SOME AIRLINE EXPERIENCE IN PREVENTING ENGINE ROTOR FAILURES

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We have spent many hours discussing the disk and blade containment problems and have heard the viewpoints of the regulatory agencies, the engine manufacturers, and the airframe manufacturers.

The airlines' viewpoint has yet to be expressed, and I will take that on since through some misfortune of mine, I am the only airline representative here.

I have learned a great deal from the information presented here. The most important being, that no matter who accumulated and presented the data, there was virtual agreement with respect to the number of serious incidents of non-containment.

I would, however, hate to leave here having you think that it was a stroke of luck, or the will of God, that has kept the non-containment problem at such a low level that loss of life or aircraft has been remote or non-existant over the past 13 to 15 years.

The other side of the coin which must be talked to is that the airlines, with the assistance of the engine manufacturers, have achieved excellent control over the type of problems which lead to an uncontained failure--and have in fact, avoided many potential problems.

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I would not like to hazard a guess what the incident rate might look like if we had sat back and failed to respond or recognize incipient problems.

I can cite a few examples from memory--the JT4 engine developed a siege of third turbine blade failures which threw shrapnel out the tailpipe and into the wing flaps because most of the failures occurred on takeoff. I am sure that the statistics shown here included some JT4 damage incidents which occurred early in that period. I can tell you that this problem was effectively controlled with a very sophisticated tool, consisting of a broom stick with a rubber hose on the end of it. I don't know how many of you have heard of the "broom stick check", but it was a rather famous check across the industry. We did nothing more than put this broom stick up the tailpipe against the turbine blades while a mechanic turned the compressor. A clicking sound meant a loose turbine blade. Three clicks meant three loose blades, which was the limit we established for having the engine changed. We probably removed 100 wheels due to this problem, but I am certain you would not find an in-flight failure in the statistics since initiation of the "broom stick check". We even took a further step, we found that we could lower the back of the engine, take the exhaust case with the thrust reverser off, change the wheel while the engine was still on-the-wing, and get the job done in less time than it took us to change the engine.

Another problem that would have made headlines if left uncontrolled, was a deflection problem on the second stage nozzle guide vanes on the JT9D engine. In this case the inner platform would deflect into the second stage disk, scoring it, and causing a disk rupture. We attacked this problem with the help of Pratt and Whitney and some others in the industry, by taking X-rays of the affected area, using a radioactive isotope installed in the turbine shaft opposite the film which was wrapped around the outside of the engine. The photo permitted us to measure and monitor the gap between the two parts and to remove the engine when a given point was reached.

Again, we did not have a single failure that surely would have fallen into the "catastropic category". This type of control came about because of the initiative that we and others in the industry have taken and continue to take to avoid these kinds of problems.

The JT3D N1 Compressor rear hub failure is another excellent example. I bet there isn't anyone in the room who has heard of or has recognized that there has been a serious cracking problem with this hub over the past three to four years. This one wasn't easy to control, because it was so difficult to get to, being located between the N1 and N2 compressors with no exterior borescope holes readily available. We did, none-the-less, develop a good control system by inserting an eddy current probe on a long handle thru the N1 gearbox and compressor shaft. It took the finesse of a brain surgeon to detect a crack in such a difficult area, but once we mastered the technique we avoided having a single hub failure.

The last one that comes to mind is the RB211 problem which caused burn thru and release of the first stage nozzle guide vane. In addition to the safety aspects of this problem was the fact that the nozzle guide vane could cause downstream damage to the tune of about three to four hundred thousand dollars worth of turbine parts. In this case we simply used frequent borescope inspections through borescope holes that were strategically located to monitor and measure the rate of burning.

If my memory were better I could reach back for more examples, but gentlemen, if you multiply the TWA experience by the number of airlines, I believe you would have to acknowledge that we have pretty good control and have, in fact, minimized our exposure. You must understand, we do not wait for a spectacular failure to occur before reacting. We are constantly on the look out for incipient problems anytime an engine goes thru our engine shops. Additionally, we trade experience with other airlines and with the engine manufacturers. Once a problem is identified, we establish a plan for the engines that are in service to avoid any inflight failures. It is our aim to develop the technology necessary to cull out the suspect engines while they are on the aircraft. To do so is vital, because there is no airline in the world that could put 400 engines on the ground and take them off to determine if they have a problem. So it is imperative that we categorically develop ways and means of finding problem engines quickly as a control and stop gap measure. It takes two to three years to cycle a given modification in a sizeable airline fleet--therefore these inspection measures are the only means of avoiding an economic catastrophy.

Quite honestly, I think we have pushed our diagnostic capability to a near limit. We need some new innovations. We need new holes in different places on the engines. We need some creative thinking that allows us to have greater visability within the engines and to test for problems that may be incipient.

We are somewhat more fortunate on the Jumbo Jets because at the insistence of the airlines, and by the good graces of the manufacturers, we do have a generous group of borescope holes, in addition to a modular concept of the major engine components, which allows for quick and more effective response in the field than we have with the older model jet engines. This is one of the reasons I get extremely nervous and extremely disturbed when I hear we are considering wrapping boiler plate around engines for better containment. It is my opinion that this is going the wrong way because, as I have stated, in order to control our problems, we must be able to see them--it is the problems we cannot see historically, that have hurt us.

I would like to continue my sales pitch for just a minute, since I am not certain that many in the industry recognize the job of the failure detection that the airlines have had in effect for a number of years. These procedures in fact allow us to anticipate and remove 85 percent of the engine failures long before they reach a critical stage. We can conveniently schedule the removal at our discretion, and in many cases maintenance and/or flight crews are not aware of the developing problems.

The first of these tools is an engine in-flight data analysis program developed twelve to thirteen years ago with the assistance of Pratt and Whitney. It involves a computer process which is nothing more than a gas path deterioration indicator. The data which is put into the computer daily is corrected to standard day conditions and is compared with a normal gas generator. The deviation for all engine parameters is then plotted. We simply look for the swing or trends in the data and it is possible to examine 1000 flying engines in 1½ hours, picking out those that appear to have a problem.

Spectographic analysis is another limited, but useful tool that can detect impending failures in some cases as far off as three to four months in advance.

We have for a number of years also been testing the AIDS system, which I'm sure some of you in the industry have heard about. We are the only domestic airline in the world who has decided to invest several million dollars in the installation of this equipment in our jumbo jet aircraft in order to capture dynamic information on not only the normal engine parameters which are observed by the flight engineers, but also into other areas of the engine to sample new parameters that we may someday find useful in furthering our engine failure detection capability. Unfortunately, we are not a research department, and we must limit the amount of Engineering we put into this kind of thing, since we are basically in the business of carrying passengers.

We have made some great strides, but with the help of the type people available in this room, we could literally turn the world over in terms of advancing our diagnostic capability. This is one of the reasons I was pleased to hear John Barringer, yesterday, telling us about trying to install a crack detector in an operating engine. As I mentioned, the approach was wrong, but the ideas was beautiful! We don't necessarily need to build the diagnostics within the engine, since the environment is too hostile. What is needed is the ability to look inside the engine. I'm sure there are many innovative ways you gentlemen can think of to do this. I'm quite proud of an industry that can see 84 percent of its failures before they occur; so the 15 percent remaining can be a very fertile area for all of us to work in.

Aside from this, I certainly think we need to continue studying the trajectory of uncontained failures that do occur as it is obvious the risk of uncontained failures will be with us forever, irrespective of what containment approach we take. So therefore, we still need to learn as much as we can when a failure occurs so the airframe manufacturer, who apparently has done a fine job up to this point, can improve on locating vital systems.