AC 20-105A

DATE 11/20/80

ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration
Washington, D.C.

Subject: ENGINE POWER-LOSS ACCIDENT PREVENTION

1. PURPOSE. This advisory circular updates statistical information and brings to the attention of aircraft owners, operators, manufacturers, and maintenance personnel the circumstances surrounding engine power-loss accidents with recommendations on how, through individual effort and consideration, those accidents can be prevented.

2. CANCELLATION. Advisory Circular 20-105, Engine Power-Loss Accident Prevention, dated 6/9/78 is cancelled.

3. BACKGROUND. A review of Federal Aviation Administration's General Aviation Accidents Factual Reports for the years 1977, 1978, and 1979, that list engine failure as a cause, showed a total of 2,608 accidents. Those accidents resulted in 473 fatalities and 1,396 injured persons. For several years, "power loss" has been the greatest single type of general aviation accident and during this review period accounted for 19.9 percent of all accidents. Analysis shows that accidents have resulted from:

a. Personnel Errors.

(1) Operations which exceeded the limitations of the powerplant.

(2) Failure of maintenance personnel to utilize acceptable maintenance procedures.

b. Failure of Engine, Engine Part, or System Component.

(1) Engines were operated beyond the overhaul time recommended by the manufacturer.

(2) There was noncompliance with airworthiness requirements regarding inspection, overhaul, repair, preservation, and/or replacement of parts.

(3) Design changes and alterations were completed without engineering evaluation and approval.

(4) Parts failed due to operation outside operating limitations; i.e., overtemp, overboost, low oil pressure, etc.

c. Fuel Starvation and Exhaustion.

(1) Fuel starvation (fuel on board the aircraft but not supplied to the engine(s)) and fuel exhaustion (no fuel available on board the aircraft) resulted in 47 percent of the engine power-loss accidents. This usually results from improper preflight planning or improper fuel management procedures.

(2) Contamination continues to be a notable factor in fuel starvation accidents. During this review period of the 1,230 engine power-loss accidents related to fuel system, fuel contamination was a cause in 381 or 31 percent of those accidents. Advisory Circular 20-43C, Aircraft Fuel Control, contains valuable information that alerts the aviation community to the possibility of inadvertent mixing or contamination of turbine and piston fuel and provides recommended servicing procedures.

d. Fuel System Design. Accidents have resulted because pilots and maintenance personnel failed to become familiar with the different fuel systems and operating procedures. Design changes, accomplished without proper evaluation, the lack of standardization of controls configuration among aircraft, plus the peculiarities in aircraft fuel system designs, have contributed to power-loss accidents.

4. RECOMMENDATIONS. The following are recommended operating practices that could help reduce engine power-loss accidents:

a. General.

(1) Know the limitations of the aircraft and aircraft powerplant. Avoid operating in excess of those limitations. Be sure all engine(s) are within acceptable operating parameters prior to takeoff. Keep proficient in all engine and systems operating procedures, including emergency procedures. The aircraft flight manual or the rotorcraft flight manual contain the normal and emergency procedures, and proper power assurance check procedures. Use the checklist during normal and emergency operations.

(2) Follow the manufacturer's operating instructions. Have a qualified person investigate all abnormal engine operating conditions (oil and fuel consumption, low power, vibration, engine instrument readings, etc).

(3) Positively utilize a powerplant and propeller maintenance program which gives full consideration to the Federal Aviation Regulations and manufacturer's recommendations.

(4) Keep abreast of technical information related to the aircraft fuel, oil, parts, airworthiness directives, manufacturer's technical publications, etc.

(5) Know proper procedures when engine inlet or carburetor icing conditions are encountered.

(6) Follow engine manufacturer's inspection procedures following propeller strike or sudden engine stoppage.

(7) Operate engine controls smoothly, as abrupt movements can result in engine malfunction and power loss.

(8) Avoid overspeed, overboost, and overheat.

(9) Do not fly an aircraft with known engine discrepancies.

b. Fuel Management.

(1) In relation to airplane performance, the fuel quantity on board the aircraft is only "time in your tanks." Management of that time should rank high on the list of a pilot's priorities. Be fully familiar with the aircraft fuel system and fuel management procedures.

(2) Make adequate preflight preparations to ensure that sufficient clean fuel is on board the aircraft for the time to destination, plus an adequate reserve, predicated on airplane performance.

(3) Know and understand the positions of the aircraft fuel selector valves. Markings should be legible, valves should be easy and smooth to operate and with positive detent action.

(4) Be familiar with the sequence for selecting fuel tanks of the aircraft. The use of fuel from tank(s) other than as recommended (especially during takeoff and landing) can result in eventual fuel starvation. Many aircraft return unused fuel from the carburetor to a tank. If the tank is full, the fuel goes overboard through the vent and is lost, thus reducing range.

(5) A pilot should know the total USABLE fuel on board the aircraft before flying. The UNUSABLE fuel should not be considered when planning a flight.

(6) Make a visual inspection to assure that the fuel tanks are full. If you are in the habit of flying with partial fuel loads, use positive means to know the quantity of fuel on board the aircraft before flight. Complete trust in fuel gauges has often resulted in fuel depletion short of destination and accidents.

(7) Make a thorough fuel drain check of all sumps before flight. Consult the owner's manual for proper procedures.

(8) During preflight inspection, determine that all tank vent openings are clear of obstructions.

(9) Check fuel flow from each tank to engine(s) prior to taxi. Remember to allow sufficient time for this check as the carburetor and lines hold fuel that would have to be used before you would know if there was no fuel flow from a tank.

(10) Determine that hand primers are closed and locked in the detent after use.

(11) Be fully familiar with fuel boost pump operating procedures.

(12) Before switching tanks, check the fuel quantity in the tank to be selected and after moving the selector check the fuel selector position to be sure proper tank is selected.

(13) After switching tanks, monitor the fuel pressure until you are sure there is fuel flow from the tank.

c. Maintenance.

(1) Maintenance should include inspection of fuel cells and tanks for discrepancies such as collapse, contamination, vent obstruction, internal damage, security, leaks, gauge accuracy, and general condition.

(2) Periodically make a visual check of the fuel filter for condition and/or contamination.

(3) Check operation and security of fuel selector and system control handles and/or knobs.

(4) During maintenance, a detailed inspection should be made of fuel quantity indicating system wiring, components, and calibration.

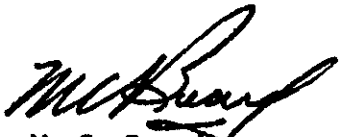
(5) Design changes and alterations to aircraft engines should be done with approved data.

(6) Replacement of engine parts should be completed following manufacturer's instructions.

(7) Maintenance should be accomplished in accordance with the manufacturer's recommendations.

(8) Have a qualified maintenance person dress out propeller blade nicks, dents, scratches, etc., as necessary, to prevent fatigue cracks that could cause propeller blade failure resulting in power-loss. The dressing of propeller blades should be done following the propeller manufacturer's recommended procedures. Excessive dressing could alter the airfoil shape of the propeller blades to the point where propeller efficiency is lost, causing insufficient propeller thrust. In the case of a twin engine aircraft that loss of thrust could prevent the aircraft from maintaining flight with one engine inoperative.

5. SUMMARY. Through the individual and collective efforts of the aviation community, we hope to eliminate factors that have caused engine power-loss accidents. This advisory circular is one of many efforts to try to reduce the "power loss" type of accidents. The simple act of "keeping the engine running" could appreciably reduce the number of accidents.



M. C. Beard
Director of Airworthiness

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ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: CERTIFICATION PROCEDURES FOR PRODUCTS AND PARTS

1. PURPOSE. This circular is to provide information concerning Section 21.303 of Federal Aviation Regulations (FAR) Part 21 and to set forth examples, as necessary, of acceptable means of compliance with its requirements. The material presented herein is intended for guidance and information only.

2. CANCELLATION. Advisory Circular 21-303.1 dated 3/2/66, "Replacement and Modification Parts" is cancelled.

3. REFERENCES. FAR Parts 1, 13, 21, 23, 25, 27, 29, 31, 33, 35, 45, and 183.

4. DEFINITIONS. As used herein, the following definitions apply:

   a. Regional Offices - The Engineering and Manufacturing Branch of the Federal Aviation Administration region in which the manufacturer is located (in the Western Region, the Aircraft Engineering Division.

   b. District Offices - The Engineering and Manufacturing District Office (EMDO) responsible for evaluation and inspection of the manufacturer's facilities (in the Western Region, the Aircraft Engineering District Office).

   c. Suppliers - Any person who furnishes articles or services related to the manufacturer of a part.

   d. Part - The replacement or modification part, material, component, or assembly for which design approval has been obtained and which is being produced under the provisions of FAR 21, Section 21.303, including proprietary parts not designed or manufactured by the PMA holders.

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e. Article - A material, component, or assembly used in a part, as specified in the approved design data.

5. GENERAL. This circular will cover only those sections of Subpart K where further discussion, information, and examples would be helpful in providing an acceptable means of compliance. The heading of each of the following paragraphs refer to the applicable sections of Subpart K.

6. PARTS MANUFACTURERS APPROVAL (PMA) - FAR 21.303(d).

a. An FAA-PMA letter will be issued after the FAA determines that the applicant has met the airworthiness requirements of the applicable Federal Aviation Regulations, and

b. The applicant submits a statement certifying that he has established the fabrication inspection system required by FAR 21.303(d). The certifying statement may be submitted later than the submittal of the design data required in FAR 21.303(c).

c. After issuance of a PMA letter, the FAA will conduct periodic inspections of the manufacturer's facilities, which may include his suppliers, to determine that the fabrication inspection system is being maintained as required by FAR 21.303(h). These periodic inspections will be the responsibility of the district office.

7. ADDITIONAL APPROVALS.

a. If a manufacturer obtains design approval for additional parts, he may have them added to his PMA letter by following the same procedure as for original issuance. The FAA will issue a supplementary letter, adding the new parts to the original approval.

b. A PMA letter may be issued for modifying (or performing processes on) new or used parts, for example, chrome plating of engine cylinder barrels or machining existing parts to another configuration. In such cases, the PMA letter will authorize approval identification of ONLY the work accomplished in conformity to FAA-approved design data. The complete part can be identified as approved ONLY if the approved design data is in the detail necessary to make a 100 percent conformity determination for the complete part, as well as the process or modification which was performed.

c. Following issue of the PMA letter, the manufacturer is eligible to apply for the appointment of qualified individuals as Designated Manufacturing Inspection Representatives (DMIR) to issue airworthiness approval tags when required for export of parts (reference FAR 183).

8. DESIGN APPROVAL - FAR 21.303(c).

a. Data Requirements - Any person may apply for parts manufacturer approval by submitting any of the following to the regional office.

(1) Evidence of a licensing agreement with the holder of a type or supplemental type certificate, together with all of the design data covered by the licensing agreement.

(2) Detailed drawings, together with test or other substantiating data showing that the part design complies with the applicable airworthiness requirements of the FAR.

(3) Data substantiating that parts produced will be identical in all respects to the corresponding part of an approved type design. If the applicant can show that each part that he wishes to have approved is identical in design, material, and processing to the corresponding approved part, the FAA will approve the applicable data. When the data submitted does not substantiate identicalness, it will be returned to the applicant with a notification that it does not conform with the approved type design. The FAA will reserve the right to require substantiation in accordance with 8(a)(2) when in its opinion the airworthiness of a critical part or design cannot be assured by the mere showing of identicalness to an approved design, or when a part or design to which identicalness is being shown is not performing satisfactorily in service.

b. Part Numbering - When design approval for a part is requested on the basis of identicalness, the applicant may use the same part number used by the type or supplemental type certificate holder. In this case an acceptable method would be to include a letter prefix added to the part number to identify the manufacturer. A part that is not identical to the part approved for the type or supplemental type certificate holder should carry a different part number. In this case, or in the case where the applicant chooses to use a different part number, the Federal Aviation Administration notification of part manufacturer approval will show the type approved part number with which the applicant's part is interchangeable.

9. AIRWORTHINESS REQUIREMENTS - FAR 21.303(d).

a. The applicant should determine that his design meets the airworthiness requirements of the Federal Aviation Regulations applicable to the product on which the part is to be installed. Airworthiness standards may be found in the following Federal Aviation Regulations:

(1) FAR 23, Airworthiness Standards: Normal, Utility, and Acrobatic Category Airplanes

(2) FAR 25, Airworthiness Standards: Transport Category Airplanes.

(3) FAR 27, Airworthiness Standards: Normal Category Rotorcraft

(4) FAR 29, Airworthiness Standards: Transport Category Rotorcraft

(5) FAR 31, Airworthiness Standards: Manned Free Balloons

(6) FAR 33, Airworthiness Standards: Aircraft Engines

(7) FAR 35, Airworthiness Standards: Propellers

b. Identification of PMA Parts. Identification of approved parts requires compliance with FAR 45.15. Design approval by the FAA does not fulfill this requirement since design approval covers only the drawings and other pertinent data and NOT physical parts. In view of the definition applied to the term "approved" in FAR Part 1, a person is not eligible to identify the parts he produces as "approved" parts unless he is so authorized by the FAA. Such authorization is provided by the issuance of a parts manufacturer approval (PMA) letter to the manufacturer for specified parts. An acceptable means of identifying such parts as approved parts is to permanently and legibly mark each part with the symbol "FAA-PMA" (Federal Aviation Administration - Parts Manufacturer Approval). This information should be shown in the PMA design data since it forms the standard for marking of the part. FAR 45.15 provides for other identification data which may be prescribed, as appropriate, in connection with each individual approval.

10. FABRICATION INSPECTION SYSTEM DESCRIPTION. The description may be in any form; however, for durability and easy reference, it is suggested that it be in the form of a manual, indexed as necessary, describing the methods, procedures, inspections, and tests which the applicant and his outside manufacturers and suppliers intend to use to meet the requirements of FAR 21.303(h)(1) through 21.303(h)(9). The description might result in a lengthy document, or it might contain only a few pages, dependent upon the size of the manufacturer's facilities and the number and complexity of parts being manufactured. In describing the inspection system, references to other documents or data maintained by the applicant may be utilized in lieu of detailed description of a particular procedure, provided that a brief description is also included in the manual and the referenced documents provide a complete description of the system. For record purposes, the description should also include a facsimile of the manufacturer's symbol or trademark, if one is used. The following paragraphs, headed by the section of FAR 21 to which they apply, provide an example of the material usually found in an acceptable fabrication inspection system description.

a. FAR 21.303(h)(1). The portion of the fabrication inspection system, which is established to comply with this section, would usually include the procedures that ensure conformity to approved design data of all supplier-furnished material, which is considered to include articles and services. Generally, this part of the fabrication inspection system description would describe the manner by which the manufacturer ensures that:

(1) All incoming articles conform to approved design data prior to their acceptance and release to production.

(2) Provisions are made for the evaluation and surveillance of suppliers by the manufacturer when he relies to any degree upon a supplier's inspection system or has delegated inspection duties to the supplier. The surveillance of suppliers of proprietary parts must be commensurate with the criticalness of the part.

(3) Suppliers, including suppliers of proprietary parts, to whom he relies for controlling conformity and quality, are formally advised that their inspection system and articles being supplied are subject to inspection by the FAA since, in effect, such suppliers constitute extensions of the manufacturer. When a foreign supplier is involved, the FAA will determine whether or not it will require the performance of any FAA duties at the foreign supplier's facilities and, if it does, whether it would result in an undue burden being placed on the FAA. If such FAA duties would be required, either a mutually acceptable means of relieving any undue burden must be found, such as under SFAR 26, or it will be necessary for the manufacturer to perform all required functions in the U.S. so that the FAA can carry out its responsibilities.

(4) Positive control is exercised over the design configuration and safe operating condition of all articles obtained from suppliers who hold an FAA production approval, or a repair station certificate for the article involved.

(5) All material review actions and design changes made by suppliers, including suppliers of proprietary articles over which the manufacturer does not exercise design control, are evaluated by the manufacturer and approved as applicable in accordance with FAR 21.303(d).

(6) Records are maintained of all inspections and tests performed by or for the manufacturer in controlling the conformity of all supplier-furnished articles.

(7) All incoming articles and services, including related inspection and test records, are identified with appropriate acceptance, rejection, or rework stamps as applicable.

b. FAR 21.303(h)(2). The inspection system description would include the system the manufacturer utilizes, with respect to compliance with this section, to ensure that the physical and chemical properties of incoming material are as specified in the approved design data.

c. FAR 21.303(h)(3). An acceptable description of the storage and issuance system established by the manufacturer would normally include the procedures which ensure:

(1) Identification, segregation, and protection of materials and articles in storage;

(2) Periodic reinspection and disposition of materials subject to deterioration from prolonged storage;

(3) Protection from damage of materials and of articles being delivered to fabrication or shipping areas and while stored in fabrication areas prior to use;

(4) Incorporation of all applicable design changes prior to release of stored articles for installation in the part; and

(5) That only those materials and articles which are identified as having passed company inspection are received into and issued from finished stores.

d. FAR 21.303(h)(4). The integrity of processes and services utilized in the manufacture of articles and parts is usually dependent upon the skill with which the work is performed, the capabilities of the equipment used, and close control of temperatures, solutions, curing time, or other critical factors. Normally, a system to control processes and services, such as welding, brazing, heat treatment, plating and radiographic, ultrasonic, or magnetic particle inspection, etc., requires that each process be performed by trained and qualified personnel and in accordance with approved specifications containing definitive standards of quality, and that periodic inspection of gauges, solutions, or any critical equipment is controlled and documented. The description with respect to this section in the inspection system manual should explain the procedure by which the manufacturer will control processes performed at his own facilities, as well as by his suppliers and would generally include a listing of manufacturing processes which are relied upon to assure quality, conformity, and safety of the completed parts.

e. FAR 21.303(h)(5). Compliance with this section usually requires that procedures be established to control all phases of inspection of the part. The inspection system description would, therefore, provide descriptions of all such procedures established by the manufacturer to ensure that all inspections and tests will be conducted in the proper sequence, when articles and processes are in an inspectable condition, for example, prior to painting or closures. This is generally achieved through use of inspection instructions, shop travellers, checklists or similar media. Following are examples of inspection functions which would be described to the extent applicable to the complexity of the parts or size of the manufacturer's facilities.

(1) Planning Procedures. Such procedures would ensure that each article used in the part is adequately inspected for conformity with the approved design. This function of the planning system would be facilitated if it provided for:

(a) Classifying design characteristics and related manufacturing defects to determine their criticalness so that the most effective fabrication inspection methods and process controls will be used with respect to critical and major characteristics and defects. (Reference FAR 21.93, MIL-STD-105 and MIL-STD-414.)

(b) Selection of appropriate inspection methods and plans for each classification to ensure that all characteristics affecting safety will be inspected and reinspected to ensure conformity to approved design data and to eliminate discrepancies from articles and completed parts.

(2) Inspection Status. This system would ensure that appropriate stamps or marks are placed on articles to indicate their inspection status. It would be helpful if this portion of the description also contains copies of all inspection forms, checklists, and imprints of the various inspection and process stamps and their meanings. Procedures normally call for suitable acceptance, rework, or rejection stamps to be placed on:

(a) Articles which have been subjected to a process such as heat treatment, welding, bonding, etc., or testing and inspection which may include hardness tests, laboratory analysis, magnetic particle inspection, or similar functions;

(b) Articles which have been inspected at the specified point in production and are found in conformity with the approved design; and

(c) Articles which are rejected as being unusable or scrap so as to preclude absolutely their installation on the part.

(3) Tool and Gauge Control. This system would provide control over periodic inspection and calibration of inspection tools, gauges, testing equipment, production jigs, fixtures, templates, etc., which are depended upon as media for inspection. The description of the means utilized for tool and gauge control would normally include a schedule of periodic inspection and calibration intervals to ensure that tools, gauges, etc., which are depended upon as media for inspection, are inspected, adjusted, repaired, or replaced prior to their becoming inaccurate. The inspection system description would also describe the procedures for implementing the tool and gauge control schedules. Such procedures would basically ensure that each piece of equipment is:

(a) Checked prior to first usage at the proper periodic interval and marked to indicate the date that the next inspection is due, and

(b) Removed from inspection and shop areas or conspicuously identified to prohibit usage after expiration of the inspection due date.

(4) Final Inspection. This function of the inspection system would ensure that each completed part is subjected to a final inspection to determine conformity with approved design data, compliance with applicable FAA airworthiness directives or manufacturer's service bulletins issued in lieu of airworthiness directives, and whether the part is safe for installation on type certificated products. Such a system would usually incorporate procedures to ensure that:

(a) Each part is inspected for completeness, adjustments, safety, calibration, markings, placards, etc., as applicable to the complexity of the part.

(b) If applicable, each completed part is subjected to a functional test to ensure that the operating characteristics meet the approved design provisions.

f. FAR 21.303(h)(6). The description of the system established for compliance with this rule normally includes the procedures utilized to ensure that drawings and data which are obsolete, or affected by superseding data, FAA airworthiness directives, or manufacturer's service bulletins are promptly removed from production and inspection areas or otherwise controlled to prevent their improper use.

g. FAR 21.303(h)(7). The description of the drawing change controls required by this regulation should include procedures to ensure that, prior to final acceptance of articles and completed parts, all changes required to be FAA approved have been approved and are incorporated in the applicable drawings or covered by change notices attached to such drawings. The inspection system manual would, therefore, normally include a section describing the drawing change control system which the manufacturer has established.

h. FAR 21.303(h)(8). The description of the procedures established for compliance with this regulation normally includes provisions for engineering evaluation of rejected materials and articles to determine whether they can be reworked, repaired, or accepted "as is" without affecting the airworthiness of the part. Approval of changes would be in accordance with FAR 21, Subpart D, as applicable to the classification of change involved.

i. FAR 21.303(h)(9). Compliance with this section requires that procedures be established for maintaining inspection records. This includes all inspections accomplished on the parts from raw materials to finished parts. There should be a procedure established for identifying inspection records where practicable with parts, such as serial numbers, dates, codes, etc. The manufacturer must file and retain the inspection records for a period of at least two years after the part has been completed.

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