

DATE: 8 Mar 71



ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION

SUBJECT: DEBRIS HAZARDS AT CIVIL AIRPORTS

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1. **PURPOSE.** To discuss problems of debris at airports, give information on foreign objects, and tell how to eliminate such objects from operational areas.
 2. **REFERENCE.** Advisory Circular 33-1B, Turbine Engine Foreign Object Ingestion and Rotor Blade Containment Type Certification Procedures, dated 22 April 1970.
 3. **DEFINITIONS.** For the purpose of this circular the term "civil airport" means landing, takeoff, or operational areas used regularly by other than public aircraft for receiving or discharging passengers or cargo. The airport areas referred to in this circular include: aircraft movement areas, paved and unpaved; runway safety areas; taxiway safety areas; and other graded airport areas.
 4. **BACKGROUND.** The number of jet powered aircraft being purchased by the air carrier and general aviation industry is steadily increasing. It is well known that jet engines are susceptible to any form of debris, such as: sand, gravel, ice, nuts, bolts, hand tools, rags, bird ingestion, pieces of tire tread, newspapers, brush cuttings, and water ingestion. The photographs in Appendix 1 show damage that has occurred to aircraft engines from the ingestion of foreign objects.
 5. **DISCUSSION.**
 - a. The B-747 has been in operation and the DC-10 and the L-1011 will soon be entering the commercial fleet. The engine inlets for these new aircraft are approximately 8 feet in diameter and will draw in much greater quantities of air than existing engines. Because
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of the known tendencies of jet engines to draw in debris, it is very important that airport operational surfaces be kept clean. It has been argued pro and con as to whether a jet engine could pick up material from a ramp without an outside force disturbing the material and causing it to become airborne. To settle this question, the National Advisory Committee for Aeronautics (NACA) conducted a study entitled: "Ingestion of Foreign Objects Into Turbine Engines By Vortices." (Reference NACA Technical Note 3330, February 1955.) During this study, pebbles typical of objects that damage jet engines, were projected into the air by the inlet vortices and were drawn into a 5000-pound thrust axial flow jet engine by the high velocity inlet air stream. The study showed that pebbles lodged in surface cracks were more readily picked up than those exposed on a smooth surface.

- b. At the same time that wide-bodied jets, with massive engine air inlets, are entering the commercial fleet, plastic or polyethylene materials are being used more and more for packaging, wrapping and insulation. Large polyethylene sheets are being used to cover and protect air freight shipments. Many articles used on airports are packaged in plastic containers. These covers and containers are relatively light in weight and are easily blown by the wind and engine blast onto runways, taxiways, and ramps. It has been noted on visits to airports that large numbers of polyethylene cargo wrappers, discarded containers, pieces of paper, etc., have been blown against the perimeter fences. Similar debris were also noted in cargo and other airport areas.
 - c. Polyethylene materials, unlike paper, do not deteriorate rapidly, and therefore, unless removed, can blow about on an airport during high and shifting winds for a considerable length of time. The accident/incident reports indicate that a four-engine jet aircraft aborted takeoff due to loss of power in one engine resulting from ingestion of a plastic cargo cover. From another report it was noted that a 3/4 inch safety wire caused failure in a fuel shut-off valve when it got positioned across two electrical terminals. As a result of this ingestion, the engine flamed out and could not be restarted in flight. Fortunately, the aircraft had one good engine left and the crew got it down safely.
 - d. Disregarding the potential debris hazard could result in an accident or serious incident. Debris on airports is considered to be comparable to hazards from birds and hazards associated with winter operations.
6. PROGRAM SUGGESTIONS. The following information is intended to help in establishing airport programs for preventing foreign object damage.

It is particularly applicable to airport owners and operators, air carrier station managers, and general aviation operators. Individuals in these positions are expected to alert ramp crews, maintenance technicians, and aircraft servicing personnel to the safety hazards that debris can cause.

- a. Identifying Causes. The causes and principle contributing factors to foreign object damage must be determined before an effective local program can be developed. In cases where foreign object damage makes engine removal necessary, it is important to the airport program to find the cause and determine how to prevent recurrence.
- b. Typical Foreign Objects. These have included: aircraft and engine fasteners (nuts, bolts, washers, safety wire, etc.); mechanics' tools (wrenches, pliers, etc.); extra flight line metal (nails, personnel badges, pens, pencils, etc.); natural stone (pebbles, gravel, sand, etc.); unnatural stone (concrete, cinders, etc.); and pieces of wood.
- c. Methods of Prevention. Determine all possible sources of potentially dangerous foreign objects. Suggestions:
 - (1) Consider using available specialized brushing, magnets, and vacuum type machines to clean aircraft operational areas as well as runway and taxiway safety areas. Also, establish a means for preventing release of litter in these general areas of operation. And, set up a procedure for engine runup areas so that engine thrusts are not directed toward adjacent aircraft.
 - (2) Minimize construction debris problems by expediting removal of dirt piles and loose materials in vicinity of operational areas.
 - (3) Account for and dispose of nuts, bolts, washers, safety wire clippings, etc. When a nut or bolt is found on the ground its presence too often is dismissed. When a nut is found it should become obvious that a bolt may be nearby.
 - (4) Account for hand tools used in aircraft or engine repair jobs. A checklist in tool boxes can aid in control of these items.

- (5) Establish clean-up procedures in construction areas and along routes where construction vehicles are used around aircraft operational areas.
 - (6) Establish a system for cleaning up including mechanical sweeping, and hand sweeping.
 - (7) Make inspections of operational areas at least once each day, with additional inspections being made in construction areas and immediately after any aircraft accident or incident.
 - (8) Give special attention to cleaning of cracks and expansion seams in hard surfaced areas where engines are run. Tests have shown that these are the main sources of foreign objects which are ingested.
7. HOW TO OBTAIN THIS PUBLICATION AND REFERENCED PUBLICATION. Obtain copies of this advisory circular, AC 150/5380-5, Debris Hazards at Civil Airports, and the referenced advisory circular from the Department of Transportation, Distribution Unit, TAD-484.3, Washington, D.C. 20590.

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AC 150/5380-5
Appendix 1



AIRCRAFT 8451
ENGINE S/N 411-300
BIRD INGESTION IN FLIGHT

FIGURE 5. DAMAGE CAUSED BY BIRD INGESTION IN FLIGHT.
NOTE TWISTED ROTOR BLADES CAUSED BY BIRD INGESTED.

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Appendix 1

APPENDIX 1. ILLUSTRATIONS OF FOREIGN OBJECT DAMAGE TO JET ENGINES.



FIGURE 1. OBJECTS INGESTED.
IN LEFT PHOTO NOTE THE EXTENSIVE DAMAGE TO VANES CAUSED BY PLEXIGLASS.
IN RIGHT PHOTO NOTE THAT THE NUT WAS EMBEDDED IN THE VANE.

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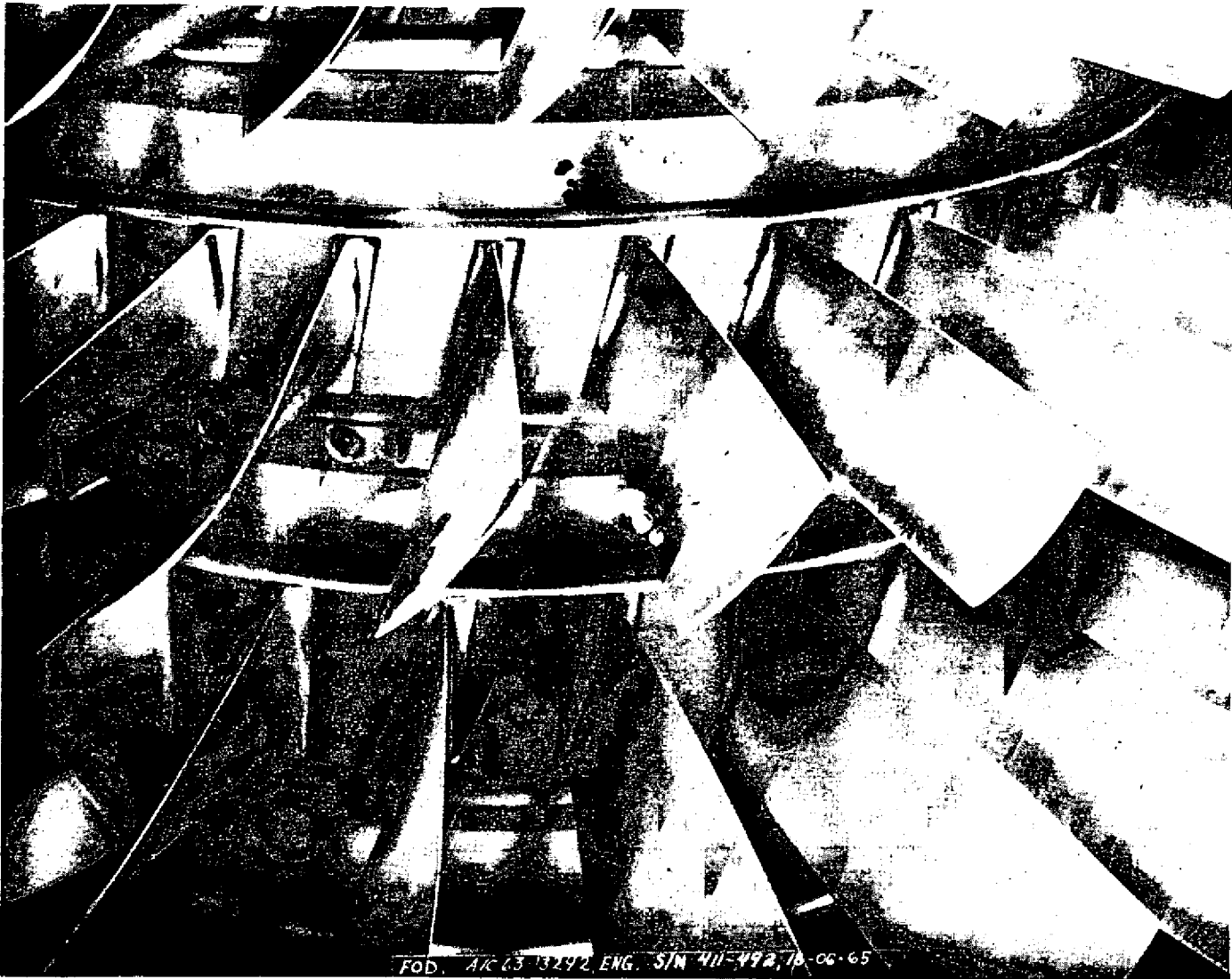


FIGURE 2. METAL INGESTION.

NOTE THE ONLY APPARENT DAMAGE WAS TO THE VANE IN WHICH THE NUT WAS EMBEDDED, SIMILAR TO THE RIGHT PHOTO IN APPENDIX 1, PAGE 1.

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Appendix 1



FIGURE 3. FOREIGN OBJECT DAMAGE AND METAL EMBEDDED IN VANE.
NOTE THIS PIECE OF METAL DID EXTENSIVE DAMAGE TO SEVERAL VANES.

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FIGURE 4. INGESTION OF CLAMP TYPE DEVICE.
NOTE THE LARGE NUMBER OF VANES DAMAGED,
THE EXTENT AND UNIFORM TYPE OF DAMAGE.