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ASSESSMENT OF DOMESTIC AUTOMOTIVE INDUSTRY PRODUCTION LEAD TIME OF 1975/76 MODEL YEARS

VOLUME I - EXECUTIVE SUMMARY

FINAL REPORT

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Mobile Source Air Pollution Control
Emission Control Technology Division
Ann Arbor, Michigan 48105

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FOREWORD

This report, prepared by The Aerospace Corporation for the Environmental Protection Agency, Division of Emission Control Technology, presents an assessment of available information pertaining to the production lead time requirements of the automotive industry for 1975/76 model year automobiles.

The status of the production lead time reported herein is that existing at the time of data acquisition visits made to selected firms in the period August 1, 1972 through October 5, 1972. The results of this study are presented in two volumes. Volume 1, the Executive Summary, presents a brief, concise review of important findings and conclusions in the Highlights and Executive Summary sections. Volume 2, the Technical Discussion, provides a comprehensive discussion of each study topic and is of interest primarily to the technical specialist. In Volume 2 a brief discussion of basic automotive product development phases is given in Section 2. A summary of emission control systems currently proposed by domestic automobile manufacturers for model years 1975/76 is presented in Section 3. The assessment of the industry's production lead time requirements, with particular emphasis on the impact of critical emission control system components and subsystems, is discussed in Section 4. Specific lead time schedules obtained from automobile manufacturers, catalyst and substrate manufacturers, automobile component manufacturers, and production equipment manufacturers are given in Sections 5 through 8. Similar lead time schedules for non-automotive industry manufacturers and for a government automotive procurement agency are presented in Sections 9 and 10, respectively. Section 11 contains a discussion of platinum-group metal production and usage. Finally, Appendix A, Section 12, contains a listing of the companies visited in the data acquisition activity.

ACKNOWLEDGMENT

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HIGHLIGHTS

A summarization and assessment were made of available information pertaining to the production lead time[1] requirements of the domestic automotive industry for 1975/76 model year automobiles. Assessment of the status of the industry as of the time of data acquisition visits and technical discussions (August 1 to October 5, 1972) resulted in the following findings.

1. General Motors, Ford, Chrysler, and American Motors are currently proceeding on 1975 model year production schedules which call for the start of full mass production at the normal new model production start date of August 1974.

2. All domestic automobile manufacturers have basically similar 1975 production schedules which are consistent with the historically established guideline for management approval of the new model car development program at approximately 28 months prior to mass production initiation.

3. These 1975 production schedules include provisions for the incorporation of an emission control system consisting of an oxidation catalytic converter, exhaust gas recirculation, air injection, improved carburetion and ignition, and devices or techniques to promote fast warmup of the induction system and catalytic converter.

4. The catalytic converter is identified by all automobile manufacturers as the most critical production lead time item in their schedule. It is schedule-controlling because of the lead time required by suppliers to develop facilities for mass producing both substrates and finished catalysts (approximately 2 years).

5. The lack of satisfactory test results from prototype automobile test programs is having a major impact upon the decisions of automobile manufacturers pertaining to final catalyst commitments. To date, no domestic manufacturer has successfully completed mileage accumulation tests to 50,000 miles, although some prototypes have come close to meeting the emission standards at extended mileage. The automobile

[1] Production lead time is herein defined as that time period allocated or required for the refinement of mass manufacturing techniques, construction of manufacturing facilities, and the procurement and installation of equipment.

manufacturers have, therefore, placed orders for long lead time equipment and tooling based on their best judgment as to what will constitute a final design. Some companies still have to choose between pellet and monolith substrates and between promoted base metal and platinum-group metal catalysts. Many final commitments to substrate and catalyst manufacturers are being delayed as long as possible in order to have more data available before making such high risk decisions.

6. Partial and staged financial commitments to catalyst and substrate manufacturers have been made by the various automobile manufacturers in order to enable the catalyst manufacturers to initiate preliminary facility design and site selection activities. However, final commitments to the catalyst suppliers are required before facility construction will be initiated.

7. Available estimates of capital cost requirements per individual supplier are in the range of $4 to $5 million for substrate production facilities, and $4 to $15 million for catalyst production facilities with capacities ranging between 3 and 10 million units per year. At these cost levels, the substrate and catalyst manufacturers will not commit venture capital without a firm production contract or other form of guarantee. It is this fact which presently most strongly impacts the projected catalyst lead time schedules, since the required production facility construction will not commence until such agreements are successfully concluded.

8. Current production lead time schedules of contending substrate and catalyst manufacturers require production order commitments, or other forms of venture capital guarantees, from the automobile manufacturers by November to December 1972 in order to ensure quantity production of oxidation catalysts in time for 1975 model year vehicles. In every case, the critical, or pacing, item in the overall catalyst production lead time schedule is the time required by the vendor for the design of the production facilities, site selection, and construction of the facility or plant.

9. The status of contractual agreements between the automobile manufacturers and the catalyst manufacturers is one of uncertainty and change because serious negotiations were apparently under way during the period of investigation (August to October 1972). Most commitments to date have been of a preliminary nature and only cover funding for preliminary engineering design of production facilities and site selection. These initial commitments have enabled the automobile companies to defer their final commitments until the November to December 1972 time period. Of the known agreements, the Ford/Engelhard agreement is the most extensive, with Ford commitments

rising to about $10 million in March 1973 (when product-design-oriented equipment and facilities are to be purchased) and to $14 million by April 1974.

10. Substrate manufacturers state, in general, that no appreciable lead time compression can be made at the present level of schedule definition. In the finished catalyst area, there is some hope of minor schedule compressions (from 0 to 3 months for monoliths; 3 to 6 months for pellet catalysts). Estimates of cost penalties for such schedule compressions range from negligible to 10 percent product cost increases for overtime pay and increased capital costs.

11. Mass production of oxidation catalysts of the automotive type has never been accomplished by any company; however, the catalyst firms believe that related production and quality control techniques (in the chemical and petrochemical industries) provide a firm basis for assurance that their proposed production lead time schedules can be met. The automobile companies, however, have expressed some reservations about the capability of the catalyst manufacturers to mass produce the catalysts in the volume necessary while maintaining quality control.

12. If substrate, finished catalyst, and converter canister elements used in certification test vehicles are not made with production equipment (e.g., if batch processing rather than continuous processing, soft tooling, etc., are used), it may raise an issue as to whether or not the catalytic converter tested was the same "in all material respects" as production units. Items of concern in this regard include catalyst loading, uniformity of loading, substrate physical properties, and canister dimensional, physical, and weldment characteristics.

13. The production lead time requirements of conventional automobile component suppliers (body stampings, frames, transmissions, carburetors, exhaust systems, wheels, brake parts, etc.) appear to be adequately met by currently projected automobile manufacturer design release and/or vendor commitment dates. The key schedule dates for such component suppliers are those for the delivery of production samples to the automobile manufacturer for certification test vehicles and for car pilot line production.

14. Conventional production equipment items (automatic transfer lines, cold stamping presses, resistance welders, etc.) can be procured as required within the lead time remaining for 1975 model year automobiles. Electron beam welders, required for edge-welding of the General Motors pelletized catalytic converter canister, are being manufactured by Hamilton Standard on a schedule consistent with the 1975 production requirements of General Motors.

15. The current production capacity of platinum-group metals in the world is not sufficient to satisfy projected requirements of the automotive industry in the United States in the post-1975 time period. However, the demand can be met by the opening of new mines in South Africa. In order to ensure adequate platinum-group metal availability in the 1975 to 1980 time period, final contract agreements between the automobile manufacturers and the South African platinum-group metal mining firms must be signed in the near future.

16. The platinum-group metal supply-demand balance is determined by the platinum-group metal loading requirement, the number of catalysts required for the various vehicle classes, the catalyst replacement interval, the mining industry capacity, and the degree of platinum-group metal recovery from spent catalysts. A thorough study of these parameters is urgently needed in order to provide all the data required for a complete and meaningful assessment of the platinum-group metal availability and demand issues.

17. The automotive industry's stainless steel requirements for the 1975 model year (for exhaust systems, catalytic converter canisters, thermal reactor liners, etc.) have not been fully quantified as to type and amount. Raw material availability is not a problem, but material processing capacity may be a problem unless the additional equipment required is ordered in a timely manner.

18. The 50,000-mile durability certification test requires approximately 5 to 6 months to complete. In order to provide for the contingency of durability test vehicle failure, the first durability test should start no later than September 1973 if two full durability test periods are desired (based on an August 1974 vehicle production start date).

19. Emission control systems currently under consideration for use in 1976 model year vehicles incorporate all components of the 1975 system plus a reduction (NO_x) catalyst(s), more sophisticated air injection systems, and further modifications to carburction, ignition, and exhaust gas recirculation systems. Production lead time schedules for the 1976 model year have not yet been disclosed by the automobile manufacturers due to the uncertainty attending critical lead time elements of the 1975 model year production schedules and the lack of satisfactory development of reduction catalysts for control of oxides of nitrogen.

20. The full-size thermal reactor is not considered a viable option or alternative to the catalytic converter for 1975 model year vehicles, as the thermal reactor is not fully developed and the automobile companies have not ordered the long lead time production equipment required for its manufacture. Ford states that the time is now past the critical point for ordering such foundry equipment for 1975 model year production.

The foundry industry (exclusive of automobile company foundries) indicates that if additional foundry capacity on its part would be required, it would take 36 months to bring it to full production status.

21. Less effective partial thermal reactors, smaller in volume and less complex than full-size reactors, are currently programmed for use in 1975 emission control systems. These could be used without catalytic converters but the resulting emission reduction capability is at present not well defined and could vary among the different automobile manufacturers, according to individual design details.

Some statements made herein may make it appear that the 1975 model year automobile production schedules have changed with time since they were originally presented at the EPA Suspension Request Hearings in April 1972. However, the overall lead time schedules have remained relatively constant during the intervening period. Adherence to these schedules has been accomplished by making (a) timely design decisions as required, (b) minor compressions in supplier lead time schedules, and (c) partial or staged commitments in critical long lead time areas.

The risk to the automobile firms in following the original lead time schedules has been increasing with time. This is due to the fact that decisions in accordance with schedule milestones have had to be made with incomplete data regarding the adequacy of proposed emission control systems. Therefore, it would appear that the current production lead time schedules will permit 1975 model year production to begin in August 1974, unless the automobile manufacturers judge that the systems under development are so unsatisfactory that further commitments will not be made on the dates required.

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EXECUTIVE SUMMARY

1. INTRODUCTION

This report presents a summarization and assessment of available information pertaining to the production lead time requirements of the domestic automotive industry for 1975/76 model year automobiles.

The status of the production lead time reported herein is that existing at the time of data acquisition visits made from August 1 through October 5, 1972. During these visits, discussions relevant to production lead time were held with selected domestic automobile manufacturers, catalyst and substrate manufacturers, automotive component manufacturers, production equipment manufacturers, nonautomotive industry manufacturers, and a government automotive procurement agency. To supplement this information in certain areas, data were used from the open literature and from previous responses by industry to EPA requests for production lead time information.

The main topic covered in this report is the production lead time requirement of automobile manufacturers and their associated component and equipment suppliers. Emphasis has been directed toward identifying critical lead time components, subsystems, and raw or processed materials associated with the introduction of emission control systems required to meet the 1975/76 emission standards--in particular, catalytic converters. In addition, associated lead time requirements for tooling commitments, system durability and certification testing, and prototype test programs have been evaluated. A description of automotive product development phases and a summary of proposed 1975/76 emission control systems is included to clarify and augment the discussion.

This section of the report summarizes the more pertinent information from this assessment. Further details are given in the main body of the report (Volume II).

2. AUTOMOTIVE PRODUCT DEVELOPMENT PHASES

The process of developing an automotive product from concept to mass production can be viewed as proceeding in discrete phases. These phases, though highly interrelated and in some instances overlapping in time, may be isolated and characterized in terms of specific activities and operations.

The term "lead time" is a generic phrase that can be (and is) applied to any one of a number of different processes in the automotive development cycle. Two specific terms involving lead time are useful in viewing the automotive development cycle. One of these is Product Development Lead Time and the other is Production Lead Time. Product Development Lead Time is the total time required for the development of the automotive product, starting from the initial formulation of the design concept and ending with Vehicle Job No. 1, the first of the production run of automobiles of a model year off the assembly line. That part of Product Development Lead Time encompassing activities concerned with the development of mass manufacturing techniques and facilities is designated as the Production Lead Time. Specifically, Production Lead Time is defined as the time reserved by the automobile manufacturer to (a) detail the product configuration for mass manufacture; (b) analyze the manufacturing processes; (c) design or plan the equipment and facilities needed to perform these processes, (d) construct, install, and check out the production equipment; and (e) escalate the manufacturing process to full volume output.

A representative product development cycle may be considered to consist of eight different phases. These phases, along with their timing and typical duration, are shown in Figure 1. The data shown are broadly representative of the practice in the automotive industry; however, the specific details in any one manufacturer's schedule may differ considerably. Except for Research and Advanced Development, the overall product development cycle spans approximately 48 months. The milestone marker shown in the chart identifies the point selected as the Production Lead Time reference, which represents the start of significant activity on the development of

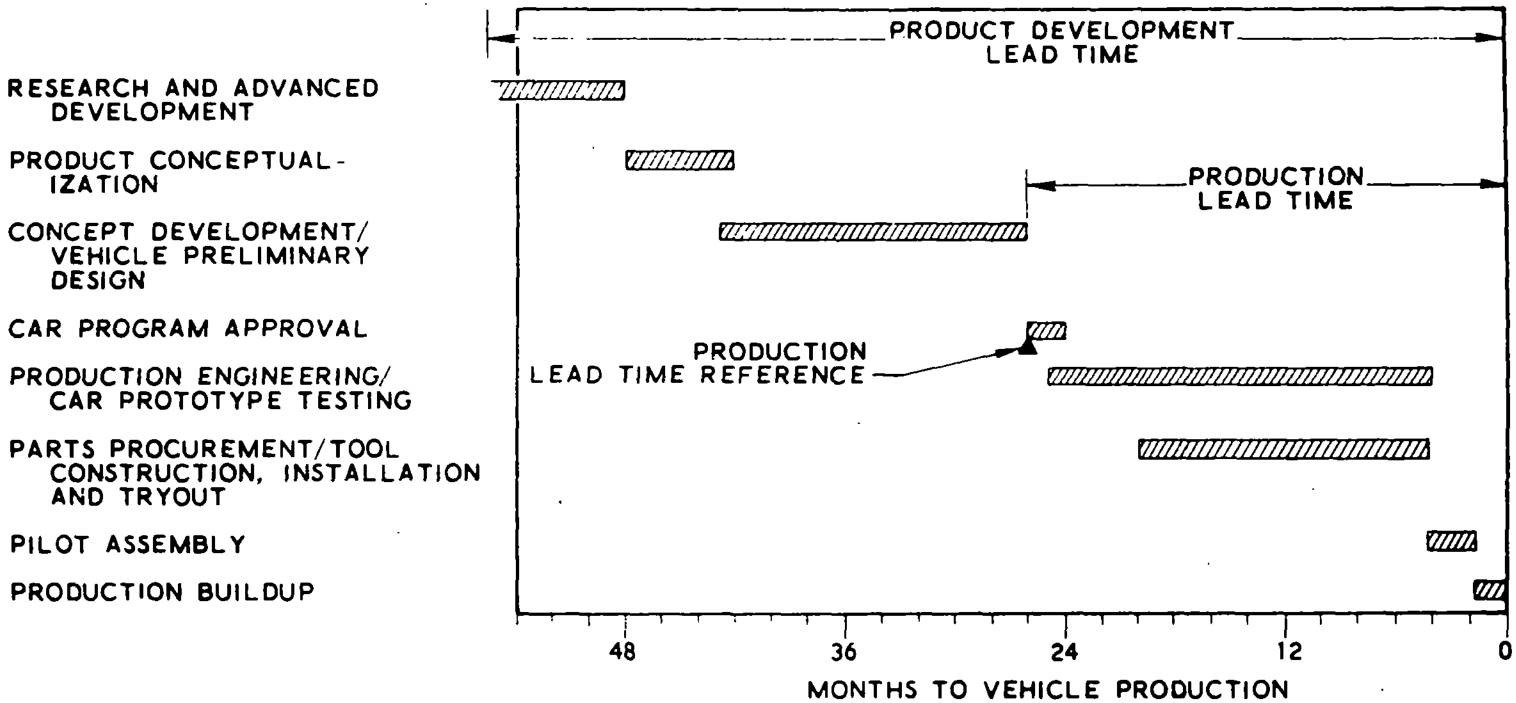


Figure 1. Automotive Product Development Phases

mass-production processes and facilities. The indicated lead time to Vehicle Job No. 1 is 26 months as compared with a range of 24 to 28 months indicated by historical data from the individual manufacturers.

3. PROPOSED 1975/76 MODEL YEAR EMISSION CONTROL SYSTEMS

The 1975 emission control system is exemplified by the following package of components and engine modifications:

- Oxidation catalytic converter
- Air injection
- Partial thermal reactor
- Exhaust gas recirculation
- Carburetor modifications
- Ignition system modifications

All first-choice systems selected by the automobile manufacturers incorporate an oxidation catalyst with air injection for the oxidation of the unburned hydrocarbon (HC) and carbon monoxide (CO) species contained in the engine exhaust. The catalyst type which appears most frequently is the platinum-group metal/monolithic converter. Base metal/pelletized and promoted base metal/pelletized catalyst designs[1] also are being evaluated by some manufacturers, including the General Motors Corporation and American Motors Corporation. Some automobile manufacturers are considering the use of a catalyst overtemperature protection device in their projected 1975 emission control systems to prevent catalyst damage under extreme/abnormal engine operating conditions (spark plug misfire, etc.).

Exhaust gas recirculation (EGR) systems will be employed in all domestic 1975 model year automobiles to control the oxides of nitrogen (NO_x). These systems will be improved versions of the EGR systems used in most of the 1973 model year vehicles.

[1] Promoted base metal catalyst formulations contain small amounts of platinum-group metals.

The emission control systems of a number of manufacturers, including those of the Chrysler Corporation, Ford Motor Company, and General Motors, utilize a partial thermal reactor in place of the conventional exhaust manifold primarily to provide more rapid warmup of the catalyst under cold start conditions. However, full-size thermal reactors are not completely developed and are not being considered for 1975 systems.

Carburetion/intake system modifications include such features as altitude compensation, quick-release choke devices, and intake manifold heating. All domestic manufacturers propose, or have in development, electronic (breakerless) ignition systems which are targeted for inclusion in their first-choice emission control system. These systems generally provide an improvement in spark-timing precision, consistency, and reliability.

Alternate systems under investigation by the automobile manufacturers for potential use in 1975 model year vehicles incorporate different types or designs of catalytic converters but are otherwise similar to the emission control packages selected as first-choice systems.

Emission control systems currently under consideration by the automobile manufacturers for use in 1976 model year vehicles will incorporate all components in the 1975 system plus:

Reduction catalyst(s) installed upstream of the oxidation catalyst(s)
More sophisticated air injection systems
Modified carburction, ignition, and EGR systems

A number of automobile manufacturers are experimenting with unconventional engine configurations, including the rotary (Wankel), stratified charge, gas turbine, Rankine, and Stirling engines. With the exception of the rotary engine, it appears that these unconventional engines will be neither developed nor be manufacturable in large quantities in time for the 1975/76 model year. Therefore, these engines are not considered in this study.

4. LEAD TIME SCHEDULES FOR AUTOMOBILE MANUFACTURERS

This section summarizes the current status of the 1975 model year production schedules of the major domestic automobile manufacturers, the major factors impacting current schedules, and the critical or limiting lead time items. Current and pending contractual agreements with potential suppliers are also delineated.

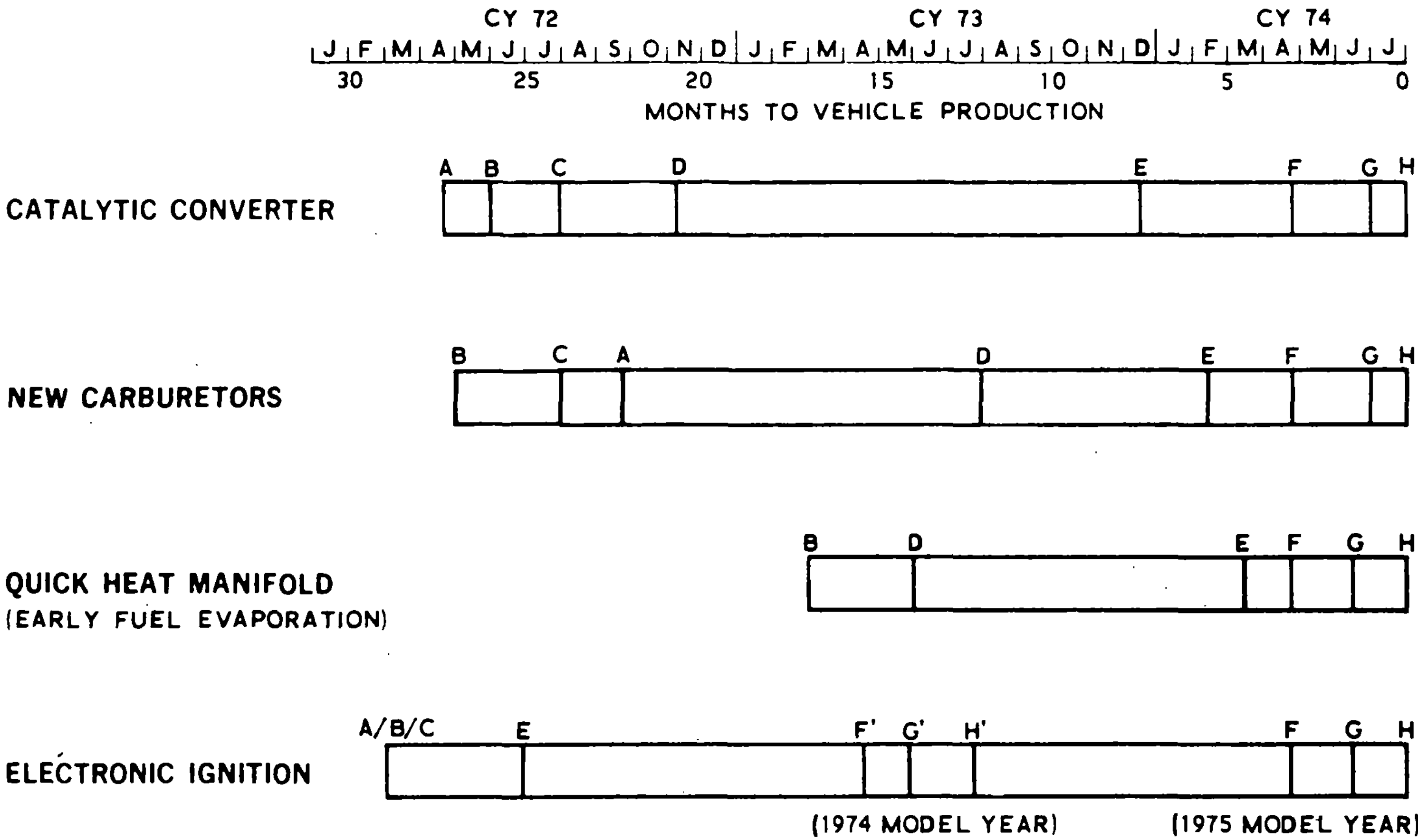
4.1 GENERAL MOTORS CORPORATION

4.1.1 Production Schedules

The 1975 emission control system master timing schedule for General Motors is presented in Figure 2. This schedule shows only the deadlines for those component systems still under development and which could impact the 1975 production lead time. Car assembly starts approximately the first week of August 1974, with component full production commencing a month earlier for the carburetor and catalytic converter, and 2 months earlier for the unitized ignition and early fuel evaporation (EFE) systems. It is to be noted that the first lead time milestones for carburetors and catalytic converters, the tooling and facilities appropriation approval dates, occurred in May and June of 1972.

General Motors considers this timetable to be more theoretical than realistic, since it is based on the assumption that all the devices needed to achieve 1975 emission levels can be developed in time, and that the manufacturing and assembly equipment necessary can be designed, built, installed, and brought up to production capacity within this period.

With respect to the catalytic converter system, General Motors has indicated a basic change in direction since the April 1972 Suspension Request Hearings. It is now planning to incorporate a mix of both platinum-group metal and base metal pellets in the under-floor catalytic converter instead of all-base metal pellets. Also, General Motors is actively working on the development of its new triple-mode (or T-MECS) emission



A - PRODUCTION DESIGN PRELIMINARY APPROVAL
B - TOOLING & FACILITIES PROGRAM APPROVAL
C - START PRODUCTION TOOLING
D - START PRODUCTION PRETEST BUILD FROM PARTIAL TOOLING
E - START PRODUCTION SAMPLE BUILD
F - START VEHICLE PILOT PART PROGRAM
G - FULL COMPONENT PRODUCTION
H - START VEHICLE PRODUCTION

Figure 2. General Motors Master Timing Schedule for 1975 Emission Components

control system in which the catalyst container is cast into the exhaust manifold. The final system selection has not yet been made; however the under-floor system is still considered as its first-choice system.

4.1.2 Major Impact Factors

General Motors maintains that to date no tests have successfully demonstrated the capability of its emission control systems to meet the 1975 Federal emission standards. Despite this lack of promising results, General Motors is making commitments for equipment and components to meet its production lead time schedules.

The major component impact factor on production lead time is that of the catalytic converter. With regard to the under-floor converter, the General Motors recent decision to incorporate platinum-group metal pellets has further intensified the testing activity and delayed certain decisions regarding this system. At the time of this investigation, the catalyst supplier had not been selected although General Motors indicated a decision was near.

With respect to the manifold-mounted T-MECS system, General Motors is investigating an extruded monolithic converter. Although it is still considering outside suppliers, General Motors is proceeding with plans to build its own monolithic converter. It presently has a pilot-type, manually operated extruding machine at the AC Spark Plug Division.

An improved carburetor design is still under development and therefore is considered to be an impact factor. For 1975, General Motors plans to have revised versions of existing carburetors as well as new-design carburetors. Additions to the plant at the Rochester Products Division are being made, and the plant is scheduled to be occupied in November 1972.

The EFE system is a system which accelerates the evaporation of fuel during engine warmup to reduce HC and CO exhaust emissions during the initial phases of the Federal test cycle. Tooling commitments for EFE do not appear to be critical at this time, based on its early successful development. The tooling and facilities appropriation approval milestone is scheduled for March 1, 1973.

4.1.3 Critical Lead Time Items

The critical lead time item is the catalytic converter system For the under-floor catalytic converter, the longest lead time item is the electron beam welder. General Motors feels that this welder is a possible source of delay due to a lack of experience with it in this particular application. Good corrosion-resistant steel (not stainless steel) for the catalyst container has been developed by General Motors, but it has had no production experience with the material in regard to its formability and weldability. The Hamilton Standard Division of the United Aircraft Corporation manufactures the electron beam welding equipment and has recently delivered the first prototype welder to the AC Spark Plug Division for equipment evaluation and development and training of personnel.

Specifically critical items were not delineated by General Motors for the T-MECS system; however, since this system has had less development time than the under-floor catalyst system, it should be identified as a critical lead time item.

4.1.4 Current and Pending Contractual Agreements

General Motors has $630,000 committed to the W. R. Grace and Company for the preliminary design of production line facilities for both monolithic and pellet catalyst plants. No other catalyst-related commitments are known to exist at this time, although preliminary contract negotiations with nine potential oxidation catalyst suppliers are under way.

General Motors is negotiating with a number of platinum-group metal mining companies in South Africa and with the Soviet Union. To date it has entered into a contract with Impala Platinum, Ltd. of Johannesburg, South Africa to develop the production capacity required to supply General Motors with 300,000 ounces of platinum and 120,000 ounces of palladium per year. General Motors considers the contract with Impala as a statement of its intent to buy the quantities cited and has placed a high priority on this issue. A number of decisions are expected to be made very soon. The actual yearly amount of platinum-group metals required by General Motors is dependent on the results of current road tests in which a cross-section of vehicles with different catalyst loadings (0.025 ounce to slightly above 0.1 ounce) are being run.

4.2 FORD MOTOR COMPANY

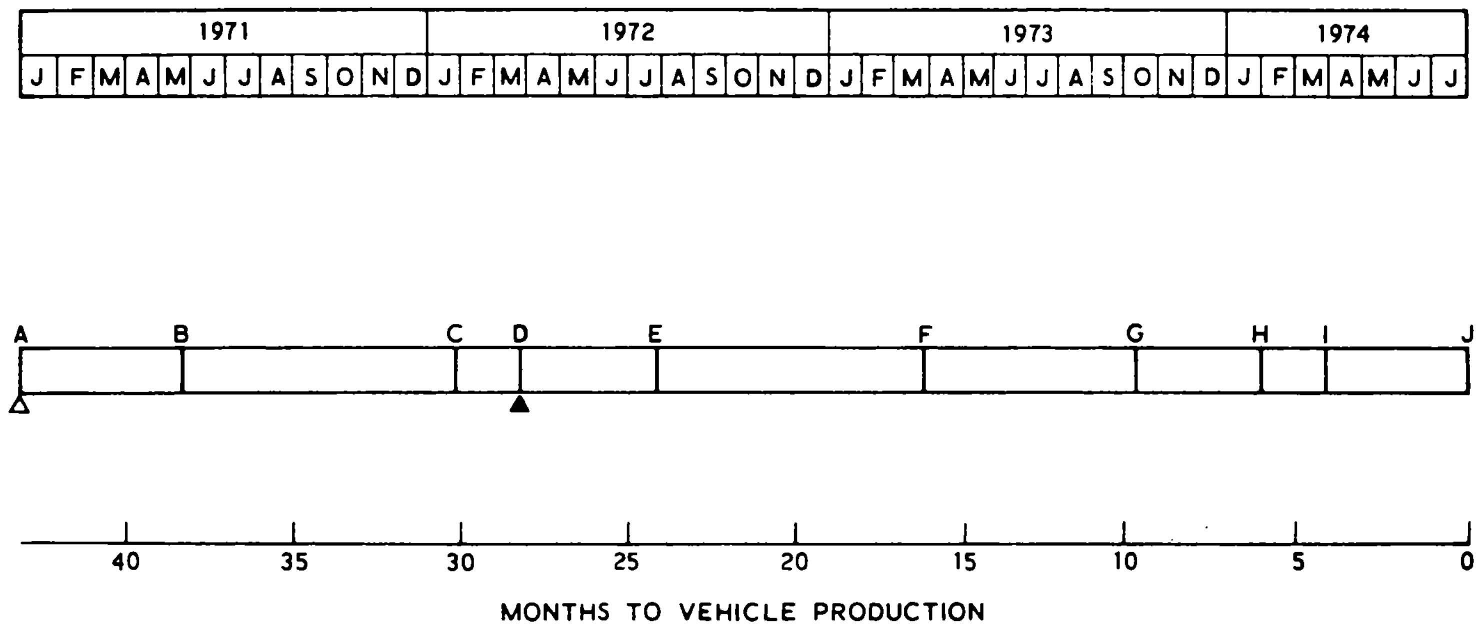
4.2.1 Production Schedule

An overall schedule depicting Ford's 1975 model year production development program is shown in Figure 3. This schedule combines elements of Ford's timing plans for the vehicle and the engine/emission system. Key milestones are shown on the lead time schedule by letter designation with explanations as noted.

Milestone "B" (May 1971) represents Ford's initial commitment to Engelhard Minerals and Chemical Company covering the development of pilot plant facilities for the production of catalytic converters. Twenty-eight months prior to vehicle Job No. 1, at milestone "D" (April 1972), the car manufacturing development program begun at 43 months was given a final review by Ford management and approval was issued to proceed with manufacturing development. The program approval point usually signals the beginning of large-scale capital equipment and tooling procurement operations and is therefore frequently identified with the production lead time requirement, even though some initial capital commitments (for example, Ford's milestone "B") already have taken place.

4.2.2 Major Impact Factors

With regard to 1975-peculiar, emission-control-related impact factors, Ford is proceeding with production development based on the use of a catalytic converter emission control system design that is presently unproven with respect to 1975 performance requirements. The 1975 car program approvals (April 1972) were issued shortly after the Ford durability test program at Riverside, California had begun and the catalytic



A - INITIATE CAR DEVELOPMENT PLAN
B - FIRST COMMITMENT TO ENGELHARD
C - START 50,000 MILE DURABILITY TESTS
D - CAR PROGRAM APPROVAL
E - COMMITMENT TO ENGELHARD MAIN PLANT/ORDER PRODUCTION TOOLING AND EQUIPMENT
F - START TOOL SET-UP AND TRYOUT
G - START CERTIFICATION TESTING
H - COMPLETE TOOL SET-UP AND TRYOUT
I - DELIVER/FABRICATE PRODUCTION SAMPLES
J - VEHICLE JOB No. 1

Figure 3. Ford Overall Schedule: 1975 Vehicle and Emission Engine Program

converter emission system road performance and durability characteristics were largely unknown for the specific designs in test. The Riverside tests are continuing, but according to Ford show little promise of meeting the 1975 emission goals.

According to Ford, if EPA elected to issue interim 1975 standards which might also be met by other control devices, such as thermal reactors, the result would be a serious impact on the engine compartment packaging design which is usually fixed at 37 months prior to Vehicle Job No. 1. Ford stated that this design milestone was critical because changes in the compartment geometry can progressively affect the entire body structure, starting with the engine cowl and proceeding to the "A" pillars flanking the windshield, the door supports, the overhang, etc. Furthermore, the time is now past the critical point for ordering arc and holding furnaces for foundry operations involved in the manufacture of full-size thermal reactor manifolds for the 1975 model year.

As much as 75 pounds of stainless steel per car may be required for converter canisters and exhaust systems and Ford is concerned about the available supply. It is unable to provide a forecast of its needs on the basis of prototype testing conducted to date. Therefore, stainless steel procurement and the associated vendor lead time requirement may be another Ford schedule impact factor.

4.2.3 Critical Lead Time Items

The controlling item in the Ford schedule is the development of vendor facilities for mass producing the catalytic converter. The critical aspect of catalytic converter production is the completion of facilities for mass manufacture of the catalyst substrate and for the wash coat and catalyzing operations.

4.2.4 Current and Pending Contractual Agreements

Known Ford contractual agreements include commitments made to Engelhard relating to catalyst manufacturing operations, and commitments made to the American Lava Corporation relating to substrate manufacture.

The first commitments involving Engelhard occurred May 24, 1971 and concerned the development of catalyst pilot plant facilities (Plant No. 1). In this agreement, Ford and Engelhard committed funds totaling $2.4 million for site procurement and initial construction operations. Half of this consisted of (nonrecoverable) Engelhard funds. The next major increment of commitment was made late in March 1972. By June 1972, Ford had committed $4.0 million to the pilot program, of which $3.7 million were direct capital investment guarantees to Engelhard. Of this total, $300,000 were reserved for assignment to American Lava.

On August 1, 1972 Ford made another commitment to Engelhard, this one relating to the development of the main plant facility (Plant No. 2). The capital involved in this agreement is not known. The Ford commitments to Engelhard plant development will rise sharply to about $10 million in March 1973 when product-design-oriented equipment and facilities are purchased, and to $14 million by April 1974.

In addition to the facilities development commitments described above, Ford has a 3-year contract with Engelhard which guarantees the supply of one-half million troy ounces of platinum per year. The contract was said to be written on a price-protected, no-cost-for-cancellation basis.

Ford's commitment to American Lava covers capital expenditures through calendar year 1972 for the scaleup of production facilities to meet a portion of Ford's (Engelhard's) substrate requirements. This agreement has been extended (capital commitment unknown) to cover, on a time-phased basis, the development of additional American Lava production capacity through the first quarter of 1974. This is a maximum cancellation agreement, similar to Engelhard's.

4.3 CHRYSLER CORPORATION

4.3.1 Production Schedules

Figure 4 shows the lead times on an overall basis for the 1975 model year vehicle. The longest lead time item is the catalytic converter system which had a production design approval date of April 1972. This lead time is 28 months prior to vehicle production which starts approximately on August 1, 1974. Milestones based on available information are shown on the lead time schedule by letter designation with explanations as noted.

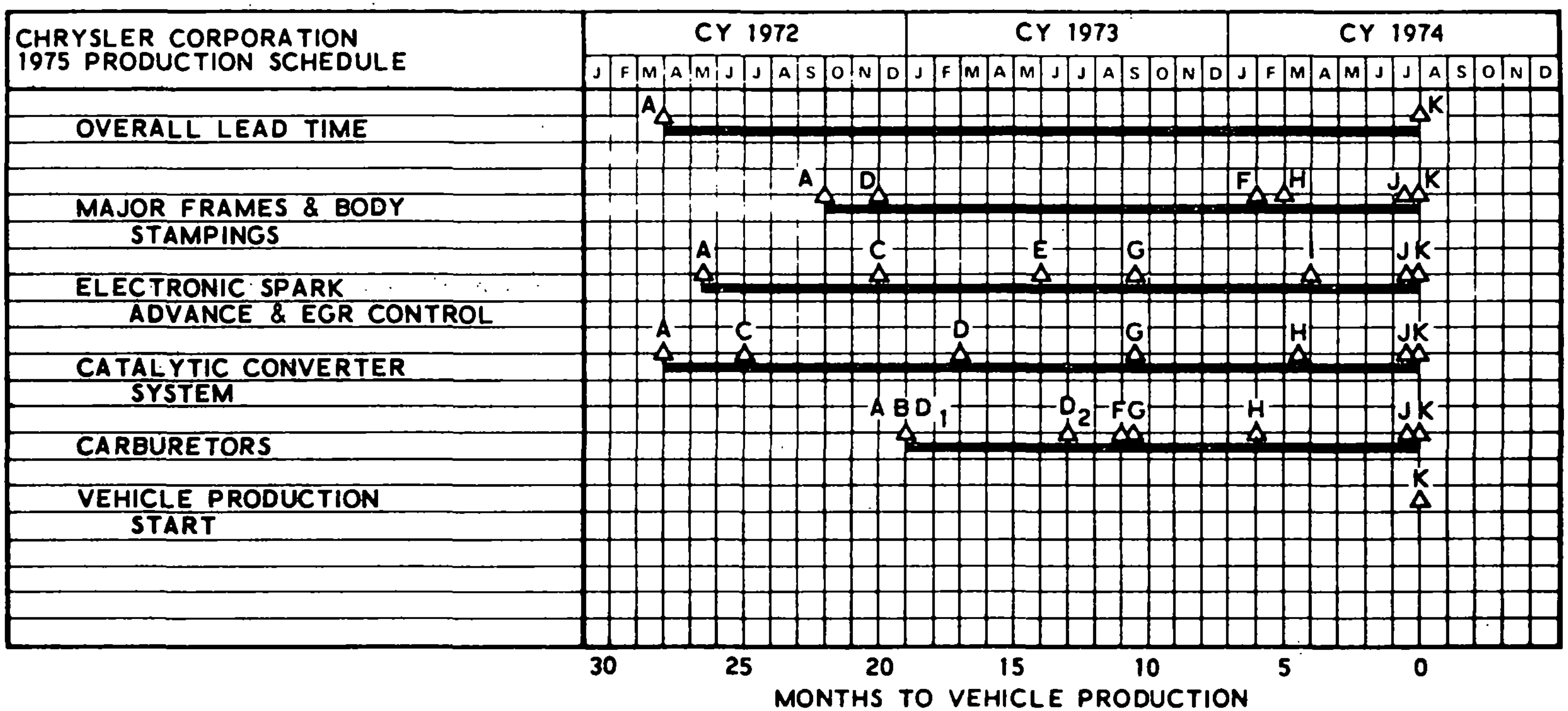
4.3.2 Major Impact Factors

An important factor in the schedule for the critical lead time catalytic converter system is the start of production of the assembled monolithic catalyst converter. Chrysler will subcontract the major components of this device. Subcontracting will involve three separate industries, since no single manufacturer has been found to manufacture an assembled converter. These industries will perform substrate manufacturing, catalyst application, and container manufacturing.

Certification of 1975 model year automobiles requires that the certification test vehicles be constructed with hardware similar in all material respects to production vehicles; therefore, in some cases, production samples are planned to be delivered earlier than the normally planned pilot runs. This would require very concentrated effort and tight coordination with all vendors to have production equipment and tooling checked out and operational for this purpose.

4.3.3 Critical Lead Time Items

According to Chrysler, the procurement of the substrate is the most critical lead time item since this must precede the application of the catalyst and assembly of the catalyzed substrate into the container. Chrysler has not placed purchase orders for substrates and has not received commitments from any vendor on meeting specific manufacturing schedules in the quantities required. The application of the catalyst to the substrate



A - PRODUCTION DESIGN PRELIM. APPROVAL
B - TOOLING & FACILITIES PROGRAM APPROVAL
C - START PRODUCTION PRETEST FROM SOFT TOOLING
D - START PRODUCTION TOOLING
E - LIMITED PRODUCTION START
F - START PRODUCTION SAMPLE BUILD
G - START EPA CERTIFICATION TESTS
H - START VEHICLE PILOT PROGRAM
I - EARLY USE
J - FULL COMPONENT PRODUCTION START
K - START VEHICLE PRODUCTION

NOTE: 1. D_1 - START PROCUREMENT OF DIE CAST DIES

2. D_2 - START OTHER MAJOR TOOLING

Figure 4. Chrysler Overall Schedule for the 1975 Emission Control System

is the second most critical item and a potential exists for the container to become critical if the design is not definitized in the near future.

4.3.4 Current and Pending Contractual Agreements

In September, Chrysler signed a contractual agreement for catalysts with the Universal Oil Products Company (UOP) and is considering Matthey Bishop, Inc. as another potential catalyst supplier. The required substrates will probably be obtained by Chrysler itself.

Relative to lead time compatibility, UOP states that it could provide catalysts by April 1974 if given an initial commitment by September 1972 and a commitment to construct a catalyst manufacturing facility by the end of December 1972. At this time, UOP is only performing engineering design, manufacturing process development, and planning work on the plant.

If UOP were to procure the catalyst substrate, a substrate commitment would be required by January 1973 with orders placed by May 1973.

Matthey Bishop provided similar lead times to Chrysler to meet an April 1974 volume production date. Chrysler is currently negotiating with both of these vendors and reports are that UOP would obtain 50% of the Chrysler catalyst requirement and Matthey Bishop 25% to 30%. The supplier for the balance has not yet been determined.

In September 1972, Chrysler also entered into an agreement with the Ore and Chemical Corporation for the delivery of 100,000 troy ounces of palladium from the Soviet Union. Since Chrysler's catalyst will probably be a mixture of platinum as well as palladium, a commitment for procurement of platinum is still required.

It appears that Chrysler intends to manufacture the majority of the catalyst containers itself. However, Arvin Industries, the Walker Manufacturing Company, and the Hayes-Albion Corporation are potential subcontractors to manufacture the container, but at this time Chrysler has made no commitments to any of them.

4.4 AMERICAN MOTORS CORPORATION

4.4.1 Production Schedules

American Motors has been working to schedules based on achievement of full production of 1975 model year automobiles by August 1, 1974. The schedules are influenced by American Motors relatively small size, which requires that it rely to a large degree on component and equipment technology developed outside the company. Its production program timing schedule for the 1975 model year vehicle is shown in Figure 5.

American Motors 1975 model year cars will require changes to the engine cylinder head, engine intake and exhaust manifolds, and body floor pans, as well as the addition of a catalytic converter. Key points to be noted are:

a. Preliminary release of all 1975 engine changes is planned for November 1, 1972.

b. Detail drawings on critical long lead time items (e.g., the cylinder head design change) would be released on March 1, 1973.

c. EPA certification tests would begin on November 1, 1973.

d. Tool construction would be completed on March 1, 1974.

e. 1975 engines would be installed in sales prototype vehicles (first build from production tool parts), beginning March 1, 1974.

4.4.2 Major Impact Factors

Incorporation of the emission control system requires many design changes to different areas of the automobile. These design and subsequent manufacturing changes are major factors in establishing the final lead time requirement for 1975 model year production development. The changes anticipated in 1975 American Motors cars involve the following components and subsystems:

a. A new cylinder head for the V-8 engine to reduce exhaust valve leakage, improve cooling capacity, and improve casting techniques.

b. Body and structural changes to accommodate the catalytic converter.

Tooling and equipment (involving new machines, welders, and assembly transfer stations) would have a major schedule impact if American Motors had to revise its engine installation process. Presently, the engine is installed from below after the body is completely assembled. If a catalytic converter system of another design required that the engine be installed from above, major changes in design and assembly would be necessary.

Experimental prototype testing is currently being conducted on the emission control system mounted in test-bed vehicles. To date, this program has not been successful in demonstrating to American Motors that the system can meet Federal emission standards for 50,000 miles. Catalytic converter configuration changes emanating from this program may have a serious impact on the design of the 1975 model year automobile as well as on the design of equipment and tooling.

4.4.3 Critical Lead Time Items

The critical path lies with vendor lead time requirements for catalytic converter production. (At the time of the EPA Suspension Request Hearings in April 1972, the critical path was associated with the requirement for new cylinder heads; this is still considered to be a serious timing factor.)

The anticipated changes required for or related to the American Motors 1975 emission control system, ranked in terms of critical lead time, are as follows:

Catalytic converter/new cylinder head for the V-8 engine
Body and structure changes to accommodate catalytic converter
New carburetor
New intake manifold
Breakerless ignition system

American Motors is carrying two different catalytic converter designs at this time, and may use different converters on different cars.

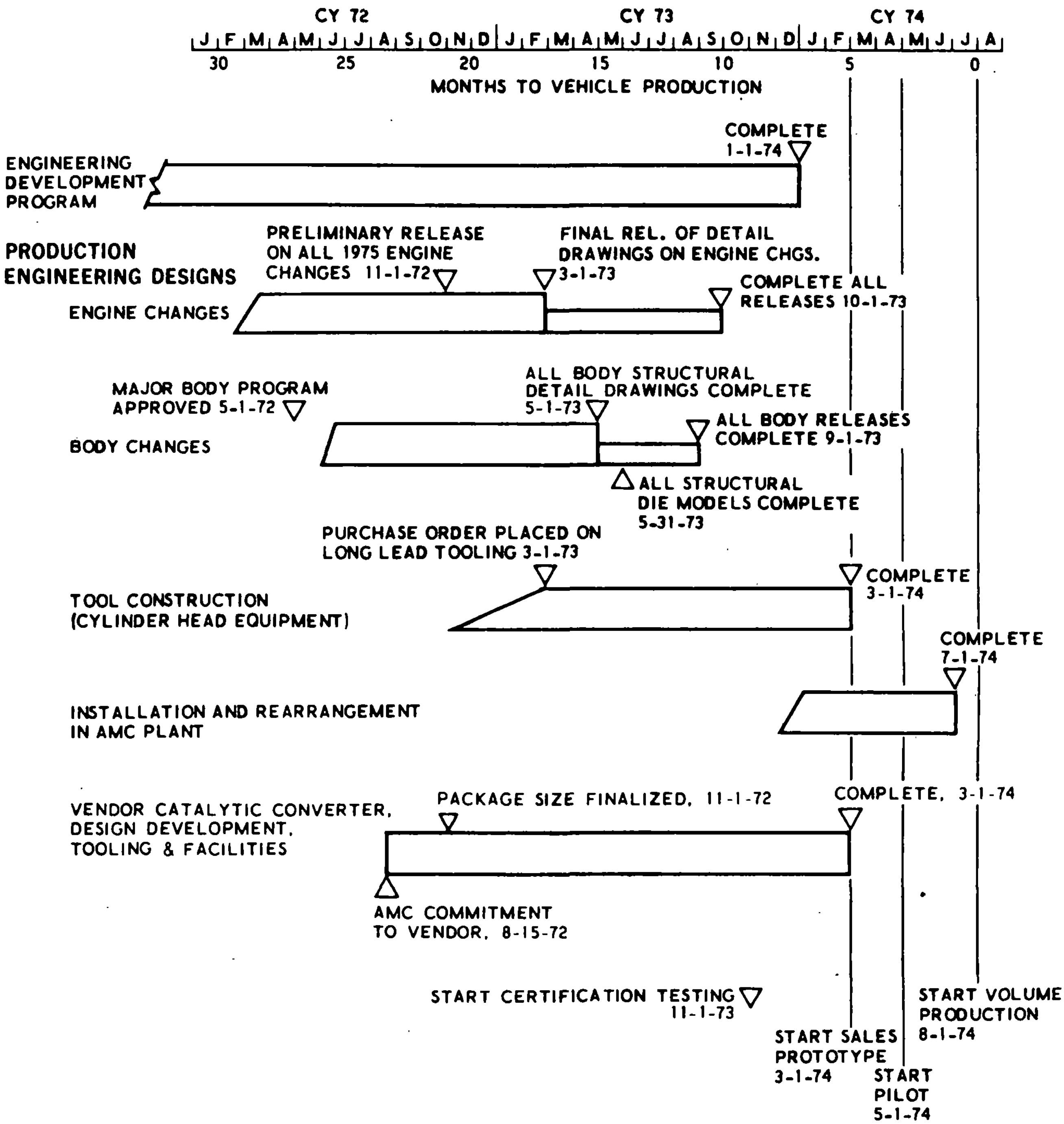


Figure 5. American Motors 1975 Emission Control Program Timing Study

4.4.4 Current and Pending Contractual Agreements

A verbal commitment to one catalytic converter supplier for a completely packaged device was made in August 1972. Neither the details of the arrangements nor the name of the supplier are available at this time. It is expected that the verbal agreement will be bolstered by a formal contract after design and delivery details are reviewed and agreed upon. Talks are continuing with potential suppliers and more than one contract may be released by American Motors.

From the timing chart shown in Figure 5, purchase orders were scheduled to be released in November 1972 for V-8 engine cylinder block castings from General Motors and for new machine, transfer, and assembly equipment for fabrication of new cylinder heads. Subsequently, release should be given for the purchase of carburetors. Purchase orders are also pending for other elements in the emission control system such as the ignition system and EGR valves.

5. LEAD TIME SCHEDULES FOR CATALYST AND SUBSTRATE MANUFACTURERS

As noted previously, all domestic first-choice 1975 emission control systems incorporate an oxidation catalyst. Therefore, a key element in 1975 model year production lead time requirements is the ability to mass produce the required catalysts in a timely manner. Industry's status with respect to this capability is discussed next.

5.1 CATALYST MANUFACTURER LEAD TIME SCHEDULES

A summary of the production lead time schedules currently proposed by representative oxidation catalyst manufacturers is shown in Figure 6. As can be seen, all schedules are structured to start full production for 1975 model year requirements in the April to July 1974 time period. Oxidation catalysts needed for preproduction stockpiling and/or vehicle emission certification testing, etc., would be provided from units produced

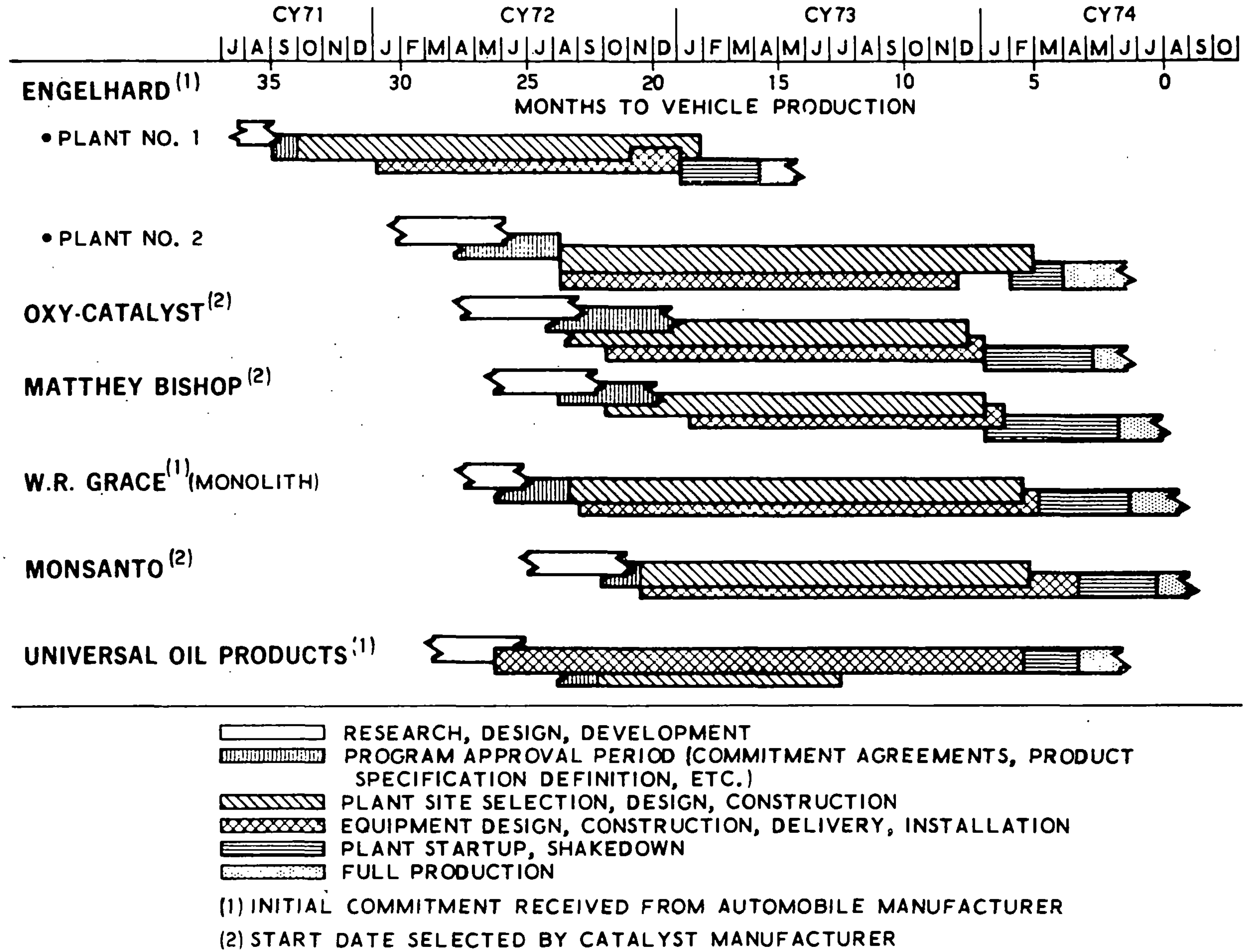


Figure 6. Production Lead Time Schedule for Catalyst Manufacturers

during the plant startup and shakedown period (January to July 1974) or from separate pilot and batch processing lines. Where it is necessary to use catalysts not produced with production manufacturing equipment and processes in certification test vehicles, the issue as to whether or not these catalysts are the same "in all material respects" as production units may arise. Due to the basic nature of the substrates and deposited catalytic materials, it may be difficult to verify that catalyst loading, uniformity of loading, and substrate physical characteristics are indeed representative of quantity production units.

As of the time of data acquisition (August to October 1972), there was considerable variability with regard to financial commitments made by the automobile companies and the amount of in-house funds being expended by the various catalyst manufacturers to retain a competitive position for potential 1975 catalyst requirements. In all cases, there was reasonable confidence that if contract negotiations pending with automobile manufacturers would shortly result in firm production orders, the schedules as shown could be met.

5.2 SUBSTRATE MANUFACTURER LEAD TIME SCHEDULES

Corresponding production lead time schedules currently proposed by representative substrate manufacturers are summarized in Figure 7. As was the case with catalyst lead time schedules (Figure 6), full production of substrates is planned for the April to July 1974 time period. Again, substrate units required for preproduction stockpiling and/or vehicle certification testing, etc., would be provided from units produced during the plant startup and shakedown period (January to July 1974) or from separate pilot and batch processing lines. Whether or not these proposed production schedules can or will in fact be implemented is of course dependent upon timely receipt of firm production contracts from the automobile manufacturers.

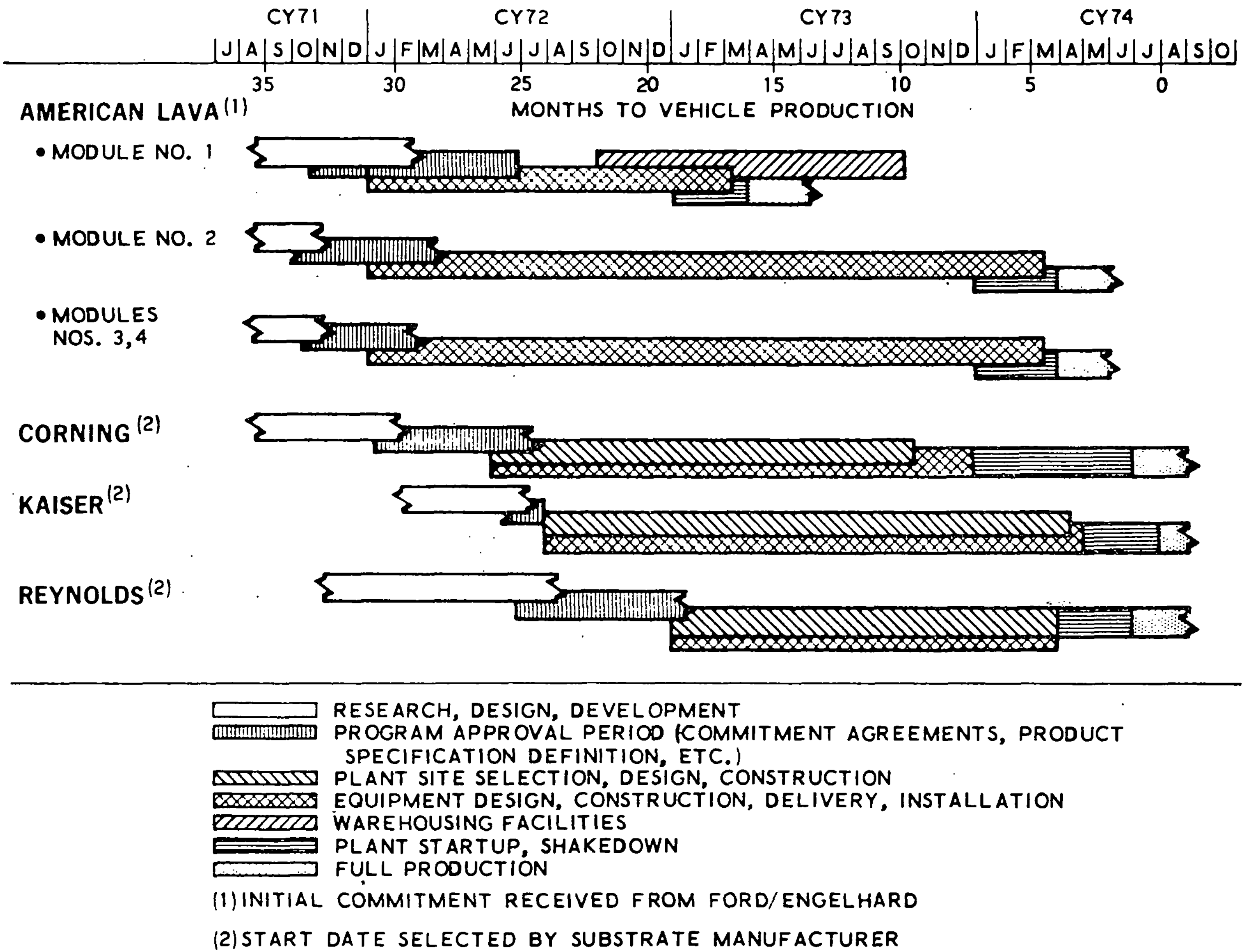


Figure 7. Production Lead Time Schedule for Substrate Manufacturers

5.3 MAJOR SCHEDULE IMPACT FACTORS

5.3.1 Plant Design and Construction

In every case, the critical or pacing item in the overall production lead time schedule is the time required for design of the production facilities, site selection, and construction of the facility or plant. Site selection and preliminary facility design activities, at a level sufficient to support the lead time schedules in Figures 6 and 7, have been or are underway. In some cases, these activities have been covered by contractual guarantees (e.g., Ford/Engelhard/American Lava agreements), while in other cases they have been supported by in-house company funds. Actual construction of the production facility will not be initiated by either the catalyst or substrate manufacturers until they receive a firm production order contract or similar financial guarantee.

5.3.2 Equipment and Materials Procurement

Raw materials for substrates and wash coats are considered available in either abundant or necessary quantities and do not materially impact the lead time schedule.

Platinum-group metals used as the catalytic agent are considered by the catalyst manufacturers to be available within the scheduled lead time for catalysts. The acquisition of these platinum-group metals is considered by most catalyst suppliers to be the province of the automobile manufacturers; they are currently negotiating with suppliers in South Africa and with the Soviet Union.

The necessary processing equipment and tools required for both substrate and catalyst manufacturing facilities are largely conventional in nature and do not represent limiting lead time items.

5.3.3 Plant Startup

Operation of either the substrate or catalyst manufacturing facilities is considered to be simple compared with the operation of a chemical or petro-chemical plant. Allowances of 2 to 6 months are included in the schedules of Figures 6 and 7.

5.3.4 Quality Control

In most cases, product specifications have not as yet been specifically delineated and definitive quality control measures have not been completely spelled out. Items of concern include porosity control, wash coat control, noble metal control, substrate breaking and chipping (monoliths), etc.

It is noted that the mass production of these types of catalysts has never been accomplished by any company; however, the catalyst firms believe that related production and quality control techniques (chemical and petro-chemical industries) provide a firm basis for assurance that quality control requirements will not adversely impact their proposed production lead time schedules.

5.3.5 Pilot Plants

All catalyst manufacturers contacted, except Grace, the Gulf Oil Company, and the Monsanto Company, have some form of pilot processing production plant in operation for purposes of manufacturing process optimization. Monsanto has made no decision on the use of a pilot plant, while Grace has decided that there is insufficient time to do so and still maintain its projected lead time schedule. Such pilot plants do not directly impact the lead time schedules as shown, but they do provide a means for providing quantities of catalyst units needed for preproduction inventory buildup and certification testing, etc., during the period prior to full operation of the completed catalyst production facilities. Where pilot plants are not available, such required quantities would have to be processed in batch production facilities.

In the case of substrate manufacturers (American Lava, Corning Glass Works, the Kaiser Aluminum and Chemical Corporation, and the Reynolds Metals Company), all have current pilot production capability.

5.3.6 Cost

Available estimates of capital cost requirements per individual supplier are in the range of $4 to $5 million for substrate production facilities and $4 to $15 million for catalyst production facilities, depending upon the selected production capacity. At these cost levels, the substrate and catalyst manufacturers will not commit venture capital without a firm production contract or other form of guarantee. It is this fact which presently strongly impacts the projected schedules of Figures 6 and 7, since the required production facility construction will not commence until such agreements are concluded.

5.4 SCHEDULE COMPRESSION POTENTIAL AND EFFECTS

With regard to the potential for compressing or shortening the production lead time schedules shown above, the substrate manufacturers have stated, in general, that no appreciable compression can be made at the present level of schedule definition (Figure 7).

In the finished catalyst area, there is some hope of minor schedule compressions, as follows:

a. Grace -- No schedule compression for monoliths; 3 to 6 months schedule reduction for pellet catalysts at a 10 to 15 cents per pound cost increase (due to premium pay and increased capital cost).

b. Matthey Bishop -- One to 2 months schedule compression for building construction with overtime work (at a negligible product cost increase).

c. Monsanto -- Some reduction in plant construction and equipment procurement time. The magnitude of schedule compression and related cost effects are not estimatable at this time.

d. Oxy-Catalyst -- Approximately 3 months schedule compression at a 10% cost increase due to overtime pay.

e. UOP -- One to 1-1/2 months reduction in facilities construction. The resulting cost penalty is not known.

5.5 CURRENT AND PENDING CONTRACT AGREEMENTS

At the time of this investigation (August to October 1972), the status of contractual agreements among the automobile manufacturers and the catalyst and substrate manufacturers was one of uncertainty and change because during this period apparently serious negotiations were underway among most of the major domestic automobile manufacturers and the various potential catalyst manufacturers. The status reported as of the time of visits made to the various companies involved was previously discussed in Sections 4.1.4, 4.2.4, 4.3.4, and 4.4.4 and is summarized in Table 1.

6. LEAD TIME SCHEDULES FOR AUTOMOBILE COMPONENT MANUFACTURERS

A large number of manufacturers normally supply "conventional" components to the automobile manufacturers. Their products include body stampings, frames, manual transmissions, carburetors, exhaust systems, wheels and brake parts, valves, window assemblies, metal trims, fans, ferrous castings, etc. Their lead time requirements, even for new component designs, are generally less than 20 months and therefore are well within the remaining time frame for 1975 model year production.

An exception could occur, however, if a given company were required to build a new facility for achieving a significantly higher output capacity. No evidence of this requirement has been indicated to date.

7. LEAD TIME SCHEDULES FOR PRODUCTION EQUIPMENT MANUFACTURERS

Various items of production equipment are essential to and inherent in modern automobile mass production facilities. Principal equipment items include automatic transfer lines (for automatic machining and assembly operations), cold stamping presses (for bodies and frames), and welders.

Although complex automatic transfer lines can require lead times (as high as 30 months) which are inconsistent with the remaining time frame for 1975 model year production, there is no evidence that such equipment, if required, was not ordered in a timely manner. Lead times for cold stamping presses and standard resistance welders (if required) imply they could be ordered in 1973 and be obtained in adequate time for 1975 model year production.

In the special case of electron beam welders planned for high volume production edge-welding of the General Motors pelletized catalytic converter container, Hamilton Standard is supplying six production welders to AC Spark Plug on a schedule consistent with meeting the General Motors 1975 production requirements.

8. NOBLE METAL PRODUCTION AND USAGE

Currently the Soviet Union is the world's largest producer of platinum-group metals. The Republic of South Africa is by far the most important manufacturer of platinum-group metals in the free world (the United States production amounts to less than 1% of the total world production). Since future platinum-group metal sales by the Soviet Union cannot be accurately predicted, it is likely that primarily South African platinum-group metals will be required to satisfy the projected needs of the automotive industry in the United States in the post-1974 time period.

Table 1. Current and Pending Contract Agreements--
Oxidation Catalysts and Substrates

Catalyst or Substrate Supplier \ Domestic Auto Company	General Motors	Ford	Chrysler	American Motors
Engelhard		~60% of 1975-requirements (up to 3.6 million units/year) Current commitment \$4.9 million Could increase to \$14 million by April 1974		
Grace	\$630,000 engineering commitment Bidding on 25% of 1975 requirements			
Matthey Bishop*		Negotiating for ~30% of 1975 requirement (~1.8 million units/year	Negotiating for 25% to 30% of 1975 requirement	
Monsanto	Bid on 1975 requirements			
Oxy-Catalyst	Negotiating			
UOP	Negotiating	Negotiating	Engineering commitment (facility design). Expect production contract for "substantial" part of 1975 requirements	
American Lava		\$300,000 capital guarantee (scale-up of facility for portion of 1975 requirements. Agreement for further scale-up in 1973; negotiating production orders.		
Reynolds	Bid on pellet requirements of potential catalyst suppliers (Davis, Oxy-Catalyst, Monsanto)			

*May also be asked to supply all of International Harvester requirements.

Preliminary information relative to the projected production of platinum-group metals indicates that the combined capacity of the South African mining firms may be adequate to supply automotive catalyst needs. However, these capacities can only be achieved if contracts are signed in the near future between the automobile manufacturers and the mining companies. Without such commitments, it is unlikely that the mining companies would proceed with their projected expansion programs because of the large capital investment required.

Accurate evaluation of the platinum-group metal supply and demand balance is currently very difficult to make, because several factors related to automotive catalysts are still unresolved. Preliminary analysis indicates that the platinum-group metal supply-demand balance is determined by a number of factors among which are: the platinum-group metal loading requirement of the automotive catalyst, the number of catalysts required on the various vehicle classes, the catalyst replacement interval, the mining industry capacity, and the degree of platinum-group metal recovery from spent catalysts. A thorough study of these parameters is urgently needed in order to provide all the data required for a complete and meaningful assessment of platinum-group metal availability and demand issues.

9. LEAD TIME SCHEDULE FOR A GOVERNMENT AUTOMOTIVE PROCUREMENT AGENCY

The lead times for procuring government military vehicles are considerably less than the production lead time associated with new model commercial passenger automobiles (e.g., 11 to 14 months for a jeep versus about 25 to 28 months for a new model year light-duty car).

The major influencing factors are the pre-existing development and tooling status at the time of procurement decision and the low production rate of government vehicles, one to two orders of magnitude less than passenger car rates. At this low rate, it apparently is not economical for a producer to make his own parts, so they are purchased from manufacturers who have equipment and facilities available, thus eliminating the time to set up parts production lines.

Other factors impacting shorter lead times include (a) tooling is available in some cases and furnished by the government to the producer, (b) the design may be known to the producer and he may have had production experience with it, (c) the government normally will not let a contract to a bidder who requires major equipment or facilities, and (d) the government establishes a slow buildup to the full production rate.

10. LEAD TIME SCHEDULES FOR NONAUTOMOTIVE INDUSTRY MANUFACTURERS

In general, nonautomotive production lead times are similar to automotive production lead times (24-28 months) only when a completely new product design or a change of major complexity is involved. For example, a new self-cleaning oven required a 24-month lead time, a completely new refrigerator design required a 30-month lead time, and an engine model year change for an outboard motor with a new mechanical starter required a 30-month lead time.

Normal model change lead times vary, of course, depending on the type and complexity of change being made. In the case of refrigerators, for example, the changes are usually related to styling only and the relative simplicity of design requires only about 6 months of lead time.

11. ASSESSMENT OF AUTOMOBILE MANUFACTURERS' PRODUCTION LEAD TIME

11.1 DEGREE OF INDUSTRY SCHEDULE CONSISTENCY

The overall production lead time schedules are summarized for the major domestic automobile manufacturers in Figure 8. As can be seen, all company schedules are in reasonable agreement with one another and with the historical model year lead time requirement for major changes of 24 to 28 months. Their consistency with one another is not surprising in view of the fact that all manufacturers were faced with the same critical lead

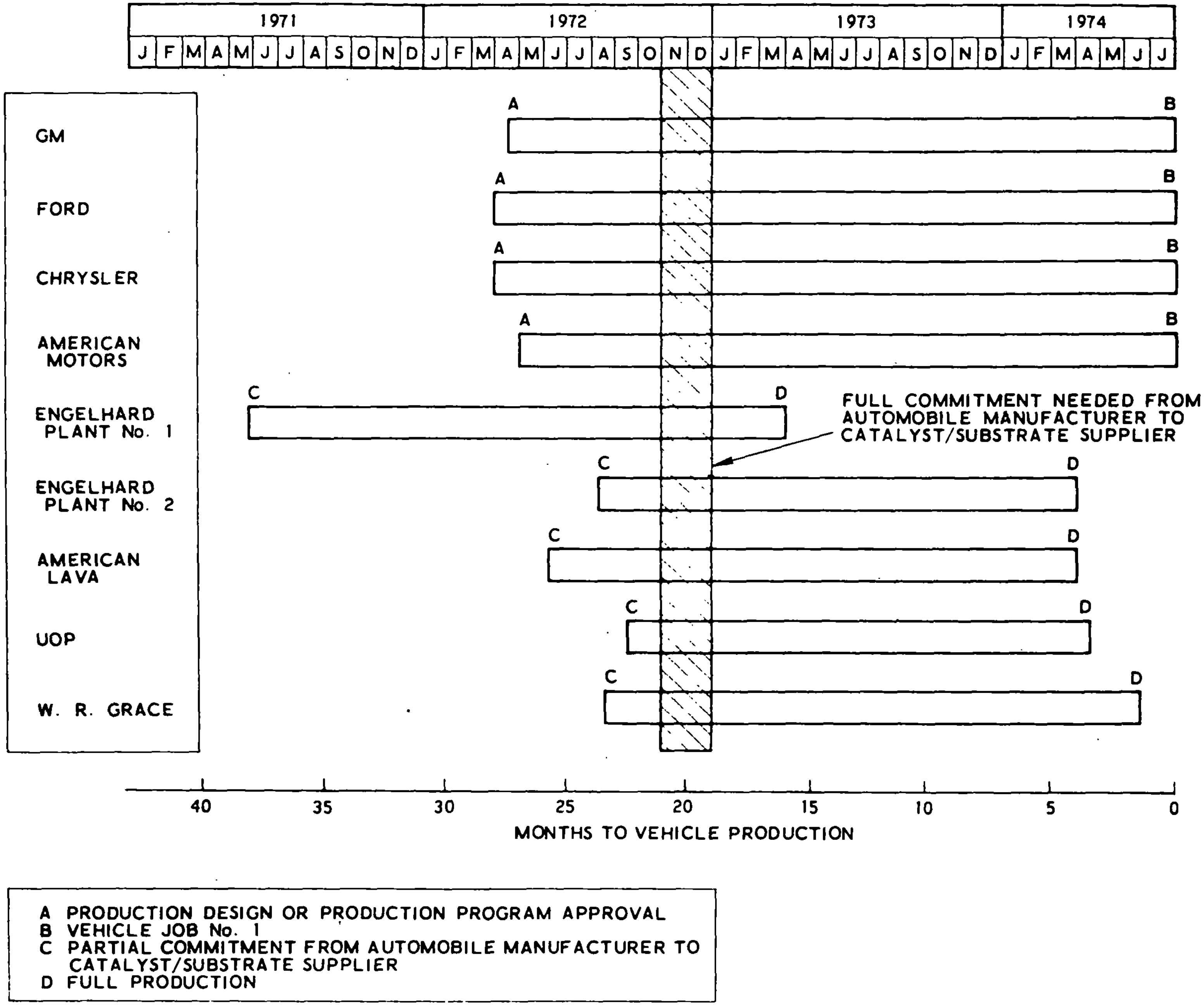


Figure 8. Overall Production Lead Time Schedules

time component, the catalytic converter, and were dealing with the same types of suppliers for catalysts and substrates. Their experience with historical production lead time precedents for major changes was undoubtedly the major factor which led to the Production Approval Milestone at the dates shown. Of course, all companies stress that their present schedules are optimistic and may not be met, for the reason that they were required to commit resources to a given unproven emission control system design in order to achieve full mass production of 1975 model year automobiles by August 1974.

Also shown in the figure are similar current production lead time schedules for representative substrate and catalyst manufacturers. Except for Engelhard, which had the benefit of early commitments by Ford, their schedules are also consistent with one another. Again, this consistency is really related to the time required to design and construct a production facility, and the same factors are influencing each individual schedule.

Finally, the catalyst, substrate, and automobile manufacturers' overall lead time schedules are consistent when compared with each other. This consistency prevails because the automobile manufacturers' schedules are, in turn, based on the catalyst manufacturers' schedules as shown.

11.2 POTENTIAL FOR INDUSTRY SCHEDULE COMPRESSION

A reduction in the normal scheduled time for a complete automobile development cycle is possible through three approaches: . increase the degree of overlap between various phases in engineering development and manufacturing development, extend the use of overtime on a given work shift, or increase the number of work shifts to a maximum of three per day. However, the greater the amount of scheduled phase overlaps, the greater the chance for making costly errors through premature decisions. Generally a 10% to 15% compression is considered to be the maximum feasible with acceptable increase in unit cost. Any additional compression is bought at excessively large cost increases and at some point no further compression is possible even with costs discounted as a judgment factor. The skilled labor market cannot suddenly be increased to meet a multitude of orders.

Schedule compression is primarily in evidence for only one area--the production of oxidation catalysts. The pacing item is the construction of new facilities; this is where the 10% to 15% schedule compression could be obtained. Equipment requirements for these facilities are generally of a standardized design not requiring long lead times.

11.3 INDUSTRY CAPACITY TO MEET HIGH PRODUCTION VOLUME

The impact of raw material reserves and production capability is noted in the manufacture of catalytic converters. Alumina for the substrate and wash coat is in plentiful supply, but the supply of platinum-group metals for the catalyst is an issue that is not completely settled at this time. It appears that the production capacity of the South African mining companies can be sufficiently increased, providing that they sign contracts in the near future with the automobile manufacturers.

There are three forms of processed materials that pose a problem for industry capability. First, there is the production capacity needed to form catalyst substrates and apply the wash coat and catalyst material. Second, there is the production capability for rolled stainless steel for use in catalytic converter canisters, exhaust systems, and thermal reactor liners, etc. Third, there is the capability of foundries to produce sufficient numbers of castings for full-size thermal reactors, if they were to be eventually used.

As of the time of data acquisition (August to October 1972), there was a noted variability in schedule status for the different catalyst and substrate manufacturers. This variability was a result of both the status of financial commitments made by the automobile companies and the amount of funds expended by catalyst and substrate manufacturers themselves in order to be able to compete for potential 1975/76 catalyst requirements. In all cases, there was reasonable confidence on the part of substrate and catalyst manufacturers that if contract negotiations pending with automobile manufacturers resulted in firm production orders in the November to December 1972 time period, the currently projected schedules for quantity production of oxidation catalysts could be met.

In contrast, the automobile manufacturers have expressed some doubt concerning the ability of the substrate and catalyst manufacturers to meet production demands. Much of this doubt centers on the fact that catalysts of the automotive type have never been mass produced in the quantities required by the automobile industry.

With regard to stainless steel capacity, it appears that raw material availability is not a problem. However, material processing capacity is a problem but it can be resolved by the timely ordering of additional equipment needed. The fact that the automotive firms have not definitely decided on the type of stainless steel required is a problem that will become more significant as the end of 1972 approaches. Commitments must be made in the November to December 1972 period by the automotive firms if 1975 model year requirements for stainless steel are to be met.

Casting capacity for the simpler, partial thermal reactor currently programmed for use in 1975 model year vehicles is presently adequately accounted for in 1975 model year production schedules. Casting capacity requirements for the larger and more complex full-size thermal reactors have not been well defined because this system has not been pursued as a first-choice approach and is not completely developed. Therefore, long lead time production equipment has not been ordered. Ford states that the time is now past the critical point for them to order arc and holding furnaces required to manufacture full-size thermal reactors for the 1975 model year. The foundry industry (exclusive of automobile company foundries) indicates that if additional foundry capacity on its part is required, 36 months are needed to achieve full production volume.

Fabricated products have posed some problems, but it appears that these will be resolved. Fabrication of the catalytic converter container and assembly of the unit should be handled adequately by a division of work among the automobile manufacturers, the catalyst manufacturers, and independent firms such as Arvin Industries and Walker which have long experience in the fabrication of exhaust systems.

No evidence of problems in the production capacity for traditional components has appeared, although new fabrication and assembly processes may be required if double-wall exhaust pipes become necessary.

11.4 TECHNOLOGICAL IMPLICATIONS OF ALTERNATIVE PLANS

Were Federal regulations to be relaxed, a number of alternative plans could be considered by the automobile manufacturers in lieu of meeting the Federal emission standards with 1975 model year automobiles in full production by August 1, 1974. Consideration of these other plans, of course, depends upon judgments leading to decisions that would have to be made by the Federal government.

If the Federal government were to grant a 1-year extension to automobile manufacturers for meeting the 1975 emission standards, the risk of introducing unproven designs for the emission control system would be reduced. Prototype testing could be continued for a longer period to allow for development of higher performance and more reliable designs, and the overlap between these tests and the manufacturing design phases could be lessened to reduce the risk of making design decisions based on preliminary information. The impact on the rest of the industry, of course, would be a deferment in the purchase of equipment, tooling, components, and raw materials. Most affected would be the catalyst industry, which is just starting to implement facilities for the mass production of substrates, catalysts, and container fabrication and packaging.

Furthermore, were a one-year suspension to be granted, the Federal government must issue a set of interim standards for exhaust emissions. If these standards could be met by the catalytic converter systems presently developed or under development (either by virtue of raising the emission standards levels or by revising the replacement intervals for converters, etc.), then the impact on the industry noted above could be averted.

Alternatively, the use of full-size thermal reactors is not considered a viable option for 1975 model year automobiles, even if interim emission standards could be met by them. This is because the automobile companies have not been developing the thermal reactor as a first-choice system and have not, therefore, proceeded to order the necessary long lead time production equipment, as they have been doing for catalytic converter systems.

Less effective partial thermal reactors, smaller in volume and less complex than full-size thermal reactors, are currently programmed for use in 1975 emission control systems. These could be used without catalytic converters but the resulting emission reduction capability is at present not well defined and could vary among the different automobile manufacturers, according to individual design details. Some partial thermal reactors resemble a slightly oversize standard exhaust manifold while others resemble the full-size reactor in outward appearance, while having a volume approximately 2/3 less. At present such partial reactors are designed primarily to oxidize HC and CO during the cold start period and to aid in warming up the catalytic converter.

If the interim standards would simply permit the continued production and sales of 1974 model year type automobiles for another production year, the manufacturers would have to be apprised of this situation prior to January 1, 1974. There still would be a lead time consideration with the extended production of the 1974 model year, since orders must be placed in advance of August 1974 production in order to continue supplies of raw materials and components and to replace worn out tooling. Practically speaking, however, the automobile manufacturers require a decision of this nature which is consistent with catalyst final commitment date requirements in order to avoid premature or unnecessary expenditures.

Without a 1-year suspension of the emission standards, the automobile manufacturers might consider continuing the production of 1974 model year cars throughout calendar year 1974, subject to approval by the Federal government. This would provide more development and certification test time for the 1975 emission control system. From a competitive marketing standpoint, of course, this action might create a reduction in sales for those manufacturers requiring the longest delay in the eventual introduction of 1975 model year cars.

11.5 PROGNOSIS FOR 1975/76 LEAD TIME REQUIREMENTS

At present, all major domestic automobile manufacturers are proceeding on a high risk basis with the necessary steps to ensure that the 1975 model year cars will be in full mass production by August 1974. Orders have been placed for long lead time equipment for all well-defined car systems; component orders will follow shortly.

Design efforts are still in progress on components and systems not fully defined. These relate to the catalytic converter and its impact on other areas of the vehicle such as the floor pan and dashboard. Decisions have been delayed in order to take full advantage of data from the research prototype test car programs. These tests are expected to continue into 1973 since the automobile manufacturers maintain they have not been able to find a case of an emission control system that meets government regulations. With regard to catalytic converters, some automobile manufacturers must still decide on pellet versus monolithic substrates and promoted base metal versus platinum-group metal catalysts.

The delays in final design decisions have also led to delays in commitments to critical suppliers. Some limited commitments have been made to catalyst firms. These commitments cover only engineering and design for new or expanded facilities. Except for the Ford contract with Engelhard, no full commitments have been made that would entail actual construction and ordering of equipment. Based on the lead time schedule projections made by catalyst and substrate manufacturers in the August to October 1972 time period, quantity production of oxidation catalysts for 1975 model year automobiles is possible if production order commitments or other acceptable venture capital guarantee arrangements were made by the automobile manufacturers in the November to December 1972 period.

Current schedules have been compressed slightly from those previously cited by the automobile manufacturers. Additional compression is unlikely except for a few isolated cases and, in general, would represent cost increases to the end product. In general, all the automobile manufacturers show good schedule consistency when compared with each other and when compared with their suppliers, particularly those companies supplying catalysts and catalyst substrates.

While staged commitments have proven successful in providing for initial work efforts, the time is at hand for making full commitments to all critical suppliers. These include catalyst and catalyst substrate manufacturers, stainless steel manufacturers, and producer/refiners of platinum-group metals. Sometime in the period of November to December 1972 the automobile manufacturers will have to conclude such arrangements in order to meet the lead time requirements for 1975 model year cars that incorporate the latest emission control system designs.

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16. ABSTRACT

A survey and analysis of the factors involved in bringing automobiles into the market place with emphasis on production engineering, prototype testing and tooling for production of the automobile and the oxidizing catalyst.

17. KEY WORDS AND DOCUMENT ANALYSIS

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