 2 3 4 5	Small Size, Low Complexity	1 2 3 4 5	T2/T3 Elect. Assembly, SSLC	0.30%	6.00%	4.00%	0.00%	0.30%	6.00%	4.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.30%	6.00%	4.00%	0.00%	
N. T1 Assembly																							
	N1.1	T1 Complete System/System Supplier	1 2 3 4 5		1 2 3 4 5	T1 System Assembly Complexity	0.70%	7.00%	8.00%	6.00%	0.70%	7.00%	8.00%	6.00%	0.00%	0.00%	0.00%	0.00%	0.70%	7.00%	8.00%	6.00%	
	N1.2	T1 High Complexity Component Supplier	1 2 3 4 5		1 2 3 4 5	T1 High Assembly Complexity	0.70%	7.00%	8.00%	4.00%	0.70%	7.00%	8.00%	4.00%	0.00%	0.00%	0.00%	0.00%	0.70%	7.00%	8.00%	4.00%	
	N1.3	T1 Moderate Complexity Component Supplier	1 2 3 4 5		1 2 3 4 5	T1 Moderate Assembly Complexity	0.50%	6.50%	6.00%	2.50%	0.50%	6.50%	6.00%	2.50%	0.00%	0.00%	0.00%	0.00%	0.50%	6.50%	6.00%	2.50%	
	N1.4	T1 Low Complexity Component Supplier	1 2 3 4 5		1 2 3 4 5	T1 Low Assembly Complexity	0.30%	6.00%	4.00%	1.00%	0.30%	6.00%	4.00%	1.00%	0.00%	0.00%	0.00%	0.00%	0.30%	6.00%	4.00%	1.00%	

APPENDIX E.5 Mark-up Rate Database Excerpt

A. T2/T3 ThermoPlast.	D. T2/T3 Forging	G. T2/T3 Machining	J. T2/T3Assembly	M.	P. OEM Assembly
B. T2/T3 Thermoset	E. T2/T3 Stamp-Form	H. T2/T3 Heat Treat	K. T2/T3 Misc.	N. T1 Assembly	Q.
C. T2/T3 Casting	F. T2/T3 Powder Metal	I. T2/T3 Plating	L.	O.	Z. MISC

Production Year/Case Study	2008
End Item Scrape Average Annual Adjustment Factor (AAF)	0.00%
Selling, General, and Administrative (SG&A), Average Annual Adjustment Factor (AAF)	0.00%
Profit, Average Annual Adjustment Factor (AAF)	0.00%
ED&T/R&D, Average Annual Adjustment Factor (AAF)	0.00%

Cat.	Item	Supplier/OEM Classification (Based On Manufacturing Overhead Categories)		Supplier/OEM Size & Complexity Description		OEM or Supplier Classification	End Item Scrap, Active Rate	SG&A, Active Rate	Profit, Active Rate	ED&T/ R&D, Active Rate	End Item Scrap Rate, Baseline	SG&A Rate, Baseline	Profit Rate, Baseline	ED&T/ R&D Rate, Baseline	End Item Scrap, AAF	SG&A, AAF	Profit, AAF	ED&T/ R&D, AAF	End Item Scrap Rate, Adjusted	SG&A Rate, Adjusted	Profit Rate, Adjusted	ED&T/ R&D Rate, Adjusted	Notes
							2020	2008	2008	2008													
P. OEM ASSEMBLY																							
	P1.1	Body & White Assembly - OEM, Includes Press Shop, Welding and Painting	1 2 3 4 5		1 2 3 4 5	OEM Body & White Assembly	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	P1.2	Casting Major Engine Components	1 2 3 4 5		1 2 3 4 5	OEM Engine Casting	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	P1.3	Machining Major Engine Components	1 2 3 4 5		1 2 3 4 5	OEM Engine Machining	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	P1.4	Engine Assembly	1 2 3 4 5		1 2 3 4 5	OEM Engine Assembly	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	P1.5	Vehicle Operations Assembly	1 2 3 4 5		1 2 3 4 5	OEM Vehicle Assembly	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	P1.6	Transmission Assembly	1 2 3 4 5		1 2 3 4 5	OEM Transmission Assembly	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
Z. MISCELLANEOUS																							
	Z1.1	Not Applicable	1 2 3 4 5	Category to be referenced when there is no impact on Mark-up associated with technology change.	1 2 3 4 5	Not Applicable	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	Z1.2	T1 Assembly, Mark-up Captured @ Bottom of quote sheet.	1 2 3 4 5		1 2 3 4 5	T1 Assembly, Mark-up Applied @ Bottom.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	

APPENDIX E.6 Packaging Costing Database Excerpt

Freight Trailer Key Dimensions	Project Trailer Size Selection		Exterior Dimensions		Interior Dimensions	
			"Inches"	"mm"	"Inches"	"mm"
1. Standard Lengths: (28', 32', 36', 40', 42', 43', 45', 48', and 53')	Length	53'	636	16154	570	14478
2. Standard Widths: 96"-102"	Width	102"	102	2591	98.5	2502
3. Standard Heights: 12.5'-13.5' Overall	Height	13.5'	162	4115	107.375	2727

Freight Trailer Information Source: www.worldtraderef.com/WTR_site/Truck_Trailers/Guide_to_Truck_Trailers.asp

Option	Packaging Description	Units	Exterior Dimensions			Interior Dimensions			Dimension Notes:	Associated Packaging	Life Expectancy "Years"	Unit Cost Estimate	Reference Source
			Length	Width	Height or Thickness	Length	Width	Height or Thickness					
A	**Primary Packaging Containers and Pallets**												
A1	Standard AIAG Container, 4 Door, Collapsible Side Walls	Inches	48	45	34	44	41.5	27.5	Other Heights Considered (39", 42", 48", 50")	Internal dunnage either expendable or returnable.	5	$200	Tier #1 CBI - Mike S.
		mm	1214	1139	860	1113	1050	696	Max Weight 2000lbs				
A2	Multi Use Rackable Pallet	Inches	48	44	6	48	44	6	Max Weight 2800lbs	Returnable vacuum formed tier pads.	5	$100	Tier #1 CBI - Mike S.
		mm	1214	1113	152	1214	1113	152					
A3	Stackable Totes (Flexcon)	Inches	21.9	15.2	12.8	19.7	14	11		Stacked on base pallet, 6 Totes/Layer, Max 7 Layers	5	$75	Tier #1 CBI - Mike S.
		mm	554	385	324	498	354	278					
A4	Stackable Totes (Generic)	Inches	20	12	12	19	11	11		Stacked on base pallet, 6 Totes/Layer, Max 7 Layers	5	$75	Tier #1 CBI - Mike S.
		mm	506	304	304	481	278	278					
A5													
B	**Retunable Internal & Support Dunnage**												
B1	1/4" HDPE Vacuum Form Tier Pads	Inches	48	45	0.25	48	45	0.25		Used with option A2 primary packaging.	5	$40	Tier #1 CBI - Mike S.
		mm	1214	1139	6	1214	1139	6					
B2	0.10" ABS Vacuum Form Tier Pads	Inches	19.7	14	0.10	19.7	14	0.10		Used with option A3 or A4 primary packaging.	5	$5	Tier #1 CBI - Mike S.
		mm	498	354	2.5	498	354	2.5					
B3	0.10" Corrugated Plastic Dividers, Generic Assumption	Inches	44	41.5	NA	44	41.5	NA		Used with option A1 primary packaging. This is an average estimated cost independent of number of cells.	2.5	$20	Estimate
		mm	1113	1050	NA	1113	1050	NA					
B4	Seat Belt, Tie-down Straps	Inches								Estimated cost per pallet for primary packaging option A2	5	$100	Tier #1 CBI
		mm											
C	**Expendable Internal Dunnage**												
C1	Cardboard Tier Pads	Inches	44	41.5	0.12	44	41.5	0.12		Used with option A1 primary packaging.	0	$1	Tier #1 CBI - Mike S.
		mm	1113	1050	3	1113	1050	3					
C2	Cardboard Divider Pads, Generic Assumption	Inches	44	41.5	NA	44	41.5	NA		Used with option A1 primary packaging.	0	$3	Tier #1 CBI - Mike S.
		mm	1113	1050	NA	1113	1050	NA					
C3													

APPENDIX F.1 MAQS Worksheet Task Reference Guide

Note: Following the table is a sample MAQS worksheet identifying the major sections.

	MAQS WORKSHEET SECTIONS			TASK DESCRIPTION	INPUT SOURCE(S) FOR TASK	REFERENCE SOURCE(S) FOR TASK	OUTPUT SOURCE(S) FOR TASK
A	**SECTION A: MAQS HEADER INFORMATION**						
	A1	**Project Details**		**Enter** case study information into MAQS header.	CBOM	P-VCSM	Costs captured in Subsystem Cost Model Analysis Templates (CMAT) are referenced by header information in the MAQS worksheet
	A2	**Quote Assumptions**					
			Capacity Planning Assumptions	**Enter** capacity planning volume assumptions into MAQS header.	CFT & P-VCSM	OEM Benchmark Data	weekly component volume provides base for all capacity planning estimates in MAQS worksheet.
			OEM/T1 Classification	**Enter** Tier 1(T1)/OEM classification for mark-up factor designation.	CFT, Mark-up Database	Supplier Benchmark Data	Mark-up rates are automatically loaded into MAQS cost summation section
			Packaging Specification	**Enter**, packaging specification assumptions	CFT	Packaging Database	Defines packaging strategy to use when developing packaging costs.
			Component Quote Level	**Check** quote level box in header to identify quoting level.	C-BOM, Process Mapping	NR	Defines quote methodology to be used in MAQS worksheet and how costs are to be presented in CMAT's

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	MAQS WORKSHEET SECTIONS			TASK DESCRIPTION	INPUT SOURCE(S) FOR TASK	REFERENCE SOURCE(S) FOR TASK	OUTPUT SOURCE(S) FOR TASK
B	**SECTION B: MAQS QUOTE SUMMARY**						
	B1	**General Component Information**					
			Reference Number	**Enter** alpha numeric reference number for each process and/or part added to the MAQS.	Defaults set in MAQS	NR	Reference numbers are a quick method of reviewing multiple processes performed on same part.
			Part Description	**Enter**, part name/description.	CBOM, Process Mapping	FEV or Munro historical naming conventions	Part description create main field for identifying parts within Bill of Materials
			Part Number	**Enter**, part number	CBOM, Process Mapping	FEV historical numbering conventions	Part Number creates main field for identifying processing level of a part within Bill of Materials
			Quantity per Assembly	**Enter** quantity of a part within the component/assembly.	CBOM, Process Mapping	Teardown process, service manuals, etc.	The quantity value enter is used through out the MAQS worksheet. More details are provided below.
	B2	**General Manufacturing Information**					
			Primary Process Description	**Enter** summary description of process	Process Mapping	NR	Reference Only
			OEM/Supplier Classification *(When referencing all quote levels with exception of Purchase Part – Commodity)*	**Enter** OEM/Supplier Classification for identified process using Mark-up Database nomenclature.	MAQS Burden Classification	Mark-up Database CFT makes assessment on what type of manufacturing facility makes the part: T1 versus OEM, T1 versus T2/T3	Automatically loads mark-up rate from database into mark-up cost section of MAQS

APPENDIX F.1 MAQS Worksheet Task Reference Guide

	MAQS WORKSHEET SECTIONS			**TASK DESCRIPTION**	**INPUT SOURCE(S) FOR TASK**	**REFERENCE SOURCE(S) FOR TASK**	**OUTPUT SOURCE(S) FOR TASK**
			OEM/Supplier Classification *(When referencing Purchase Part – Commodity quote level)*	**Enter** predefined alpha numeric characters to direct commodity based purchase part costs to different areas of the MAQS worksheet.	MAQS Quote Summary section contains legend of applicable values.	"S" = purchase component, cost binned to T1/OEM material cost. "Alpha Numeric Characters" matching reference number e.g., B2A, places the purchase cost as T2/T3 material cost subject to additional mark-up. "SAC" = Purchase component cost is only included in the MAQS worksheet to have a Mark-up factor accounted for by the T1 (or OEM if applicable). The actual component cost is kept in a separate MAQS worksheet to keep the cost resolution.	
			Material Specification	**Enter** material type identified in process using Material Database nomenclature.	CBOM/ Process Mapping	Material Database	Automatically loads material cost from database into manufacturing rates section of MAQS
			Labor Classification	**Enter** Labor type used in process using Labor Database nomenclature.	Process Mapping	Labor Database	Automatically loads labor rate from database into manufacturing rates section of MAQS
			Burden Classification	**Enter** Burden type used in process using Burden Database nomenclature.	Process Mapping & MAQS Manufacturing Assumptions	Manufacturing Overhead/Burden Database	Automatically loads burden rate from database into manufacturing rates section of MAQS
	B3	**Manufacturing Rates**					
			Finished Piece/Hour	The rate parts are produced at for the defined process. Automatically populated from Manufacturing Assumption section of MAQS	Process Mapping and Manufacturing Assumptions section of MAQS	NR	Variable used in the calculation of labor and burden costs.
			Number of Operators	Number of operators required for the defined process. Automatically populated from the Manufacturing Assumption Section of the MAQS	MAQS Manufacturing Assumption section	NR	Variable used in the calculation of labor costs.
			Number of Lines	Number of pieces of similar equipment/lines required for the defined process to meet rate. Automatically populated from the Mfg'ing Assumption. Section of the MAQS.	MAQS Manufacturing Assumption section	NR	Variable used in the calculation of the Applied Burden rate.

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	MAQS WORKSHEET SECTIONS			**TASK DESCRIPTION**	**INPUT SOURCE(S) FOR TASK**	**REFERENCE SOURCE(S) FOR TASK**	**OUTPUT SOURCE(S) FOR TASK**
			Parallel Processing Multiplier	Number of pieces of parallel processing equipment required for the defined process to meet rate. Automatically populated from the Manufacturing Assumption section of the MAQS.	MAQS Manufacturing Assumption section	NR	Variable used in the calculation of Applied Burden rate.
			Material Usage “lbs”	**Enter** total amount of material used to process single part per defined process.	Process Mapping	NR	Variable used in the calculation of material costs.
			Material Cost $/lb	Automatically uploaded from Material Database	Material Database	Material Specification	Variable used in the calculation of material costs.
			Labor Rate $/Hr	Automatically uploaded from Labor Database	Labor Database	Labor Classification	Variable used in the calculation of labor costs.
			Burden Rate $/Hr	Automatically uploaded from Burden Database	Burden Database	Burden Classification	Variable used in the calculation of Applied Burden Rate.
			Applied Burden Rate $/Hour	Total burden rate considering multiple piece of equipment performing the same task and/or using equipment/lines with parallel processing capabilities. Automatically calculated in Quote Summary Section of MAQS	Number of Lines x Parallel Processing Multiplier x Burden Rate = Applied Burden Rate.	Quote Summary section of MAQS	Variable used in the calculation of burden costs.
	B4	**Manufacturing Costs**					
			Material Costs “$”	Material cost for defined process. Automatically calculated in Quote Summary section of MAQS	Material Usage “lbs” x Material Cost “$/lb”	Pull data from Manufacturing Rates section of MAQS	Material contribution to TMC “Total 1” for the defined process.
			Labor/Part “$”	Labor cost for defined process. Automatically calculated in Quote Summary section of MAQS	=(Labor Rate “$/Hr” x Number of Operators)/ Finished Piece/Hour	Pull data from Manufacturing Rates section of MAQS	Labor contribution to TMC “Total 1” for the defined process.
			Burden/Part “$”	Burden cost for defined process. Automatically calculated in Quote Summary sec. of MAQS	=(Applied Burden Rate “$/Hr”)/ Finished Piece/Hour	Pull data from Manufacturing Rates section of MAQS	Burden contribution to TMC “Total 1” for the defined process.

APPENDIX F.1 MAQS Worksheet Task Reference Guide

	MAQS WORKSHEET SECTIONS			**TASK DESCRIPTION**	**INPUT SOURCE(S) FOR TASK**	**REFERENCE SOURCE(S) FOR TASK**	**OUTPUT SOURCE(S) FOR TASK**
			Total 1 = Material + Labor + Burden "$"	Total 1 = Total Manufacturing Cost for the defined value add process. Automatically calculated in Quote Summary section of MAQS	= Material Cost "$" + Labor/Part "$" + Burden/ Part "$"	Pull data from Manufacturing Cost section of MAQS	Variable used to calculate Mark-up Contribution, "Total 2" and "Total 3" (additional details below)
	B5	**Mark-up Costs**					
			End Item Scrap Rate "%"	End Item Scrap Rate for defined process. Automatically uploaded from Mark-up Database	Mark-up Database	OEM Supplier Classification	Used in calculation of End Item Scrap costs for defined process.
			SG&A Rate "%"	SG&A rate for defined process. Automatically uploaded from Mark-up Database	Mark-up Database	OEM Supplier Classification	Used in calculation of SG&A costs for defined process.
			Profit Rate "%"	Profit rate for defined process. Automatically uploaded from Mark-up Database	Mark-up Database	OEM Supplier Classification	Used in calculation of profit costs for defined process.
			ED&T Rate "%"	ED&T rate for defined process. Automatically uploaded from Mark-up Database	Mark-up Database	OEM Supplier Classification	Used in calculation of ED&T costs for defined process.
			Total Mark-up Rate "%"	Total Mark-up rate for defined process. Automatically calculated in Quote Summary Section of MAQS	= End Item Scrap + SG&A + Profit +ED&T "%"	Calculated from data in Mark-up Cost section of MAQS	Used in calculation of Total Mark-up Costs for defined process.
			Total Mark-up Costs "$"	Total Mark-up Cost for defined process. Automatically calculated in Quote Summary Section of MAQS	=Total Mark-up Rate "%" x Total 1 "$"	Calculated from data in Mark-up Costs and Manufacturing Costs Sections of MAQS	Used in calculation of Total 2 (See below for additional details)

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	MAQS WORKSHEET SECTIONS			TASK DESCRIPTION	INPUT SOURCE(S) FOR TASK	REFERENCE SOURCE(S) FOR TASK	OUTPUT SOURCE(S) FOR TASK
	B6	**Total Costs**					
			Total 2 = Total 1 + Total Mark-up	Total 2 is different than Total 1 only for components processed by T2/T3 suppliers because of the added mark-up. Automatically calculated in Quote Summary Section of MAQS	=Total 1 $ + Total Mark-up Cost $	Calculated from data in Mark-up Costs and Manufacturing Costs sections of MAQS	Used in calculation of Total 3 (See below for additional details)
			Total 3 = Total 2 * QTY/Assembly	Total 3 accounts for cases where multiple pieces are required in the assembly. Automatically calculated in Quote Summary Section of MAQS	Total 3 = Total 2 $ * QTY/ Assembly	Calculated from data in Total Costs & General Component Information sections of MAQS	The "Total 3" costs are added up from all four quote levels (T1 or OEM, Purchase-High Impact, Purchase-Low Impact and Purchase-Commodity) to arrive at the component/ assembly Total Manufacturing Cost.
	B7	**Tooling and Investment**					
			Tooling Assumptions	**Enter** those tooling costs and assumptions which cannot be excluded as a result of the technology differences between the base and new technology configurations.	CFT	NR	Tooling is totaled for the base and new technology configurations and a differential calculated in the Subsystem and System Cost Model Summary Templates.
			Investment Assumptions	**Enter** Unique investment costs and assumptions which may drive burden rate changes.	CFT	NR	Unique Investment cases and costs are captured for potential development of new burden rates.

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	MAQS WORKSHEET SECTIONS			TASK DESCRIPTION	INPUT SOURCE(S) FOR TASK	REFERENCE SOURCE(S) FOR TASK	OUTPUT SOURCE(S) FOR TASK
C	**SECTION C: MAQS BREAKOUT CALCULATOR- REFERENCE ONLY "Costs broken out into categories with quantity per assembly taken into account"**						
	C1	**Manufacturing Costs**					
			Manufacturing Cost (QTY) >Material >Labor >Burden >TMC	Takes into account quantity (qty) of components per assembly to calculate Total Material, Labor and Burden and TMC per defined process. Automatically calculated in Breakout Calculator section of MAQS	Total Material = Material Cost x QTY. Total Labor = Labor Cost x QTY. Etc….	Calculated from the Manufacturing Cost and General Component Information sections of MAQS	The costs for each manufacturing cost element (material, labor, etc) are added up from all four quote levels (T1 or OEM, Purchase-High Impact, Purchase-Low Impact, and Purchase-Commodity) to arrive at the total cost contribution, for each element, for the component/assembly.
	C2	**Mark-up Costs**					
			Mark-up Costs (QTY) >End Item Scrap > SG&A >Profit >ED&T >Total Mark-up Cost	Takes into account qty. of components per assembly and sets mark-up rates to calculate Total Mark-up Costs for each mark-up category per the defined process. Automatically calculated in Breakout Calculator section of MAQS	Total End Item Scrap = QTY. x Total 1 x End Item Scrap rate. Total SG&A = QTY. x Total 1 x SG&A Rate Etc…..	Calculated from the General Component Information, Manufacturing Cost and Mark-up Cost Sections of MAQS	The costs for each mark-up cost element (scrap, SG@A etc) are added up from all four quote levels (T1 or OEM, Purchase-High Impact, Purchase-Low Impact, and Purchase-Commodity) to arrive at the total cost contribution, for each mark-up element, for the component/ assembly.

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		MAQS WORKSHEET SECTIONS	TASK DESCRIPTION	INPUT SOURCE(S) FOR TASK	REFERENCE SOURCE(S) FOR TASK	OUTPUT SOURCE(S) FOR TASK
D	**SECTION D: MANUFACTURING ASSUMPIONS**					
	D1	**Process Information**				
		Process and Equipment Assumptions	**Enter**, define mass production manufacturing methodology based off serial process mapping	Process Mapping and CFT	Historical industry data and expertise	Process and equipment assumptions provide support information for “Project Process Requirement” (Manufacturing Assumption Section of MAQS)
		Tooling, Fixturing and Gauge Assumptions	**Enter,** define tooling impact associated with technology upgrade features.	Process Mapping and CFT	Historical industry data and expertise	Tooling, fixture and gauge assumptions provide support information for “Tool Assumption Costs” (Quote Summary Section of MAQS)
	D2	**Process Operation Pattern**				
		Day/Week	**Enter**, default is 5, assumption is everyone on average operates 5 days/week to capitalize on investment.	MAQS Manufacturing Assumption section	NR	Variable used in calculation of available hours/week for manufacturing.
		Shifts/Day	**Enter**, default is 2, assumption is everyone on average operates 2 shifts/day to capitalize on investment.	MAQS Manufacturing Assumption section	NR	Variable used in calculation of available hours/week for manufacturing.
		Hrs./Shift	**Enter**, default is 10, Selected 10 as default supporting heavy automation, complex set-ups and long change-over times for majority of components.	MAQS Manufacturing Assumption section	NR	Variable used in calculation of available hours/week for manufacturing.
		Hrs/Wk.	Automatically calculated, average available hours per week for manufacturing.	=Day/week x Shifts/Day x Hrs/Shift	Manufacturing Assumption section of MAQS	Variable used in calculation of Pieces/Hour.
		Wks./Yr.	**Enter**, default is 47, assumption is everyone on average operates 47 week/year to capitalize on investment.	MAQS Manufacturing Assumption section	NR	Variable used in calculation of available Hours/Yr for manufacturing.
		Hrs./Yr.	Automatically calculated, average available hours per year for manufacturing	=Hrs/Wk x Wks/Yr.	Manufacturing Assumption section of MAQS	NR

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	MAQS WORKSHEET SECTIONS			TASK DESCRIPTION	INPUT SOURCE(S) FOR TASK	REFERENCE SOURCE(S) FOR TASK	OUTPUT SOURCE(S) FOR TASK
	D3	**Minimum Calculated Cycle Times**					
			Pcs./Hr. (100% Eff.)	Automatically calculated, number of piece required per hour from the manufacturer to support the OEM facility (on weekly basis) assuming 100% efficiency	=(Weekly Component-Assembly Volume x QTY per Assembly) / Hrs./Week	Manufacturing assumption data from MAQS Header Sec., General Component Information from MAQS Quote Summary sec., and Hrs/Week information from Manufacturing Assumption sec. of MAQS	Variable used in calculation or Pcs./Hr. @ Stated Efficiency
			Cycle Time/Operation "Sec."	Automatically calculated, tack time per part in seconds @ 100% efficiency	=(Pcs./Hr.)/ 3600 Seconds	Manufacturing Assumption section of MAQS	Reference only
			Efficiency % (Stated Efficiency)	**Enter,** default 85%, assumption with breaks, downtime, etc., average manufacturing time available would be 8.5 hours out of 10.	CFT	Historical industry data and expertise	Variable used in calculation of Pcs./Hr at stated efficiency.
			Pcs./Hr. @ Stated Efficiency	Automatically calculated, number of piece required per hour from the manufacturer to support the OEM facility (on weekly basis) assuming efficiency **"X"**	= Pcs./Hr. (100% Eff.)/ Efficiency	Manufacturing assumption data from MAQS Header Sec., General Component Information from MAQS Quote Summary sec., and Hrs/Week information from Manufacturing Assumption sec. of MAQS	Value establishes specification to ensure defined mass production process can meet capacity. "Resulting Pcs./Hr. ≥ "Pcs./Hr. @ Stated Efficiency"
			Cycle Time/Operation @ State Efficiency "Sec"	Automatically calculated, tack time per part in seconds @ stated efficiency	(Pcs./Hr. @ State Efficiency)/ 3600 Seconds	Manufacturing Assumption section of MAQS	Reference Only

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	MAQS WORKSHEET SECTIONS			TASK DESCRIPTION	INPUT SOURCE(S) FOR TASK	REFERENCE SOURCE(S) FOR TASK	OUTPUT SOURCE(S) FOR TASK
	D4	**Project Process Requirements**					
			Lean Design Calculation for Complete Process Time "Sec."	**Enter,** total serial processing time for a defined process from Process Map.	Process Mapping	NR	Total serial process time is referenced to mass production assumption calculations e.g., (Piece/Cycle/ Machine) x (Tack Time /Machine/ Cycle) x (Parallel Processing Multiplier) x (Number of Equipment/ Machine Required). Pending situation mass production assumption calculation ≤ total serial process time.
			Parallel Operations/Machine or Stations/Line	**Enter,** based on process and equipment assumptions is the total number of operations performed for a defined process.	Process and Equipment Assumptions	MAQS Manufacturing Assumption section	Reference for establishing parallel processing requirements and number of equivalent lines/equipment.
			Piece/Cycle/Machine	**Enter,** accounts for equipment/processes where multiple parts can be produced at the same time (e.g., multiple cavity injection mold)	Process Mapping and Process and Equipment Assumptions	MAQS Manufacturing Assumption section	Variable used in calculation of “Resulting Piece/Hour”
			Tack Time/Machine/Cycle "Seconds"	**Enter,** based on Process and Equipment Assumptions is the time it takes for a given piece of equipment from start to finish to complete it’s process cycle.	Process Mapping and Process and Equipment Assumptions	MAQS Manufacturing Assumption section	Variable used in calculation of “Resulting Piece/Hour”
			Multiplier, If Required for Parallel Processing (1=Nothing)	**Enter,** based on process and equipments assumptions is the assignment of a burden multiplier to account for equipment with parallel processing capabilities. (e.g., 7 Part Spindle Turning CNC Machine versus a single part spindle turning machine)	Process and Equipment Assumptions	MAQS Manufacturing Assumption section	Populates “Parallel Processing Multiplier” in the Quote Summary section of the MAQS for Applied Burden Rate calculation.
			Number of Equivalent Machines Required	**Enter**, based on required pieces/hr. @ stated efficiency, is the number of pieces of equipment required to meet capacity rates.	Required “Pcs./Hr. @ Stated Efficiency” and “Resulting Pieces /Hour” from defined process and equipment assumptions	MAQS Manufacturing Assumption section	Populates “Number of Lines” in the Quote Summary section of the MAQS for Applied Burden Rate calculation. Variable used in calculation of “Resulting Piece/Hour”

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	MAQS WORKSHEET SECTIONS			TASK DESCRIPTION	INPUT SOURCE(S) FOR TASK	REFERENCE SOURCE(S) FOR TASK	OUTPUT SOURCE(S) FOR TASK
			Resulting Pieces/Hour	Automatically calculated, defines the pieces per hour which can be manufactured under the defined mass production process and equipment assumptions.	= {3600 seconds/ (Tack Time/Machine/Cycle)} * {(Pieces/ Machine/Cycle) * (Number of Equivalent Machines Required)}	MAQS Manufacturing Assumption section	Populates “Finished Pieces/Hour” in the Quote Summary section of the MAQS which is then used in the calculation of labor and burden costs.
			Resulting Cycle Time/ Part "Sec”	Automatically calculated, defines the average tack time per part based on resulting pieces/hour.	=3600 Seconds/ (Resulting Pieces/Hour)	MAQS Manufacturing Assumption section	Checked with respect to “Cycle Time/Operation @ Stated Efficiency “Sec” to ensure manufacturing process and equipment assumptions can meet capacity requirements.
			Total Number of Direct Operators	**Enter**, the number of direct laborers required to support Process and equipment assumptions	Process and Equipment Assumptions	MAQS Manufacturing Assumption section	Populates “Number of Operators” in the Quote Summary section of the MAQS which is then used in the calculation of labor Costs.

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	MAQS WORKSHEET SECTIONS			TASK DESCRIPTION	INPUT SOURCE(S) FOR TASK	REFERENCE SOURCE(S) FOR TASK	OUTPUT SOURCE(S) FOR TASK
E	**SECTION E: PACKAGING CALCULATIONS**						
	E1	**Packaging Calculation**					
			Package Calculation Data Entry Box	**Enter**, the selected packaging configuration, part size and expected pack density.	Packaging Database, Part Measurements Information	MAQS Header - Packaging Assumptions	Expected pack density variables feed "Number of Parts per Pallet/Rack" calculation.
	E2	**Rack/Pallet Investment Amortization**					
			Supplier, Customer and In-transit Inventory Requirements (Parts)	Automatically calculated, defines the total inventory required to support the "Supplier, Customer and In-transit Inventory Requirements"	= Weekly Component Volume X "Supplier, Customer and In-transit inventory requirements"	MAQS Header and Packaging section.	Variable used to determine total number of pallets/racks required.
			Supplier, Customer and In-transit Inventory Requirements (Weeks)	**Enter**, default 6 weeks, number of weeks of packaging required to cover plant stock turn-over, transit times, container cleaning, etc	CFT	NR	Variable used to calculate "Supplier, Customer and In-transit Inventory Requirements".
			Number of Parts per Pallet/ Rack	**Enter**, for base ballet assumptions (48"x45") how many parts can be loaded onto pallet maintaining height requirements.	Packaging Database, Package Calculation Entry Box	NR	Variable used to determine total number of pallets/racks required.
			Total Number of Pallets/ Racks Required	Automatically calculated defines how many complete pallets/racks are required to support supplier, customer and in-transit inventory requirements	= (Supplier, Customer and In-transit Inventory Requirements (Parts))/ (# of Parts per Pallet/ Rack)	MAQS Package Calculation section	Variable used to determine Total Packaging Costs.
			Cost per Pallet /Rack	**Enter**, cost of one complete pallet/rack set.	Packaging Database, Package Calculation Entry Box	MAQS Package Calculation section	Variable used to determine Total Packaging Costs
			Interest Rate	**Enter**, default 5%, interest rate to cover lost invest. opportunity w. packaging hardware purchase.	CFT	NR	Variable used in calculation of Returnable "Cost/Piece"

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	MAQS WORKSHEET SECTIONS			TASK DESCRIPTION	INPUT SOURCE(S) FOR TASK	REFERENCE SOURCE(S) FOR TASK	OUTPUT SOURCE(S) FOR TASK
			Number of Service Months	**Enter**, default 60 months, expected service life of packaging before it needs to be replaced.	CFT	NR	Variable used in calculation of Returnable "Package Cost/Piece"
			Total # of Pieces/ Amortization Period	Automatically calculated, defines the total number of parts, during the defined service life, which will be used to amortize the packaging costs.	= Weekly Component Volume X Number of Service Months X Average Weeks/Month	NR	Variable used in calculation of Returnable "Cost/Piece"
			Lump Sum Payment (%)	**Enter**, default 0%, any upfront customer payments towards packaging,	CFT	NR	Variable used in calculation of Returnable "Package Cost/Piece"
			Total Amount	Automatically calculated, defines the total packaging cost for the assumed volumes, transit times, inventory hold and service life, etc.	= Total Number of Pallets/ Racks Required X Cost per Pallet /Rack	MAQS Package Calculation Section	Variable used in calculation of Returnable "Cost/Piece"
			Cost/Piece (Returnable)	Automatically calculated, defines the additional cost per part required to cover the returnable packaging expenditure.	Calculated using standard amortization formula.	MAQS Package Calculation section	Cost/Piece is added to any contribution from expendable packaging, if applicable, to obtain the Packaging Cost Total / Part
	E3	**Expendable Packing in Piece Cost**					
			Tier Pad Piece Price, Divider Pad Piece Price, Other #1,2,3 Piece Price, etc	**Enter**, from Packaging database enter unit cost of identified expendable packing.	Packaging Database, Package Calculation Entry Box	MAQS Package Calculation section	Variable used in calculation of Expendable "Cost/Piece"
			Tier Pads per Pallet/Rack, Divider Pads per Pallet/Rack, etc	**Enter**, from Package Calculation Data Entry Box, enter quantity of identified expendable packaging required per pallet.	Package Calculation Entry Box	MAQS Package Calculation section	Variable used in calculation of Expendable "Cost/Piece"
			Cost/piece (Expendable)	Automatically calculated, defines the additional cost per part required to cover the expendable packaging expenditure.	=(Total Expendable Packaging Expense for Pallet) /(Number of Parts/Pallet)	MAQS Package Calculation Section	Cost/Piece is added to any contribution from returnable packaging, to obtain the Packaging Cost Total / Part

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	MAQS WORKSHEET SECTIONS			TASK DESCRIPTION	INPUT SOURCE(S) FOR TASK	REFERENCE SOURCE(S) FOR TASK	OUTPUT SOURCE(S) FOR TASK
F	**SECTION 6: UNIT COST SUMMARY**						
			T1 or OEM Total Manufacturing Costs (Includes TMC + T2/T3 Mark-up)	Automatically calculated, presents the Total Manufacturing Cost of the components including all Tier 2/Tier 3 mark-up broken out into the 7 cost elements.	MAQS Worksheet Calculations	NR	Values are used to calculate Base Cost Impact to Vehicle.
			T1 or OEM Mark-up Rates	Rates Automatically loaded when the OEM/T1 Classification is recoded in the header.	Mark-up Database,	MAQS Worksheet Header	Rates are used to calculate Tier 1 (or OEM if applicable) mark-up costs.
			(SAC) and T1 or OEM Mark-up Values/Costs	Automatically calculated, T1 (or OEM if applicable) mark-up costs. Note: If there are any Purchase Parts – Commodity based, classified as “SAC’s”, the values are subtracted out in this area after T1 mark-up costs are calculated.	=(“T1 or OEM TMC”) x (“T1 or OEM Mark-up Rates”)	NR	T1 (or OEM if applicable) mark-up costs are added to TMC to obtain Base Cost Impact to Vehicle
			Base Cost Impact to Vehicle (Includes TMC + Tier 2/3 Mark-up and Tier 1 Mark-up)	Automatically calculates the total base cost for the component/assembly broken out into the 7 cost elements. Note: In addition, tooling and investment impact (if applicable) are summed up within this section.	= (“T1 or OEM TMC”) + (“(SAC) and T1 or OEM Mark-up Values/ Costs”)	NR	Total is added to Packaging Cost to obtain the Net Cost Impact to Vehicle. Note these values are also carried into the Subsystem Cost Model Analysis Templates
			Net Cost Impact to Vehicle	Automatically calculated, Final Unit Cost Impact to Vehicle	= Base Cost Impact to Vehicle + Packaging	NR	FINAL UNIT COST

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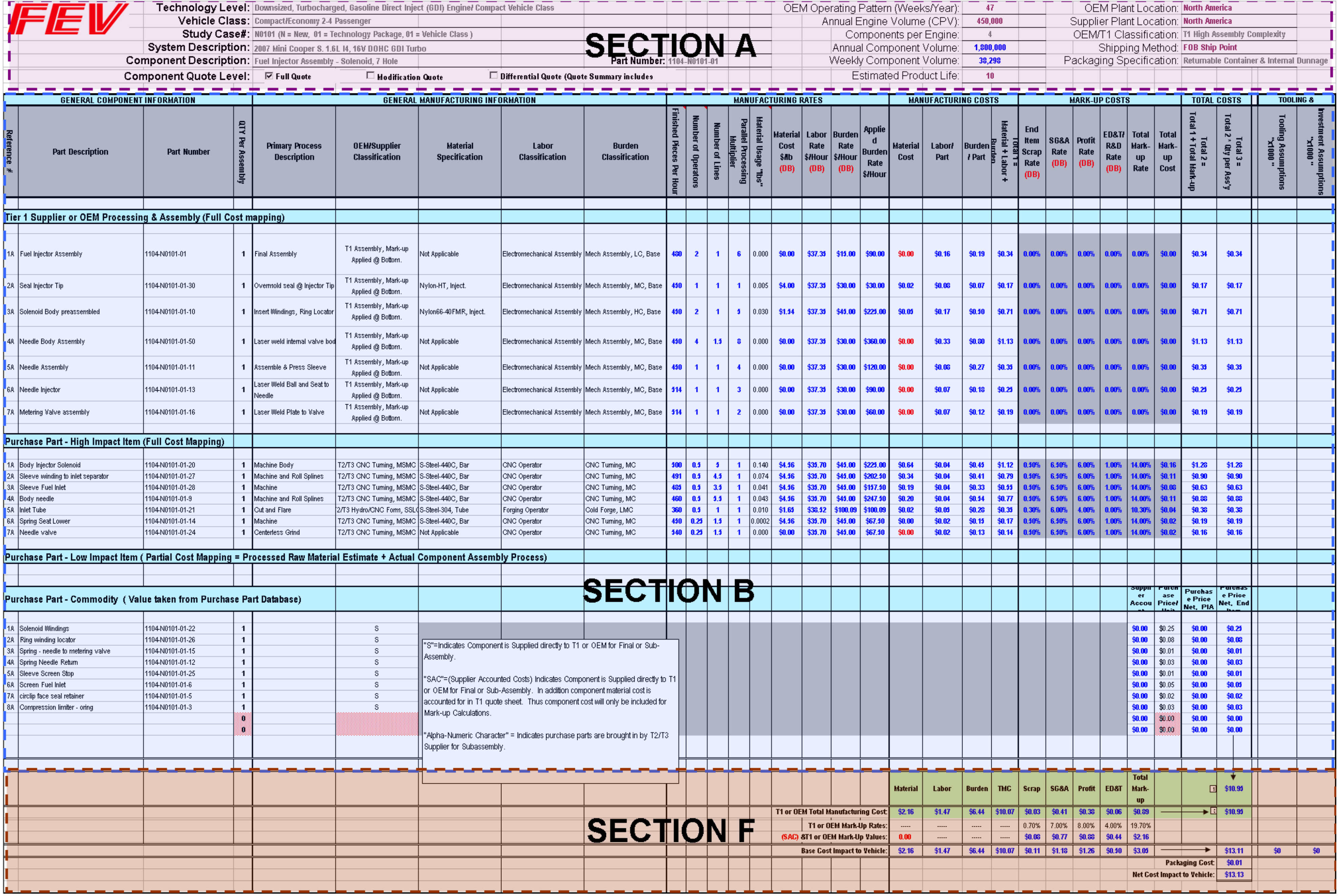


SECTION A

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Fuel Injector Assembly - Solenoid, 7 Hole
Part Number: 1104-N0101-01
Component Quote Level: ☑ Full Quote ☐ Modification Quote ☐ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 4
Annual Component Volume: 1,800,000
Weekly Component Volume: 38,298
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 High Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Returnable Container & Internal Dunnage

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING &	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden / Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
1A	Fuel Injector Assembly	1104-N0101-01	1	Final Assembly	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	Electromechanical Assembly	Mech Assembly, LC, Base	480	2	1	6	0.000	$0.00	$37.35	$15.00	$90.00	$0.00	$0.16	$0.19	$0.34	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.34	$0.34		
2A	Seal Injector Tip	1104-N0101-01-30	1	Overmold seal @ Injector Tip	T1 Assembly, Mark-up Applied @ Bottom.	Nylon-HT, Inject.	Electromechanical Assembly	Mech Assembly, MC, Base	450	1	1	1	0.005	$4.00	$37.35	$30.00	$30.00	$0.02	$0.08	$0.07	$0.17	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.17	$0.17		
3A	Solenoid Body preassembled	1104-N0101-01-10	1	Insert Windings, Ring Locator	T1 Assembly, Mark-up Applied @ Bottom.	Nylon66-40FMR, Inject.	Electromechanical Assembly	Mech Assembly, HC, Base	450	2	1	5	0.030	$1.54	$37.35	$45.00	$225.00	$0.05	$0.17	$0.50	$0.71	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.71	$0.71		
4A	Needle Body Assembly	1104-N0101-01-50	1	Laser weld internal valve bod	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	Electromechanical Assembly	Mech Assembly, MC, Base	450	4	1.5	8	0.000	$0.00	$37.35	$30.00	$360.00	$0.00	$0.33	$0.80	$1.13	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.13	$1.13		
5A	Needle Assembly	1104-N0101-01-11	1	Assemble & Press Sleeve	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	Electromechanical Assembly	Mech Assembly, MC, Base	450	1	1	4	0.000	$0.00	$37.35	$30.00	$120.00	$0.00	$0.08	$0.27	$0.35	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.35	$0.35		
6A	Needle Injector	1104-N0101-01-13	1	Laser Weld Ball and Seat to Needle	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	Electromechanical Assembly	Mech Assembly, MC, Base	514	1	1	3	0.000	$0.00	$37.35	$30.00	$90.00	$0.00	$0.07	$0.18	$0.25	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.25	$0.25		
7A	Metering Valve assembly	1104-N0101-01-16	1	Laser Weld Plate to Valve	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	Electromechanical Assembly	Mech Assembly, MC, Base	514	1	1	2	0.000	$0.00	$37.35	$30.00	$60.00	$0.00	$0.07	$0.12	$0.19	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.19	$0.19		
Purchase Part - High Impact Item (Full Cost Mapping)																															
1A	Body Injector Solenoid	1104-N0101-01-20	1	Machine Body	T2/T3 CNC Turning, MSMC	S-Steel-440C, Bar	CNC Operator	CNC Turning, MC	500	0.5	5	1	0.140	$4.56	$35.70	$45.00	$225.00	$0.64	$0.04	$0.45	$1.12	0.50%	6.50%	6.00%	1.00%	14.00%	$0.16	$1.28	$1.28		
2A	Sleeve winding to inlet separator	1104-N0101-01-27	1	Machine and Roll Splines	T2/T3 CNC Turning, MSMC	S-Steel-440C, Bar	CNC Operator	CNC Turning, MC	491	0.5	4.5	1	0.074	$4.56	$35.70	$45.00	$202.50	$0.34	$0.04	$0.41	$0.79	0.50%	6.50%	6.00%	1.00%	14.00%	$0.11	$0.90	$0.90		
3A	Sleeve Fuel Inlet	1104-N0101-01-28	1	Machine	T2/T3 CNC Turning, MSMC	S-Steel-440C, Bar	CNC Operator	CNC Turning, MC	485	0.5	3.5	1	0.041	$4.56	$35.70	$45.00	$157.50	$0.19	$0.04	$0.33	$0.55	0.50%	6.50%	6.00%	1.00%	14.00%	$0.08	$0.63	$0.63		
4A	Body needle	1104-N0101-01-9	1	Machine and Roll Splines	T2/T3 CNC Turning, MSMC	S-Steel-440C, Bar	CNC Operator	CNC Turning, MC	460	0.5	5.5	1	0.043	$4.56	$35.70	$45.00	$247.50	$0.20	$0.04	$0.54	$0.77	0.50%	6.50%	6.00%	1.00%	14.00%	$0.11	$0.88	$0.88		
5A	Inlet Tube	1104-N0101-01-21	1	Cut and Flare	2/T3 Hydro/CNC Form, SSL	S-Steel-304, Tube	Forging Operator	Cold Forge, LMC	360	0.5	1	1	0.010	$1.65	$38.52	$100.09	$100.09	$0.02	$0.05	$0.28	$0.35	0.30%	6.00%	4.00%	0.00%	10.30%	$0.04	$0.38	$0.38		
6A	Spring Seat Lower	1104-N0101-01-14	1	Machine	T2/T3 CNC Turning, MSMC	S-Steel-440C, Bar	CNC Operator	CNC Turning, MC	450	0.25	1.5	1	0.0002	$4.56	$35.70	$45.00	$67.50	$0.00	$0.02	$0.15	$0.17	0.50%	6.50%	6.00%	1.00%	14.00%	$0.02	$0.19	$0.19		
7A	Needle valve	1104-N0101-01-24	1	Centerless Grind	T2/T3 CNC Turning, MSMC	Not Applicable	CNC Operator	CNC Turning, MC	540	0.25	1.5	1	0.000	$0.00	$35.70	$45.00	$67.50	$0.00	$0.02	$0.13	$0.14	0.50%	6.50%	6.00%	1.00%	14.00%	$0.02	$0.16	$0.16		
Purchase Part - Low Impact Item (Partial Cost Mapping = Processed Raw Material Estimate + Actual Component Assembly Process)																															
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Solenoid Windings	1104-N0101-01-22	1		S																					$0.00	$0.25	$0.00	$0.25		
2A	Ring winding locator	1104-N0101-01-26	1		S																					$0.00	$0.08	$0.00	$0.08		
3A	Spring - needle to metering valve	1104-N0101-01-15	1		S																					$0.00	$0.01	$0.00	$0.01		
4A	Spring Needle Return	1104-N0101-01-12	1		S																					$0.00	$0.03	$0.00	$0.03		
5A	Sleeve Screen Stop	1104-N0101-01-25	1		S																					$0.00	$0.01	$0.00	$0.01		
6A	Screen Fuel Inlet	1104-N0101-01-6	1		S																					$0.00	$0.05	$0.00	$0.05		
7A	circlip face seal retainer	1104-N0101-01-5	1		S																					$0.00	$0.02	$0.00	$0.02		
8A	Compression limiter - oring	1104-N0101-01-3	1		S																					$0.00	$0.03	$0.00	$0.03		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
																		Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$10.95		
																	T1 or OEM Total Manufacturing Cost:	$2.16	$1.47	$6.44	$10.07	$0.03	$0.41	$0.38	$0.06	$0.89	→		$10.95		
																	T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.70%	7.00%	8.00%	4.00%	19.70%					
																	(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.08	$0.77	$0.88	$0.44	$2.16					
																	Base Cost Impact to Vehicle:	$2.16	$1.47	$6.44	$10.07	$0.11	$1.18	$1.26	$0.50	$3.05	→		$13.11	$0	$0
																												Packaging Cost:	$0.01		
																												Net Cost Impact to Vehicle:	$13.13		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

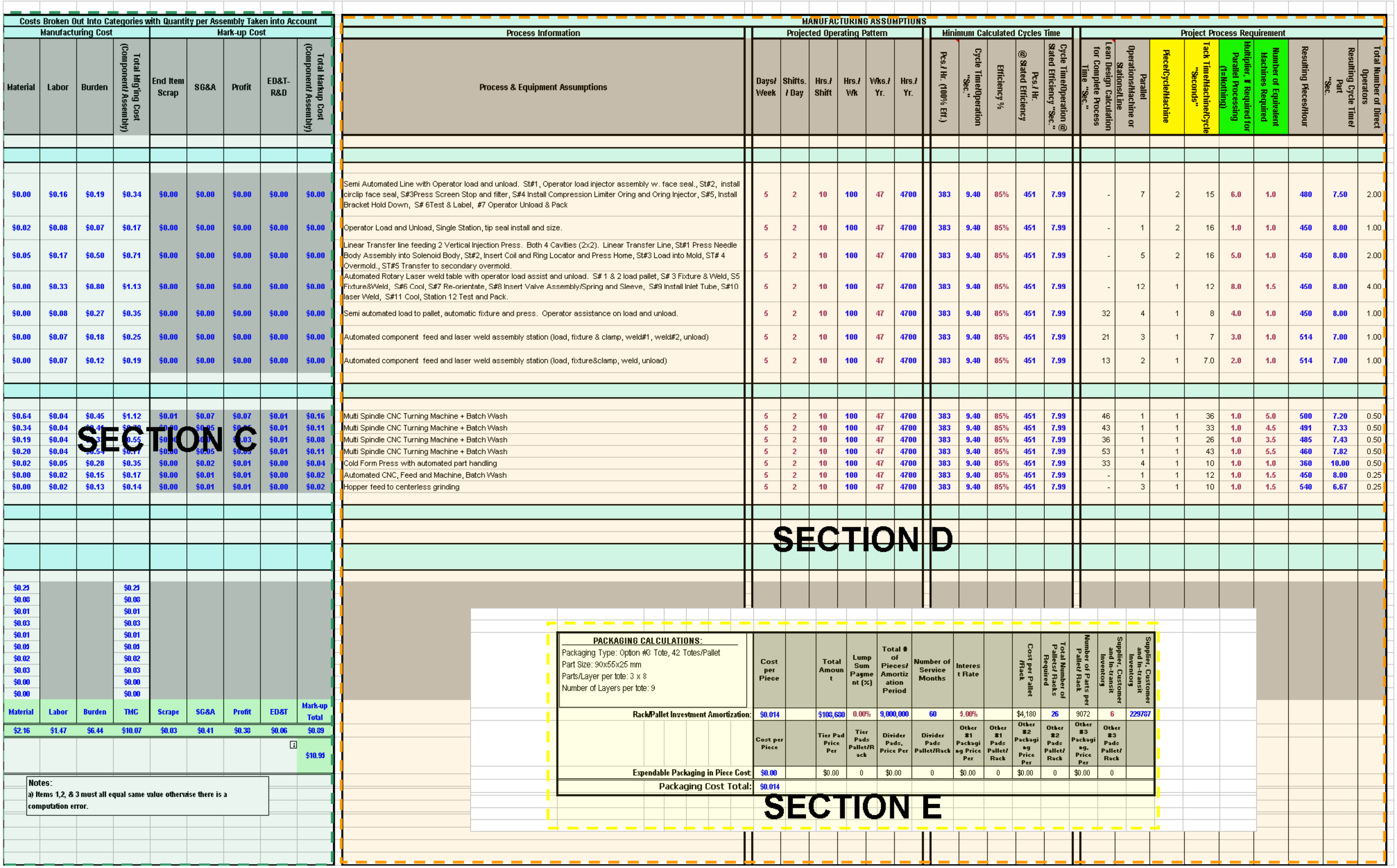
"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

SECTION B

SECTION F

APPENDIX F.1 MAQS Worksheet Task Reference Guide



Costs Broken Out Into Categories with Quantity per Assembly Taken into Account

Manufacturing Cost				Mark-up Cost				
Material	Labor	Burden	Total Mfg'ing Cost (Component/ Assembly)	End Item Scrap	SG&A	Profit	ED&T- R&D	Total Markup Cost (Component/ Assembly)
$0.00	$0.16	$0.19	$0.34	$0.00	$0.00	$0.00	$0.00	$0.00
$0.02	$0.08	$0.07	$0.17	$0.00	$0.00	$0.00	$0.00	$0.00
$0.05	$0.17	$0.50	$0.71	$0.00	$0.00	$0.00	$0.00	$0.00
$0.00	$0.33	$0.80	$1.13	$0.00	$0.00	$0.00	$0.00	$0.00
$0.00	$0.08	$0.27	$0.35	$0.00	$0.00	$0.00	$0.00	$0.00
$0.00	$0.07	$0.18	$0.25	$0.00	$0.00	$0.00	$0.00	$0.00
$0.00	$0.07	$0.12	$0.19	$0.00	$0.00	$0.00	$0.00	$0.00
$0.64	$0.04	$0.45	$1.12	$0.01	$0.07	$0.07	$0.01	$0.16
$0.34	$0.04	$0.41	$0.79	$0.00	$0.05	$0.05	$0.01	$0.11
$0.19	$0.04	[illegible]	$0.55	[illegible]	[illegible]	$0.03	$0.01	$0.08
$0.20	$0.04	$0.54	$0.77	$0.00	$0.05	[illegible]	$0.01	$0.11
$0.02	$0.05	$0.28	$0.35	$0.00	$0.02	$0.01	$0.00	$0.04
$0.00	$0.02	$0.15	$0.17	$0.00	$0.01	$0.01	$0.00	$0.02
$0.00	$0.02	$0.13	$0.14	$0.00	$0.01	$0.01	$0.00	$0.02
$0.25			$0.25					
$0.08			$0.08					
$0.01			$0.01					
$0.03			$0.03					
$0.01			$0.01					
$0.05			$0.05					
$0.02			$0.02					
$0.03			$0.03					
$0.00			$0.00					
$0.00			$0.00					
Material	Labor	Burden	TMC	Scrape	SG&A	Profit	ED&T	Mark-up Total
$2.16	$1.47	$6.44	$10.07	$0.03	$0.41	$0.38	$0.06	$0.89
								$10.95

Notes:
a) Items 1,2, & 3 must all equal same value otherwise there is a computation error.

SECTION C

MANUFACTURING ASSUMPTIONS

Process Information	Projected Operating Pattern						Minimum Calculated Cycles Time					Project Process Requirement								
Process & Equipment Assumptions	Days/ Week	Shifts. / Day	Hrs./ Shift	Hrs./ Wk	Wks./ Yr.	Hrs./ Yr.	Pcs./ Hr. (100% Eff.)	Cycle Time/Operation "Sec."	Efficiency %	Pcs./ Hr. @ Stated Efficiency	Cycle Time/Operation @ Stated Efficiency "Sec."	Lean Design Calculation for Complete Process Time "Sec."	Parallel Operations/Machine or Stations/Line	Piece/Cycle/Machine	Tack Time/Machine/Cycle "Seconds"	Multiplier, # Required for Parallel Processing (1=Nothing)	Number of Equivalent Machines Required	Resulting Pieces/Hour	Resulting Cycle Time/ Part "Sec.	Total Number of Direct Operators
Semi Automated Line with Operator load and unload. St#1, Operator load injector assembly w. face seal., St#2, install circlip face seal, S#3Press Screen Stop and filter, S#4 Install Compression Limiter Oring and Oring Injector, S#5, Install Bracket Hold Down, S# 6Test & Label, #7 Operator Unload & Pack	5	2	10	100	47	4700	383	9.40	85%	451	7.99	-	7	2	15	6.0	1.0	480	7.50	2.00
Operator Load and Unload, Single Station, tip seal install and size.	5	2	10	100	47	4700	383	9.40	85%	451	7.99	-	1	2	16	1.0	1.0	450	8.00	1.00
Linear Transfer line feeding 2 Vertical Injection Press. Both 4 Cavities (2x2). Linear Transfer Line, St#1 Press Needle Body Assembly into Solenoid Body, St#2, Insert Coil and Ring Locator and Press Home, St#3 Load into Mold, ST# 4 Overmold., ST#5 Transfer to secondary overmold.	5	2	10	100	47	4700	383	9.40	85%	451	7.99	-	5	2	16	5.0	1.0	450	8.00	2.00
Automated Rotary Laser weld table with operator load assist and unload. S# 1 & 2 load pallet, S# 3 Fixture & Weld, S5 Fixture&Weld, S#6 Cool, S#7 Re-orientate, S#8 Insert Valve Assembly/Spring and Sleeve, S#9 Install Inlet Tube, S#10 laser Weld, S#11 Cool, Station 12 Test and Pack.	5	2	10	100	47	4700	383	9.40	85%	451	7.99	-	12	1	12	8.0	1.5	450	8.00	4.00
Semi automated load to pallet, automatic fixture and press. Operator assistance on load and unload.	5	2	10	100	47	4700	383	9.40	85%	451	7.99	32	4	1	8	4.0	1.0	450	8.00	1.00
Automated component feed and laser weld assembly station (load, fixture & clamp, weld#1, weld#2, unload)	5	2	10	100	47	4700	383	9.40	85%	451	7.99	21	3	1	7	3.0	1.0	514	7.00	1.00
Automated component feed and laser weld assembly station (load, fixture&clamp, weld, unload)	5	2	10	100	47	4700	383	9.40	85%	451	7.99	13	2	1	7.0	2.0	1.0	514	7.00	1.00
Multi Spindle CNC Turning Machine + Batch Wash	5	2	10	100	47	4700	383	9.40	85%	451	7.99	46	1	1	36	1.0	5.0	500	7.20	0.50
Multi Spindle CNC Turning Machine + Batch Wash	5	2	10	100	47	4700	383	9.40	85%	451	7.99	43	1	1	33	1.0	4.5	491	7.33	0.50
Multi Spindle CNC Turning Machine + Batch Wash	5	2	10	100	47	4700	383	9.40	85%	451	7.99	36	1	1	26	1.0	3.5	485	7.43	0.50
Multi Spindle CNC Turning Machine + Batch Wash	5	2	10	100	47	4700	383	9.40	85%	451	7.99	53	1	1	43	1.0	5.5	460	7.82	0.50
Cold Form Press with automated part handling	5	2	10	100	47	4700	383	9.40	85%	451	7.99	33	4	1	10	1.0	1.0	360	10.00	0.50
Automated CNC, Feed and Machine, Batch Wash	5	2	10	100	47	4700	383	9.40	85%	451	7.99	-	1	1	12	1.0	1.5	450	8.00	0.25
Hopper feed to centerless grinding	5	2	10	100	47	4700	383	9.40	85%	451	7.99	-	3	1	10	1.0	1.5	540	6.67	0.25

SECTION D

PACKAGING CALCULATIONS:

Packaging Type: Option #3 Tote, 42 Totes/Pallet
Part Size: 90x55x25 mm
Parts/Layer per tote: 3 x 8
Number of Layers per tote: 9

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces/ Amortization Period	Number of Service Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory	Supplier, Customer and In-transit Inventory
Rack/Pallet Investment Amortization:	$0.014		$106,680	0.00%	9,000,000	60	5.00%		$4,180	26	9072	6	229787
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/ Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/ Rack	Other #3 Packaging. Price Per	Other #3 Pads Pallet/ Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.014												

SECTION E

APPENDIX G.1
MAQS Worksheets (Worksheet Sections A,B,E and F)
Case Study #0101

Engine Subsystems	MAQS Worksheets Location within Appendix G.1	Net Incremental Component/Assembly Cost Impact to OEM
Engine Frames, Mountings & Brackets Subsystem	Not Applicable	$0.00
Crank Drive Subsystem	Appendix G.1 - 03, Pages 1-7	$0.00
Counter Balance Subsystem	Appendix G.1 - 04, Pages 1-4	($35.95)
Cylinder Block Subsystem	Appendix G.1 - 05, Pages 1-8	$0.44
Cylinder Head Subsystem	Appendix G.1 - 06, Pages 1-8	$16.55
Valve Train Subsystem	Appendix G.1 - 07, Pages 1-4	$10.06
Timing Drive Subsystem	Appendix G.1 - 08, Pages 1-2	$1.60
Accessory Drive Subsystem	Not Applicable	$0.00
Intake Subsystem	Appendix G.1 - 10, Pages 1-2	($12.73)
Fuel Induction Subsystem	Appendix G.1 - 11, Pages 1-12	$107.32
Exhaust Subsystem	Appendix G.1 - 12, Pages 1-6	$37.77
Lubrication (Oil Pans/Sumps) Subsystem	Appendix G.1 - 13, Pages 1-11	$34.46
Cooling Subsystem	Appendix G.1 - 14, Pages 1-9	$41.56
Induction Air Charging Subsystem	Appendix G.1 - 15, Pages 1-16	$258.89
Exhaust Gas Re-Circulations Subsystem	Not Applicable	$0.00
Breather Subsystem	Appendix G.1 - 17, Pages 1-2	$4.17
Engine Management, Engine Electronic and Electrical Subsystem	Appendix G.1 - 60, Pages 1-5	$56.61
Accessory (e.g. Starter Motor, Power Steering Pump, Air Conditioning Compressor) Subsystem	Appendix G.1 - 70, Pages 1-4	$16.95
	Total Unit Cost =>	$537.70

Appendix G.1 - Subsystem 03
Crank Drive Subsystem
Case Study #0101
MAQS Worksheets

Crankshaft 0301

Manufacturing Assumption and Quote Summary

APPENDIX G.1-03 (1of4)
Print Date:9/1/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Shaft - Crank **Part Number:** 0301-N0101-01
Component Quote Level: **Full Quote** ☐ **Modification Quote** ☒

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: TBD

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
	Shaft - Crank (Mini Cooper)	0301-N0101-01	1	Considered for Weight Delta Only, Assume Fabrication and Machining times a wash between Mini and Chrysler Crankshaft	OEM	MA-Steel-MnVS, Bar	Not Applicable	Not Applicable	116	0	25.28	$0.73	$0.00	$0.00	$18.45	$0.00	$0.00	$18.45	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$18.45	$18.45		
	Shaft - Crank (Chrysler Gema)	0301-B0101-01	1	"See Note Above"	OEM	MA-Steel-MnVS, Bar	Not Applicable	Not Applicable	116	0	-39.81	$0.73	$0.00	$0.00	-$29.06	$0.00	$0.00	-$29.06	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	-$29.06	-$29.06		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	-$10.61		
														T1 or OEM Total Manufacturing Cost:	-$10.61	$0.00	$0.00	-$10.61	$0.00	$0.00	$0.00	$0.00	$0.00		3	-$10.61		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.70%	7.00%	8.00%	0.00%	15.70%					
														(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	-$0.07	-$0.74	-$0.85	$0.00	-$1.67					
														Base Cost Impact to Vehicle:	-$10.61	$0.00	$0.00	-$10.61	-$0.07	-$0.74	-$0.85	$0.00	-$1.67			-$12.27	$0	$0
																									Packaging Cost:	$0.00		
																									Net Cost Impact to Vehicle:	-$12.27		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

PACKAGING CALCULATIONS:

Assume No Impact to Packaging

Con.Rod0303

Manufacturing Assumption and Quote Summary

APPENDIX G.1-03, (2of4)
Print Date:9/1/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Rod Subassembly - Connecting **Part Number:** 0303-N0101-01
Component Quote Level: **Full Quote** ☐ **Modification Quote** ☒

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 4
Annual Component Volume: 1,800,000
Weekly Component Volume: 38,298
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Rod Subassembly - Connecting	0303-N0101-01-01	1	Weight Cost Differential Only, Fabrication and Machining are equivalent between Mini & Chrysler Con. Rods. Mini-Cooper Rod L/R = 138.5/(85.9/2) = 3.22	S	MA-Steel-C70S6, Bar	Not Applicable	Not Applicable	450	0	0.964	$0.70	$0.00	$0.00	$0.67	$0.00	$0.00	$0.67	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.67	$0.67		
1B	Rod Subassembly - Connecting	0303-N0101-01	1	Install Bushing & Size	S	Not Applicable	General Assembly	Mech. Assembly, MC	450	0	0.000	$0.00	$35.51	$125.19	$0.00	$0.00	$0.28	$0.28	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.28	$0.28		
2A	Rod Subassembly - Connecting	0303-B0101-01&02	1	Chrysler GEMA Rod Weight		MA-Steel-C70S6, Bar	Not Applicable	Not Applicable	450	0	-0.979	$0.70	$0.00	$0.00	-$0.69	$0.00	$0.00	-$0.69	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	-$0.69	-$0.69		
2B	Rod Subassembly - Connecting	0303-B0101-01&02-M	1	Additional Material Required to Equalize L/R Ratio GEMA Prod. L/R = 2.96, R = 97/2 = 48.5 & L =143.75mm Assuming Mini L/R (3.22). Hold stroke constant L=3.22*48.5= 156.17mm Therefore rod length would increase by 12.42mm		MA-Steel-C70S6, Bar	Not Applicable	Not Applicable	450	0	-0.032	$0.70	$0.00	$0.00	-$0.02	$0.00	$0.00	-$0.02	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	-$0.02	-$0.02		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
	Bushing - Connecting Rod	0303-N0101-02	1	Aluminum Bronze	S																		$0.00	$0.33	$0.00	$0.33		
			0	(Blank 40x30x0.5 mmm)																			$0.00	$0.00	$0.00	$0.00		
			0	Mean ρ = 0.270																			$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$0.58		
T1 or OEM Total Manufacturing Cost:	$0.30	$0.00	$0.28	$0.58	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$0.58		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.50%	6.50%	6.00%	2.50%	15.50%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.00	$0.04	$0.03	$0.01	$0.09					
Base Cost Impact to Vehicle:	$0.30	$0.00	$0.28	$0.58	$0.00	$0.04	$0.03	$0.01	$0.09	→		$0.67	$0	$0
											Packaging Cost:	$0.00		
											Net Cost Impact to Vehicle:	$0.67		

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Rod Subassembly - Connecting **Part Number:** 0303-N0101-01
Component Quote Level: Full Quote ☐ Modification Quote ☒

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 4
Annual Component Volume: 1,800,000
Weekly Component Volume: 38,298
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	18,000,000	60	5.00%		$0	229787	1	6	229787
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$1.00	0	$3.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

PACKAGING CALCULATIONS:

No Change Required For Packaging.

Manufacturing Assumption and Quote Summary

APPENDIX G.1-03, (3of4)

Print Date:9/1/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Piston - Engine, Machined
Part Number: 0304-N0101-01
Component Quote Level: ☐ Full Quote ☐ Modification Quote ☑ Differential Quote (Quote Summary includes costing for both Technology Packages)

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 4
Annual Component Volume: 1,800,000
Weekly Component Volume: 38,298
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 Moderate Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
1A	Piston - Engine, Cast (Mini Cooper)	0304-N0101-01-01	1	Consider weight, material and scrap (+5%) differences in cast hypereutectic material.	T2/T3 Internal Supplier	Aluminum-B390, Cast	Mold/Cast/Sinter Operator	Diecast, LMC	517	3	3	1	0.651	$1.20	$43.52	$100.05	$300.15	$0.78	$0.25	$0.58	$1.61	5.00%	0.00%	0.00%	0.00%	5.00%	$0.08	$1.70	$1.70		
1B	Piston - Engine, Machined (Mini Cooper)	0304-N0101-01-01	1	T6 Heat Treat	T2/T3 Internal Supplier	Not Applicable	Heat Treat Operator	Heat Treat, SMS, MHC	442	2	4	1	0.000	$0.00	$46.52	$100.00	$400.00	$0.00	$0.21	$0.90	$1.12	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.12	$1.12		
1C	Piston - Engine, Machined (Mini Cooper)	0304-N0101-01	1	Machining (5% Premium on Time Accounted for in rate)	T2/T3 Internal Supplier	Not Applicable	CNC Operator	Rot./Lin. Trans. Machining Line, TP, PREM.	480	1	2	1.05	0.000	$0.00	$35.70	$260.00	$546.00	$0.00	$0.07	$1.14	$1.21	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.21	$1.21		
2A	Piston - Engine, Machined (Chrysler GEMA))	0304-B0101-01-01	1	Consider weight and material differences only as cost factor in primary fabrication process.	T2/T3 Internal Supplier	Aluminum-384, Cast	Mold/Cast/Sinter Operator	Diecast, LMC	-514	3	3	1	-0.764	$1.14	$43.52	$100.05	$300.15	-$0.87	-$0.25	-$0.58	-$1.71	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	-$1.71	-$1.71		
2B	Piston - Engine, Machined (Chrysler GEMA))	0304-B0101-01-01	1	T5 Heat Treat	T2/T3 Internal Supplier	Not Applicable	Heat Treat Operator	Heat Treat, SMS, LMC	-420	1	2	1	0.000	$0.00	$46.52	$50.00	$100.00	$0.00	-$0.11	-$0.24	-$0.35	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	-$0.35	-$0.35		
2C	Piston - Engine, Machined (Chrysler GEMA))	0304-B0101-01-01	1	Machining	T2/T3 Internal Supplier	Not Applicable	CNC Operator	Rot./Lin. Trans. Machining Line, TP	-480	1	2	1	0.000	$0.00	$35.70	$250.00	$500.00	$0.00	-$0.07	-$1.04	-$1.12	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	-$1.12	-$1.12		
									#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
									#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
									#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		

Note, both the Mini and Chrysler GEMA pistons have anodized top ring groove and a dry-film skirt coating.

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up			
										1	$0.85		
T1 or OEM Total Manufacturing Cost:	-$0.09	$0.10	$0.76	$0.77	$0.08	$0.00	$0.00	$0.00	$0.08	→ 3	$0.85		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.50%	6.50%	6.00%	2.50%	15.50%				
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.00	$0.06	$0.05	$0.02	$0.13				
Base Cost Impact to Vehicle:	-$0.09	$0.10	$0.76	$0.77	$0.08	$0.06	$0.05	$0.02	$0.21	→	$0.98	$0	$0

Packaging Cost: $0.00
Net Cost Impact to Vehicle: $0.98

Manufacturing Assumption and Quote Summary

APPENDIX G.1-03, (3of4)

Print Date:9/1/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Piston - Engine, Machined
Part Number: 0304-N0101-01
Component Quote Level: ☐ Full Quote ☐ Modification Quote ☑ Differential Quote (Quote Summary includes costing for both Technology Packages)

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 4
Annual Component Volume: 1,800,000
Weekly Component Volume: 38,298
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 Moderate Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"

PACKAGING CALCULATIONS:
Packaging Type: NO CHANGE TO PACKAGING
Part Size:
Parts/Layer:
Number of Layers:

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	18,000,000	60	5.00%		$0	250	1	6	229787
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Manufacturing Assumption and Quote Summary

APPENDIX G.1-03 (4of4)
Print Date:9/1/2009

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Engine Assembly of Crank Drive Subsystem Components **Part Number:** 0300-N0101-01
Component Quote Level: ☐ Full Quote ☐ Modification Quote ☑ Differential Quote (Quote Summary includes costing for both Technology Packages)

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: OEM Engine Assembly
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
	No impact to engine assembly. Assume wrist pin retaining clip labor/burden add would be offset by labor/burden press fit pin design.		0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Shaft - Crank	0301-N0101-01	1	(OEM Mark-up included in Crankshaft Worksheet)																						$0.00	$0.00	$0.00	$0.00		
2A	Rod Subassembly - Connecting	0303-N0101-01	4		SAC																					$2.66	$0.67	$0.00	$2.66		
3A	Piston - Engine, Machined	0304-N0101-01	4		SAC																					$3.92	$0.98	$0.00	$3.92		
4A	Ring/Clip - Piston Pin Retainer	0304-N0101-02	8		S																					$0.00	$0.03	$0.00	$0.24		
5A	Pin- Piston	0304-N0101-03	4	GEMA 15Cr3(SAE5015) Case Hardened Mini 31CrMoV9 Nitrided	S																					$0.00	$0.24	$0.00	$0.96		
6A	Compression Ring - Piston, Top	0304-N0101-04	4		S																					$0.00	$0.35	$0.00	$1.42		
7A	Compression Ring - Piston, 2nd	0304-N0101-05	4		S																					$0.00	$0.17	$0.00	$0.66		
8A	Spacer/Expander/Coil Spring - Oil Ring, Piston	0304-N0101-07	4		S																					$0.00	$0.17	$0.00	$0.68		
9A	Rail(s) - Oil Ring, Piston	0304-N0101-08	4		S																					$0.00	$0.06	$0.00	$0.22		
10A	Bearing - Connecting Rod to Crank Shaft	0390-N0101-01	8	AlSn20Mn Base, AlSn10Ni Turbo DI	S																					$0.00	$0.19	$0.00	$1.51		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
																		Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$12.27		
																	T1 or OEM Total Manufacturing Cost:	$12.27	$0.00	$0.00	$12.27	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$12.27		
																	T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%					
																	(SAC) &T1 or OEM Mark-Up Values:	(6.58)	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00					
																	Base Cost Impact to Vehicle:	$5.69	$0.00	$0.00	$5.69	$0.00	$0.00	$0.00	$0.00	$0.00	→		$5.69	$0	$0
																												Packaging Cost:	$0.00		
																												Net Cost Impact to Vehicle:	$5.69		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

PACKAGING CALCULATIONS:
Packaging Type: **No Changes Required to Packaging**
Part Size:
Parts/Layer:
Number of Layers:

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	250	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Appendix G.1 - Subsystem 04
Counter Balance Subsystem
Case Study #0101
MAQS Worksheets

Balance Shaft Subassembly 0401

Manufacturing Assumption and Quote Summary

APPENDIX G.1-04, (1of2)
Print Date:9/1/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Chrysler GEMA, 2.4L I4, 16V DOHC, NA, dVVT, 173hp
Component Description: Balance Shaft Assembly (Part of Oil Pump Assembly)
Part Number: 0401-B0101-01
Component Quote Level: ☑ Full Quote ☐ Modification Quote ☐ Differential Quote (Quote Summary includes costing for both Technology Packages)

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 Moderate Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Returnable Dunnage

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION				
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)								
1A	Upper and Lower Housing assembly Machining	0401-B0101-11-01	1	Assemble upper and lower housings, machine bearings.	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, LC, Base
2A	Balance Shaft Long and Short	0401-B0101-06/07	2	Press Gears onto balance shafts. (1 of each shaft type)	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, LC, Base
3A	Final Assembly of Balance Shaft Assembly	0401-B0101-01	1	Assemble Shafts into Houisng and rundown fasteners.	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, LC, Base
Purchase Part - High Impact Item (Full Cost Mapping)								
1A	Bottom Housing Casting	0401-B0101-03-1-1	1	Casting	T2/T3 Diecast, MSMC	Aluminum-A380, Cast	Mold/Cast/Sinter Operator	Diecast, LMC
1B	Bottom Housing Casting	0401-B0101-03-1	1	Machine Casting	T2/T3 Diecast, MSMC	Not Applicable	CNC Operator	CNC Machining, LMC
2A	Top Housing Balance Shaft Casting	0401-B0101-08-1-1	1	Casting	T2/T3 Diecast, MSMC	Aluminum-A380, Cast	Mold/Cast/Sinter Operator	Diecast, LMC
2B	Top Housing Balance Shaft	0401-B0101-08-1	1	Machine Casting	T2/T3 Diecast, MSMC	Not Applicable	CNC Operator	CNC Machining, LMC
3A	Balance Shaft Short Casting	0401-B0101-06-1-1-1	1	Casting	T2/T3 Diecast, MSMC	Nodular Iron, Cast	Mold/Cast/Sinter Operator	Perm. Cast, LMC
3B	Balance Shaft Short Casting	0401-B0101-06-1-1-1	1	Heat Treating	T2/T3 Heat Treat, MSMC	Not Applicable	Heat Treat Operator	Heat Treat, MLS, LMC
3C	Balance Shaft Short Machined	0401-B0101-06-1-1	1	Machine	T2/T3 CNC Turning, MSMC	Not Applicable	CNC Operator	CNC Turning, HC
3D	Balance Shaft Short Machined	0401-B0101-06-1-1	1	Grind	T2/T3 CNC Turning, MSMC	Not Applicable	CNC Operator	Grinding, SMS, MHC
3E	Balance Shaft Short Machined	0401-B0101-06	1	Balance	T2/T3 CNC Turning, MSMC	Not Applicable	CNC Operator	Balancing, MLS, LMC
4A	Balance Shaft Short Casting	0401-B0101-07-1-1-1	1	Casting	T2/T3 Diecast, MSMC	Nodular Iron, Cast	Mold/Cast/Sinter Operator	Perm. Cast, LMC
4B	Balance Shaft Short Casting	0401-B0101-07-1-1-1	1	Heat Treating	T2/T3 Heat Treat, MSMC	Not Applicable	Heat Treat Operator	Heat Treat, MLS, LMC
4C	Balance Shaft Short Machined	0401-B0101-07-1-1	1	Machine	T2/T3 CNC Turning, MSMC	Not Applicable	CNC Operator	CNC Turning, HC
4D	Balance Shaft Short Machined	0401-B0101-07-1-1	1	Grind	T2/T3 CNC Turning, MSMC	Not Applicable	CNC Operator	Grinding, SMS, MHC
4E	Balance Shaft Short Machined	0401-B0101-07	1	Balance	T2/T3 CNC Turning, MSMC	Not Applicable	CNC Operator	Balancing, MLS, LMC
5A	Gear Balance Shaft	0401-B0101-06-2-1	2	Machine Blank & Hob Teeth (Same process for both Gears)	T2/T3 CNC Turning, MSMC	LC-Steel-1215, Bar	CNC Operator	Balancing, MLS, LMC
5B	Gear Balance Shaft	0401-B0101-06-2-1	2	Heat Treating	T2/T3 Heat Treat, MSMC	Not Applicable	Heat Treat Operator	Heat Treat, SMS, LMC
Purchase Part - Commodity (Value taken from Purchase Part Database)								
1A	Dowel Upper to lower housing alignment	0401-B0101-04	2		S			
2A	Bearing Shell Balance Shaft	0401-B0101-05	4		S			
3A	Bolt Balance Shaft Housing	0401-B0101-09	6		S			
4A	Cap Shaft Close out	0401-B0101-10	2		S			
			0					
			0					
			0					
			0					
			0					
			0					
			0					
			0					

	MANUFACTURING RATES									MANUFACTURING COSTS			
Reference #	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Mutiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)													
1A	240	2	1	8	0.000	$0.00	$35.51	$15.00	$120.00	$0.00	$0.30	$0.50	$0.80
2A	240	1	2	1	0.000	$0.00	$35.51	$15.00	$30.00	$0.00	$0.15	$0.13	$0.27
3A	240	4	1	5	0.000	$0.00	$35.51	$15.00	$75.00	$0.00	$0.59	$0.31	$0.90
Purchase Part - High Impact Item (Full Cost Mapping)													
1A	112	1	1	1	2.351	$1.10	$43.52	$100.05	$100.05	$2.59	$0.39	$0.89	$3.87
1B	115	1	1.5	1	0.000	$0.00	$35.70	$25.00	$37.50	$0.00	$0.31	$0.33	$0.64
2A	111	1	1	1	2.609	$1.10	$43.52	$100.05	$100.05	$2.87	$0.39	$0.90	$4.17
2B	114	1	2	1	0.000	$0.00	$35.70	$25.00	$50.00	$0.00	$0.31	$0.44	$0.75
3A	242	3	1	1	1.721	$0.35	$43.52	$100.06	$100.06	$0.60	$0.54	$0.41	$1.56
3B	242	1	1	1	0.000	$0.00	$46.52	$100.00	$100.00	$0.00	$0.19	$0.41	$0.61
3C	113	0.5	1.5	1	0.000	$0.00	$35.70	$75.00	$112.50	$0.00	$0.16	$1.00	$1.16
3D	132	0.5	1.25	1	0.000	$0.00	$35.70	$65.00	$81.25	$0.00	$0.13	$0.61	$0.75
3E	120	0.5	1	1	0.000	$0.00	$35.70	$25.00	$25.00	$0.00	$0.15	$0.21	$0.36
4A	226	3	1	1	2.242	$0.35	$43.52	$100.06	$100.06	$0.78	$0.58	$0.44	$1.80
4B	242	1	1	1	0.000	$0.00	$46.52	$100.00	$100.00	$0.00	$0.19	$0.41	$0.61
4C	114	0.5	2.25	1	0.000	$0.00	$35.70	$75.00	$168.75	$0.00	$0.16	$1.48	$1.64
4D	142	0.5	1.3	1	0.000	$0.00	$35.70	$65.00	$84.50	$0.00	$0.13	$0.60	$0.72
4E	120	0.5	1	1	0.000	$0.00	$35.70	$25.00	$25.00	$0.00	$0.15	$0.21	$0.36
5A	235	2	4.5	1	0.000	$0.62	$35.70	$25.00	$112.50	$0.00	$0.30	$0.48	$0.78
5B	360	1	1	1	0.000	$0.00	$46.52	$50.00	$50.00	$0.00	$0.13	$0.14	$0.27

	MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)										
1A	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.80	$0.80		
2A	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.27	$0.55		
3A	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.90	$0.90		
Purchase Part - High Impact Item (Full Cost Mapping)										
1A	5.00%	6.50%	6.00%	1.00%	18.50%	$0.72	$4.58	$4.58		
1B	5.00%	6.50%	6.00%	1.00%	18.50%	$0.12	$0.75	$0.75		
2A	5.00%	6.50%	6.00%	1.00%	18.50%	$0.77	$4.94	$4.94		
2B	5.00%	6.50%	6.00%	1.00%	18.50%	$0.14	$0.89	$0.89		
3A	5.00%	6.50%	6.00%	1.00%	18.50%	$0.29	$1.84	$1.84		
3B	0.50%	6.50%	6.00%	1.00%	14.00%	$0.08	$0.69	$0.69		
3C	0.50%	6.50%	6.00%	1.00%	14.00%	$0.16	$1.32	$1.32		
3D	0.50%	6.50%	6.00%	1.00%	14.00%	$0.10	$0.85	$0.85		
3E	0.50%	6.50%	6.00%	1.00%	14.00%	$0.05	$0.41	$0.41		
4A	5.00%	6.50%	6.00%	1.00%	18.50%	$0.33	$2.14	$2.14		
4B	0.50%	6.50%	6.00%	1.00%	14.00%	$0.08	$0.69	$0.69		
4C	0.50%	6.50%	6.00%	1.00%	14.00%	$0.23	$1.86	$1.86		
4D	0.50%	6.50%	6.00%	1.00%	14.00%	$0.10	$0.82	$0.82		
4E	0.50%	6.50%	6.00%	1.00%	14.00%	$0.05	$0.41	$0.41		
5A	0.50%	6.50%	6.00%	1.00%	14.00%	$0.11	$0.89	$1.79		
5B	0.50%	6.50%	6.00%	1.00%	14.00%	$0.04	$0.31	$0.61		
Purchase Part - Commodity (Value taken from Purchase Part Database)					Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A					$0.00	$0.03	$0.00	$0.05		
2A					$0.00	$0.25	$0.00	$1.00		
3A					$0.00	$0.06	$0.00	$0.36		
4A					$0.00	$0.14	$0.00	$0.28		
					$0.00	$0.00	$0.00	$0.00		
					$0.00	$0.00	$0.00	$0.00		
					$0.00	$0.00	$0.00	$0.00		
					$0.00	$0.00	$0.00	$0.00		
					$0.00	$0.00	$0.00	$0.00		
					$0.00	$0.00	$0.00	$0.00		
					$0.00	$0.00	$0.00	$0.00		
					$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up					
											1	$28.54		
T1 or OEM Total Manufacturing Cost:	$8.53	$5.83	$10.65	$25.01	$0.68	$1.37	$1.26	$0.21	$3.53	→	3	$28.54		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.50%	6.50%	6.00%	2.50%	15.50%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.14	$1.85	$1.71	$0.71	$4.42					
Base Cost Impact to Vehicle:	$8.53	$5.83	$10.65	$25.01	$0.82	$3.22	$2.98	$0.92	$7.95	→		$32.96	$0	$0
											Packaging Cost:	$0.05		
											Net Cost Impact to Vehicle:	$33.01		

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Chrysler GEMA, 2.4L I4, 16V DOHC, NA, dVVT, 173hp
Component Description: Balance Shaft Assembly (Part of Oil Pump Assembly) **Part Number:** 0401-B0101-01
Component Quote Level: ☑ Full Quote ☐ Modification Quote ☐ Differential Quote (Quote Summary includes costing for both Technology Packages)

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 Moderate Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Returnable Dunnage

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Mutiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"

PACKAGING CALCULATIONS:
Consider additional volume as result of Balance Shaft subassembly:
Packaging Type: Option #2
Part Size: 190x220 x120
Parts/Layer: 5 x 5
Number of Layers:7

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
n:	$0.053		$105,000	0.00%	2,250,000	60	5.00%		$420	250	175	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.053												

Engine Assembly 04

Manufacturing Assumption and Quote Summary

APPENDIX G.1-04, (2of2)

Print Date:9/1/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Engine Assembly of Balance Shaft Assembly **Part Number:**
Component Quote Level: ☑ Full Quote ☐ Modification Quote ☐ Differential Quote (Quote Summary includes costing for both Technology Packages)

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: OEM Engine Assembly
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Mutiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
	Mount Balance Shaft Assembly to Engine	0401-B0101-01	1	Install Balance Shaft Assembly to block, 4 Bolts.	OEM Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly-OEM	Engine Assembly, OEM	212	1	1	1	0.000	$0.00	$83.31	$150.21	$150.21	$0.00	$0.39	$0.71	$1.10	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.10	$1.10		
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Bolt - Balance Shaft Assembly Mount to Block	PC 12.9	4	(Packaging Included in Cost)	S																					$0.00	$0.46	$0.00	$1.83		
2A	Balance Shaft Assembly (Part of Oil Pump Assembly)	0401-B0101-01	1		SAC																					$33.01	$33.01	$0.00	$33.01		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
																		Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$35.95		
																	T1 or OEM Total Manufacturing Cost:	$34.84	$0.39	$0.71	$35.95	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$35.95		
																	T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%					
																	(SAC) &T1 or OEM Mark-Up Values:	(33.01)	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00					
																	Base Cost Impact to Vehicle:	$1.83	$0.39	$0.71	$2.93	$0.00	$0.00	$0.00	$0.00	$0.00	→		$2.93	$0	$0
																												Packaging Cost:	$0.00		
																												Net Cost Impact to Vehicle:	$2.93		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

PACKAGING CALCULATIONS:
Packaging Type:
Part Size:
Parts/Layer:
Number of Layers:

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	250	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Appendix G.1 - Subsystem 05
Cylinder Block Subsystem
Case Study #0101
MAQS Worksheets

Manufacturing Assumption and Quote Summary

APPENDIX G.1-05, (1of5)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Cylinder Block Assembly - Machined w. Studs, Plugs, etc. **Part Number:** 0501-N0101-01
Component Quote Level: **Full Quote** ☐ **Modification Quote** ☒

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Cylinder Block Subassembly - Machined w/o Studs/Plugs, etc	0501-N0101-01 (Mini Cooper)	1	Upper cylinder block machining	OEM	Not Applicable	CNC Operator-OEM	CNC Milling, LS, HC	135	0.25	0.000	$0.00	$68.07	$250.00	$0.00	$0.13	$1.86	$1.98	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.98	$1.98		
1B	Cylinder Block Subassembly - Machined w/o Studs/Plugs, etc	0501-B0101-01 (Chrysler GEMA)	1	Machining operation adds for mounting balance shaft assembly.	OEM	Not Applicable	CNC Operator-OEM	CNC Milling, LS, HC	-288	0.25	0.000	$0.00	$68.07	$250.00	$0.00	-$0.06	-$0.87	-$0.93	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	-$0.93	-$0.93		
1C	Cylinder Block Subassembly - Cast	0501-N0101-03	1	Main Cooper Block minus liners =29.19 Chrysler GEMA Block minus liners = (33.655 + 2.08)	OEM	Aluminum-A380, Cast	Not Applicable	Not Applicable	NA	0	-6.545	$1.10	$0.00	$0.00	-$7.20	$0.00	$0.00	-$7.20	5.00%	0.00%	0.00%	0.00%	5.00%	-$0.36	-$7.56	-$7.56		
									#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
									#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
									#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
									#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
									#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
									#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
									#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
Purchase Part - High Impact Item (Full Cost Mapping)																												
1A	Cylinder Liners - Cast Iron	0501-N0101-04	4	Mini Cooper Liners = 1.9 lbs/liner, Chrysler GEMA Engine = 2.44lbs/liner	OEM	Nodular Iron, Cast	Not Applicable	Not Applicable	NA	0	-0.540	$0.35	$0.00	$0.00	-$0.19	$0.00	$0.00	-$0.19	0.30%	6.00%	4.00%	0.00%	10.30%	-$0.02	-$0.21	-$0.83		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.30%	6.00%	4.00%	0.00%	10.30%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.30%	6.00%	4.00%	0.00%	10.30%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.30%	6.00%	4.00%	0.00%	10.30%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.30%	6.00%	4.00%	0.00%	10.30%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.30%	6.00%	4.00%	0.00%	10.30%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.30%	6.00%	4.00%	0.00%	10.30%	#N/A	#N/A	$0.00		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up			-$7.34		
T1 or OEM Total Manufacturing Cost:	-$7.96	$0.07	$0.99	-$6.90	-$0.36	-$0.05	-$0.03	$0.00	-$0.44			-$7.34		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.70%	7.00%	8.00%	0.00%	15.70%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	-$0.05	-$0.51	-$0.59	$0.00	-$1.15					
Base Cost Impact to Vehicle:	-$7.96	$0.07	$0.99	-$6.90	-$0.41	-$0.56	-$0.62	$0.00	-$1.59			-$8.49	$0	$0
											Packaging Cost:	$0.00		
											Net Cost Impact to Vehicle:	-$8.49		

Timing Chain Cover Adds 3.98 lbs to Chrysler GEMA Head, Block, Girdle. Divided by coverage contribution:
Head 130/450 = 28.9% or 1.15lbs
Block = 235/450 = 52.2% or 2.08 lbs
Girdle = 85/450 = 18.9% or 0.75
Mini Cooper has integrated Cover in Head/Block/Bead Plate

Assume casting speed for Chrysler and Mini Cooper Block will be approximately the same. Thus no additional Labor or Burden costs were accounted for.

Assume processing speed for Chrysler and Mini Cooper liners will be approximately the same. Thus no additional Labor or Burden costs were accounted

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Cylinder Block Assembly - Machined w. Studs, Plugs, etc. **Part Number:** 0501-N0101-01
Component Quote Level: **Full Quote** ☐ **Modification Quote** ☒

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

PACKAGING CALCULATIONS:
Negligible Affect to Packaging

Bed Plate 0503

Manufacturing Assumption and Quote Summary

APPENDIX G.1-05, (2of5)
Print Date:9/2/2009

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Bed Plate Assembly - Machined w. Studs, Plugs, etc. **Part Number:** 0503-N0101-01
Component Quote Level: Full Quote ☐ Modification Quote ☒

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
A1.1	Bed Plate Subassembly - Cast	0503-N0101-02	1	Bed Plate casting	OEM	Aluminum-A380, Cast	Not Applicable	Not Applicable	NA	0	-3.663	$1.10	$0.00	$0.00	-$4.03	$0.00	$0.00	-$4.03	5.00%	0.00%	0.00%	0.00%	5.00%	-$0.20	-$4.23	-$4.23		
									#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
Purchase Part - High Impact Item (Full Cost Mapping)																												
1A	Bearing Cap - Bolt Through - Insert, Steel	0503-N0101-03	5	Main Bearing Caps, Cast	S	Nodular Iron, Cast	Not Applicable	Not Applicable	NA	0	-0.190	$0.35	$0.00	$0.00	-$0.07	$0.00	$0.00	-$0.07	5.00%	6.00%	4.00%	0.00%	15.00%	-$0.01	-$0.08	-$0.38		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.30%	6.00%	4.00%	0.00%	10.30%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.30%	6.00%	4.00%	0.00%	10.30%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.30%	6.00%	4.00%	0.00%	10.30%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.30%	6.00%	4.00%	0.00%	10.30%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.30%	6.00%	4.00%	0.00%	10.30%	#N/A	#N/A	$0.00		
			0						#DIV/0!	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.30%	6.00%	4.00%	0.00%	10.30%	#N/A	#N/A	$0.00		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		

Mini Cooper Bed Plate integrated Bearing Cap Weight = 18.01 lbs
Chrysler Girdle has non integrated bearing caps
Weight of Girdle =17.423+ Cover Contribution 0.75 -Oil Filter Inlet 0.25 lbs = 17.923
Weight of Caps = 0.94/bs/Cap
Ratio of Cap/(Cap+Girdle) = 20.8%

Therefore for Mini Cooper assumption is that 20.8% of Bedplate weight are for Bearing Caps, Thus the following calculations are made:
Weight of Base Bed Plate Material = 79.2%x18.01 = 14.26 lbs
Weight of Bearing Caps = 20.8%x18.01 = 3.75 lbs

Assume casting speed for Chrysler and Mini Cooper Bed Plate will be approximately same. Thus no additional Labor or Burden costs were accounted

Assume casting speed for Chrysler and Mini Cooper Bearing Caps will be approximately the same. Thus no additional Labor or Burden

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Bed Plate Assembly - Machined w. Studs, Plugs, etc. **Part Number:** 0503-N0101-01
Component Quote Level: Full Quote ☐ Modification Quote ☒

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
			0																				$0.00	$0.00	$0.00	$0.00		

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		Total 3	Tooling	Investment
											-$4.61		
T1 or OEM Total Manufacturing Cost:	-$4.36	$0.00	$0.00	-$4.36	-$0.22	-$0.02	-$0.01	$0.00	-$0.25	→	-$4.61		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.70%	7.00%	8.00%	0.00%	15.70%				
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	-$0.03	-$0.32	-$0.37	$0.00	-$0.72				
Base Cost Impact to Vehicle:	-$4.36	$0.00	$0.00	-$4.36	-$0.25	-$0.34	-$0.38	$0.00	-$0.98	→	-$5.34	$0	$0

Packaging Cost: $0.00
Net Cost Impact to Vehicle: -$5.34

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$1.00	0	$3.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Negligible Affect To Packaging

Manufacturing Assumption and Quote Summary

APPENDIX G.1-05, (3of5)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Squirter - Oil, Piston Cooler & Retainer **Part Number:** 0504-N0101-01/02
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 4
Annual Component Volume: 1,800,000
Weekly Component Volume: 38,298
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Cardboard Boxes

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Purchase Part - Low Impact Item (Partial Cost Mapping = Processed Raw Material Estimate + Actual Component Assembly Process)																												
1A	Bolt - Piston Cooler Valve/Retainer	0504-N0101-02	1	Purchase Part Cost Est. Break	S	Purchased Parts	General Assembly	Mech. Assembly, LC	206	0.5	0.350	$1.00	$35.51	$100.19	$0.35	$0.09	$0.49	$0.92	0.30%	6.00%	4.00%	0.00%	10.30%	$0.10	$1.02	$1.02		
2A	Squirter - Oil, Piston Cooler	0504-N0101-01	1	Purchase Part Cost Est. Break	S	Purchased Parts	General Assembly	Mech. Assembly, LC	240	0.5	0.300	$1.00	$35.51	$100.19	$0.30	$0.07	$0.42	$0.79	0.30%	6.00%	4.00%	0.00%	10.30%	$0.08	$0.87	$0.87		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$1.89		
														T1 or OEM Total Manufacturing Cost:	$0.65	$0.16	$0.90	$1.71	$0.01	$0.10	$0.07	$0.00	$0.18	→	3	$1.89		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.30%	6.00%	4.00%	0.00%	10.30%					
														(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.01	$0.11	$0.08	$0.00	$0.19					
														Base Cost Impact to Vehicle:	$0.65	$0.16	$0.90	$1.71	$0.01	$0.22	$0.14	$0.00	$0.37	→		$2.09	$0	$0
																									Packaging Cost:	$0.01		
																									Net Cost Impact to Vehicle:	$2.10		

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	18,000,000	60	5.00%		$0	460	500	6	229787
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.01		$0.00	0	$0.00	0	$2.50	2	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.010												

PACKAGING CALCULAIONS:

Use $0.005 additional cost for both squirter and bolt/check valve.

Assume 250 parts/box, $2.50/Box,

File:Cylinder Block 05, 032509.xls
EPA Contract: EP-C-07-069 WA1-3

Form Author: G. Kolwich
(248)373-6000 Ext. 2411

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Bearings & Thrust Shims - Crankshaft,
Part Number: 0590-N0101-01/02/03
Component Quote Level: **Full Quote** ☐ **Modification Quote** X

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: NA

Treat as Set, 5 Upper, 5 Lower, 2 Thrust Shims

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
	Bearing - Crankshaft, 1/2 Bearing (Top)	0590-N0101-01	5		S																		$0.00	$0.19	$0.00	$0.97		
	Bearing/Shim - Crankshaft Thrust	0590-N0101-02	2		S																		$0.00	$0.12	$0.00	$0.24		
	Bearing - Crankshaft, 1/2 Bearing (Bottom)	0590-N0101-03	5		S																		$0.00	$0.18	$0.00	$0.92		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		☐	$2.13		
														T1 or OEM Total Manufacturing Cost:	$2.13	$0.00	$0.00	$2.13	$0.00	$0.00	$0.00	$0.00	$0.00			$2.13		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%					
														(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00					
														Base Cost Impact to Vehicle:	$2.13	$0.00	$0.00	$2.13	$0.00	$0.00	$0.00	$0.00	$0.00			$2.13	$0	$0
																									Packaging Cost:	$0.00		
																									Net Cost Impact to Vehicle:	$2.13		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$1.00	0	$3.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

No Impact to Packaging

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: OEM Assembly of Cylinder Block Components to Engine
Part Number:
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
	Squirter - Oil, Piston Cooler - Assembly	0504-N0101-01	4	Engine Assembly	OEM	Not Applicable	General Assembly-OEM	Mech. Assembly, HC	800	1	0.000	$0.00	$83.31	$150.19	$0.00	$0.10	$0.19	$0.29	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.29	$1.17		
	Squirter - Oil, Piston Cooler - Assembly	0504-N0101-01	4	Engine Assembly	OEM	Not Applicable	General Assembly-OEM	Mech. Assembly, HC	1440	1	0.000	$0.00	$83.31	$150.19	$0.00	$0.06	$0.10	$0.16	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.16	$0.65		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
	Squirter - Oil, Piston Cooler & Bolt - Piston Cooler Valve/Retainer	0504-N0101-01/02	4		SAC																		$8.38	$2.10	$0.00	$8.38		
	Bearing Set (Upper/Lower/Thrust Shim)	0590-N0101-01/02/03	1	(UPGRADE SET)	SAC																		$2.13	$2.13	$0.00	$2.13		
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		☐	$12.33		
														T1 or OEM Total Manufacturing Cost:	$10.51	$0.65	$1.17	$12.33	$0.00	$0.00	$0.00	$0.00	$0.00	→	☐	$12.33		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.70%	7.00%	8.00%	0.00%	15.70%					
														(SAC) &T1 or OEM Mark-Up Values:	(10.51)	-----	-----	-----	$0.09	$0.86	$0.99	$0.00	$1.94					
														Base Cost Impact to Vehicle:	$0.00	$0.65	$1.17	$1.82	$0.09	$0.86	$0.99	$0.00	$1.94	→		$3.75	$0	$0
																									Packaging Cost:	$0.00		
																									Net Cost Impact to Vehicle:	$3.75		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly

Pallet Options
Option1: 48"(122cm)x45"(114cm)x34"(86cm)
Investment $200 US funds (Mike S.)
Assume Plastic Returnables Last 5 Years

Option2: Vacuum Form Pack Made from 1/4" HDPE (Approx. Same Pallet size as Option #1. (Mike S. 020909)
Investment $20K for tool
Piece Price, Pallet Base $100/Base
Piece Price, Tier Pad $40/Pad

Cardboard Tier Pads for Option 1 Pallets $1.00/Pad (Mike S.)
Cardboard Divider Pads for Option 1 Pallet $3.00/Pad (Mike S.)

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

No Additional Packaging Affects

Appendix G.1 - Subsystem 06
Cylinder Head Subsystem
Case Study #0101
MAQS Worksheets

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Cylinder Head Assembly - Machined w. Studs, Plugs, etc.
Part Number: 0601-N0101-01
Component Quote Level: Full Quote ☐ Modification Quote ☒

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Cylinder Head - Machined w/o. Studs, Valves, etc.	0601-N0101-01	1	Cylinder head machining, plug assembly & test	OEM	Not Applicable	CNC Operator-OEM	CNC Milling, LS, HC	83	0.25	0.000	$0.00	$68.07	$250.00	$0.00	$0.21	$3.03	$3.24	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$3.24	$3.24	Require tooling for machining & cap assembly	Require investment for cap assembly
1B	Cylinder Head - Heat Treat	0601-N0101-02	1	T6 Heat Treat, only consider solution step (quench and artificial age for T6 and T5 approx. estimated to have same cost impact)	OEM	Not Applicable	Heat Treat Operator-OEM	Heat Treat, MLS, MHC	81	0.25	0.000	$0.00	$137.35	$250.00	$				0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$3.50	$3.50		
1C	Cylinder Head Subassembly - Cast **Mini Cooper**	0601-N0101-02-01	1	Cylinder head casting & rough machining	OEM	Aluminum-356-T6, Cast	Not Applicable	Not Applicable	89	0	29.01	$1.20	$0.00	$0.00	$34.81	$0.00	$0.00	$34.81	5.00%	0.00%	0.00%	0.00%	5.00%	$1.74	$36.55	$36.55		
1D	Cylinder Head Subassembly - Cast **Chrysler**	0601-N0101-02-01	1	Cylinder head casting & rough machining	OEM	Aluminum-A319-T5, Cast	Not Applicable	Not Applicable	89	0	-30.99	$1.15	$0.00	$0.00	-$35.64	$0.00	$0.00	-$35.64	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	-$35.64	-$35.64		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		

5% Added Scrap Cost For A356

Mini Cooper Head = 30.33- (M8x60 studs x 15) 0.69 - Back Support Cap 0.61 = 29.03lbs

Chrysler GEMA Head = 30.64 - (Valve Guides Intake and Exhaust) 0.53 - (2 M8 Studsx80) 0.12 and (2 M10 Studs x60) 0.15 + (Timing Chain Cover Contribution) 1.15 = 29.84

Assume casting speed for Chrysler and Mini Cooper Heads will be approximately the same. Thus no additional Labor or Burden costs were accounted for.

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Cylinder Head Assembly - Machined w. Studs, Plugs, etc. **Part Number:** 0601-N0101-01
Component Quote Level: Full Quote ☐ Modification Quote ☒

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up			$7.65		
														T1 or OEM Total Manufacturing Cost:	-$0.83	$0.63	$6.11	$5.91	$1.74	$0.00	$0.00	$0.00	$1.74			$7.65		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.70%	7.00%	8.00%	0.00%	15.70%					
														(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.05	$0.54	$0.61	$0.00	$1.20					
														Base Cost Impact to Vehicle:	-$0.83	$0.63	$6.11	$5.91	$1.79	$0.54	$0.61	$0.00	$2.94			$8.85	$0	$0
																									Packaging Cost:	$0.00		
																									Net Cost Impact to Vehicle:	$8.85		

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	0.00%		$0	0	1	0	0
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

PACKAGING CALCULATIONS:
Negligible Affect to Packaging

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Seat - Intake Valve, Seat - Exhaust Valve,
Part Number: 0602-N0101-03/04
Component Quote Level: Full Quote ☐ Modification Quote ☒

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 8 SETS
Annual Component Volume: 3,600,000
Weekly Component Volume: 76,596
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Seat - Intake Valve	0602-N0101-03	8	Material difference	S																		$0.00	$0.02	$0.00	$0.14		
2A	Seat - Exhaust Valve	0602-N0101-04	8	Material difference	S																		$0.00	$0.03	$0.00	$0.20		
																							$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Absolute Cost for Premium Valve Seats
Intake Valve, COMO 1207 => $0.18/Valve
Exhaust Valve, AR20 => $0.25/Valve

Benchmark data from Munro on Baseline Intake and Exhaust Valve Seat $0.16 and $0.22

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		☐	$0.34		
T1 or OEM Total Manufacturing Cost:	$0.34	$0.00	$0.00	$0.34	$0.00	$0.00	$0.00	$0.00	$0.00		☐	$0.34		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00					
Base Cost Impact to Vehicle:	$0.34	$0.00	$0.00	$0.34	$0.00	$0.00	$0.00	$0.00	$0.00			$0.34	$0	$0
											Packaging Cost:	$0.00		
											Net Cost Impact to Vehicle:	$0.34		

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	36,000,000	60	0.00%		$0	0	1	0	0
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

PACKAGING CALCULATIONS:
No Affect to Packaging

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Cap, Head (Fuel Pump & Vacuum Mount) **Part Number:** 0606-N0101-03
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Cap, Head (Fuel Pump & Vacuum Mount)	0606-N0101-03-01	1	CNC Machining	S	Not Applicable	Mold/Cast/Sinter Operator	Diecast, LMC	240	0.5	0.000	$0.00	$43.52	$100.05	$0.00	$0.09	$0.42	$0.51	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.51	$0.51		
1B	Cap, Head (Fuel Pump & Vacuum Mount)	0606-N0101-03-02	1	Die casting	S	Aluminum-A380, Cast	Mold/Cast/Sinter Operator	Diecast, LMC	240	0.5	0.610	$1.10	$43.52	$100.05	$0.67	$0.09	$0.42	$1.18	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.18	$1.18		
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		☐	$1.69		
														T1 or OEM Total Manufacturing Cost:	$0.67	$0.18	$0.83	$1.69	$0.00	$0.00	$0.00	$0.00	$0.00		☐	$1.69		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.50%	6.50%	6.00%	2.50%	15.50%					
														(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.01	$0.11	$0.10	$0.04	$0.26					
														Base Cost Impact to Vehicle:	$0.67	$0.18	$0.83	$1.69	$0.01	$0.11	$0.10	$0.04	$0.26			$1.95	$0	$0
																									Packaging Cost:	$0.03		
																									Net Cost Impact to Vehicle:	$1.98		

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.032		$64,079	0.00%	2,250,000	60	5.00%		$5,140	12	4608	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.032												

PACKAGING CALCULATIONS:
Option #3 Packaging with returnable dividers.

Part Size: 250x 30x45

Parts per layer: 1 rows of 16
Number of layers: 6
Number of parts/Tote = 96

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Gasket - Cylinder Head to Block **Part Number:** 0685-N0101-01
Component Quote Level: Full Quote ☐ Modification Quote ☒

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
	Gasket - Cylinder Head to Block	0685-N0101-01	1	Change from 2 to 3 layer gasket	S																		$0.00	$1.46	$0.00	$1.46		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up			$1.46		
														T1 or OEM Total Manufacturing Cost:	$1.46	$0.00	$0.00	$1.46	$0.00	$0.00	$0.00	$0.00	$0.00			$1.46		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%					
														(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00					
														Base Cost Impact to Vehicle:	$1.46	$0.00	$0.00	$1.46	$0.00	$0.00	$0.00	$0.00	$0.00			$1.46	$0	$0
																									Packaging Cost:	$0.00		
																									Net Cost Impact to Vehicle:	$1.46		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

PACKAGING CALCULATIONS:
Negligible Affect to Packaging

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: OEM Assembly of Cylinder Head Components to Engine **Part Number:** NA
Component Quote Level: Full Quote ☐ Modification Quote ☒

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Cap, Head (Fuel Pump & Vacuum Mour	0606-N0101-03-01	1	Head and cam assembly	OEM	Not Applicable	Not Applicable	Not Applicable	150	0	0.000	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.00	$0.00	Require tooling for cap assembly	Require investment for cap assembly
1B	Cap, Head (Fuel Pump & Vacuum Mount)	0606-N0101-03-01	1	Head & Cap Machining	OEM	Not Applicable	Not Applicable	Not Applicable	217	0.25	0.000	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.00	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		

NOTES:
Did not add any additional costs to add Cap, Head (Fuel Pump & Vacuum Mount). Assumption is additional labor& burden would be negligible in having existing automated process.

Machining for O/S face of Cap, Head (Fuel Pump & Vacuum Mount) covered as part of Cylinder Head Machining.

Purchase Part - Commodity (Value taken from Purchase Part Database)						Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item
1A	Seat - Intake/Exhaust Valves	0602-N0101-03	8	Material difference	SAC	$2.75	$0.34	$0.00	$2.75
2A	Cap, Head (Fuel Pump & Vacuum Mount)	0606-N0101-03-01	1	Added Part	SAC	$1.98	$1.98	$0.00	$1.98
3A	Bolt - Cap Bearing, Camshaft	0680-N0101-01	4	Added Part	S	$0.00	$0.08	$0.00	$0.32
4A	Gasket - Cylinder Head to Block	0685-N0101-01	1	Modified Part	SAC	$1.46	$1.46	$0.00	$1.46
5A	Bolt - Manifold, Exhaust	0680-N0101-10	10	510 Stainless or A286 Inconel	S	$0.00	$0.36	$0.00	$3.60
			0			$0.00	$0.00	$0.00	$0.00
			0			$0.00	$0.00	$0.00	$0.00
			0			$0.00	$0.00	$0.00	$0.00
			0			$0.00	$0.00	$0.00	$0.00
			0			$0.00	$0.00	$0.00	$0.00
			0			$0.00	$0.00	$0.00	$0.00
			0			$0.00	$0.00	$0.00	$0.00
			0			$0.00	$0.00	$0.00	$0.00
			0			$0.00	$0.00	$0.00	$0.00

Stainless Steel Exhaust Manifold Hanger Studs:
Upgrade to Stainless:
Estimated base stud $0.35 and Stainless stud $0.70
310/316 (Studs on Mini are Magnetic)
410 series good for high temp fastener application not recommended for use w. Aluminum due to Galvanic Action

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up				Tooling	Investment
											☐	$10.11		
T1 or OEM Total Manufacturing Cost:	$10.11	$0.00	$0.00	$10.11	$0.00	$0.00	$0.00	$0.00	$0.00	→	☐	$10.11		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%					
(SAC) &T1 or OEM Mark-Up Values:	(6.19)	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00					
Base Cost Impact to Vehicle:	$3.92	$0.00	$0.00	$3.92	$0.00	$0.00	$0.00	$0.00	$0.00	→		$3.92	$0	$0
											Packaging Cost:	$0.00		
											Net Cost Impact to Vehicle:	$3.92		

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: OEM Assembly of Cylinder Head Components to Engine
Part Number: NA
Component Quote Level: Full Quote ☐ Modification Quote ☒

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

PACKAGING CALCULATIONS:
Exhaust manifold bolt packaging, no change for material upgrade.

Packaging cost for Cam Cap bolts are included in piece price, increase in material usage only.

Appendix G.1 - Subsystem 07
Valve Train Subsystem
Case Study #0101
MAQS Worksheets

Valves Int.0701 & Exh.0702

Manufacturing Assumption and Quote Summary

APPENDIX G.1-07, (1of3)
Printed:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Valve - Intake & Valve - Outlet
Part Number: 0701-N0101-01 & 0702-N0101-01
Component Quote Level: ☐ Full Quote ☐ Modification Quote ☑ Differential Quote (Quote Summary includes costing for both

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 8
Annual Component Volume: 3,600,000
Weekly Component Volume: 76,596
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 High Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification:

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
	Valve - Inlet	0701-N0101-01	1	Intake valves would need to be upgraded - typical upgrade would be from nitrided JIS SUH11 (Fe-1.5Si, 8.5Cr, 0.5C) to Silichrome	S																					$0.00	$0.11	$0.00	$0.11		
	Valve - Outlet	0702-N0101-01	1	Exhaust valves would need to be upgraded typical upgrade would be from nitrided JIS SUH 35 (Fe, 9Mn, 21Cr 4Ni, 0.5C and 0.4N) to Inconel head and Silichrome stem. Exhaust valves on Mini Cooper Turbo DI are Sodium filled as well. This design approach is not considered preferred and thus will note be included in cost analysis.	S																					$0.00	$0.97	$0.00	$0.97		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up					
											1	$1.08		
T1 or OEM Total Manufacturing Cost:	$1.08	$0.00	$0.00	$1.08	$0.00	$0.00	$0.00	$0.00	$0.00		3	$1.08		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.70%	7.00%	8.00%	4.00%	19.70%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.01	$0.08	$0.09	$0.04	$0.21					
Base Cost Impact to Vehicle:	$1.08	$0.00	$0.00	$1.08	$0.01	$0.08	$0.09	$0.04	$0.21			$1.30	$0	$0
											Packaging Cost:	$0.00		
											Net Cost Impact to Vehicle:	$1.30		

PACKAGING CALCULATIONS:
Packaging Type: NO IMPACT TO PACKAGING
Part Size:
Parts/Layer:
Number of Layers:

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	36,000,000	60	5.00%		$0	250	1	6	459574
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Camshafts 0706

Manufacturing Assumption and Quote Summary

APPENDIX G.1-07, (2of3)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Camshaft - Intake Machine & Exhaust Machined **Part Number:** 0706-N0101-02 & 0706-N0101-11
Component Quote Level: ☐ Full Quote ☐ Modification Quote ☑ Differential Quote (Quote Summary includes costing for both Technology Packages)

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 Moderate Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
1A	Camshaft - Intake Machined (MINI)	0706-N0101-02	1	Weight Delta between Mini and Chrysler GEMA camshafts. Estimate no cost impact relative to fabrication or machining.	T1 Assembly, Mark-up Applied @ Bottom.	Nodular Iron, Cast	Not Applicable	Not Applicable	113	1	1	1	3.886	$0.35	$0.00	$0.00	$0.00	$1.36	$0.00	$0.00	$1.36	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.36	$1.36		
2A	Camshaft - Exhaust Machined (MINI)	0706-N0101-11	1	Weight Delta between Mini and Chrysler GEMA camshafts. Estimate no cost impact relative to fabrication or machining.	T1 Assembly, Mark-up Applied @ Bottom.	Nodular Iron, Cast	Not Applicable	Not Applicable	113	1	1	1	4.256	$0.35	$0.00	$0.00	$0.00	$1.49	$0.00	$0.00	$1.49	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.49	$1.49		
3A	Camshaft - Intake Machined (MINI)	0706-B0101-02	1	Weight Delta between Mini and Chrysler GEMA camshafts. Estimate no cost impact relative to fabrication or machining.	T1 Assembly, Mark-up Applied @ Bottom.	Nodular Iron, Cast	Not Applicable	Not Applicable	113	1	1	1	-4.260	$0.35	$0.00	$0.00	$0.00	-$1.49	$0.00	$0.00	-$1.49	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	-$1.49	-$1.49		
4A	Camshaft - Exhaust Machined (MINI)	0706-B0101-11	1	Weight Delta between Mini and Chrysler GEMA camshafts. Estimate no cost impact relative to fabrication or machining.	T1 Assembly, Mark-up Applied @ Bottom.	Nodular Iron, Cast	Not Applicable	Not Applicable	113	1	1	1	-4.630	$0.35	$0.00	$0.00	$0.00	-$1.62	$0.00	$0.00	-$1.62	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	-$1.62	-$1.62		
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up					
											1	-$0.26		
T1 or OEM Total Manufacturing Cost:	-$0.26	$0.00	$0.00	-$0.26	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	-$0.26		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	5.00%	6.50%	6.00%	2.50%	20.00%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	-$0.01	-$0.02	-$0.02	-$0.01	-$0.05					
Base Cost Impact to Vehicle:	-$0.26	$0.00	$0.00	-$0.26	-$0.01	-$0.02	-$0.02	-$0.01	-$0.05	→		-$0.31	$0	$0
											Packaging Cost:	$0.00		
											Net Cost Impact to Vehicle:	-$0.31		

PACKAGING CALCULATIONS:
Packaging Type: *NO IMPACT TO PACKAGING*
Part Size:
Parts/Layer:
Number of Layers:

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	250	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Manufacturing Assumption and Quote Summary

APPENDIX G.1-07, (3of3)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Engine Assembly Impact from upgraded Valve Train components **Part Number:** 0700
Component Quote Level: ☐ Full Quote ☐ Modification Quote ☑ Differential Quote (Quote Summary includes costing for both Technology Packages)

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: OEM Engine Assembly
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
	No engine assembly cost impact as a result of valve train upgrades.		0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Valves Intake and Exhaust	Delta (Mini$-Chrysler$)	8		SAC																					$10.37	$1.30	$0.00	$10.37		
2A	Camshafts Exhaust & Intake	Delta (Mini$-Chrysler$)	1		SAC																					($0.31)	($0.31)	$0.00	-$0.31		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$10.06		
T1 or OEM Total Manufacturing Cost:	$10.06	$0.00	$0.00	$10.06	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$10.06		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%					
(SAC) &T1 or OEM Mark-Up Values:	(10.06)	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00					
Base Cost Impact to Vehicle:	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	→		$0.00	$0	$0

Packaging Cost: $0.00
Net Cost Impact to Vehicle: $0.00

PACKAGING CALCULATIONS:
Packaging Type:
Part Size:
Parts/Layer:
Number of Layers:

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	250	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Appendix G.1 - Subsystem 08
Timing Drive Subsystem
Case Study #0101
MAQS Worksheets

Manufacturing Assumption and Quote Summary

APPENDIX G.1-08, (1of1)
Print Date:9/2/2009

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Sprocket - Crankshaft, Timing Drive **Part Number:** 0801-N0101-01
Component Quote Level: ☐ Full Quote ☑ Modification Quote ☐ Differential Quote (Quote Summary includes costing for both Technology Packages)

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 Low Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Mutiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
	Sprocket - Crankshaft, Timing Drive	0801-N0101-01	1	(Smart Sprocket royalty, mark-ups included)	S																					$0.00	$1.60	$0.00	$1.60		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$1.60		
T1 or OEM Total Manufacturing Cost:	$1.60	$0.00	$0.00	$1.60	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$1.60		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00					
Base Cost Impact to Vehicle:	$1.60	$0.00	$0.00	$1.60	$0.00	$0.00	$0.00	$0.00	$0.00	→		$1.60	$0	$0
											Packaging Cost:	$0.00		
											Net Cost Impact to Vehicle:	$1.60		

PACKAGING CALCULATIONS:
Packaging Type: No Change to Packaging
Part Size:
Parts/Layer:
Number of Layers:

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	250	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Appendix G.1 - Subsystem 10
Intake Subsystem
Case Study #0101
MAQS Worksheets

Manufacturing Assumption and Quote Summary

APPENDIX G.1-10 (1of1)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Manifold Assembly - Intake **Part Number:** 1001-N0101-01
Component Quote Level: ☐ Full Quote ☐ Modification Quote ☑ Differential Quote (Quote Summary includes costing for both Technology Packages)

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 Moderate Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Vacuum Form Returnables

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
1A	Manifold - Intake, Bottom Half (Mini)	1001-N0101-01-07	1	Injection Molding	T1 Assembly, Mark-up Applied @ Bottom.	Nylon6-30GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, MLS	254	0.5	1	1	1.408	$1.76	$43.52	$150.01	$150.01	$2.48	$0.09	$0.59	$3.15	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$3.15	$3.15		
1B	Manifold - Intake, Top Half (Mini)	1001-N0101-01-06	1	Injection Molding	T1 Assembly, Mark-up Applied @ Bottom.	Nylon6-30GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, MLS	267	0.5	1	1	0.949	$1.76	$43.52	$150.01	$150.01	$1.67	$0.08	$0.56	$2.31	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$2.31	$2.31		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
1A	Manifold - Intake, Bottom Half (Chrysler)	1001-B0101-01-07	1	Injection Molding	T1 Assembly, Mark-up Applied @ Bottom.	Nylon6-30GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, MLS	-226	0.5	1	1	-5.036	$1.76	$43.52	$150.01	$150.01	-$8.86	-$0.10	-$0.67	-$9.62	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	-$9.62	-$9.62		
1B	Manifold - Intake, Top Half (Chrysler)	1001-B0101-01-06	1	Injection Molding	T1 Assembly, Mark-up Applied @ Bottom.	Nylon6-30GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, MLS	-255	0.5	1	1	-3.380	$1.76	$43.52	$150.01	$150.01	-$5.95	-$0.09	-$0.59	-$6.62	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	-$6.62	-$6.62		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
																		Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	-$10.78		
																	T1 or OEM Total Manufacturing Cost:	-$10.66	-$0.01	-$0.10	-$10.78	$0.00	$0.00	$0.00	$0.00	$0.00		3	-$10.78		
																	T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.50%	6.50%	6.00%	2.50%	15.50%					
																	(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	-$0.05	-$0.70	-$0.65	-$0.27	-$1.67					
																	Base Cost Impact to Vehicle:	-$10.66	-$0.01	-$0.10	-$10.78	-$0.05	-$0.70	-$0.65	-$0.27	-$1.67			-$12.45	$0	$0
																											Packaging Cost:	-$0.28		
																											Net Cost Impact to Vehicle:	-$12.73		

Equipment, Tooling and Fixturing for friction welding top and bottom sections of intake manifold together would be less expensive for Mini versus GEMA. However since time and burden rate differences would be minor, we have not included the difference as a line code in the quote.

PACKAGING CALCULATIONS:
MINI COOPER INTAKE MANIFOLD = $0.08
Packaging Type: Option #2
Part Size: 370x280x170
Parts/Layer: 4 x 3 =12
Number of Layers: 5

PACKAGING CALCULATIONS:
CHRYSLER GEMA INTAKE MANIFOLD = $0.36
Packaging Type: Option #2
Part Size: 370x380x225
Parts/Layer: 3 x 3
Number of Layers:3

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.362		$723,404	0.00%	2,250,000	60	5.00%		$340	2128	27	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.362												

Appendix G.1 - Subsystem 11
Fuel Induction Subsystem
Case Study #0101
MAQS Worksheets

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Fuel Rail - High Pressure **Part Number:** 1101-N0101-02
Component Quote Level: ☑ Full Quote ☐ Modification ☐ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 Low Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
	Fuel Rail High Pressure	1101-N0101-02	1	Assembly, Braze & Test	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, LC, Base	288	3	1	10	0.000	$0.00	$35.51	$15.00	$150.00	$0.00	$0.37	$0.52	$0.89	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.89	$0.89		
Purchase Part - High Impact Item (Full Cost Mapping)																															
1A	Tube - Injector Rail	1101-N0101-02-06	1	Turn & cross Drill	T1 Assembly, Mark-up Applied @ Bottom.	S-Steel-304, Tube	CNC Operator	CNC Turning, MC	180	0.5	1	1	0.600	$1.65	$35.70	$45.00	$45.00	$0.99	$0.10	$0.25	$1.34	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.34	$1.34		
2A	Threaded Plug Rail Inlet	1101-N0101-02-05	1	Machine & Tap	T1 Assembly, Mark-up Applied @ Bottom.	S-Steel-304, Bar	CNC Operator	CNC Turning, MC	138	1	1.5	1	0.060	$1.65	$35.70	$45.00	$67.50	$0.10	$0.26	$0.49	$0.84	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.84	$0.84		
3A	Boss High Pressure Sensor	1101-N0101-02-03	1	Machine & Tap	T1 Assembly, Mark-up Applied @ Bottom.	S-Steel-304, Bar	CNC Operator	CNC Turning, LMC	164	0.5	1.5	1	0.080	$1.65	$35.70	$100.00	$150.00	$0.13	$0.11	$0.92	$1.16	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.16	$1.16		
4A	Cup Injector Port	1101-N0101-02-01	4	Plating	T1 Assembly, Mark-up Applied @ Bottom.	Plating, Fuel Rail	Plating/Coating Operator	Plate/Finish, SMS, MHC	720	1	1	1	0.001	$20.00	$55.17	$125.17	$125.17	$0.02	$0.08	$0.17	$0.27	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.27	$1.08		
4B	Cup Injector Port	1101-N0101-02-01-1	4	Machine & Cross Drill	T1 Assembly, Mark-up Applied @ Bottom.	S-Steel-304, Bar	CNC Operator	CNC Turning, HC	480	2	4	1	0.260	$1.65	$35.70	$75.00	$300.00	$0.43	$0.15	$0.63	$1.20	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.20	$4.81		
5A	Bracket Rail Mounting	1101-N0101-02-02	2	Stamping	T1 Assembly, Mark-up Applied @ Bottom.	S-Steel-304, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	610	0.5	1	1	0.147	$1.64	$42.18	$100.10	$100.10	$0.24	$0.03	$0.16	$0.44	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.44	$0.88		
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Plug Rail End	1101-N0101-02-04	1	Stainless 304	S																					$0.00	$0.09	$0.00	$0.09		
2A	High Pressure Fuel Sensor Assembly	1101-N0101-03	1	Pressure Sensor	S																					$0.00	$7.50	$0.00	$7.50		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
																		Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$18.59		
																	T1 or OEM Total Manufacturing Cost:	$11.09	$1.81	$5.70	$18.59	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$18.59		
																	T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.30%	6.00%	4.00%	1.00%	11.30%					
																	(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.06	$1.12	$0.74	$0.19	$2.10					
																	Base Cost Impact to Vehicle:	$11.09	$1.81	$5.70	$18.59	$0.06	$1.12	$0.74	$0.19	$2.10	→		$20.70	$0	$0
																												Packaging Cost:	$0.07		
																												Net Cost Impact to Vehicle:	$20.76		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

PACKAGING CALCULATIONS:
Packaging Type: Option #3, Tote w. Vacuum Form Pack
Part Size: 300x55x100mm
Parts/Layer: 8
Number of Layers:3

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.068		$136,636	0.00%	2,250,000	60	5.00%		$2,740	50	1152	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.068												

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Fuel Injector Assembly - Solenoid, 7 Hole **Part Number:** 1104-N0101-01
Component Quote Level: ☑ Full Quote ☐ Modification Quote ☐ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 4
Annual Component Volume: 1,800,000
Weekly Component Volume: 38,298
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 High Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Returnable Container & Internal Dunnage

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
1A	Fuel Injector Assembly	1104-N0101-01	1	Final Assembly	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	Electromechanical Assembly	Mech Assembly, LC, Base	480	2	1	6	0.000	$0.00	$37.35	$15.00	$90.00	$0.00	$0.16	$0.19	$0.34	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.34	$0.34		
2A	Seal Injector Tip	1104-N0101-01-30	1	Overmold seal @ Injector Tip	T1 Assembly, Mark-up Applied @ Bottom.	Nylon-HT, Inject.	Electromechanical Assembly	Mech Assembly, MC, Base	450	1	1	1	0.005	$4.00	$37.35	$30.00	$30.00	$0.02	$0.08	$0.07	$0.17	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.17	$0.17		
3A	Solenoid Body preassembled	1104-N0101-01-10	1	Insert Windings, Ring Locator ar	T1 Assembly, Mark-up Applied @ Bottom.	Nylon66-40FMR, Inject.	Electromechanical Assembly	Mech Assembly, HC, Base	450	2	1	5	0.030	$1.54	$37.35	$45.00	$225.00	$0.05	$0.17	$0.50	$0.71	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.71	$0.71		
4A	Needle Body Assembly	1104-N0101-01-50	1	Laser weld internal valve body (	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	Electromechanical Assembly	Mech Assembly, MC, Base	450	4	1.5	8	0.000	$0.00	$37.35	$30.00	$360.00	$0.00	$0.33	$0.80	$1.13	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.13	$1.13		
5A	Needle Assembly	1104-N0101-01-11	1	Assemble & Press Sleeve	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	Electromechanical Assembly	Mech Assembly, MC, Base	450	1	1	4	0.000	$0.00	$37.35	$30.00	$120.00	$0.00	$0.08	$0.27	$0.35	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.35	$0.35		
6A	Needle Injector	1104-N0101-01-13	1	Laser Weld Ball and Seat to Needle	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	Electromechanical Assembly	Mech Assembly, MC, Base	514	1	1	3	0.000	$0.00	$37.35	$30.00	$90.00	$0.00	$0.07	$0.18	$0.25	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.25	$0.25		
7A	Metering Valve assembly	1104-N0101-01-16	1	Laser Weld Plate to Valve	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	Electromechanical Assembly	Mech Assembly, MC, Base	514	1	1	2	0.000	$0.00	$37.35	$30.00	$60.00	$0.00	$0.07	$0.12	$0.19	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.19	$0.19		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
Purchase Part - High Impact Item (Full Cost Mapping)																															
1A	Body Injector Solenoid	1104-N0101-01-20	1	Machine Body	T2/T3 CNC Turning, MSMC	S-Steel-440C, Bar	CNC Operator	CNC Turning, MC	500	0.5	5	1	0.140	$4.56	$35.70	$45.00	$225.00	$0.64	$0.04	$0.45	$1.12	0.50%	6.50%	6.00%	1.00%	14.00%	$0.16	$1.28	$1.28		
2A	Sleeve winding to inlet separator	1104-N0101-01-27	1	Machine and Roll Splines	T2/T3 CNC Turning, MSMC	S-Steel-440C, Bar	CNC Operator	CNC Turning, MC	491	0.5	4.5	1	0.074	$4.56	$35.70	$45.00	$202.50	$0.34	$0.04	$0.41	$0.79	0.50%	6.50%	6.00%	1.00%	14.00%	$0.11	$0.90	$0.90		
3A	Sleeve Fuel Inlet	1104-N0101-01-28	1	Machine	T2/T3 CNC Turning, MSMC	S-Steel-440C, Bar	CNC Operator	CNC Turning, MC	485	0.5	3.5	1	0.041	$4.56	$35.70	$45.00	$157.50	$0.19	$0.04	$0.33	$0.55	0.50%	6.50%	6.00%	1.00%	14.00%	$0.08	$0.63	$0.63		
4A	Body needle	1104-N0101-01-9	1	Machine and Roll Splines	T2/T3 CNC Turning, MSMC	S-Steel-440C, Bar	CNC Operator	CNC Turning, MC	460	0.5	5.5	1	0.043	$4.56	$35.70	$45.00	$247.50	$0.20	$0.04	$0.54	$0.77	0.50%	6.50%	6.00%	1.00%	14.00%	$0.11	$0.88	$0.88		
5A	Inlet Tube	1104-N0101-01-21	1	Cut and Flare	T2/T3 Hydro/CNC Form, SSLC	S-Steel-304, Tube	Forging Operator	Cold Forge, LMC	360	0.5	1	1	0.010	$1.65	$38.52	$100.09	$100.09	$0.02	$0.05	$0.28	$0.35	0.30%	6.00%	4.00%	0.00%	10.30%	$0.04	$0.38	$0.38		
6A	Spring Seat Lower	1104-N0101-01-14	1	Machine	T2/T3 CNC Turning, MSMC	S-Steel-440C, Bar	CNC Operator	CNC Turning, MC	450	0.25	1.5	1	0.0002	$4.56	$35.70	$45.00	$67.50	$0.00	$0.02	$0.15	$0.17	0.50%	6.50%	6.00%	1.00%	14.00%	$0.02	$0.19	$0.19		
7A	Needle valve	1104-N0101-01-24	1	Centerless Grind	T2/T3 CNC Turning, MSMC	Not Applicable	CNC Operator	CNC Turning, MC	540	0.25	1.5	1	0.000	$0.00	$35.70	$45.00	$67.50	$0.00	$0.02	$0.13	$0.14	0.50%	6.50%	6.00%	1.00%	14.00%	$0.02	$0.16	$0.16		
7B	Needle valve	1104-N0101-01-24-01	1	Machine Heat Treat	T2/T3 CNC Turning, MSMC	S-Steel-440C, Bar	CNC Operator	CNC Turning, MC	540	0.25	1.5	1	0.002	$4.56	$35.70	$45.00	$67.50	$0.01	$0.02	$0.13	$0.15	0.50%	6.50%	6.00%	1.00%	14.00%	$0.02	$0.17	$0.17		
8A	Ball Needle seat	1104-N0101-01-23	1	EDM Mounting Pocket	T2/T3 CNC Turning, MSMC	Not Applicable	CNC Operator	CNC Turning, MC	720	0.25	1	1	0.000	$0.00	$35.70	$45.00	$45.00	$0.00	$0.01	$0.06	$0.07	0.50%	6.50%	6.00%	1.00%	14.00%	$0.01	$0.09	$0.09		
8A	Ball Needle seat	1104-N0101-01-23	1	Grind/Lap/Wash	T2/T3 CNC Turning, MSMC	Not Applicable	CNC Operator	CNC Turning, MC	540	0.25	1.5	1	0.000	$0.00	$35.70	$45.00	$67.50	$0.00	$0.02	$0.13	$0.14	0.50%	6.50%	6.00%	1.00%	14.00%	$0.02	$0.16	$0.16		
8A	Ball Needle seat	1104-N0101-01-23	1	Cold Head/Machine/Heat Treat	T2/T3 CNC Turning, MSMC	S-Steel-440C, Bar	CNC Operator	Cold Forge, LMC	720	0.25	1	1	0.0003	$4.56	$35.70	$100.09	$100.09	$0.00	$0.01	$0.14	$0.15	0.50%	6.50%	6.00%	1.00%	14.00%	$0.02	$0.17	$0.17		
9A	Metering Valve	1104-N0101-01-18	1	Machined	T2/T3 CNC Turning, MSMC	S-Steel-440C, Bar	CNC Operator	CNC Turning, MC	470	0.25	3	1	0.005	$4.56	$35.70	$45.00	$135.00	$0.02	$0.02	$0.29	$0.33	0.50%	6.50%	6.00%	1.00%	14.00%	$0.05	$0.38	$0.38		
10A	Plate Metering Valve	1104-N0101-01-19	1	Stamping	T2/T3 Stamp/Form, MSMC	S-Steel-304, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	766	0.25	1	1	0.0002	$1.64	$42.18	$100.10	$100.10	$0.00	$0.01	$0.13	$0.14	0.50%	6.50%	6.00%	1.00%	14.00%	$0.02	$0.17	$0.17		
11A	Tip - Injector	1104-N0101-01-08	1	EDM Micro Popping	T2/T3 CNC Turning, MSMC	Not Applicable	CNC Operator	CNC Milling, MHC	480	0.5	2	1	0.000	$0.00	$35.70	$150.15	$300.30	$0.00	$0.04	$0.63	$0.66	0.50%	6.50%	6.00%	1.00%	14.00%	$0.09	$0.76	$0.76		
11B	Tip - Injector	1104-N0101-01-08-01	1	Metal Injection Molding	T2/T3 Powder Metal, LSHC	S-Steel-440-MIM	Mold/Cast/Sinter Operator	Powder Metal, MHC	480	1	1	1	0.002	$13.68	$43.52	$150.14	$150.14	$0.03	$0.09	$0.31	$0.43	0.70%	7.00%	8.00%	2.00%	17.70%	$0.08	$0.51	$0.51		
12A	Face seal Injector to head	1104-N0101-01-4-1	1	Powder Metal	T2/T3 Powder Metal, SSLC	PM-SMF-SS410	Mold/Cast/Sinter Operator	Powder Metal, LMC	1440	0.5	1	1	0.005	$4.92	$43.52	$100.14	$100.14	$0.02	$0.02	$0.07	$0.11	0.30%	6.00%	4.00%	0.00%	10.30%	$0.01	$0.12	$0.12		
13A	Bracket Injector hold-down	1104-N0101-01-2	1	Stamping	T2/T3 Stamp/Form, MSMC	HC-Steel-4130, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	600	0.5	1	1	0.078	$0.78	$42.18	$100.10	$100.10	$0.06	$0.04	$0.17	$0.26	0.50%	6.50%	6.00%	1.00%	14.00%	$0.04	$0.30	$0.30		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
Purchase Part - Low Impact Item (Partial Cost Mapping = Processed Raw Material Estimate + Actual Component Assembly Process)																															
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Solenoid Windings	1104-N0101-01-22	1		S																					$0.00	$0.25	$0.00	$0.25		
2A	Ring winding locator	1104-N0101-01-26	1		S																					$0.00	$0.08	$0.00	$0.08		
3A	Spring - needle to metering valve	1104-N0101-01-15	1		S																					$0.00	$0.01	$0.00	$0.01		
4A	Spring Needle Return	1104-N0101-01-12	1		S																					$0.00	$0.03	$0.00	$0.03		
5A	Sleeve Screen Stop	1104-N0101-01-25	1		S																					$0.00	$0.01	$0.00	$0.01		
6A	Screen Fuel Inlet	1104-N0101-01-6	1		S																					$0.00	$0.05	$0.00	$0.05		
7A	circlip face seal retainer	1104-N0101-01-5	1		S																					$0.00	$0.02	$0.00	$0.02		
8A	Compression limiter - oring	1104-N0101-01-3	1		S																					$0.00	$0.03	$0.00	$0.03		
9A	O-Ring Injector to rail seal	1104-N0101-01-1	1		S																					$0.00	$0.09	$0.00	$0.09		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Fuel Injector Assembly - Solenoid, 7 Hole
Part Number: 1104-N0101-01
Component Quote Level: ☑ Full Quote ☐ Modification Quote ☐ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 4
Annual Component Volume: 1,800,000
Weekly Component Volume: 38,298
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 High Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Returnable Container & Internal Dunnage

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
																		Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$10.95		
																	T1 or OEM Total Manufacturing Cost:	$2.16	$1.47	$6.44	$10.07	$0.03	$0.41	$0.38	$0.06	$0.89		3	$10.95		
																	T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.70%	7.00%	8.00%	4.00%	19.70%					
																	(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.08	$0.77	$0.88	$0.44	$2.16					
																	Base Cost Impact to Vehicle:	$2.16	$1.47	$6.44	$10.07	$0.11	$1.18	$1.26	$0.50	$3.05			$13.11	$0	$0
																												Packaging Cost:	$0.01		
																												Net Cost Impact to Vehicle:	$13.13		

PACKAGING CALCULATIONS:
Packaging Type: Option #3 Tote, 42 Totes/Pallet
Part Size: 90x55x25 mm
Parts/Layer per tote: 3 x 8
Number of Layers per tote: 9

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces/ Amortization Period	Number of Service Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.014		$108,680	0.00%	9,000,000	60	5.00%		$4,180	26	9072	6	229787
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.014												

Manufacturing Assumption and Quote Summary

APPENDIX G.1-11, (3of7)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Fuel Pump - High Pressure w. Vol.Control Valve (Driven-Off Intake Cam) **Part Number:** 1107-N0101-01
Component Quote Level: ☑ Full Quote ☐ Modification ☐ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 High Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
1A	Fuel Pump - High Pressure w. Vol. Control Valve	1107-N0101-01	1	Final Assembly Line	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, HC, Base	360	3	1	10	0.250	$0.00	$35.51	$45.00	$450.00	$0.00	$0.30	$1.25	$1.55	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.55	$1.55		
2A	Swash Plate Drive Assembly	1107-N0101-01-09	1	Subassembly Line	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, MC, Base	360	1	1	8	0.000	$0.00	$35.51	$30.00	$240.00	$0.00	$0.10	$0.67	$0.77	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.77	$0.77		
3A	Bellow piston cavity	1107-N0101-01-14	2	Weld Subassembly	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, MC, Base	300	2	1	4	0.000	$0.00	$35.51	$30.00	$120.00	$0.00	$0.24	$0.40	$0.64	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.64	$1.27		
4A	Bellow Retainer	1107-N0101-01-16	2	Press Orifice Insert onto Bellows Retainer	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, MC, Base	600	1	1	1	0.000	$0.00	$35.51	$30.00	$30.00	$0.00	$0.06	$0.05	$0.11	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.11	$0.22		
5A	Shaft Drive Adapter	1107-N0101-01-09-6	1	Press Ball, Springs and Insert	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, MC, Base	300	0.5	1	1	0.000	$0.00	$35.51	$30.00	$30.00	$0.00	$0.06	$0.10	$0.16	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.16	$0.16		
Purchase Part - High Impact Item (Full Cost Mapping)																															
1A	Housing Fuel Pump	1107-N0101-01-25-1	1	Extrude Housing	T2/T3 Cold Forge, MSMC	Aluminum-7075-T6, Ext.	Extruding/Drawing Operator	Cold Forge, MHC	96	2	1	1	1.800	$3.21	$54.35	$150.09	$150.09	$5.78	$1.13	$1.56	$8.47	0.50%	6.50%	6.00%	1.00%	14.00%	$1.19	$9.66	$9.66		
1B	Housing Fuel Pump	1107-N0101-01-25-1	1	Machine Housing	T2/T3 CNC Milling, LSHC	Not Applicable	CNC Operator	CNC Machining, LMC	121	4	14	1	0.000	$0.00	$35.70	$25.00	$350.00	$0.00	$1.18	$2.88	$4.06	0.70%	7.00%	8.00%	2.00%	17.70%	$0.72	$4.78	$4.78		
1C	Housing Fuel Pump	1107-N0101-01-25	1	Assemble Ball Plugs	T2/T3 Mech. Assembly, SSLC	Purchased Parts	General Assembly	Mech Assembly, LC, Base	240	1	1	4	0.110	$1.00	$35.51	$15.00	$60.00	$0.11	$0.15	$0.25	$0.51	0.30%	6.00%	4.00%	0.00%	10.30%	$0.05	$0.56	$0.56		
2A	Bar Stock - Check Valve Assembly	1107-N0101-01-22-1	1	Machining	T2/T3 CNC Turning, SSLC	S-Steel-304, Bar	Lathe/Turning Operator	S-CNC Turning, HC	180	0.25	2	1	0.040	$1.65	$37.60	$85.00	$170.00	$0.07	$0.05	$0.94	$1.06	0.30%	6.00%	4.00%	0.00%	10.30%	$0.11	$1.17	$1.17		
2B	Check Valve Assembly	1107-N0101-01-22	1	Assemble components	T2/T3 Mech. Assembly, SSLC	Purchased Parts	General Assembly	Mech Assembly, MC, Base	277	1	1	2	0.030	$1.00	$35.51	$30.00	$60.00	$0.03	$0.13	$0.22	$0.37	0.30%	6.00%	4.00%	0.00%	10.30%	$0.04	$0.41	$0.41		
3A	Retainer Check Valve Assembly	1107-N0101-01-24-1	1	Machining	T2/T3 CNC Turning, SSLC	Ni-Al-Bronze-630000, Bar	Lathe/Turning Operator	CNC Turning, LC	144	1	2	1	0.075	$2.44	$37.60	$25.00	$50.00	$0.18	$0.26	$0.35	$0.79	0.30%	6.00%	4.00%	0.00%	10.30%	$0.08	$0.87	$0.87		
4A	Plate - Check Valve	1107-N0101-01-20	2	Machining	T2/T3 CNC Turning, SSLC	S-Steel-304, Bar	Lathe/Turning Operator	CNC Turning, LC	257	0.5	2	2	0.000	$1.65	$37.60	$25.00	$100.00	$0.00	$0.07	$0.39	$0.46	0.30%	6.00%	4.00%	0.00%	10.30%	$0.05	$0.51	$1.02		
5A	Seat - Check Valve Plate	1107-N0101-01-21	2	Machining	T2/T3 CNC Turning, SSLC	S-Steel-304, Bar	Lathe/Turning Operator	S-CNC Turning, MC	250	1	2.5	1	0.005	$1.65	$37.60	$55.00	$137.50	$0.01	$0.15	$0.55	$0.71	0.30%	6.00%	4.00%	0.00%	10.30%	$0.07	$0.78	$1.56		
6A	Retainer Check Valve	1107-N0101-01-17	2	Machining	T2/T3 CNC Turning, SSLC	S-Steel-316, Bar	Lathe/Turning Operator	S-CNC Turning, HC	251	1	3	1	0.050	$2.44	$37.60	$85.00	$255.00	$0.12	$0.15	$1.02	$1.29	0.30%	6.00%	4.00%	0.00%	10.30%	$0.13	$1.42	$2.84		
7A	Bellow piston cavity	1107-N0101-01-14-1	2	Cut and Form Tube Stock	T2/T3 Hydro/CNC Form, MSMC	Titanium-6AL4V, Bar	Cut/Punch/Forming Operator	Hydro/CNC Form, MLS, MHC	225	1	1	1	0.010	$34.37	$42.18	$150.12	$150.12	$0.34	$0.19	$0.67	$1.20	5.00%	6.50%	6.00%	1.00%	18.50%	$0.22	$1.42	$2.84		
8A	Spring Seat	1107-N0101-01-14-2	2	Machining	T2/T3 CNC Turning, SSLC	S-Steel-316, Bar	Lathe/Turning Operator	S-CNC Turning, MC	235	1	3	1	0.050	$2.44	$37.60	$55.00	$165.00	$0.12	$0.16	$0.70	$0.98	0.30%	6.00%	4.00%	0.00%	10.30%	$0.10	$1.09	$2.17		
9A	Top Seat and Sealing Flange	1107-N0101-01-14-3	2	Machining	T2/T3 CNC Turning, SSLC	S-Steel-316, Bar	Lathe/Turning Operator	S-CNC Turning, MC	230	1	3	1	0.110	$2.44	$37.60	$55.00	$165.00	$0.27	$0.16	$0.72	$1.15	0.30%	6.00%	4.00%	0.00%	10.30%	$0.12	$1.27	$2.54		
10A	Bellow Retainer	1107-N0101-01-16-1	2	Machining	T2/T3 CNC Turning, SSLC	A-Steel-41XXS, Bar	Lathe/Turning Operator	S-CNC Turning, MC	231	2	5	1	0.500	$0.78	$37.60	$55.00	$275.00	$0.39	$0.33	$1.19	$1.91	0.30%	6.00%	4.00%	0.00%	10.30%	$0.20	$2.10	$4.21		
11A	Piston High pressure pump	1107-N0101-01-11	2	Machining	T2/T3 CNC Turning, SSLC	A-Steel-4140, Bar	Lathe/Turning Operator	S-CNC Turning, MC	225	2	4	1.5	0.030	$0.78	$37.60	$55.00	$330.00	$0.02	$0.33	$1.47	$1.82	0.30%	6.00%	4.00%	0.00%	10.30%	$0.19	$2.01	$4.02		
12A	Cap Piston contact to swash plate	1107-N0101-01-10	2	Plating	T2/T3 Plate/Finish Mech., SSLC	Not Applicable	Plating/Coating Operator	Plate/Finish, SMS, LMC	360	0.5	1	1	0.000	$0.00	$55.17	$100.17	$100.17	$0.00	$0.08	$0.28	$0.35	0.30%	6.00%	4.00%	0.00%	10.30%	$0.04	$0.39	$0.78		
12B	Cap Piston contact to swash plate	1107-N0101-01-10	2	Machining	T2/T3 CNC Turning, SSLC	A-Steel-4140, Bar	Lathe/Turning Operator	S-CNC Turning, MC	225	1	2	1.5	0.000	$0.78	$37.60	$55.00	$165.00	$0.00	$0.17	$0.73	$0.90	0.30%	6.00%	4.00%	0.00%	10.30%	$0.09	$0.99	$1.99		
13A	Casting: Swash Plate Drive Housing	1107-N0101-01-09-2	1	Aluminum Diecast	T2/T3 Diecast, SSLC	Aluminum-A380, Cast	Mold/Cast/Sinter Operator	Diecast, LMC	286	0.5	1	1	0.209	$1.10	$43.52	$100.05	$100.05	$0.23	$0.08	$0.35	$0.66	5.00%	6.00%	4.00%	0.00%	15.00%	$0.10	$0.75	$0.75		
13A	Swash Plate Drive Housing Machined	1107-N0101-01-09-1	1	Machine Casting	T2/T3 CNC Turning, MSMC	Not Applicable	Mold/Cast/Sinter Operator	RTM Turning, HC, PP, Base	300	0.5	1	1	0.000	$0.00	$43.52	$200.00	$200.00	$0.00	$0.07	$0.67	$0.74	0.50%	6.50%	6.00%	1.00%	14.00%	$0.10	$0.84	$0.84		
14A	Swash Plate Assy - Cast	1107-N0101-01-09-5-3	1	Iron Casting	T2/T3 Perm. Cast, MSMC	Nodular Iron, Cast	Mold/Cast/Sinter Operator	Perm. Cast, MHC	286	3	1	1	0.219	$0.35	$43.52	$150.06	$150.06	$0.08	$0.46	$0.53	$1.06	5.00%	6.50%	6.00%	1.00%	18.50%	$0.20	$1.25	$1.25		
14B	Swash Plate Assy	1107-N0101-01-09-5-2	1	Machine Casting	T2/T3 CNC Turning, MSMC	Not Applicable	CNC Operator	RTM Turning, HC, PP, Base	360	0.5	1	1.2	0.000	$0.00	$35.70	$200.00	$240.00	$0.00	$0.05	$0.67	$0.72	0.50%	6.50%	6.00%	1.00%	14.00%	$0.10	$0.82	$0.82		
14C	Swash Plate Assy	1107-N0101-01-09-5-1	1	Heat Treat	T2/T3 Plate/Finish Mech., SSLC	Not Applicable	Heat Treat Operator	Heat Treat, SMS, MHC	250	1	1	1	0.000	$0.00	$46.52	$100.00	$100.00	$0.00	$0.19	$0.40	$0.59	0.30%	6.00%	4.00%	0.00%	10.30%	$0.06	$0.65	$0.65		
14D	Swash Plate Assy	1107-N0101-01-09-5	1	Grind	T2/T3 CNC Turning, MSMC	Not Applicable	CNC Operator	CNC Turning, MC	124	1	1	1	0.000	$0.00	$35.70	$45.00	$45.00	$0.00	$0.29	$0.36	$0.65	0.50%	6.50%	6.00%	1.00%	14.00%	$0.09	$0.74	$0.74		
15A	Shaft Drive Adapter PM	1107-N0101-01-09-6-5	1	Press and Sinter	T2/T3 Powder Metal, SSLC	PM-SMF-Iron Base	Mold/Cast/Sinter Operator	Powder Metal, LMC	632	1	1	1	0.037	$1.00	$43.52	$100.14	$100.14	$0.04	$0.07	$0.16	$0.26	0.30%	6.00%	4.00%	0.00%	10.30%	$0.03	$0.29	$0.29		
15B	Shaft Drive Adapter w/out backlash adjuster	1107-N0101-01-09-6-1	1	Machining	T2/T3 CNC Milling, SSLC	Not Applicable	Mold/Cast/Sinter Operator	CNC Machining, LMC	200	0.25	1	2	0.000	$0.00	$43.52	$25.00	$50.00	$0.00	$0.05	$0.25	$0.30	0.30%	6.00%	4.00%	0.00%	10.30%	$0.03	$0.34	$0.34		
17A	Mount Bracket HP fuel Pump	1107-N0101-01-03	1	Ground Flat	T2/T3 CNC Milling, SSLC	Not Applicable	Cut/Punch/Forming Operator	Fine blank, LMC	600	1	1	1	0.000	$0.00	$42.18	$100.13	$100.13	$0.00	$0.07	$0.17	$0.24	0.30%	6.00%	4.00%	0.00%	10.30%	$0.02	$0.26	$0.26		
17B	Mount Bracket HP fuel Pump	1107-N0101-01-03-1	1	Fineblanked	T2/T3 Fine Blank, SSLC	MC-Steel-1000S, Coil	Cut/Punch/Forming Operator	Fine blank, LMC	391	0.5	1	1	1.080	$0.55	$42.18	$100.13	$100.13	$0.59	$0.05	$0.26	$0.90	0.30%	6.00%	4.00%	0.00%	10.30%	$0.09	$1.00	$1.00		
18A	Spacer - Mount Bracket - swash plate retainer	1107-N0101-01-02	1	Fineblanked	T2/T3 Fine Blank, SSLC	Not Applicable	Cut/Punch/Forming Operator	Fine blank, LMC	600	1	1	1	0.000	$0.00	$42.18	$100.13	$100.13	$0.00	$0.07	$0.17	$0.24	0.30%	6.00%	4.00%	0.00%	10.30%	$0.02	$0.26	$0.26		
18B	Spacer - Mount Bracket	1107-N0101-01-02-1	1	Fineblanked	T2/T3 Fine Blank, SSLC	MC-Steel-1000S, Coil	Cut/Punch/Forming Operator	Fine blank, LMC	439	0.5	1	1	0.557	$0.55	$42.18	$100.13	$100.13	$0.31	$0.05	$0.23	$0.58	0.30%	6.00%	4.00%	0.00%	10.30%	$0.06	$0.64	$0.64		
19A	Diaphragm Temperature Compensating	1107-N0101-01-08	1	Assemble & Test	T2/T3 Mech. Assembly, SSLC	Purchased Parts	Cut/Punch/Forming Operator	Mech Assembly, LC, Base	300	1	1	3	0.120	$1.00	$42.18	$15.00	$45.00	$0.12	$0.14	$0.15	$0.41	0.30%	6.00%	4.00%	0.00%	10.30%	$0.04	$0.45	$0.45		
19B	Top Stamping Diaphragm Temperature Compensating	1107-N0101-01-08-1	1	Form & Stamp	T2/T3 Stamp/Form, SSLC	LC-Steel-1000S, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	621	0.5	1	1	0.042	$0.45	$42.18	$100.10	$100.10	$0.02	$0.03	$0.16	$0.21	0.30%	6.00%	4.00%	0.00%	10.30%	$0.02	$0.24	$0.24		
19C	Bottom Stamping Diaphragm Temperature Compensating	1107-N0101-01-08-2	1	Form & Stamp	T2/T3 Stamp/Form, SSLC	LC-Steel-1000S, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	643	0.5	1	1	0.018	$0.45	$42.18	$100.10	$100.10	$0.01	$0.03	$0.16	$0.20	0.30%	6.00%	4.00%	0.00%	10.30%	$0.02	$0.22	$0.22		
20A	Fitting Fuel Inlet	1107-N0101-01-06	1	Machine	T2/T3 CNC Turning, SSLC	S-Steel-304, Bar	Lathe/Turning Operator	S-CNC Turning, MC	123	0.5	1.5	1	0.120	$1.65	$37.60	$55.00	$82.50	$0.20	$0.15	$0.67	$1.02	0.30%	6.00%	4.00%	0.00%	10.30%	$0.11	$1.13	$1.13		

Manufacturing Assumption and Quote Summary

APPENDIX G.1-11, (3of7)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Fuel Pump - High Pressure w. Vol.Control Valve (Driven-Off Intake Cam) **Part Number:** 1107-N0101-01
Component Quote Level: ☑ Full Quote ☐ Modification ☐ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 High Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	4mm Ball Plug	NA	7	Purchase Part	B1A																					$0.00	$0.01	$0.07	$0.00		
2A	Seat Fuel Outlet Fitting	NA	1	Purchase Part	B1A																					$0.00	$0.04	$0.04	$0.00		
3A	Check Ball	1107-N0101-01-22-3	1	Purchase Part	B3A																					$0.00	$0.01	$0.01	$0.00		
4A	Spring Check Ball	1107-N0101-01-22-4	1	Purchase Part	B3A																					$0.00	$0.01	$0.01	$0.00		
5A	Seat Check Ball	1107-N0101-01-22-5	1	Purchase Part	B3A																					$0.00	$0.01	$0.01	$0.00		
6A	Spring Check Valve	1107-N0101-01-23	1	Purchase Part	S																					$0.00	$0.03	$0.00	$0.03		
7A	Seat Check valve spring	1107-N0101-01-18	2	Purchase Part	S																					$0.00	$0.06	$0.00	$0.12		
8A	Spring - Check Valve	1107-N0101-01-19	2	Purchase Part	S																					$0.00	$0.01	$0.00	$0.02		
9A	Spring Bellow return	1107-N0101-01-13	2	Purchase Part	S																					$0.00	$0.05	$0.00	$0.10		
10A	Pin Guide	Pin Guide	2	Purchase Part	S																					$0.00	$0.02	$0.00	$0.04		
11A	O-Ring Bellow OD sealing	1107-N0101-01-15	2	Purchase Part	S																					$0.00	$0.07	$0.00	$0.14		
12A	Tip Insert - Orifice	1107-N0101-01-16-2	2	Purchase Part	S																					$0.00	$0.02	$0.00	$0.04		
13A	Spring HP piston	1107-N0101-01-12	2	Purchase Part	S																					$0.00	$0.06	$0.00	$0.12		
14A	Seal Swash Plate shaft	1107-N0101-01-09-4	1	Purchase Part	S																					$0.00	$0.19	$0.00	$0.19		
15A	Bearing Roller, Swash Plate Shaft	1107-N0101-01-09-8	1	Purchase Part	S																					$0.00	$0.23	$0.00	$0.23		
16A	Bearing Roller Thrust, Swash Plate	1107-N0101-01-09-7	1	Purchase Part	S																					$0.00	$0.65	$0.00	$0.65		
17A	Spring Backlash adjust	1107-N0101-01-09-6-4	2	Purchase Part	S																					$0.00	$0.01	$0.00	$0.02		
18A	Ball Backlash Adjust	1107-N0101-01-09-6-3	2	Purchase Part	S																					$0.00	$0.01	$0.00	$0.02		
19A	Ball Seat/Retainer	1107-N0101-01-09-6-2	2	Purchase Part	S																					$0.00	$0.01	$0.00	$0.02		
20A	O-ring OD Seal to pump housing	1107-N0101-01-09-3	1	Purchase Part	S																					$0.00	$0.08	$0.00	$0.08		
21A	Bolt Mount bracket	1107-N0101-01-01	3	Purchase Part	S																					$0.00	$0.05	$0.00	$0.15		
22A	Oil Swash Plate cavity	1107-N0101-01-26	1	Purchase Part	S																					$0.00	$0.20	$0.00	$0.20		
23A	Spring Stamping Diaphragm Temperature Comp	1107-N0101-01-08-3	1	Purchase Part	B19A																					$0.00	$0.07	$0.07	$0.00		
23B	Diaphragm Temperature Compensating	1107-N0101-01-08-3-1	1	Purchase Part	B19A																					$0.00	$0.05	$0.05	$0.00		
24	Screen Fuel Inlet	1107-N0101-01-07	1	Purchase Part	S																					$0.00	$0.08	$0.00	$0.08		
25	Solenoid Fuel Pump Control	1107-N0101-01-05	1	Purchase Part	S																					$0.00	$10.00	$0.00	$10.00		
26	Bolt Control Solenoid - fuel pump	1107-N0101-01-04	2	Purchase Part	S																					$0.00	$0.06	$0.00	$0.12		
27	Seal - High Pressure Fuel Pump to Cylinder Head	1185-N0101-01	1	Purchase Part	S																					$0.00	$0.08	$0.00	$0.08		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up					
											1	$58.06		
T1 or OEM Total Manufacturing Cost:	$16.99	$8.24	$28.32	$53.55	$0.33	$2.30	$1.76	$0.14	$4.52	→	3	$58.06		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.70%	7.00%	8.00%	4.00%	19.70%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.41	$4.06	$4.65	$2.32	$11.44					
Base Cost Impact to Vehicle:	$16.99	$8.24	$28.32	$53.55	$0.73	$6.36	$6.40	$2.46	$15.96	→		$69.50	$0	$0
											Packaging Cost:	$0.11		
											Net Cost Impact to Vehicle:	$69.61		

PACKAGING CALCULATIONS:
Packaging Type: Option #3 Totes
Part Size: 100x100x100
Parts/Layer: 4x2
Number of Layers: 3

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.111		$221,160	0.00%	2,250,000	60	5.00%		$3,880	57	1008	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.111												

Manufacturing Assumption and Quote Summary

APPENDIX G1-11, (4of7)
Print Date:9/2/2009

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Pipe Assembly - Fuel, High Pressure, Pump to Rail **Part Number:** 1170-N0101-01
Component Quote Level: ☑ Full Quote ☐ Modification ☐ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 Low Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Returnable

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
1A	Pipe - Fuel, High Pressure, Pump to Rail	1170-N0101-01	1	Assembly Tube Nuts and Flare	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, LC, Base	225	1	1	2	0.000	$0.00	$35.51	$15.00	$30.00	$0.00	$0.16	$0.13	$0.29	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.29	$0.29		
Purchase Part - High Impact Item (Full Cost Mapping)																															
1A	Tube Stock HP pump to rail	1170-N0101-01-01	1	CNC Tube Bending	T1 Assembly, Mark-up Applied @ Bottom.	S-Steel-304, Tube	Cut/Punch/Forming Operator	Hydro/CNC Form, SMS, LMC	171	0.25	1	1	0.060	$1.65	$42.18	$100.12	$100.12	$0.10	$0.06	$0.58	$0.74	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.74	$0.74		
2A	Tube Nut HP pump to rail	1170-N0101-01-02	2	Screw Machine Hex Bar Stock	T1 Assembly, Mark-up Applied @ Bottom.	S-Steel-304, Tube	CNC Operator	CNC Turning, LC	288	0.5	2	1	0.088	$1.65	$35.70	$25.00	$50.00	$0.15	$0.06	$0.17	$0.38	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.38	$0.76		
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
																		Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$1.80		
																	T1 or OEM Total Manufacturing Cost:	$0.39	$0.34	$1.06	$1.80	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$1.80		
																	T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.30%	6.00%	4.00%	1.00%	11.30%					
																	(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.01	$0.11	$0.07	$0.02	$0.20					
																	Base Cost Impact to Vehicle:	$0.39	$0.34	$1.06	$1.80	$0.01	$0.11	$0.07	$0.02	$0.20	→		$2.00	$0	$0
																												Packaging Cost:	$0.008		
																												Net Cost Impact to Vehicle:	$2.01		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

PACKAGING CALCULATIONS:
Packaging Type: Option #3 Packaging
Part Size:=(1/2*(170*70))*50)= 2.975E5mm^3
Tote Volume= 508x300x300=45.7E6mm^3
Parts/Tote = 150

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.008		$16,117	0.00%	2,250,000	60	5.00%		$2,020	8	7200	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.008												

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: B0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Chrysler GEMA, 2.4L I4, 16V DOHC, NA, dVVT, 173hp
Component Description: Fuel Rail Assembly **Part Number:** 1101-B0101-01
Component Quote Level: ☑ Full Quote ☐ Modification ☑ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 Low Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
1A	Fuel Rail Assembly	1101-B0101-01	1	Flow Drill Injector Cups to Rail	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, HC, Base	157	2	1	1	0.000	$0.00	$35.51	$45.00	$45.00	$0.00	$0.45	$0.29	$0.74	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.74	$0.74		
2A	Fuel Rail Assembly	1101-B0101-01	1	Projection Weld Brackets	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, LC, Base	257	1	1	1	0.000	$0.00	$35.51	$15.00	$15.00	$0.00	$0.14	$0.06	$0.20	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.20	$0.20		
3A	Fuel Rail Assembly	1101-B0101-01	1	Assembly end caps and inlet tube and braze weld assembly.	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, LC, Base	157	2	1	4	0.000	$0.00	$35.51	$15.00	$60.00	$0.00	$0.45	$0.38	$0.84	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.84	$0.84		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
Purchase Part - High Impact Item (Full Cost Mapping)																															
1A	Tube Injector Rail	1101-B0101-01-3	1	Cut to length and back extrude inlet	T1 Assembly, Mark-up Applied @ Bottom.	S-Steel-304, Tube	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	300	1	1	1	0.563	$1.65	$42.18	$100.10	$100.10	$0.93	$0.14	$0.33	$1.40	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.40	$1.40		
2A	End Cap	1101-B0101-01-4	2	Stamp	T1 Assembly, Mark-up Applied @ Bottom.	S-Steel-304, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	706	0.5	1	1	0.011	$1.64	$42.18	$100.10	$100.10	$0.02	$0.03	$0.14	$0.19	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.19	$0.38		
3A	Cup Injector Port	1101-B0101-01-5	4	Stamp	T1 Assembly, Mark-up Applied @ Bottom.	S-Steel-304, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	735	0.5	1	1	0.006	$1.64	$42.18	$100.10	$100.10	$0.01	$0.03	$0.14	$0.17	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.17	$0.70		
4A	Bracket Rail Mounting	1101-B0101-01-6	2	Stamp	T1 Assembly, Mark-up Applied @ Bottom.	S-Steel-304, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	679	0.5	1	1	0.095	$1.64	$42.18	$100.10	$100.10	$0.16	$0.03	$0.15	$0.33	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.33	$0.67		
5A	Inlet Tube	1101-B0101-01-7	1	Bend & Form	T1 Assembly, Mark-up Applied @ Bottom.	S-Steel-304, Tube	Cut/Punch/Forming Operator	Hydro/CNC Form, SMS, LMC	600	0.5	1	1	0.029	$1.65	$42.18	$100.12	$100.12	$0.05	$0.04	$0.17	$0.25	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.25	$0.25		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up	1	$5.18		
T1 or OEM Total Manufacturing Cost:	$1.36	$1.46	$2.35	$5.18	$0.00	$0.00	$0.00	$0.00	$0.00	3	$5.18		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.30%	6.00%	4.00%	1.00%	11.30%				
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.02	$0.31	$0.21	$0.05	$0.58				
Base Cost Impact to Vehicle:	$1.36	$1.46	$2.35	$5.18	$0.02	$0.31	$0.21	$0.05	$0.58		$5.76	$0	$0
										Packaging Cost:	$0.07		
										Net Cost Impact to Vehicle:	$5.83		

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: B0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Chrysler GEMA, 2.4L I4, 16V DOHC, NA, dVVT, 173hp
Component Description: Fuel Rail Assembly **Part Number:** 1101-B0101-01
Component Quote Level: ☑ Full Quote ☐ Modification ☑ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 Low Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "

Pallet Options
Option1: 48"(122cm)x45"(114cm)x34"(86cm)
Investment $200 US funds (Mike S.)
Assume Plastic Returnables Last 5 Years

Option2: Vacuum Form Pack Made from 1/4" HDPE (Approx. Same Pallet size as Option #1.
(Mike S. 020909)
Investment $20K for tool
Piece Price, Pallet Base $100/Base
Piece Price, Tier Pad $40/Pad

Option3: Smaller Totes Approx 20"(508 mm)x12"(300mm)x12"(300mm)
Package: 8 Layers of 6 on single Pallet Base.
Cost per Tote: $75/Tote
Cost per Base $100/Base

Cardboard Tier Pads for Option 1 Pallets $1.00/Pad (Mike S.)
Cardboard Divider Pads for Option 1 Pallet $3.00/Pad (Mike S.)
ABS Vacuum Form Pads 2.5mm Thick for Option #3 Pallets, $5.00
Returnable Dividers For Option 1 Pallet - 8 Cells (2x4)xHeight of Pallet, =$20.00

PACKAGING CALCULATIONS: Packaging Type: Option #3 Part Size: Parts/Layer: 1X12 Number of Layers 3	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.069		$138,963	0.00%	2,250,000	60	5.00%		$4,180	33	1728	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.069												

Manufacturing Assumption and Quote Summary

APPENDIX G.1-11 (6of7)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Chrysler GEMA, 2.4L I4, 16V DOHC, NA, dVVT, 173hp
Component Description: Fuel Injector Assembly - Low Pressure, 4 Hole
Part Number: 1104-B0101-01
Component Quote Level: ☑ Full Quote ☐ Modification ☐ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 4
Annual Component Volume: 1,800,000
Weekly Component Volume: 38,298
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 High Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
1A	Injector Tip Assembly	1104-B0101-01-80	1	Assemble Injector Tip	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, MC, Base	1800	0.5	1	4	0.000	$0.00	$35.51	$30.00	$120.00	$0.00	$0.01	$0.07	$0.08	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.08	$0.08		
2A	Injector Needle Assembly	1104-B0101-01-70	1	Assemble Injector Needle	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, MC, Base	480	0.5	2	3	0.000	$0.00	$35.51	$30.00	$180.00	$0.00	$0.04	$0.38	$0.41	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.41	$0.41		
3A	Needle Body Assembly	1104-B0101-01-71	1	Assemble Injector Needle	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, MC, Base	480	2	2	7	0.000	$0.00	$35.51	$30.00	$420.00	$0.00	$0.15	$0.88	$1.02	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.02	$1.02		
4A	Solenoid Body Overmold	1104-B0101-01-72	1	Overmold Solenoid Body	T1 Assembly, Mark-up Applied @ Bottom.	Nylon66-40FMR, Inject.	Electromechanical Assembly	Mech Assembly, HC, Base	450	2	2	1	0.030	$1.54	$37.35	$45.00	$90.00	$0.05	$0.17	$0.20	$0.41	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.41	$0.41		
5A	Final Assembly	1104-B0101-01-73	1	Final Assembly & Test	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, HC, Base	480	2	2	6	0.000	$0.00	$35.51	$45.00	$540.00	$0.00	$0.15	$1.13	$1.27	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.27	$1.27		
Purchase Part - High Impact Item (Full Cost Mapping)																															
1A	Tube Inlet	1104-B010101-01-21	1	Machine	T2/T3 CNC Turning, MSMC	A-Steel-41XXS, Bar	CNC Operator	CNC Turning, LC	471	2	5.5	1	0.035	$0.78	$35.70	$25.00	$137.50	$0.03	$0.15	$0.29	$0.47	0.50%	6.50%	6.00%	1.00%	14.00%	$0.07	$0.54	$0.54		
2A	Inlet Sleeve Adaptor Stamped	1104-B0101-01-50	1	Stamped	T2/T3 Stamp/Form, SSLC	A-Steel-41XXS, Bar	Cut/Punch/Forming Operator	Stamp/Form, SMS, MHC	1200	0.5	1	1	0.008	$0.78	$42.18	$125.10	$125.10	$0.01	$0.02	$0.10	$0.13	0.30%	6.00%	4.00%	0.00%	10.30%	$0.01	$0.14	$0.14		
3A	Coupler Fuel Inlet	1104-B0101-01-28	1	Machine	T2/T3 CNC Turning, MSMC	A-Steel-41XXS, Bar	CNC Operator	S-CNC Turning, LC	450	1	4	1	0.023	$0.78	$35.70	$35.00	$140.00	$0.02	$0.08	$0.31	$0.41	0.50%	6.50%	6.00%	1.00%	14.00%	$0.06	$0.47	$0.47		
4A	Body, Needle	1104-B0101-01-09	1	Machine	T2/T3 CNC Turning, MSMC	A-Steel-41XXS, Bar	CNC Operator	S-CNC Turning, LC	465	1	4	1	0.049	$0.78	$35.70	$35.00	$140.00	$0.04	$0.08	$0.30	$0.42	0.50%	6.50%	6.00%	1.00%	14.00%	$0.06	$0.47	$0.47		
5A	Can Solenoid Housing	1104-B0101-01-51	1	Stamped	T2/T3 Stamp/Form, SSLC	A-Steel-41XXS, Bar	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	720	0.5	1	1	0.043	$0.78	$42.18	$100.10	$100.10	$0.03	$0.03	$0.14	$0.20	0.30%	6.00%	4.00%	0.00%	10.30%	$0.02	$0.22	$0.22		
6A	Needle Valve	1104-B0101-01-24	1	Stamped/Forged	T2/T3 Stamp/Form, SSLC	A-Steel-41XXS, Bar	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	600	0.5	1	1	0.005	$0.78	$42.18	$100.10	$100.10	$0.00	$0.04	$0.17	$0.21	0.30%	6.00%	4.00%	0.00%	10.30%	$0.02	$0.23	$0.23		
7A	Needle Valve Seat	1104-B0101-01-52	1	Machine	T2/T3 CNC Turning, MSMC	A-Steel-41XXS, Bar	CNC Operator	S-CNC Turning, LC	643	0.5	2.5	1	0.005	$0.78	$35.70	$35.00	$87.50	$0.00	$0.03	$0.14	$0.17	0.50%	6.50%	6.00%	1.00%	14.00%	$0.02	$0.19	$0.19		
8A	Bracket Injector Hold down	1104-B0101-01-02-01	1	Stamp	T2/T3 Stamp/Form, SSLC	SPR-Steel, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	1800	0.25	1	1	0.021	$0.65	$42.18	$100.10	$100.10	$0.01	$0.01	$0.06	$0.07	0.30%	6.00%	4.00%	0.00%	10.30%	$0.01	$0.08	$0.08		
8B	Bracket Injector Hold down	1104-B0101-01-02	1	Heat Treat & Plate	T2/T3 Heat Treat, SSLC	General Underhood Plating	Plating/Coating Operator	Plate/Finish, SMS, LMC	1800	0.5	1	1	0.001	$15.00	$55.17	$100.17	$100.17	$0.02	$0.02	$0.06	$0.09	0.30%	6.00%	4.00%	0.00%	10.30%	$0.01	$0.09	$0.09		
9A	Injector Tip Housing	1104-N0101-01-08	1	Machine	T2/T3 CNC Turning, MSMC	A-Steel-41XXS, Bar	CNC Operator	S-CNC Turning, MC	450	1	4.5	1	0.003	$0.78	$35.70	$55.00	$247.50	$0.00	$0.08	$0.55	$0.63	0.50%	6.50%	6.00%	1.00%	14.00%	$0.09	$0.72	$0.72		
10A	Plate - Injector Tip	1104-N0101-01-08-02	1	Stamp	T2/T3 CNC Turning, MSMC	HC-Steel-4130, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	3600	0.25	1	1	0.000	$0.78	$42.18	$100.10	$100.10	$0.00	$0.00	$0.03	$0.03	0.50%	6.50%	6.00%	1.00%	14.00%	$0.00	$0.04	$0.04		
10B	Plate - Injector Tip	1104-N0101-01-08-01	1	Laser Injector Holes	T2/T3 CNC Turning, MSMC	Not Applicable	CNC Operator	CNC Milling, LMC	3600	0.25	1	1	0.000	$0.00	$35.70	$125.15	$125.15	$0.00	$0.00	$0.03	$0.04	0.50%	6.50%	6.00%	1.00%	14.00%	$0.01	$0.04	$0.04		
11A	Tip Relief Plate	1104-B0101-01-70	1	Stamp	T2/T3 Stamp/Form, SSLC	HC-Steel-4130, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	2057	0.25	1	1	0.000	$0.78	$42.18	$100.10	$100.10	$0.00	$0.01	$0.05	$0.05	0.30%	6.00%	4.00%	0.00%	10.30%	$0.01	$0.06	$0.06		
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Sleeve Screen-Screen Stop	1104-B0101-01-25	1		S																					$0.00	$0.01	$0.00	$0.01		
2A	Screen, Fuel Inlet	1104-B0101-01-06	1		S																					$0.00	$0.05	$0.00	$0.05		
3A	Retainer Metering valve, Upper Spring Seat	1104-B0101-01-17	1		S																					$0.00	$0.02	$0.00	$0.02		
4A	Ball Needle Seat	1104-B0101-01-23	1	(Used Pricing from Mini Injector)	S																					$0.00	$0.41	$0.00	$0.41		
5A	Spring - Needle Return	1104-B0101-01-12	1		S																					$0.00	$0.03	$0.00	$0.03		
6A	Solenoid Winding Assembly	1104-N0101-01-22	1		S																					$0.00	$0.15	$0.00	$0.15		
7A	O-Ring Injector to Rail Seal	1104-B0101-01-61	1		S																					$0.00	$0.09	$0.00	$0.09		
8A	O-Ring Injector to Head	1104-B0101-01-62	1		S																					$0.00	$0.05	$0.00	$0.05		
9A	Sleeve Injector Head	1104-B0101-01-63	1		S																					$0.00	$0.02	$0.00	$0.02		
10A	Injector Slip Washer	1104-B0101-01-64	1		S																					$0.00	$0.01	$0.00	$0.01		
																		Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$7.31		
																	T1 or OEM Total Manufacturing Cost:	$1.03	$1.04	$4.86	$6.93	$0.01	$0.19	$0.16	$0.02	$0.38		3	$7.31		
																	T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.70%	7.00%	8.00%	4.00%	19.70%					
																	(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.05	$0.51	$0.59	$0.29	$1.44					
																	Base Cost Impact to Vehicle:	$1.03	$1.04	$4.86	$6.93	$0.06	$0.70	$0.74	$0.31	$1.82			$8.76	$0	$0
																												Packaging Cost:	$0.01		
																												Net Cost Impact to Vehicle:	$8.77		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Chrysler GEMA, 2.4L I4, 16V DOHC, NA, dVVT, 173hp
Component Description: Fuel Injector Assembly - Low Pressure, 4 Hole **Part Number:** 1104-B0101-01
Component Quote Level: ☑ Full Quote ☐ Modification ☐ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 4
Annual Component Volume: 1,800,000
Weekly Component Volume: 38,298
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 High Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "

PACKAGING CALCULATIONS: Packaging Type: Option #3 Tote Part Size: 90x55x25 mm Parts/Layer: 3 x 8 Number of Layers: 9	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.012		$97,961	0.00%	9,000,000	60	5.00%		$4,420	22	10368	6	229787
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.012												

Engine Assembly-1100 R5

Manufacturing Assumption and Quote Summary

APPENDIX G.1-11, (7of7)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: OEM Assembly of Fuel Induction Components to Engine **Part Number:** 1100
Component Quote Level: ☐ Full Quote ☐ Modification ☑ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: OEM Engine Assembly
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
1A	Fuel Rail - High Pressure	1101-N0101-02	1	Install Fuel Rail to Cylinder Head **(Two Additional Fasteners Over Base GEMA Engine)**	OEM Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly-OEM	Engine Assembly, OEM	257	1	1	1	0.000	$0.00	$83.31	$150.21	$150.21	$0.00	$0.32	$0.58	$0.91	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.91	$0.91		
2A	Fuel Injector Assembly - Solenoid, 7 Hole	1104-N0101-01	4	**Install Fuel Injectors to Cylinder Head, Considered Wash to Base Engine**	OEM Assembly, Mark-up Applied @ Bottom.	Not Applicable	Not Applicable	Not Applicable	451	1	1	1	0.000	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.00	$0.00		
	Fuel Pump - High Pressure w. Vol.Control Valve (Driven-Off Intake Cam)	1107-N0101-01	1	Install Fuel Pump to Cylinder Head, 3 Fasteners	OEM Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly-OEM	Engine Assembly, OEM	171	1	1	1	0.000	$0.00	$83.31	$150.21	$150.21	$0.00	$0.49	$0.88	$1.36	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.36	$1.36		
	Pipe Assembly - Fuel, High Pressure, Pump to Rail	1170-N0101-01	1	Install High Pressure Pipe Between Fuel Rail and Pump. Run Down Two Tube Nuts	OEM Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly-OEM	Engine Assembly, OEM	257	1	1	1	0.000	$0.00	$83.31	$150.21	$150.21	$0.00	$0.32	$0.58	$0.91	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.91	$0.91		
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Fuel Rail - High Pressure (w. HP Sensor)	1101-N0101-02	1	(Mini Cooper)	SAC																					$20.76	$20.76	$0.00	$20.76		
2A	Fuel Injector Assembly - Solenoid, 7 Hole	1104-N0101-01	4	(Mini Cooper)	SAC																					$52.50	$13.13	$0.00	$52.50		
3A	Fuel Pump - High Pressure w. Vol.Control Valve (Driven-Off Intake Cam)	1107-N0101-01	1	(Mini Cooper)	SAC																					$69.61	$69.61	$0.00	$69.61		
4A	Pipe Assembly - Fuel, High Pressure, Pump to Rail	1170-N0101-01	1	(Mini Cooper)	SAC																					$2.01	$2.01	$0.00	$2.01		
			0																							$0.00	$0.00	$0.00	$0.00		
5A	Fuel Rail Assembly	1101-B0101-01	1	Chrysler GEMA	SAC																					($5.83)	($5.83)	$0.00	-$5.83		
6A	Fuel Injector Assembly - Low Pressure, 4 Hole	1104-B0101-01	4	Chrysler GEMA	SAC																					($35.07)	($8.77)	$0.00	-$35.07		
			0																							$0.00	$0.00	$0.00	$0.00		
7A	Bolt - Fuel Pump (to head)	1180-N0101-02	3		S																					$0.00	$0.03	$0.00	$0.09		
8A	Bolt - Fuel Rail (to head)	1180-N0101-01	2		S																					$0.00	$0.03	$0.00	$0.06		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up			Total 3	Tooling	Investment
											1	$107.31		
T1 or OEM Total Manufacturing Cost:	$104.14	$1.13	$2.04	$107.31	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$107.31		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%					
(SAC) &T1 or OEM Mark-Up Values:	(103.99)	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00					
Base Cost Impact to Vehicle:	$0.15	$1.13	$2.04	$3.33	$0.00	$0.00	$0.00	$0.00	$0.00	→		$3.33	$0	$0
											Packaging Cost:	$0.00		
											Net Cost Impact to Vehicle:	$3.33		

PACKAGING CALCULATIONS:
No Packaging Considerations Required.
Packaging Type:
Part Size:
Parts/Layer:
Number of Layers:

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Appendix G.1 - Subsystem 12
Exhaust Subsystem
Case Study #0101
MAQS Worksheets

Manufacturing Assumption and Quote Summary

APPENDIX G.1-12 (1of4)

Print Date:9/2/2009

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Manifold - Exhaust, Dual Wall **Part Number:** 1201-N0101-01
Component Quote Level: ☐ Full Quote ☐ Modification ☑ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 Moderate Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification:

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
1A	Manifold - Exhaust, Dual Wall (Mini)	1201-N0101-01-02	1	Cast	T1 Assembly, Mark-up Applied @ Bottom.	NiResist Iron, D5S, Cast	Mold/Cast/Sinter Operator	Sand Cast, HMC	141	6	1.5	2	7.760	$3.50	$43.52	$150.07	$450.21	$27.16	$1.85	$3.19	$32.20	10.00%	0.00%	0.00%	0.00%	10.00%	$3.22	$35.42	$35.42		
1B	Manifold - Exhaust, Dual Wall (Mini)	1201-N0101-01-01	1	Heat Treat, Pre Machine	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	Heat Treat Operator	Heat Treat, MLS, MHC	129	1	3	1	0.000	$0.00	$46.52	$250.00	$750.00	$0.00	$0.36	$5.83	$6.20	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$6.20	$6.20		
1C	Manifold - Exhaust, Dual Wall (Mini)	1201-N0101-01	1	Machining	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	Mold/Cast/Sinter Operator	CNC Machining, MHC	120	3	3	1.5	0.000	$0.00	$43.52	$45.00	$202.50	$0.00	$1.09	$1.69	$2.78	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$2.78	$2.78		
2A	Manifold - Exhaust, (Chrysler)	1201-B0101-01-02	1	Cast	T1 Assembly, Mark-up Applied @ Bottom.	Nodular Iron, Cast	Mold/Cast/Sinter Operator	Sand Cast, HMC	-145	6	1.5	1	-12.920	$0.35	$43.52	$150.07	$225.11	-$4.52	-$1.81	-$1.56	-$7.89	5.00%	0.00%	0.00%	0.00%	5.00%	-$0.39	-$8.28	-$8.28		
2B	Manifold - Exhaust, Dual Wall (Chrysler)	1201-B0101-01-01	1	Heat Treat, Pre Machine	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	Heat Treat Operator	Heat Treat, MLS, MHC	-125	1	2.5	1	0.000	$0.00	$46.52	$250.00	$625.00	$0.00	-$0.37	-$5.00	-$5.37	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	-$5.37	-$5.37		
2C	Manifold - Exhaust, Dual Wall (Chrysler)	1201-B0101-01	1	Machining	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	Mold/Cast/Sinter Operator	CNC Machining, MHC	-120	3	3	1	0.000	$0.00	$43.52	$45.00	$135.00	$0.00	-$1.09	-$1.13	-$2.21	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	-$2.21	-$2.21		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		

Casting & Machining Assumptions:
Casting: Assumption processing time increase due to part complexity and material grade is offset by reduction in material volume.
Machining: 50% premium paid on machining NiResist material over base nodular cast iron.

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up					
											1	$28.52		
T1 or OEM Total Manufacturing Cost:	$22.64	$0.03	$3.03	$25.70	$2.83	$0.00	$0.00	$0.00	$2.83	→	3	$28.52		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.50%	6.50%	6.00%	2.50%	15.50%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.14	$1.85	$1.71	$0.71	$4.42					
Base Cost Impact to Vehicle:	$22.64	$0.03	$3.03	$25.70	$2.97	$1.85	$1.71	$0.71	$7.25	→		$32.95	$0	$0
											Packaging Cost:	-$0.12		
											Net Cost Impact to Vehicle:	$32.82		

Manifold Exhaust 1201

Manufacturing Assumption and Quote Summary

APPENDIX G.1-12 (1of4)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Manifold - Exhaust, Dual Wall **Part Number:** 1201-N0101-01
Component Quote Level: ☐ Full Quote ☐ Modification ☑ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 Moderate Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification:

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "

PACKAGING CALCULATIONS: GEMA
Packaging Type: Option #2
Part Size: 380x280x130
Parts/Layer:3x4
Number of Layers: 6
Cost = $0.076/Part

PACKAGING CALCULATIONS: MINI Packaging Type: Option #2 Part Size:320x120X115 Parts/Layer: 3x10 Number of Layers: 7 Cost $0.03/Part	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.152		$303,191	0.00%	2,250,000	60	5.00%		$380	798	72	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.152												

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Bracket Subassembly- Heat Shield, Top, Turbo **Part Number:** 1275-N0101-02
Component Quote Level: ☐ Full Quote ☐ Modification ☑ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 Low Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: (Included in piece cost)

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
	Bracket Subassembly- Heat Shield, Top, Turbo	1275-N0101-02	1	Install Ceramic Fiber Paper (Fiberfrax 440), crimp and form.	T1 Assembly, Mark-up Applied @ Bottom.	Fiberfrax 440	General Assembly	Mech Assembly, MC, Base	450	1	1	1	256	$0.01	$35.51	$30.00	$30.00	$1.77	$0.08	$0.07	$1.91	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.91	$1.91		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
																		Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$1.91		
																	T1 or OEM Total Manufacturing Cost:	$1.77	$0.08	$0.07	$1.91	$0.00	$0.00	$0.00	$0.00	$0.00		3	$1.91		
																	T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.30%	6.00%	4.00%	0.00%	10.30%					
																	(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.01	$0.11	$0.08	$0.00	$0.20					
																	Base Cost Impact to Vehicle:	$1.77	$0.08	$0.07	$1.91	$0.01	$0.11	$0.08	$0.00	$0.20			$2.11	$0	$0
																												Packaging Cost:	$0.00		
																												Net Cost Impact to Vehicle:	$2.11		

Material Size "In^2" and Material Cost $/Inch^2.

PACKAGING CALCULATIONS:
Packaging Type:
Part Size:
Parts/Layer:
Number of Layers:

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Exhaust Sealing 1285

Manufacturing Assumption and Quote Summary

APPENDIX G.1-12, (3of4)
Print Date:9/2/2009

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Bracket Subassembly - Exhaust Manifold w. Integrated Gasket **Part Number:** 1275-N0101-01
Component Quote Level: ☐ Full Quote ☐ Modification ☑ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 Low Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Bracket Subassembly - Exhaust Manifold w. Integrated Gasket	1275-N0101-01	1	Upgrade from 2 to 3 layer exhaust gasket. Only considering gasket, no consideration required for heat shield mounting.	S																					$0.00	$0.95	$0.00	$0.95		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$0.95		
T1 or OEM Total Manufacturing Cost:	$0.95	$0.00	$0.00	$0.95	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$0.95		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00					
Base Cost Impact to Vehicle:	$0.95	$0.00	$0.00	$0.95	$0.00	$0.00	$0.00	$0.00	$0.00	→		$0.95	$0	$0
											Packaging Cost:	$0.00		
											Net Cost Impact to Vehicle:	$0.95		

PACKAGING CALCULATIONS:
Packaging Type:
Part Size:
Parts/Layer:
Number of Layers:

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Engine Assembly 1200

Manufacturing Assumption and Quote Summary

APPENDIX G.1-12 (4 of4)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Vehicle Operations or Engine Assembly of Exhaust Components **Part Number:** 1200
Component Quote Level: ☐ Full Quote ☐ Modification ☑ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: OEM Engine Assembly
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
	No differential labor/burden costs incurred to assembly exhaust system components.		0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
	Manifold Exhaust	1201-N0101-01	1		SAC																					$32.82	$32.82	$0.00	$32.82		
	Exhaust Brackets/Heat Shields	1275-N0101-02	1		SAC																					$2.11	$2.11	$0.00	$2.11		
	Exhaust Sealing	1275(85)-N0101-01	1		SAC																					$0.95	$0.95	$0.00	$0.95		
	Nut- Manifold Exhaust to Cylinder Head	1280-N0101-01	10		S																					$0.00	$0.18	$0.00	$1.83		
	Nut - Turbo to C.C. Catalytic Converter	1280-N0101-06	3		S																					$0.00	$0.02	$0.00	$0.06		
	Nut - Exhaust Manifold to Turbo	1280-N0101-07	4	(0.193-0.05)	S																					$0.00	$0.00	$0.00	$0.00		
	Cover cost of Nut-Exhaust Manifold to Turbo in Air Induction Engine Assembly Cost Sheet.		0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up				
										1	$37.77		
T1 or OEM Total Manufacturing Cost:	$37.77	$0.00	$0.00	$37.77	$0.00	$0.00	$0.00	$0.00	$0.00	→ 3	$37.77		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%				
(SAC) &T1 or OEM Mark-Up Values:	(35.88)	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00				
Base Cost Impact to Vehicle:	$1.89	$0.00	$0.00	$1.89	$0.00	$0.00	$0.00	$0.00	$0.00	→	$1.89	$0	$0
										Packaging Cost:	$0.00		
										Net Cost Impact to Vehicle:	$1.89		

PACKAGING CALCULATIONS:
Packaging Type: No change to packaging
Part Size:
Parts/Layer:
Number of Layers:

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Appendix G.1 - Subsystem 13
Lubrication Subsystem
Case Study #0101
MAQS Worksheets

Oil Pump 1302

Manufacturing Assumption and Quote Summary

APPENDIX G.1-13 (1of6)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Oil Pump Assembly **Part Number:** 1302-N0101-01
Component Quote Level: ☐ Full Quote ☐ Modification ☑ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 High Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification:

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Oil Pump Assembly	1302-N0101-01	1	Increase in Pump Capacity 15-20% (13%PCJ & 5% Turbo)	S																					$0.00	$3.08	$0.00	$3.08		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up	1	$3.08		
T1 or OEM Total Manufacturing Cost:	$3.08	$0.00	$0.00	$3.08	$0.00	$0.00	$0.00	$0.00	$0.00	→ 3	$3.08		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.70%	7.00%	8.00%	4.00%	19.70%				
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.02	$0.22	$0.25	$0.12	$0.61				
Base Cost Impact to Vehicle:	$3.08	$0.00	$0.00	$3.08	$0.02	$0.22	$0.25	$0.12	$0.61	→	$3.69	$0	$0
										Packaging Cost:	$0.00		
										Net Cost Impact to Vehicle:	$3.69		

PACKAGING CALCULATIONS:
No Packaging Updates Required
Packaging Type:
Part Size:
Parts/Layer:
Number of Layers:

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Filter Cooler Assembly 1306

Manufacturing Assumption and Quote Summary

APPENDIX G.1-13 (2of6)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Filter Cooler Assembly - Oil (Includes Seals)
Part Number: 1306-N0101-01
Component Quote Level: Full Quote ☐ Modification Quote ☒

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Oil Cooler Adapter/Base Plate Subassembly	1306-N0101-01-02-1A	1	Toggle Lock Adaptor and Base Plate Together	S	Not Applicable	General Assembly	Mech. Assembly, MC	300	1	0.000	$0.00	$35.51	$125.19	$0.00	$0.12	$0.42	$0.54	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.54	$0.54		
2A	Oil Cooler	1306-N0101-01-02	1	Fixture and Braze Weld	S	Not Applicable	General Assembly	Mech. Assembly, MC	180	1	0.000	$0.00	$35.51	$125.19	$0.00	$0.20	$0.70	$0.89	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.89	$0.89		
3A	Filter Cooler Assembly - Oil (Includes Seals & aux	1306-N0101-01	1	Final Assembly of filter/cooler assembly (Only Consider Turbo/DI Driven Costs)	S	Not Applicable	General Assembly	Mech. Assembly, MC	240	5	0.000	$0.00	$35.51	$125.19	$0.00	$0.74	$0.52	$1.26	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.26	$1.26		
Purchase Part - High Impact Item (Full Cost Mapping)																												
1A	Housing Oil Filter Preassembled	1306-N0101-01-08	1	Casting (50% Mass Attributed to Turbo/DI oil cooler features)	S	Aluminum-A380, Cast	Mold/Cast/Sinter Operator	Diecast, LMC	160	1	0.900	$1.10	$43.52	$100.05	$0.99	$0.27	$0.63	$1.89	0.30%	6.00%	4.00%	0.00%	10.30%	$0.19	$2.08	$2.08		
1B	Housing Oil Filter Preassembled	1306-N0101-01-08	1	Machine Casting Features (Hole Attributed to Turbo/DI Only)	S	Not Applicable	Mold/Cast/Sinter Operator	Perm. Cast, MHC	150	1	0.000	$0.00	$43.52	$150.06	$0.00	$0.29	$1.00	$1.29	0.30%	6.00%	4.00%	0.00%	10.30%	$0.13	$1.42	$1.42		
2A	Oil Cooler Adapter Plate	1306-N0101-01-02-1	1	Stamping	S	Aluminum-3003/4047B, Cladding	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	480	0.5	0.253	$2.10	$42.18	$100.10	$0.53	$0.04	$0.21	$0.78	0.30%	6.00%	4.00%	0.00%	10.30%	$0.08	$0.86	$0.86		
3A	Oil Cooler Base Plate	1306-N0101-01-02-2	1	Stamping	S	Aluminum-3003/4047B, Cladding	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	480	0.5	0.253	$2.10	$42.18	$100.10	$0.53	$0.04	$0.21	$0.78	0.30%	6.00%	4.00%	0.00%	10.30%	$0.08	$0.86	$0.86		
4A	Oil Cooler Cooling Plate stack-Lance	1306-N0101-01-02-3	5	Stamping	S	Aluminum-3003/4047A, Cladding	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	581	1	0.018	$1.65	$42.18	$100.10	$0.03	$0.07	$0.17	$0.27	0.30%	6.00%	4.00%	0.00%	10.30%	$0.03	$0.30	$1.52		
5A	Oil Cooler Cooling Plate stack	1306-N0101-01-02-31	7	Stamping	S	Aluminum-3003/4047A, Cladding	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	1161	0.5	0.018	$1.65	$42.18	$100.10	$0.03	$0.02	$0.09	$0.13	0.30%	6.00%	4.00%	0.00%	10.30%	$0.01	$0.15	$1.04		
6A	Oil Cooler Top Plate	1306-N0101-01-02-4	1	Stamping	S	Aluminum-3003/4047A, Cladding	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	581	0.5	0.062	$1.65	$42.18	$100.10	$0.10	$0.04	$0.17	$0.31	0.30%	6.00%	4.00%	0.00%	10.30%	$0.03	$0.34	$0.34		
Purchase Part - Commodity (Value taken from Purchase Part Database)																								Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Gasket housing to block Oil	1306-N0101-01-09	1		S																		$0.00	$0.07	$0.00	$0.07		
2A	Gasket housing to block - coolant	1306-N0101-01-10	1		S																		$0.00	$0.06	$0.00	$0.06		
3A	Gasket Oil Cooler Odd Shape	1306-N0101-01-07	1		S																		$0.00	$0.06	$0.00	$0.06		
4A	Gasket Oil Cooler Square	1306-N0101-01-06	1		S																		$0.00	$0.06	$0.00	$0.06		
5A	Gasket Oil Cooler Oval	1306-N0101-01-05	1		S																		$0.00	$0.06	$0.00	$0.06		
6A	Gasket Oil Cooler Round	1306-N0101-01-04	1		S																		$0.00	$0.05	$0.00	$0.05		
7A	Bolt Oil Cooler to housing	1306-N0101-01-03	5		S																		$0.00	$0.01	$0.00	$0.06		
8A	Tube Assembly- Oil, Cooler/Filter Ass'y Outlet to Turbocharger	1370-N0101-01	1		SAC																		$4.09	$4.09	$0.00	$4.09		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Filter Cooler Assembly - Oil (Includes Seals) **Part Number:** 1306-N0101-01
Component Quote Level: Full Quote ☐ Modification Quote ☒

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$15.33		
														T1 or OEM Total Manufacturing Cost:	$7.02	$2.23	$5.31	$14.57	$0.02	$0.44	$0.29	$0.00	$0.76	→	3	$15.33		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.50%	6.50%	6.00%	2.50%	15.50%					
														(SAC) &T1 or OEM Mark-Up Values:	(4.09)	-----	-----	-----	$0.08	$1.00	$0.92	$0.38	$2.38					
														Base Cost Impact to Vehicle:	$2.93	$2.23	$5.31	$10.48	$0.10	$1.44	$1.21	$0.38	$3.13	→		$13.61	$0	$0
																									Packaging Cost:	$0.16		
																									Net Cost Impact to Vehicle:	$13.78		

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.068		$136,778	0.00%	2,250,000	60	5.00%		$200	684	84	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.10		$1.00	8	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.164												

Option #2 Packaging with expendable tier dividers and pads.

Two parts nested together.

Part Packaging Volume: 300x360x120

Parts/Layer = 3x4=12
Number of Layers = 7

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Tube Assembly - Oil, Turbo to Engine Block **Part Number:** 1370
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
	Tube Assembly - Oil, Turbo to Engine Block	1370-N0101-02	1	Assemble End Fittings and O-rings onto Tube and Crimp in Place. Pressure Test	S	Not Applicable	General Assembly	Mech. Assembly, LC	240	2	0.000	$0.00	$35.51	$100.19	$0.00	$0.30	$0.42	$0.71	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.71	$0.71		
Purchase Part - High Impact Item (Full Cost Mapping)																												
1A	Tube Stock - Oil, Turbo to Engine Block	1370-N0101-02-2	1	Tube Bending	S	LC-Steel-1215, Tubing	Cut/Punch/Forming Operator	Hydro/CNC Form, SMS,	360	0.5	0.210	$0.62	$42.18	$100.12	$0.13	$0.06	$0.28	$0.47	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.47	$0.47		
1B	Tube Stock - Oil, Turbo to Engine Block	1370-N0101-02-1	1	Flare Tube Ends	S	Not Applicable	Cut/Punch/Forming Operator	Hydro/CNC Form, SMS,	240	1	0.210	$0.00	$42.18	$100.12	$0.00	$0.18	$0.42	$0.59	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.59	$0.59		
1C	Tube Stock - Oil, Turbo to Engine Block	1370-N0101-02-3	1	Plate	S	General Underhood Pla	Plating/Coating Operator	Plate/Finish, SMS, MHC	720	1	0.001	$15.00	$55.17	$125.17	$0.02	$0.08	$0.17	$0.27	0.30%	6.00%	4.00%	0.00%	10.30%	$0.03	$0.29	$0.29		
2A	Fitting Tube End	1370-N0101-02-4	2	Forge Blank	S	MC-Steel-1018, Bar	Forging Operator	Cold Forge, LMC	900	0.5	0.165	$0.55	$38.52	$100.09	$0.09	$0.02	$0.11	$0.22	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.22	$0.45		
2B	Fitting Tube End	1370-N0101-02-4	2	Machine	S	Not Applicable	CNC Operator	CNC Milling, SMS, LC	360	0.5	0.000	$0.00	$35.70	$100.15	$0.00	$0.05	$0.28	$0.33	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.33	$0.66		
2C	Fitting Tube End	1370-N0101-02-4	2	Plate	S	General Underhood Pla	Plating/Coating Operator	Plate/Finish, SMS, MHC	1800	1	0.001	$15.00	$55.17	$125.17	$0.02	$0.03	$0.07	$0.12	0.30%	6.00%	4.00%	0.00%	10.30%	$0.01	$0.13	$0.25		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	O-ring - Tube Fitting	1370-N0101-02-3	1		S																		$0.00	$0.06	$0.00	$0.06		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up				
										1	$3.48		
T1 or OEM Total Manufacturing Cost:	$0.42	$0.81	$2.20	$3.43	$0.00	$0.03	$0.02	$0.00	$0.05	→ 3	$3.48		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.30%	6.00%	4.00%	0.00%	10.30%				
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.01	$0.21	$0.14	$0.00	$0.36				
Base Cost Impact to Vehicle:	$0.42	$0.81	$2.20	$3.43	$0.01	$0.24	$0.16	$0.00	$0.41	→	$3.84	$0	$0
										Packaging Cost:	$0.06		
										Net Cost Impact to Vehicle:	$3.90		

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Tube Assembly - Oil, Turbo to Engine Block **Part Number:** 1370
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.055		$110,206	0.00%	2,250,000	60	5.00%		$4,420	25	2304	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.055												

Option #3: Returnable Totes and Dividers

Part Nest Size: 300x30x90

Parts per layer 16
Number of Layers = 3
= 48 Parts per Tote

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Tube Assembly- Oil, Cooler/Filter Ass'y Outlet to Turbocharger **Part Number:** 1370-N0101-01
Component Quote Level: **Full Quote** ☒ **Modification Quote** ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Fitting Hose Oil Cooler to Turbo	1306-N0101-01-11-2	1	Braze weld Tube Fitting to Bracket Mount	S	Not Applicable	General Assembly	Mech. Assembly, LC	257	1	0.000	$0.00	$35.51	$100.19	$0.00	$0.14	$0.39	$0.53	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.53	$0.53		
1B	Tube Assembly- Oil, Cooler/Filter Ass'y Outlet to Turbocharger	1306-N0101-01-11 (1370-N0101-01)	1	Crimp End Fitting to Hose and Add Protective Heat Shield, Oring and Clamp	S	Not Applicable	General Assembly	Mech. Assembly, LC	240	3	0.000	$0.00	$35.51	$100.19	$0.00	$0.44	$0.42	$0.86	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.86	$0.86		
Purchase Part - High Impact Item (Full Cost Mapping)																												
1A	Hose Oil Cooler to Turbo	1306-N0101-01-11-1	1	Extrude & Shape Hose	S	SBR-Fiber Rein. W. Outer Wrap, Extruded	Extruding/Drawing Operator	Comp./Ext. Mold, LMC	545	1.5	0.007	$2.05	$54.35	$100.04	$0.01	$0.15	$0.18	$0.35	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.35	$0.35		
2A	Tube Fitting end	1306-N0101-01-11-2-1	1	Machining	S	LC-Steel-1215, Tubing	CNC Operator	CNC Turning, LMC	200	0.25	0.150	$0.62	$35.70	$100.00	$0.09	$0.04	$0.50	$0.64	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.64	$0.64		
3A	Bracket Tube Fitting end attach	1306-N0101-01-11-2-1-1	1	Fine blank, LMC	S	LC-Steel-1000S, Coil	Cut/Punch/Forming Operator	Fine blank, LMC	1000	0.5	0.207	$0.45	$42.18	$100.13	$0.09	$0.02	$0.10	$0.21	0.30%	6.00%	4.00%	0.00%	10.30%	$0.02	$0.24	$0.24		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Collar Tube fitting attachment	1306-N0101-01-11-2-1-2	1		S																		$0.00	$0.05	$0.00	$0.05		
2A	Heat Shield, Hose	1306-N0101-01-11-2	1		S																		$0.00	$0.75	$0.00	$0.75		
3A	Hose Clamp	1306-N0101-01-11-3	1		S																		$0.00	$0.22	$0.00	$0.22		
4A	O-ring	1306-N0101-01-11-4	1		S																		$0.00	$0.06	$0.00	$0.06		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up					
											1	$3.68		
T1 or OEM Total Manufacturing Cost:	$1.27	$0.80	$1.59	$3.66	$0.00	$0.01	$0.01	$0.00	$0.02		3	$3.68		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.30%	6.00%	4.00%	0.00%	10.30%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.01	$0.22	$0.15	$0.00	$0.38					
Base Cost Impact to Vehicle:	$1.27	$0.80	$1.59	$3.66	$0.01	$0.23	$0.16	$0.00	$0.40			$4.06	$0	$0
											Packaging Cost:	$0.03		
											Net Cost Impact to Vehicle:	$4.09		

Manufacturing Assumption and Quote Summary

APPENDIX G.1-13, (4of6)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Tube Assembly- Oil, Cooler/Filter Ass'y Outlet to Turbocharger **Part Number:** 1370-N0101-01
Component Quote Level: **Full Quote** ☒ **Modification Quote** ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.026		$51,950	0.00%	2,250,000	60	5.00%		$5,860	9	6480	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.026												

Packaging Option #3: Returnable Totes & Dividers

Part Nesting Size: 220x30x30

Parts per Layer: 15
Layers per Tote: 9

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Oil - Synthetic **Part Number:** 1399-N0101-08
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	OIL - ENGINE 0W-40 ILSAC GF3 MS-10725	NA	1		S																		$0.00	$4.00	$0.00	$4.00		
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$4.00		
														T1 or OEM Total Manufacturing Cost:	$4.00	$0.00	$0.00	$4.00	$0.00	$0.00	$0.00	$0.00	$0.00		3	$4.00		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%					
														(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00					
														Base Cost Impact to Vehicle:	$4.00	$0.00	$0.00	$4.00	$0.00	$0.00	$0.00	$0.00	$0.00			$4.00	$0	$0
																									Packaging Cost:	$0.00		
																									Net Cost Impact to Vehicle:	$4.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Standard Pallet L4'xW4'xD3'
Area = 122cm x 114 cm = 1440 sq. cm
Depth = 86 cm

Part Size:
Parts Per Layer:
Parts Per Pallet:

Manufacturing Assumption and Quote Summary

APPENDIX G.1-13, (6of6)

Print Date:9/2/2009

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: OEM Assembly of Additional or Revised Lubrication Components to Engine
Part Number: 1300-N0101-00
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year):	47
Annual Engine Volume (CPV):	450,000
Components per Engine:	1
Annual Component Volume:	450,000
Weekly Component Volume:	9,574
Estimated Product Life:	10

OEM Plant Location:	North America
Supplier Plant Location:	North America
Shipping Method:	F.O.B
Packaging Specification:	Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Tube Assembly - Oil, Turbo to Engine Block	1370-N0101-02	1	Install Tube Assembly to Engine	OEM	Not Applicable	General Assembly-OEM	Engine Assembly, OEM	129	1	0.000	$0.00	$83.31	$150.21	$0.00	$0.65	$1.17	$1.82	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.82	$1.82		
2A	Tube Assembly- Oil, Cooler/Filter Ass'y Outlet to Turbocharger	1306-N0101-01-11 (1370-N0101-01)	1	Install Hose to Turbo Assembly, Run Down Bolt	OEM	Not Applicable	General Assembly-OEM	Engine Assembly, OEM	240	1	0.000	$0.00	$83.31	$150.21	$0.00	$0.35	$0.63	$0.97	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.97	$0.97		
3A	Filter Cooler Assembly - Oil (Includes Seals)	1306-N0101-01	1	Install Filter Cooler Assembly and Run Down 4 Bolts	OEM	Not Applicable	General Assembly-OEM	Engine Assembly, OEM	180	1	0.000	$0.00	$83.31	$150.21	$0.00	$0.46	$0.83	$1.30	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.30	$1.30		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Bolt - Tube Assembly , Oil, Turbo Outlet & Block I	1380-N0101-06	2	Banjo Bolts	S																		$0.00	$0.24	$0.00	$0.48		
2A	Washer - Bolt - Tube Assembly , Oil, Turbo Outlet	1380-N0101-09	4	Banjo Washers	S																		$0.00	$0.03	$0.00	$0.12		
3A	Tube Assembly - Oil, Turbo to Engine Block	1370-N0101-02	1		SAC																		$3.84	$3.84	$0.00	$3.84		
4A	Bolt hose oil cooler to turbo	1306-N0101-01-12	1		S																		$0.00	$0.05	$0.00	$0.05		
5A	Bolt - Filter Cooler Assembly	1380-N0101-08	4		S																		$0.00	$0.07	$0.00	$0.28		
6A	Filter Cooler Assembly - Oil (Includes Seals)	1306-N0101-01	1		SAC																		$13.78	$13.78	$0.00	$13.78		
7A	Tube Assembly- Oil, Cooler/Filter Ass'y Outlet to Turbocharger	1370-N0101-01	1		SAC																		$4.09	$4.09	$0.00	$4.09		
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$26.72		
														T1 or OEM Total Manufacturing Cost:	$22.64	$1.46	$2.63	$26.72	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$26.72		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%					
														(SAC) &T1 or OEM Mark-Up Values:	(21.71)	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00					
														Base Cost Impact to Vehicle:	$0.93	$1.46	$2.63	$5.02	$0.00	$0.00	$0.00	$0.00	$0.00	→		$5.02	$0	$0
																									Packaging Cost:	$0.00		
																									Net Cost Impact to Vehicle:	$5.02		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Packaging Cost for Fasteners included in fastener piece price.

No other packaging costs required.

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: OEM Assembly of Additional or Revised Lubrication Components to Engine **Part Number:** 1300-N0101-00
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "

Appendix G.1 - Subsystem 14

Cooling Subsystem

Case Study #0101

MAQS Worksheets

Manufacturing Assumption and Quote Summary

APPENDIX G.1-14 (1of5)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Pump- Auxiliary Coolant, Electric
Part Number: 1401-N0101-02
Component Quote Level: ☑ Full Quote ☐ Modification ☐ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 High Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Returnable Packaging

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
1A	Charge Impeller Assembly	1401-N0101-02-3-1	1	Magnetize Impeller Assembly	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, MC, Base	240	1	1	1	0.000	$0.00	$35.51	$30.00	$30.00	$0.00	$0.15	$0.13	$0.27	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.27	$0.27		
2A	Pump-Auxiliary Coolant Final Assembly	1401-N0101-02	1	Final Assembly	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, MC, Base	240	2	1	9	0.000	$0.00	$35.51	$30.00	$270.00	$0.00	$0.30	$1.13	$1.42	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.42	$1.42		
	INTENTIONAL BLANK SPACE		0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
3A	Pump-Auxiliary Coolant, Electric Subassembly	1401- N0101-00 (New P/N)	1	Assemble pump to bracket and hoses to pump.	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, LC, Base	200	4	1	4	0.000	$0.00	$35.51	$15.00	$60.00	$0.00	$0.71	$0.30	$1.01	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.01	$1.01		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
Purchase Part - High Impact Item (Full Cost Mapping)																															
1A	Motor Housing Assembly	1401-N0101-02-1-1	1	Injection Mold Housing w. Terminals	T1 Assembly, Mark-up Applied @ Bottom.	PPS-GF40, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, MLS	360	0.5	1	2	0.110	$6.02	$43.52	$150.01	$300.02	$0.66	$0.06	$0.83	$1.56	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.56	$1.56		
2A	End Cap Motor close out	1401-N0101-02-1-2	1	Injection Mold Housing w. Terminals	T1 Assembly, Mark-up Applied @ Bottom.	PPS-GF35-MF30, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, MLS	769	0.5	1	1	0.025	$3.86	$43.52	$150.01	$150.01	$0.10	$0.03	$0.20	$0.32	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.32	$0.32		
3A	Housing Impellor Cavity	1401-N0101-02-2-1	1	Injection Mold Housing w. Terminals	T1 Assembly, Mark-up Applied @ Bottom.	PPS-GF35-MF30, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, MLS	626	0.5	1	1	0.094	$3.86	$43.52	$150.01	$150.01	$0.36	$0.03	$0.24	$0.64	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.64	$0.64		
4A	Impellor Water Pump	1401-N0101-02-3-1-1	1	Injection Mold Housing w. Terminals	T1 Assembly, Mark-up Applied @ Bottom.	PPS-GF40, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, MLS	333	0.5	1	1.5	0.100	$6.02	$43.52	$150.01	$225.02	$0.60	$0.07	$0.68	$1.34	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.34	$1.34		
	INTENTIONAL BLANK SPACE		0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
1A	Bracket Subassembly - Auxiliary Pump to Oil Filter/Cooler Ass'y	1475-N0101-01-03	1	Progressive Die Blank	T1 Assembly, Mark-up Applied @ Bottom.	LC-Steel-1000S, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	600	0.5	1	1	0.808	$0.45	$42.18	$100.10	$100.10	$0.36	$0.04	$0.17	$0.57	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.57	$0.57		
1B	Bracket Subassembly - Auxiliary Pump to Oil Filter/Cooler Ass'y	1475-N0101-01-02	1	Stage Tooling (3 Stage)	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	240	1	1	1	0.000	$0.00	$42.18	$100.10	$100.10	$0.00	$0.18	$0.42	$0.59	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.59	$0.59		
1C	Bracket Subassembly - Auxiliary Pump to Oil Filter/Cooler Ass'y	1475-N0101-01-01	1	Apply Coating	T2/T3 Plate/Finish Mech., SSLC	Powder Coat	Plating/Coating Operator	Plate/Finish, SMS, LMC	720	1	1	1	0.010	$20.00	$55.17	$100.17	$100.17	$0.20	$0.08	$0.14	$0.42	0.30%	6.00%	4.00%	0.00%	10.30%	$0.04	$0.46	$0.46		
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Terminals	1401-N0101-02-71	1	Terminals Tin Plate	S																					$0.00	$0.09	$0.00	$0.09		
2A	O-ring - Motor Housing to Impeller Housing	1401-N0101-02-72	1	Silicone	S																					$0.00	$0.04	$0.00	$0.04		
3A	AlNiCo Magnets	1401-N0101-02-73	4	(Uncharged, Approx 10x20x2.5)	S																					$0.00	$0.45	$0.00	$1.80		
4A	Motor Winding Assembly	1401-N0101-02-1-1-3	1		S																					$0.00	$4.50	$0.00	$4.50		
5A	PCB Motor Control Assembly	1401-N0101-02-1-1-2	1		S																					$0.00	$5.00	$0.00	$5.00		
6A	E-Clip	1401-N0101-02-5	1		S																					$0.00	$0.02	$0.00	$0.02		
7A	Heat Sink	1401-N0101-02-6	1		S																					$0.00	$0.05	$0.00	$0.05		
8A	Screw Impellor cavity to motor housing	1401-N0101-02-2-2	4		S																					$0.00	$0.02	$0.00	$0.08		
9A	Bolt pump to bracket	1401-N0101-02-02	3		S																					$0.00	$0.01	$0.00	$0.03		
10A	Wire Harness Retention Clips	NA	2	Required for O2 Sensor, Thus No Cost Impact.	S																					$0.00	$0.00	$0.00	$0.00		
11A	Hose Assembly - Oil Filer/Cooler Ass'y to Auxiliary Pump	1470-N0101-04	1		SAC																					$2.07	$2.07	$0.00	$2.07		
12A	Hose Assembly - Auxiliary Pump to Turbo	1470-N0101-03	1		SAC																					$3.81	$3.81	$0.00	$3.81		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$25.67		
T1 or OEM Total Manufacturing Cost:	$19.78	$1.63	$4.22	$25.63	$0.00	$0.02	$0.02	$0.00	$0.04		3	$25.67		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.70%	7.00%	8.00%	4.00%	19.70%					
(SAC) &T1 or OEM Mark-Up Values:	(5.88)	-----	-----	-----	$0.18	$1.80	$2.05	$1.03	$5.06					
Base Cost Impact to Vehicle:	$13.90	$1.63	$4.22	$19.75	$0.18	$1.82	$2.07	$1.03	$5.10			$24.85	$0	$0
											Packaging Cost:	$0.06		
											Net Cost Impact to Vehicle:	$24.91		

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Pump- Auxiliary Coolant, Electric **Part Number:** 1401-N0101-02
Component Quote Level: ☑ Full Quote ☐ Modification ☐ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 High Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Returnable Packaging

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "

PACKAGING CALCULATIONS:
Packaging Type: Option 1 w. Expendable Dividers
Part Size: 340X130X90
Parts/Layer:3X9
Number of Layers: 9

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.059		$118,203	0.00%	2,250,000	60	5.00%		$500	236	243	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.059												

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Hose Assembly - Oil Filer/Cooler Ass'y to Auxiliary Pump **Part Number:** 1470-N0101-04
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Hose - Oil Filter/Cooler Ass'y to Auxiliary Pump	1470-N0101-04-1	1	Extrude & Shape Hose	S	SBR-Fiber Rein., Extruded	Extruding/Drawing Operator	Comp./Ext. Mold, LMC	273	1.5	0.127	$1.85	$54.35	$100.04	$0.23	$0.30	$0.37	$0.90	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.90	$0.90		
2A	Hose - Oil Filter/Cooler Ass'y to Auxiliary Pump	1470-N0101-04-1	1	Assemble Sheathing and Glue Clamps	S	Purchased Parts	General Assembly	Mech Assembly, LC, Base	240	2	$0.62	$1.00	$35.51	$15.00	$0.62	$0.30	$0.06	$0.98	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.98	$0.98		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
Purchase Part - Commodity (Value taken from Purchase Part Database)																								Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Sheath Hose Protection (Aux-Filter)	1470-N0101-04-2	1	Nylon	B2B																		$0.00	$0.28	$0.28	$0.00		
2A	Hose Clamp	1470-N0101-03-1	2	Steel- Zinc Phosphate	B2B																		$0.00	$0.17	$0.34	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$1.88		
T1 or OEM Total Manufacturing Cost:	$0.85	$0.59	$0.43	$1.88	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$1.88		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.30%	6.00%	4.00%	0.00%	10.30%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.01	$0.11	$0.08	$0.00	$0.19					
Base Cost Impact to Vehicle:	$0.85	$0.59	$0.43	$1.88	$0.01	$0.11	$0.08	$0.00	$0.19	→		$2.07	$0	$0
											Packaging Cost:	$0.00		
											Net Cost Impact to Vehicle:	$2.07		

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	2,250,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Packaging Options: Shipped w. Aux. Pump, No Packaging Costs Required

Manufacturing Assumption and Quote Summary

APPENDIX G.1-14 (3of5)
Print Date:9/2/2009

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Hose Assembly - Auxiliary Pump to Turbo
Part Number: 1470-N0101-03
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Fitting Hose End	1306-N0101-01-11-5	1	Cold Headed Tubing	S	LC-Steel-1215, Tubing	Forging Operator	Cold Forge, LMC	720	0.5	0.092	$0.62	$38.52	$100.09	$0.06	$0.03	$0.14	$0.22	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.22	$0.22		
2A	Fitting Tube End	1370-N0101-02-4	1	CNC Machine	S	LC-Steel-1215, Bar	CNC Operator	CNC Turning, MHC	240	0.5	0.270	$0.62	$35.70	$125.00	$0.17	$0.07	$0.52	$0.76	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.76	$0.76		
3A	Tube	1306-N0101-01-11-5-2	1	Cut to size and form	S	LC-Steel-1215, Tubing	Cut/Punch/Forming Operator	Hydro/CNC Form, SMS, LMC	360	0.5	0.030	$0.62	$42.18	$100.12	$0.02	$0.06	$0.28	$0.36	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.36	$0.36		
4A	Tube Assembly - Banjo Joint for Turbo	1470-N0101-03-03	1	Assemble, Braze and Plate	S	Not Applicable	General Assembly	Mech. Assembly, LC	257	2	0.000	$0.00	$35.51	$100.19	$0.00	$0.28	$0.39	$0.67	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.67	$0.67		
5A	Hose Assembly - Auxiliary Pump to Turbo	1470-N0101-03-02	1	Extrude & Shape Hose	S	SBR-Fiber Rein., Extruded	Extruding/Drawing Operator	Comp./Ext. Mold, LMC	581	1.5	0.091	$1.85	$54.35	$100.04	$0.17	$0.14	$0.17	$0.48	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.48	$0.48		
6A	Hose Assembly - Auxiliary Pump to Turbo	1470-N0101-03-01	1	Overmold Banjo Tube to Hose	S	Nylon66, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	360	1	0.007	$1.74	$43.52	$100.01	$0.01	$0.12	$0.28	$0.41	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.41	$0.41		
7A	Hose Assembly - Auxiliary Pump to Turbo	1470-N0101-03	1	Assemble Sheathing and Glue Clamp	S	Purchased Parts	General Assembly	Mech Assembly, LC, Base	200	1	$0.30	$1.00	$35.51	$15.00	$0.30	$0.18	$0.08	$0.55	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.55	$0.55		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Hose Clamp	1470-N0101-03-1	1	Steel- Zinc Phosphate	B3C																		$0.00	$0.17	$0.17	$0.00		
2A	Sheath Hose protection (Turbo)	1470-N0101-03-2	1		B3C																		$0.00	$0.13	$0.13	$0.00		
																							$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up					
												1	$3.45		
T1 or OEM Total Manufacturing Cost:	$0.72	$0.87	$1.85	$3.45	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$3.45		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.30%	6.00%	4.00%	0.00%	10.30%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.01	$0.21	$0.14	$0.00	$0.36					
Base Cost Impact to Vehicle:	$0.72	$0.87	$1.85	$3.45	$0.01	$0.21	$0.14	$0.00	$0.36	→		$3.81	$0	$0
											Packaging Cost:	$0.00		
											Net Cost Impact to Vehicle:	$3.81		

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Hose Assembly - Auxiliary Pump to Turbo **Part Number:** 1470-N0101-03
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Packaging Options: Shipped w. Aux. Pump, No Packaging Costs Required

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Hose Assembly - Turbo Assembly to Thermostat/Coolant Valve
Part Number: 1470-N0101-02
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Tube Assembly Prefabricated	1470-N0101-02-04-01	1	Assemble, Braze	S	Not Applicable	General Assembly	Mech Assembly, HC, Base	240	1	0.000	$0.00	$35.51	$45.00	$0.00	$0.15	$0.19	$0.34	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.34	$0.34		
2A	Tube Assembly Prefabricated	1470-N0101-02-04-02	1	Projection Weld Brkt	S	Not Applicable	General Assembly	Mech Assembly, LC, Base	240	1	0.000	$0.00	$35.51	$15.00	$0.00	$0.15	$0.06	$0.21	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.21	$0.21		
3A	Tube Assembly Prefabricated	1470-N0101-02-04-02	1	Plating	S	General Underhood Plating	Plating/Coating Operator	Plate/Finish, MLS, LMC	720	1	0.001	$15.00	$55.17	$150.17	$0.02	$0.08	$0.21	$0.30	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.30	$0.30		
4A	Hose Assembly - Turbo Assembly to Thermostat/Coolant Valve	1470-N0101-02	1	Assemble SBR Tube with two hose clamps	S	Not Applicable	General Assembly	Mech Assembly, LC, Base	240	2	0.000	$0.00	$35.51	$15.00	$0.00	$0.30	$0.06	$0.36	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.36	$0.36		
			0						#####	0	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00%	0.00%	0.00%	0.00%	0.00%	#N/A	#N/A	$0.00		
Purchase Part - High Impact Item (Full Cost Mapping)																												
1A	Fitting Tube End	1370-N0101-02-4	1	CNC Machine	S	LC-Steel-1215, Bar	CNC Operator	CNC Turning, MHC	240	0.5	0.270	$0.62	$35.70	$125.00	$0.17	$0.07	$0.52	$0.76	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.76	$0.76		
2A	Bracket Tube Attachment	1470-N0101-02-4-4	1	Stamping	S	LC-Steel-1000S, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	600	0.5	0.233	$0.45	$42.18	$100.10	$0.10	$0.04	$0.17	$0.31	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.31	$0.31		
3A	Preformed Tube 10mm OD	1470-N0101-02-4-1	1	Cut to size and form	S	LC-Steel-1215, Tubing	Cut/Punch/Forming Operator	Hydro/CNC Form, SMS, LMC	360	0.5	0.150	$0.62	$42.18	$100.12	$0.09	$0.06	$0.28	$0.43	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.43	$0.43		
4A	Preformed Tube 14mm OD	1470-N0101-02-4-2	1	Cut to size and form	S	LC-Steel-1215, Tubing	Cut/Punch/Forming Operator	Hydro/CNC Form, SMS, LMC	240	1	0.060	$0.62	$42.18	$100.12	$0.04	$0.18	$0.42	$0.63	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.63	$0.63		
5A	Hose - Oil Filter/Cooler Ass'y to Auxiliary Pump	1470-N0101-04-1	1	Extrude & Shape Hose	S	SBR-Fiber Rein., Extruded	Extruding/Drawing Operator	Comp./Ext. Mold, LMC	933	1.5	0.055	$1.85	$54.35	$100.04	$0.10	$0.09	$0.11	$0.30	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.30	$0.30		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Hose Clamp small ID	1470-N0101-02-2	1		S																		$0.00	$0.24	$0.00	$0.24		
2A	Hose Clamp large ID	1470-N0101-02-3	1		S																		$0.00	$0.26	$0.00	$0.26		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up					
											1	$4.13		
T1 or OEM Total Manufacturing Cost:	$1.02	$1.10	$2.01	$4.13	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$4.13		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.03%	6.00%	4.00%	0.00%	10.03%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.00	$0.25	$0.17	$0.00	$0.41					
Base Cost Impact to Vehicle:	$1.02	$1.10	$2.01	$4.13	$0.00	$0.25	$0.17	$0.00	$0.41	→		$4.55	$0	$0
											Packaging Cost:	$0.04		
											Net Cost Impact to Vehicle:	$4.59		

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Hose Assembly - Turbo Assembly to Thermostat/Coolant Valve
Part Number: 1470-N0101-02
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.015		$30,395	0.00%	2,250,000	60	5.00%		$200	152	378	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.03		$1.00	10	$3.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.042												

Pallet Option #1 w. Expendable Tier Pads

Part Size 400x80x90

Parts/Layer = 3x14
Number of Layers = 9

Manufacturing Assumption and Quote Summary

APPENDIX G.1-14, (5of5)

Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: OEM Assembly of Additional or Revised Assembly Components to Engine **Part Number:** 1400-N0101-00
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Assembly Pump-Aux. Coolant Subassembly	1401-N0101-02+ Subs	1	Mount Auxiliary Pump to Oil Cooler/Filter (2 Screws), Make Electrical Connection Constrain wire in Clips	OEM	Not Applicable	General Assembly-OEM	Engine Assembly, OEM	129	1	0.000	$0.00	$83.31	$150.21	$0.00	$0.65	$1.17	$1.82	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.82	$1.82		
2A	Hose Assembly, Turbo -Aux Pump and Hose Ass'y- Turbo - Thermostat Valve	1470-N0101-02/03	1	Install and run Banjo bolt (x2) @ turbo.	OEM	Not Applicable	General Assembly-OEM	Engine Assembly, OEM	129	1	0.000	$0.00	$83.31	$150.21	$0.00	$0.65	$1.17	$1.82	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.82	$1.82		
3A	Hose, Oil Cooler to Aux Pump and Hose Ass'y Turbo Thermostat Valve to Thermostat Valve	1470-N0101-02/04	1	Press on Tubes and release Hose Clamps	OEM	Not Applicable	General Assembly-OEM	Engine Assembly, OEM	129	1	0.000	$0.00	$83.31	$150.21	$0.00	$0.65	$1.17	$1.82	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.82	$1.82		
4A	Hose Assembly - Turbo Assembly to Thermostat/Coolant Valve	1470-N0101-02	0	Run fastener to secure Hose Assembly Bracket to Engine	OEM	Not Applicable	General Assembly-OEM	Engine Assembly, OEM	300	1	0.000	$0.00	$83.31	$150.21	$0.00	$0.28	$0.50	$0.78	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.78	$0.00		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Bolt-Hose, coolant Inlet and Outlet @ Turbo	1480-N0101-06	2	Banjo Bolts	S																		$0.00	$0.24	$0.00	$0.48		
2A	Washer banjo Bolt-Hose, coolant Inlet and Outlet	1480-N0101-13	4	Banjo Washers	S																		$0.00	$0.02	$0.00	$0.08		
3A	Bolt-Hose Bracket, coolant Inlet and Outlet @ Turbo	1480-N0101-14	1		S																		$0.00	$0.12	$0.00	$0.12		
4A	Bolt Aux pump bracket to oil cooler	1480-N0101-07	3		S																		$0.00	$0.02	$0.00	$0.06		
5A	Pump- Auxiliary Coolant, Electric	1401-N0101-02	1		SAC																		$24.91	$24.91	$0.00	$24.91		
6A	Hose Assembly - Turbo Assembly to Thermostat/Coolant Valve	1470-N0101-02	1		SAC																		$4.59	$4.59	$0.00	$4.59		
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$35.68		
														T1 or OEM Total Manufacturing Cost:	$30.23	$1.94	$3.50	$35.68	$0.00	$0.00	$0.00	$0.00	$0.00		3	$35.68		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%					
														(SAC) &T1 or OEM Mark-Up Values:	(29.49)	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00					
														Base Cost Impact to Vehicle:	$0.74	$1.94	$3.50	$6.19	$0.00	$0.00	$0.00	$0.00	$0.00			$6.19	$0	$0
																									Packaging Cost:	$0.00		
																									Net Cost Impact to Vehicle:	$6.19		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Packaging Cost for Fasteners included in fastener piece price.

No other packaging costs required.

Appendix G.1 - Subsystem 15
Air Induction Charging Subsystem
Case Study #0101
MAQS Worksheets

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Turbo Charging Assembly **Part Number:** 1501-N0101-01
Component Quote Level: ☑ Full Quote ☐ Modification Quote ☐ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 High Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Returnable

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
1A	Block Turbo shaft support - cooling & lub	1201-N0101-01-10	1	Subassembly Center Support Block	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, MC, Base	177	4	1	8	0.000	$0.00	$35.51	$30.00	$240.00	$0.00	$0.80	$1.35	$2.15	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$2.15	$2.15		
2A	Housing Turbo Exhaust	1201-N0101-01-09	1	Subassembly Exhaust Housing	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, LC, Base	180	2	1	3	0.000	$0.00	$35.51	$15.00	$45.00	$0.00	$0.39	$0.25	$0.64	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.64	$0.64		
3A	Final Assembly Line	1501-N0101-01	1	Final Product Assembly & Test	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, LC, Base	180	11	1	13	0.000	$0.00	$35.51	$15.00	$195.00	$0.00	$2.17	$1.08	$3.25	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$3.25	$3.25		
4A	Turbine Shaft Assembly - Welded	1201-N0101-01-01-24-01	1	Electron Beam Weld Turbine Impeller to Shaft and Grind Profile	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, MC, Base	180	1	1	2	0.000	$0.00	$35.51	$30.00	$60.00	$0.00	$0.20	$0.33	$0.53	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.53	$0.53		
5A	Turbo Assembly Center Housing Rotating Assembly (CHRA) Balancing	1201-N0101-01-01-24	1	High Speed Dynamic Balancing	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, HC, Base	180	4.5	3	1	0.000	$0.00	$35.51	$45.00	$135.00	$0.00	$0.89	$0.75	$1.64	10.00%	0.00%	0.00%	0.00%	10.00%	$0.16	$1.80	$1.80		
Purchase Part - High Impact Item (Full Cost Mapping)																															
1A	Housing Turbo Intake Casting	1201-N0101-01-07-01-2	1	Cast Intake Housing	T2/T3 Sand Cast, MSMC	Aluminum-A319-T5, Cast	Mold/Cast/Sinter Operator	Sand Cast, HMC	120	6	1	1	2.200	$1.15	$43.52	$150.07	$150.07	$2.53	$2.18	$1.25	$5.96	5.00%	6.50%	6.00%	1.00%	18.50%	$1.10	$7.06	$7.06		
1B	Housing Turbo Intake Casting	1201-N0101-01-07-01-1	1	T5 Heat Treat	T2/T3 Heat Treat, MSMC	Not Applicable	Heat Treat Operator	Heat Treat, MLS, LMC	125	1	1	1	0.000	$0.00	$46.52	$100.00	$100.00	$0.00	$0.37	$0.80	$1.17	0.50%	6.50%	6.00%	1.00%	14.00%	$0.16	$1.34	$1.34		
1C	Housing Turbo Intake Casting	1201-N0101-01-07-01	1	Machine Intake Housing	T2/T3 CNC Milling, MSMC	Not Applicable	CNC Operator	CNC Machining, MHC	119	3	7	1	0.000	$0.00	$35.70	$45.00	$315.00	$0.00	$0.90	$2.64	$3.53	0.50%	6.50%	6.00%	1.00%	14.00%	$0.49	$4.03	$4.03		
2A	Block Center Bearing Support	1201-N0101-01-30-02	1	Sand Casting	T2/T3 Sand Cast, MSMC	SiMo Ductile Iron, Cast	Mold/Cast/Sinter Operator	Sand Cast, HMC	160	9	1	1	3.500	$0.60	$43.52	$150.07	$150.07	$2.10	$2.45	$0.94	$5.49	5.00%	6.50%	6.00%	1.00%	18.50%	$1.01	$6.50	$6.50		
2B	Block Center Bearing Support	1201-N0101-01-30-01	1	T5 Heat Treat	T2/T3 Heat Treat, MSMC	Not Applicable	Heat Treat Operator	Heat Treat, MLS, LMC	167	1	1	1	0.000	$0.00	$46.52	$100.00	$100.00	$0.00	$0.28	$0.60	$0.88	0.50%	6.50%	6.00%	1.00%	14.00%	$0.12	$1.00	$1.00		
2C	Block Center Bearing Support	1201-N0101-01-30	1	Critical Faces Machine	T2/T3 CNC Milling, MSMC	Not Applicable	CNC Operator	CNC Machining, MHC	122	4	8	1	0.000	$0.00	$35.70	$45.00	$360.00	$0.00	$1.18	$2.96	$4.14	0.50%	6.50%	6.00%	1.00%	14.00%	$0.58	$4.72	$4.72		
3A	Housing Turbo Exhaust	1201-N0101-01-09-01-02	1	Sand Casting	T2/T3 Sand Cast, MSMC	NiResist Iron, D5S, Cast	Mold/Cast/Sinter Operator	Sand Cast, HMC	120	6	1	1	6.890	$3.50	$43.52	$150.07	$150.07	$24.12	$2.18	$1.25	$27.54	5.00%	6.50%	6.00%	1.00%	18.50%	$5.10	$32.64	$32.64		
3B	Housing Turbo Intake Casting	1201-N0101-01-09-01-01	1	T5 Heat Treat	T2/T3 Heat Treat, MSMC	Not Applicable	Heat Treat Operator	Heat Treat, MLS, LMC	114	1	1	1	0.000	$0.00	$46.52	$100.00	$100.00	$0.00	$0.41	$0.88	$1.28	0.50%	6.50%	6.00%	1.00%	14.00%	$0.18	$1.46	$1.46		
3C	Housing Turbo Exhaust	1201-N0101-01-09-01	1	Machine Casting	T2/T3 CNC Milling, MSMC	Not Applicable	CNC Operator	CNC Machining, MHC, PREM.	114	3	6	1	0.000	$0.00	$35.70	$55.00	$330.00	$0.00	$0.94	$2.90	$3.84	0.50%	6.50%	6.00%	1.00%	14.00%	$0.54	$4.38	$4.38		
4A	Support Plate intake side	1201-N0101-01-26-02	1	Diecasting	T2/T3 Diecast, SSLC	Aluminum-A380, Cast	Mold/Cast/Sinter Operator	Diecast, LMC	275	1	1	1	0.421	$1.10	$43.52	$100.05	$100.05	$0.46	$0.16	$0.36	$0.99	5.00%	6.00%	4.00%	0.00%	15.00%	$0.15	$1.13	$1.13		
4B	Support Plate intake side	1201-N0101-01-26-01	1	T5 Heat Treat	T2/T3 Heat Treat, MSMC	Not Applicable	Heat Treat Operator	Heat Treat, MLS, LMC	267	1	1	1	0.000	$0.00	$46.52	$100.00	$100.00	$0.00	$0.17	$0.38	$0.55	0.50%	6.50%	6.00%	1.00%	14.00%	$0.08	$0.63	$0.63		
4C	Support Plate intake side	1201-N0101-01-26	1	Machine Casting	T2/T3 CNC Turning, SSLC	Not Applicable	CNC Operator	CNC Turning, MC	129	1	2	1	0.000	$0.00	$35.70	$45.00	$90.00	$0.00	$0.28	$0.70	$0.98	0.30%	6.00%	4.00%	0.00%	10.30%	$0.10	$1.08	$1.08		
5A	Heat Shield Exhaust shaft seal	1201-N0101-01-29	1	Stamp	T2/T3 Stamp/Form, SSLC	Inconel-713C, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	621	0.5	1	1	0.029	$6.00	$42.18	$100.10	$100.10	$0.17	$0.03	$0.16	$0.37	0.30%	6.00%	4.00%	0.00%	10.30%	$0.04	$0.41	$0.41		
6A	Anti-rotate plate - bushing	1201-N0101-01-34	1	Stamp	T2/T3 Stamp/Form, SSLC	SPR-Steel, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	720	0.5	1	1	0.005	$0.65	$42.18	$100.10	$100.10	$0.00	$0.03	$0.14	$0.17	0.30%	6.00%	4.00%	0.00%	10.30%	$0.02	$0.19	$0.19		
7A	Plate Brass Oil Diverter	1201-N0101-01-19-1	1	Stamp Part	T2/T3 Stamp/Form, SSLC	Bronze-89320, Bar	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	679	0.5	1	1	0.027	$2.56	$42.18	$100.10	$100.10	$0.07	$0.03	$0.15	$0.25	0.30%	6.00%	4.00%	0.00%	10.30%	$0.03	$0.27	$0.27		
7B	Plate Brass Oil Diverter	1201-N0101-01-19	1	Machine Oil Pass Through	T2/T3 CNC Milling, MSMC	Not Applicable	CNC Operator	CNC Machining, LMC	257	0.25	1	2	0.000	$0.00	$35.70	$25.00	$50.00	$0.00	$0.03	$0.19	$0.23	0.50%	6.50%	6.00%	1.00%	14.00%	$0.03	$0.26	$0.26		
8A	Bushing - Turbine Shaft	1201-N0101-01-32	1	Screw Machine	T2/T3 CNC Turning, MSMC	Bronze-89320, Bar	CNC Operator	S-CNC Turning, HC	117	1	2.5	1	0.070	$2.56	$35.70	$85.00	$212.50	$0.18	$0.31	$1.82	$2.30	0.50%	6.50%	6.00%	1.00%	14.00%	$0.32	$2.63	$2.63		
9A	Seal Carrier support plate mount	1201-N0101-01-27-01	1	Screw Machine	T2/T3 CNC Turning, MSMC	A-Steel-4140, Bar	CNC Operator	S-CNC Turning, LC	160	1	2	1	0.040	$0.78	$35.70	$35.00	$70.00	$0.03	$0.22	$0.44	$0.69	0.50%	6.50%	6.00%	1.00%	14.00%	$0.10	$0.79	$0.79		
10A	Valve Exhaust Dump	1201-N0101-01-09-01-05-02	1	Investment Cast	T2/T3 Invest. Cast, LSHC	Nickel Alloy Gen, Cast	Mold/Cast/Sinter Operator	Invest. Cast, HMC	120	7	1	1	0.150	$5.00	$43.52	$150.08	$150.08	$0.75	$2.54	$1.25	$4.54	5.00%	7.00%	8.00%	2.00%	22.00%	$1.00	$5.54	$5.54		
10B	Valve Exhaust Dump	1201-N0101-01-09-01-05-01	1	Heat Treat	T2/T3 Heat Treat, MSMC	Not Applicable	Heat Treat Operator	Heat Treat, MLS, LMC	118	1	1	1	0.000	$0.00	$46.52	$100.00	$100.00	$0.00	$0.39	$0.84	$1.24	0.50%	6.50%	6.00%	1.00%	14.00%	$0.17	$1.41	$1.41		
10C	Valve Exhaust Dump	1201-N0101-01-09-01-05	1	Machine	T2/T3 CNC Milling, MSMC	Not Applicable	CNC Operator	CNC Machining, LMC, PREM.	180	0.5	1	1	0.000	$0.00	$35.70	$35.00	$35.00	$0.00	$0.10	$0.19	$0.29	0.50%	6.50%	6.00%	1.00%	14.00%	$0.04	$0.33	$0.33		
11A	Arm - Valve to Shaft	1201-N0101-01-09-01-06-02	1	Investment Cast	T2/T3 Invest. Cast, LSHC	Nickel Alloy Gen, Cast	Mold/Cast/Sinter Operator	Invest. Cast, HMC	120	7	1	1	0.153	$5.00	$43.52	$150.08	$150.08	$0.77	$2.54	$1.25	$4.55	5.00%	7.00%	8.00%	2.00%	22.00%	$1.00	$5.56	$5.56		
11B	Arm - Valve to Shaft	1201-N0101-01-09-01-06-01	1	Heat Treat	T2/T3 Heat Treat, MSMC	Not Applicable	Heat Treat Operator	Heat Treat, MLS, LMC	118	1	1	1	0.000	$0.00	$46.52	$100.00	$100.00	$0.00	$0.39	$0.84	$1.24	0.50%	6.50%	6.00%	1.00%	14.00%	$0.17	$1.41	$1.41		
11C	Arm - Valve to Shaft	1201-N0101-01-09-01-06	1	Machine	T2/T3 CNC Milling, MSMC	Not Applicable	CNC Operator	CNC Machining, LMC, PREM.	120	0.5	1	1	0.000	$0.00	$35.70	$35.00	$35.00	$0.00	$0.15	$0.29	$0.44	0.50%	6.50%	6.00%	1.00%	14.00%	$0.06	$0.50	$0.50		
12A	Block control rod attachment	1201-N0101-01-09-01-10	1	Permanent Cast	T2/T3 Perm. Cast, SSLC	S-Steel-310, Cast	Mold/Cast/Sinter Operator	Perm. Cast, LMC	960	3	1	1	0.042	$2.40	$43.52	$100.06	$100.06	$0.10	$0.14	$0.10	$0.34	5.00%	6.00%	4.00%	0.00%	15.00%	$0.05	$0.39	$0.39		
12B	Block control rod attachment	1201-N0101-01-09-01-10	1	Machine	T2/T3 CNC Milling, MSMC	Not Applicable	CNC Operator	CNC Machining, LMC, PREM.	200	0.5	1	1	0.000	$0.00	$35.70	$35.00	$35.00	$0.00	$0.09	$0.18	$0.26	0.50%	6.50%	6.00%	1.00%	14.00%	$0.04	$0.30	$0.30		
13A	Arm Dump Valve Control	1201-N0101-01-09-01-08	1	Permanent Cast	T2/T3 Perm. Cast, SSLC	S-Steel-310, Cast	Mold/Cast/Sinter Operator	Perm. Cast, LMC	960	3	1	1	0.050	$2.40	$43.52	$100.06	$100.06	$0.12	$0.14	$0.10	$0.36	5.00%	6.00%	4.00%	0.00%	15.00%	$0.05	$0.41	$0.41		
14A	Impeller Intake	1201-N0101-01-16-03	1	Rubber/Plaster Mold	T2/T3 Invest. Cast, LSHC	Aluminum-356-T6, Cast	Mold/Cast/Sinter Operator	Invest. Cast, HMC	180	5	1.25	1	0.064	$1.20	$43.52	$150.08	$187.60	$0.08	$1.21	$1.04	$2.33	25.00%	7.00%	8.00%	2.00%	42.00%	$0.98	$3.31	$3.31		
14B	Impeller Intake	1201-N0101-01-16-02	1	T6 Heat Treat	T2/T3 Heat Treat, MSMC	Not Applicable	Heat Treat Operator	Heat Treat, MLS, LMC	174	1	1.5	1	0.000	$0.00	$46.52	$100.00	$150.00	$0.00	$0.27	$0.86	$1.13	20.00%	6.50%	6.00%	1.00%	33.50%	$0.38	$1.51	$1.51	Impeller Wheels, 5% Casting fallout, 10% Wheel Balance Fallout and 10% Final Assembly Balance Fallout	
14C	Impeller Intake	1201-N0101-01-16-01	1	Machine	T2/T3 CNC Turning, MSMC	Not Applicable	CNC Operator	CNC Turning, MC	164	1	2.5	1	0.000	$0.00	$35.70	$45.00	$112.50	$0.00	$0.22	$0.69	$0.91	20.00%	6.50%	6.00%	1.00%	33.50%	$0.30	$1.21	$1.21		
14D	Impeller Intake	1201-N0101-01-16	1	2 Plane Dynamic Balance	T2/T3 CNC Turning, MSMC	Not Applicable	Precision Assembly	Balancing, SMS, MHC	180	4.5	3	1	0.000	$0.00	$25.74	$45.00	$135.00	$0.00	$0.64	$0.75	$1.39	20.00%	6.50%	6.00%	1.00%	33.50%	$0.47	$1.86	$1.86		
15A	Turbine Wheel	1201-N0101-01-01-24-05	1	Investment Cast	T2/T3 Invest. Cast, LSHC	Inconel-713, Cast	Mold/Cast/Sinter Operator	Invest. Cast, HMC	180	9	1.5	1	0.075	$6.00	$43.52	$150.08	$225.12	$0.45	$2.18	$1.25	$3.88	25.00%	7.00%	8.00%	2.00%	42.00%	$1.63	$5.51	$5.51		
15B	Turbine Wheel	1201-N0101-01-01-24-04	1	Heat Treat	T2/T3 Heat Treat, MSMC	Not Applicable	Heat Treat Operator	Heat Treat, MLS, LMC	178	1	1.5	1	0.000	$0.00	$46.52	$100.00	$150.00	$0.00	$0.26	$0.84	$1.11	20.00%	6.50%	6.00%	1.00%	33.50%	$0.37	$1.48	$1.48		
15C	Turbine Wheel	1201-N0101-01-01-24-03	1	Machine	T2/T3 CNC Turning, MSMC	Not Applicable	CNC Operator	CNC Turning, MC	180	0.5	1	1	0.000	$0.00	$35.70	$45.00	$45.00	$0.00	$0.10	$0.25	$0.35	20.00%	6.50%	6.00%	1.00%	33.50%	$0.12	$0.47	$0.47		
15D	Turbine Wheel	1201-N0101-01-01-24-02	1	2 Plane Dynamic Balance	T2/T3 CNC Turning, MSMC	Not Applicable	Precision Assembly	Balancing, SMS, MHC	180	4.5	3	1	0.000	$0.00	$25.74	$45.00	$135.00	$0.00	$0.64	$0.75	$1.39	20.00%	6.50%	6.00%	1.00%	33.50%	$0.47	$1.86	$1.86		
16A	Turnbine Shaft	1201-N0101-01-01-24-03-01	1	Machine & Grind Shaft	T2/T3 CNC Turning, MSMC	A-Steel-4140, Bar	CNC Operator	S-CNC Turning, MC	176	1	2.5	1	0.255	$0.78	$35.70	$55.00	$137.50	$0.20	$0.20	$0.78	$1.18	10.00%	6.50%	6.00%	1.00%	23.50%	$0.28	$1.46	$1.46		

Turbo Assembly 1501 Rev 5

Manufacturing Assumption and Quote Summary

APPENDIX G.1-15(1of11)
Print Date:9/1/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Turbo Charging Assembly
Part Number: 1501-N0101-01
Component Quote Level: ☑ Full Quote ☐ Modification Quote ☐ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 High Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: Returnable

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION				
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification
16B	Turnbine Shaft	1201-N0101-01-01-24-03	1	Heat Treat	T2/T3 Heat Treat, MSMC	Not Applicable	Heat Treat Operator	Heat Treat, MLS, LMC
Purchase Part - Commodity (Value taken from Purchase Part Database)								
1A	Seal Shaft exhaust end	1201-N0101-01-25	1	(M2 Tool Steel & Inconel)	S			
2A	Plug Threaded	1201-N0101-01-30-03	2		S			
3A	Sleeve Shaft Bushing	1201-N0101-01-30-02	1		S			
4A	Snap Ring - Bearing retainer	1201-N0101-01-31	1		S			
5a	C-Clip - Bushing Retainer	1201-N0101-01-33	1		S			
6A	O-Ring Inner ID of support plate to block	1201-N0101-01-21	1		S			
7A	Spacer Oil Diverter Plates	1201-N0101-01-20	1		S			
8A	Seal - Shaft Support Plate to seal carrier	1201-N0101-01-28	1		S			
9A	Nut turbine Shaft	1201-N0101-01-15	1		S			
10A	O-Ring Intake Housing to block seal	1201-N0101-01-14	1		S			
11A	Bolt Intake Housing to Shaft Housing	1201-N0101-01-04	4		S			
12A	Pin Housing to Center Block Locating	1201-N0101-01-09-01-13	1		S			
13A	Bushing Dump Valve Shaft	1201-N0101-01-09-01-09	1	(Specialized Alloy or Nitrided)	S			
14A	Washer - Valve Retainer	1201-N0101-01-09-01-07	1	Stainless	S			
15A	Washer Block retainer	1201-N0101-01-09-01-11	1	Steel	S			
16A	Stud Turbo to Exhaust Manifold	1201-N0101-01-11	4	Stainless (A286)	S			
17A	Stud - Catalytic Coverter	1280-N0101-07	3	Stainless (A286)	S			
18A	Clamp Exhaust housing to shaft block	1201-N0101-01-08	1	Stainless	S			
19A	Nut Saddle Clamp	1201-N0101-01-13	1	Stainless	S			
20A	Solenoid Intake Bypass	1201-N0101-01-05	1		S			
21A	Gasket Intake Housing Solenoid	1201-N0101-01-12	1		S			
22A	Bolt Solenoid to Intake Housing	1201-N0101-01-06	3		S			
23A	Diaphram Exhaust dump valve	1201-N0101-01-01	1		S			
24A	Nut Exhaust Diaphram Shaft	1201-N0101-01-02	2		S			
25A	Nut Diaphram to Intake Housing	1201-N0101-01-03	2		S			
26A	Gasket - Turbo Inlet to Exhaust Manifold	1285-N0101-01	1		S			
27A	Nut - Turbo to exhaust Manifold	1280-N0101-10	4		S			
28A	Tag ID	1201-N0101-01-07-02	1		S			
29A	Rivet ID Tag	1201-N0101-01-07-03	1		S			
			0					

	MANUFACTURING RATES								MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
16B	250	1	1	1	0.000	$0.00	$46.52	$100.00	$100.00	$0.00	$0.19	$0.40	$0.59	10.00%	6.50%	6.00%	1.00%	23.50%	$0.14	$0.72	$0.72		

Reference #	Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item
1A	$0.00	$1.00	$0.00	$1.00
2A	$0.00	$0.04	$0.00	$0.08
3A	$0.00	$0.03	$0.00	$0.03
4A	$0.00	$0.02	$0.00	$0.02
5a	$0.00	$0.01	$0.00	$0.01
6A	$0.00	$0.18	$0.00	$0.18
7A	$0.00	$0.06	$0.00	$0.06
8A	$0.00	$0.02	$0.00	$0.02
9A	$0.00	$0.08	$0.00	$0.08
10A	$0.00	$0.08	$0.00	$0.08
11A	$0.00	$0.07	$0.00	$0.30
12A	$0.00	$0.01	$0.00	$0.01
13A	$0.00	$0.86	$0.00	$0.86
14A	$0.00	$0.17	$0.00	$0.17
15A	$0.00	$0.03	$0.00	$0.03
16A	$0.00	$0.27	$0.00	$1.07
17A	$0.00	$0.37	$0.00	$1.10
18A	$0.00	$1.24	$0.00	$1.24
19A	$0.00	$0.03	$0.00	$0.03
20A	$0.00	$6.00	$0.00	$6.00
21A	$0.00	$0.08	$0.00	$0.08
22A	$0.00	$0.06	$0.00	$0.18
23A	$0.00	$5.00	$0.00	$5.00
24A	$0.00	$0.01	$0.00	$0.01
25A	$0.00	$0.01	$0.00	$0.02
26A	$0.00	$1.60	$0.00	$1.60
27A	$0.00	$0.09	$0.00	$0.35
28A	$0.00	$0.10	$0.00	$0.10
29A	$0.00	$0.01	$0.00	$0.01
	$0.00	$0.00	$0.00	$0.00

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up				Tooling	Investment
												1	$126.77		
T1 or OEM Total Manufacturing Cost:	$49.30	$26.79	$33.75	$109.84	$5.45	$5.38	$5.15	$0.94	$16.93	→	3	$126.77		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.70%	7.00%	8.00%	4.00%	19.70%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.89	$8.87	$10.14	$5.07	$24.97					
Base Cost Impact to Vehicle:	$49.30	$26.79	$33.75	$109.84	$6.34	$14.26	$15.29	$6.01	$41.90	→		$151.75	$0	$0
											Packaging Cost:	$0.11		
											Net Cost Impact to Vehicle:	$151.85		

PACKAGING CALCULATIONS:
Packaging Type: Option #2
Part Size: 300x200X190
Parts/Layer: 4x5
Number of Layers: 4

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.108		$215,426	0.00%	2,250,000	60	5.00%		$300	718	80	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.108												

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Cooler Assembly - Charged Air **Part Number:** 1505-N0101-01
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1B	Tube with cooling fins	1505-N0101-01-1-1	5	Insert Cooling Fins, Laser weld seem on Tube, Pressure Test.	S	Not Applicable	General Assembly	Mech. Assembly, MC	566	2	0.000	$0.00	$35.51	$125.19	$0.00	$0.13	$0.22	$0.35	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.35	$1.73		
2C	Cooler Assembly - Charged Air Heat Exchanger	1505-N0101-01-01-02	1	Assemble Tube Assemblies, Outer Fins, Top/Bottom Plates and Header Plates, Gasket & End Caps	S	Not Applicable	General Assembly	Mech. Assembly, MC	116	5	0.000	$0.00	$35.51	$125.19	$0.00	$1.53	$1.08	$2.61	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$2.61	$2.61		
Purchase Part - High Impact Item (Full Cost Mapping)																												
1A	Tube	1505-N0101-01-1-2	5	Pre-Form & Cut to Length	S	Aluminum-3003/4047A, Cladding	Cut/Punch/Forming Operator	Stamp/Form, SMS, MH(	514	0.5	0.320	$1.65	$42.18	$125.10	$0.53	$0.04	$0.24	$0.81	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.81	$4.06		
2A	Cooling Fins Inside Tube	1505-N0101-01-1-3-01	5	Form and Cut to Length	S	Aluminum-3003/4047A, Cladding	Cut/Punch/Forming Operator	Stamp/Form, SMS, MH(	720	0.5	0.100	$1.65	$42.18	$125.10	$0.17	$0.03	$0.17	$0.37	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.37	$1.84		
3A	Top/Bottom Plates	1505-N0101-01-1-4	2	Form and Cut to Length	S	Aluminum-3003/4047A, Cladding	Cut/Punch/Forming Operator	Stamp/Form, SMS, MH(	720	0.5	0.110	$1.65	$42.18	$125.10	$0.18	$0.03	$0.17	$0.38	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.38	$0.77		
4A	Cooling Fins Outer	1505-N0101-01-1-5--01	6	Lance, Form, Cut to length	S	Aluminum-3003/4047A, Cladding	Cut/Punch/Forming Operator	Stamp/Form, SMS, MH(	720	0.5	0.140	$1.65	$42.18	$125.10	$0.23	$0.03	$0.17	$0.43	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.43	$2.60		
4B	Header Plate	1505-N0101-01-1-6-01	2	Pierce and Form	S	Aluminum-3003/4047B, Cladding	Cut/Punch/Forming Operator	Stamp/Form, SMS, MH(	529	0.25	0.130	$2.10	$42.18	$125.10	$0.27	$0.02	$0.24	$0.53	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.53	$1.06		
5A	End Cap R Cooler Assembly - Charged Air Heat Exchange	1505-N0101-01-2	1	Injection Mold	S	Nylon66-30GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	655	0.5	0.254	$1.54	$43.52	$100.01	$0.39	$0.03	$0.15	$0.58	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.58	$0.58		
5B	End Cap L Cooler Assembly - Charged Air Heat Exchange	1505-N0101-01-3	1	Injection Mold	S	Nylon66-50GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	643	0.5	0.299	$1.54	$43.52	$100.01	$0.46	$0.03	$0.16	$0.65	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.65	$0.65		
Purchase Part - Commodity (Value taken from Purchase Part Database)																								Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Gasket End Cap	1505-N0101-01-4	2		S																		$0.00	$0.15	$0.00	$0.30		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$16.20		
														T1 or OEM Total Manufacturing Cost:	$6.91	$2.85	$6.44	$16.20	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$16.20		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.50%	6.00%	6.00%	2.00%	14.50%					
														(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.08	$0.97	$0.97	$0.32	$2.35					
														Base Cost Impact to Vehicle:	$6.91	$2.85	$6.44	$16.20	$0.08	$0.97	$0.97	$0.32	$2.35	→		$18.55	$0	$0
																									Packaging Cost:	$0.10		
																									Net Cost Impact to Vehicle:	$18.65		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Cooler Assembly - Charged Air **Part Number:** 1505-N0101-01
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.096		$382,979	0.00%	4,500,000	60	5.00%		$420	912	63	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.096												

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Tube Assembly - Turbo Waste Gate Pneumatic Control **Part Number:** 1570-N0101-03
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Tube Reservoir to Solenoid	1770-N0101-03-1	1	Assemble sheathing and glue on end connections.	S	Not Applicable	General Assembly	Mech. Assembly, LC	180	1	0.000	$0.00	$35.51	$100.19	$0.00	$0.20	$0.56	$0.75	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.75	$0.75		
2A	Tube Reservoir to Pump	1770-N0101-03-2	1	Assemble sheathing and glue on end connections.	S	Not Applicable	General Assembly	Mech. Assembly, LC	157	1	0.000	$0.00	$35.51	$100.19	$0.00	$0.23	$0.64	$0.87	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.87	$0.87		
3A	Tube - Sol to Wastegate	1770-N0101-03-4	1	Assemble sheathing	S	Not Applicable	General Assembly	Mech. Assembly, LC	300	1	0.000	$0.00	$35.51	$100.19	$0.00	$0.12	$0.33	$0.45	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.45	$0.45		
Purchase Part - High Impact Item (Full Cost Mapping)																												
1A	Tube Reservoir to Solenoid	1770-N0101-03-1-1	1	Extrude and Form	S	Nylon12, Inject.	Extruding/Drawing Operator	Comp./Ext. Mold, LMC	400	1.5	0.009	$3.03	$54.35	$100.04	$0.03	$0.20	$0.25	$0.48	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.48	$0.48		
2A	Tube Preformed	1770-N0101-03-2-1	1	Extrude and Form	S	Nylon12, Inject.	Extruding/Drawing Operator	Comp./Ext. Mold, LMC	257	1.5	0.020	$3.03	$54.35	$100.04	$0.06	$0.32	$0.39	$0.77	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.77	$0.77		
3A	Tube - Sol to Wastegate	1770-N0101-03-4-1	1	Extrude	S	Thermoset-SBR	Extruding/Drawing Operator	Comp./Ext. Mold, LMC	514	0.5	0.095	$1.32	$54.35	$100.04	$0.13	$0.05	$0.19	$0.37	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.37	$0.37		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Hose Tube end connections	1770-N0101-03-1-2	4	Rubber	S																		$0.00	$0.04	$0.00	$0.16		
2A	Sheath Tube-Short	1770-N0101-03-1-3	1	Nylon	S																		$0.00	$0.20	$0.00	$0.20		
3A	Sheath Tube - medium	1770-N0101-03-2-2	1	Nylon	S																		$0.00	$0.50	$0.00	$0.50		
4A	Sheath Tube-Long	1770-N0101-03-4-2	1	Nylon	S																		$0.00	$0.60	$0.00	$0.60		
5A	Zip Tie - tube to tube	1770-N0101-03-3	3		S																		$0.00	$0.02	$0.00	$0.06		
6A	Zip Tie Edge Bitter - tube to tube	1770-N0101-03-6	1		S																		$0.00	$0.12	$0.00	$0.12		
7A	Isolator/Hose wrap	1770-N0101-03-5	1		S																		$0.00	$0.08	$0.00	$0.08		
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$5.41		
														T1 or OEM Total Manufacturing Cost:	$1.93	$1.12	$2.36	$5.41	$0.00	$0.00	$0.00	$0.00	$0.00		3	$5.41		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.30%	6.00%	4.00%	1.00%	11.30%					
														(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.02	$0.32	$0.22	$0.05	$0.61					
														Base Cost Impact to Vehicle:	$1.93	$1.12	$2.36	$5.41	$0.02	$0.32	$0.22	$0.05	$0.61			$6.03	$0	$0
																									Packaging Cost:	$0.10		
																									Net Cost Impact to Vehicle:	$6.12		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.013		$26,596	0.00%	2,250,000	60	5.00%		$200	133	432	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.09		$1.00	10	$3.00	9	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.099												

Packaging Option #1 with expendable dividers.

12 Cells per Layer, 4 parts per Cell.
9 Layers.

Total # of Parts/Pallet =432

Manufacturing Assumption and Quote Summary

APPENDIX G.1-15 (4of11)
Print Date:9/1/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Tube Ass'y w. Vehicle Tie Down Canister, Air Cooler Inlet **Part Number:** 1570-N0101-20/21/22
Component Quote Level: **Full Quote** ☒ **Modification Quote** ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Resonator Tube Sub-Assembly	1570-N0101-21	1	Spin Weld Housing Inner to Baffle Inner	S	Not Applicable	General Assembly	Mech. Assembly, LC	300	3	0.000	$0.00	$35.51	$100.19	$0.00	$0.36	$0.33	$0.69	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.69	$0.69		
2A	Tube Ass'y w. Vehicle Tie Down Canister, Air Cooler	1570-N0101-19	1	Assembly Tubes to Resonator	S	Not Applicable	General Assembly	Mech. Assembly, LC	200	3	0.000	$0.00	$35.51	$100.19	$0.00	$0.53	$0.50	$1.03	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.03	$1.03		
Purchase Part - High Impact Item (Full Cost Mapping)																												
1A	Hose Long	1570-N0101-19-2	1	Extrude and Form	S	SBR-Fiber Rein., Extruded	Extruding/Drawing Operator	Comp./Ext. Mold, LMC	295	1.5	0.691	$1.85	$54.35	$100.04	$1.28	$0.28	$0.34	$1.89	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.89	$1.89		
1B	Hose Long w. Overmold Clamp	1570-N0101-19-2	1	Overmold Clamp to Hose	S	Not Applicable	Extruding/Drawing Operator	Comp./Ext. Mold, LMC	240	1	0.000	$0.00	$54.35	$100.04	$0.00	$0.23	$0.42	$0.64	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.64	$0.64		
2A	Hose Short Preformed	1570-N0101-19-6	1	Extrude and Form	S	SBR-Fiber Rein., Extruded	Extruding/Drawing Operator	Comp./Ext. Mold, LMC	450	1.5	0.387	$1.85	$54.35	$100.04	$0.71	$0.18	$0.22	$1.12	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.12	$1.12		
3A	Housing Outer Shell	1570-N0101-19-4-1	1	Injection Mold	S	Nylon66-30GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	554	0.25	0.513	$1.54	$43.52	$100.01	$0.79	$0.02	$0.18	$0.99	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.99	$0.99		
3B	Baffle Inner Tube & End Cap	1570-N0101-19-4-2	1	Injection Mold	S	Nylon66-50GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	610	0.25	0.203	$1.54	$43.52	$100.01	$0.31	$0.02	$0.16	$0.49	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.49	$0.49		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Hose Clamp	1570-N0101-19-3	3	2"	S																		$0.00	$0.27	$0.00	$0.81		
2A	Sleeve Tube Anti-Crush	1570-N0101-19-4-3	2	Steel, Nickel/Zinc Plate	S																		$0.00	$0.30	$0.00	$0.60		
3A	Hose clamp	1570-N0101-19-8	1	2" w. Retention Teeth	S																		$0.00	$0.35	$0.00	$0.35		
4A	Grommet Fastener Isolator	1570-N0101-19-4-4	1		S																		$0.00	$0.08	$0.00	$0.08		
5A	Sleeve Anti-Crush, Fastener	1570-N0101-19-4-5	1		S																		$0.00	$0.05	$0.00	$0.05		
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$8.75		
														T1 or OEM Total Manufacturing Cost:	$4.98	$1.61	$2.16	$8.75	$0.00	$0.00	$0.00	$0.00	$0.00		3	$8.75		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.30%	6.00%	4.00%	1.00%	11.30%					
														(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.03	$0.53	$0.35	$0.09	$0.99					
														Base Cost Impact to Vehicle:	$4.98	$1.61	$2.16	$8.75	$0.03	$0.53	$0.35	$0.09	$0.99			$9.74	$0	$0
																									Packaging Cost:	$0.08		
																									Net Cost Impact to Vehicle:	$9.82		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.030		$59,840	0.00%	2,250,000	60	5.00%		$200	299	192	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.05		$1.00	9	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.077												

Option #1 with Tier Pad Dividers

Part Size =600x180x110
Parts per Pallet = 2 Rows of 12, 8 layers= 192 parts

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Tube Ass'y w. Vehicle Tie Down Canister, Air Cooler Outlet
Part Number: 1570-N0101-30
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Tube	1570-N0101-30-5	1	Install Inserts and Grommets	S	Not Applicable	General Assembly	Mech. Assembly, LC	240	5	0.000	$0.00	$35.51	$100.19	$0.00	$0.74	$0.42	$1.16	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.16	$1.16		
2	Tube - Charge Air Cooler Outlet	1570-N0101-30	1	Install Hose, Clamp	S	Not Applicable	General Assembly	Mech. Assembly, LC	180	2	0.000	$0.00	$35.51	$100.19	$0.00	$0.39	$0.56	$0.95	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.95	$0.95		
Purchase Part - High Impact Item (Full Cost Mapping)																												
1A	Tube	1570-N0101-30-5	1	Friction Weld	S	Not Applicable	Mold/Cast/Sinter Operator	Inject. Mold, SMS	180	3	0.000	$0.00	$43.52	$100.01	$0.00	$0.73	$0.56	$1.28	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.28	$1.28		
1B	Tube	1570-N0101-30-5-2	1	Extrude & Blow Form Tube	S	Nylon6-15GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	145	1	1.612	$1.59	$43.52	$100.01	$2.56	$0.30	$0.69	$3.55	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$3.55	$3.55		
2A	Tube Attachment #1	1570-N0101-30-5-31	1	Injection Mold	S	Nylon6-15GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	720	0.25	0.015	$1.59	$43.52	$100.01	$0.02	$0.02	$0.14	$0.18	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.18	$0.18		
3A	Tube Attachment #2	1570-N0101-30-5-32	1	Injection Mold	S	Nylon6-15GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	720	0.25	0.015	$1.59	$43.52	$100.01	$0.02	$0.02	$0.14	$0.18	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.18	$0.18		
4A	Tube Attachment #3	1570-N0101-30-5-33	1	Injection Mold	S	Nylon6-15GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	720	0.25	0.015	$1.59	$43.52	$100.01	$0.02	$0.02	$0.14	$0.18	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.18	$0.18		
5A	Hose preformed	1570-N0101-30-3	1	Extrude and Form	S	SBR-Fiber Rein., Extrud	Extruding/Drawing Operator	Comp./Ext. Mold, LMC	367	1.5	0.676	$1.85	$54.35	$100.04	$1.25	$0.22	$0.27	$1.74	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.74	$1.74		
5B	Hose w/Clamps	1570-N0101-30-1	1	Overmold Clamp to Hose	S	Not Applicable	Extruding/Drawing Operator	Comp./Ext. Mold, LMC	240	1	0.000	$0.00	$54.35	$100.04	$0.00	$0.23	$0.42	$0.64	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.64	$0.64		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Insert Brass Threaded	1570-N0101-30-6	1		S																		$0.00	$0.04	$0.00	$0.04		
2A	Sleeve Tube Anti-Crush	1570-N0101-19-4-3	2		S																		$0.00	$0.30	$0.00	$0.60		
3A	Grommet Fastener Isolator	1570-N0101-19-4-4	1		S																		$0.00	$0.08	$0.00	$0.08		
4A	Sleeve Anti-Crush, Fastener	1570-N0101-19-4-5	1		S																		$0.00	$0.05	$0.00	$0.05		
5A	Nut - Flag w/Isolator	1570-N0101-30-7	1		S																		$0.00	$0.25	$0.00	$0.25		
6A	Sleeve Anti Crush	1570-N0101-30-8	1		S																		$0.00	$0.30	$0.00	$0.30		
7A	Hose Clamp	1570-N0101-30-4	2		S																		$0.00	$0.29	$0.00	$0.58		
8A	Sensor - Intake Temperature, Outlet Charged Air	1599-N0101-03	1		S																		$0.00	$5.00	$0.00	$5.00		
9A	Bolt - Sensor, Charge Air Temperature	1580-N0101-10	1		S																		$0.00	$0.04	$0.00	$0.04		
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$16.81		
														T1 or OEM Total Manufacturing Cost:	$10.83	$2.65	$3.32	$16.81	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$16.81		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.30%	6.00%	4.00%	1.00%	11.30%					
														(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.05	$1.01	$0.67	$0.17	$1.90					
														Base Cost Impact to Vehicle:	$10.83	$2.65	$3.32	$16.81	$0.05	$1.01	$0.67	$0.17	$1.90	→		$18.70	$0	$0
																									Packaging Cost:	$0.06		
																									Net Cost Impact to Vehicle:	$18.76		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.057		$227,394	0.00%	4,500,000	60	5.00%		$380	598	96	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.057												

Pallet Option #2,

Part Size = 600x150x140

Parts per Pallet = 2 Rows, 8 per row, 6 Layers = 96 Parts per Pallet

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Tube - Elbow, Upper to Charged Air Coupler By-Pass **Part Number:** 1570-N0101-40
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
	Tube - Elbow, Upper to Charged Air Coupler By-Pas	1570-N0101-40	1	Crimp End Hose Piece onto Hose and Add O-Ring	S	Not Applicable	General Assembly	Mech. Assembly, LC	240	1	0.000	$0.00	$35.51	$100.19	$0.00	$0.15	$0.42	$0.57	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.57	$0.57		
Purchase Part - High Impact Item (Full Cost Mapping)																												
1A	Tube (Hose) preformed	1570-N0101-40-1	1	Extrude and Form	S	SBR-Fiber Rein., Extruded	Extruding/Drawing Operator	Comp./Ext. Mold, LMC	400	1.5	0.620	$1.85	$54.35	$100.04	$1.15	$0.20	$0.25	$1.60	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.60	$1.60		
1B	Tube (Hose) w/Clamps	1570-N0101-40-1-1	1	Overmold Clamp to Hose	S	Not Applicable	Extruding/Drawing Operator	Comp./Ext. Mold, LMC	240	1	0.000	$0.00	$54.35	$100.04	$0.00	$0.23	$0.42	$0.64	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.64	$0.64		
Purchase Part - Commodity (Value taken from Purchase Part Database)																								Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
	Hose Clamp	1570-N0101-40-2	1		S																		$0.00	$0.25	$0.00	$0.25		
	Hose end piece	1570-N0101-40-3	1		S																		$0.00	$0.75	$0.00	$0.75		
	O-ring Seal Tube OD	1570-N0101-40-4	1		S																		$0.00	$0.11	$0.00	$0.11		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$3.92		
														T1 or OEM Total Manufacturing Cost:	$2.26	$0.58	$1.08	$3.92	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$3.92		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.30%	6.00%	4.00%	1.00%	11.30%					
														(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.01	$0.24	$0.16	$0.04	$0.44					
														Base Cost Impact to Vehicle:	$2.26	$0.58	$1.08	$3.92	$0.01	$0.24	$0.16	$0.04	$0.44	→		$4.36	$0	$0
																									Packaging Cost:	$0.03		
																									Net Cost Impact to Vehicle:	$4.39		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.010		$19,947	0.00%	2,250,000	60	5.00%		$200	100	576	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.02		$1.00	10	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.027												

Package Option #1
Part Size = 200x140x90mm

Each Layer = 4 rows of 16
Number of Layers = 9
Total Parts per Pallet = 576

Tube Inlet ETB-1570

Manufacturing Assumption and Quote Summary

APPENDIX G.1-15 (7of11)
Print Date:9/1/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Tube: Coupler Y Branch to By-Pass/Elbow Coupler By-Pass to Throttle Body/Elbow Coupler By-Pass to Throttle Body/Tube - Flex Elbow, Silencer to Environment **Part Number:** 1570-N0101-41/42/43/44
Component Quote Level: **Full Quote** ☒ **Modification Quote** ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Flex Tube Silencer to Environment	1070-N0101-05-3 (1570-N0101-44)	1	Heat Stake Cap to Flex Tube and add foam.	S	Not Applicable	General Assembly	Mech. Assembly, LC	240	1	0.000	$0.00	$35.51	$100.19	$0.00	$0.15	$0.42	$0.57	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.57	$0.57		
2A	Silencer - Charge Air By-Pass	1070-N0101-05-2 (1599-N0101-04)	1	Insert Inner Baffle and Vibration Weld Housing	S	Not Applicable	General Assembly	Mech. Assembly, LC	240	1	0.000	$0.00	$35.51	$100.19	$0.00	$0.15	$0.42	$0.57	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.57	$0.57		
3A	Hose Ass'y Silencer to Y Couple (Tube - Charged Air Bypass to Silencer)	1070-N0101-05-5 (1570-N0101-43)	1	Assemble Protective Sheath and Isolator	S	Not Applicable	General Assembly	Mech. Assembly, LC	300	1	0.000	$0.00	$35.51	$100.19	$0.00	$0.12	$0.33	$0.45	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.45	$0.45		
4A	Tube Inlet to throttle body	1070-N0101-05 (1570-N0101-42)	1	Assemble Individual Tube Assemblies with clamps	S	Not Applicable	General Assembly	Mech. Assembly, LC	120	4	0.000	$0.00	$35.51	$100.19	$0.00	$1.18	$0.83	$2.02	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$2.02	$2.02		
Purchase Part - High Impact Item (Full Cost Mapping)																												
1A	Tube - Flex Elbow, Silencer to Environment	1070-N0101-05-15-1 (1570-N0101-44)	1	Injection Mold	S	TPE-PP/EPDM, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	710	1	0.205	$0.99	$43.52	$100.01	$0.20	$0.06	$0.14	$0.41	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.41	$0.41		
2A	Tube - Flex Elbow, Silencer to Environment, Snap	1070-N0101-05-15-2 (1570-N0101-44)	1	Injection Mold	S	Nylon6-15GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	720	0.5	0.020	$1.59	$43.52	$100.01	$0.03	$0.03	$0.14	$0.20	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.20	$0.20		
3A	Silencer Outer Shell	1070-N0101-05-2-1	1	Injection Mold	S	PBT-GF20, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	509	0.5	0.270	$1.45	$43.52	$100.01	$0.39	$0.04	$0.20	$0.63	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.63	$0.63		
4A	Silencer Inner Baffle	1070-N0101-05-2-1-2-3	1	Injection Mold	S	PBT-GF20, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	986	0.5	0.140	$1.45	$43.52	$100.01	$0.20	$0.02	$0.10	$0.33	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.33	$0.33		
5A	Silencer End Cap	1070-N0101-05-2-1-2	1	Injection Mold	S	PBT-GF20, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	900	0.5	0.140	$1.45	$43.52	$100.01	$0.20	$0.02	$0.11	$0.34	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.34	$0.34		
6A	Tube (Hose) preformed	1570-N0101-40-1	1	Extrude and Form	S	SBR-Fiber Rein., Extrud	Extruding/Drawing Operator	Comp./Ext. Mold, LMC	383	1.5	0.380	$1.85	$54.35	$100.04	$0.70	$0.21	$0.26	$1.18	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.18	$1.18		
7A	Tube Y-Coupler to bypass	1070-N0101-05-8-1 (1570-N0101-41)	1	Injection Mold	S	Nylon6-30GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	923	0.5	0.289	$1.76	$43.52	$100.01	$0.51	$0.02	$0.11	$0.64	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.64	$0.64		
8A	Elbow Coupler Bypass to Throttle (Tube-Elbow Coupler By-Pass to Throttle Body)	1070-N0101-05-10-1 (1570-N0101-42)	1	Extrude and Form	S	SBR-Fiber Rein., Extrud	Extruding/Drawing Operator	Comp./Ext. Mold, LMC	343	1.5	0.723	$1.85	$54.35	$100.04	$1.34	$0.24	$0.29	$1.87	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.87	$1.87		
8B	Elbow Coupler Bypass to Throttle w. Clamp (Tube-Elbow Coupler By-Pass to Throttle Body)	1070-N0101-05-11 (1570-N0101-42)	1	Overmold Clamp to Hose	S	Not Applicable	Extruding/Drawing Operator	Comp./Ext. Mold, LMC	240	1	0.000	$0.00	$54.35	$100.04	$0.00	$0.23	$0.42	$0.64	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.64	$0.64		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Seal foam press in place tape style	1070-N0101-05-16	1		S																		$0.00	$0.10	$0.00	$0.10		
2A	Grommet - Silencer to Engine	1070-N0101-05-99	1		S																		$0.00	$0.15	$0.00	$0.15		
3A	Sheath Hose Protection	1070-N0101-05-14	1		S																		$0.00	$0.38	$0.00	$0.38		
4A	Isolator Hose	1070-N0101-05-7	1		S																		$0.00	$0.12	$0.00	$0.12		
5A	Hose Clamp lrg end molded in place	1070-N0101-05-12	1		S																		$0.00	$0.40	$0.00	$0.40		
6a	Hose Clamp sml end	1070-N0101-05-11	1		S																		$0.00	$0.27	$0.00	$0.27		
7a	Hose Clamp	1070-N0101-05-4	3		S																		$0.00	$0.16	$0.00	$0.48		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$11.73		
														T1 or OEM Total Manufacturing Cost:	$5.48	$2.48	$3.77	$11.73	$0.00	$0.00	$0.00	$0.00	$0.00		3	$11.73		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.30%	6.00%	4.00%	1.00%	11.30%					
														(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.04	$0.70	$0.47	$0.12	$1.33					
														Base Cost Impact to Vehicle:	$5.48	$2.48	$3.77	$11.73	$0.04	$0.70	$0.47	$0.12	$1.33			$13.05	$0	$0
																									Packaging Cost:	$0.07		
																									Net Cost Impact to Vehicle:	$13.12		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Manufacturing Assumption and Quote Summary

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Tube: Coupler Y Branch to By-Pass/Elbow Coupler By-Pass to Throttle Body/Elbow Coupler By-Pass to Throttle Body/Tube - Flex Elbow, Silencer to Environment
Part Number: 1570-N0101-41/42/43/44
Component Quote Level: **Full Quote** ☒ **Modification Quote** ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.066		$131,649	0.00%	2,250,000	60	5.00%		$220	598	96	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.066												

Pallet Options: Option #1 No Tier Pads, 8 Cell Returnable Pallet Dividers

Part Size: 600x300x100

Parts/Layer = 2x4 = 8
Number of Layers = 12

Bracket-Support Turbo 1575

Manufacturing Assumption and Quote Summary

APPENDIX G.1-15(8of11)
Print Date:9/1/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Bracket - Support, Turbo Assembly **Part Number:** 1575-N0101-01
Component Quote Level: **Full Quote** ☒ **Modification Quote** ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
	Bracket - Support, Turbo Assembly	1575-N0101-01 (1275-N0101-04)	1	Forging	S	S-Steel-304, Bar	Forging Operator	Cold Forge, LMC	257	1	0.649	$1.65	$38.52	$100.09	$1.07	$0.15	$0.39	$1.61	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.61	$1.61		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up					
											1	$1.61		
T1 or OEM Total Manufacturing Cost:	$1.07	$0.15	$0.39	$1.61	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$1.61		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.30%	6.00%	4.00%	0.00%	10.30%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.00	$0.10	$0.06	$0.00	$0.17					
Base Cost Impact to Vehicle:	$1.07	$0.15	$0.39	$1.61	$0.00	$0.10	$0.06	$0.00	$0.17	→		$1.78	$0	$0
											Packaging Cost:	$0.06		
											Net Cost Impact to Vehicle:	$1.84		

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.001		$1,596	0.00%	2,250,000	60	5.00%		$100	16	3600	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.06		$0.00	0	$0.00	0	$3.50	60	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.059												

Packaged in Expendible Card Board Boxes
(Weight Consideration<40lbs)
Card Board Box: 300x220x120
($3.50/Box)

Parts per Box: 15 per layer x 4 Layers/Box = 60 Parts/Box

Per Pallet (1/2 Pallet), 4x5 Boxes per layer
3 layers = 60 Boxes

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Vacuum Reservoir - Turbo Waste Gate **Part Number:** 1599-N0101-01
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Vacuum Reservoir	7070-N0101-02 (1599-N01010-01)	1	Vibration Weld and Assembly Inserts	S	Not Applicable	General Assembly	Mech. Assembly, LC	240	2	0.000	$0.00	$35.51	$100.19	$0.00	$0.30	$0.42	$0.71	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.71	$0.71		
Purchase Part - High Impact Item (Full Cost Mapping)																												
1A	Cover - cap: Vacuum Reservoir	7070-N0101-02-1	1	PA6 GF35	S	Nylon6-30GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	1037	0.5	0.158	$1.76	$43.52	$100.01	$0.28	$0.02	$0.10	$0.40	0.30%	6.00%	4.00%	0.00%	10.30%	$0.04	$0.44	$0.44		
2A	Base Reservoir: Vacuum Reservoir	7070-N0101-02-2	1	PA6 GF35	S	Nylon6-30GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	861	0.5	0.454	$1.76	$43.52	$100.01	$0.80	$0.03	$0.12	$0.94	0.30%	6.00%	4.00%	0.00%	10.30%	$0.10	$1.04	$1.04		
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Anti-Crush Sleeves Vacuum Reservoir	7070-N0101-02-3	3																				$0.00	$0.04	$0.12	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up					
											1	$2.19		
T1 or OEM Total Manufacturing Cost:	$1.08	$0.34	$0.63	$2.05	$0.00	$0.08	$0.05	$0.00	$0.14	→	3	$2.19		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.50%	6.50%	6.00%	2.50%	15.50%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.01	$0.14	$0.13	$0.05	$0.34					
Base Cost Impact to Vehicle:	$1.08	$0.34	$0.63	$2.05	$0.01	$0.22	$0.18	$0.05	$0.48	→		$2.53	$0	$0
											Packaging Cost:	$0.10		
											Net Cost Impact to Vehicle:	$2.63		

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.017		$33,497	0.00%	2,250,000	60	5.00%		$200	167	343	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.08		$1.00	8	$3.00	7	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.101												

Pallet Option #1 w. Disposable Tier Pads

Part Size:170x150x115

Parts Layer = 7x7 =49
Number of Layers = 7

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Value - Thrust Control, Turbo Waste Gate Pneumatic Control **Part Number:** 1599-N0101-02
Component Quote Level: Full Quote ☒ Modification Quote ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Purchase Part - Commodity (Value taken from Purchase Part Database)																							Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Value - Thrust Control, Turbo Waste Gate Pneumatic Control	1599-N0101-02	1	(Look @ Evaluating as Low Impact Supplier)	S																		$0.00	$5.19	$0.00	$5.19		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
			0																				$0.00	$0.00	$0.00	$0.00		
															Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$5.19		
														T1 or OEM Total Manufacturing Cost:	$5.19	$0.00	$0.00	$5.19	$0.00	$0.00	$0.00	$0.00	$0.00		3	$5.19		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.50%	6.50%	6.00%	2.50%	15.50%					
														(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.03	$0.34	$0.31	$0.13	$0.80					
														Base Cost Impact to Vehicle:	$5.19	$0.00	$0.00	$5.19	$0.03	$0.34	$0.31	$0.13	$0.80			$5.99	$0	$0
																									Packaging Cost:	$0.02		
																									Net Cost Impact to Vehicle:	$6.02		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.024		$48,980	0.00%	2,250,000	60	5.00%		$4,420	11	5184	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.024												

Packaging Option #3 w. Returnable Trays

Part Size 80x90x50

Parts/Layer = 6x3 = 18
Number of Layers = 6

Engine Assembly 1500

Manufacturing Assumption and Quote Summary

APPENDIX G.1-15 (11of11)
Print Date:9/1/2009

FEV

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Engine And Vehicle Assembly **Part Number:** 1500-N0101-01
Component Quote Level: ☑ Full Quote ☐ Modification Quote ☐ Differential Quote (Quote Summary includes costing for

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: OEM Vehicle Assembly
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
1A	Turbo Charging Assembly	1501-N0101-01	1	Mount Turbo Assembly to Intake Manifold, 4 Nuts	OEM Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly-OEM	Vehicle Operations, OEM	82	1	1	1	0.000	$0.00	$83.31	$125.21	$125.21	$0.00	$1.02	$1.53	$2.55	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$2.55	$2.55		
2A	Bracket - Support, Turbo Assembly	1575-N0101-01	1	Install Turbo Support Bracket, 2 Bolts	OEM Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly-OEM	Vehicle Operations, OEM	97	1	1	1	0.000	$0.00	$83.31	$125.21	$125.21	$0.00	$0.86	$1.29	$2.14	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$2.14	$2.14		
3A	Vacuum Reservoir - Turbo Waste Gate	1599-N0101-01	1	Install Vacuum Reservoir, 2 Bolts and 1 Nut	OEM Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly-OEM	Vehicle Operations, OEM	90	1	1	1	0.000	$0.00	$83.31	$125.21	$125.21	$0.00	$0.93	$1.39	$2.32	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$2.32	$2.32		
4A	Value - Thrust Control, Turbo Waste Gate Pneumatic Control	1599-N0101-02	1	Install Valve to Mount Bracket, No Additional Fastener	OEM Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly-OEM	Vehicle Operations, OEM	240	1	1	1	0.000	$0.00	$83.31	$125.21	$125.21	$0.00	$0.35	$0.52	$0.87	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.87	$0.87		
5A	Tube Assembly - Turbo Waste Gate Pneumatic Control	1570-N0101-03	1	Install Waste Gate Tubing, 6 Attachment Points	OEM Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly-OEM	Vehicle Operations, OEM	73	1	1	1	0.000	$0.00	$83.31	$125.21	$125.21	$0.00	$1.13	$1.70	$2.84	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$2.84	$2.84		
6A	Cooler Assembly - Charged Air	1505-N0101-01	1	Install Vehicle H/W for Charged Air Cooler and Charged Air Cooler.	OEM Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly-OEM	Vehicle Operations, OEM	49	1	1	1	0.000	$0.00	$83.31	$125.21	$125.21	$0.00	$1.71	$2.57	$4.29	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$4.29	$4.29		
7A	Tube Ass'y w. Vehicle Tie Down Canister, Air Cooler Inlet	1570-N0101-20/21/22	1	Install Tube Assembly, Turbo Assembly to Charged Air Cooler	OEM Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly-OEM	Vehicle Operations, OEM	75	1	1	1	0.000	$0.00	$83.31	$125.21	$125.21	$0.00	$1.11	$1.67	$2.78	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$2.78	$2.78		
8A	Tube Ass'y w. Vehicle Tie Down Canister, Air Cooler Outlet	1570-N0101-30	1	Install Tube Assembly, Charged Air Cooler to Coupler/ETB bypass	OEM Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly-OEM	Vehicle Operations, OEM	61	1	1	1	0.000	$0.00	$83.31	$125.21	$125.21	$0.00	$1.37	$2.05	$3.42	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$3.42	$3.42		
9A	Tube - Elbow, Upper to Charged Air Coupler By-Pass	1570-N0101-40	1	Make Connection Between Charged Air Outlet Tube and Electronic Throttle Body Inlet Tube.	OEM Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly-OEM	Vehicle Operations, OEM	189	1	1	1	0.000	$0.00	$83.31	$125.21	$125.21	$0.00	$0.44	$0.66	$1.10	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$1.10	$1.10		
10A	Tube: Coupler Y Branch to By-Pass/Elbow Coupler By-Pass to Throttle Body/Elbow Coupler By-Pass to Throttle Body/Tube - Flex Elbow, Silencer to Environment	1570-N0101-41/42/43/44	1	Make Connection to Throttle Body and Snap in Bypass Tube to Vehicle Body	OEM Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly-OEM	Vehicle Operations, OEM	92	1	1	1	0.000	$0.00	$83.31	$125.21	$125.21	$0.00	$0.90	$1.36	$2.26	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$2.26	$2.26		
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Turbo Charging Assembly	1501-N0101-01	1		SAC																					$151.85	$151.85	$0.00	$151.85		
2A	Bracket - Support, Turbo Assembly	1575-N0101-01	1		SAC																					$1.84	$1.84	$0.00	$1.84		
3A	Vacuum Reservoir - Turbo Waste Gate	1599-N0101-01	1		SAC																					$2.63	$2.63	$0.00	$2.63		
4A	Value - Thrust Control, Turbo Waste Gate Pneumatic Control	1599-N0101-02	1		SAC																					$6.02	$6.02	$0.00	$6.02		
5A	Tube Assembly - Turbo Waste Gate Pneumatic C	1570-N0101-03	1		SAC																					$6.12	$6.12	$0.00	$6.12		
6A	Cooler Assembly - Charged Air	1505-N0101-01	1		SAC																					$18.65	$18.65	$0.00	$18.65		
7A	Tube Ass'y w. Vehicle Tie Down Canister, Air Cooler Inlet	1570-N0101-20/21/22	1		SAC																					$9.82	$9.82	$0.00	$9.82		
8A	Tube Ass'y w. Vehicle Tie Down Canister, Air Cooler Outlet	1570-N0101-30	1		SAC																					$18.76	$18.76	$0.00	$18.76		
9A	Tube - Elbow, Upper to Charged Air Coupler By-Pass	1570-N0101-40	1		SAC																					$4.39	$4.39	$0.00	$4.39		
10A	Tube: Coupler Y Branch to By-Pass/Elbow Coupler By-Pass to Throttle Body/Elbow Coupler By-Pass to Throttle Body/Tube - Flex Elbow, Silencer to Environment	1570-N0101-41/42/43/44	1		SAC																					$0.00	$0.00	$0.00	$0.00		
11A	Nut - Exhaust Manifold to Turbo	1280-N0101-07	4		S																					$0.00	$0.14	$0.00	$0.57		
12A	Bolt - Bracket Support, Turbo Assembly	1580-N0101-03	1		S																					$0.00	$0.05	$0.00	$0.05		
13A	Bolt - Bracket Support, Turbo Assembly	1580-N0101-04	1		S																					$0.00	$0.04	$0.00	$0.04		
14A	Bolt - Pressure Reservoir, Turbo Waste Gate	1580-N0101-05	2		S																					$0.00	$0.05	$0.00	$0.09		
15A	Nut - Pressure Reservoir, Turbo Waste Gate	1580-N0101-06	1		S																					$0.00	$0.01	$0.00	$0.01		
16A	Bolt - Tube, Charge Air Cooler to Vehicle	1580-N0101-09	2	Hardware Not Available	S																					$0.00	$0.04	$0.00	$0.07		
17A	Internal Threaded Part (Vehicle H/W)	NA	2	Hardware Not Available	S																					$0.00	$0.03	$0.00	$0.05		
18A	Isolators Veh. Mnt. Charged Air Cooler	NA	2		S																					$0.00	$0.08	$0.00	$0.16		
19A	Bolt - Tube Ass'y w. Vehicle Canister Tie Down	NA	1	Hardware Not Available	S																					$0.00	$0.01	$0.00	$0.01		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Manufacturing Assumption and Quote Summary

APPENDIX G.1-15 (11of11)
Print Date:9/1/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Engine And Vehicle Assembly
Part Number: 1500-N0101-01
Component Quote Level: ☑ Full Quote ☐ Modification Quote ☐ Differential Quote (Quote Summary includes costing for

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: OEM Vehicle Assembly
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
20A	Internal Threaded Part (Vehicle H/W Inlet (1 pc) & Outlet (2 pcs) Air Tube Canister Tie Down)	NA	3	Hardware Not Available	S																					$0.00	$0.02	$0.00	$0.05		
21A	Bolt - Tube Charged Air Cooler Outlet	NA	2	Hardware Not Available	S																					$0.00	$0.01	$0.00	$0.02		
22A	Screw Tube Intake Manifold to Attachment	NA	1	Hardware Not Available	S																					$0.00	$0.01	$0.00	$0.01		
																		Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$245.77		
																	T1 or OEM Total Manufacturing Cost:	$221.21	$9.81	$14.75	$245.77	$0.00	$0.00	$0.00	$0.00	$0.00		3	$245.77		
																	T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%					
																	(SAC) &T1 or OEM Mark-Up Values:	(220.07)	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00					
																	Base Cost Impact to Vehicle:	$1.14	$9.81	$14.75	$25.70	$0.00	$0.00	$0.00	$0.00	$0.00			$25.70	$0	$0
																												Packaging Cost:	$0.00		
																												Net Cost Impact to Vehicle:	$25.70		

PACKAGING CALCULATIONS:

No Packaging Considerations Required. Packaging Costs for fasteners (bolts, nuts, etc.) is captured in the piece costs.

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Appendix G.1 - Subsystem 17
Breather Subsystem
Case Study #0101
MAQS Worksheets

Oil-Air Separator 1702

Manufacturing Assumption and Quote Summary

APPENDIX G.1-17 (1of1)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Oil/Air Separator **Part Number:** 1702-N0101-00
Component Quote Level: ☐ Full Quote ☐ Modification ☑ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 Moderate Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
1A	Oil/Air Separator	1702-N0101-00	1	Final Assembly of PCV system to cover.	T1 Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly	Mech Assembly, LC, Base	257	1	1	3	0.000	$0.00	$35.51	$15.00	$45.00	$0.00	$0.14	$0.18	$0.31	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.31	$0.31		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
Purchase Part - High Impact Item (Full Cost Mapping)																															
1A	Valve - Non Return Intake Hose & Manifold Side	1702-N0101-01/41-01	2	Injection Mold Flap with overmold Hinge	T2/T3 Inject. Mold, MSMC	Nylon66-30GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	720	1	1	1	0.005	$1.54	$43.52	$100.01	$100.01	$0.01	$0.06	$0.14	$0.21	0.50%	6.50%	6.00%	1.00%	14.00%	$0.03	$0.24	$0.47		
1B	Valve - Non Return Intake Hose & Manifold Side	1702-N0101-01/41-02	2	Two Shot Overmold	T2/T3 Inject. Mold, MSMC	Thermoset-NBR	Mold/Cast/Sinter Operator	Inject. Mold, SMS	800	0	1	1	0.002	$1.27	$43.52	$100.01	$100.01	$0.00	$0.00	$0.13	$0.13	0.50%	6.50%	6.00%	1.00%	14.00%	$0.02	$0.15	$0.29		
2A	Separator - Cyclone	1702-N0101-10	1	Injection Mold (Additional Plastic added to Mini Cover over GEMA cover)	T2/T3 Inject. Mold, MSMC	Nylon66-30GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, MLS	545	0	1	1	0.818	$1.54	$43.52	$150.01	$150.01	$1.26	$0.00	$0.28	$1.53	0.50%	6.50%	6.00%	1.00%	14.00%	$0.21	$1.75	$1.75		
3A	Valve - Pressure Control	1702-N0101-20	1	Nylon Injection Mold	T2/T3 Inject. Mold, MSMC	Nylon66-30GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	391	1	1	1	0.005	$1.54	$43.52	$100.01	$100.01	$0.01	$0.11	$0.26	$0.37	0.50%	6.50%	6.00%	1.00%	14.00%	$0.05	$0.43	$0.43		
3B	Valve - Pressure Control	1702-N0101-20	1	Two Shot Overmold	T2/T3 Inject. Mold, MSMC	Thermoset-NBR	Mold/Cast/Sinter Operator	Inject. Mold, SMS	389	0	1	1	0.002	$1.27	$43.52	$100.01	$100.01	$0.00	$0.00	$0.26	$0.26	0.50%	6.50%	6.00%	1.00%	14.00%	$0.04	$0.30	$0.30		
			0						#####	0	1	1	0.000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	$0.00		
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Hinge Flow control flap	1702-N0101-80	2		S																					$0.00	$0.03	$0.00	$0.06		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$3.61		
T1 or OEM Total Manufacturing Cost:	$1.35	$0.37	$1.49	$3.21	$0.01	$0.18	$0.17	$0.03	$0.40	→	3	$3.61		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.50%	6.50%	6.00%	2.50%	15.50%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.02	$0.23	$0.22	$0.09	$0.56					
Base Cost Impact to Vehicle:	$1.35	$0.37	$1.49	$3.21	$0.03	$0.42	$0.39	$0.12	$0.96	→		$4.17	$0	$0
											Packaging Cost:	$0.00		
											Net Cost Impact to Vehicle:	$4.17		

PACKAGING CALCULATIONS:
No Packaging Impact

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Appendix G.1 - Subsystem 60 Engine Management, Engine Electronic, and Electrical Subsystems

Case Study #0101

MAQS Worksheets

PCM HW 6002A

Manufacturing Assumption and Quote Summary

APPENDIX G.1-60, (1of4)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Power Train Control Module (PCM) Assembly - Hardware **Part Number:** 0602-N0101-01
Component Quote Level: ☐ Full Quote ☑ Modification ☐ Differential Quote (Quote Summary includes costing for both Technology Packages)

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 High Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Power Train Control Module (PCM) Assembly - Hardware	0602-N0101-01	1	The PCM H/W is carry over except for the PFI drivers. GDI drivers use a 75-80VDC Boost Circuit and 25A Peak/Hold Drivers. The turbo is just another low-side driver really no cost.	S																					$0.00	$40.00	$0.00	$40.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up					
											1	$40.00		
T1 or OEM Total Manufacturing Cost:	$40.00	$0.00	$0.00	$40.00	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$40.00		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%					
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00					
Base Cost Impact to Vehicle:	$40.00	$0.00	$0.00	$40.00	$0.00	$0.00	$0.00	$0.00	$0.00	→		$40.00	$0	$0
											Packaging Cost:	$0.00		
											Net Cost Impact to Vehicle:	$40.00		

PACKAGING CALCULATIONS:
Packaging Type: **NA**
Part Size:
Parts/Layer:
Number of Layers:

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Manufacturing Assumption and Quote Summary

APPENDIX G.1-60, (2of4)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Power Train Control Module (PCM) Assembly - Software **Part Number:** 6002-N0101-50
Component Quote Level: ☐ Full Quote ☑ Modification ☑ Differential Quote (Quote Summary includes costing for both Technology Packages)

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 High Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Power Train Control Module (PCM) Assembly - Software	6002-N0101-50	1	• Control system is much more complicated in order to control injection timing, split injections, fuel rail pressure, electric water pump, electric thermostat, etc.	S																					$0.00	$0.00	$0.00	$0.00		
	Per discussion with Brian Nelson, Software will be covered by indirect cost multiplier. 5/20/09		0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up	1	$0.00		
T1 or OEM Total Manufacturing Cost:	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	3	$0.00		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%				
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00				
Base Cost Impact to Vehicle:	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		$0.00	$0	$0
										Packaging Cost:	$0.00		
										Net Cost Impact to Vehicle:	$0.00		

PACKAGING CALCULATIONS:
Packaging Type: **NA**
Part Size:
Parts/Layer:
Number of Layers:

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Manufacturing Assumption and Quote Summary

APPENDIX G.1-60 (3of4)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Engine Electrical Systems (including Wiring Harnesses, Earth Straps, Ignition Harness, Coils, Sockets) **Part Number:** 6003-N0101-01/30
Component Quote Level: ☐ Full Quote ☐ Modification ☑ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: T1 Moderate Assembly Complexity
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Wire Turbo Connector	0603-N0101-30	2	($0.50/Wire Circuit)	S																					$0.00	$0.50	$0.00	$1.00		
2A	Wire Coolant Aux Pump	0603-N0101-30	3	($0.50/Wire Circuit)	S																					$0.00	$0.50	$0.00	$1.50		
3A	Clip Harness Retention		2		S																					$0.00	$0.01	$0.00	$0.02		
4A	Wire Waste Gate Sol	0603-N0101-30	2	($0.50/Wire Circuit)	S																					$0.00	$0.50	$0.00	$1.00		
5A	Wire Charge Air Temp	0603-N0101-30	4	($0.50/Wire Circuit)	S																					$0.00	$0.50	$0.00	$2.00		
6A	Clip Harness Retention		1		S																					$0.00	$0.01	$0.00	$0.01		
7A	Edge Biter Harness Retention		3		S																					$0.00	$0.02	$0.00	$0.06		
8A	Wire HP Fuel Pump Control		2	($0.50/Wire Circuit)	S																					$0.00	$0.50	$0.00	$1.00		
9A	Wire Fuel Pressure Sensor	0603-N0101-30	3	($0.50/Wire Circuit)	S																					$0.00	$0.50	$0.00	$1.50		
10A	Ignition Coil Assembly - Single Spark	0603-N0101-01	4		S																					$0.00	$1.01	$0.00	$4.04		
																										$0.00		$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up				
										1	$12.13		
T1 or OEM Total Manufacturing Cost:	$12.13	$0.00	$0.00	$12.13	$0.00	$0.00	$0.00	$0.00	$0.00	→ 3	$12.13		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%				
(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00				
Base Cost Impact to Vehicle:	$12.13	$0.00	$0.00	$12.13	$0.00	$0.00	$0.00	$0.00	$0.00	→	$12.13	$0	$0
										Packaging Cost:	$0.00		
										Net Cost Impact to Vehicle:	$12.13		

PACKAGING CALCULATIONS:
Negligible Change to Packaging

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Engine Assembly 6000

Manufacturing Assumption and Quote Summary

APPENDIX G.1-60 (4of4)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Engine Electrical Systems (including Wiring Harnesses, Earth Straps, Ignition Harness, Coils, Sockets)   **Part Number:** 6003-N0101-01-50
Component Quote Level: ☐ Full Quote   ☐ Modification   ☑ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: OEM Engine Assembly
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
	Additional Electrical Connections due to Turbo & DI Adds	NA	1	Install Connectors, Secure Wiring	OEM Engine Assembly	Not Applicable	General Assembly-OEM	Engine Assembly, OEM	52	1	1	1	0.000	$0.00	$83.31	$150.21	$150.21	$0.00	$1.60	$2.88	$4.48	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$4.48	$4.48		
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Power Train Control Module (PCM) Assembly - Hardware	0602-N0101-01	1		SAC																					$40.00	$40.00	$0.00	$40.00		
2A	Power Train Control Module (PCM) Assembly - Software	6002-N0101-50	1		SAC																					$0.00	$0.00	$0.00	$0.00		
3A	Engine Electrical Systems (including Wiring Harnesses, Earth Straps, Ignition Harness, Coils, Sockets)	0603-N0101-01/30	1		SAC																					$12.13	$12.13	$0.00	$12.13		
4A																										$0.00	$0.00	$0.00	$0.00		
5A																										$0.00	$0.00	$0.00	$0.00		
6A																										$0.00	$0.00	$0.00	$0.00		
7A																										$0.00	$0.00	$0.00	$0.00		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

	Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up					
											1	$56.61		
T1 or OEM Total Manufacturing Cost:	$52.13	$1.60	$2.88	$56.61	$0.00	$0.00	$0.00	$0.00	$0.00	→	3	$56.61		
T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%					
(SAC) &T1 or OEM Mark-Up Values:	(52.13)	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00					
Base Cost Impact to Vehicle:	$0.00	$1.60	$2.88	$4.48	$0.00	$0.00	$0.00	$0.00	$0.00	→		$4.48	$0	$0
											Packaging Cost:	$0.00		
											Net Cost Impact to Vehicle:	$4.48		

PACKAGING CALCULATIONS:
Negligible Change to Packaging

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

Appendix G.1 - Subsystem 70
Accessory Subsystem
Case Study #0101
MAQS Worksheets

Vacuum Pump

Manufacturing Assumption and Quote Summary

APPENDIX G.1-70, (1of2)
Print Date:9/2/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Vacuum Pump Assembly **Part Number:** 7004-N0101-01
Component Quote Level: **Full Quote** ☒ **Modification Quote** ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																												
1A	Vacuum Pump Assembly	7004-N0101-01	1	Final Assembly & Test Vacuum Pump	S	Not Applicable	General Assembly	Mech. Assembly, MC	240	3	0.000	$0.00	$35.51	$125.19	$0.00	$0.44	$0.52	$0.97	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.97	$0.97		
1B	Base Vac Pump Rotor Support	7004-N0101-01-07-01	1	Subassembly Exhaust and Oil Vent Valve	S	Not Applicable	General Assembly	Mech. Assembly, MC	240	1	0.000	$0.00	$35.51	$125.19	$0.00	$0.15	$0.52	$0.67	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$0.67	$0.67		
Purchase Part - High Impact Item (Full Cost Mapping)																												
1A	Base Vac Pump rotor support Casting	7004-N0101-01-07-01-02	1	Machine Casting	S	Not Applicable	Mold/Cast/Sinter Operator	Diecast, LMC	257	1	0.000	$0.00	$43.52	$100.05	$0.00	$0.17	$0.39	$0.56	0.30%	6.00%	4.00%	0.00%	10.30%	$0.06	$0.62	$0.62		
1B	Base Vac Pump rotor support Casting	7004-N0101-01-07-01-02-1	1	Casting	S	Aluminum-A380, Cast	Mold/Cast/Sinter Operator	Diecast, LMC	183	0.5	0.542	$1.10	$43.52	$100.05	$0.60	$0.12	$0.55	$1.26	0.30%	6.00%	4.00%	0.00%	10.30%	$0.13	$1.39	$1.39		
2A	Plate Oil vent relief	7004-N0101-01-07-01-04	1	Stamping & Heat Treat	S	SPR-Steel, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	720	0.25	0.005	$0.65	$42.18	$100.10	$0.00	$0.01	$0.14	$0.16	0.30%	6.00%	4.00%	0.00%	10.30%	$0.02	$0.17	$0.17		
3A	Plate retainer/limiter - Oil vent relief	7004-N0101-01-07-01-05	1	Stamping & Plating	S	LC-Steel-1000S, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	720	0.25	0.008	$0.45	$42.18	$100.10	$0.00	$0.01	$0.14	$0.16	0.30%	6.00%	4.00%	0.00%	10.30%	$0.02	$0.17	$0.17		
4A	Rotor Vac Pump	7004-N0101-01-08	1	Induction Harden	S	Not Applicable	Lathe/Turning Operator	CNC Turning, MHC	600	0.15	0.000	$0.00	$37.60	$125.00	$0.00	$0.01	$0.21	$0.22	0.30%	6.00%	4.00%	0.00%	10.30%	$0.02	$0.24	$0.24		
4B	Rotor Vac Pump	7004-N0101-01-08	1	Machine for Critical Tol.	S	Not Applicable	Lathe/Turning Operator	CNC Turning, MHC	109	0.85	0.000	$0.00	$37.60	$125.00	$0.00	$0.29	$1.15	$1.44	0.30%	6.00%	4.00%	0.00%	10.30%	$0.15	$1.59	$1.59		
4C	Rotor Vac Pump raw part	7004-N0101-01-08-1-1	1	PM Sinter	S	PM-SMF-FN0205	Mold/Cast/Sinter Operator	Powder Metal, MHC	240	0.5	0.631	$2.00	$43.52	$150.14	$1.26	$0.09	$0.63	$1.98	0.30%	6.00%	4.00%	0.00%	10.30%	$0.20	$2.18	$2.18		
5A	Adapter Rotor Drive	7004-N0101-01-09	1	PM Sinter	S	PM-SMF-FC0208	Mold/Cast/Sinter Operator	Powder Metal, LMC	360	0.5	0.139	$1.00	$43.52	$100.14	$0.14	$0.06	$0.28	$0.48	0.30%	6.00%	4.00%	0.00%	10.30%	$0.05	$0.53	$0.53		
6A	Retainer Rotor drive adapter	7004-N0101-01-10	1	Stamp & Plate	S	LC-Steel-1000S, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	1200	0.25	0.001	$0.45	$42.18	$100.10	$0.00	$0.01	$0.08	$0.09	0.30%	6.00%	4.00%	0.00%	10.30%	$0.01	$0.10	$0.10		
7A	Vane Vacuum Pump	7004-N0101-01-05	1	Form Edges and Plate	S	Not Applicable	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	720	0.25	0.000	$0.00	$42.18	$100.10	$0.00	$0.01	$0.14	$0.15	0.30%	6.00%	4.00%	0.00%	10.30%	$0.02	$0.17	$0.17		
7B	Vane Vacuum Pump	7004-N0101-01-05-01	1	Stamp Out Form	S	LC-Steel-1000S, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	1200	0.25	0.167	$0.45	$42.18	$100.10	$0.08	$0.01	$0.08	$0.17	0.30%	6.00%	4.00%	0.00%	10.30%	$0.02	$0.18	$0.18		
8A	Seal Pump Vane to wall	7004-N0101-01-06	2	PM Sinter	S	Not Applicable	Mold/Cast/Sinter Operator	Powder Metal, LMC	600	0.25	0.000	$0.00	$43.52	$100.14	$0.00	$0.02	$0.17	$0.19	0.30%	6.00%	4.00%	0.00%	10.30%	$0.02	$0.20	$0.41		
8B	Seal Pump Vane to wall	7004-N0101-01-06-01	2	PM Sinter	S	PM-SMF-FN0205	Mold/Cast/Sinter Operator	Powder Metal, LMC	480	0.25	0.026	$2.00	$43.52	$100.14	$0.05	$0.02	$0.21	$0.28	0.30%	6.00%	4.00%	0.00%	10.30%	$0.03	$0.31	$0.63		
9A	Cover Vacuum Pump	7004-N0101-01-01	1	Stamp & Plate	S	LC-Steel-1000S, Coil	Cut/Punch/Forming Operator	Stamp/Form, SMS, LMC	180	1	1.070	$0.45	$42.18	$100.10	$0.48	$0.23	$0.56	$1.27	0.30%	6.00%	4.00%	0.00%	10.30%	$0.13	$1.40	$1.40		
10A	Fitting Vac Outlet Port	7004-N0101-01-03	1	Assemble Outlet Fitting	S	Purchased Parts	General Assembly	Mech. Assembly, LC	450	1	0.265	$1.00	$35.51	$100.19	$0.27	$0.08	$0.22	$0.57	0.30%	6.00%	4.00%	0.00%	10.30%	$0.06	$0.62	$0.62		
10B	Fitting Vac Outlet Port	7004-N0101-01-03-01	1	Injection Mold Housing	S	Nylon66-30GF, Inject.	Mold/Cast/Sinter Operator	Inject. Mold, SMS	480	0.25	0.014	$1.54	$43.52	$100.01	$0.02	$0.02	$0.21	$0.25	0.30%	6.00%	4.00%	0.00%	10.30%	$0.03	$0.28	$0.28		
Purchase Part - Commodity (Value taken from Purchase Part Database)																								Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
1A	Fitting Clean Air Inlet	7004-N0101-01-07-01-03	1		S																			$0.12	$0.00	$0.12		
2A	Rivet solid, Oil vent plates	7004-N0101-01-07-01-06	1		S																			$0.01	$0.00	$0.01		
3A	Gasket Vac Pump Cover (SBR)	7004-N0101-01-02	1		S																			$0.08	$0.00	$0.08		
4A	Bolt - Vacuum Pump Housing	7080-N0101-10	4		S																			$0.03	$0.00	$0.12		
5A	Sleeve Anti Crush	7004-N0101-01-03-02	1		B10A																			$0.01	$0.01	$0.00		
5B	Check Valve	7004-N0101-01-03-03	1		B10A																			$0.10	$0.10	$0.00		
5C	Spring Check Valve	7004-N0101-01-03-04	1		B10A																			$0.02	$0.02	$0.00		
5D	Seat check valve spring	7004-N0101-01-03-05	1		B10A																			$0.07	$0.07	$0.00		
5E	O-Ring - Vac fitting	7004-N0101-01-04	1		B10A																			$0.06	$0.06	$0.00		
6A	Bolt - Vac Fitting	7080-N0101-10	1		S																			$0.03	$0.00	$0.03		
														T1 or OEM Total Manufacturing Cost:	$3.31	$1.81	$6.56	$11.69	$0.03	$0.58	$0.39	$0.00	$1.00	→	3	$12.68		
														T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.50%	6.50%	6.00%	2.50%	15.50%					
														T1 or OEM Mark-Up Values:	-----	-----	-----	-----	$0.06	$0.82	$0.76	$0.32	$1.97					
														Base Cost Impact to Vehicle:	$3.31	$1.81	$6.56	$11.69	$0.09	$1.41	$1.15	$0.32	$2.96	→		$14.65	$0	$0
																									Packaging Cost:	$0.09		
																									Net Cost Impact to Vehicle:	$14.74		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Vacuum Pump Assembly **Part Number:** 7004-N0101-01
Component Quote Level: **Full Quote** ☒ **Modification Quote** ☐

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
Shipping Method: F.O.B
Packaging Specification: Returnable w. Expendable Separators

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES						MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS			TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM or Supplier	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate	SG&A Rate	Profit Rate	ED&T/ R&D Rate	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y		Tooling Assumptions "x1000 "	Investment Assumptions "x1000 "

Packaging Calculations	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.018		$35,461	0.00%	2,250,000	60	5.00%		$200	177	432	8	76596
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.08		$1.00	9	$3.00	8	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.094												

Standard Pallet L4'xW4'xD3'
Area = 122cm x 114 cm = 1440 sq. cm
Depth = 86 cm

Part Size 19x13x10
Each Layer 9x6=54parts
@ 8 layers = 432 Parts

Assume Pallets Need to be Replaced
Every 5 Years.

Manufacturing Assumption and Quote Summary

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine/ Compact Vehicle Class
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 (N = New, 01 = Technology Package, 01 = Vehicle Class)
System Description: 2007 Mini Cooper S. 1.6L I4, 16V DOHC GDI Turbo
Component Description: Engine Assembly of Accessory Subsystem Components to Engine **Part Number:** 7000
Component Quote Level: ☑ Full Quote ☐ Modification Quote ☐ Differential Quote (Quote Summary includes

OEM Operating Pattern (Weeks/Year): 47
Annual Engine Volume (CPV): 450,000
Components per Engine: 1
Annual Component Volume: 450,000
Weekly Component Volume: 9,574
Estimated Product Life: 10

OEM Plant Location: North America
Supplier Plant Location: North America
OEM/T1 Classification: OEM Engine Assembly
Shipping Method: FOB Ship Point
Packaging Specification: NA

GENERAL COMPONENT INFORMATION				GENERAL MANUFACTURING INFORMATION					MANUFACTURING RATES									MANUFACTURING COSTS				MARK-UP COSTS						TOTAL COSTS		TOOLING & INVESTMENT	
Reference #	Part Description	Part Number	QTY Per Assembly	Primary Process Description	OEM/Supplier Classification	Material Specification	Labor Classification	Burden Classification	Finished Pieces Per Hour	Number of Operators	Number of Lines	Parallel Processing Multiplier	Material Usage "lbs"	Material Cost $/lb (DB)	Labor Rate $/Hour (DB)	Burden Rate $/Hour (DB)	Applied Burden Rate $/Hour	Material Cost	Labor/ Part	Burden/ Part	Total 1 = Material + Labor + Burden	End Item Scrap Rate (DB)	SG&A Rate (DB)	Profit Rate (DB)	ED&T/ R&D Rate (DB)	Total Mark-up Rate	Total Mark-up Cost	Total 2 = Total 1 + Total Mark-up	Total 3 = Total 2 * Qty per Ass'y	Tooling Assumptions "x1000"	Investment Assumptions "x1000"
Tier 1 Supplier or OEM Processing & Assembly (Full Cost mapping)																															
	Vacuum Pump Assembly	7004-N0101-01	1	Mount Vacuum Pump to Head	OEM Assembly, Mark-up Applied @ Bottom.	Not Applicable	General Assembly-OEM	Engine Assembly, OEM	113	1	1	1	0.000	$0.00	$83.31	$150.21	$150.21	$0.00	$0.74	$1.34	$2.08	0.00%	0.00%	0.00%	0.00%	0.00%	$0.00	$2.08	$2.08		
Purchase Part - Commodity (Value taken from Purchase Part Database)																										Supplier Account Cost	Purchase Price/ Unit	Purchase Price Net, PIA	Purchase Price Net, End Item		
	Bolt - Vacuum Pump	7080-N0101-01	2		S																					$0.00	$0.03	$0.00	$0.05		
	Seal - Vacuum Pump to Head	7004-N0101-01-11	1		S																					$0.00	$0.08	$0.00	$0.08		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
			0																							$0.00	$0.00	$0.00	$0.00		
																		Material	Labor	Burden	TMC	Scrap	SG&A	Profit	ED&T	Total Mark-up		1	$2.20		
																	T1 or OEM Total Manufacturing Cost:	$0.13	$0.74	$1.34	$2.20	$0.00	$0.00	$0.00	$0.00	$0.00		3	$2.20		
																	T1 or OEM Mark-Up Rates:	-----	-----	-----	-----	0.00%	0.00%	0.00%	0.00%	0.00%					
																	(SAC) &T1 or OEM Mark-Up Values:	0.00	-----	-----	-----	$0.00	$0.00	$0.00	$0.00	$0.00					
																	Base Cost Impact to Vehicle:	$0.13	$0.74	$1.34	$2.20	$0.00	$0.00	$0.00	$0.00	$0.00			$2.20	$0	$0
																												Packaging Cost:	$0.00		
																												Net Cost Impact to Vehicle:	$2.20		

"S"=Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly.

"SAC"=(Supplier Accounted Costs) Indicates Component is Supplied directly to T1 or OEM for Final or Sub-Assembly. In addition component material cost is accounted for in T1 quote sheet. Thus component cost will only be included for Mark-up Calculations.

"Alpha-Numeric Character" = Indicates purchase parts are brought in by T2/T3 Supplier for Subassembly.

PACKAGING CALCULATIONS:

Packaging for fasteners covered in piece price.

	Cost per Piece		Total Amount	Lump Sum Payment (%)	Total # of Pieces	Number of Months	Interest Rate		Cost per Pallet /Rack	Total Number of Pallets/ Racks Required	Number of Parts per Pallet/ Rack	Supplier, Customer and In-transit Inventory Requirements (Weeks)	Supplier, Customer and In-transit Inventory Requirements (Parts)
Rack/Pallet Investment Amortization:	$0.000		$0	0.00%	4,500,000	60	5.00%		$0	57447	1	6	57447
	Cost per Piece		Tier Pad Price Per	Tier Pads Pallet/Rack	Divider Pads, Price Per	Divider Pads Pallet/Rack	Other #1 Packaging Price Per	Other #1 Pads Pallet/Rack	Other #2 Packaging Price Per	Other #2 Pads Pallet/Rack	Other #3 Packaging, Price Per	Other #3 Pads Pallet/Rack	
Expendable Packaging in Piece Cost:	$0.00		$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	
Packaging Cost Total:	$0.000												

APPENDIX H.1
Subsystem Cost Model Analysis Templates
Case Study #0101

Engine Subsystems	Subsystem CMAT Locations within Appendix H.1	Net Incremental Component/Assembly Cost Impact to OEM
Engine Frames, Mountings & Brackets Subsystem	Not Applicable	$0.00
Crank Drive Subsystem	Appendix H.1 - 03, Pages 2-4	$0.00
Counter Balance Subsystem	Appendix H.1 - 04, Pages 5-7	($35.95)
Cylinder Block Subsystem	Appendix H.1 - 05, Pages 8-10	$0.44
Cylinder Head Subsystem	Appendix H.1 - 06, Pages 11-13	$16.55
Valve Train Subsystem	Appendix H.1 - 07, Pages 14-16	$10.06
Timing Drive Subsystem	Appendix H.1 - 08, Pages 17-19	$1.60
Accessory Drive Subsystem	Not Applicable	$0.00
Intake Subsystem	Appendix H.1 - 10, Pages 20-22	($12.73)
Fuel Induction Subsystem	Appendix H.1 - 11, Pages 23-25	$107.32
Exhaust Subsystem	Appendix H.1 - 12, Pages 26-28	$37.77
Lubrication (Oil Pans/Sumps) Subsystem	Appendix H.1 - 13, Pages 29-31	$34.46
Cooling Subsystem	Appendix H.1 - 14, Pages 32-34	$41.56
Induction Air Charging Subsystem	Appendix H.1 - 15, Pages 35-37	$258.89
Exhaust Gas Re-Circulations Subsystem	Not Applicable	$0.00
Breather Subsystem	Appendix H.1 - 17, Pages 38-40	$4.17
Engine Management, Engine Electronic and Electrical Subsystem	Appendix H.1 - 60, Pages 41-43	$56.61
Accessory (e.g. Starter Motor, Power Steering Pump, Air Conditioning Compressor) Subsystem	Appendix H.1 - 70, Pages 44-46	$16.95
	Total Unit Cost =>	$537.70

FEV

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, Turbo, DI w. dVVT (Study Case# N0101)										
												Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	03					**Crank Drive Subsystem**																
		01				**Crank Shaft**																
					A.	Shaft - Crank	03 01 - N0101 - 01	1			Diff.	$ (10.61)	$ -	$ -	$ (10.61)	$ (0.07)	$ (0.74)	$ (0.85)	$ -	$ (1.67)	$ -	$ (12.27)
		03				**Connect Rods (Assemblies: Connecting Rod, Connecting Rod Cap)**																
			A			Rod Subassembly - Connecting	03 03 - N0101 - 01	4			Diff.	$ 1.19	$ -	$ 1.11	$ 2.30	$ 0.01	$ 0.15	$ 0.14	$ 0.06	$ 0.36	$ -	$ 2.66
					A1	Bushing - Connecting Rod	03 03 - N0101 - 02	4	PIA Rod Subassembly													
					A2	Rod - Connecting	03 03 - N0101 - 03	4	PIA Rod Subassembly													
					B	Cap- Connecting Rod	03 03 - N0101 - 04	4	PIA Rod Subassembly													
		04				**Pistons (Assemblies, Including Pistons, Ring Packs, Piston Pins, Circlips)**																
					A	Piston - Engine, Machined	03 04 - N0101 - 01	4			Diff.	$ (0.36)	$ 0.39	$ 3.04	$ 3.07	$ 0.34	$ 0.22	$ 0.20	$ 0.08	$ 0.85	$ -	$ 3.92
					B	Ring/Clip - Piston Pin Retainer	03 04 - N0101 - 02	8	Purchase Parts Engine Ass'y													
					C	Pin- Piston	03 04 - N0101 - 03	4	Purchase Parts Engine Ass'y													
					D	Compression Ring - Piston, Top	03 04 - N0101 - 04	4	Purchase Parts Engine Ass'y													
					E	Compression Ring - Piston, 2nd	03 04 - N0101 - 05	4	Purchase Parts Engine Ass'y													
			F			Oil Ring Subassembly																
					F1	Spacer/Expander/Coil Spring - Oil Ring, Piston	03 04 - N0101 - 07	4	Purchase Parts Engine Ass'y													
					F2	Rail(s) - Oil Ring, Piston	03 04 - N0101 - 08	4	Purchase Parts Engine Ass'y													
		90				**Bearing Elements: Connecting Rod Bearing Shells, Connecting Rod Bush**																
					A	Bearing - Connecting Rod to Crank Shaft	03 90 - N0101 - 01	8	Purchase Parts Engine Ass'y													
		100				**Engine Assembly**																
			A			Assembly of Crank Drive Subsystem Components to Engine	03 00 - N0101 - 01	NA			Diff.	$ 5.69	$ -	$ -	$ 5.69	$ -	$ -	$ -	$ -	$ -	$ -	$ 5.69
												($4.09)	$ 0.39	$ 4.15	$ 0.46	$ 0.28	$ (0.37)	$ (0.51)	$ 0.14	$ (0.46)	$ -	$ 0.00

NOTES:

1. ▨ = A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.

FEV

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

APPENDIX H.1.03
Printed: 12/9/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA, PFI w. dVVT (Study Case# B0101)										
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
						03 Crank Drive Subsystem																
						01 Crank Shaft																
						A. Shaft - Crank	03 01 - N0101 - 01	1			Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						03 Connect Rods (Assemblies: Connecting Rod, Connecting Rod Cap)																
						A Rod Subassembly - Connecting	03 03 - N0101 - 01	4			Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						A1 Bushing - Connecting Rod	03 03 - N0101 - 02	4	PIA Rod Subassembly													
						A2 Rod - Connecting	03 03 - N0101 - 03	4	PIA Rod Subassembly													
						B Cap- Connecting Rod	03 03 - N0101 - 04	4	PIA Rod Subassembly													
						04 Pistons (Assemblies, Including Pistons, Ring Packs, Piston Pins, Circlips)																
						A Piston - Engine, Machined	03 04 - N0101 - 01	4			Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						B Ring/Clip - Piston Pin Retainer	03 04 - N0101 - 02	8	Purchase Parts Engine Ass'y													
						C Pin- Piston	03 04 - N0101 - 03	4	Purchase Parts Engine Ass'y													
						D Compression Ring - Piston, Top	03 04 - N0101 - 04	4	Purchase Parts Engine Ass'y													
						E Compression Ring - Piston, 2nd	03 04 - N0101 - 05	4	Purchase Parts Engine Ass'y													
						F Oil Ring Subassembly																
						F1 Spacer/Expander/Coil Spring - Oil Ring, Piston	03 04 - N0101 - 07	4	Purchase Parts Engine Ass'y													
						F2 Rail(s) - Oil Ring, Piston	03 04 - N0101 - 08	4	Purchase Parts Engine Ass'y													
						90 Bearing Elements: Connecting Rod Bearing Shells, Connecting Rod Bush																
						A Bearing - Connecting Rod to Crank Shaft	03 90 - N0101 - 01	8	Purchase Parts Engine Ass'y													
						100 Engine Assembly																
						A Assembly of Crank Drive Subsystem Components to Engine	03 00 - N0101 - 01	NA			Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

NOTES:

1. ▨ **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT (Study Case# N0101)

BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT (Study Case# B0101)

GENERAL PART INFORMATION

Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	03 Crank Drive Subsystem																					
		01				**Crank Shaft**						$0.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
				A.		Shaft - Crank	03 01 - N0101 - 01	1			Diff.	($10.61)	$ -	$ -	$ (10.61)	$ (0.07)	$ (0.74)	$ (0.85)	$ -	$ (1.67)	$ -	$ (12.27)
		03				**Connect Rods (Assemblies: Connecting Rod, Connecting Rod Cap)**																
			A			Rod Subassembly - Connecting	03 03 - N0101 - 01	4			Diff.	$1.19	$ -	$ 1.11	$ 2.30	$ 0.01	$ 0.15	$ 0.14	$ 0.06	$ 0.36	$ -	$ 2.66
				A1		Bushing - Connecting Rod	03 03 - N0101 - 02	4	PIA Rod Subassembly													
				A2		Rod - Connecting	03 03 - N0101 - 03	4	PIA Rod Subassembly													
				B		Cap- Connecting Rod	03 03 - N0101 - 04	4	PIA Rod Subassembly													
		04				**Pistons (Assemblies, Including Pistons, Ring Packs, Piston Pins, Circlips)**																
				A		Piston - Engine, Machined	03 04 - N0101 - 01	4			Diff.	($0.36)	$ 0.39	$ 3.04	$ 3.07	$ 0.34	$ 0.22	$ 0.20	$ 0.08	$ 0.85	$ -	$ 3.92
				B		Ring/Clip - Piston Pin Retainer	03 04 - N0101 - 02	8	Purchase Parts Engine Ass'y													
				C		Pin- Piston	03 04 - N0101 - 03	4	Purchase Parts Engine Ass'y													
				D		Compression Ring - Piston, Top	03 04 - N0101 - 04	4	Purchase Parts Engine Ass'y													
				E		Compression Ring - Piston, 2nd	03 04 - N0101 - 05	4	Purchase Parts Engine Ass'y													
			F			Oil Ring Subassembly																
				F1		Spacer/Expander/Coil Spring - Oil Ring, Piston	03 04 - N0101 - 07	4	Purchase Parts Engine Ass'y													
				F2		Rail(s) - Oil Ring, Piston	03 04 - N0101 - 08	4	Purchase Parts Engine Ass'y													
		90				**Bearing Elements: Connecting Rod Bearing Shells, Connecting Rod Bush**																
				A		Bearing - Connecting Rod to Crank Shaft	03 90 - N0101 - 01	8	Purchase Parts Engine Ass'y													
		100				**Engine Assembly**																
			A			Assembly of Crank Drive Subsystem Components to Engine	03 00 - N0101 - 01	NA			Diff.	$5.69	$ -	$ -	$ 5.69	$ -	$ -	$ -	$ -	$ -	$ -	$ 5.69
												$ (4.09)	$ 0.39	$ 4.15	$ 0.46	$ 0.28	$ (0.37)	$ (0.51)	$ 0.14	$ (0.46)	$ -	$ 0.00

NOTES:

1. ▨ **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, Turbo, DI w. dVVT (Study Case# N0101)

Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number				QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
															Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	04					**Counter Balance Subsystem**																			
		01				**Moved Parts**																			
		A				Balance Shaft Subassembly (Part of Oil Pump Assembly)	04	01	B0101	01	1			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		100																							
		A				Assembly of Balance Shaft Assembly to Engine	04	00	B0101	01	NA			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
															$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA, PFI w. dVVT (Study Case# B0101)										
												Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	04 Counter Balance Subsystem																					
		01				**Moved Parts**																
		A				Balance Shaft Subassembly (Part of Oil Pump Assembly)	04 01 B0101 01	1			Full	$ 8.53	$ 5.83	$10.65	**$ 25.01**	$ 0.82	$ 3.22	$ 2.98	$ 0.92	**$ 7.95**	$ 0.05	**$ 33.01**
		100																				
		A				Assembly of Balance Shaft Assembly to Engine	04 00 B0101 01	NA			Full	$ 1.83	$ 0.39	$ 0.71	**$ 2.93**	$ -	$ -	$ -	$ -	**$ -**	$ -	**$ 2.93**
												$10.37	$ 6.22	$11.36	**$ 27.94**	$ 0.82	$ 3.22	$ 2.98	$ 0.92	**$ 7.95**	$ 0.05	**$ 35.95**

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT (Study Case# N0101)

BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT (Study Case# B0101)

GENERAL PART INFORMATION

Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	04					**Counter Balance Subsystem**																
		01				**Moved Parts**																
		A				Balance Shaft Subassembly (Part of Oil Pump Assembly)	04 01 B0101 01	1			Full	($8.53)	$ (5.83)	$ (10.65)	**$ (25.01)**	$ (0.82)	$ (3.22)	$ (2.98)	$ (0.92)	**$ (7.95)**	$ (0.05)	**$ (33.01)**
		100																				
		A				Assembly of Balance Shaft Assembly to Engine	04 00 B0101 01	NA			Full	($1.83)	$ (0.39)	$ (0.71)	**$ (2.93)**	$ -	$ -	$ -	$ -	**$ -**	$ -	**$ (2.93)**
												$ (10.37)	$ (6.22)	$ (11.36)	**$ (27.94)**	$ (0.82)	$ (3.22)	$ (2.98)	$ (0.92)	**$ (7.95)**	$ (0.05)	**$ (35.95)**

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, Turbo, DI w. dVVT (Study Case# N0101)

Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	05 Cylinder Block Subsystem																					
						01 Cylinder Block																
						A Cylinder Block Assembly - Machined w. Studs, Plugs, etc.	05 01 - N0101 - 01	1			Diff.	$ (7.96)	$ 0.07	$ 0.99	$ (6.90)	$ (0.41)	$ (0.56)	$ (0.62)	$ -	$ (1.59)	$ -	$ (8.49)
						A1 Cylinder Block Subassembly - Machined w/o Studs/Plugs, etc	05 01 - N0101 - 02	1	PIA													
						A1.1 Cylinder Block Subassembly - Cast	05 01 - N0101 - 03	1	PIA													
						A1.1. Cylinder Liners - Cast Iron	05 01 - N0101 - 04	1	PIA													
						03 Bedplates					Diff.	$ (4.36)	$ -	$ -	$ (4.36)	$ (0.25)	$ (0.34)	$ (0.38)	$ -	$ (0.98)	$ -	$ (5.34)
						A Bed Plate Assembly - Machined w. Studs, Plugs, etc.	05 03 - N0101 - 01	1														
						A1 Bed Plate Assembly - Machined w/o. Studs, Plugs, etc.	05 03 - N0101 - 02	1	PIA													
						A1.1 Bed Plate Subassembly - Cast	05 03 - N0101 - 02	1	PIA													
						A1.1. Bearing Cap - Bolt Through - Insert, Steel	05 03 - N0101 - 03	5	PIA													
						04 Piston Cooling																
						A Squirter - Oil, Piston Cooler	05 04 - N0101 - 01	4			Full	$ 2.60	$ 0.64	$ 3.62	$ 6.86	$ 0.04	$ 0.87	$ 0.58	$ -	$ 1.49	$ 0.04	$ 8.38
						B Bolt - Piston Cooler Valve/Retainer	05 04 - N0101 - 02	4	(Grouped w. A)													
						90 Bearing Elements: Crankshaft bearing shells			(Costs shown per engine bearing set)													
						A Bearing - Crankshaft, Block 1/2 Bearing (Top w. Lub. Pass	05 90 - N0101 - 01	1	5pcs/set		Diff.	$ 2.13	$ -	$ -	$ 2.13	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.13
						B Bearing/Shim - Crankshaft Thrust	05 90 - N0101 - 02	1	2pcs/set (Grouped w. A)													
						C Bearing - Crankshaft, Block 1/2 Bearing (Bottom)	05 90 - N0101 - 03	1	5 pcs/set (Grouped w. A)													
						100 Engine Assembly																
						A Assembly of Additional Cylinder Block Components					Diff.	$ -	$ 0.65	$ 1.17	$ 1.82	$ 0.09	$ 0.86	$ 0.99	$ -	$ 1.94	$ -	$ 3.75
												$ (7.59)	$ 1.36	$ 5.78	$ (0.46)	$ (0.53)	$ 0.83	$ 0.56	$ -	$ 0.86	$ 0.04	$ 0.44

NOTES:

1. ▨ **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION | **BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA, PFI w. dVVT (Study Case# B0101)**

Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
						05 Cylinder Block Subsystem																
						01 Cylinder Block																
						A Cylinder Block Assembly - Machined w. Studs, Plugs, etc.	05 01 - N0101 - 01	1			Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						A1 Cylinder Block Subassembly - Machined w/o Studs/Plugs, etc	05 01 - N0101 - 02	1	PIA													
						A1.1 Cylinder Block Subassembly - Cast	05 01 - N0101 - 03	1	PIA													
						A1.1. Cylinder Liners - Cast Iron	05 01 - N0101 - 04	1	PIA													
						03 Bedplates					Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						A Bed Plate Assembly - Machined w. Studs, Plugs, etc.	05 03 - N0101 - 01	1														
						A1 Bed Plate Assembly - Machined w/o. Studs, Plugs, etc.	05 03 - N0101 - 02	1	PIA													
						A1.1 Bed Plate Subassembly - Cast	05 03 - N0101 - 02	1	PIA													
						A1.1. Bearing Cap - Bolt Through - Insert, Steel	05 03 - N0101 - 03	5	PIA													
						04 Piston Cooling																
						A Squirter - Oil, Piston Cooler	05 04 - N0101 - 01	4			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						B Bolt - Piston Cooler Valve/Retainer	05 04 - N0101 - 02	4	(Grouped w. A)													
						90 Bearing Elements: Crankshaft bearing shells			(Costs shown per engine bearing set)													
						A Bearing - Crankshaft, Block 1/2 Bearing (Top w. Lub. Pass	05 90 - N0101 - 01	1	5pcs/set		Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						B Bearing/Shim - Crankshaft Thrust	05 90 - N0101 - 02	1	2pcs/set (Grouped w. A)													
						C Bearing - Crankshaft, Block 1/2 Bearing (Bottom)	05 90 - N0101 - 03	1	5 pcs/set (Grouped w. A)													
						100 Engine Assembly																
						A Assembly of Additional Cylinder Block Components					Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION

INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT (Study Case# N0101)

BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT (Study Case# B0101)

Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
						05 Cylinder Block Subsystem																
						01 Cylinder Block																
						A Cylinder Block Assembly - Machined w. Studs, Plugs, etc.	05 01 - N0101 - 01	1			Diff.	($7.96)	$ 0.07	$ 0.99	$ (6.90)	$ (0.41)	$ (0.56)	$ (0.62)	$ -	$ (1.59)	$ -	$ (8.49)
						A1 Cylinder Block Subassembly - Machined w/o Studs/Plugs, etc	05 01 - N0101 - 02	1	PIA													
						A1.1 Cylinder Block Subassembly - Cast	05 01 - N0101 - 03	1	PIA													
						A1.1. Cylinder Liners - Cast Iron	05 01 - N0101 - 04	1	PIA													
						03 Bedplates					Diff.	($4.36)	$ -	$ -	$ (4.36)	$ (0.25)	$ (0.34)	$ (0.38)	$ -	$ (0.98)	$ -	$ (5.34)
						A Bed Plate Assembly - Machined w. Studs, Plugs, etc.	05 03 - N0101 - 01	1														
						A1 Bed Plate Assembly - Machined w/o. Studs, Plugs, etc.	05 03 - N0101 - 02	1	PIA													
						A1.1 Bed Plate Subassembly - Cast	05 03 - N0101 - 02	1	PIA													
						A1.1. Bearing Cap - Bolt Through - Insert, Steel	05 03 - N0101 - 03	5	PIA													
												$0.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						04 Piston Cooling																
						A Squirter - Oil, Piston Cooler	05 04 - N0101 - 01	4			Full	$2.60	$ 0.64	$ 3.62	$ 6.86	$ 0.04	$ 0.87	$ 0.58	$ -	$ 1.49	$ 0.04	$ 8.38
						B Bolt - Piston Cooler Valve/Retainer	05 04 - N0101 - 02	4	(Grouped w. A)													
						90 Bearing Elements: Crankshaft bearing shells			(Costs shown per engine bearing set)													
						A Bearing - Crankshaft, Block 1/2 Bearing (Top w. Lub. Pass	05 90 - N0101 - 01	1	5pcs/set		Diff.	$2.13	$ -	$ -	$ 2.13	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.13
						B Bearing/Shim - Crankshaft Thrust	05 90 - N0101 - 02	1	2pcs/set (Grouped w. A)													
						C Bearing - Crankshaft, Block 1/2 Bearing (Bottom)	05 90 - N0101 - 03	1	5 pcs/set (Grouped w. A)													
						100 Engine Assembly																
						A Assembly of Additional Cylinder Block Components					Diff.	$0.00	$ 0.65	$ 1.17	$ 1.82	$ 0.09	$ 0.86	$ 0.99	$ -	$ 1.94	$ -	$ 3.75
												$ (7.59)	$ 1.36	$ 5.78	$ (0.46)	$ (0.53)	$ 0.83	$ 0.56	$ -	$ 0.86	$ 0.04	$ 0.44

NOTES:
1. ░ **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, Turbo, DI w. dVVT (Study Case# N0101)										
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
						06 Cylinder Head Subsystem																
						01 Cylinder Head																
						A Cylinder Head Assembly - Machined w. Studs, Valves, etc.	06 01 - N0101 - 01	1			Diff	$ (0.83)	$ 0.63	$ 6.11	$ 5.91	$ 1.79	$ 0.54	$ 0.61	$ -	$ 2.94	$ -	$ 8.85
						A1 Cylinder Head - Machined w/o. Studs, Valves, etc.	06 01 - N0101 - 02	1	PIA Head Assembly													
						A1.1 Cylinder Head Subassembly - Cast	06 01 - N0101 - 03	1	PIA Head Assembly													
						02 Valve Guides. Valve Seats																
						C Seat - Intake Valve	06 02 - N0101 - 03	8			Diff	$ 0.34	$ -	$ -	$ 0.34	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.34
						D Seat - Exhaust Valve	06 02 - N0101 - 04	8	(Grouped w. C)													
						06 Camshaft Bearing Housing																
						C Cap, Head (Fuel Pump & Vacuum Mount)	06 06 - N0101 - 03	1			Full	$ 0.67	$ 0.18	$ 0.83	$ 1.69	$ 0.01	$ 0.11	$ 0.10	$ 0.04	$ 0.26	$ 0.03	$ 1.98
						80 Boltings: Cylinder Head, Cylinder Head Cover, Manifold																
						Boltings & Screws General																
						A Bolt - Cap Bearing, Camshaft	06 80 - N0101 - 01	4	PIA Engine Assembly													
						Dowel Pins/Plugs/Studs - Cylinder Head																
						A Bolt - Manifold, Exhaust	06 80 - N0101 - 10	10	PIA Engine Assembly													
						85 Sealing Elements: Cylinder Head, Cylinder Head Cover, ...																
						A Gasket - Cylinder Head to Block	06 85 - N0101 - 01	1			Diff.	$ 1.46	$ -	$ -	$ 1.46	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.46
						100 Engine Assembly																
						A Assembly of Additional/Revised Cylinder Head Components		1			Diff.	$ 3.92	$ -	$ -	$ 3.92	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.92
												$ 5.57	$ 0.81	$ 6.94	$ 13.32	$ 1.80	$ 0.65	$ 0.71	$ 0.04	$ 3.20	$ 0.03	$ 16.55

NOTES:

1. ▨ = A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA, PFI w. dVVT (Study Case# B0101)										
												Manufacturing				Markup						
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Material	Labor	Burden	Total Manufacturing Cost (Component/ Assembly)	End Item Scrap	SG&A	Profit	ED&T-R&D	Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
						06 Cylinder Head Subsystem																
						01 Cylinder Head																
						A Cylinder Head Assembly - Machined w. Studs, Valves, etc.	06 01 - N0101 - 01	1			Diff	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						A1 Cylinder Head - Machined w/o. Studs, Valves, etc.	06 01 - N0101 - 02	1	PIA Head Assembly													
						A1.1 Cylinder Head Subassembly - Cast	06 01 - N0101 - 03	1	PIA Head Assembly													
						02 Valve Guides. Valve Seats																
						C Seat - Intake Valve	06 02 - N0101 - 03	8			Diff	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						D Seat - Exhaust Valve	06 02 - N0101 - 04	8	(Grouped w. C)													
						06 Camshaft Bearing Housing																
						C Cap, Head (Fuel Pump & Vacuum Mount)	06 06 - N0101 - 03	1			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						80 Boltings: Cylinder Head, Cylinder Head Cover, Manifold																
						Boltings & Screws General																
						A Bolt - Cap Bearing, Camshaft	06 80 - N0101 - 01	4	PIA Engine Assembly													
						Dowel Pins/Plugs/Studs - Cylinder Head																
						A Bolt - Manifold, Exhaust	06 80 - N0101 - 10	10	PIA Engine Assembly													
						85 Sealing Elements: Cylinder Head, Cylinder Head Cover, ...																
						A Gasket - Cylinder Head to Block	06 85 - N0101 - 01	1			Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						100 Engine Assembly																
						A Assembly of Additional/Revised Cylinder Head Components		1			Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

NOTES:

1. ▨ **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE

Light-Duty Technology Cost Study

EP-C-07-069 WA1-3

APPENDIX H.1.06
Printed: 12/9/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT
(Study Case# N0101)

BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT
(Study Case# B0101)

GENERAL PART INFORMATION												Manufacturing				Markup						
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Material	Labor	Burden	Total Manufacturing Cost (Component/ Assembly)	End Item Scrap	SG&A	Profit	ED&T-R&D	Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
						06 Cylinder Head Subsystem																
						01 Cylinder Head																
						A Cylinder Head Assembly - Machined w. Studs, Valves, etc.	06 01 - N0101 - 01	1			Diff	($0.83)	$ 0.63	$ 6.11	**$ 5.91**	$ 1.79	$ 0.54	$ 0.61	$ -	**$ 2.94**	$ -	**$ 8.85**
						A1 Cylinder Head - Machined w/o. Studs, Valves, etc.	06 01 - N0101 - 02	1	PIA Head Assembly													
						A1.1 Cylinder Head Subassembly - Cast	06 01 - N0101 - 03	1	PIA Head Assembly													
						02 Valve Guides. Valve Seats																
						C Seat - Intake Valve	06 02 - N0101 - 03	8			Diff	$0.34	$ -	$ -	**$ 0.34**	$ -	$ -	$ -	$ -	**$ -**	$ -	**$ 0.34**
						D Seat - Exhaust Valve	06 02 - N0101 - 04	8	(Grouped w. C)													
						06 Camshaft Bearing Housing																
						C Cap, Head (Fuel Pump & Vacuum Mount)	06 06 - N0101 - 03	1			Full	$0.67	$ 0.18	$ 0.83	**$ 1.69**	$ 0.01	$ 0.11	$ 0.10	$ 0.04	**$ 0.26**	$ 0.03	**$ 1.98**
						80 Boltings: Cylinder Head, Cylinder Head Cover, Manifold																
						Boltings & Screws General																
						A Bolt - Cap Bearing, Camshaft	06 80 - N0101 - 01	4	PIA Engine Assembly													
						Dowel Pins/Plugs/Studs - Cylinder Head																
						A Bolt - Manifold, Exhaust	06 80 - N0101 - 10	10	PIA Engine Assembly													
						85 Sealing Elements: Cylinder Head, Cylinder Head Cover, ...																
						A Gasket - Cylinder Head to Block	06 85 - N0101 - 01	1			Diff.	$1.46	$ -	$ -	**$ 1.46**	$ -	$ -	$ -	$ -	**$ -**	$ -	**$ 1.46**
						100 Engine Assembly																
						A Assembly of Additional/Revised Cylinder Head Components		1			Diff.	$3.92	$ -	$ -	**$ 3.92**	$ -	$ -	$ -	$ -	**$ -**	$ -	**$ 3.92**
												$ 5.57	$ 0.81	$ 6.94	**$ 13.32**	$ 1.80	$ 0.65	$ 0.71	$ 0.04	**$ 3.20**	$ 0.03	**$ 16.55**

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

APPENDIX H.1.07
Printed: 12/9/2009

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

GENERAL PART INFORMATION																	NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, Turbo, DI w. dVVT (Study Case# N0101)										
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number						QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
																	Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
						07 Valve Train Subsystem																					
						01 Inlet Valves																					
						A Valve - Intake	07	01	-	N0101	-	01	8			Diff.	$ 8.66	$ -	$ -	$ 8.66	$ 0.06	$ 0.61	$ 0.69	$ 0.35	$ 1.71	$ -	$ 10.37
						02 Outlet Valves																					
						A Valve - Exhaust	07	02	-	N0101	-	01	8	Exhaust Valves grouped with Intake Valve Costs		Diff.											
						06 Camshafts																					
						A Camshaft Assembly - Intake Machined	07	06	-	N0101	-	01	1			Diff.	$ (0.26)	$ -	$ -	$ (0.26)	$ (0.01)	$ (0.02)	$ (0.02)	$ (0.01)	$ (0.05)	$ -	$ (0.31)
						A1 Camshaft - Intake Machined	07	06	-	N0101	-	02	1	PIA													
						B Camshaft Assembly - Exhaust Machined	07	06	-	N0101	-	10	1	Exhaust Cam Shaft grouped with Intake Cam Shaft Costs		Diff.											
						B1 Camshaft - Exhaust Machine	07	06	-	N0101	-	11	1	PIA													
						100 Engine Assembly																					
						A Engine Assembly Impact								Mark-up affect only		Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
																	$8.40	$ -	$ -	$ 8.40	$ 0.05	$ 0.59	$ 0.68	$ 0.34	$ 1.65	$ -	$ 10.06

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA, PFI w. dVVT (Study Case# B0101)										
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	07					Valve Train Subsystem																
		01				Inlet Valves																
				A		Valve - Intake	07 01 - N0101 - 01	8			Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		02				Outlet Valves																
				A		Valve - Exhaust	07 02 - N0101 - 01	8	Exhaust Valves grouped with Intake Valve Costs		Diff.											
		06				Camshafts																
		A				Camshaft Assembly - Intake Machined	07 06 - N0101 - 01	1			Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
				A1		Camshaft - Intake Machined	07 06 - N0101 - 02	1	PIA													
		B				Camshaft Assembly - Exhaust Machined	07 06 - N0101 - 10	1	Exhaust Cam Shaft grouped with Intake Cam Shaft Costs		Diff.											
				B1		Camshaft - Exhaust Machine	07 06 - N0101 - 11	1	PIA													
		100				Engine Assembly																
				A		Engine Assembly Impact			Mark-up affect only		Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

NOTES:
1. ▨ = A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT (Study Case# N0101)

BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT (Study Case# B0101)

GENERAL PART INFORMATION												Manufacturing				Markup						
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Material	Labor	Burden	Total Manufacturing Cost (Component/ Assembly)	End Item Scrap	SG&A	Profit	ED&T-R&D	Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
						07 Valve Train Subsystem																
						01 Inlet Valves																
						A Valve - Intake	07 01 - N0101 - 01	8			Diff.	$8.66	$ -	$ -	**$ 8.66**	$ 0.06	$ 0.61	$ 0.69	$ 0.35	**$ 1.71**	$ -	**$ 10.37**
						02 Outlet Valves																
						A Valve - Exhaust	07 02 - N0101 - 01	8	Exhaust Valves grouped with Intake Valve Costs		Diff.											
						06 Camshafts																
						A Camshaft Assembly - Intake Machined	07 06 - N0101 - 01	1			Diff.	($0.26)	$ -	$ -	**$ (0.26)**	$ (0.01)	$ (0.02)	$ (0.02)	$ (0.01)	**$ (0.05)**	$ -	**$ (0.31)**
						A1 Camshaft - Intake Machined	07 06 - N0101 - 02	1	PIA													
						B Camshaft Assembly - Exhaust Machined	07 06 - N0101 - 10	1	Exhaust Cam Shaft grouped with Intake Cam Shaft Costs		Diff.											
						B1 Camshaft - Exhaust Machine	07 06 - N0101 - 11	1	PIA													
						100 Engine Assembly																
						A Engine Assembly Impact			Mark-up affect only		Diff.	$0.00	$ -	$ -	**$ -**	$ -	$ -	$ -	$ -	**$ -**	$ -	**$ -**
												$ 8.40	$ -	$ -	**$ 8.40**	$ 0.05	$ 0.59	$ 0.68	$ 0.34	**$ 1.65**	$ -	**$ 10.06**

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, Turbo, DI w. dVVT (Study Case# N0101)										
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	08					Timing Drive Subsystem																
		01				Timing Wheels (Sprockets)																
				A		Sprocket - Crankshaft, Timing Drive	08 01 - N0101 - 01	1	Smart Sprocket		Mod	$ 1.60	$ -	$ -	$ 1.60	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.60
		100				Engine Assembly																
				A		Timing Drive Impact to engine assembly			NA			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$1.60	$ -	$ -	$ 1.60	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.60

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

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SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

APPENDIX H.1.08
Printed: 12/9/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

GENERAL PART INFORMATION												BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA, PFI w. dVVT (Study Case# B0101)										
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	08					Timing Drive Subsystem																
		01				Timing Wheels (Sprockets)																
					A	Sprocket - Crankshaft, Timing Drive	08 01 - N0101 - 01	1	Smart Sprocket		Mod	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		100				Engine Assembly																
					A	Timing Drive Impact to engine assembly			NA			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

GENERAL PART INFORMATION

INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT (Study Case# N0101)

BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT (Study Case# B0101)

Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing Material	Manufacturing Labor	Manufacturing Burden	Total Manufacturing Cost (Component/ Assembly)	Markup End Item Scrap	Markup SG&A	Markup Profit	Markup ED&T-R&D	Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
	08					Timing Drive Subsystem																
		01				Timing Wheels (Sprockets)																
					A	Sprocket - Crankshaft, Timing Drive	08 01 - N0101 - 01	1	Smart Sprocket		Mod	$1.60	$ -	$ -	$ 1.60	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.60
		100				Engine Assembly																
					A	Timing Drive Impact to engine assembly			NA			$0.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$ 1.60	$ -	$ -	$ 1.60	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.60

NOTES:

1. 🟨 = **A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, Turbo, DI w. dVVT (Study Case# N0101)											
												Manufacturing			**Total Manufacturing Cost (Component/ Assembly)**	Markup				**Total Markup Cost (Component/ Assembly)**	**Total Packaging Cost (Component/ Assembly)**	**Net Component/ Assembly Cost Impact to OEM**
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	10 Intake Subsystem																					
		01				**Intake Manifolds**																
		A				Manifold Assembly - Intake	10 01 - N0101 - 01	1			Diff.	$ (10.66)	$ (0.01)	$ (0.10)	**$ (10.78)**	$ (0.05)	$ (0.70)	$ (0.65)	$ (0.27)	**$ (1.67)**	$ (0.28)	**$ (12.73)**
		100				**Engine Assembly**																
				A		Timing Drive Impact to engine assembly	10 00 N0101 00	1	NA			$ -	$ -	$ -	**$ -**	$ -	$ -	$ -	$ -	**$ -**	$ -	**$ -**
												($10.66)	$ (0.01)	$ (0.10)	**$ (10.78)**	$ (0.05)	$ (0.70)	$ (0.65)	$ (0.27)	**$ (1.67)**	$ (0.28)	**$ (12.73)**

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

APPENDIX H.1.10
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SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA, PFI w. dVVT (Study Case# B0101)											
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	10					**Intake Subsystem**																
		01				**Intake Manifolds**																
			A			Manifold Assembly - Intake	10 01 - N0101 - 01	1			Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		100				**Engine Assembly**																
				A		Timing Drive Impact to engine assembly	10 00 N0101 00	1	NA			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

NOTES:

1. ▨ **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT (Study Case# N0101) BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT (Study Case# B0101)										
												Manufacturing				Markup						
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Material	Labor	Burden	Total Manufacturing Cost (Component/ Assembly)	End Item Scrap	SG&A	Profit	ED&T-R&D	Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
						10 Intake Subsystem																
						01 Intake Manifolds																
						A Manifold Assembly - Intake	10 01 - N0101 - 01	1			Diff.	($10.66)	$ (0.01)	$ (0.10)	$ (10.78)	$ (0.05)	$ (0.70)	$ (0.65)	$ (0.27)	$ (1.67)	$ (0.28)	$ (12.73)
						100 Engine Assembly																
						A Timing Drive Impact to engine assembly	10 00 N0101 00	1	NA			$0.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$ (10.66)	$ (0.01)	$ (0.10)	$ (10.78)	$ (0.05)	$ (0.70)	$ (0.65)	$ (0.27)	$ (1.67)	$ (0.28)	$ (12.73)

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION | **NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, Turbo, DI w. dVVT (Study Case# N0101)**

Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing Material	Manufacturing Labor	Manufacturing Burden	Total Manufacturing Cost (Component/ Assembly)	Markup End Item Scrap	Markup SG&A	Markup Profit	Markup ED&T-R&D	Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
	11					**Fuel Induction Subsystem**																
		01				**Fuel Rails**																
		A				Fuel Rail w. High Pressure Sensor Assembly	11 01 - N0101 - 01	1			Full	$ 11.09	$ 1.81	$ 5.70	**$ 18.59**	$ 0.06	$ 1.12	$ 0.74	$ 0.19	**$ 2.10**	$ 0.07	**$ 20.76**
		A1				Fuel Rail - High Pressure	11 01 - N0101 - 02	1	PIA Fuel Rail Assembly													
		A2				Sensor - Fuel, High Pressure	11 01 - N0101 - 03	1	PIA Fuel Rail Assembly													
		04				**Fuel Injectors**																
		A				Fuel Injector Assembly - Solenoid, 7 Hole	11 04 - N0101 - 01	4			Full	$8.63	$5.88	$25.74	**$ 40.25**	$ 0.43	$ 4.72	$ 5.03	$ 2.01	**$ 12.18**	$ 0.05	**$ 52.49**
		07				**Fuel Injection Pumps**																
		A				Fuel Pump - High Pressure w. Vol.Cotrol Valve (Driven-Off Intake Cam)	11 07 - N0101 - 01	1			Full	$16.99	$8.24	$28.32	**$ 53.55**	$ 0.73	$ 6.36	$ 6.40	$ 2.46	**$ 15.96**	$ 0.11	**$ 69.61**
		70				**Pipes, Hoses: Low Pressure, High Pressure**																
		A				Pipe Assembly - Fuel, High Pressure, Pump to Rail	11 70 - N0101 - 01	1			Full	$0.39	$0.34	$1.06	**$ 1.80**	$ 0.01	$ 0.11	$ 0.07	$ 0.02	**$ 0.20**	$ 0.01	**$ 2.01**
		80				**Bolting**																
			A			Bolt - Fuel Rail	11 80 - N0101 - 01	4	PIA Engine Assembly		Diff.											
			B			Bolt - Fuel Pump	11 80 - N0101 - 02	3	PIA Engine Assembly		Full											
			C			Retainer - Fuel Injector	11 80 - N0101 - 03	4	PIA Injector		Full											
			D			Washer, Retainer - Fuel Injector	11 80 - N0101 - 04	4	PIA Injector		Full											
			E			O-ring Retainer, Fuel Injector	11 80 - N0101 - 05	4	PIA Injector		Full											
			F			Spacer - Retainer, Fuel Injector	11 80 - N0101 - 06	4	PIA Injector		Full											
		85				**Sealing Elements**																
				A		Seal - High Pressure Fuel Pump to Cylinder Head	11 85 - N0101 - 01	1	PIA Fuel Pump		Full											
		100				**Engine Assembly**																
				A		Fuel Induction impact to engine assembly					Diff.	$ 0.15	$ 1.13	$ 2.04	**$ 3.33**	$ -	$ -	$ -	$ -	**$ -**	$ -	**$ 3.33**
												$37.24	$17.41	$62.87	**$ 117.52**	$ 1.23	$12.30	$12.25	$ 4.67	**$ 30.44**	$ 0.24	**$ 148.20**

NOTES:

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SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

GENERAL PART INFORMATION												BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA, PFI w. dVVT (Study Case# B0101)										
												Manufacturing				Markup						
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Material	Labor	Burden	Total Manufacturing Cost (Component/ Assembly)	End Item Scrap	SG&A	Profit	ED&T-R&D	Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
	11					**Fuel Induction Subsystem**																
		01				**Fuel Rails**																
			A			Fuel Rail w. High Pressure Sensor Assembly	11 01 - N0101 - 01	1			Full	$ 1.36	$ 1.46	$ 2.35	$ 5.18	$ 0.02	$ 0.31	$ 0.21	$ 0.05	$ 0.58	$ 0.07	$ 5.83
			A1			Fuel Rail - High Pressure	11 01 - N0101 - 02	1	PIA Fuel Rail Assembly													
			A2			Sensor - Fuel, High Pressure	11 01 - N0101 - 03	1	PIA Fuel Rail Assembly													
		04				**Fuel Injectors**																
			A			Fuel Injector Assembly - Solenoid, 7 Hole	11 04 - N0101 - 01	4			Full	$ 4.13	$ 4.15	$19.46	$ 27.74	$ 0.26	$ 2.79	$ 2.98	$ 1.26	$ 7.28	$ 0.05	$ 35.07
		07				**Fuel Injection Pumps**																
			A			Fuel Pump - High Pressure w. Vol.Cotrol Valve (Driven-Off Intake Cam)	11 07 - N0101 - 01	1			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		70				**Pipes, Hoses: Low Pressure, High Pressure**																
			A			Pipe Assembly - Fuel, High Pressure, Pump to Rail	11 70 - N0101 - 01	1			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		80				**Bolting**																
				A		Bolt - Fuel Rail	11 80 - N0101 - 01	4	PIA Engine Assembly		Diff.											
				B		Bolt - Fuel Pump	11 80 - N0101 - 02	3	PIA Engine Assembly		Full											
				C		Retainer - Fuel Injector	11 80 - N0101 - 03	4	PIA Injector		Full											
				D		Washer, Retainer - Fuel Injector	11 80 - N0101 - 04	4	PIA Injector		Full											
				E		O-ring Retainer, Fuel Injector	11 80 - N0101 - 05	4	PIA Injector		Full											
				F		Spacer - Retainer, Fuel Injector	11 80 - N0101 - 06	4	PIA Injector		Full											
		85				**Sealing Elements**																
					A	Seal - High Pressure Fuel Pump to Cylinder Head	11 85 - N0101 - 01	1	PIA Fuel Pump		Full											
		100				**Engine Assembly**																
					A	Fuel Induction impact to engine assembly					Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$ 5.49	$ 5.61	$21.81	$ 32.91	$ 0.27	$ 3.10	$ 3.19	$ 1.31	$ 7.87	$ 0.12	$ 40.90

NOTES:

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SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT (Study Case# N0101)

BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT (Study Case# B0101)

GENERAL PART INFORMATION												Manufacturing				Markup						
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Material	Labor	Burden	Total Manufacturing Cost (Component/ Assembly)	End Item Scrap	SG&A	Profit	ED&T-R&D	Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
	11					**Fuel Induction Subsystem**																
		01				**Fuel Rails**																
		A				Fuel Rail w. High Pressure Sensor Assembly	11 01 - N0101 - 01	1			Full	$9.72	$ 0.35	$ 3.35	$ 13.42	$ 0.04	$ 0.81	$ 0.54	$ 0.13	$ 1.52	$ (0.00)	$ 14.93
		A1				Fuel Rail - High Pressure	11 01 - N0101 - 02	1	PIA Fuel Rail Assembly													
		A2				Sensor - Fuel, High Pressure	11 01 - N0101 - 03	1	PIA Fuel Rail Assembly													
		04				**Fuel Injectors**																
		A				Fuel Injector Assembly - Solenoid, 7 Hole	11 04 - N0101 - 01	4			Full	$4.50	$ 1.74	$ 6.28	$ 12.51	$ 0.18	$ 1.93	$ 2.05	$ 0.75	$ 4.90	$ 0.01	$ 17.42
		07				**Fuel Injection Pumps**																
		A				Fuel Pump - High Pressure w. Vol.Cotrol Valve (Driven-Off Intake Cam)	11 07 - N0101 - 01	1			Full	$16.99	$ 8.24	$ 28.32	$ 53.55	$ 0.73	$ 6.36	$ 6.40	$ 2.46	$ 15.96	$ 0.11	$ 69.61
		70				**Pipes, Hoses: Low Pressure, High Pressure**																
		A				Pipe Assembly - Fuel, High Pressure, Pump to Rail	11 70 - N0101 - 01	1			Full	$0.39	$ 0.34	$ 1.06	$ 1.80	$ 0.01	$ 0.11	$ 0.07	$ 0.02	$ 0.20	$ 0.01	$ 2.01
		80				**Bolting**																
			A			Bolt - Fuel Rail	11 80 - N0101 - 01	4	PIA Engine Assembly		Diff.											
			B			Bolt - Fuel Pump	11 80 - N0101 - 02	3	PIA Engine Assembly		Full											
			C			Retainer - Fuel Injector	11 80 - N0101 - 03	4	PIA Injector		Full											
			D			Washer, Retainer - Fuel Injector	11 80 - N0101 - 04	4	PIA Injector		Full											
			E			O-ring Retainer, Fuel Injector	11 80 - N0101 - 05	4	PIA Injector		Full											
			F			Spacer - Retainer, Fuel Injector	11 80 - N0101 - 06	4	PIA Injector		Full											
		85				**Sealing Elements**																
				A		Seal - High Pressure Fuel Pump to Cylinder Head	11 85 - N0101 - 01	1	PIA Fuel Pump		Full											
		100				**Engine Assembly**																
				A		Fuel Induction impact to engine assembly					Diff.	$0.15	$ 1.13	$ 2.04	$ 3.33	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.33
												$ 31.75	$ 11.80	$ 41.05	$ 84.60	$ 0.95	$ 9.20	$ 9.06	$ 3.36	$ 22.57	$ 0.12	$ 107.30

NOTES:

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FEV

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

GENERAL PART INFORMATION												NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, Turbo, DI w. dVVT (Study Case# N0101)										
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	12					**Exhaust Subsystem**																
		01				**Exhaust Manifold**																
					A	Manifold - Exhaust, Dual Wall	12 01 - N0101 - 01	1			Diff.	$ 22.64	$ 0.03	$ 3.03	$ 25.70	$ 2.97	$ 1.85	$ 1.71	$ 0.71	$ 7.25	$ (0.12)	$ 32.82
		75				**Brackets**																
				B		Bracket Subassembly- Heat Shield, Top, Turbo	12 75 - N0101 - 02	1			Diff.	$ 1.77	$ 0.08	$ 0.07	$ 1.91	$ 0.01	$ 0.11	$ 0.08	$ -	$ 0.20	$ -	$ 2.11
		80				**Bolting**																
					A	Nut- Manifold Exhaust to Cylinder Head	12 80 - N0101 - 01	10	PIA Engine Assembly													
					F	Nut - Turbo to C.C. Catalytic Converter	12 80 - N0101 - 06	3	PIA Engine Assembly													
					G	Nut - Exhaust Manifold to Turbo	12 80 - N0101 - 07	4	Covered in Air Induction													
		85				**Sealing Elements**																
			A			Gasket Assembly - Exhaust Manifold	12 85 - B0101 - 01	1			Diff.	$ 0.95	$ -	$ -	$ 0.95	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.95
						Bracket Subassembly - Exhaust Manifold w. Integrated Gasket	12 75 - N0101 - 01	1	Gasket integrated into heat shield mounting bracket.													
		100				**Vehicle Operations or Engine Assembly**																
			A			Assembly of Exhaust System Components to Engine	12 00 - N0101 - 01		Component Cost Only		Diff.	$ 1.89	$ -	$ -	$ 1.89	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.89
												$27.24	$ 0.11	$ 3.09	$ 30.45	$ 2.97	$ 1.97	$ 1.79	$ 0.71	$ 7.44	$ (0.12)	$ 37.77

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

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SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

APPENDIX H.1.12
Printed: 12/9/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA, PFI w. dVVT (Study Case# B0101)										
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
						12 Exhaust Subsystem																
						01 Exhaust Manifold																
						A Manifold - Exhaust, Dual Wall	12 01 - N0101 - 01	1			Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						75 Brackets																
						B Bracket Subassembly- Heat Shield, Top, Turbo	12 75 - N0101 - 02	1			Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						80 Bolting																
						A Nut- Manifold Exhaust to Cylinder Head	12 80 - N0101 - 01	10	PIA Engine Assembly													
						F Nut - Turbo to C.C. Catalytic Converter	12 80 - N0101 - 06	3	PIA Engine Assembly													
						G Nut - Exhaust Manifold to Turbo	12 80 - N0101 - 07	4	Covered in Air Induction													
						85 Sealing Elements																
						A Gasket Assembly - Exhaust Manifold	12 85 - B0101 - 01	1			Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						Bracket Subassembly - Exhaust Manifold w. Integrated Gasket	12 75 - N0101 - 01	1	Gasket integrated into heat shield mounting bracket.													
						100 Vehicle Operations or Engine Assembly																
						A Assembly of Exhaust System Components to Engine	12 00 - N0101 - 01		Component Cost Only		Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

NOTES:

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SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT (Study Case# N0101)

BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT (Study Case# B0101)

GENERAL PART INFORMATION

Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	12 Exhaust Subsystem																					
		01				**Exhaust Manifold**																
					A	Manifold - Exhaust, Dual Wall	12 01 - N0101 - 01	1			Diff.	$22.64	$ 0.03	$ 3.03	$ 25.70	$ 2.97	$ 1.85	$ 1.71	$ 0.71	$ 7.25	$ (0.12)	$ 32.82
		75				**Brackets**																
				B		Bracket Subassembly- Heat Shield, Top, Turbo	12 75 - N0101 - 02	1			Diff.	$1.77	$ 0.08	$ 0.07	$ 1.91	$ 0.01	$ 0.11	$ 0.08	$ -	$ 0.20	$ -	$ 2.11
		80				**Bolting**																
					A	Nut- Manifold Exhaust to Cylinder Head	12 80 - N0101 - 01	10	PIA Engine Assembly													
					F	Nut - Turbo to C.C. Catalytic Converter	12 80 - N0101 - 06	3	PIA Engine Assembly													
					G	Nut - Exhaust Manifold to Turbo	12 80 - N0101 - 07	4	Covered in Air Induction													
		85				**Sealing Elements**																
			A			Gasket Assembly - Exhaust Manifold	12 85 - B0101 - 01	1			Diff.	$0.95	$ -	$ -	$ 0.95	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.95
						Bracket Subassembly - Exhaust Manifold w. Integrated Gasket	12 75 - N0101 - 01	1	Gasket integrated into heat shield mounting bracket.													
		100				**Vehicle Operations or Engine Assembly**																
			A			Assembly of Exhaust System Components to Engine	12 00 - N0101 - 01		Component Cost Only		Diff.	$1.89	$ -	$ -	$ 1.89	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.89
												$ 27.24	$ 0.11	$ 3.09	$ 30.45	$ 2.97	$ 1.97	$ 1.79	$ 0.71	$ 7.44	$ (0.12)	$ 37.77

NOTES:

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FEV

SUBSYTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, Turbo, DI w. dVVT (Study Case# N0101)										
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	13					**Lubrication Subsystem (e.g.Oil Pans, Sumps)**																
		02				**Oil Pumps**																
			A			Oil Pump Assembly	13 02 - N0101 - 01	1		1	Diff.	$ 3.08	$ -	$ -	$ 3.08	$ 0.02	$ 0.22	$ 0.25	$ 0.12	$ 0.61	$ -	$ 3.69
		06				**Oil Filter**																
			A			Filter Cooler Assembly - Oil (Includes Seals)	13 06 - N0101 - 01	1		1	Diff.	$2.93	$2.23	$5.31	$ 10.48	$ 0.10	$ 1.44	$ 1.21	$ 0.38	$ 3.13	$ 0.16	$ 13.78
		70				**Pipes, Hoses: Suction Pipe for Oil Pump, Oil Return, High Pressure, Low Pressure.**																
			A			Tube Assembly- Oil, Cooler/Filter Ass'y Outlet to Turbocharger	13 70 - N0101 - 01	1	(Shipped PIA to Filter/Cooler Assembly, although showing cost broke out separately)	1	Full	$1.27	$0.80	$1.59	$ 3.66	$ 0.01	$ 0.23	$ 0.16	$ -	$ 0.40	$ 0.03	$ 4.09
			B			Tube Assembly - Oil, Turbo to Engine Block (Piston Squirter's)	13 70 - N0101 - 02	1		1	Full	$0.42	$0.81	$2.20	$ 3.43	$ 0.01	$ 0.24	$ 0.16	$ -	$ 0.41	$ 0.06	$ 3.90
		80				**Boltings & Clamps**																
				C		Bolt - Filter Cooler Assembly	13 80 - N0101 - 03	4	PIA to Engine Assembly													
				D		Bolt - Tube Assembly , Oil, Turbo Inlet	13 80 - N0101 - 09	1	PIA to Engine Assembly													
				E		Clamp - Tube Assembly, Oil, Cooler/Filter Outlet	13 80 - N0101 - 05	1	PIA Tube Assembly-Oil, …													
				F		Bolt - Tube Assembly , Oil, Turbo Outlet & Block Inlet	13 80 - N0101 - 06	2	PIA to Engine Assembly													
		85				**Sealing Elements: Oil Pan Gasket,…**																
				C		Seal - Tube Assembly, Oil, Turbo Inlet	13 85 - N0101 - 03	1	PIA Tube Assembly-Oil, …													
				D		Compression Seal-Tube Ass'y, Oil Turbo Outlet & Block	13 85 - N0101 - 04	4	PIA Tube Assembly-Oil, …													
		99				**Miscellaneous**																
			F			Oil - Synthetic	13 99 - N0101 - 08	1		1	Diff.	$4.00	$0.00	$0.00	$ 4.00	$ -	$ -	$ -	$ -	$ -	$ -	$ 4.00
		100				**Engine Assembly**																
			A			Assemble Additional or Modified Lubrication Subsystem Parts to Engine				1	Diff.	$0.93	$1.46	$2.63	$ 5.02	$ -	$ -	$ -	$ -	$ -	$ -	$ 5.02
												$12.63	$ 5.30	$11.74	$ 29.67	$ 0.14	$ 2.13	$ 1.78	$ 0.51	$ 4.55	$ 0.24	$ 34.46

NOTES:

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FEV

SUBSYTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA, PFI w. dVVT (Study Case# B0101)										
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
						13 Lubrication Subsystem (e.g.Oil Pans, Sumps)																
						02 Oil Pumps																
						A Oil Pump Assembly	13 02 - N0101 - 01	1		1	Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						06 Oil Filter																
						A Filter Cooler Assembly - Oil (Includes Seals)	13 06 - N0101 - 01	1		1	Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						70 Pipes, Hoses: Suction Pipe for Oil Pump, Oil Return, High Pressure, Low Pressure.																
						A Tube Assembly- Oil, Cooler/Filter Ass'y Outlet to Turbocharger	13 70 - N0101 - 01	1	(Shipped PIA to Filter/Cooler Assembly, although showing cost broke out separately)	1	Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						B Tube Assembly - Oil, Turbo to Engine Block (Piston Squirter's)	13 70 - N0101 - 02	1		1	Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						80 Boltings & Clamps																
						C Bolt - Filter Cooler Assembly	13 80 - N0101 - 03	4	PIA to Engine Assembly													
						D Bolt - Tube Assembly , Oil, Turbo Inlet	13 80 - N0101 - 09	1	PIA to Engine Assembly													
						E Clamp - Tube Assembly, Oil, Cooler/Filter Outlet	13 80 - N0101 - 05	1	PIA Tube Assembly-Oil, …													
						F Bolt - Tube Assembly , Oil, Turbo Outlet & Block Inlet	13 80 - N0101 - 06	2	PIA to Engine Assembly													
						85 Sealing Elements: Oil Pan Gasket,…																
						C Seal - Tube Assembly, Oil, Turbo Inlet	13 85 - N0101 - 03	1	PIA Tube Assembly-Oil, …													
						D Compression Seal-Tube Ass'y, Oil Turbo Outlet & Block	13 85 - N0101 - 04	4	PIA Tube Assembly-Oil, …													
						99 Miscellaneous																
						F Oil - Synthetic	13 99 - N0101 - 08	1		1	Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						100 Engine Assembly																
						A Assemble Additional or Modified Lubrication Subsystem Parts to Engine				1	Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

NOTES:

1. ▨ **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT (Study Case# N0101)

BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT (Study Case# B0101)

GENERAL PART INFORMATION												Manufacturing				Markup						
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Material	Labor	Burden	Total Manufacturing Cost (Component/ Assembly)	End Item Scrap	SG&A	Profit	ED&T-R&D	Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
						13 Lubrication Subsystem (e.g.Oil Pans, Sumps)																
						02 Oil Pumps																
						A Oil Pump Assembly	13 02 - N0101 - 01	1		1	Diff.	$3.08	$ -	$ -	$ 3.08	$ 0.02	$ 0.22	$ 0.25	$ 0.12	$ 0.61	$ -	$ 3.69
						06 Oil Filter																
						A Filter Cooler Assembly - Oil (Includes Seals)	13 06 - N0101 - 01	1		1	Diff.	$2.93	$ 2.23	$ 5.31	$ 10.48	$ 0.10	$ 1.44	$ 1.21	$ 0.38	$ 3.13	$ 0.16	$ 13.78
						70 Pipes, Hoses: Suction Pipe for Oil Pump, Oil Return, High Pressure, Low Pressure.																
						A Tube Assembly- Oil, Cooler/Filter Ass'y Outlet to Turbocharger	13 70 - N0101 - 01	1	(Shipped PIA to Filter/Cooler Assembly, although showing cost broke out separately)	1	Full	$1.27	$ 0.80	$ 1.59	$ 3.66	$ 0.01	$ 0.23	$ 0.16	$ -	$ 0.40	$ 0.03	$ 4.09
						B Tube Assembly - Oil, Turbo to Engine Block (Piston Squirter's)	13 70 - N0101 - 02	1		1	Full	$ 0.42	$ 0.81	$ 2.20	$ 3.43	$ 0.01	$ 0.24	$ 0.16	$ -	$ 0.41	$ 0.06	$ 3.90
						80 Boltings & Clamps																
						C Bolt - Filter Cooler Assembly	13 80 - N0101 - 03	4	PIA to Engine Assembly													
						D Bolt - Tube Assembly , Oil, Turbo Inlet	13 80 - N0101 - 09	1	PIA to Engine Assembly													
						E Clamp - Tube Assembly, Oil, Cooler/Filter Outlet	13 80 - N0101 - 05	1	PIA Tube Assembly-Oil, …													
						F Bolt - Tube Assembly , Oil, Turbo Outlet & Block Inlet	13 80 - N0101 - 06	2	PIA to Engine Assembly													
						85 Sealing Elements: Oil Pan Gasket,…																
						C Seal - Tube Assembly, Oil, Turbo Inlet	13 85 - N0101 - 03	1	PIA Tube Assembly-Oil, …													
						D Compression Seal-Tube Ass'y, Oil Turbo Outlet & Block	13 85 - N0101 - 04	4	PIA Tube Assembly-Oil, …													
						99 Miscellaneous																
						F Oil - Synthetic	13 99 - N0101 - 08	1		1	Diff.	$ 4.00	$ -	$ -	$ 4.00	$ -	$ -	$ -	$ -	$ -	$ -	$ 4.00
						100 Engine Assembly																
						A Assemble Additional or Modified Lubrication Subsystem Parts to Engine				1	Diff.	$0.93	$ 1.46	$ 2.63	$ 5.02	$ -	$ -	$ -	$ -	$ -	$ -	$ 5.02
												$ 12.63	$ 5.30	$ 11.74	$ 29.67	$ 0.14	$ 2.13	$ 1.78	$ 0.51	$ 4.55	$ 0.24	$ 34.46

NOTES:

1. ▨ = A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, Turbo, DI w. dVVT (Study Case# N0101)										
												Manufacturing				Markup						
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Material	Labor	Burden	Total Manufacturing Cost (Component/ Assembly)	End Item Scrap	SG&A	Profit	ED&T-R&D	Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
	14					**Cooling Subsystem**																
		01				**Water Pumps**																
		B				Pump- Auxiliary Coolant, Electric	14 01 - N0101 - 02	1			Full	$ 13.90	$ 1.63	$ 4.22	$ 19.75	$ 0.18	$ 1.82	$ 2.07	$ 1.03	$ 5.10	$ 0.06	$ 24.91
		70				**Pipes, Hoses, Ducting**																
		B				Hose Assembly - Turbo Assembly to Thermostat/Coolant Valve	14 70 - N0101 - 02	1			Full	$ 1.02	$ 1.10	$ 2.01	$ 4.13	$ 0.00	$ 0.25	$ 0.17	$ -	$ 0.41	$ 0.04	$ 4.59
		C				Hose Assembly - Auxiliary Pump to Turbo	14 70 - N0101 - 03	1			Full	$ 0.72	$ 0.87	$ 1.85	$ 3.45	$ 0.01	$ 0.21	$ 0.14	$ -	$ 0.36	$ -	$ 3.81
				D		Hose Assembly - Oil Filer/Cooler Ass'y to Auxiliary Pump	14 70 - N0101 - 04	1			Full	$ 0.85	$ 0.59	$ 0.43	$ 1.88	$ 0.01	$ 0.11	$ 0.08	$ -	$ 0.19	$ -	$ 2.07
		75				**Brackets**																
			A			Bracket Subassembly - Auxiliary Pump to Oil Filter/Cooler Ass'y	14 75 - N0101 - 01	1	PIA to Aux. Pump													
		80				**Boltings & Clamps**																
				D		Clamp-Hose Thermo/Coolant Valve Ass'y to Turbo @ Thermo	14 80 - N0101 - 04	1	PIA to Hose Assembly													
				E		Bolt-Hose Ass'yThermo/Coolant Valve to Turbo, BRKT Mount	14 80 - N0101 - 05	1	PIA to Engine Assembly													
				F		Bolt-Hose, Inlet and Outlet @ Turbo	14 80 - N0101 - 06	2	PIA to Engine Assembly													
				G		Bolt - Auxiliary Pump to Oil Filter Cooler Bracket Assembly	14 80 - N0101 - 07	2	PIA to Engine Assembly													
				I		Clamp - Hose, Auxiliary Pump to Turbo	14 80 - N0101 - 09	1	PIA to Hose Assembly													
				J		Clamp - Hose, Oil Filter Cooler Assembly to Auxiliary Pump	14 80 - N0101 - 10	2	PIA to Hose Assembly													
				M		Washer Banjo Bolt - Hose Coolant Inlet & Outlet Turbo	14 80 - N0101 - 13	4	PIA to Engine Assembly													
		100				**Engine Assembly**																
			A			Assembly Additional or Revised Cooling Subsystem parts to Engine					Mod	$ 0.74	$ 1.94	$ 3.50	$ 6.19	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.19
												$17.24	$ 6.14	$12.02	$ 35.40	$ 0.20	$ 2.39	$ 2.45	$ 1.03	$ 6.06	$ 0.10	$ 41.56

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA, PFI w. dVVT (Study Case# B0101)										
												Manufacturing				Markup						
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Material	Labor	Burden	Total Manufacturing Cost (Component/ Assembly)	End Item Scrap	SG&A	Profit	ED&T-R&D	Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
	14					**Cooling Subsystem**																
		01				**Water Pumps**																
		B				Pump- Auxiliary Coolant, Electric	14 01 - N0101 - 02	1			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		70				**Pipes, Hoses, Ducting**																
		B				Hose Assembly - Turbo Assembly to Thermostat/Coolant Valve	14 70 - N0101 - 02	1			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		C				Hose Assembly - Auxiliary Pump to Turbo	14 70 - N0101 - 03	1			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
				D		Hose Assembly - Oil Filer/Cooler Ass'y to Auxiliary Pump	14 70 - N0101 - 04	1			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		75				**Brackets**																
			A			Bracket Subassembly - Auxiliary Pump to Oil Filter/Cooler Ass'y	14 75 - N0101 - 01	1	PIA to Aux. Pump													
		80				**Boltings & Clamps**																
				D		Clamp-Hose Thermo/Coolant Valve Ass'y to Turbo @ Thermo	14 80 - N0101 - 04	1	PIA to Hose Assembly													
				E		Bolt-Hose Ass'yThermo/Coolant Valve to Turbo, BRKT Mount	14 80 - N0101 - 05	1	PIA to Engine Assembly													
				F		Bolt-Hose, Inlet and Outlet @ Turbo	14 80 - N0101 - 06	2	PIA to Engine Assembly													
				G		Bolt - Auxiliary Pump to Oil Filter Cooler Bracket Assembly	14 80 - N0101 - 07	2	PIA to Engine Assembly													
				I		Clamp - Hose, Auxiliary Pump to Turbo	14 80 - N0101 - 09	1	PIA to Hose Assembly													
				J		Clamp - Hose, Oil Filter Cooler Assembly to Auxiliary Pump	14 80 - N0101 - 10	2	PIA to Hose Assembly													
				M		Washer Banjo Bolt - Hose Coolant Inlet & Outlet Turbo	14 80 - N0101 - 13	4	PIA to Engine Assembly													
		100				**Engine Assembly**																
			A			Assembly Additional or Revised Cooling Subsystem parts to Engine					Mod	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

NOTES:

1. ▨ **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

GENERAL PART INFORMATION

INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT (Study Case# N0101)

BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT (Study Case# B0101)

Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	14					**Cooling Subsystem**																
		01				**Water Pumps**																
		B				Pump- Auxiliary Coolant, Electric	14 01 - N0101 - 02	1			Full	$13.90	$ 1.63	$ 4.22	**$ 19.75**	$ 0.18	$ 1.82	$ 2.07	$ 1.03	**$ 5.10**	$ 0.06	**$ 24.91**
		70				**Pipes, Hoses, Ducting**																
		B				Hose Assembly - Turbo Assembly to Thermostat/Coolant Valve	14 70 - N0101 - 02	1			Full	$1.02	$ 1.10	$ 2.01	**$ 4.13**	$ 0.00	$ 0.25	$ 0.17	$ -	**$ 0.41**	$ 0.04	**$ 4.59**
		C				Hose Assembly - Auxiliary Pump to Turbo	14 70 - N0101 - 03	1			Full	$ 0.72	$ 0.87	$ 1.85	**$ 3.45**	$ 0.01	$ 0.21	$ 0.14	$ -	**$ 0.36**	$ -	**$ 3.81**
				D		Hose Assembly - Oil Filer/Cooler Ass'y to Auxiliary Pump	14 70 - N0101 - 04	1			Full	$0.85	$ 0.59	$ 0.43	**$ 1.88**	$ 0.01	$ 0.11	$ 0.08	$ -	**$ 0.19**	$ -	**$ 2.07**
		75				**Brackets**																
			A			Bracket Subassembly - Auxiliary Pump to Oil Filter/Cooler Ass'y	14 75 - N0101 - 01	1	PIA to Aux. Pump													
		80				**Boltings & Clamps**																
				D		Clamp-Hose Thermo/Coolant Valve Ass'y to Turbo @ Thermo	14 80 - N0101 - 04	1	PIA to Hose Assembly													
				E		Bolt-Hose Ass'yThermo/Coolant Valve to Turbo, BRKT Mount	14 80 - N0101 - 05	1	PIA to Engine Assembly													
				F		Bolt-Hose, Inlet and Outlet @ Turbo	14 80 - N0101 - 06	2	PIA to Engine Assembly													
				G		Bolt - Auxiliary Pump to Oil Filter Cooler Bracket Assembly	14 80 - N0101 - 07	2	PIA to Engine Assembly													
				I		Clamp - Hose, Auxiliary Pump to Turbo	14 80 - N0101 - 09	1	PIA to Hose Assembly													
				J		Clamp - Hose, Oil Filter Cooler Assembly to Auxiliary Pump	14 80 - N0101 - 10	2	PIA to Hose Assembly													
				M		Washer Banjo Bolt - Hose Coolant Inlet & Outlet Turbo	14 80 - N0101 - 13	4	PIA to Engine Assembly													
		100				**Engine Assembly**																
			A			Assembly Additional or Revised Cooling Subsystem parts to Engine					Mod	$ 0.74	$ 1.94	$ 3.50	**$ 6.19**	$ -	$ -	$ -	$ -	**$ -**	$ -	**$ 6.19**
												$ 17.24	$ 6.14	$ 12.02	**$ 35.40**	$ 0.20	$ 2.39	$ 2.45	$ 1.03	**$ 6.06**	$ 0.10	**$ 41.56**

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

GENERAL PART INFORMATION												NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, Turbo, DI w. dVVT (Study Case# N0101)										
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component / Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
						15 Induction Air Charging Subsystem																
						01 Turbo Chargers (Assemblies)																
						A Turbo Charger Assembly	15 01 - N0101 - 01	1			Full	$ 49.30	$26.79	$33.75	$ 109.84	$ 6.34	$14.26	$15.29	$ 6.01	$ 41.90	$ 0.11	$ 151.85
						A1 Waste Gate Anti Surge Control Valve	15 01 - N0101 - 02	1	PIA													
						05 Heat Exchanger																
						A Cooler Assembly - Charged Air	15 05 - N0101 - 01	1			Full	$ 6.91	$ 2.85	$ 6.44	$ 16.20	$ 0.08	$ 0.97	$ 0.97	$ 0.32	$ 2.35	$ 0.10	$ 18.65
						70 Pipes, Hoses, Ducting																
						A Tube Assembly - Turbo Waste Gate Pneumatic Control	15 70 - N0101 - 03	1			Full	$ 1.93	$ 1.12	$ 2.36	$ 5.41	$ 0.02	$ 0.32	$ 0.22	$ 0.05	$ 0.61	$ 0.10	$ 6.12
						B Tube Ass'y w. Vehicle Tie Down Resonator, Air Cooler Inlet	15 70 - N0101 - 19	1			Full	$ 4.98	$ 1.61	$ 2.16	$ 8.75	$ 0.03	$ 0.53	$ 0.35	$ 0.09	$ 0.99	$ 0.08	$ 9.82
						BI Tube - Turbo Outlet to Vehicle Mount Coupler	15 70 - N0101 - 20	1	PIA													
						B2 Coupler - Turbo Outlet Tube to Cooler Intake Tube	15 70 - N0101 - 21	1	PIA													
						B3 Tube - Coupler to Charge Air Cooler	15 70 - N0101 - 22	1	PIA													
						C Tube Ass'y w. Vehicle Tie Down, Air Cooler Outlet	15 70 N0101 30	1			Full	$ 10.83	$ 2.65	$ 3.32	$ 16.81	$ 0.05	$ 1.01	$ 0.67	$ 0.17	$ 1.90	$ 0.06	$ 18.76
						C1 Tube - Charge Air Cooler Outlet	15 70 - N0101 - 01	1	PIA													
						C2 Tube - Formed, Charge Air Cooler Tube Outlet	15 70 - N0101 - 31	1	PIA													
						D Tube - Elbow, Upper to Charged Air Coupler By-Pass	15 70 - N0101 - 40	1			Full	$ 2.26	$ 0.58	$ 1.08	$ 3.92	$ 0.01	$ 0.24	$ 0.16	$ 0.04	$ 0.44	$ 0.03	$ 4.39
						E Tube - Coupler Y Branch to By-Pass	15 70 - N0101 - 41	1	(E,F,G, H Combined)		Full	$ 5.48	$ 2.48	$ 3.77	$ 11.73	$ 0.04	$ 0.70	$ 0.47	$ 0.12	$ 1.33	$ 0.07	$ 13.12
						F Tube - Elbow Coupler By-Pass to Throttle Body	15 70 - N0101 - 42	1	PIA													
						G Tube - Charged Air Bypass to Silencer	15 70 - N0101 - 43	1	PIA													
						H Tube - Flex Elbow, Silencer to Environment	15 70 - N0101 - 44	1	PIA													
						75 Brackets																
						A Bracket - Support, Turbo Assembly	15 75 - N0101 - 01	1			Full	$ 1.07	$ 0.15	$ 0.39	$ 1.61	$ 0.00	$ 0.10	$ 0.06	$ -	$ 0.17	$ 0.06	$ 1.84
						80 Boltings, Clamps, Misc Fastening																
						C Bolt - Bracket Support, Turbo Assembly	15 80 - N0101 - 03	1	PIA Engine Assembly													
						D Bolt - Bracket Support, Turbo Assembly	15 80 - N0101 - 04	1	PIA Engine Assembly													
						E Bolt - Pressure Reservoir, Turbo Waste Gate	15 80 - N0101 - 05	2	PIA Engine Assembly													
						F Nut - Pressure Reservoir, Turbo Waste Gate	15 80 - N0101 - 06	1	PIA Engine Assembly													
						H Clamp - Tube, Large, Turbo to Throttle Body	15 80 - N0101 - 08	9	PIA To Hoses													
						I Bolt - Tube, Charge Air Cooler to Vehicle	15 80 - N0101 - 09	2	PIA Engine Assembly													
						J Screw - Sensor, Charge Air Temperature	15 80 - N0101 - 10	1	PIA Tube Charged Air													
						L Clamp - Tubing Charged Air By-Pass	15 80 - N0101 - 12	3	PIA To Hoses													
						M Retainer - Vehicle, Charged Air By-Pass Elbow	15 80 - N0101 - 13	1	PIA Tube-Flex Elbow…													
						99 Miscellaneous																
						A Vacuum Reservoir - Turbo Waste Gate	15 99 - N0101 - 01	1			Full	$ 1.08	$ 0.34	$ 0.63	$ 2.05	$ 0.01	$ 0.22	$ 0.18	$ 0.05	$ 0.48	$ 0.10	$ 2.63
						B Value - Thrust Control, Turbo Waste Gate Pneumatic Control	15 99 - N0101 - 02	1			Full	$ 5.19	$ -	$ -	$ 5.19	$ 0.03	$ 0.34	$ 0.31	$ 0.13	$ 0.80	$ 0.02	$ 6.02
						C Sensor - Intake Temperature, Outlet Charged Air Cooler	15 99 - N0101 - 03	1	PIA Tube Charged Air													
						D Baffle - Charge Air By-Pass	15 99 - N0101 - 04	1	PIA Tube-Flex Elbow…													
						100 Vehicle/Engine Assembly																
						A Engine and Vehicle Asssembly of Air Induction Components					Full	$ 1.14	$ 9.81	$14.75	$ 25.70	$ -	$ -	$ -	$ -	$ -	$ -	$ 25.70
												$90.16	$48.38	$68.66	$ 207.21	$ 6.61	$18.68	$18.69	$ 6.98	$ 50.97	$ 0.71	$ 258.89

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA, PFI w. dVVT (Study Case# B0101)										
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component / Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
						15 Induction Air Charging Subsystem																
						01 Turbo Chargers (Assemblies)																
						A Turbo Charger Assembly	15 01 - N0101 - 01	1			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						A1 Waste Gate Anti Surge Control Valve	15 01 - N0101 - 02	1	PIA													
						05 Heat Exchanger																
						A Cooler Assembly - Charged Air	15 05 - N0101 - 01	1			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						70 Pipes, Hoses, Ducting																
						A Tube Assembly - Turbo Waste Gate Pneumatic Control	15 70 - N0101 - 03	1			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						B Tube Ass'y w. Vehicle Tie Down Resonator, Air Cooler Inlet	15 70 - N0101 - 19	1			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						BI Tube - Turbo Outlet to Vehicle Mount Coupler	15 70 - N0101 - 20	1	PIA													
						B2 Coupler - Turbo Outlet Tube to Cooler Intake Tube	15 70 - N0101 - 21	1	PIA													
						B3 Tube - Coupler to Charge Air Cooler	15 70 - N0101 - 22	1	PIA													
						C Tube Ass'y w. Vehicle Tie Down, Air Cooler Outlet	15 70 N0101 30	1			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						C1 Tube - Charge Air Cooler Outlet	15 70 - N0101 - 01	1	PIA													
						C2 Tube - Formed, Charge Air Cooler Tube Outlet	15 70 - N0101 - 31	1	PIA													
						D Tube - Elbow, Upper to Charged Air Coupler By-Pass	15 70 - N0101 - 40	1			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						E Tube - Coupler Y Branch to By-Pass	15 70 - N0101 - 41	1	(E,F,G, H Combined)		Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						F Tube - Elbow Coupler By-Pass to Throttle Body	15 70 - N0101 - 42	1	PIA													
						G Tube - Charged Air Bypass to Silencer	15 70 - N0101 - 43	1	PIA													
						H Tube - Flex Elbow, Silencer to Environment	15 70 - N0101 - 44	1	PIA													
						75 Brackets																
						A Bracket - Support, Turbo Assembly	15 75 - N0101 - 01	1			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						80 Boltings, Clamps, Misc Fastening																
						C Bolt - Bracket Support, Turbo Assembly	15 80 - N0101 - 03	1	PIA Engine Assembly													
						D Bolt - Bracket Support, Turbo Assembly	15 80 - N0101 - 04	1	PIA Engine Assembly													
						E Bolt - Pressure Reservoir, Turbo Waste Gate	15 80 - N0101 - 05	2	PIA Engine Assembly													
						F Nut - Pressure Reservoir, Turbo Waste Gate	15 80 - N0101 - 06	1	PIA Engine Assembly													
						H Clamp - Tube, Large, Turbo to Throttle Body	15 80 - N0101 - 08	9	PIA To Hoses													
						I Bolt - Tube, Charge Air Cooler to Vehicle	15 80 - N0101 - 09	2	PIA Engine Assembly													
						J Screw - Sensor, Charge Air Temperature	15 80 - N0101 - 10	1	PIA Tube Charged Air													
						L Clamp - Tubing Charged Air By-Pass	15 80 - N0101 - 12	3	PIA To Hoses													
						M Retainer - Vehicle, Charged Air By-Pass Elbow	15 80 - N0101 - 13	1	PIA Tube-Flex Elbow…													
						99 Miscellaneous																
						A Vacuum Reservoir - Turbo Waste Gate	15 99 - N0101 - 01	1			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						B Value - Thrust Control, Turbo Waste Gate Pneumatic Control	15 99 - N0101 - 02	1			Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						C Sensor - Intake Temperature, Outlet Charged Air Cooler	15 99 - N0101 - 03	1	PIA Tube Charged Air													
						D Baffle - Charge Air By-Pass	15 99 - N0101 - 04	1	PIA Tube-Flex Elbow…													
						100 Vehicle/Engine Assembly																
						A Engine and Vehicle Asssembly of Air Induction Components					Full	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

GENERAL PART INFORMATION

INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT (Study Case# N0101)

BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT (Study Case# B0101)

Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
						15 Induction Air Charging Subsystem																
						01 Turbo Chargers (Assemblies)																
						A Turbo Charger Assembly	15 01 - N0101 - 01	1			Full	$ 49.30	$ 26.79	$ 33.75	$ 109.84	$ 6.34	$ 14.26	$ 15.29	$ 6.01	$ 41.90	$ 0.11	$ 151.85
						A1 Waste Gate Anti Surge Control Valve	15 01 - N0101 - 02	1	PIA													
						05 Heat Exchanger																
						A Cooler Assembly - Charged Air	15 05 - N0101 - 01	1			Full	$ 6.91	$ 2.85	$ 6.44	$ 16.20	$ 0.08	$ 0.97	$ 0.97	$ 0.32	$ 2.35	$ 0.10	$ 18.65
						70 Pipes, Hoses, Ducting																
						A Tube Assembly - Turbo Waste Gate Pneumatic Control	15 70 - N0101 - 03	1			Full	$ 1.93	$ 1.12	$ 2.36	$ 5.41	$ 0.02	$ 0.32	$ 0.22	$ 0.05	$ 0.61	$ 0.10	$ 6.12
						B Tube Ass'y w. Vehicle Tie Down Resonator, Air Cooler Inlet	15 70 - N0101 - 19	1			Full	$ 4.98	$ 1.61	$ 2.16	$ 8.75	$ 0.03	$ 0.53	$ 0.35	$ 0.09	$ 0.99	$ 0.08	$ 9.82
						BI Tube - Turbo Outlet to Vehicle Mount Coupler	15 70 - N0101 - 20	1	PIA													
						B2 Coupler - Turbo Outlet Tube to Cooler Intake Tube	15 70 - N0101 - 21	1	PIA													
						B3 Tube - Coupler to Charge Air Cooler	15 70 - N0101 - 22	1	PIA													
						C Tube Ass'y w. Vehicle Tie Down, Air Cooler Outlet	15 70 N0101 30	1			Full	$ 10.83	$ 2.65	$ 3.32	$ 16.81	$ 0.05	$ 1.01	$ 0.67	$ 0.17	$ 1.90	$ 0.06	$ 18.76
						C1 Tube - Charge Air Cooler Outlet	15 70 - N0101 - 01	1	PIA													
						C2 Tube - Formed, Charge Air Cooler Tube Outlet	15 70 - N0101 - 31	1	PIA													
						D Tube - Elbow, Upper to Charged Air Coupler By-Pass	15 70 - N0101 - 40	1			Full	$ 2.26	$ 0.58	$ 1.08	$ 3.92	$ 0.01	$ 0.24	$ 0.16	$ 0.04	$ 0.44	$ 0.03	$ 4.39
						E Tube - Coupler Y Branch to By-Pass	15 70 - N0101 - 41	1	(E,F,G, H Combined)		Full	$ 5.48	$ 2.48	$ 3.77	$ 11.73	$ 0.04	$ 0.70	$ 0.47	$ 0.12	$ 1.33	$ 0.07	$ 13.12
						F Tube - Elbow Coupler By-Pass to Throttle Body	15 70 - N0101 - 42	1	PIA													
						G Tube - Charged Air Bypass to Silencer	15 70 - N0101 - 43	1	PIA													
						H Tube - Flex Elbow, Silencer to Environment	15 70 - N0101 - 44	1	PIA													
						75 Brackets																
						A Bracket - Support, Turbo Assembly	15 75 - N0101 - 01	1			Full	$ 1.07	$ 0.15	$ 0.39	$ 1.61	$ 0.00	$ 0.10	$ 0.06	$ -	$ 0.17	$ 0.06	$ 1.84
						80 Boltings, Clamps, Misc Fastening																
						C Bolt - Bracket Support, Turbo Assembly	15 80 - N0101 - 03	1	PIA Engine Assembly													
						D Bolt - Bracket Support, Turbo Assembly	15 80 - N0101 - 04	1	PIA Engine Assembly													
						E Bolt - Pressure Reservoir, Turbo Waste Gate	15 80 - N0101 - 05	2	PIA Engine Assembly													
						F Nut - Pressure Reservoir, Turbo Waste Gate	15 80 - N0101 - 06	1	PIA Engine Assembly													
						H Clamp - Tube, Large, Turbo to Throttle Body	15 80 - N0101 - 08	9	PIA To Hoses													
						I Bolt - Tube, Charge Air Cooler to Vehicle	15 80 - N0101 - 09	2	PIA Engine Assembly													
						J Screw - Sensor, Charge Air Temperature	15 80 - N0101 - 10	1	PIA Tube Charged Air													
						L Clamp - Tubing Charged Air By-Pass	15 80 - N0101 - 12	3	PIA To Hoses													
						M Retainer - Vehicle, Charged Air By-Pass Elbow	15 80 - N0101 - 13	1	PIA Tube-Flex Elbow…													
						99 Miscellaneous																
						A Vacuum Reservoir - Turbo Waste Gate	15 99 - N0101 - 01	1			Full	$ 1.08	$ 0.34	$ 0.63	$ 2.05	$ 0.01	$ 0.22	$ 0.18	$ 0.05	$ 0.48	$ 0.10	$ 2.63
						B Value - Thrust Control, Turbo Waste Gate Pneumatic Control	15 99 - N0101 - 02	1			Full	$ 5.19	$ -	$ -	$ 5.19	$ 0.03	$ 0.34	$ 0.31	$ 0.13	$ 0.80	$ 0.02	$ 6.02
						C Sensor - Intake Temperature, Outlet Charged Air Cooler	15 99 - N0101 - 03	1	PIA Tube Charged Air													
						D Baffle - Charge Air By-Pass	15 99 - N0101 - 04	1	PIA Tube-Flex Elbow…													
						100 Vehicle/Engine Assembly																
						A Engine and Vehicle Asssembly of Air Induction Components					Full	$ 1.14	$ 9.81	$ 14.75	$ 25.70	$ -	$ -	$ -	$ -	$ -	$ -	$ 25.70
												$ 90.16	$ 48.38	$ 68.66	$ 207.21	$ 6.61	$ 18.68	$ 18.69	$ 6.98	$ 50.97	$ 0.71	$ 258.89

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

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SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

APPENDIX H.1.17
Printed: 12/9/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

GENERAL PART INFORMATION												NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, Turbo, DI w. dVVT (Study Case# N0101)											
												Manufacturing				Markup							
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Material	Labor	Burden	Total Manufacturing Cost (Component/ Assembly)	End Item Scrap	SG&A	Profit	ED&T- R&D	Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
	17					**Breather Subsystem**																
		02				**Oil/Air Separator**																
			A			PCV ASSEMBLY - (Built into Cylinder Head Cover)	17 02 - N0101 - 00	1		1	Diff	$ 1.35	$ 0.37	$ 1.49	$ 3.21	$ 0.03	$ 0.42	$ 0.39	$ 0.12	$ 0.96	$ -	$ 4.17
				A1		Valve - Non Return Intake Hose Side	17 02 - N0101 - 01	1														
				A2		Separator - Cyclone	17 02 - N0101 - 10	1														
				A3		Valve - Pressure Control	17 02 - N0101 - 20	1														
				A4		Valve - Oil Drain	17 02 - N0101 - 30	1														
				A5		Valve - Non Return Intake Manifold Side	17 02 - N0101 - 40	1														
		100				**Engine Assembly**																
			A			Engine Assembly Additions/Modifications for Breather Subsystem					NA	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$1.35	$ 0.37	$ 1.49	$ 3.21	$ 0.03	$ 0.42	$ 0.39	$ 0.12	$ 0.96	$ -	$ 4.17

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

APPENDIX H.1.17
Printed: 12/9/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

GENERAL PART INFORMATION												BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA, PFI w. dVVT (Study Case# B0101)										
												Manufacturing				Markup						
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Material	Labor	Burden	Total Manufacturing Cost (Component/ Assembly)	End Item Scrap	SG&A	Profit	ED&T-R&D	Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
	17					**Breather Subsystem**																
		02				**Oil/Air Separator**																
			A			PCV ASSEMBLY - (Built into Cylinder Head Cover)	17 02 - N0101 - 00	1		1	Diff	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
				A1		Valve - Non Return Intake Hose Side	17 02 - N0101 - 01	1														
				A2		Separator - Cyclone	17 02 - N0101 - 10	1														
				A3		Valve - Pressure Control	17 02 - N0101 - 20	1														
				A4		Valve - Oil Drain	17 02 - N0101 - 30	1														
				A5		Valve - Non Return Intake Manifold Side	17 02 - N0101 - 40	1														
		100				**Engine Assembly**																
			A			Engine Assembly Additions/Modifications for Breather Subsystem					NA	$ -	$ -	$ -		$ -	$ -	$ -	$ -		$ -	$ -
												$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

NOTES:

1. ▨ **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT (Study Case# N0101)

BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT (Study Case# B0101)

GENERAL PART INFORMATION

Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	17					**Breather Subsystem**																
		02				**Oil/Air Separator**																
			A			PCV ASSEMBLY - (Built into Cylinder Head Cover)	17 02 - N0101 - 00	1		1	Diff	$1.35	$ 0.37	$ 1.49	$ 3.21	$ 0.03	$ 0.42	$ 0.39	$ 0.12	$ 0.96	$ -	$ 4.17
				A1		Valve - Non Return Intake Hose Side	17 02 - N0101 - 01	1														
				A2		Separator - Cyclone	17 02 - N0101 - 10	1														
				A3		Valve - Pressure Control	17 02 - N0101 - 20	1														
				A4		Valve - Oil Drain	17 02 - N0101 - 30	1														
				A5		Valve - Non Return Intake Manifold Side	17 02 - N0101 - 40	1														
		100				**Engine Assembly**																
			A			Engine Assembly Additions/Modifications for Breather Subsystem					NA	$0.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$ 1.35	$ 0.37	$ 1.49	$ 3.21	$ 0.03	$ 0.42	$ 0.39	$ 0.12	$ 0.96	$ -	$ 4.17

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

APPENDIX H.1.60
Printed: 12/9/2009

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, Turbo, DI w. dVVT (Study Case# N0101)										
												Manufacturing				Markup						
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Material	Labor	Burden	Total Manufacturing Cost (Component/ Assembly)	End Item Scrap	SG&A	Profit	ED&T-R&D	Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
	60					**Engine Management, Engine Electronic and Electrical Subsystems**																
		02				**Engine Management Systems, Engine Electronic Systems**																
		A				Power Train Control Module (PCM) Assembly - Hardware	60 02 - N0101 - 01	1			Diff.	$ 40.00	$ -	$ -	$ 40.00	$ -	$ -	$ -	$ -	$ -	$ -	$ 40.00
		B				Power Train Control Module (PCM) Assembly - Software	60 02 - N0101 - 50	1	Included in Indirect Cost (IC)Multiplier		NA	$0.00	$0.00	$0.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		03				**Engine Electrical Systems (including Wiring Harnesses, Earth Straps, Ignition Harness, Coils, Sockets)**					Diff.	$12.13	$0.00	$0.00	$ 12.13	$ -	$ -	$ -	$ -	$ -	$ -	$ 12.13
		A				Ignition Coil Assembly - Single Spark	60 03 - N0101 - 01	4	PIA to Engine Assembly													
		C				Wire Harness Assembly #1 - Engine, Main	60 03 - N0101 - 30	1	PIA to Engine Assembly													
		100				**Engine Electrical Systems (including Wiring Harnesses, Earth Straps, Ignition Harness, Coils, Sockets)**																
		A				Assembly Modification & Addition to Engine Management & Electrical Subsystems			Added Electrical Connections		Diff.	$ -	$ 1.60	$ 2.88	$ 4.48	$ -	$ -	$ -	$ -	$ -	$ -	$ 4.48
												$52.13	$ 1.60	$ 2.88	$ 56.61	$ -	$ -	$ -	$ -	$ -	$ -	$ 56.61

NOTES:
1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

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SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

APPENDIX H.1.60
Printed: 12/9/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA, PFI w. dVVT (Study Case# B0101)										
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	60					**Engine Management, Engine Electronic and Electrical Subsystems**																
		02				**Engine Management Systems, Engine Electronic Systems**																
			A			Power Train Control Module (PCM) Assembly - Hardware	60 02 - N0101 - 01	1			Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
			B			Power Train Control Module (PCM) Assembly - Software	60 02 - N0101 - 50	1	Included in Indirect Cost (IC)Multiplier		NA	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		03				**Engine Electrical Systems (including Wiring Harnesses, Earth Straps, Ignition Harness, Coils, Sockets)**					Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
			A			Ignition Coil Assembly - Single Spark	60 03 - N0101 - 01	4	PIA to Engine Assembly													
			C			Wire Harness Assembly #1 - Engine, Main	60 03 - N0101 - 30	1	PIA to Engine Assembly													
		100				**Engine Electrical Systems (including Wiring Harnesses, Earth Straps, Ignition Harness, Coils, Sockets)**																
			A			Assembly Modification & Addition to Engine Management & Electrical Subsystems			Added Electrical Connections		Diff.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

NOTES:

1. ▨ **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT (Study Case# N0101)

BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT (Study Case# B0101)

GENERAL PART INFORMATION

Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	60					**Engine Management, Engine Electronic and Electrical Subsystems**																
		02				**Engine Management Systems, Engine Electronic Systems**																
		A				Power Train Control Module (PCM) Assembly - Hardware	60 02 - N0101 - 01	1			Diff.	$40.00	$ -	$ -	**$ 40.00**	$ -	$ -	$ -	$ -	**$ -**	$ -	**$ 40.00**
		B				Power Train Control Module (PCM) Assembly - Software	60 02 - N0101 - 50	1	Included in Indirect Cost (IC)Multiplier		NA	$0.00	$ -	$ -	**$ -**	$ -	$ -	$ -	$ -	**$ -**	$ -	**$ -**
		03				**Engine Electrical Systems (including Wiring Harnesses, Earth Straps, Ignition Harness, Coils, Sockets)**					Diff.	$12.13	$ -	$ -	**$ 12.13**	$ -	$ -	$ -	$ -	**$ -**	$ -	**$ 12.13**
		A				Ignition Coil Assembly - Single Spark	60 03 - N0101 - 01	4	PIA to Engine Assembly													
		C				Wire Harness Assembly #1 - Engine, Main	60 03 - N0101 - 30	1	PIA to Engine Assembly													
		100				**Engine Electrical Systems (including Wiring Harnesses, Earth Straps, Ignition Harness, Coils, Sockets)**																
		A				Assembly Modification & Addition to Engine Management & Electrical Subsystems			Added Electrical Connections		Diff.	$0.00	$ 1.60	$ 2.88	**$ 4.48**	$ -	$ -	$ -	$ -	**$ -**	$ -	**$ 4.48**
												$ 52.13	$ 1.60	$ 2.88	**$ 56.61**	$ -	$ -	$ -	$ -	**$ -**	$ -	**$ 56.61**

NOTES:

1. ▨ **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

FEV

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, Turbo, DI w. dVVT (Study Case# N0101)										
												Manufacturing				Markup						
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Material	Labor	Burden	Total Manufacturing Cost (Component/ Assembly)	End Item Scrap	SG&A	Profit	ED&T-R&D	Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
	70					**Accessories Subsystem (Starter Engines, Generators, Power Steering Pumps, etc)**																
		04				**Vacuum Pumps**																
			A			Vacuum Pump Assembly	70 04 - N0101 - 01	1		1	Full	$ 3.31	$ 1.81	$ 6.56	$ 11.69	$ 0.09	$ 1.41	$ 1.15	$ 0.32	$ 2.96	$ 0.09	$ 14.74
		80				**Boltings**																
				A		Bolt - Vacuum Pump	70 80 - N0101 - 01	2	PIA Engine Assembly	1	Full											
		100				**Engine Assembly**																
			A			Engine Assembly Additions/Modifications for Accessory Subsystem				1	Full	$ 0.13	$ 0.74	$ 1.34	$ 2.20	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.20
												$3.44	$ 2.55	$ 7.90	$ 13.89	$ 0.09	$ 1.41	$ 1.15	$ 0.32	$ 2.96	$ 0.09	$ 16.95

NOTES:

1. ▨ **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

GENERAL PART INFORMATION												BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA, PFI w. dVVT (Study Case# B0101)										
Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
						70 Accessories Subsystem (Starter Engines, Generators, Power Steering Pumps, etc)																
						04 Vacuum Pumps																
						A Vacuum Pump Assembly	70 04 - N0101 - 01	1		1	Full	$ -	$ -	$ -		$ -	$ -	$ -	$ -		$ -	
						80 Boltings																
						A Bolt - Vacuum Pump	70 80 - N0101 - 01	2	PIA Engine Assembly	1	Full											
						100 Engine Assembly																
						A Engine Assembly Additions/Modifications for Accessory Subsystem				1	Full	$ -	$ -	$ -		$ -	$ -	$ -	$ -		$ -	
												$ -	$ -	$ -	**$ -**	$ -	$ -	$ -	$ -	**$ -**	$ -	**$ -**

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

FEV

SUBSYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Light-Duty Technology Cost Study
EP-C-07-069 WA1-3

APPENDIX H.1.70
Printed: 12/9/2009

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package,
01=Vehicle Class

INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT (Study Case# N0101)

BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT (Study Case# B0101)

GENERAL PART INFORMATION

Item	Subsystem	Sub-Subsystem	Assembly	Subassembly	Component	Name/Description	Part Number	QTY/ P.T	Notes	Level	Full Mod. Diff.	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
												Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	70					**Accessories Subsystem (Starter Engines, Generators, Power Steering Pumps, etc)**																
		04				**Vacuum Pumps**																
			A			Vacuum Pump Assembly	70 04 - N0101 - 01	1		1	Full	$3.31	$ 1.81	$ 6.56	$ 11.69	$ 0.09	$ 1.41	$ 1.15	$ 0.32	$ 2.96	$ 0.09	$ 14.74
		80				**Boltings**																
					A	Bolt - Vacuum Pump	70 80 - N0101 - 01	2	PIA Engine Assembly	1	Full											
		100				**Engine Assembly**																
			A			Engine Assembly Additions/Modifications for Accessory Subsystem				1	Full	$ 0.13	$ 0.74	$ 1.34	$ 2.20	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.20
												$ 3.44	$ 2.55	$ 7.90	$ 13.89	$ 0.09	$ 1.41	$ 1.15	$ 0.32	$ 2.96	$ 0.09	$ 16.95

NOTES:

1. ▨ **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

APPENDIX H.2 SYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)

Case Study #0101

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

GENERAL PART INFORMATION						NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, Turbo, DI w. dVVT (Study Case# N0101)										
Item	Subsystem	Subsystem Description	Notes	Level	Addition or Modification	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component / Assembly)	Net Component/ Assembly Cost Impact to OEM
						Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	02	**Engine Frames, Mountings & Brackets Subsystem**	No Modifications or Additions Required	1	NA											
	03	**Crank Drive Subsystem**	Last Updated 5/20/09	1	Mod.	$ (4.09)	$ 0.39	$ 4.15	$ 0.46	$ 0.28	$ (0.37)	$ (0.51)	$ 0.14	$ (0.46)	$ -	$ 0.00
	04	**Counter Balance Subsystem**	Last Updated 5/20/09	1	TBD	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	05	**Cylinder Block Subsystem**	Last Updated 5/20/09	1	Mod.	$ (7.59)	$ 1.36	$ 5.78	$ (0.46)	$ (0.53)	$ 0.83	$ 0.56	$ -	$ 0.86	$ 0.04	$ 0.44
	06	**Cylinder Head Subsystem**	Last Updated 5/20/09	1	Mod.	$ 5.57	$ 0.81	$ 6.94	$ 13.32	$ 1.80	$ 0.65	$ 0.71	$ 0.04	$ 3.20	$ 0.03	$ 16.55
	07	**Valve Train Subsystem**	Last Updated 5/20/09	1	Mod	$8.40	$ -	$ -	$ 8.40	$ 0.05	$ 0.59	$ 0.68	$ 0.34	$ 1.65	$ -	$ 10.06
	08	**Timing Drive Subsystem**	Last Updated 5/20/09	1	Mod	$1.60	$ -	$ -	$ 1.60	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.60
	09	**Accessory Drive Subsystem**	No Modifications or Additions Required	1	NA											
	10	**Intake Subsystem**	Last Updated 5/20/09	1	NA	($10.66)	$ (0.01)	$ (0.10)	$ (10.78)	$ (0.05)	$ (0.70)	$ (0.65)	$ (0.27)	$ (1.67)	$ (0.28)	$ (12.73)
	11	**Fuel Induction Subsystem**	Last Update 5/20/09	1	Add & Mod	$37.25	$17.41	$ 62.87	$ 117.53	$ 1.23	$ 12.30	$ 12.25	$ 4.67	$ 30.44	$ 0.24	$ 148.21
	12	**Exhaust Subsystem**	Last Updated 5/20/09	1	Mod	$27.24	$ 0.11	$ 3.09	$ 30.44	$ 2.97	$ 1.97	$ 1.79	$ 0.71	$ 7.44	$ (0.12)	$ 37.77
	13	**Lubrication Subsystems (Oil Pans/Sumps)**	Last Updated 5/20/09	1	Add & Mod	$12.63	$ 5.30	$ 11.74	$ 29.67	$ 0.14	$ 2.13	$ 1.78	$ 0.51	$ 4.55	$ 0.24	$ 34.46
	14	**Cooling Subsystem**	Last Updated 5/20/09	1	Add	$17.24	$ 6.14	$ 12.02	$ 35.40	$ 0.20	$ 2.39	$ 2.45	$ 1.03	$ 6.06	$ 0.10	$ 41.56
	15	**Induction Air Charging Subsystem**	Last Updated 5/20/09	1	Add	$90.16	$48.38	$ 68.66	$ 207.21	$ 6.61	$ 18.68	$ 18.69	$ 6.98	$ 50.97	$ 0.71	$ 258.89
	16	**Exhaust Gas Re-Circulation Subsystem**	Subsystem does not exist on either Base or New Technology Package.	1	NA											
	17	**Breather Subsystem**	Last Updated 5/20/09	1	Mod	$1.35	$ 0.37	$ 1.49	$ 3.21	$ 0.03	$ 0.42	$ 0.39	$ 0.12	$ 0.96	$ -	$ 4.17
	60	**Engine Management Systems, Engine Electronic Systems, Electrical Subsystems**	Last Updated 5/20/09	1	Mod	$52.13	$ 1.60	$ 2.88	$ 56.61	$ -	$ -	$ -	$ -	$ -	$ -	$ 56.61
	70	**Accessory Subsystems (Starter Engines, Generators, Power Steering Pumps, etc)**	Last Updated 4/2/09	1	Add.	$3.44	$ 2.55	$ 7.90	$ 13.89	$ 0.09	$ 1.41	$ 1.15	$ 0.32	$ 2.96	$ 0.09	$ 16.95
						$234.68	$84.41	$187.40	$ 506.50	$12.81	$ 40.28	$ 39.29	$14.59	$ 106.97	$ 1.06	$ 614.53

NOTES:

1. 🟨 **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**

APPENDIX H.2 SYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Case Study #0101

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

GENERAL PART INFORMATION						BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA, PFI w. dVVT (Study Case# B0101)										
Item	Subsystem	Subsystem Description	Notes	Level	Addition or Modification	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component / Assembly)	Net Component/ Assembly Cost Impact to OEM
						Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	02	Engine Frames, Mountings & Brackets Subsystem	No Modifications or Additions Required	1	NA											
	03	Crank Drive Subsystem	Last Updated 5/20/09	1	Mod.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	04	Counter Balance Subsystem	Last Updated 5/20/09	1	TBD	$ 10.37	$ 6.22	$ 11.36	$ 27.94	$ 0.82	$ 3.22	$ 2.98	$ 0.92	$ 7.95	$ 0.05	$ 35.95
	05	Cylinder Block Subsystem	Last Updated 5/20/09	1	Mod.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	06	Cylinder Head Subsystem	Last Updated 5/20/09	1	Mod.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	07	Valve Train Subsystem	Last Updated 5/20/09	1	Mod	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	08	Timing Drive Subsystem	Last Updated 5/20/09	1	Mod	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	09	Accessory Drive Subsystem	No Modifications or Additions Required	1	NA											
	10	Intake Subsystem	Last Updated 5/20/09	1	NA	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	11	Fuel Induction Subsystem	Last Update 5/20/09	1	Add & Mod	$ 5.49	$ 5.61	$ 21.81	$ 32.91	$ 0.27	$ 3.10	$ 3.19	$ 1.31	$ 7.87	$ 0.11	$ 40.89
	12	Exhaust Subsystem	Last Updated 5/20/09	1	Mod	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	13	Lubrication Subsystems (Oil Pans/Sumps)	Last Updated 5/20/09	1	Add & Mod	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	14	Cooling Subsystem	Last Updated 5/20/09	1	Add	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	15	Induction Air Charging Subsystem	Last Updated 5/20/09	1	Add	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	16	Exhaust Gas Re-Circulation Subsystem	Subsystem does not exist on either Base or New Technology Package.	1	NA											
	17	Breather Subsystem	Last Updated 5/20/09	1	Mod	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	60	Engine Management Systems, Engine Electronic Systems, Electrical Subsystems	Last Updated 5/20/09	1	Mod	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	70	Accessory Subsystems (Starter Engines, Generators, Power Steering Pumps, etc)	Last Updated 4/2/09	1	Add.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
						$15.86	$11.83	$33.17	$ 60.86	$ 1.10	$ 6.33	$ 6.16	$ 2.23	$ 15.82	$ 0.16	$ 76.84

NOTES:

1. ▨ = A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.

APPENDIX H.2 SYSTEM COST MODEL ANALYSIS TEMPLATE (CMAT)
Case Study #0101

Technology Level: Downsized, Turbocharged, Gasoline Direct Inject (GDI) Engine
Vehicle Class: Compact/Economy 2-4 Passenger
Study Case#: N0101 & B0101 (N=New, B=Base,) 01=Technology Package, 01=Vehicle Class

GENERAL PART INFORMATION

INCREMENTAL COST TO UPGRADE TO NEW TECHNOLOGY PACKAGE

NEW TECHNOLOGY PACKAGE: 1.6L I4, 16V DOHC, DI, Turbo w. dVVT (Study Case# N0101)

BASE TECHNOLOGY PACKAGE: 2.4L I4, 16V DOHC, NA w. dVVT (Study Case# B0101)

Item	Subsystem	Subsystem Description	Notes	Level	Addition or Modification	Manufacturing			Total Manufacturing Cost (Component/ Assembly)	Markup				Total Markup Cost (Component/ Assembly)	Total Packaging Cost (Component/ Assembly)	Net Component/ Assembly Cost Impact to OEM
						Material	Labor	Burden		End Item Scrap	SG&A	Profit	ED&T-R&D			
	02	**Engine Frames, Mountings & Brackets Subsystem**	No Modifications or Additions Required	1	NA											
	03	**Crank Drive Subsystem**	Last Updated 5/20/09	1	Mod.	$ (4.09)	$ 0.39	$ 4.15	**$ 0.46**	$ 0.28	$ (0.37)	$ (0.51)	$ 0.14	**$ (0.46)**	$ -	**$ 0.00**
	04	**Counter Balance Subsystem**	Last Updated 5/20/09	1	TBD	$ (10.37)	$ (6.22)	$ (11.36)	**$ (27.94)**	$ (0.82)	$ (3.22)	$ (2.98)	$ (0.92)	**$ (7.95)**	$ (0.05)	**$ (35.95)**
	05	**Cylinder Block Subsystem**	Last Updated 5/20/09	1	Mod.	$ (7.59)	$ 1.36	$ 5.78	**$ (0.46)**	$ (0.53)	$ 0.83	$ 0.56	$ -	**$ 0.86**	$ 0.04	**$ 0.44**
	06	**Cylinder Head Subsystem**	Last Updated 5/20/09	1	Mod.	$ 5.57	$ 0.81	$ 6.94	**$ 13.32**	$ 1.80	$ 0.65	$ 0.71	$ 0.04	**$ 3.20**	$ 0.03	**$ 16.55**
	07	**Valve Train Subsystem**	Last Updated 5/20/09	1	Mod	$ 8.40	$ -	$ -	**$ 8.40**	$ 0.05	$ 0.59	$ 0.68	$ 0.34	**$ 1.65**	$ -	**$ 10.06**
	08	**Timing Drive Subsystem**	Last Updated 5/20/09	1	Mod	$ 1.60	$ -	$ -	**$ 1.60**	$ -	$ -	$ -	$ -	**$ -**	$ -	**$ 1.60**
	09	**Accessory Drive Subsystem**	No Modifications or Additions Required	1	NA											
	10	**Intake Subsystem**	Last Updated 5/20/09	1	NA	$ (10.66)	$ (0.01)	$ (0.10)	**$ (10.78)**	$ (0.05)	$ (0.70)	$ (0.65)	$ (0.27)	**$ (1.67)**	$ (0.28)	**$ (12.73)**
	11	**Fuel Induction Subsystem**	Last Update 5/20/09	1	Add & Mod	$ 31.76	$ 11.80	$ 41.05	**$ 84.62**	$ 0.95	$ 9.20	$ 9.06	$ 3.36	**$ 22.58**	$ 0.13	**$ 107.32**
	12	**Exhaust Subsystem**	Last Updated 5/20/09	1	Mod	$ 27.24	$ 0.11	$ 3.09	**$ 30.44**	$ 2.97	$ 1.97	$ 1.79	$ 0.71	**$ 7.44**	$ (0.12)	**$ 37.77**
	13	**Lubrication Subsystems (Oil Pans/Sumps)**	Last Updated 5/20/09	1	Add & Mod	$ 12.63	$ 5.30	$ 11.74	**$ 29.67**	$ 0.14	$ 2.13	$ 1.78	$ 0.51	**$ 4.55**	$ 0.24	**$ 34.46**
	14	**Cooling Subsystem**	Last Updated 5/20/09	1	Add	$ 17.24	$ 6.14	$ 12.02	**$ 35.40**	$ 0.20	$ 2.39	$ 2.45	$ 1.03	**$ 6.06**	$ 0.10	**$ 41.56**
	15	**Induction Air Charging Subsystem**	Last Updated 5/20/09	1	Add	$ 90.16	$ 48.38	$ 68.66	**$ 207.21**	$ 6.61	$ 18.68	$ 18.69	$ 6.98	**$ 50.97**	$ 0.71	**$ 258.89**
	16	**Exhaust Gas Re-Circulation Subsystem**	Subsystem does not exist on either Base or New Technology Package.	1	NA											
	17	**Breather Subsystem**	Last Updated 5/20/09	1	Mod	$ 1.35	$ 0.37	$ 1.49	**$ 3.21**	$ 0.03	$ 0.42	$ 0.39	$ 0.12	**$ 0.96**	$ -	**$ 4.17**
	60	**Engine Management Systems, Engine Electronic Systems, Electrical Subsystems**	Last Updated 5/20/09	1	Mod	$ 52.13	$ 1.60	$ 2.88	**$ 56.61**	$ -	$ -	$ -	$ -	**$ -**	$ -	**$ 56.61**
	70	**Accessory Subsystems (Starter Engines, Generators, Power Steering Pumps, etc)**	Last Updated 4/2/09	1	Add.	$ 3.44	$ 2.55	$ 7.90	**$ 13.89**	$ 0.09	$ 1.41	$ 1.15	$ 0.32	**$ 2.96**	$ 0.09	**$ 16.95**
						$ 218.82	$ 72.58	$ 154.24	**$ 445.64**	$ 11.72	$ 33.96	$ 33.12	$ 12.36	**$ 91.16**	$ 0.90	**$ 537.70**

NOTES:

1. ▨ **= A highlighted Sub-subsystem, Assembly or Component row indicates design and/or manufacturing differentials are accounted for in the quote sheet of the competing technology.**