

## 17. SUMMARY OF THE GENERAL AVIATION MANUFACTURERS'

### POSITION ON AIRCRAFT PISTON ENGINE EMISSIONS

J. Lynn Helms

Piper Aircraft Corporation  
Lock Haven, Pennsylvania

The members of the General Aviation Manufacturers Association are pleased to participate in this symposium and wish to express their appreciation to NASA, particularly the Lewis Research Center, for hosting the meeting. A technical meeting, with representation from all groups associated with aircraft piston engine emissions, is particularly appropriate at this time. A considerable amount of technical results from the laboratory, test stands, and flight tests is now available. This meeting fills a need for an update to all concerned on what is known and not known about aircraft piston engine emissions and the resultant installation and operational unknowns.

The standards governing the emissions of aircraft piston engines were established nearly 3 years ago. Those standards were established without a valid technical basis applicable to aircraft engines. In the public hearings held at that time, the General Aviation Manufacturers Association pointed out the extremely small contribution to atmospheric pollution made by piston engine aircraft. It was pointed out that the gains in environmental quality would be extremely small (completely unmeasurable) and the costs extremely high in proportion to any benefits. On the basis of the tests completed since then, and the considerably greater (but still incomplete) knowledge that we have today, the conclusions we expressed in the 1973 public hearings have been reinforced.

We strongly recommend that the EPA rescind the aircraft piston engine emissions regulations currently on the books. This should be done because of the very small emission reduction potential and the very poor benefit-cost ratio involved in this form of emission reduction. The limited resources of this industry can far better be devoted to items of much greater benefit to the citizens of this country - reducing noise, improving fuel efficiency (which will incidently reduce exhaust emissions), and improving the safety, operational, and economic aspects of our aircraft, all far greater contributions to our total national transportation system.

I have summarized the position of the General Aviation Manufacturers Association. We believe it is based on the facts, and it is the same position we held in 1973. However, we recognize that, regardless of our position and regardless of the facts as we see them, the regulations regarding aircraft piston engine emissions are on the books. We have been working hard to respond to these regulations to determine if it is possible to meet the regulations or to determine what level can be approached and to define an orderly program for compliance.

Up to now the research effort on reducing aircraft piston engine emissions has primarily been concentrated on operating with leaner fuel-air mixtures to reduce hydrocarbons and carbon monoxide. Other approaches, such as modifications to spark timing, which could possibly be implemented within the next several years, have not shown promise. For the en route phase of flight, the current mixture leaning practices provide near-optimum fuel-air ratios from both standpoints of fuel economy and exhaust emissions. Development efforts on reducing engine emissions have properly been concentrated on operations in the vicinity of the airport where most richer than optimum mixture operations occur. The research results show that although some fuel-injected engines might operate satisfactorily with leaner than current fuel scheduling in the initial climb and approach modes they still would not meet EPA standards. Also, there appears to be a possibility that with the addition of complex and costly automatic mixture control devices some further reduction in emission levels might be obtained. Fully effective devices are many years away. It is not possible to predict, with confidence, how close these changes could bring the body of aircraft piston engines toward meeting the existing standards. There is considerable variation from one engine model to another of a given class, and the effects of production tolerances, test conditions, engine hour accumulation, and aircraft installation constitute additional unknowns.

Let me emphasize that the practicality of the emission reduction approaches which have been tentatively identified have yet to be proven. In the case of some of the automatic mixture control devices, the implementing hardware technology has yet to be developed and tested. Current aircraft fuel control systems have evolved over many years of development and refinement based on field experience. Certainly much can be done on the test stand and on in-flight tests. However, before we deliver an aircraft with a new fuel scheduling system to a customer it must be tested over the full spectrum of conditions expected in operation including time. We must have a firm handle on all of the operational, environmental, and manufacturing variables involved and their effects on safety and operation of the aircraft. In the case of modified fuel scheduling, this requires a costly and time consuming process using current types of injector systems. In the case of automatic mixture control devices, it would require a much longer and more costly development program and this would result in a major increase in production costs for very little benefit.

Based on current information, a projection has been made of the emission reductions possible, and rough estimates of the costs involved have been established. Currently, aircraft piston engines make up approximately 0.1 percent of the total atmospheric hydrocarbon, carbon monoxide, and NO<sub>x</sub> pollution. Based on an estimated potential of a 30 percent reduction in emissions during the landing-takeoff cycle, where 5 to 10 percent of aviation fuel is burned, a reduction of approximately 2 percent in total emissions is projected for a typical piston engine aircraft with a modified fuel system. By the year 2000 roughly one-half of the fleet would be made up of aircraft powered by modified engines. On this basis, a reduction in total atmospheric pollution of the order of 0.001 percent is projected for the year 2000. These numbers could easily be off by a factor of two, five, or even greater in either direction. However, the point remains - the contribution of any possible aircraft piston engine emission reduction to the total atmospheric pollution reduction is dramatically miniscule and unmeasurable.

If we look at the economics, it is estimated that a 5 to 15 percent increase in product cost to the consumer would probably be necessary for the engine and aircraft modifications required to provide the emissions reductions assumed previously. With a \$1 billion average annual sales rate for piston engine aircraft, the cost is estimated to be \$50 to \$150 million per year, or at least \$1 to \$2 billion in this time period. Thus, the benefit to cost ratio works out to be approximately 0.000001 percent per million dollars spent. Surely other far more important needs exist for these resources.

It is clear on the basis of what we know today (disregarding the cost-benefit aspect) that it will be impossible to meet the existing standards by December 31, 1979, either as to levels or time. If it is not possible to rescind or indefinitely postpone the applicability of the standards, then it is clear that both the industry and the government agencies represented at this meeting need to aggressively continue research and development efforts to provide the information upon which realistic standards, and a practical schedule for their implementation, can be based. As a part of this effort, we feel that it is important that good, definitive information regarding implementation costs and schedules be developed so that a practical program reflecting cost-benefit trades can be devised.

As the industry began preparing for this symposium several months ago, it was hoped that sufficient information would be available to enable us to make a concrete proposal to modify the standards and the implementation schedule. Unfortunately, as we have seen during the past two days of discussion, sufficient knowledge is not available to allow the definition of realistic standards. We plan to continue our efforts toward the goal of establishing realistic standards and a workable implementation program. Even if the standards are rescinded, our industry will continue with a meaningful program. It is necessary that this effort be continued and that new standards and schedules be established

in the near future in order to avoid serious dislocation within the industry because of the long lead time commitments necessary on many purchased items, such as engines, and the long flow time in the aircraft manufacturing process.

We feel that the symposium has been extremely worthwhile in providing a free exchange of information on what is known and not known on aircraft piston engine emissions. The hidden spectre throughout is the potential impact on flight safety. It seems very likely we will reverse the positive trend of 60 years if we continue on this present path; that is, we will have less flight safety.

Based on all the information available to us today we can draw the following conclusions:

- (1) Sufficient testing has now been accomplished to confirm trends of expected results.
- (2) The technology does not exist to meet the present EPA standards or schedule.
- (3) We do not yet know what limits can be met.
- (4) System technology to achieve automatic mixture control is presently unknown.
- (5) The impact of emission reduction efforts on time between overhaul and engine reliability are completely unknown.
- (6) Flight safety requirements prevent the adoption of any system requiring manual leaning during the taxi phase.
- (7) Wide and unpredictable excursions exist in production tolerances.
- (8) Each aircraft installation is different and not completely predictable.
- (9) No technical option exists that is compatible with production and tooling lead times.
- (10) Achieving the EPA emissions standards would only reduce atmospheric pollution by approximately 0.001 percent.
- (11) Costs of tens to hundreds of millions of dollars per year will result for the extremely small reductions obtained.
- (12) There will be an adverse impact on flight safety, though we do not know how to quantify.

Differences with these conclusions can exist only in degree, not subject matter.

We live in complex times with ideas and opinions subject to extreme criticism or appraisal by either genuine evaluators or purposeless dissidents. These cultural environmental characteristics are exacerbated by the political events of the day and single-interest groups, either pro or con to an idea.

None of these, however, relieve our joint responsibility for fulfilling the established requirements of our respective offices. Just as industry has a firm responsibility to take a leading role in a national environment improvement effort so also does the federal government and its included agencies and bureaus have an equal responsibility to stand up and be counted when it is time to acknowledge the need for change. Government need not do so with any feeling of valid condemnation from industry or outspoken critics. Equally, our congressional committee system clearly establishes a recognition by the Congress for the need to continually review and revise laws and their applicability.

It is now clearly evident that when these standards were established in 1973 the national mood of cleaning up the environment overwhelmed our knowledge of what could be done and the safety aspects affected by establishing aircraft piston engine emission standards. We now have a joint responsibility to redirect the two most vital resources we have - talent and time - toward solving problems with a much higher potential pay out to our nation's citizenry. Cost is merely our way of accounting for use of these two more vital resources.

It is time we clearly state that the potential benefit of even massive efforts to reduce aircraft piston engine emissions is unmeasurable at best and an extremely poor use of our national resources. Aside from the economic impact of large scale unemployment and plant reductions, it is a case whereby simple logic confirms that what we get is not worth the effort. It was not the intent of Congress when it enacted the Clean Air Amendment of 1970 to arbitrarily establish a basis to waste tens of millions of dollars for a benefit so small that even this nation's advanced technology cannot measure. Congress fully expects the responsible government organization to bring such situations to their attention.

We thereby recommend that -

- (1) The emissions requirements specified for aircraft piston engines be rescinded, and
- (2) A joint industry-government task force compile a report containing all of the data obtained (which substantiates the recommendation for rescission) with that report made available to all interested parties, whether dissidents or supporters, rather than engage in continuing rhetorical debate, or

- (3) If the previous two recommendations cannot be accepted, then the emissions levels and schedule for aircraft piston engines must be indefinitely postponed until such testing has been completed as to allow the establishment of meaningful values and dates.

## DISCUSSION

COMMENT - J. Barriage: Speaking for the FAA, I appreciate the provisions and the excellence of the discussions and presentations which we have experienced these past 2 days. Each of us recognizes that there is a great deal more to be done. I think each of us also recognizes that we need to continue defining the work that needs to be done and to define the manner in which we are able to arrive at a solution. Obviously, as has been brought out, there are differences of views, but it's healthy to bring them out and discuss them. We appreciate NASA-Lewis having this symposium and handling it so beautifully.

COMMENT - G. Kittredge: We, too, appreciate the opportunity to have been able to take part in this symposium. In my own case, it's the first chance I've had to get together with such a complete spectrum of talent from the aerospace industry and associated government agencies. We look forward to the publication of the proceedings. We'll study these very carefully and with thoroughness. We want to respond to your comments, Mr. Helms. To do them justice, we would like to study them more thoroughly on an agency basis before we comment. I have a few impromptu comments which are my own only. I do want to restate, with regard to our air quality arguments, that certainly what you say is correct in so far as nationwide impact is concerned. With respect to general aviation operations, we're really mostly concerned with the local impact, largely that of carbon monoxide in reasonably close proximity to heavily used general aviation airports. With regard to the very valid points brought up by Mr. Helms and discussed more completely yesterday on testing and measurement problems, we accept that these have delayed work on actual reduction of engine emissions. Since the session yesterday, the FAA and myself have talked this over. We will make an effort to get a meaningful industry/government group to work on this within the next several weeks. The SAE committee I referred to yesterday is scheduled to meet within 2 weeks. Our proposal is to set up a subgroup that would include the people who've spoken on this subject here during the past 2 days and to work to fill in some of the gaps in the present emissions measurement procedures. We don't see this as a formidable problem, because of the excellent base that now exists as a result of your 3 years of experience. One comment on engine cost. This morning's session was the first exposure I'd had to actual cost estimates as to implementation of this program for the very wide array of engine models and aircraft types that you have to deal with. I do feel, in a somewhat defensive way, that since the approaches that have been talked about most seriously for use in meeting the standards do result in fuel economy benefits as well, that the costs of the total program can be spread over the presumed fuel economy advantages to your customers as well as to air quality control. You said it the other way around in your presentation. It's equally valid either way. One other comment that really wasn't brought out by Mr. Helms, but did come out this morning, has to do with old engines and old aircraft. I should have said this morning that we have this comment in hand from the turbine engine manufacturing segment of the industry. It was presented at our public hearings on this

subject in February 1976. We have to respond to it. But engines that are likely to be made in relatively limited quantities in the future to serve for replacement purposes in existing old design aircraft will have, presumably, minimum impact on air quality and justify some sort of exemption or delay or something of that nature. I can assure you that this is being worked on.

COMMENT - G. Banerian: This concludes the formal presentation of our program. As all of you know, the purpose of the meeting wasn't to debate the merits of the regulations, but to provide data for future regulatory action and petitioning for change if deemed necessary. I want to thank all of you for participating as you did and presenting your material in a most professional way. I, also, thank the Lewis Research Center for a good job in arranging this meeting. As you know, the action items for regulatory action are with FAA and EPA and not with NASA. We'll do what we can to assist them, but the initiative is with them.