

Analysis of Technical Issues Relating to:

California's Request for Waiver of
Federal Preemption with Respect to
Exhaust Emission Standards for 1979 and
Subsequent Model Year Heavy Duty Vehicles

Emission Control Technology Division

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Introduction

This document provides technical information and analysis in support of the decision regarding California's request for a waiver of Federal preemption with respect to exhaust emission standards for 1979 and subsequent model year heavy duty vehicles. Three technical issues discussed and analyzed are: (1) stringency of standards, (2) availability of technology and lead time available for implementation, and (3) cost of compliance. Assuming there are no legal problems involved, EPA is required to grant the waiver unless it finds that the California standards are equal to or less stringent than Federal standards, that insufficient lead time is available for compliance, or that costs of compliance are excessively high.

References to the transcript, "Public Hearing on California's Request for Waiver of Federal Preemption with Respect to Emission Standards and Test Procedures for 1979 and Subsequent Model Year Heavy Duty Motor Vehicles and Application of SHED Evaporative Test Procedures for 1978 and Subsequent Model Year Motor Vehicles" are recorded throughout this document as [TR at (page)] meaning transcript at the page being referenced.

Conclusions

As a result of the analysis that follows, the EPA technical staff concludes:

1. The California standards are more stringent than applicable Federal standards.

2. There are three separate conclusions regarding lead time.

(i) There is not sufficient lead time remaining to permit mandatory certification under the new test procedures included in California's 1979 regulation.

(ii) Technology is generally available for compliance with California's 1980 standards and sufficient lead time remains for application of that technology to heavy duty engines. There is some risk that fuel efficient technology cannot be applied to some gasoline engines used in high weight vehicles. However, several manufacturers were reasonably optimistic regarding their ability to overcome potential problems within the available lead time.

(iii) Technology which can readily be applied to heavy duty engines for compliance with California's 1983 standards is not currently available; however, it cannot be established that acceptable technology cannot be developed within the available lead time.

3. No arguments have been presented indicating costs of compliance are excessive.

Stringency of Standards

EPA technical staff conclude and the record of the hearing supports that the standards for which a waiver has been requested (see table 1)

duty engines (40 g/BHP-hr of CO, 16 g/BHP-hr of HC +NOx).

Table 1

Proposed California Standards for
Heavy Duty Engines

<u>Model Year</u>	<u>HC*</u> (g/BHP-hr)	<u>CO</u> (g/BHP-hr)	<u>NOx</u> (g/BHP-hr)	<u>HC + NOx*</u> (g/BHP-hr)
1979	1.5	25	7.5	
or		25	-	5
1980 -	1.0	25	-	6.0
1982				
or		25	-	5
1983	.5	25	-	4.5

* HC standard based upon measurement using a heated flame ionization detector.

No evidence was presented at the public hearing indicating that the proposed California standards are not more stringent than current Federal standards. The only discussions pertaining to relative stringency were: comments made by the CARB representative arguing that their proposed standards for 1979 were more stringent than proposed Federal standards for 1979 (see TR at 12); and comments made by General Motors claiming that California's standards for 1979 were more stringent than California's standard for 1978 (see TR at 86-87).

The point regarding relative stringency between the 1979 CARB standards and proposed Federal standards for 1979 is not pertinent to the waiver decision since the Federal standards have not been adopted.

When such standards are adopted, EPA will have to consider the relative stringency of California standards and decide if it will be necessary for the new Federal standards to preempt any existing California standards for which a waiver has been granted.

The comments made by General Motors are relevant to the waiver decision only to the extent that they reinforce the point that the proposed California standards for 1979 are indeed more stringent than current Federal standards. This is the case since EPA has already granted a Waiver for California's 1978 standards as they were determined to be more stringent than current Federal standards, and since General Motors has claimed that California has made their standards for 1979 even more stringent.

Lead Time

Lead Time Available for Compliance with the 1979 Standard: With regard to the 1979 California standards and accompanying test procedures, various manufacturers stated that they would have a lead time problem in meeting the 1979 model year California test requirements associated with instrumentation acquisition, set-up, and check-out. In response to lead time concerns, the CARB indicated that it had adopted the October 5, 1976 heavy duty vehicle regulation in order to be consistent with the proposed corresponding Federal test requirements [TR at 191], and that it had only acted in this matter in order to achieve a mutually acceptable

transition to these anticipated Federal test requirements. In adopting these regulations, the CARB indicated that it had relied to some extent on EPA's judgment with respect to the requisite amount of lead time [TR at 31]. The CARB indicated it would defer implementation of the new test procedure until such time as they also became effective Federally [TR at 14, 22, 32]. In the event that Federal regulations were subsequently promulgated which permitted a manufacturer to certify under the present Federal test procedures for the 1979 model year, the CARB indicated it would adopt a similar approach [TR at 32-33].

Several manufacturers indicated that it may be possible to comply with the new test procedures in 1979, if the final Federal test procedures are published and if subsequent revisions expected by California are completed in the Spring of 1977 [TR at 44, 67-68, 90, 119-120, 184-185]. However, there were other situations in which some manufacturers indicated it would not be possible to implement the new procedures by 1979 even if the procedures were immediately finalized. General Motors stated that the changes in the California heavy duty test procedures would require extensive revisions to the existing diesel test facilities in addition to the procurement of new instrumentation, and thus, it would not be able to meet the 1979 model year test requirements [TR at 89-90]. While Ford indicated it could acquire the necessary instrumentation in time for two test cells, enough to certify California engines for 1979, [TR at 161, 185], it devoted a considerable portion of its testimony addressing the need for clarification and correction of the new test procedures before they could be implemented [TR at 163-165, 170-178].

The analysis performed within EPA in support of its own decisions regarding implementation of the new test procedures at the Federal level for the 1979 model year resulted in the conclusion that the procedure could not be implemented on a mandatory basis for 1979. It was concluded that some manufacturers could comply given an early definition of final procedures, but not all manufacturers could be expected to be able to comply [see the lead time analysis issue in DRAFT - "Summary and Analysis of Comments to the NPRM: Revised Heavy Duty Engine Regulations for 1979 and Later Model Years", dated March 4, 1977].

Except for the instrumentation and test procedures issue, the record clearly indicates that emission control technology is available for compliance with the 1979 standard [TR at 165, 205].

Considering both the testimony presented at the hearings and the analysis that EPA has performed independently in support of its own proposed 1979 regulations, it is concluded that there is not sufficient lead time for compliance with California's 1979 standard. This leaves EPA with basically two options regarding the granting of a waiver for 1979:

(1) deny the waiver, in which case the California 1978 standards would carry over through 1979; or

(2) grant the waiver on the basis that the standards and test procedures be implemented only on an option basis, leaving the manufacturer the option of certifying under the 1978 standards.

The second alternative is recommended as it would be most consistent with the approach which has been recommended at the Federal level [see draft final regulations package for heavy duty vehicles, dated March 4, 1977].

Lead Time Available for Compliance with the 1980-82 Standards: With regard to the 1980-1982 California heavy duty standards and test procedures, the lead time issues focus upon technology availability rather than test procedures. The record generally indicates that the new procedures can be implemented for 1980 and this is supported by the analysis performed independently within EPA regarding its own proposed standards.

Chrysler, Ford and General Motors all indicated, with qualifications, that the 1980 standards were technologically feasible. Ford indicated:

"As stated during the October 5, 1976 CARB public hearing, Ford anticipates that the proposed standards for '80-'82 could result in fuel economy penalties of about 5-10 percent over the '77 California levels, mainly because of the lower hydrocarbon and NOx standards which will require more EGR flow and less spark advance. Of course, some of this fuel economy loss could be recovered with application of catalysts on all of Fords' heavy duty engines, but Ford lacks data at present to quantify the overall fuel economy effects, if such catalyst systems were used.

"Ford does not currently have final and proven design assumptions for the emission control systems needed to meet the '80 and '83 standards. However, Ford does have sufficient experience with light truck catalyst technology to provide reasonable assurance that such systems can be employed to meet the proposed California standards. Our experience with catalysts on the larger trucks is so limited that Ford is not able to quantify the technical problems that must be resolved for these vehicles. Thus, the key issues as far as Ford is concerned, are in the areas of lead time, procedural clarification, and consistency."

[TR at 165].

In clarifying Ford's statements regarding lead time for 1980 the following discussion took place:

MR. JACKSON (EPA): "So there is no question of technology?"

MR. MAUGH (FORD): "Not for 1980."

MR GRAY (EPA): "To follow up on that, you did make some qualification regarding possible use of catalysts to minimize fuel economy penalties. Do you have any judgement as to what percent of the Ford heavy duty engines would require catalyst packages at this point?"

MR. MAUGH (Ford): "We do not. We have as you know, two heavy duty engine families that were certified in '77 with catalysts, but those were light duty trucks - not heavy duty trucks. In other words they were under 10,000 GVW trucks. We have no experience with catalysts on the high GVW trucks and certainly there have been a number of problems raised today by other manufacturers with respect to catalyst application on that type of vehicle.

"We don't have enough experience at this point in time to even indicate that we have defined those problems. On the other hand, we also don't have the basis on which to project that we can't resolve them when we do find them. So we can't make any statement with respect to our ability or inability in that particular area."
[TR at 195-196]

Chrysler indicated that:

"The proposed 1980-82 standards will require the addition of catalysts to the system and, of course, require the use of unleaded fuel. Additional exhaust gas recirculation and spark control to meet the hydrocarbon and NOx standard will result in approximately a 10 percent fuel economy penalty. The cost of the systems will increase approximately \$150. The only real question marks at this time involve durability, but those problems should be solved by 1980." [TR at 205]

Further questioning illustrated that Chrysler's projected fuel economy penalties may be pessimistic:

MR GRAY (EPA): "With regard to the 1980 levels, you mentioned that in addition to a catalyst, those engines probably would also require EGR and spark control to meet the HC + NOx standards. And you are projecting a 10 percent fuel economy penalty.

"Do you feel that once you add the catalyst over the '77 certified vehicles, that supposedly . . . have some spark retard, I guess, that you won't be able to recover some of that penalty and maybe end up with a net change of perhaps not that great for the penalty?"

MR. WAGNER: "That's possible of course, but this is our best estimate at this time." [TR at 206-207]

General Motors stated that the requisite technology was not available to most effectively meet the hydrocarbon standard in effect in the optional set of standards for model years 1980-1982 in its full product line, [TR at 91], but did indicate that it could meet an emission standard slightly less stringent than the 1980-1982 standard one year earlier than the effective date of these standards [TR at 85]. Furthermore, General Motors stated that its heavy duty gasoline engines for vehicles with a gross vehicle weight rating (GVWR) of less than 18,000 pounds could meet the 1980 standards through application of catalyst technology developed for light duty trucks [TR at 93, 102]. It was pointed out that these vehicles represented 70% of General Motors' heavy duty product line above 8500 pounds GVWR [TR at 102]. On the other hand, General Motors contended that the requisite catalyst technology was not presently available to permit the remaining 30% of its gasoline-powered heavy duty product line to meet the 1980-1982 California standards [TR at 102], but still had not definitely concluded that it could not meet these standards with a non-catalyst emission control system [TR at 105]. They indicated that this 30 percent of its product line would require the use of a catalyst emission control system in order to meet the 1980-1982 California standards, and that its concerns with the use of such a system lie in the area of customer satisfaction criteria and durability [TR 106-108]. With respect to its diesel-powered heavy duty engines and vehicles, General Motors stated that these vehicles and engines could meet the

1980 standards with a four percent increase in fuel consumption and an increase in exhaust smoke. [TR at 96, 132, 135]. The increase in exhaust smoke would not hinder these vehicles and engines in meeting the Federal smoke standard [TR at 125].

International Harvester was the only manufacturer that indicated that requisite technology was not presently available to meet the 1980-1982 California standards:

"In summary, IH is convinced that California's proposed 1980-1982 standards will require the use of converters on gasoline engines. Lead time is not sufficient to design and test acceptable conclusion converter equipped exhaust systems. To allow for the necessary development and lead time for application of converters to engines used in heavy duty service, we request that the standards be established no earlier than for the 1983 model year." [TR at 48-49].

International Harvester did indicate that the standards could be met without a converter at a significant fuel penalty (34%) and that they consider that basically to be a non-option [TR at 55, 65]. However, it was indicated that it was not impossible that International Harvester would market a non-catalyst engine in 1980 [TR at 55]. Also, if the waiver was granted, they could concentrate efforts on some underdetermined, but restricted product line and probably perfect a catalyst system for use in that line by 1980 [TR at 70-75]. International Harvester indicated at present it was not selling a diesel engine in California as their engine had failed to meet the 1977 certification. However, they could not project what the situation would be in 1980 [TR at 68].

While no diesel manufacturers (i.e., manufacturers of diesels only - General Motors and International Harvester produce diesel and gasoline engines) testified at the hearing, the CARB presented information in its statement indicating that Cummins had expressed confidence in having its engines meet the 1980 standards, and Caterpillar had already certified six 1977 engine models to the level of the 1980-1982 California standards [TR at 16, 34].

Considering the above information, it is concluded that there is not sufficient reason to deny the waiver requested for 1980 based upon lead time considerations.

Lead Time Available for Compliance with the 1983 Standards: With regard to the 1983 California standards, very limited information pertaining to available technology and lead time for implementation was presented at the hearings.

In its statement regarding the 1983 standards, the CARB testified that of the 1977 model year engines certified in California:

". . . seven gasoline and 12 diesel [engines], manufactured by eight heavy duty engine manufacturers which in 1977 certified at or below California's 1983 hydrocarbon standard of .5 grams per brake-horsepower hour. The change in HC instrumentation may affect the certification levels of some of the gasoline models. Of these 19 engine models, 10 also met the 1980 California standard of 6 grams brakehorsepower hour for HC + NOx combined. In fact, two of these engines -- one gasoline and one diesel -- met the 1983 standards of 0.5/25/4.5.

"We do not mean to imply that just because the 1983 California standards have been met by two 1977 models, the technology is currently available to make all heavy duty engines achieve these levels. We do believe, however, that the fact that technology exists to allow some heavy duty engines to achieve the 1983 standards today, combined with the six year lead time available to heavy duty manufacturers, satisfies the requirements of Section 202(a) of the Clean Air Act as interpreted above by the Administrator." [TR at 18-19].

The testimony by Ford regarding the ability to comply with the 1983 standards is best summarized by the following interchange:

MR. JACKSON (EPA): "So for 1983, technology is available?"

MR. MAUGH (Ford): "We can't say that we have the technology to meet those standards in practice. On the other hand, we believe that the technology that we have today will meet those standards, and that the problems we encounter will be resolved, but we have no basis to do that other than judgement. It is a judgemental position."

Chrysler was cautiously optimistic regarding its ability to develop technology for the 1983 model year:

MR. GRAY (EPA): "Regarding the '83 standards, is it your best estimate then that there is lead time remaining; that it is reasonable to expect that technology might come along although you haven't seen the technology demonstrated this date?"

MR. WAGNER (Chrysler): "Well, that's six years from now and certainly we would expect that there would be time for any number of advances in technology. I think it has to be recognized that we are in the realm of speculation, however. I think we have proven in the past that we have been able to perform a number of miracles in six years." [TR at 207]

and;

MR. JACKSON (EPA): "And the assumption for '83 is that technology appears to be there but there is some speculation - I think you

said - with regard to the exact outcome of the application of that technology."

MR. WAGNER (Chrysler): "That is a hard one, Ben. We say that technology exists. You usually like to have some test behind you; at least on some equipment that says that you are going to make it before you can say that technology actually exists. We are all working with three-way catalysts, electronic controls and electronic fuel metering. They all have possibilities. We have yet to generate test results that indicate that we really have a functional system. Will we be able to do that in six years? I am fairly optimistic." [TR at 208-209]

Likewise, General Motors exhibited a qualified optimism regarding the 1983 standards:

"Our gasoline and diesel engines will be able after additional development, to comply with the 1983 hydrocarbon standard, but we presently project a catalyst change as necessary.

"Engine studies performed to date have failed to demonstrate ability to comply with the 4.5 HC + NOx standard. It appears some new, and yet untried system will be required to achieve compliance.

"Our experience to date has shown an increasing fuel economy penalty as we bring our gasoline engines below 6 grams NOx, and that the fuel economy benefits from the addition of the catalytic converter for hydrocarbon control, will be small, because at very low NOx levels, we find the Brake Specific Fuel Consumption to be almost totally dependent on the NOx level achieved.

"We presently have inhouse, an outside contracted diesel research and development programs which are and have been targeted at compliance with a five gram HC + NOx standard level. And that five gram target has been on the existing instrumentation so that the hydrocarbon component is at the lesser level. It may be necessary to derate diesel engines in order to achieve a 4.5 gram per horsepower hour standard.

"In summary of our position with respect to 1983 and subsequent year standards, General Motors does not have, at this time, the technology required to comply with the 1983 California standards. Neither can we predict when technology will be available to allow compliance." [TR at 98,99].

However, General Motors did indicate it thought it would be able to sell trucks in California in 1983, although they may have to have derated engines:

MR. JACKSON (EPA): "Aside from the availability of the Detroit diesels to qualify, do you still believe that you will be able to sell trucks in California in 1983 -- heavy duty trucks?"

MR. HANLEY (GM): "Yes. They may have derated engines."

MR. JACKSON: "Which engines are you talking about?"

MR. HANLEY: "Both gasoline and diesel. If we can't meet it with a fully rated engine, then the alternative is to begin to compromise the power of the engine."

MR. JACKSON: "And that is Detroit diesel engines?"

MR. HANLEY: "And gasoline engines."

MR. HANSON (GM): "They wouldn't be derated; they would have other compromises made. Possibly more in the fuel consumption and driveability areas." [TR at 148]

International Harvester was the only manufacturer to be completely pessimistic regarding the 1983 standards, stating that:

"The 1983 proposed standards of 0.5 hydrocarbon and 4.5 HC + NOx combined do not appear technologically feasible at this time. . ."
[TR at 49].

Based upon the above information, it is concluded that technology which can be readily applied to heavy duty engines is not currently available. However, the chances of extending light duty vehicle technology or of developing new technology appear to be feasible within the remaining lead time.

Cost of Compliance

Very little specific information was provided at the hearing regarding the cost of compliance. The cost estimates varied over a wide range reflecting the unknowns regarding the final control system types that would be employed and reflecting the unresolved trade-off decisions regarding initial control system cost versus fuel economy.

The estimates provided by Ford were based upon the assumption that catalyst technology will be used on gasoline engines. Ford's estimate of the incremental cost of a catalyst system beyond the cost of current (1977 through 1979) California systems was \$130 to \$300. [TR at 197]. The applicability of these costs to the various levels of standards was clarified by the following discussion:

MR. JACKSON (EPA): "So what it really comes down to is that on one end of it you would say that the cost of meeting the 1983 standards may not be greater than meeting the 1980 standards?"

MR. MAUGH (Ford): "No. I think that we would project that we will be able to meet the 1980 standards on many of our engines without catalysts and on none of them in 1983, so that 1983 clearly will cost substantially more than 1980 on an average truck basis." [TR at 198].

Ford also anticipated that the 1980-82 standards could result in fuel economy penalties of about five to ten percent over 1977 California levels, but indicated some undetermined amount of fuel economy loss could be recovered with the use of catalyst emission control systems [TR at 166].

Chrysler estimated that control systems required to meet the 1980 standards would increase vehicle costs by approximately \$150 and would result in approximately a 10 percent fuel economy penalty [TR at 205]. Chrysler further indicated that another \$200 in control system costs and an increase in fuel penalties to as high as 25 percent could result if electronic timing and fuel controls with three-way catalysts are required to meet the 1983 standards [TR at 206]. However, Chrysler's uncertainty regarding the magnitude of fuel penalties which may occur was reflected by the following discussion:

MR. GRAY (EPA): "With regard to the 1980 levels, you mentioned that in addition to a catalyst, those engines probably would also require EGR and spark control to meet the HC + NOx standard. And you are projecting a 10 percent fuel economy penalty.

"Do you feel that once you add the catalyst over the '77 certified vehicles, that supposedly have had to already help, have some spark retard. . . that you won't be able to recover some of that penalty and maybe end up with a net change of perhaps not that great for the penalty?"

MR. WAGNER (Chrysler): "That's possible of course, but this is our best estimate at this time."

General Motors stated that the cost associated with meeting the 1980-82 standards would not exceed 500 dollars [TR at 134]. Mr. Hanley from General Motors offered the following as his reason for not being prepared to discuss cost impact in detail:

"We did not address cost in our statement because we don't have firm hardware on which to estimate and because we did not see that viable arguments could be made from a cost benefit analysis that would influence the decision on the waiver." [TR at 133].

With regard to fuel penalties, General Motors estimated that a 10 percent penalty could occur under the 1980-82 standards if catalysts cannot be used [TR at 129, 130], and that a 15 to 20 percent penalty was expected under the 1983 standards [TR at 138].

International Harvester estimated cost increases for 1980-82 vehicles to be \$395 to \$490 per truck [TR at 48]. No estimate was given for control systems required for 1983 as International Harvester claimed those standards are not technologically feasible at this time [TR at 49].

The cost estimates made by CARB were included in its staff report, number 76-20-2, "Public Hearing on Proposed Changes to Regulations Regarding Exhaust Emission Standards and Test Procedures for 1979 and Subsequent Model Heavy Duty Engines," dated October 5, 1976. For gasoline engines, CARB estimated that:

". . . a 1.0 HC and 6.0 HC + NO_x standard in 1980 would cost less than \$50 for gasoline engines on the average, requiring all gasoline engines to have air injection and EGR. . . . A catalyst system used for a 1.0 gram HC and 4.5 gram HC + NO_x standard would add approximately another \$150 to that cost.

"For (d)iesel engines, a 6.0 gram HC + NO_x standard is estimated to add about \$300 more to 1977 model costs; a 4.5 gram HC + NO_x standard would add another \$300." [See page 8 of staff report].

The CARB report further estimated that at the 6.0 HC + NO_x level, no fuel penalty was expected even without catalysts and at the 4.5 HC + NO_x level, no fuel penalty was expected with the use of catalysts.

Engine testing sponsored by EPA at Southwest Research Institute, on a 350 CID Chevrolet gasoline engine, indicated that substantial emission reduction can be achieved without fuel penalties if some advanced emission control systems presently used on light duty vehicles are adapted to the heavy duty gasoline engine. The following table indicated some of the potential gains in 9-mode fuel economy associated with various control technologies.

Table 2

9-Mode Test Results with Prototype Emission Control Hardware

<u>System</u>	<u>BSFC (lbs/ BHP-hr.)</u>	<u>% BSFC improve- ment</u>	<u>HC + NOx (gm/ BHP-hr.)</u>	<u>CO (gm/ BHP-hr.)</u>	<u>HC (gm/ BHP-hr.)</u>
Baseline	.740	-	13.3	25.4	4.2
EFI-EGR-PL- Fuel-Off	.651	12.0	4.6	26.1	.9
EFG-EGR-PL- Decel	.704	4.8	5.1	25.4	1.0
AI-EGR-TR- Decel	.676	8.6	4.9	5.2	.2
EFI-TR	.682	7.7	10.2	12.7	.8
EFI-TR-AI	.682	7.7	10.4	2.2	.1
BL W/Ign.	.641	13.3	17.0	32.1	5.8

Legend

- EFI - Electronic Fuel Injection
- PL - Port Liners
- EGR - Exhaust Gas Recirculation
- AI - Air Injection
- BL - Baseline
- TR - Thermal Reactor
- Fuel-off - Fuel Shut Off on Close Throttle Portion of Test (EFI)
- Decel - Fuel on During Closed Throttle (EFI)

Considering the magnitude and uncertainty of the cost estimates associated with the proposed standards for both 1980 and 1983, there appears to be no basis for denying a waiver based upon excessive costs. Of greatest concern are the estimated fuel penalties, for if penalties on the order of 10 to 20 percent should occur, the cost associated with the additional fuel consumed would over shadow projected increases in initial control system costs. Based upon the full record of testimony presented, it appears unlikely that substantial fuel penalties will occur as a result of the 1980 standards. Information presented regarding the 1983 standards is highly speculative. Considering the degree of speculation of all of the estimates, the favorable indications of the data in Table 2, and the available lead time, there appears to be no basis for denial of a waiver for the 1983 standards because of excessive cost through fuel penalties.