CHAPTER 5. SKI INSTALLATIONS

500. PURPOSE. This chapter provides information for ski installations on small airplane. The information provided for main ski and nose ski installations applies to wheel replacement skis only. Tire-cushioned skis other than tail skis, wheel penetration skis, and hydraulically adjustable or retractable skis involve special considerations and cannot be installed by relying solely on data in this advisory circular (AC).

501. HAZARDS AND WARNINGS. Operation of ski planes exposes the airplane and its occupants to additional risks not associated with wheel-equipped landplanes. The additional weight and surface area of skis impose additional ground and air loads on the airplane. Ground handling, taxiing, takeoff, and landing can place significant side loads and twisting moments to the landing gear and its attachment structure which can cause hidden and/or cumulative damage. Improper rigging and/or weak springs or shock cords can cause the skis to "dump," or rotate nose down in flight, possibly rendering the airplane uncontrollable or causing it to break up in flight. Skis with weak springs or shock cords may rotate nose down and "dig," or penetrate the snow, during takeoff or landing on uneven or drifted snow, which could result in an accident. In-service failure of ski attachment hardware, springs, shock cords, or cables creates a high risk of those parts or a ski itself entering the propeller arc, which has resulted in complete loss of airplanes in flight. For these reasons, proper installation, rigging, periodic inspection, and maintenance of skis and their attaching parts are of utmost importance to safety. Consultation with experienced ski maintenance technicians and operators is strongly recommended when considering any new ski installation or any alteration of an existing ski installation.

502. ADDITIONAL REFERENCE MATERIAL (current editions).

a. Airframe and ski manufacturers' data, if available.

b. AC 43.13-1, Acceptable Methods, Techniques, and Practices—Airplane Inspection and Repair.

c. AC 43-210, Standardized Procedures for Requesting Field Approval of Data, Major Alterations, and Repairs.

d. Civil Aviation Regulation (CAR) 6, Rotorcraft Airworthiness; Normal Category.

e. FAA Order 8110.54, Instructions for Continued Airworthiness.

f. FAA-H-8083-23, Seaplane, Ski plane, and Float/Ski Equipped Helicopter Operations Handbook.

503. INSTALLATION CONSIDERATIONS.

a. Determining Eligibility of an Airplane. Only an airplane approved for operation on skis is eligible for ski installations in accordance with this chapter. Eligibility can be determined by referring to the Aircraft Specifications, type certificate data sheets (TCDS), Aircraft Listing, Summary of Supplemental Type Certificates, or by contacting the manufacturer. Also determine the need for any required alterations to the airplane to make it eligible for ski operations. (See ski plane-specific entries throughout TCDS A4CE on airspeeds, weight and balance limitations and additional placards, and the Required Equipment listing for the first model in Aircraft Specification A-790 for examples.) If the airplane is not approved in a ski plane configuration by type design, then skis cannot be installed by relying solely on data in this AC. Contact FAA engineering for approval or obtain/develop approved data from another source.

b. Identification of Approved Model Skis. Determine that the skis are of an approved model by examining the identification plates or placards displayed on the skis. Skis of approved models will have such plates or placards, and the Technical Standard Order (TSO) number TSO-C28, an Aircraft Component, Accessory, or equipment type certificate (TC) number, or an airplane part number (if the skis have been approved as part of the airplane) will be engraved or imprinted on each plate or placard.

c. Maximum Limit Load Rating.

(1) Known limit landing load factor. Before installation, determine that the maximum limit load rating (L) of the ski as specified on its identification plate or placard is at least equal to the maximum static load on it (S) times the limit landing load factor *(fl)* previously determined from drop tests of the airplane by its manufacturer. This requirement can be expressed by the following equation:

$$L = S \times fl$$

(2) Unknown limit landing load factor. In lieu of a value *fl* determined from such drop tests, a value of *fl* determined from the following formula may be used:

$$\eta = 2.80 + \frac{9000}{(W + 4000)}$$

where "W" is the certificated gross weight of the airplane

d. Oversize Ski Installations. This limitation is to assure that the oversize skis will not adversely affect the performance, stability, controllability, and spin recovery behavior of the airplane or impose excessive loads on it.

e. Landing Gear Moment Reactions: Landing Gear Bending Moments. In order to avoid excessive bending moments on the landing gear and attachment structure, the ski pedestal height measured from the bottom surface of the ski to the axle centerline must not exceed 130 percent of the static rolling radius of the standard tire approved for the airplane, when the tire is installed on the standard wheel at the approved inflation pressure. Do not use oversize or "tundra" tires to determine the static rolling radius.

504. FABRICATION AND INSTALLATION.

a. Hub-Axle Clearance. The pedestal hub should fit the axle to provide a clearance of 0.005" minimum to 0.020" maximum. Hubs may be bushed to adjust for axle size, using any ferrous or nonferrous metal, hard rubber, or fiber. If rubber or fiber bushings are used, use retaining washers of sufficient size on each side to retain the hub if the bushing should slip or fail. (See Figure 5-1.) Field experience has shown that the use of good quality, low-temperature grease; particularly modern synthetic-based grease, improves ski operation and wear protection when used on the axle-to-hub or axle-to-bushing faying surfaces.

FIGURE 5-1. TYPICAL HUB INSTALLATION

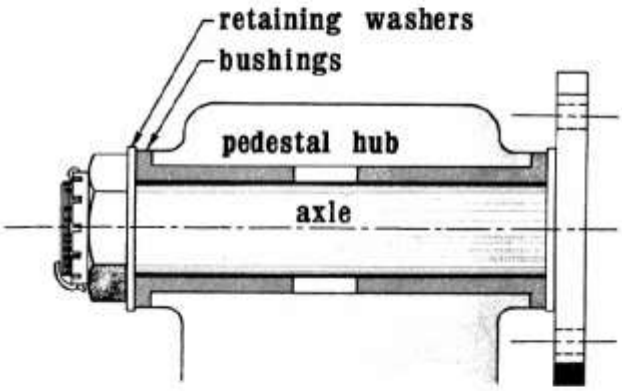
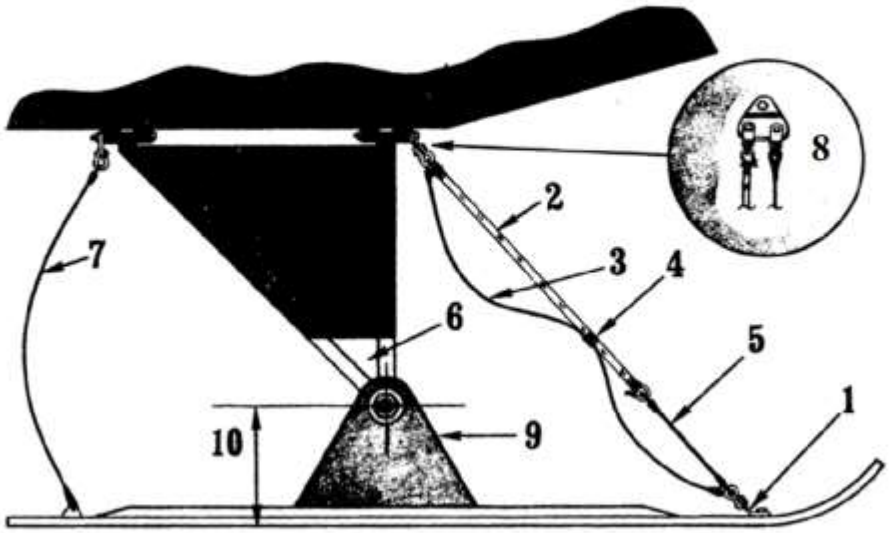


FIGURE 5-2. TYPICAL SKI INSTALLATION



1. Fitting
2. Shock Cord
3. Safety Cable
4. Tape
5. Crust-cutter Cable
6. Fabric removed to facilitate inspection
7. Check Cable
8. Clevis
9. Ski Pedestal
10. Pedestal Height

b. Crust-Cutter Cables. Crust-cutter cables are optional. However, when operating in severe crust conditions, it is advisable to have this cable installed to prevent the shock cord from being cut if the nose of the ski breaks through the crust while taxiing.

c. Cable and Shock Cord Attachment and Attachment Fittings.

(1) Field experience. Service reports indicate that failure of the ski itself is not a predominant factor in ski failures. Rigging (improper tension and terminal attachments) and cast-type pedestal material failures are predominant. Failures of the safety cable and shock cord attachment fittings usually occur at the ski end and not at the fuselage end.

(2) Separating attachment points. It is strongly recommended that tension cords and safety cables be attached to entirely separate fittings at their fuselage ends. Although the attachment fitting detail shown in Figure 5-2 may be adequate for some installations where alternate attachment locations are unavailable, we recommend that each cord and cable be attached to its own fitting (such as the right-hand fitting in Figure 5-3) and attached at separate points on the fuselage when possible. Provide separate means of attaching cables and shock cords at the forward and aft ends of the skis.

(3) Fabrication. Approved skis are normally supplied with cables, shock cord, and fittings. However the specifications in Table 5-1, subparagraphs (a) through (c) below, and Figure 5-3 may be used for fabricating and installing cables, shock cord assemblies, and fuselage fittings.

NOTE: Field experience indicates that accelerated wear and damage can occur to a 1/8" safety or crust-cutting cable and its attachment hardware in normal service on skis having a limit load rating of 1,500 pounds or more. The FAA

recommends a minimum cable size of 5/32" for use in fabricating safety or crust-cutting cables for use with skis of 1,500 pounds or greater limit load rating. 1/8" cables may be suitable for use on airplanes with light-weight skis and maximum certificated weights less than 1,500 pounds, such as those meeting the definition of light sport aircraft.

TABLE 5-1. RECOMMENDED MINIMUM CABLE AND SHOCK CORD SIZES

Ski Limit Load Rating (Pounds)	Single Safety Cable	Double Safety Cable	Single Crust-Cutting Cable	Double Crust-Cutting Cable	Single Shock Cord	Double Shock Cord
Less than 1,500	1/8"	1/8"	1/8"	1/8"	1/2"	1/2"
1,500-3,000	5/32"	5/32"	5/32"	5/32"	1/2"	1/2"
3,000-5,000	Do Not Use	5/32"	5/32"	5/32"	Do Not Use	1/2"
5,000-7,000	Do Not Use	5/32"	5/32"	5/32"	3/4"	3/4"
7,000-9,000	Do Not Use	3/16"	Do Not Use	5/32"	Do Not Use	3/4"

(a) Make check cable, safety cable, and crust-cutting cable ends by the splice, swage, or nicopress methods. Cable clamps may be used if adjustable lengths are desired, but they are not recommended. Use standard airplane hardware only. (Hardware used to attach cables must be compatible with cable size.) Refer to AC 43.13-1, chapter 7, as amended, for more information on cable fabrication.

(b) Shock cord ends may be fabricated by any of the following methods:

1. Make a wrapped splice using a proper size rope thimble and No. 9 cotton cord, 0.041" (minimum) safety wire (ref. National Aerospace Standard NASM20995), 1025 steel, or its equivalent (AISI 4130). Attach with clevis or spring steel snap fastener. (*Do not* use cast iron snaps.)

2. Use approved spring-type shock cord end fasteners, 1025 steel, or its equivalent (AISI 4130).

(c) Fitting (Figure 5-3) Specifications and Installation:

1. Fittings fabricated for 1/8-inch cable or 1/2-inch shock cord must be at least 0.065" 1025 steel or its equivalent.

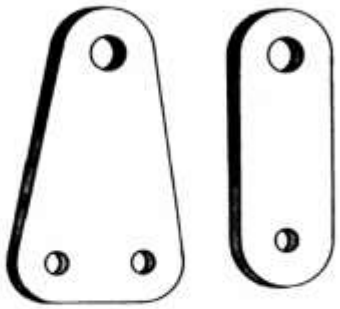
2. Fittings fabricated for 5/32-inch cable or 3/4-inch shock cord must be at least 0.080" 1025 steel or its equivalent.

3. An improperly installed fitting may impose excessive eccentric loads on the fitting and attach bolts and result in failure of the fitting or bolts.

4. If attaching cables directly to holes in fittings, radius the hole edges to reduce stress concentration and accelerated wear of the thimble. Stainless steel thimbles are recommended for increased wear resistance.

5. If attaching cables to fittings using clevises, clevis bolt castellated nuts should be used, then properly torqued and safetied with cotter pins. Field experience has shown that diaper-pin-style quick-releasing safety devices are more prone to failure during operation, and are not recommended.

FIGURE 5-3. TYPICAL FUSELAGE FITTINGS



d. Provisions for Inspection. An airplane using fabric-covered landing gear should have at least the lower 4 inches of fabric removed to facilitate inspection of the axle attachment area, and to prevent the entrapment of snow and ice, which can lead to damage and corrosion of the landing gear. (See Item 6 in Figure 5-2.)

505. RIGGING OF SKIS.

a. Location of Attach Fittings on Fuselage or Landing Gear. Locate fittings so the shock cord and cable angles are not less than 20 degrees when measured in the vertical plane with the shock absorber in the fully extended position (see Angle B, Figures 5-4 and 5-5).

NOTE: Do not attach fittings to wing-brace struts, except by special approval (manufacturer or FAA).

b. Main Ski Incidence Angles.

(1) Set cable lengths with the airplane level and no weight on the landing gear.

(2) Adjust length of check cable to provide a ±0- to ±5-degree ski incidence angle (reference Figures 5-4 and 5-6).

(3) Adjust length of safety cable to provide a ±15-degree ski incidence angle (reference Figures 5-5 and 5-6).

FIGURE 5-4. MAIN SKI AT MAXIMUM POSITIVE INCIDENCE (CHECK CABLE TAUT)

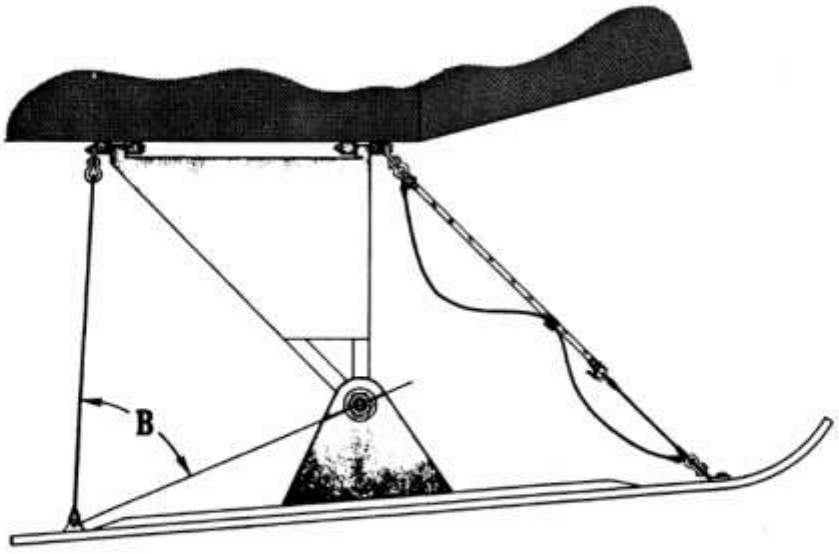


FIGURE 5-5. MAIN SKI AT MAXIMUM NEGATIVE INCIDENCE (SAFETY CABLE TAUT)

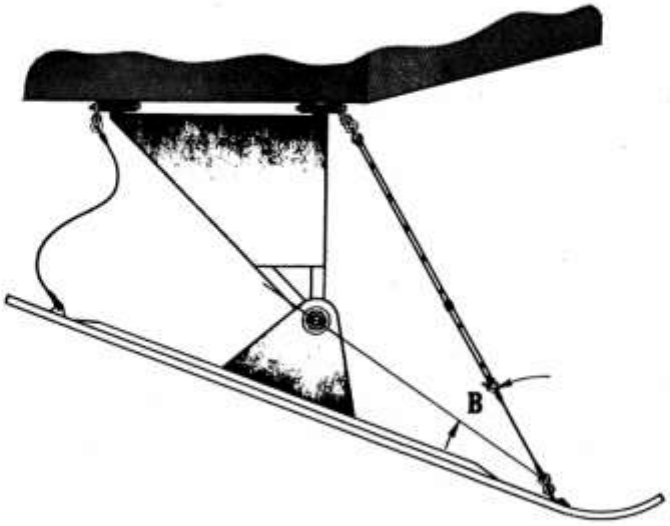
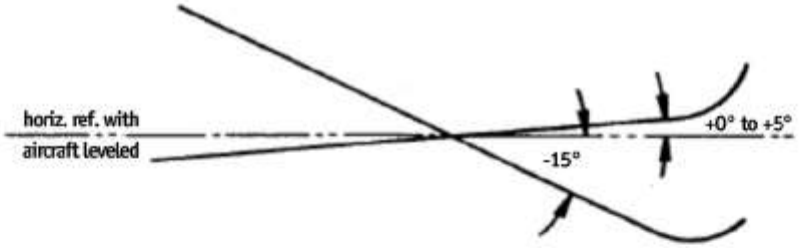


FIGURE 5-6. MAIN SKI INCIDENCE ANGLES



c. Tension Required in Main Ski Shock Cords.

(1) Apply sufficient shock cord tension to the forward ends of the skis to prevent flutter and "dumping" throughout the range of airspeeds and attitudes at which the airplane will operate on skis. Because of the various angles used in attaching the shock cord to the skis, shock cord tension cannot be specified. It is possible to specify the downward force that must be applied to the forward end of the ski in order to overcome the shock cord tension and cause the check cable to slacken when the ski is in the normal flight attitude. That downward force is commonly referred to as the *shock cord tension force,* or simply the *tension force.* In most installations on rigid, truss type landing gear, the tension force should be approximately as listed in Table 5-2.

TABLE 5-2. APPROXIMATE MAIN SKI TENSION FORCES

Ski Limit Load Capacity	*Downward Force (pounds)*
1500-3000	*20-40*
3000-5000	*40-60*
5000-7000	*60-120*
7000-9000	*120-200*

NOTE: Do not rely upon these tension force values for main ski installations on airplanes with spring steel or other flexible landing gear. Shock cord tensions great enough to require the downward forces listed in Table 5-2 to overcome them may produce excessive toe-in of the main skis on such airplanes. Variations in gear leg flexibility make it difficult to establish a generic table of tension forces appropriate for all airplanes with flexible landing gear.

(2) The shock cord tension must also be sufficient to return the skis to the normal flight attitude from their maximum negative incidence at all airspeeds up to the airplane's never-exceed speed with skis installed. In the absence of more precise data, each shock cord must be able to produce a nose-up moment about the ski pedestal bearing centerline of $M = (0.0000036)(W)(V_{NE})2$ ft•lbs, when the ski is at its maximum negative incidence, where W is the maximum certificated gross weight of the airplane and V_{NE} is its never-exceed speed with skis installed.

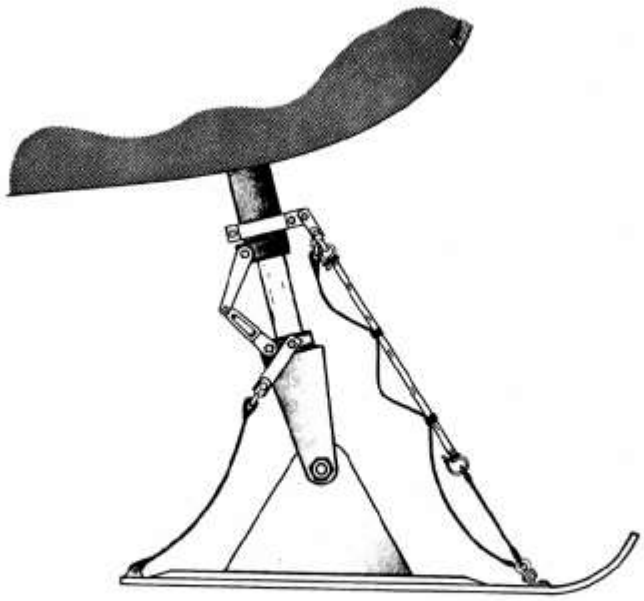
d. Springs in Place of Shock Cords. If springs are used in place of shock cords to provide rigging tension, they must be able to withstand extreme cold and slight external scratching without premature fatigue failure, and must not cause skis, rigging, or landing gear to experience flutter or objectionable vibration during an airplane flight and dive tests.

e. Nose Ski Installation. Install the nose ski on an airplane with tricycle landing gear in the same manner as the main skis (see Figure 5-7), except:

(1) Adjust length of safety cable to provide ±5- to ±15-degree ski incidence.

(2) Where it is possible for the nose ski rigging to contact the propeller tips due to vibration, install a 1/4-inch shock cord to hold the rigging out of the propeller arc.

FIGURE 5-7. TYPICAL NOSE SKI INSTALLATION



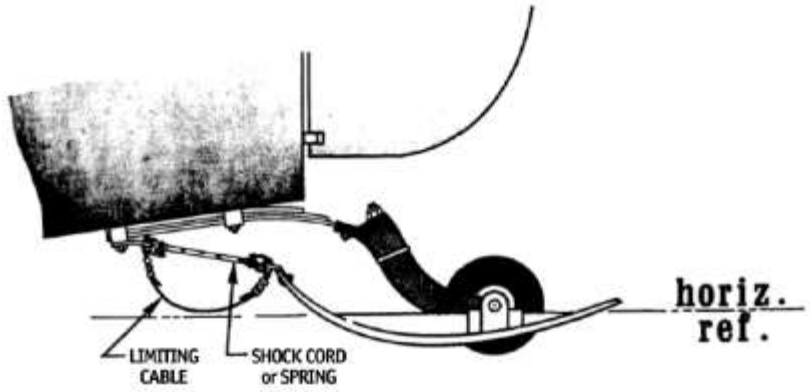
f. Tail Ski Installation.

(1) When installing a tail ski on an airplane with conventional landing gear, use a tail ski that has been approved on an airplane of approximately the same weight and whose tail wheel bears approximately the same fraction of that weight when the airplane is in the three-point attitude (within 10 percent), or select the tail ski as outlined in paragraphs 501 and 503. Some types of tail ski require that the tail wheel be removed to install the rest on its upper surface "ski."

(2) Adjust the length of the limiting cable (reference Figure 5-8) to allow the ski to turn approximately 35 degrees either side of the straight-forward position with the weight of the airplane resting on the ski.

(3) The shock cord (reference Figure 5-8) must be of a length that will hold the ski in the straight-forward position during flight.

FIGURE 5-8. TYPICAL TAIL SKI INSTALLATION



506. DOCUMENTATION.

a. Airplane or Ski Manufacturer's Data. Comply with the requirements for placards, markings, and manuals required to operate the airplane as a skiplane, as listed in the approved or accepted documents discussed in paragraph 503a.

b. Performance Information. The following Paragraphs contain the minimum additional performance data required for airplanes equipped with new or altered ski installations. Consult AC 43-210 (current edition) chapter 4, for additional guidance regarding approved Aircraft Flight Manual (AFM) supplements.

(1) For an airplane that requires an approved AFM, obtain FAA approval for an AFM supplement that adds the following or similar information to the Performance section of the Manual.

(a) Takeoff. Under the most favorable conditions of smoothly packed snow at temperatures approximating 32° F, the skiplane takeoff distance is approximately 10 percent greater than that shown for the landplane.

NOTE: In estimating takeoff distance for other conditions, caution should be exercised as lower temperatures or other snow conditions will usually increase these distances.

(b) Landing. Under the most favorable conditions of smoothly packed snow at temperatures approximately 32° F, the skiplane

landing distance is approximately 20 percent greater than that shown for the landplane.

NOTE: In estimating landing distances for other conditions, caution should be exercised as other temperatures or other snow conditions may either decrease or increase these distances.

(c) Climb Performance. In cases where the landing gear is fixed (both landplane and skiplane), where climb requirements are not critical, and the climb reduction is small (30 to 50 feet per minute), the FAA will accept a statement of the approximate reduction in climb performance placed in the performance information section of the AFMS. For larger variations in climb performance, where the minimum requirements are critical, or the landing gear of the landplane is retractable, appropriate climb data should be obtained to determine the changes and new curves, tables, or a note should be incorporated into the AFMS.

(2) For an airplane that does not require an AFM, make the information in paragraph 506b(1) available to the pilot in for form of placards, markings, manuals, or any combination thereof. One type of acceptable manual is an approved Supplementary AFM.

507. FLIGHT AND HANDLING OPERATIONAL CHECKS. Accomplish an operational check in accordance with Title 14 of the Code of Federal Regulations (14 CFR) part 91, § 91.407(b), to determine the takeoff, landing, and ground handling characteristics. Ensure that the ski angles during tail high and tail low landings will not cause the skis to dig in or fail from localized stress. Verify that ground control is adequate to satisfactorily complete a landing run with a turnoff at slow speed. In flight, the skis must ride steady with check cables taut, and must not produce excessive drag or unsatisfactory flight characteristics. Enter a notation of this check in the airplane records.

508. MAINTENANCE (INCLUDING INSPECTION).

a. Inspection and Repair Data Sources. Contact the airplane and ski manufacturers for any specific inspection and maintenance instructions they may have developed. Refer to AC 43.13-1 (as amended), chapter 9, for more information.

b. Instructions for Continued Airworthiness (ICA). The modifier (developer of the ski installation or alteration) must provide instructions for future inspection, maintenance, and repair of the added or altered parts, and is also responsible for assessing the need for any changes to the product-level ICA (changes that affect the airplane as a whole when the skis are installed). For simple airplane/ski combinations where skis of the same model have been approved on similar airplanes with appropriate ICA, it may only be necessary to reference those ICA in the maintenance records of the newly altered airplane and/or in Block 8 of the FAA Form 337 documenting the ski installation. For complex ski installations requiring special considerations, the modifier may need to develop new installation-specific ICA. In either case, the modifier must ensure that adequate and appropriate ICA is available to the skiplane owner or operator. Consult current editions of AC 43-210, chapter 5, and FAA Order 8110.54, for additional guidance regarding ICA.

c. Interchanging of Skis and Wheels. A person appropriately authorized by 14 CFR part 43, § 43.3, must perform a new weight and balance computation when the skis are initially installed. The FAA recommends that the airplane be weighed for this initial computation. After the initial installation, removing the skis and reinstalling the wheels or vice versa is considered a preventive maintenance operation if it does not involve complex assembly operations or a new weight and balance computation (ref. part 43, appendix A, paragraph (b)(4)(c)(18)).

NOTE: During subsequent weight and balance changes to the airplane, be sure to update its weight and

balance records and its equipment list to account for all approved ski, wheel, and float installations.

d. Periodic Inspection Required. Seasonally removed and installed equipment items such as skis should be inspected at installation to comply with §§ 91.407(a) and 91.409(a), and part 43, appendix D, paragraphs (e)(1) and (e)(10), if they were not installed on the airplane at the time of the last inspection. All available data described in this paragraph should be used during the inspection.

509. THRU 599. RESERVED