CHAPTER 1. POWERPLANT

AIRWORTHINESS COMPLIANCE CHECK SHEET #1

1. SUBJECT: Generator Installation - FAR 23 Aircraft

2. APPLICABLE FEDERAL AVIATION REGULATIONS

23.611 Inspection Provisions
23.1163 Powerplant Accessories
23.1351 Electrical System Installation, Generator Controls
23.1361 Master Switch Arrangement

Generator installations which are the same as those made by the airframe manufacturer, or other installations which are already approved, may be accepted without further investigation. On other installations, the following points should be checked to determine that the installation is satisfactory.

3. CHECKLIST

a. Structural Requirements:

(1) When the generator is mounted on an engine accessory pad, are its weight and overhang moment within the rating of the pad? (FAR 23.1163.) (Maximum weight and overhang moments for engine accessory drive pads are normally listed on the engine specifications.)

b. Hazards to the Aircraft or its Occupants:

(1) When the generator is mounted on an engine accessory pad, is the maximum continuous torque load on the drive shaft within the rating of the pad? (FAR 23.1163, FAR 23.1351.) The maximum continuous torque rating of the pad is normally listed on the engine specifications. To determine the maximum continuous torque applied by the generator use the following equation:

$$T = \frac{8460\ VI}{eSL}$$

Where T = maximum continuous torque (in pound - inches)
V = regulated system voltage (volts)
I = rated generator current (amperes)
*e = generator efficiency (percent)
SL = lowest generator speed (RPM) at which rated generator current and voltage can be maintained.

*60% should be used unless generator manufacturer's data shows a higher value.

(2) When the generator is mounted on an engine accessory pad, is the shear section on the generator such that it

will fail at a torque lower than the maximum static torque of the engine pad? (FAR 23.1163) (The maximum static torque for accessory pads is normally listed in the engine specifications.)

(3) Is the generator installed so as to minimize the possibility that arcing or sparks may come in contact with flammable fluids or vapors in a free state? (FAR 23.1163.)

NOTE: An evaluation should be made of the possibility of sparks or hot air from the generator cooling air outlets coming in contact with flammable fluids. An example would be locating the generator beneath an engine-driven fuel pump not properly fitted with overboard drain lines. A seal leak developing in the fuel pump could result in a fire.

(4) Is the electrical cable or wiring of the proper size for the electrical load involved and is it installed so as to minimize the possibility of fire or smoke? (FAR 23.1351.)

NOTE: AC 43.13-1 Chapter 11.

(5) If electrical wiring or equipment is installed near the compass, was the compass checked for possible error? (FAR 23.1351.)

(6) Can maximum engine RPM be attained without danger of overspeeding the generator? (Refer to the generator nameplate, engine specifications and engine operating instructions for evaluation information.)

c. Operating Aspects:

(1) When the generator is required by the operating rules for operation under IFR, is its capacity sufficient to supply all probable combinations of continuous loads with adequate reserve for battery charging? Output ratings should be compared to maximum probable loads per AC 43.13-1, paragraph 238. (FAR 23.1351.) In no case shall the output exceed 80% of total rated generator capacity.

(2) Is the voltage regulator (associated with the generator) capable of maintaining rated voltage over the range of probable engine speeds at full electric system load? (FAR 23.1351.)

(3) Is the master switch provided which will disconnect the generator from the main distribution system at a point adjacent to the generator? (FAR 23.1361.)

d. Detail Design Standards:

(1) Is the generator installed so as to permit inspection of the condition of the brushes and wiring terminals without removal of adjacent equipment? (FAR 23.611.)

(2) Is the generator installed so as to be protected from fuel, oil, water, and other detrimental substances and mechanical damage? (FAR 23.1351.)

AIRWORTHINESS COMPLIANCE CHECK SHEET #2

1. SUBJECT: Generator Installations - FAR 25 Aircraft

2. APPLICABLE FEDERAL AVIATION REGULATIONS

25.611 Inspection Provisions
25.1163 Powerplant Accessories
25.1309 Equipment, Systems, and Installations
25.1351 Electrical System Capacity

Generating System

25.1357 Electrical Protection

Generator installations which are the same as those made by the airframe manufacturer, or other installations which are already approved, may be accepted without further investigation. On other installations, the following points should be checked to determine that the installation is satisfactory.

3. CHECKLIST

a. Structural Requirements:

(1) When the generator is mounted on an engine accessory pad is its overhang moment within the rating of the pad? (FAR 25.1163.) Maximum overhang moments for engine accessory drive pads are normally listed on the engine specifications.

b. Hazards to the Aircraft or its Occupants:

(1) When the generator is mounted on an engine accessory pad, is the maximum continuous torque load on the drive shaft within the rating of the pad? (FAR 25.1163.) (The maximum continuous torque rating of the pad is normally listed on the engine specification.) To determine the maximum continuous torque applied by direct current generators, use the following formula:

$$T = \frac{8460\ VI}{eSL}$$

Where T = maximum continuous torque (in pound-inches)

V = regulated system voltage (volts)
I = rated generator current (amperes)
e = generator efficient (percent); 60% should be used unless generator manufacturer's data shows higher value.
SL = lowest generator speed (RPM) at which rated generator current and voltage can be maintained.

(2) When the generator is mounted on an engine accessory pad, is the shear section on the generator such that it will fail at a torque lower than the maximum static torque of the engine pad? (FAR 25.1163.) (The maximum static torque for accessory pads is normally listed in the engine specifications.)

(3) Does the rated continuous rotational speed of the generator correspond approximately with drive shaft RPM when the engine is operated at cruise RPM? (FAR 25.1163.)

(4) Is the generator installed so as to minimize the possibility that arcing or sparks may come in contact with flammable fluids or vapors in a free state? (FAR 25.1163.)

(5) Is the generating system (including regulators and controls) so designed that no probable malfunction can result in permanent loss of electrical service to utilization systems which are necessary to maintain controlled flight or effect a safe landing? (FAR 25.1351.)

(6) Is the generating system provided with a device which will disconnect a generator which produces hazardous over-voltage? (FAR 25.1357.) (By hazardous overvoltage is meant an overvoltage of such magnitude and duration as could render essential electrical equipment inoperative.)

c. Operating Aspects:

(1) Are the generators so rated and distributed among the engines that the electric power system is capable of supplying (in probable operating combinations and for probable durations) (a) all loads connected to the system with the system functioning normally? (b) all essential loads after failure of any one engine, generator or storage battery? (c) all essential loads after failure of any two engines on four-or-more-engine airplanes? (FAR 25.1309, and 25.1351.)

NOTE: A load is defined as essential when its functioning is necessary in showing compliance with the regulations (FAR 25.1309.) Load reduction is permissible if the generators can safely handle any temporary overload condition

and if the crew is warned that partial electric power system failure has occurred (FAR 25.1351). If a particular load is not required to maintain controlled flight, it need not be considered as an essential load in condition (c) above. (FAR 25.1309.)

(2) Are accessible controls provided to permit independent disconnection of each generator from the electric power system during flight? (FAR 25.1351.)

(3) Are the generator controls (provided in (b) above) so grouped so as to permit expeditious disconnection of all generators? (FAR 25.1351.)

(4) Are means provided to indicate to appropriate crew members those generating system quantities which are essential for safe operation of the system? (For direct current systems, the voltage and current supplied by each generator are considered essential.) (FAR 25.1351.)

d. Detail Design Standard:

(1) Is the generator capable of withstanding the probable extremes in environmental conditions to which it will be subjected? (FAR 25.1353.)

Environmental conditions which should be considered would include vibration, temperature, altitude, and cooling.

(2) Is the generator installed so as to permit inspection of the condition of the brushes and wiring terminals without removal of adjacent equipment? (FAR 25.611.)

AIRWORTHINESS COMPLIANCE CHECK SHEET #3

1. SUBJECT: Wind-Driven Generator Installations - FAR 23 Aircraft

2. APPLICABLE FEDERAL AVIATION REGULATIONS

23.611	Inspection Provisions
23.1351	Electrical System Installation
23.1361	Master Switch Arrangement
23.301	Strength Requirements, General
.303	
.305	
.307	
23.321	Flight Loads
23.471	Ground Loads
23.601	Design and Construction, General
.603	
.605	
.607	

.609
.611
23.629 Flutter and Vibration Prevention
91.167 Test Flight Passenger Provisions

3. CHECKLIST

a. Structural Requirements

(1) Is the installation satisfactory for the required loads? (FAR 23.301, .303, .305, .307, .321, .471)

Note: Wind-driven generators can be installed preferably by attachment to fuselage structural members. Engine mount or landing gear attach fittings are usually utilized, though unit supporting structure (bracketry) has successfully been extended from other structural strong points. MOUNTING ON WING-LIFT STRUTS SHOULD BE AVOIDED. INSTALLATIONS OF THIS TYPE HAVE CAUSED STRUT FAILURES RESULTING FROM FATIGUE BROUGHT ON BY VIBRATION CHARACTERISTICS. To maintain structural integrity, the installation should be adequate to withstand the required loads. In lieu of a calculated value of these loads, the following ultimate values in "g's" may be used.

	Normal and Utility	Acrobatic
Fwd	1.65	2.25
Up	3.0	4.5
Side	1.5	1.5
Down	6.6	9.0

With a relatively lightweight generator installation a reasonably accurate check of these values can usually be made by grasping the installation by hand and pulling or pushing in the required direction.

(2) Are the flutter or vibration characteristics of the installation satisfactory? (FAR 23.629)

Note: The relatively light weight of these installations should not normally affect the flutter and vibration properties of the airplane as a whole. There is a possibility, however, of unit vibration being transmitted to the airplane. This should be checked on the ground during taxiing and in flight up to V sub NE. If a generator brake is installed, the tests should be accomplished with the propeller fixed as well as windmilling. V sub NE should be approached with caution during these tests. (FAR 91.167)

b. Hazards to the Aircraft and Its Occupants

(1) Is the electrical cable or wiring of the proper size for the electrical load involved and is it installed so as to minimize the possibility of fire or smoke? (FAR 23.1351, AC 43.13-1)

(2) If electrical wiring or equipment is installed near the compass, was the compass checked for possible error? (FAR 23.1351)

(3) If the generator is so located that the extended propeller disc will intersect any portion of the pilot or passenger, are such persons adequately protected from injury due to a flying generator propeller blade? (FAR 23.1351)

(A sheet of .032 heat treated aluminum alloy or .25 inch plywood is considered sufficient to furnish adequate protection.)

c. Operating Aspects

(1) When the generator is required by the operating rules (for operation under Instrument Flight Rule), is its capacity sufficient to supply all probable combinations of continuous loads with adequate reserve for battery charging? Output ratings should be compared to maximum probable loads per AC 43.13-1, paragraph 238. (FAR 23.1351, FAR 23.1351)

(2) Is the generator propeller correct for developing the required output in relation to aircraft airspeed? (FAR 23.1351)

(3) Is the voltage regulator (associated with the generator) capable of maintaining voltage within rated limits at cruise airspeeds with full electric system load applied?

(4) Are there automatic means provided to prevent current from flowing from the battery into the generator when the generator voltage becomes lower than the battery voltage? (FAR 23.1351)

(This function is normally provided by the regulator or generator control unit.)

(5) Is a master switch provided which will disconnect the generator from the main distribution system at a point adjacent to the generator? (FAR 23.1361)

d. Detail Design Standard

(1) Is the generator installed so as to permit inspection of the condition of the brushes and wiring terminals without removal of adjacent equipment? (FAR 23.611)

(2) Is the generator installed so as to be protected from fuel, oil, water, and other detrimental substances and mechanical damage? (FAR 23.1357)

(3) Is the material used in the installation satisfactory for the purpose intended and of an approved type, and is the workmanship of a high standard? (FAR 23.603)

(Approved materials are those produced to a government specification or established industry standard.)

(4) Will the method of fabrication used result in a consistently sound structure and are standard fasteners (approved type; i.e., AN, NAS, SAW, MIL, etc.) used? (FAR 23.605, 23.607)

(5) Are all members suitable protected against weathering, corrosion, and abrasion? Particular care should be taken with seaplanes where parts of different metals are in close proximity. (FAR 23.609)

AIRWORTHINESS COMPLIANCE CHECK SHEET #4

1. SUBJECT. Motor and Dynamotor Installations - FAR 25 Aircraft.

2. APPLICABLE FEDERAL AVIATION REGULATIONS.

21.305 Approval of Materials, Parts, Processes and Appliances
25.301 Loads
25.303 Loads
25.305 Strength and Deformation
25.307 Proof of Structure
25.321 Flight Loads
25.365 Flight Loads
25.367 Flight Loads
25.471 Ground Loads
25.473 Ground Loads
25.489 Ground Loads
25.491 Ground Loads
25.499 Ground Loads
25.503 Ground Loads
25.507 Ground Loads
25.511 Ground Loads
25.561 Emergency Landing Conditions
25.603 Materials
25.605 Fabrication Methods
25.607 Standard Fastenings
25.609 Protection
25.611 Inspection Provisions
25.615 Material Strength Properties and Design Values
25.863 Flammable Fluid Fire Protection
25.1309 Equipment, Systems, and Installations
25.1357 Electrical Protection
25.1353 Electrical Equipment and Installations

25.1359 Electrical System Fire and Smoke Protection

Motor or dynamotor installations which are the same as those made by the airframe manufacturer, or other installations which are already approved, may be accepted without further investigation. On other installations the following points should be checked to determine that the installation is satisfactory.

3. CHECKLIST.

a. Structural Requirements.

(1) Is the equipment installed in such a manner that the installation can withstand the required loads? The effect on other structure (primary or secondary) should be considered. (FARs 25.301, 25.303, 25.305, 25.307, 25.321, 25.365, 25.367, 25.373, 25.471, 25.473, 25.489, 25.491, 25.499, 25.503, 25.507, 25.511).

NOTE: This answer can be determined by a direct comparison with an existing approved installation having the same or similar (approximately same weight and size) equipment installed, by structural analysis, or by static test.

Such installations do not necessarily lend themselves to analysis but are adaptable to static test. In conducting this test, the following procedure may be used:

(a) Determine the weight and c.g. of the equipment.

(b) Mount the equipment in the position in the airplane or simulate the equipment with a dummy so that the required loads can be applied at the c.g. position of the actual equipment.

(c) The required loads should then be applied by any suitable means. If the equipment is light in weight, the inspector could use his own strength and/or weight to determine that the installation will withstand the required loads.

All items of mass which would be apt to injure the passengers or crew in the event of a crash landing should have their supporting structure designed to the crash load requirements or the applicable critical flight or landing load factors of FAR 25.301, 25.303 or 25.471, 25.473, 25.489, 25.491, 25.499, 25.503, 25.507, 25.511, whichever is greater.

Supporting structure of other mass items should be designated to the critical flight or landing load factors of FAR 25.301, 25.303, or 25.471, 25.473, 25.489, 25.491, 25.499, 25.503, 25.507, 25.511. The values shown in FAR 25.561 may be used in lieu of a

determination of these values.

(2) Are suitable materials used in the construction, including standard fasteners, and will the method of fabrication result in a consistently sound structure? (FAR 25.603, 25.605, 25.607, 25.615, 21.305)

(3) Are means provided to permit proper inspections of the installation and related or adjacent parts and components? (FAR 25.611)

b. Hazards to the Aircraft and its Occupants

(1) Is a fuse or circuit breaker of the appropriate rating installed in the connecting cables? (FAR 25.1357)

(2) If a circuit breaker is installed, is it of a type which will open the circuit irrespective of the position of the control in case of a fault? (FAR 25.1357)

(3) If the motor or dynamotor performs a function essential to safety, is its circuit protective device (fuse or circuit breaker) located so that it is accessible for replacement or resetting in flight? (FAR 25.1357)

(4) Are any connecting cables, which are necessary in emergency procedures and located in designated fire zones, fire-resistant? (FAR 25.1359)

An accepted criterion for "fire-resistant" is that the cable should withstand a 2000 degree F. oxidizing flame impinging on its surface for at least 5 minutes without adverse effect on the circuit function. The 2000 degree F. oxidizing flame should envelop at least a 12 inch section of the cable, using a test setup simulating the actual aircraft installation. Thermocouples for measurement of flame temperature should be located within one-fourth inch of the surface exposed to the flame.

(5) If the motor or dynamotor is located in areas of the airplane where flammable fluids or vapors might be liberated by leakage or failure in fluid systems, are design precautions made to either prevent ignition of such fluids (due to operation of the motor or dynamotor) or to control any fire resulting from such ignition? (FARs 25.863 and 25.1359)

(6) If a probable malfunction in motor or dynamotor can generate hazardous quantities of smoke within the cabin, are adequate means provided to detect the faulty machine and to disconnect it from the source of power? (FAR 25.1359.)

c. Operation Aspects:

None

d. Detail Design Standards:

(1) If the motor or dynamotor performs a function which is essential to safety, will this function be performed reliably under all reasonably foreseeable environmental conditions? (FARs 25.1309 and 25.1353)

NOTE: Environmental conditions may include extremes of temperature, pressure, humidity, ventilation, position, acceleration, vibration and presence of detrimental substances.

(2) Are adequate means provided to examine the equipment to determine brush condition and for lubrication, if required? (FAR 25.611)

AIRWORTHINESS COMPLIANCE CHECK SHEET #5

1. SUBJECT: Engine Lubrication Oil Filter Installation - FAR 23 Aircraft

2. APPLICABLE FEDERAL AVIATION REGULATIONS:

23.301 Loads
23.1017 Oil system lines, fittings, and accessories
23.1019 Oil filters
23.1021 Oil system drains
23.1121 Exhaust system, general
23.1183 Lines and fittings
23.1337 Instrument lines

Engine lubricating oil filters designed to remove solid particles and other contaminants from the oil during circulation are of two general types: (a) full flow filters in which the entire flow of oil passes through the filter, and (b) bypass filters in which a small portion of the total oil flow is diverted through the filter and returned to the engine sump or oil tank.

The installation of an oil filter shall not be a substitute for the engine screen, strainer, or cleaner provided by the engine manufacturer, unless the installation has been evaluated by the engine manufacturer and found to provide equivalent or better protection. Oil filter installations approved on an STC have been coordinated with the engine manufacturer and are acceptable in lieu of the engine screen. Filter installations which are the same as those made by the engine or aircraft manufacturer, or other installations which are already approved for a particular model of aircraft or engine, may be accepted without further investigation. On other installations, the following points should be checked to determine that the installation is satisfactory.

3. CHECKLIST

a. Structural Requirements

(1) If the filter housing is mounted on existing structure or on a bracket attached to such structure, is all of the structure adequate to support the required loads? (FAR 23.301.)

b. Hazards to the Aircraft and its Occupants

(1) Is the pressure line to the filter 1/provided with a restricted orifice at the point of pressure takeoff at the engine, to minimize escape of oil in case of connecting line failure? (FAR 23.1337)

1/This applies to a bypass filter only, since a restricted orifice would prevent the proper oil flow rate through a full flow filter.

(2) Are the filter and connection lines installed away from or under the exhaust system to minimize the possibility of oil leakage contacting the exhaust manifold? (FAR 23.1121)

c. Operating Aspects:

(1) Does an investigation, at all power ratings, of the engine oil pressure prior to and subsequent to the filter installation indicate that there is no difference in engine oil pressure? (FAR 23.1019)

d. Detail Design Standards

(1) If the filter is mounted in the engine compartment, are the lines and fittings (which are under pressure, or which attach directly to the engine, or which are subject to relative motion between components) flexible, fire-resistant lines with fire-resistant end fittings of the permanently attached, detachable or other approved type? (FARs 23.1017 and 23.1183)

(2) Is the filter * constructed so that complete stoppage of flow through the filter element will not jeopardize the continued operation of the engine oil supply system? (FAR 23.1019)

* Not a critical item for a bypass filter, since the oil circulation system will continue to function even if the filter is completely clogged. A full flow filter must be equipped with a flow relief valve that opens when a preset differential pressure across the filter element is exceeded. This condition will exist for starting when the oil is cold and, also, when the service life of the filter element is reached and no additional solids can be retained by the filter

element.

(3) Has the filter been substantiated for the pressure to which it will be subjected when installed? (FAR 23.1019)

(4) If the filter housing is equipped with a drain, does the drain plug or valve incorporate means for positive locking or safetying? (FAR 23.1021)

(5) If the filter housing is equipped with a removable cover, does the cover wing nut or bolt incorporate means for locking after tightening? (AC 43.13-1, Chap. 5-127)

AIRWORTHINESS COMPLIANCE CHECK SHEET #6

1. SUBJECT: Modification of an Airplane to Replace the Engine Exhaust System With One of New Design - FAR 23 Aircraft

2, APPLICABLE FEDERAL AVIATION REGULATIONS

23.1121 Exhaust System - General
23.1123 Exhaust Manifold

The primary function of the exhaust manifold is to conduct exhaust gases overboard with minimum hazard to the airplane and pilot. The system must be reliable, exert a minimum back pressure, be accessible for inspection and not interfere with engine-cooling airflow. The material must be particularly suitable for operation under high temperature and corrosive effects of the gas, and the weight should be held to a minimum consistent with the needs of the system.

3. CHECKLIST

a. Structural Requirements:

(1) For any change or alteration of the airplane structure, have the original strength and integrity of the structure been retained? (AC 43.13-2 Chapter 1)

NOTE: If the specific alteration cannot be evaluated using AC 43.13 or equivalent reference, it should be referred to the Engineering Service Representative.

(2) Is the exhaust manifold properly supported and attached to the engine so that vibration and any other loads imposed during normal operation will not affect the service life of the manifold? (FAR 23.1123.)

NOTE: Brackets supporting the manifold should be properly attached to the engine. Attachment to any highly stressed components, such as cylinder hold-down studs, crankcase studs, and through bolts should be avoided.

b. Hazards to the Aircraft or its Occupants:

(1) Are any of the exhaust system components located near any systems carrying flammable fluids or vapors? (FAR 23.1121.)

(2) Where exhaust system components are unavoidably located near systems carrying flammable fluids or vapors, have suitable precautions been taken to preclude a fire hazard? (FAR 23.1121.)

(3) Are any drain lines or fittings which may be subject to leakage located over exhaust manifolds, thus creating a fire hazard? (FAR 23.1121.)

(4) Have fireproof shields been provided between the exhaust manifold and any flammable parts of the airplane structure? (FAR 23.1121.)

(5) Is the exhaust tailpipe so located so that glare could affect the pilot's visibility, particularly during night flight? (FAR 23.1121.)

(6) Is it possible for exhaust gas to enter any part of the airplane, particularly personnel compartments? (FAR 23.1121.)

NOTE: If the answer to item (6) is "yes" or questionable, the Engineering Service Representative should be contacted to conduct tests to determine if carbon monoxide contamination of cabin air is occurring. Carbon monoxide content should not exceed one part in 20,000.

c. Test Procedure to Determine CO Content:

(1) A carbon monoxide indicator should be used in determining compliance with the above requirement. The instrument manufactured by the Mines Safety Appliance Company or the Bulb Type Colorimetric Indicator may be used for this purpose, one of which is located at each Flight Engineering and Factory Inspection Branch Office. The following procedure should be used:

(a) The aircraft should be flown in level flight at MC power or as nearly so as possible. Carburetor should be set full rich with all windows closed; readings should be taken in at least the following locations:

1 Along the floor (approximately 4 inches above) in front of each occupant.

2 On each side of the cabin approximately a foot forward of each occupant.

3 A few inches in front of each occupant's face.

4 In front of the cabin heater opening(s) with heat on.

(b) Conduct the same investigation as outlined in (a) 1 through 3 except with windows partially open, thus tending to produce a vacuum in the cabin.

(c) The aircraft should then be flown in a glide with power off (idling) and readings taken a few inches in front of each occupant's face with both windows open and closed as in paragraph (b)?

(d) The highest reading obtained at any of the above points shall not exceed .005%.

d. Operating Aspects:

(1) Does the new exhaust manifold appear to be substantially the same in design dimensions and attachment as the old one?

NOTE: Check the following in making this comparison:

(a) Has the arrangement been changed?

(b) Has the diameter (cross sectional area) of any of the pipe sections been decreased?

(c) Has the length of any of the pipe sections been changed?

If the comparison reveals a substantial change, refer to the Engineering Service Representative for a back pressure test.

d. Detail Design Standards:

(1) Is the manifold constructed of suitable fireproof, corrosion-resistant material? (FAR 23.1123.)

(2) Will expansion due to operating temperatures result in failure of the components? (FAR 23.1123.)

(3) Where necessary, are provisions incorporated for flexibility? (FAR 23.1123.)

AIRWORTHINESS COMPLIANCE CHECK SHEET #7

1. SUBJECT: Modification of an Electric Starting System by Substitution of a Starter made by a Different Manufacturer, Assuming that the Size and Shape of the Engine Mounting Pad is Correct - FAR 23 Aircraft

2. APPLICABLE FEDERAL AVIATION REGULATIONS.

23.901 Components
23.1163 Powerplant Accessories
23.1351 Installation
23.1357 Fuses or Circuit Breakers

Consideration must be given to the fact that prescribed engine or starter mechanical limitations cannot be exceeded. Electrical limitations and devices such as relays, switches and the current carrying capacity of wires must also be evaluated.

3. CHECKLIST

a. Structural Requirements:

(1) Is the starter constructed, arranged and installed to assure continued safe operation of the airplane and powerplant? (FAR 23.901)

(2) Is the allowable weight and overhang moment of the starter less than that recorded in the engine specification for the applicable mounting pad? (FAR 23.1163)

NOTE: The overhang moment is the product of the weight (pounds) of the starter and the distance (inches) from the mounting end to the center of gravity of the starter.

b. Hazards:

(1) Does the starter incorporate electrical protective devices such as fuses or circuit breakers? (FAR 23.1357)

NOTE: Fuses are not required in the main circuits of the starter motor; therefore, either answer is acceptable. This question has been incorporated to make this information a matter of record.

(2) Are the switches, relays, engaging solenoids and wire size proper for the starter and the electrical service provided by the battery or ground power source? (FAR 23.1351)

(3) Is the starter motor installed so as to minimize contact with inflammables from fluid or vapor lines in the event or arcing or sparking of the motor?

c. Operational:

(1) Does the starter dog properly mesh and fully engage the engine dog, when the meshing cable or solenoid is actuated? (FAR 23.1163)

(2) Is there adequate clearance between the starter and

engine dogs in the fully retracted position, to prevent riding of the dogs? (Refer to manufacturer's instruction manual for clearance.) (FAR 23.1163)

d. Detail Design:

(1) Is the starter of a type that is acceptable under one of the following means?

(a) Qualification under an AN or MIL specification.
(b) Completing a qualification test approved by FAA.
(c) Prior satisfactory service record on another approved installation.
(FAR 23.1163)

(2) Will the starter dog turn in the direction of rotation required by the engine dog? (FAR 23.1163)

(3) Is the speed ratio of the starter accessory drive correct as recorded in the engine specification? (FAR 23.1163)

(4) Is the maximum static torque delivered by the starter less than that specified in the engine specification? (FAR 23.1163)

(5) Is the starter overload prevention mechanism satisfactory to permit engaging and disengaging in order to deliver sufficient but not excessive cranking torque to motor the engine? (FAR 23.1163)

(6) Is the starter clearance envelope satisfactory with respect to interference, accessibility, inspection, maintenance, removal, and electrical connections to be made? (FAR 23.901)

(7) Is the starter motor suitably protected from fuel, oil, water, and other detrimental conditions? (FAR 23.1351)

AIRWORTHINESS COMPLIANCE CHECK SHEET #8

1. SUBJECT: Battery Installations - FAR 23 Aircraft

2. APPLICABLE FEDERAL AVIATION REGULATIONS

23.301	Loads
23.307	Proof of Structure
23.337	Maneuvering Load Factors
23.341	Gust Load Factors
23.473	Load Factor for Landing Conditions
23.605	Fabrication Methods
23.613	Material Strength Properties and Design Values
23.561	Protection
23.1351	Batteries
23.1353	Storage Battery Design and Installation

Battery installations which are the same as those made by the airframe manufacturer, or other installations which are already approved, may be accepted without further investigation. On other installations the following points should be checked to determine that the installation is satisfactory.

3. CHECKLIST

a. Structural Requirements:

(1) Is the battery installed in such a manner that it can withstand the required loads? (FARs 23.301, 23. 337, 23.341, and 23.473.) (See paragraph (3) (b) below.)

(2) If a mounting bracket is used, will the method used in its fabrication produce a consistently sound structure? (FAR 23.605.)

(3) If the equipment is mounted either on existing structure or on a bracket attached to existing structure, is all of the structure (including the bracket, if used) adequate to support the required loads? (FAR 23.307, 23.613, and 23.561.) This answer can be determined by either of two methods:

(a) By direct comparison with an existing approved installation having the same or similar (approximately the same weight and size) equipment installed.

(b) By structural analysis or static test. Such installations do not lend themselves readily to analysis, but are normally adaptable to static test. In conducting a static test, the following procedure may be used:

1 Determine the weight and c.g. position of the equipment item.

2 Mount the equipment in its position in the airplane or simulate the equipment with a dummy so that the required loads can be applied at the c.g. position of the actual equipment.

3 The required loads should then be applied by any suitable means. If the equipment is light in weight, the inspector could use his own strength and/or weight to determine that the mounted equipment meets the required loads.
In accordance with FAR 23.561, all items of mass which would be apt to injure the passengers or crew in the event of a minor crash landing should have their supporting structure designed to the crash load requirements of FAR 23.561 insofar as the forward, upward, and sideward directions are concerned. The applicable downward load factor

shall be the critical flight or landing load factor specified in FAR 23.341 and 23.473. In lieu of a calculated determination of the down load factor, the ultimate factors of 6.6, 6.6, and 9.0 may be used for the normal, utility, and acrobatic categories, respectively. For equipment location not covered by FAR 23.561, the required loads (ref. FAR 23.301) are the flight and landing load factors of FARs 23.337, 23.341, and 23.473. In lieu of a calculated determination of these loads, the down load factors referenced above may be used.

(4) Is the equipment so installed that it does not adversely affect other structure (either primary or secondary)? (FAR 23.1431.)

b. Hazards to the Aircraft and its Occupants:

(1) Are the parts of the airplane adjacent to the battery protected against corrosion from any products likely to be emitted by the battery during servicing or flight? (FAR 23.1353.)

(Methods which may be used to obtain protection include: acid-proof paint which will resist corrosive action by emitted electrolyte, drain to discharge corrosive liquids clear of the aircraft, positive pressure vents to carry corrosive fumes outside the aircraft, enclosed battery cases which would contain any amount of electrolyte that might be spilled, or combinations of these methods.)

(2) Is the battery container or compartment vented in such a manner that any explosive gases released by the battery during flight are carried outside the airplanes?

(3) Is the battery container or compartment vented in such a manner that any noxious gases emitted by the battery are directed away from the crew and passengers?

(4) Are the battery connector terminals or other exposed parts protected against electrical contact with the battery container or compartment? (FAR 23.1351.)

c. Operating Aspects:

(1) If a battery is the only source of electrical power, does the battery have sufficient capacity to supply the electrical power necessary for dependable operation of all electrical equipment essential to the safe operation of the airplane? (FAR 23.1351.)

(The necessary capacity can be determined by assuming the loads (including nonessential loads) connected in probable combination and for probable durations under

those flight conditions which would require the greatest amount of electrical energy. The current drained from the battery will have different values during the flight. Obtain the average current and multiply by the maximum flight duration in hours. This is the ampere-hour capacity required for the battery at a discharge time rate equal to the maximum flight duration time of the airplane.)

d. Detail Design Standards:

(1) Is the battery accessible for inspection or servicing on the ground? (FAR 23.1353.)

AIRWORTHINESS COMPLIANCE CHECK SHEET #9

1. SUBJECT: Battery Installations - FAR 25 Aircraft

2. APPLICABLE FEDERAL AVIATION REGULATIONS

25.301	Loads
25.305	Strength and Deformation
25.307	Proof of Structure
25.321	Flight Loads
25.471	Ground Loads
25.561	Emergency Landing Conditions
25.603	Materials
25.605	Fabrication Methods
25.607	Standard Fastenings
25.609	Protection
25.611	Inspection Provisions
25.613	Material Strength Properties and Design Values
25.1353	Electrical Equipment and Installations

Battery installations which are the same as those made by the airframe manufacturer, or other installations which are already approved, may be accepted without further investigation. On other installations, the following points should be checked to determine that the installation is satisfactory.

3. CHECKLIST

a. Structural Requirements:

(1) Is the battery installed in such a manner that the installation can withstand the required loads? The effect on other structure (primary or secondary) should be considered. (FARs 25.301, 25.305, 25.307, 25.321, 25.471, and 25.561.)

NOTE: This answer can be determined by a direct comparison with an existing approved installation having the same or similar (approximately same weight and size)

equipment installed, by structural analysis, or by static test. Such installations do not necessarily lend themselves to analysis but are adaptable to static test. In conducting this test, the following procedure may be used:

(a) Determine the weight and c.g. of the equipment.

(b) Mount the equipment in the position in the airplane or simulate the equipment with a dummy so that the required loads can be applied at the c.g. position of the actual equipment.

(c) The required loads should then be applied by any suitable means. If the equipment is light in weight, the inspector could use his own strength and/or weight to determine that the installation will withstand the required loads.

NOTE: All items of mass which would be apt to injure the passengers or crew in the event of a crash landing should have their supporting structure designed to the crash load requirements of FAR 25.561 or the applicable critical flight or landing load factors of FARs 25.321, or 25.471, whichever is greater.

Supporting structure of other mass items should be designed to the critical flight or landing load factors of FARs 25.321, or 25.471. The values shown in FAR 25.561 may be used in lieu of determination of these values.

(2) Are suitable materials used in the construction, including standard fasteners, and will the method of fabrication result in a consistently sound structure? (FARs 25.603, 25.605, 25.607, 25.613, and 21.305.)

(3) Are means provided to permit proper inspections of the installation and related adjacent parts as components? (FAR 25.611.)

b. Hazards to the Aircraft and its Occupants:

(1) Is the battery container or compartment vented in such a manner that any gases or fumes emitted by the battery are carried outside the airplane? (FAR 25.1353.)

(2) Are the parts of the airplane adjacent to the battery protected against corrosion from any products likely to be emitted by the battery during servicing or flight? (FARs 25.1353, and 25.609.)

(Methods which may be used to obtain protection include: acid proof paint which will resist corrosion by emitted electrolyte, drains to discharge corrosive liquids clear of the aircraft, positive pressure vents to carry corrosive fumes outside the aircraft, enclosed

battery cases which would contain any amount of electrolyte that might be spilled, or combinations of these methods.)

(3) Is adequate provision made for the drainage of spilled or excess battery fluid? (FAR 25.1353.)

c. Operating Aspects:

None

d. Detail Design Standards:
None

AIRWORTHINESS COMPLIANCE CHECK SHEET #10

1. SUBJECT: Modification of an Airplane Involving Installation of a Fuel Flowmeter - FAR 23 Aircraft

2. APPLICABLE FEDERAL AVIATION REGULATIONS

23.955 Fuel Flow Rate
Fuel Flow Rate for Gravity Systems
Fuel Flow Rate for Pump Systems
Fuel Flow Rate for Auxiliary Fuel Systems and Fuel Transfer Systems
23.993 Fuel System Lines and Fittings
23.1183 Lines and Fittings
23.1337 Fuel Flowmeter System
TSO-C44 Fuel Flowmeters

Whenever a flowmeter is installed in the fuel system, the fuel flow rate will be affected. To determine if an adequate supply of fuel is available at the carburetor, it is necessary to conduct fuel flow tests. The tests may be conducted on the airplane or on a suitable mockup which duplicates the particular fuel system. The Engineering Service Representative should be contacted with reference to conducting the necessary tests.

3. CHECKLIST

a. Structural Requirements:

(1) If changes or alterations of the airplane structure are made, has the original strength and integrity of the structure been retained? (AC 43.13-2 Chapter 1.)

NOTE: If the specific alteration cannot be evaluated using AC 43.13-1 or equivalent references, it should be referred to the Engineering Service Representative.

(2) If additional lines are required for the installation, are they properly installed and supported? (FAR 23.993.)

b. Hazards to the Aircraft or its Occupants:

(1) All lines and fittings installed in connection with the flowmeter will be under pressure. Does the installation comply with the powerplant fire protection provisions? (FAR 23.1183.)

c. Operating Aspects:

(1) Do test results show an adequate supply of fuel at the carburetor during normal operation and with the metering element blocked? (FAR 23.995.)

d. Detail Design Standards:

(1) To insure an airworthy installation, is the flowmeter of an approved type?
Flowmeters approved for installation in civil aircraft prior to October 15, 1967, may continue to be used. New models of fuel flowmeters manufactured after October 15, 1967, shall conform to the requirements of TSO-C44. In either case, final approval is dependent on the satisfactory installation of the flowmeter in the airplane.

(2) Is the indicator and associated components properly installed?

To insure that the indicator and its associated components have been properly installed, the manufacturer's installation instructions should be reviewed. The Engineering Service Representative should be contacted for assistance in making this determination unless a supplementary compliance check sheet is available which covers the instrument installation portion.

AIRWORTHINESS COMPLIANCE CHECK SHEET #11

1. SUBJECT: Modification of a Fuel System by the Installation of a Fuel Pump to Transfer Fuel from an Auxiliary to a Main Fuel Tank - FAR 23 Aircraft

2. APPLICABLE FEDERAL AVIATION REGULATIONS

23.901 Components
23.951 General
Fuel System Arrangement
Pressure Cross Feed Arrangements
23.955 Fuel Flow Rate for Pump Systems
Fuel Flow Rate for Auxiliary Fuel Systems and Fuel Transfer systems
23.991 Fuel Pump Installation
23.1163 Powerplant Accessories
23.1351 Installation

23.1357 Fuses or Circuit Breakers

The main function of the fuel system is to deliver the required fuel flow rate and pressure to meet all engine demands; this is accomplished by the total performance of all fuel pumps (main or emergency, auxiliary or fuel transfer).

3. CHECKLIST

a. Structural Requirements:

(1) Is the fuel pump of a type that is acceptable under one of the following means? (FAR 23.1163.)

(a) Qualification under an AN or MIL specification.
(b) Completing a qualification test approved by FAA.
(c) Prior satisfactory service record on another approved installation.

(2) Is the fuel pump constructed, arranged and installed in a manner which will assure the continued safe operation of the airplane and powerplant? (FAR 23.901)

NOTE: The fuel pump pad of mechanically driven pumps shall be matched to the engine pad, type of drive, rotation of drive, and the pump weight, and overhang moment shall not exceed that listed in the engine specification. In addition, the required torque (continuous or static) to drive the pump shall not exceed that specified in the engine specification.

b. Hazards to the Aircraft or its Occupants:

(1) Does the electric driven fuel pump incorporate electrical protective devices? Are the switches, relays and wire size proper for the motor? (FARs 23.1351, and 23.1357.)

(2) Does the pressure cross feed line from the fuel pump to the main tank pass through personnel or cargo holds? (FAR 23.951.)

Note: If the answer is affirmative, fuel valve shutoffs at the supply of fuel to these lines shall be provided unless possible sources of fuel leakage in these lines are enclosed in fuel- and fume proof enclosure drained and vented to the exterior of the airplane.

c. Operating Aspects:

(1) Is the fuel flow from the transfer system equal to 0.9 pound per hour for each maximum continuous horsepower or 125 percent of the actual maximum continuous fuel

consumption of the engine? (FAR 23.955.)

NOTE: A lower flow rate is acceptable for a small auxiliary tank feeding into a large main tank, provided it is placarded requiring that auxiliary tank must only be opened to the main tank when a satisfactory fuel level still remains in the main tank.

d. Detail Design Standards:

(1) Does the fuel pump draw fuel from only one tank at a time? (FAR 23.951.)

(2) Does the installation of the fuel pump provide fuel to each engine at the flow rate and pressure adequate for proper engine functioning? (FAR 23.951.)

AIRWORTHINESS COMPLIANCE CHECK SHEET #12

1. SUBJECT: Modification of an Airplane to Relocate an Auxiliary Fuel Tank Without Altering the Fuel System Arrangement - FAR 23 Aircraft

2. APPLICABLE FEDERAL AVIATION REGULATIONS

23.955 Fuel Flow Rate
Fuel Flow Rate for Gravity System
Fuel Flow Rate for Pump System
Fuel Flow Rate for Auxiliary Fuel System and Fuel Transfer Systems
23.957 Flow Between Interconnected Tanks
23.959 Determination of Unstable Fuel Supply and Fuel System Operation on Low Fuel
23.961 Fuel System Hot Weather Operation
23.963 Fuel Tank - General
23.965 Fuel Tank Tests
23.967 Fuel Tank Installation
23.969 Fuel Tank Expansion Space
23.971 Fuel Tank Sump
23.973 Fuel Tank Filler Connection
23.975 Fuel Tank Vents and Carburetor Vapor Vents
23.1589 Loading Information

3. CHECKLIST

a. Structural Requirements:

(1) If changes or alterations of the airplane structure are made, have the original strength and integrity of the structure been retained? (AC 43.13-2 Chapter 1.)

NOTE: If the specific alteration cannot be evaluated using AC 43.13-1 or equivalent references, it should be referred to the Engineering Service Representative.

(2) Has the modification been evaluated to determine to what extent the c.g. of the airplane will be affected? (FAR 23.1589.)

(3) Is the fuel tank properly and adequately supported? (FAR 23.967)

(4) Are all lines properly supported? (FAR 23.993.)?

(5) Have nonabsorbent pads been provided between the tank and its supports? (FAR 23.967.)

b. Hazards to the Aircraft or its Occupants:

(1) Does the installation provide proper ventilation and drainage for the tank compartment and also adjacent compartments? (FAR 23.967.)

(2) Has the rerouting of existing fuel lines or installation of new lines or fittings created a fire hazard? (FAR 23.993, and 23.1183.)

(3) Has the tank been installed with the proper clearances between it and the firewall? (FAR 23.967.)

c. Operating Aspects:

(1) Have any changes been made in the fuel system which would require a redetermination of the fuel flow rate? (FAR 23.955.)

NOTE: If the answer to item (1) is yes, check the following items to determine if fuel flow tests are necessary:

(a) Has the inside diameter of any of the plumbing been decreased?

(b) Have additional fittings or valves been added to the system?

(c) Has the overall length of the plumbing been increased?

(d) For gravity systems, has the height location of the tank been decreased in its relationship to the position of the carburetor?

(e) If fuel flow tests are necessary, contact the Engineering Service Representative.

(2) Has relocation affected the amount of unusable fuel in the tank? (FAR 23.959.)

NOTE: If the answer to item (2) is yes, contact the Engineering Service Representative to conduct the

flight tests necessary to make this determination.

(3) Has the fuel quantity gauge been calibrated to reflect any change in amount of unusable fuel? (FAR 23.963.)

(4) Has the change in amount of unusable fuel affected the empty weight of the airplane?

NOTE: If the unusable fuel exceeds five percent of the tank capacity or one gallon, whichever is greater, a placard shall be provided noting the quantity of fuel which is not available for flight. Notation to this effect shall also be made in the flight manual. (FAR 23.1587.)

d. Detail Design Standards:

(1) Are all new lines, fittings and hoses suitable for the particular application? (FAR 23.993.)

(2) Has the new location of the filler connection been properly marked> (FAR 23.973.)

(3) Is it possible for spilled fuel to enter the fuel tank compartment? (FAR 23.973.)

(4) Have the new locations of drains and vents been checked for fire hazards? (FAR 23.1183.)