AIRFRAME & POWERPLANT MECHANICS

AIRFRAME HANDBOOK
VOLUME 2 OF 2

FAA-H-8083-31A-ATB

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Preface

Airframe & Powerplant Mechanics Handbook—Airframe (FAA-H-8083-31A & FAA-H-8083-31A-ATB - 2 Volume Set) is one of a set of 3 handbooks for individuals preparing for certification as an Airframe or Powerplant mechanic. It is intended that this handbook provide the basic information on principles and technical procedures relating to the airframe rating. It is designed to aid students enrolled in a formal course of instruction, as well as individuals studying on his or her own.

Because there are so many types of aircraft in use today, it is reasonable to expect that differences exist in airframe components and systems. To avoid repetition, the practice of using representative systems and units is carried throughout the handbook. Subject matter is from a generalized point of view and should be supplemented by manufacturer's manuals and other textbooks if more detail is desired. This handbook is not intended to replace, or supersede official regulations or the manufacturer's instructions. Occasionally the word "must" or similar language is used where the desired action is deemed critical. The use of such language is not intended to add to, interpret, or relieve a duty imposed by Title 14 of the Code of Federal Regulations (14 CFR).

This book has been developed by the U.S. Department of Transportation, Federal Aviation Administration, Airman Testing Standards Branch, AFS-630, Oklahoma City, OK 73125 and published and distributed by Aircraft Technical Book Company, Tabernash, CO 80478. Comments regarding this publication may be sent to FAA at *AFS630comments@faa.gov* and to Aircraft Technical Book Company at *techsupport@actechbooks.com* or by phone to 970.726.5111

Revisions and updates to this book:
Each book in this series (the H-8083-ATB editions) are subject to constant updates, corrections, and clarifications by Aircraft Technical Book Company. Typically revision suggestions are identified by A&P instructors. Those suggestions are then sent for peer review by other working instructors and if agreed, the change is made; immediately to the eBook and with the next printing to the printed book. Nothing is removed from the original FAA text. All revisions are corrections, or clarifications. If you are a working A&P instructor and would like to participate on the ATB peer review team, please call 970.726.5111.

Revision Log

From original FAA-H-8083-31A through this printing.

Airframe Volume 1

1-38 Corrected to current identification of AC43.13-1B/2B.

2-11 Figure 2-12; removed the trim tab locations shown on the flaps. Added trim tab to aileron. Removed trim tab shown on second elevator.

2-28 Corrected sequence of images and labeling on Figure 2-45 so that lowering the collective lowers pitch angle, and raising the collective increases pitch.

2-29 Figure 2-46; Replaced Figure to show a collective lever with an actual twist grip throttle.

2-45 Figure 2-75; replaced line drawing with picture of an actual aircraft type cable tensiometer.

3-5 Figure 3-4; noted that specifications for on cotton is for reference only as it is no longer produced.

4-5/47 Replaced images of various tools for clarity and modernization.

4-6 Figure 4-10; replaced drawing of heavy duty punch with photo of an aircraft appropriate light weight automatic center punch.

4-14 Added and clarified procedural text on filing technique for clarity.

4-33 E (KE) rivets are alloy 7050 aluminum, not 2017. 2117-T rivets are heat treated by the manufacturer.

4-34 Section rewrite: rivet pitch is same as rivet spacing; clarified rivet spacing minimums for protruding and flush rivets; clarified "must" vs. "may"; corrected additional typos.

4-59 Figure 4-120; setback is measured R+T; (not R+1).

4-64 Adjusted incorrect equations and results.

4-65 Figure 4-126; multiplier is 44.5% of T.

4-67 Figure 4-131; sight line is located one radius outboard.

4-82 Replaced Figure 4-164 depicting an actual joggled metal.

4-87 Clarified contradictory statement regarding acceptability of repairing or splicing a damaged metal component based on AC43.13 1B/2B.

7-15 Figure 7-21; replaced with clearer representation of topic.

9-6 Figure 9-8; corrected to show proper north/south polarity.

9-16 Figure 9-25; replaced incorrect formula L = 0.021.

9-17 Fixed incorrect equation (right column, top line).

9-20 Replaced incorrect formula S + E × I.

9-33 Figure 9-51; labels for parallel and series windings were reversed.

9-91 Figure 9-154; fixed color of terminal and designation.

Airframe Volume 2

10-10 Figure 10-15; safety wiring on transducer shown loosening the fitting, image corrected to show proper wiring.

10-13 Figure 10-23; drain hole in pitot tube shown in the wrong location. Redrawn, placing it in an acceptable place.

11-7 Corrected text errors regarding number of electrons in each shell of an atom.

11-45 Figure 11-101; deviation spacing is measured in degrees, not dots.

11-76 Added that sealant on an antenna mount interface also acts as a moisture barrier.

12-3 Removed comment of "complete interchangeability of mineral based fluids.

12-38 Corrected Figure numbering references.

13-15/17 Numerous references to "tow-in/tow-out" corrected to "toe-in/toe-out".

16-23 Figures 16-38 and 16-39. Revised altitudes to proper height.

16-39/40 *Refrigeration Turbine Unit or Air Cycle Machine and Secondary Heat Exchanger*; rewrote portions of text for improved clarity.

16-48 Figure 16-79; Replaced poor image with photo of aircraft evaporator from AirComm Corp.

16-50 Two references to "compressors" in 2nd paragraph corrected to "condensers".

16-56 Figure 16-93; Replaced poor drawing of condenser with photo of damaged condenser fins and enhanced caption.

16-57 Figure 16-94; Added improved photo of iced condenser fins.

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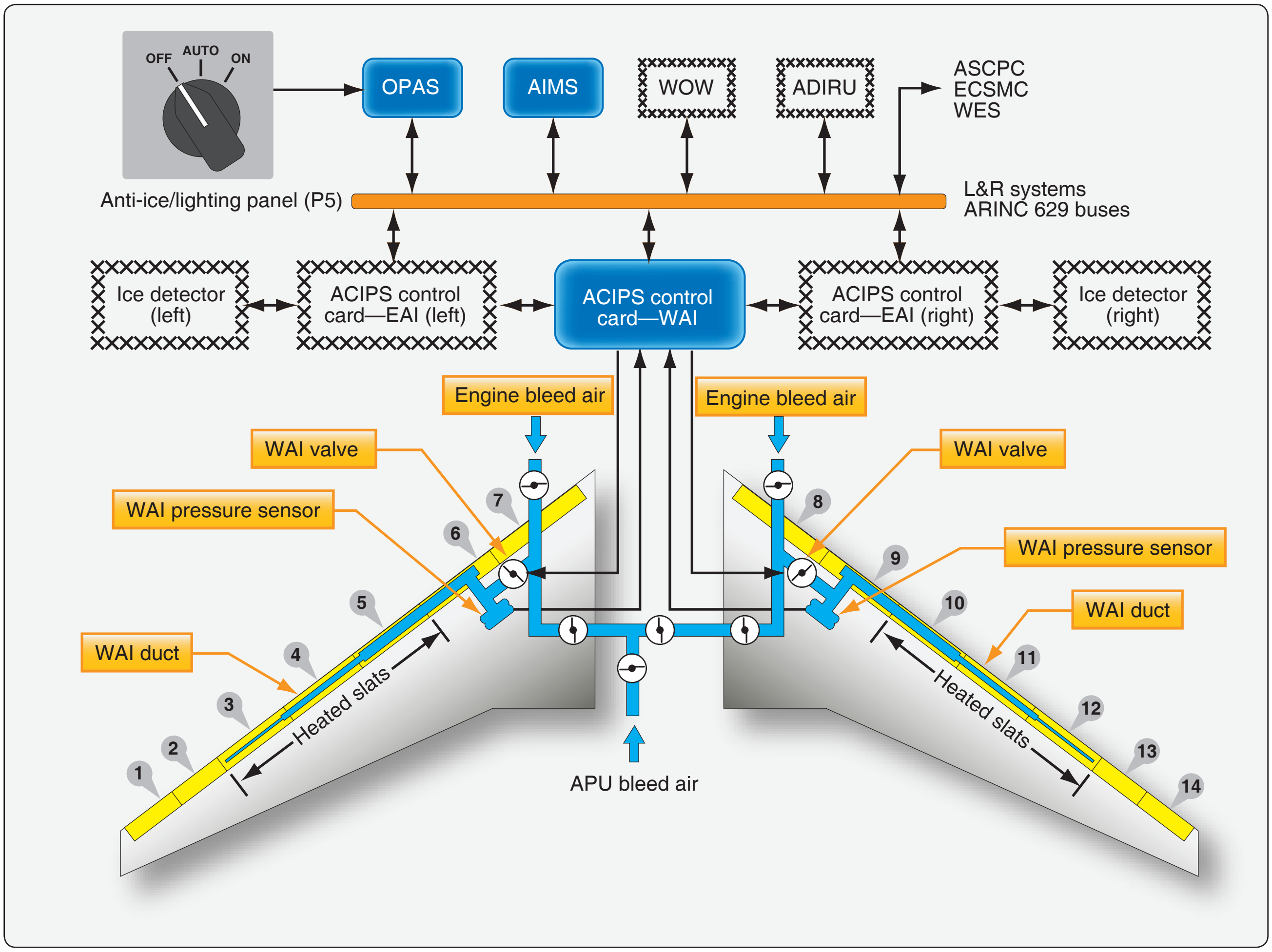

Figure 15-9. *Wing leading edge slat anti-ice system.*

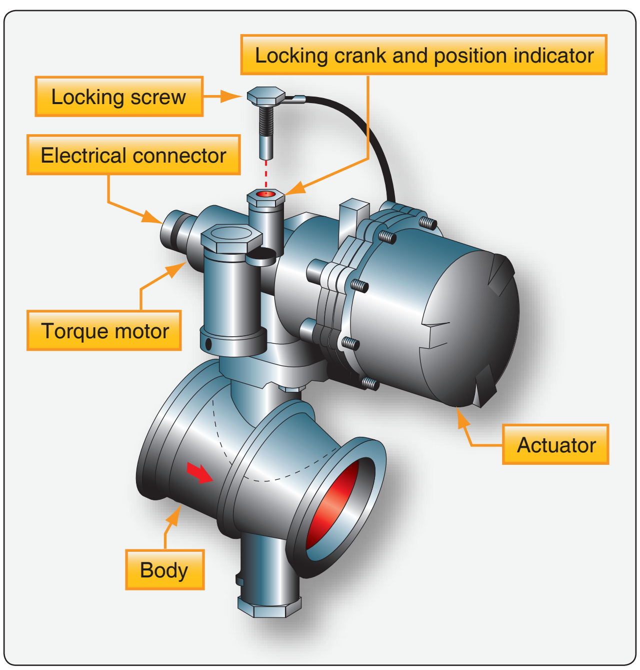

Figure 15-10. *A wing anti-ice valve.*

There is one selector for the WAI system. The selector has three positions: auto, on, and off. With the selector in auto and no operational mode inhibits, the WAI ACIPS computer card sends a signal to open the WAI valves when either ice detector detects ice. The valves close after a 3-minute delay when the ice detector no longer detects ice. The time delay prevents frequent on/off cycles during intermittent icing conditions. With the selector on and no operational mode inhibits, the WAI valves open. With the selector off, the WAI valves close. The operational mode for the WAI valves can be inhibited by many different sets of conditions. *[Figure 15-12]*

The operational mode is inhibited if all of these conditions occur:

- Auto mode is selected
- Takeoff mode is selected
- Airplane has been in the air less than 10 minutes

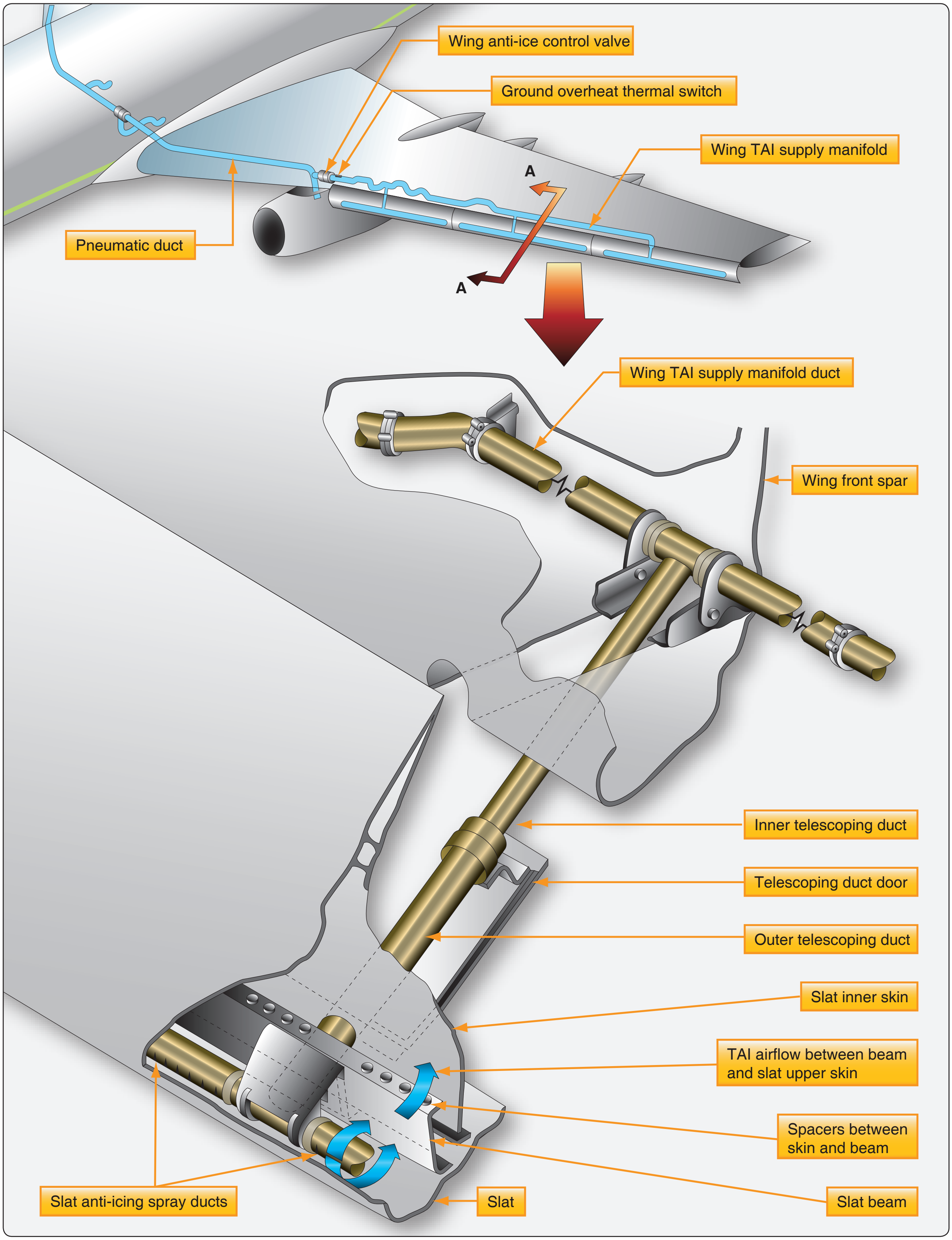

Figure 15-11. *WAI ducting.*

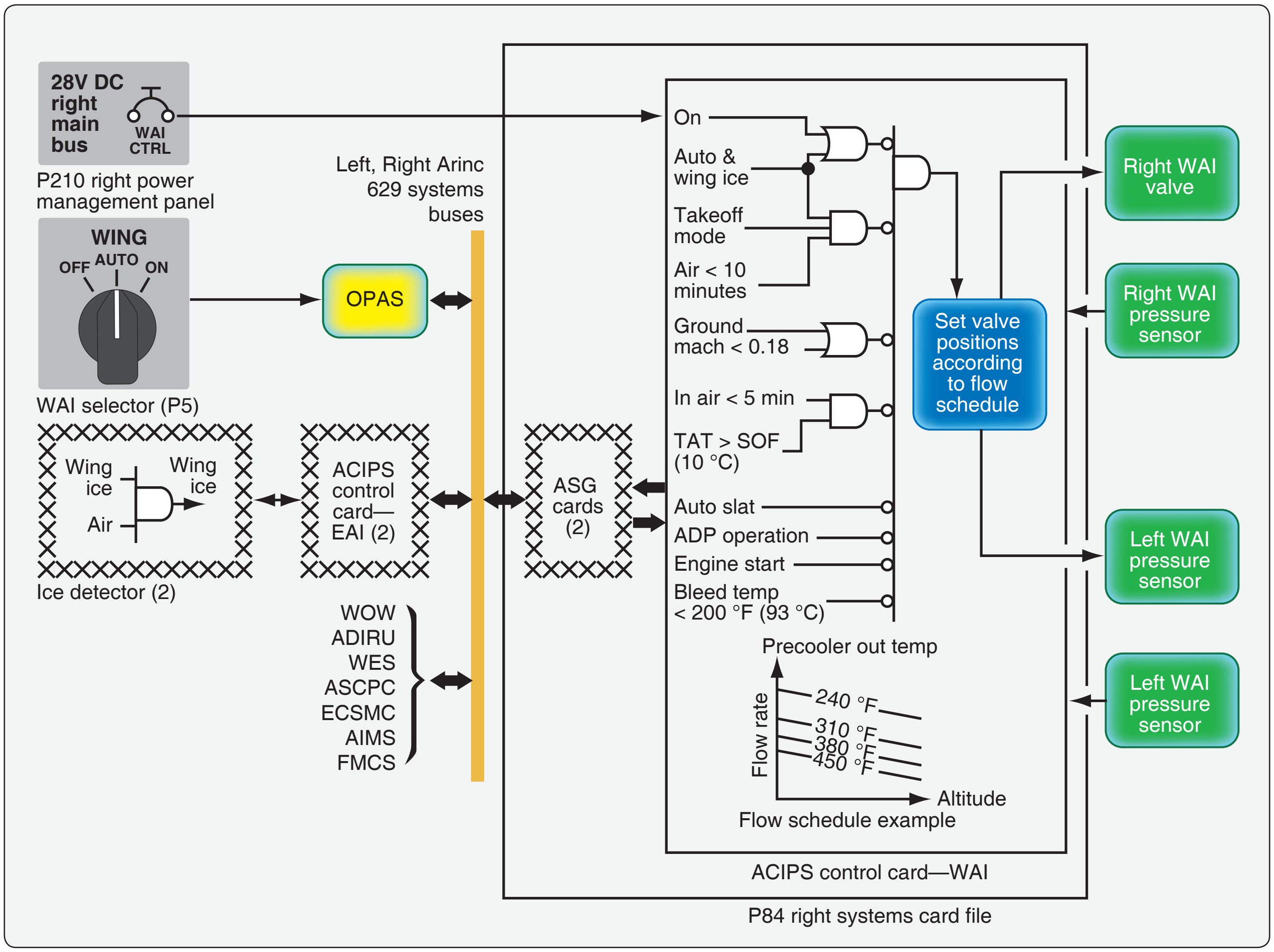

Figure 15-12. *WAI inhibit logic schematic.*

With auto or on selected, the operational mode is inhibited if any of these conditions occur:

- Airplane on the ground (except during an initiated or periodic built-in test equipment (BITE) test)
- Total Air Temperature (TAT) is more than 50 °F (10 °C) and the time since takeoff is less than 5 minutes
- Auto slat operation
- Air-driven hydraulic pump operation
- Engine start
- Bleed air temperature less than 200 °F (93 °C).

The WAI valves stay closed as long as the operational mode inhibit is active. If the valves are already open, the operational mode inhibit causes the valves to close.

WAI Indication System

The aircrew can monitor the WAI system on the onboard computer maintenance page. *[Figure 15-13]* The following information is shown:

- WING MANIFOLD PRESS—pneumatic duct pressure in PSIG
- VALVE—WAI valve open, closed, or regulating
- AIR PRESS—pressure downstream of the WAI valves in PSIG
- AIR FLOW—air flow through the WAI valves in pounds per minute

WAI System (BITE) Test

BITE circuits in the WAI ACIPS computer card continuously monitor the WAI system. Faults that affect the dispatch of the aircraft cause status messages. Other faults cause

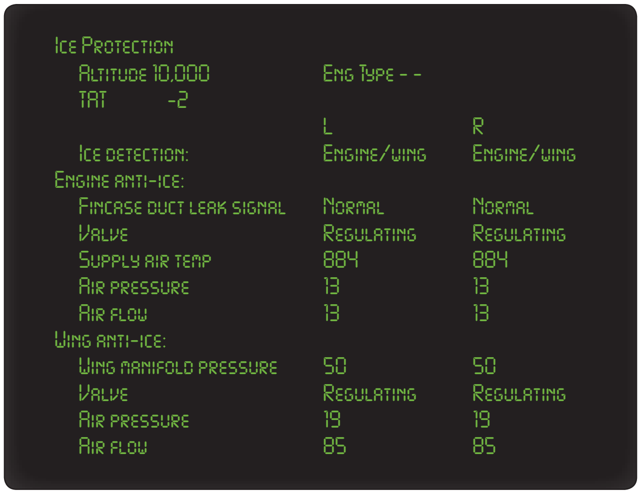

Figure 15-13. *Ice protection onboard computer maintenance page.*

central maintenance computer system (CMCS) maintenance messages. The BITE in the WAI ACIPS computer card also performs automatic power-up and periodic tests. Faults found during these tests that affect dispatch cause status messages. Other faults cause CMCS maintenance messages. The power-up test occurs when the card gets power. BITE does a test of the card hardware and software functions and the valve and pressure sensor interfaces. The valves do not move during this test.

The periodic test occurs when all these conditions are true:

- The airplane has been on the ground between 1 and 5 minutes.
- The WAI selector is set to auto or on.
- Air-driven hydraulic pumps are not in intermittent operation.
- Bleed pressure is sufficient to open the WAI valves.
- The time since the last periodic test is more than 24 hours.
- During this test, the WAI valves cycle open and closed. This test makes sure that valve malfunctions are detected.

Thermal Electric Anti-Icing

Electricity is used to heat various components on an aircraft so that ice does not form. This type of anti-ice is typically limited to small components due to high amperage draw. Effective thermal electric anti-ice is used on most air data probes, such as pitot tubes, static air ports, TAT and AOA probes, ice detectors, and engine P2/T2 sensors. Water lines, waste water drains, and some turboprop inlet cowls are also heated with electricity to prevent ice from forming. Transport category and high-performance aircraft use thermal electric anti-icing in windshields.

In devices that use thermal electric anti-ice, current flows through an integral conductive element that produces heat. The temperature of the component is elevated above the freezing point of water, so ice cannot form. Various schemes are used, such as an internal coil wire, externally wrapped blankets or tapes, as well as conductive films and heated gaskets. A basic discussion of probe heat follows. Windshield heat and portable water heat anti-ice are discussed later in this chapter. Propeller deice boots, which also are used for anti-ice, are also thermal electric and discussed in this chapter.

Data probes that protrude into the ambient airstream are particularly susceptible to ice formation in flight. *Figure 15-14* illustrates the types and location probes that use thermal electric heat on one airliner. A pitot tube, for example, contains an internal electric element that is controlled by a switch in the cockpit. Use caution checking the function of the pitot heat when the aircraft is on the ground. The tube gets extremely hot since it must keep ice from forming at altitude in temperatures near -50 °F at speeds possibly over 500 miles per hour. An ammeter or load meter in the circuit can be used as a substitute to touching the probe, if so equipped.

Simple probe heat circuits exist on GA aircraft with a switch and a circuit breaker to activate and protect the device. Advanced aircraft may have more complex circuitry in which control is by computer and flight condition of the aircraft is considered before thermal electric heaters are activated automatically. *Figure 15-15* shows such a circuit for a pitot tube. The primary flight computer (PFC) supplies signals for the air data card (ADC) to energize ground and air heat control relays to activate probe heat. Information concerning speed of the aircraft, whether it is in the air or on the ground, and if the engines are running are factors considered by the ADC logic. Similar control is use for other probe heaters.

Chemical Anti-Icing

Chemical anti-icing is used in some aircraft to anti-ice the leading edges of the wing, stabilizers, windshields, and propellers. The wing and stabilizer systems are often called weeping wing systems or are known by their trade name of TKS™ systems. Ice protection is based upon the freezing point depressant concept. An antifreeze solution is pumped from a reservoir through a mesh screen embedded in the leading edges of the wings and stabilizers. Activated by a switch in the cockpit, the liquid flows over the wing and tail surfaces, preventing the formation of ice as it flows. The solution mixes with the supercooled water in the cloud, depresses its freezing point, and allows the mixture to flow off of the aircraft without freezing. The system is designed to anti-ice, but it is also capable of deicing an aircraft as well. When ice has accumulated on the leading edges,

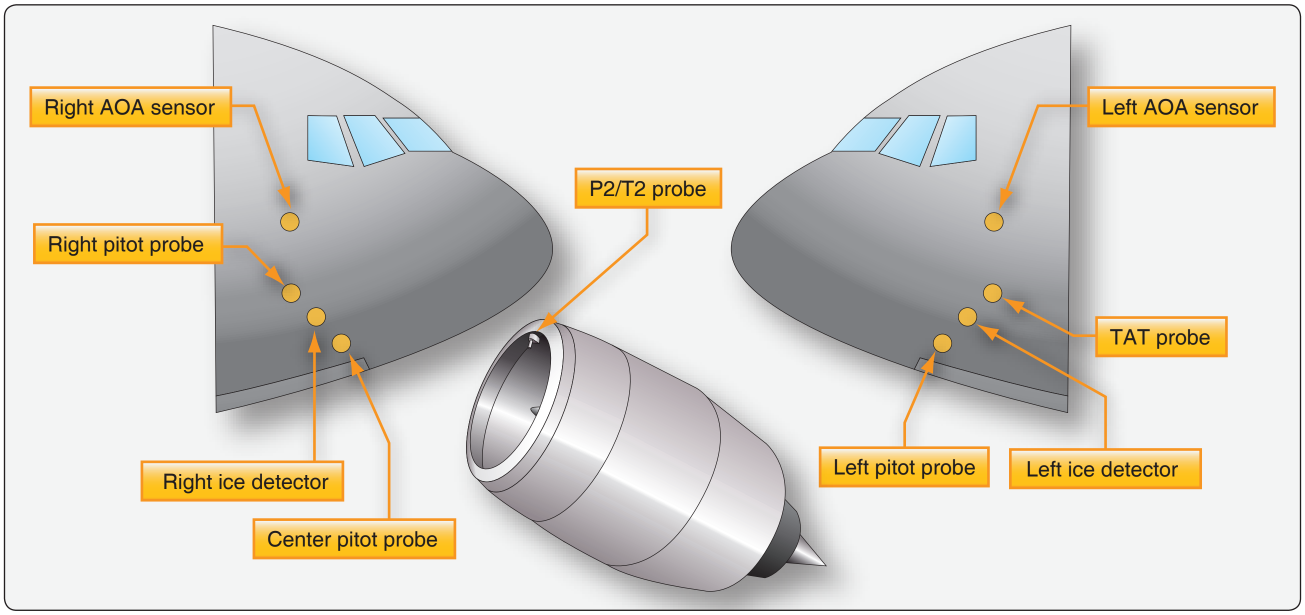

Figure 15-14. *Probes with thermal electric anti-icing on one commercial airliner.*

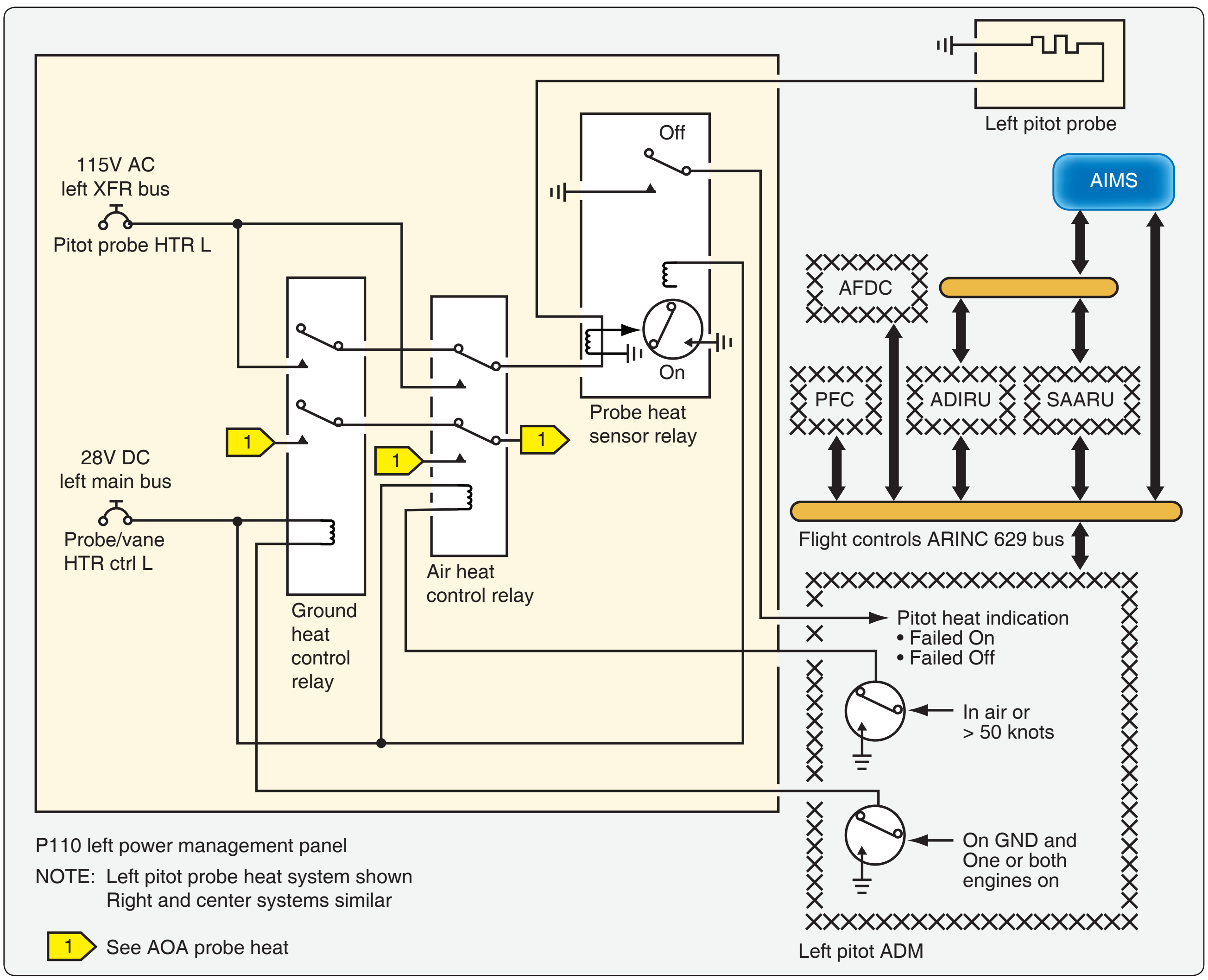

Figure 15-15. *Pitot probe heat system.*

the antifreeze solution chemically breaks down the bond between the ice and airframe. This allows aerodynamic forces to carry the ice away. Thus, the system clears the airframe of accumulated ice before transitioning to anti-ice protection. *Figure 15-16* shows a chemical anti-ice system.

The TKS™ weeping wing system contains formed titanium panels that are laser drilled with over 800 tiny holes (.0025-inch diameter) per square inch. These are mated with non-perforated stainless-steel rear panels and bonded to wing and stabilizer leading edges. As fluid is delivered from a central reservoir and pump, it seeps through the holes. Aerodynamic forces cause the fluid to coat the upper and lower surfaces of the airfoil. The glycol-based fluid prevents ice from adhering to the aircraft structure.

Some aircraft with weeping wing systems are certified to fly into known icing conditions. Others use it as a hedge against unexpected ice encountered in flight. The systems are basically the same. Reservoir capacity permits 1- 2 hours of operation. TKS™ weeping wings are used primarily on reciprocating aircraft that lack a supply of warm bleed air for the installation of a thermal anti-ice system. However, the system is simple and effective leading to its use on some turbine powered corporate aircraft as well.

Wing and Stabilizer Deicing Systems

GA aircraft and turboprop commuter-type aircraft often use a pneumatic deicing system to break off ice after it has formed on the leading-edge surfaces. The leading edges of the wings and stabilizers have inflatable boots attached to them. The boots expand when inflated by pneumatic pressure, which breaks away ice accumulated on the boot. Most boots are inflated for 6 to 8 seconds. They are deflated by vacuum suction. The vacuum is continuously applied to hold the boots tightly against the aircraft while not in use.

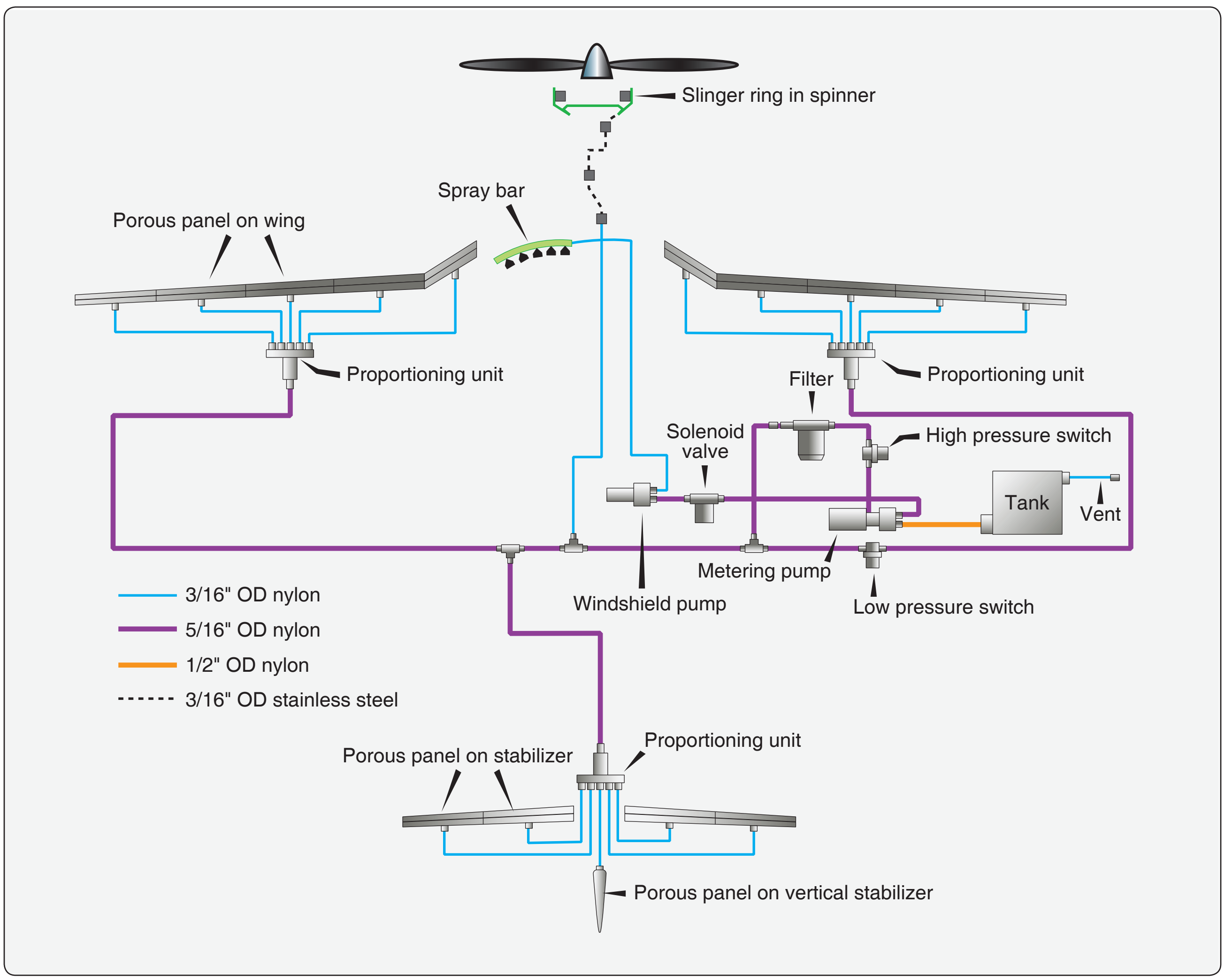

Figure 15-16. *Chemical deicing system.*