

## **HARMONIZING ENGINE DESIGN RULES UNITED STATES - EUROPE**

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### **ABSTRACT**

This presentation provides an overview of the efforts that have been in process over the past 15 years to improve the standards for engine design certification. An important feature is the co-operation between the US and Europe to develop, through harmonisation, a common set of standards. Having common standards is important so that all engine manufacturers can design to a common level of safety that will be accepted world-wide.

The purpose of the presentation is to inform the committee of the efforts from the manufacturing side of the industry. This positive exchange of information is intended to update the committee that effective protection from the bird hazard results from combined efforts throughout the industry.

The purpose of this presentation is to give you an overview of the efforts the manufacturers side of the aviation industry has taken to minimize the threat of birds to aircraft safety, specifically bird ingestion into engines. These efforts are not without complexity both on industry and regulatory authority sides. It is not the purpose here to be a forum to judge an issue or even to particularize the still open issues but rather to let you know of the extensive effort taken by industry to make engines tolerant to the bird threat. We all want engines tolerant to the real threat, yet still provide an economical powerplant for viable, commercial application.

-Question often thought of- Why can't you make an engine withstand to ingestion of all birds.

-A- It would not be possible or practical to design an engine to tolerate the ingestion of all birds. What you and I want are engines that can tolerate the real hazard safely. Here is how it's done.

When an product is designed, manufactured, and offered for sale to the public, regulatory agencies in part protect the consuming public against deficiencies in design or manufacturing quality. Each country has its own agency. The agency for US aviation products is the Federal Aviation Administration (FAA). In Europe each country has its regulatory agency. All the European agencies voluntarily coordinate under the Joint Aviation Authorities (JAA). These agencies develop standards, or regulations, against which products, such as engines, are designed and manufactured.

The designer of an engine in the US must satisfy the FAA that an engine design will meet the requirements of the FAR 33 and in Europe satisfy the country of design regulations as recommended by JAR E800 and JAR E540. This is done during what we call the certification phase of a new engine development. Once all of the certification requirements have been met to the satisfaction of the regulatory agencies, type and production certificates are issued. FAR Part 33.77, and JAR Part E800 define the tolerance an engine must have to foreign object ingestion, including bird ingestion. This Part defines what the standard is, and how it is to be satisfied, i.e. by test or analysis.

The current FAR and JAR requirements provide for damage to an engine due to the ingestion of a large bird, and power loss potential due to bird flocks. For a large bird the regulations require a demonstration ingesting a large bird with the desired outcome that any resultant damage must not threaten the aircraft, and be safely shutdown. For flocking birds the regulations require a demonstration ingesting selected numbers of medium and small birds with the desired outcome that the engine must continue to operate at least 75% power for 5 minutes.

The current FAR's evolved from advisory circulars during the '60's and '70's. An accident in 1976 involving bird ingestions into engines of a jumbo jet raised the question as to whether the numbers, types, and sizes of birds specified by the FAR's accurately reflect the real threat from birds world wide. In response to that question, the FAA sponsored three bird ingestion studies into commercial transport category aircraft and contracted the major engine manufacturers to assist by providing data relative to the numbers, sizes, and types of birds that were ingested and the outcome to the engine. From that effort it was found that the numbers, sizes, and types of birds that were found to be threatening were not accurately reflected by the FAR's and

that there were geographic regions with different threat.

Having said all that, what do we do? Answer - Change the rules.

There is a process whereby interested parties outside the FAA can petition for a FAR, or rule, change and there are players in this process. Over the years spanning the interest in revising the bird ingestion rules the process and the players have changed. These changes have been beneficial and are expediting getting revised rules in place. Hopefully I can explain in overview fashion the process and its successes and define the players.

AIA stands for the Aerospace Industries Association of America. It represents the US industry side of aviation and its members, on bird related issues, include: McDonnell Douglas, Boeing, Textron Lycoming, Pratt & Whitney, GE, Garrett, Williams International, and Allison. There is a similar parallel organization in Europe referred to as AECMA which stands for Association Europeene des Constructeurs de Material Aeroespacial and its members on their bird related issues include: Rolls Royce and SNECMA. The members of AECMA are observers and participants in many AIA committees including the bird ingestion committee. Other observers and participants include PW Canada and IAE.

In 1984, at the request of the FAA, the AIA studied the data from the FAA studies then recommended that the FAA revise FAR 33.77 to increase the severity of bird design and testing...to reflect the actual numbers and bird sizes being ingested in the last 10 years. In this recommendation the AIA provided a draft rule change. The FAA circulated a draft Notice of Proposed Rule Making (NPRM). According to the process at the time, interested parties could comment to the draft. After all comments the FAA could then resubmit a revised draft or formal NPRM incorporating, best possible, the comments from the first draft. Depending on the issues in the proposal this process could repeat and take a long time - years - and result in a compromise rule. During the same time period the European community was working to revise the engine bird ingestion standards also. If this process continued one outcome would be more than one set of standards that an engine manufacturer had to design to. With aircraft flying internationally manufacturers would have to satisfy multiple standards. It appeared that the US community and the European community both recognized the need for more severe bird ingestion but were taking different paths toward increasing this severity..

That is all nice. So how does this make engines more tolerant to birds??

To broadly and simply generalize the different paths, The US felt the increase in test severity should be in increasing the bird size whereas the European community was working to increase the severity of the test and criteria without changing the size of the bird. In order to understand the differences, the European and US initially collaborated on the technical viewpoints and established a Harmonization Working Group which has continued to tune the wording so that the standards established by the FAA and the JAA will be the same. What has resulted was increasing the severity from both points of view. i.e. increase the size of the birds and the severity of the tests. both

The original requirements specified engines should be tested to demonstrate tolerance to a large bird of 4 lbs without hazard to the aircraft, and tolerance to a flock simulated by ingestion of 1-1/2 LB birds the number determined by the inlet area. After ingestion of 1-1/2 LB birds in the US the engine must remain operating at at least 75% power for 5 minutes, and in Europe there must be: no immediate or ultimate loss of engine performance, serious increase of ...temperatures or deterioration of... handling characteristics, or sustained loss of performance below 25%.

The harmonized NPRM/NPA require that the large bird shall be up to 8 lbs. depending on engine inlet size, and that the medium birds shall be a combination of 1-1/2 and/or 2-1/2 LB birds. The mix being a function of engine inlet area. In addition the medium birds must be aimed at critical areas on the fan, and the run-on requirements change to 20 minutes composed of a combination of power settings simulating typical power settings in making a return and landing.

Knowing of the coming rule, and because of its importance in safety, all the recently certified engines have been designed and tested to the new standards - even in advance of their implementation. In the US the FAA issued a special condition applied to FAR Part 33.77, for each engine applying for certification. The special condition acknowledged that the "...applicable regulations do not contain adequate or appropriate safety standards..." and specified that the new engine applying under this special condition had to meet specified standards. The specified standards reflect the new harmonized standards.

I want now to show you some video segments that I hope you will find interesting. One is the ingestion of an 8 LB bird into a large fan. The other is the ingestion of multiple medium birds into a fan. ....

In summary I have outlined to you:

- 1) How the standards relative to bird ingestion into engines is established.
- 2) How the inadequacy of the standards was identified
- 3) How that deficiency was addressed
- 4) The international cooperation that went into harmonizing the standards so that manufacturers would certify to only one set of standards and those standards would reflect the actual threat seen in service.
- 5) That the new engines have been certified to the new recognized standards even in advance of their introduction.

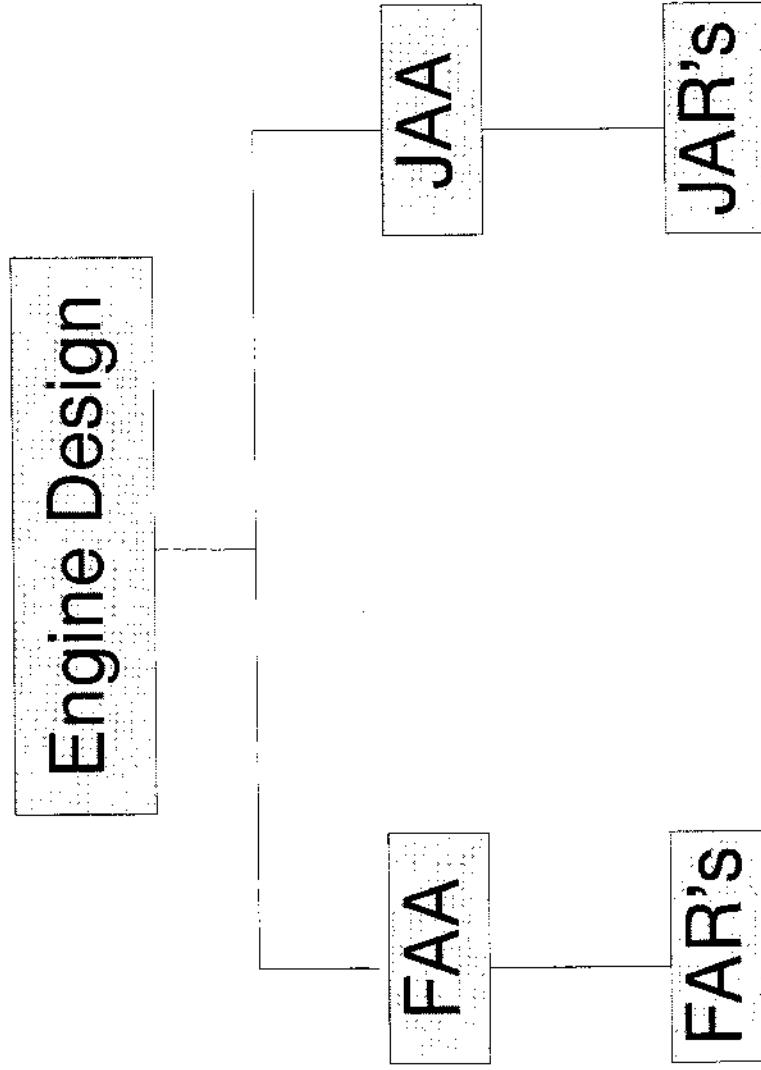
In closing I would like to say that all of our efforts have been effective in reducing damaging bird ingestions through out the world. It is good to see so many areas contribute to this safety problem from the many perspectives. I hope I have given you some insight into the way that manufacturers have been working to minimize the hazard. Airport bird control will always remain a crucial factor.

R. Parker

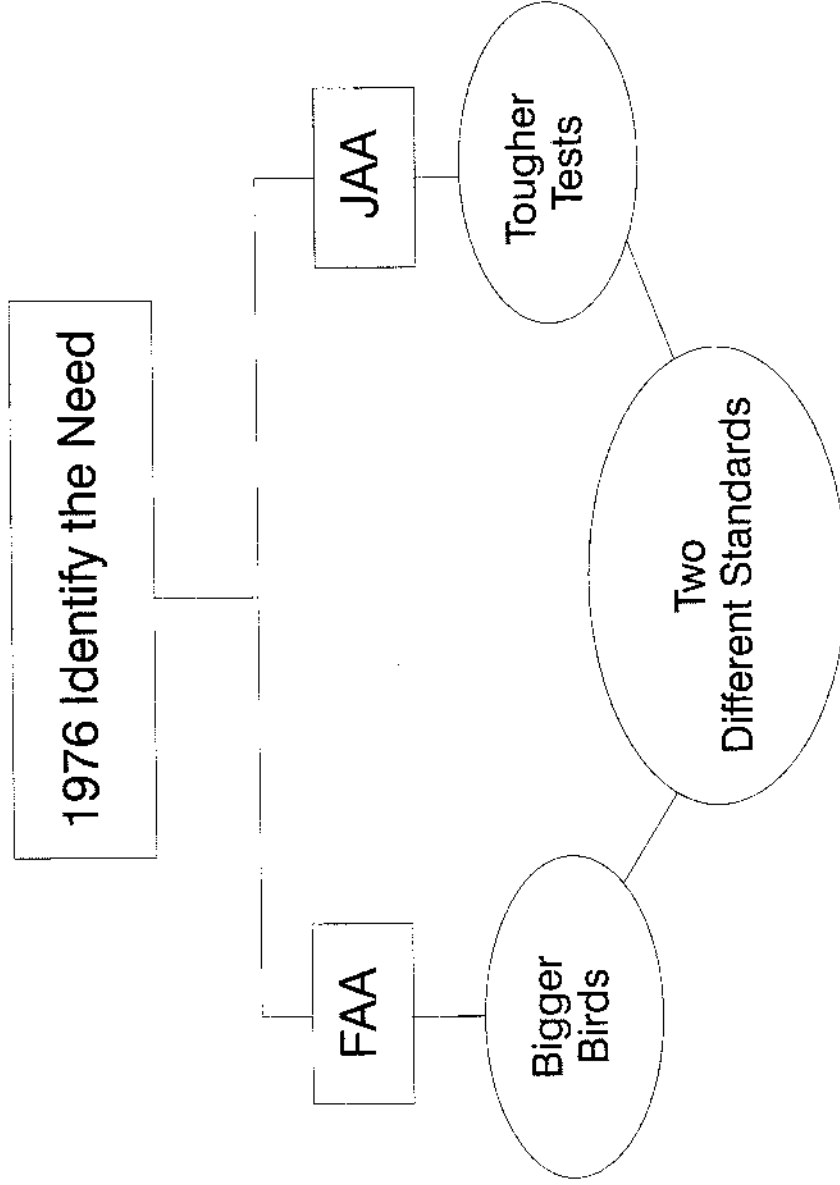
# Harmonization Standardizing Engine Design Rules Between US and Europe

# Current Rules

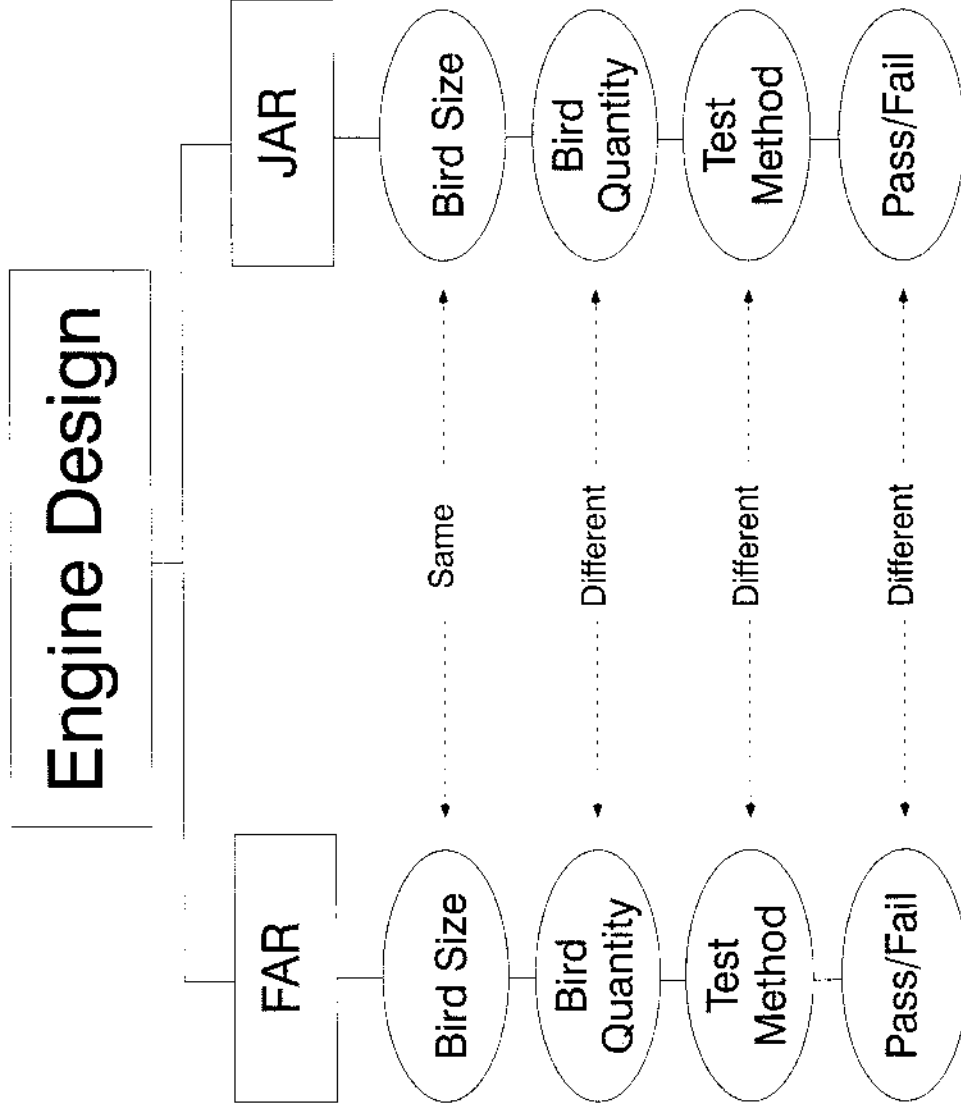
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# Fix the Rules



# Current Criteria



# Harmonization

