॥ नमस्ते ॥

DE-ICING SYSTEMS

Why DE-ICING SYSTEM ?

- When ice, snow or frost are allowed to accumulate on aircraft surfaces and then are removed, the process is known as de-icing.
- Smaller turbine powered aircraft and reciprocating aircraft often incorporate de-ice systems rather anti-ice system
- although some aircraft my use a combination of de-ice and anti-ice for overall ice protection.

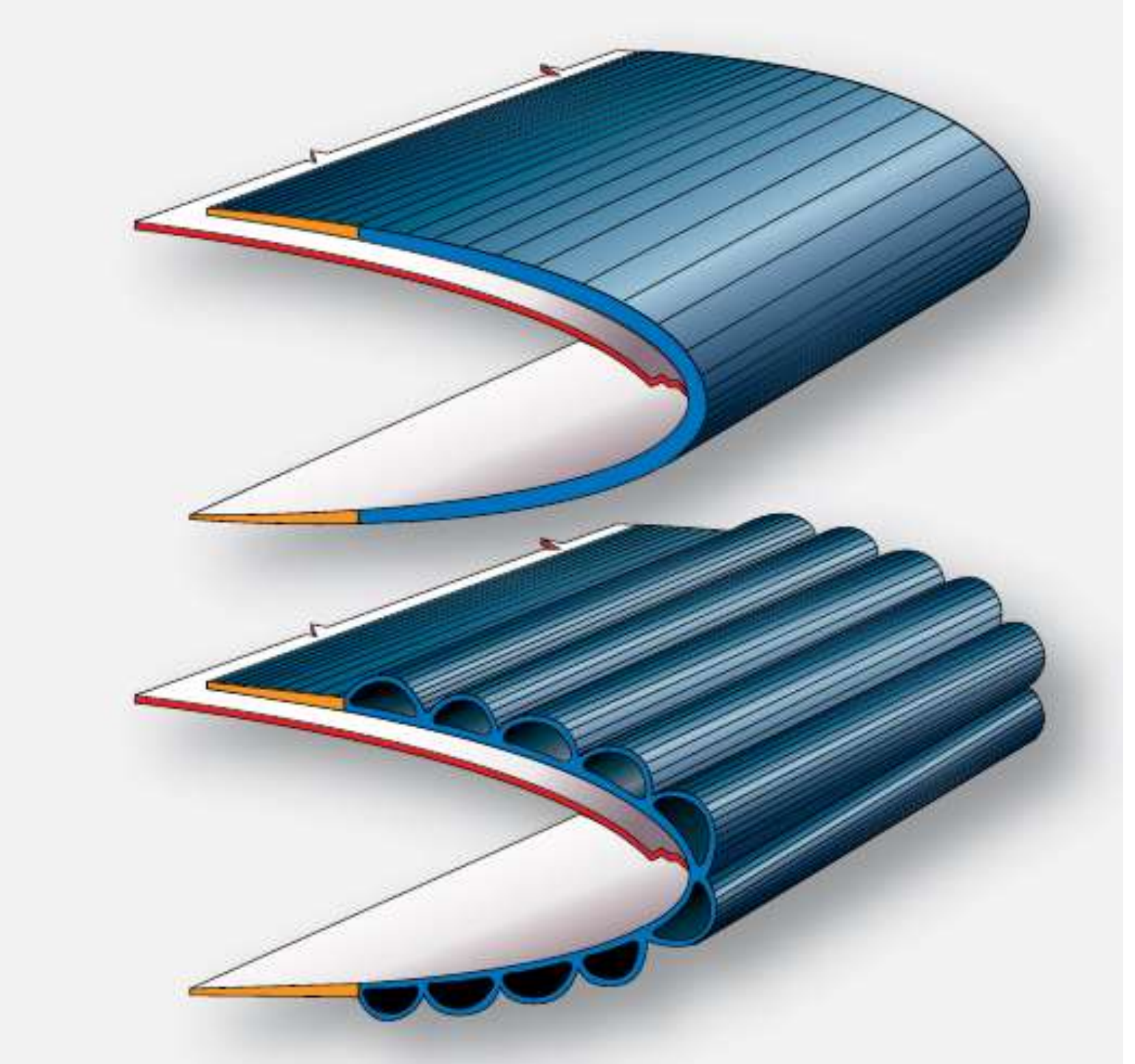
PNEUMATIC DE-ICE BOOTS

- **PNEUMATIC DE-ICE BOOTS are**

- **Used On small turbine powered aircraft and reciprocating engine aircraft**
- **Used in Wings and Stabilizers**
- **Position: The leading edges of the wings and stabilizers**

Principle

- The most common means for de-icing wings and stabilizers on small turbine powered aircraft and reciprocating engine aircraft.
- 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.



CONSTRUCTION OF DE-ICE BOOTS

- De-icer boots are made of soft, pliable rubber, or rubberized fabric, and contain tubular air cells.
- The outer ply of the de-icer boot is of conductive neoprene to provide resistance to deterioration by the elements and many chemicals.
- The neoprene also provide a conductive surface to dissipate static electricity charges .
- These charges, if allowed to accumulate, would eventually discharge through the boot to the metal skin beneath, causing static interference with the radio equipment.

INSTALLATION OF DE-ICE BOOTS

- The de-icer boots are bonded with an adhesive to the leading edge of wing and tail surfaces.
- The trailing edges of this type boot are tapered to provide a smooth airfoil.
- Elimination of fairing strips, screws, and rivnuts used on older types of de-icing boots reduces the weight of the de-ice system.
- The de-icer boot air cells are connected to system pressure and vacuum lines by non-kinking flexible hose.

SOURCES OF OPERATING AIR

In Reciprocating Engine

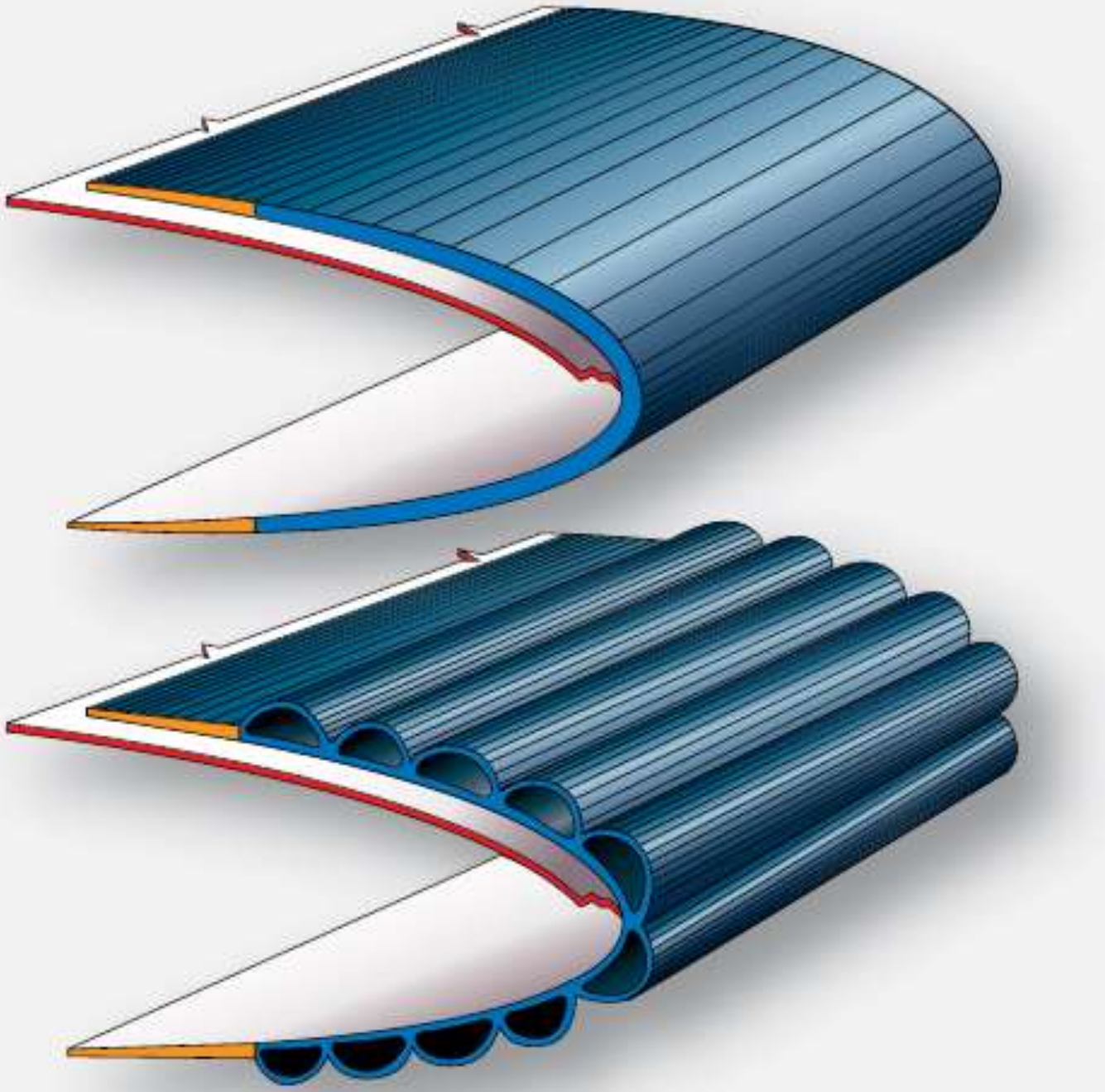
- Dedicated engine-driven air pump mounted on the accessory drive gear box of the engine.
- The suction side of the pump is used to operate the gyroscopic instruments if installed on the aircraft.
- It is also used to hold the de-ice boots tight to the aircraft when they are not inflated.
- The pressure side of the pump supplies air to inflate the de-ice boots, which breaks up ice that has formed on the wing and stabilizer leading edges.
- The pump operates continuously. Valves, regulators, and switches in the cockpit are used to control the flow of source air to the system.

In Turbine Engine

- The source of de-ice boot operating air on turbine engine aircraft is typically bleed air from the engine compressor(s).
- A relatively low volume of air on an intermittent basis is required to operate the boots.
- This has little effect on engine power enabling use of bleed air instead of adding a separate engine-driven air pump.
- Valves controlled by switches in the cockpit deliver air to the boots when requested.

RECIPROCATING ENGINE AIRCRAFT DE-ICE SYSTEMS

- General aviation reciprocating engine aircraft, especially twin-engine models, are commonly equipped with pneumatic de-icer systems.
- Rubber boots are attached with glue to the leading edges of the wings and stabilizers.
- These boots have a series of inflatable tubes.
- During operation, the tubes are inflated and deflated in an alternating cycle.
- *This* inflation and deflation causes the ice to crack and break off.
- The ice is then carried away by the airstream.
- Boots used in GA aircraft typically inflate and deflate along the length of the wing.



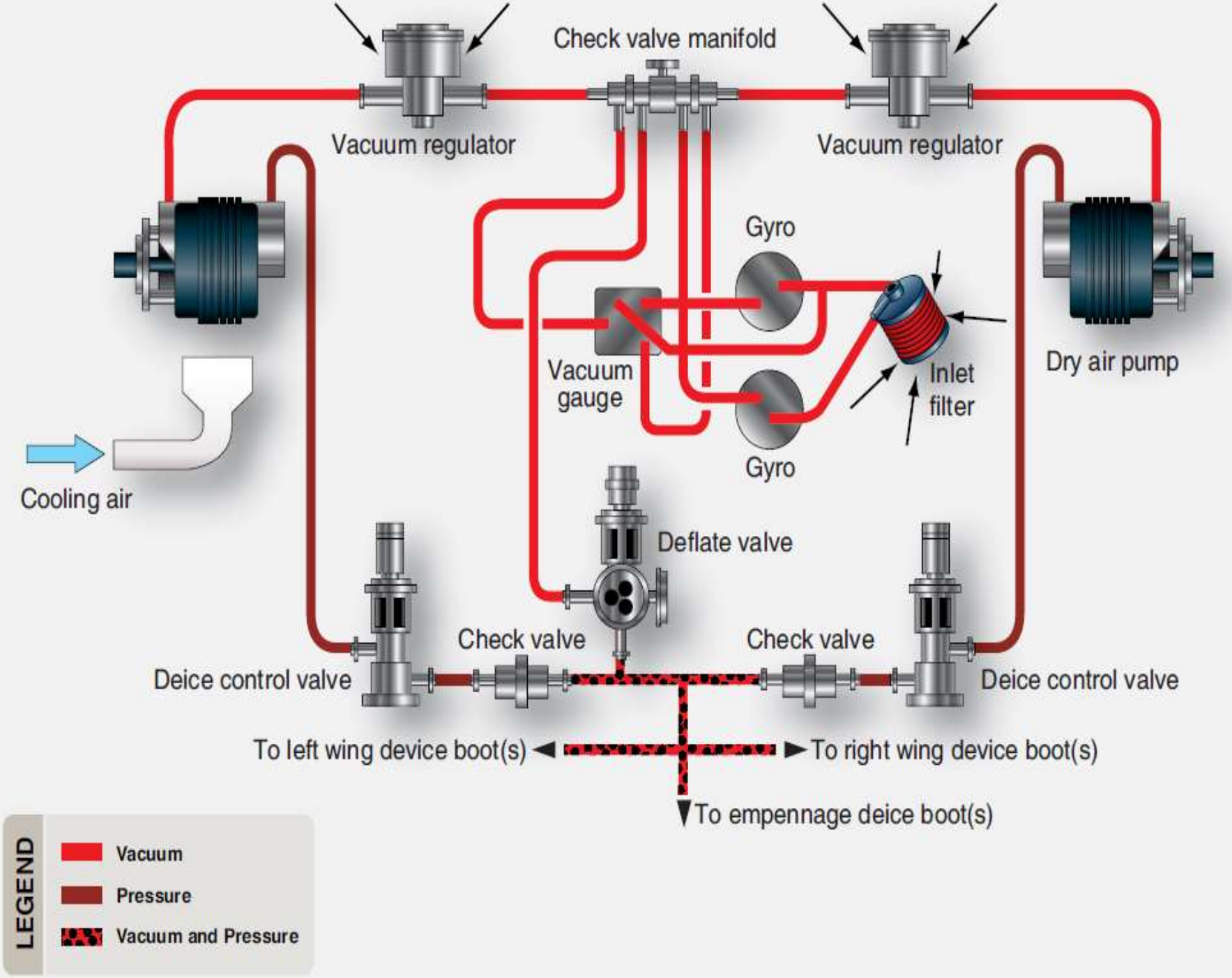
System Operation

Deicing system components

1. Wet-Type Engine-Driven Air Pump
2. Dry-Type Engine-Driven Air Pump
3. Oil Separator
4. Control Valve
5. Deflate Valve
6. Distributor Valve
7. Timer/Control Unit
8. Regulators and Relief Valves
9. Manifold Assembly
10. Inlet Filter

Connections

- In normal flight, all of the components in the de-ice system are de-energized.
- Discharge air from the dry air pumps is dumped overboard through the de-ice control valves.
- The deflate valve is open connecting the de-ice boots to the suction side of the pump through the check valve manifold and the vacuum regulator.
- The gyroscopic instruments are also connected to the vacuum side of the dry air pump.
- The vacuum regulator is set to supply the optimum suction for the gyros, which is sufficient to hold the boots tightly against the airfoil surfaces.


Check valve manifold
Vacuum regulator
Vacuum regulator
Gyro
Vacuum gauge
Inlet filter
Dry air pump
Cooling air
Gyro
Deflate valve
Check valve
Check valve
Deice control valve
Deice control valve
To left wing device boot(s)
To right wing device boot(s)
To empennage deice boot(s)
LEGEND
Vacuum
Pressure
Vacuum and Pressure

Working

- When the switch is pushed ON, the solenoid-operated de-ice control valves in each nacelle open and the deflate valve energizes and closes.
- Pressurized air from the discharge side of the pumps is routed through the control valves to the de-ice boot.
- When the system reaches 17 psi, pressure switches located on the deflate valve de-energize the de-ice control valve solenoids.
- The valves close and route pump air output overboard.
- The deflate valve opens and the boots are again connected to vacuum.
- On this simple system, the pilot must manually start this inflation/deflation cycle by pushing the switch each time de-ice is required.

DE-ICE SYSTEM FOR TURBOPROP AIRCRAFT

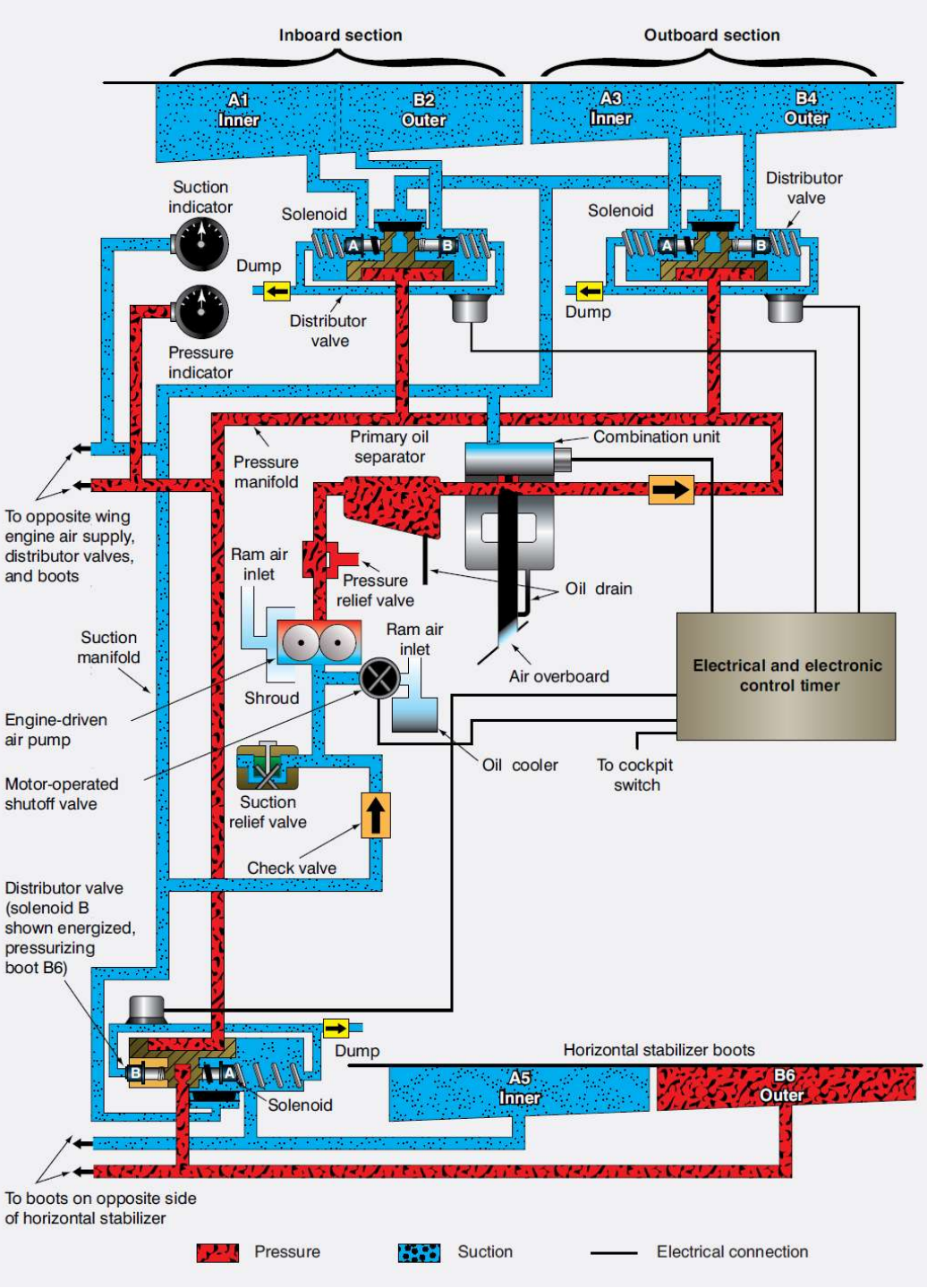
- **The source of pneumatic air is engine bleed air, which is used to inflate two inboard wing boots, two outboard boots, and horizontal stabilizer boots.**
- **Additional bleed air is routed through the brake de-ice valve to the brakes.**
- **A three position switch controls the operation of the boots. This switch is spring loaded to the center OFF position.**
- **When ice has accumulated, the switch should be selected to the single cycle (up) position and released.**

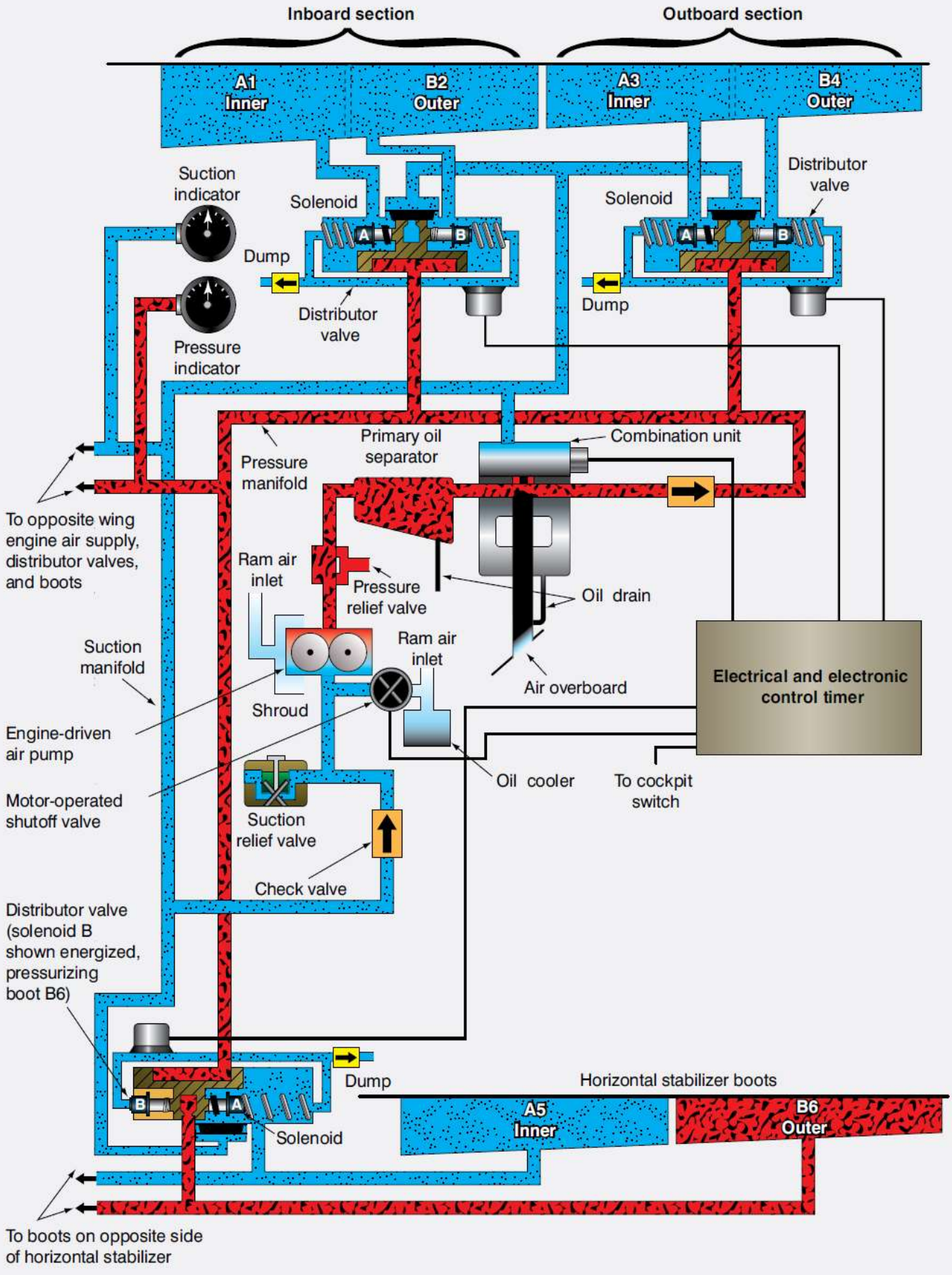
- **Pressure regulated bleed air from the engine compressors supply air through bleed air flow control units and pneumatic shutoff valves to a pneumatic control assembly that inflates the wing boots.**
- **After an inflation period of 6 seconds, an electronic timer switches the distributor in the control assembly to deflate the wing boots and a 4 second inflation begins in the horizontal stabilizer boots.**

- **After these boots have been inflated and deflated, the cycle is complete, and all boots are again held down tightly against the wings and horizontal stabilizer by vacuum.**
- **The spring-loaded switch must be selected up again for another cycle to occur. Each engine supplies a common bleed air manifold.**

- **To ensure the operation of the system, if one engine is inoperative, a flow control unit with check valve is incorporated in the bleed air line from each engine to prevent the loss of pressure through the compressor of the inoperative engine.**
- **If the boots fail to function sequentially, they may be operated manually by selecting the DOWN position of the same de-ice cycle switch.**

- Depressing and holding it in the manual DOWN position inflates all the boots simultaneously.
- When the switch is released, it returns to the (spring-loaded) off position, and each boot is deflated and held by vacuum.
- When operated manually, the boot should not be left inflated for more than 7 to 10 seconds, as a new layer of ice may begin to form on the expanded boots and become un-removable.
- If one engine is inoperative, the loss of its pneumatic pressure does not affect boot operation.
- Electric power to the boot system is required to inflate the boots in either single-cycle or manual operation.
- When electric power is lost, the vacuum holds the boots tightly against the leading edge.


Inboard section
Outboard section
A1 Inner
B2 Outer
A3 Inner
B4 Outer
Suction indicator
Solenoid
Distributor valve
Dump
Pressure indicator
Pressure manifold
Primary oil separator
Combination unit
To opposite wing engine air supply, distributor valves, and boots
Ram air inlet
Pressure relief valve
Oil drain
Suction manifold
Ram air inlet
Shroud
Air overboard
Electrical and electronic control timer
Engine-driven air pump
Motor-operated shutoff valve
Oil cooler
To cockpit switch
Suction relief valve
Check valve
Distributor valve (solenoid B shown energized, pressurizing boot B6)
Horizontal stabilizer boots
A5 Inner
B6 Outer
To boots on opposite side of horizontal stabilizer
Pressure
Suction
Electrical connection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Horizontal stabilizer boots
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To boots on opposite side of horizontal stabilizer
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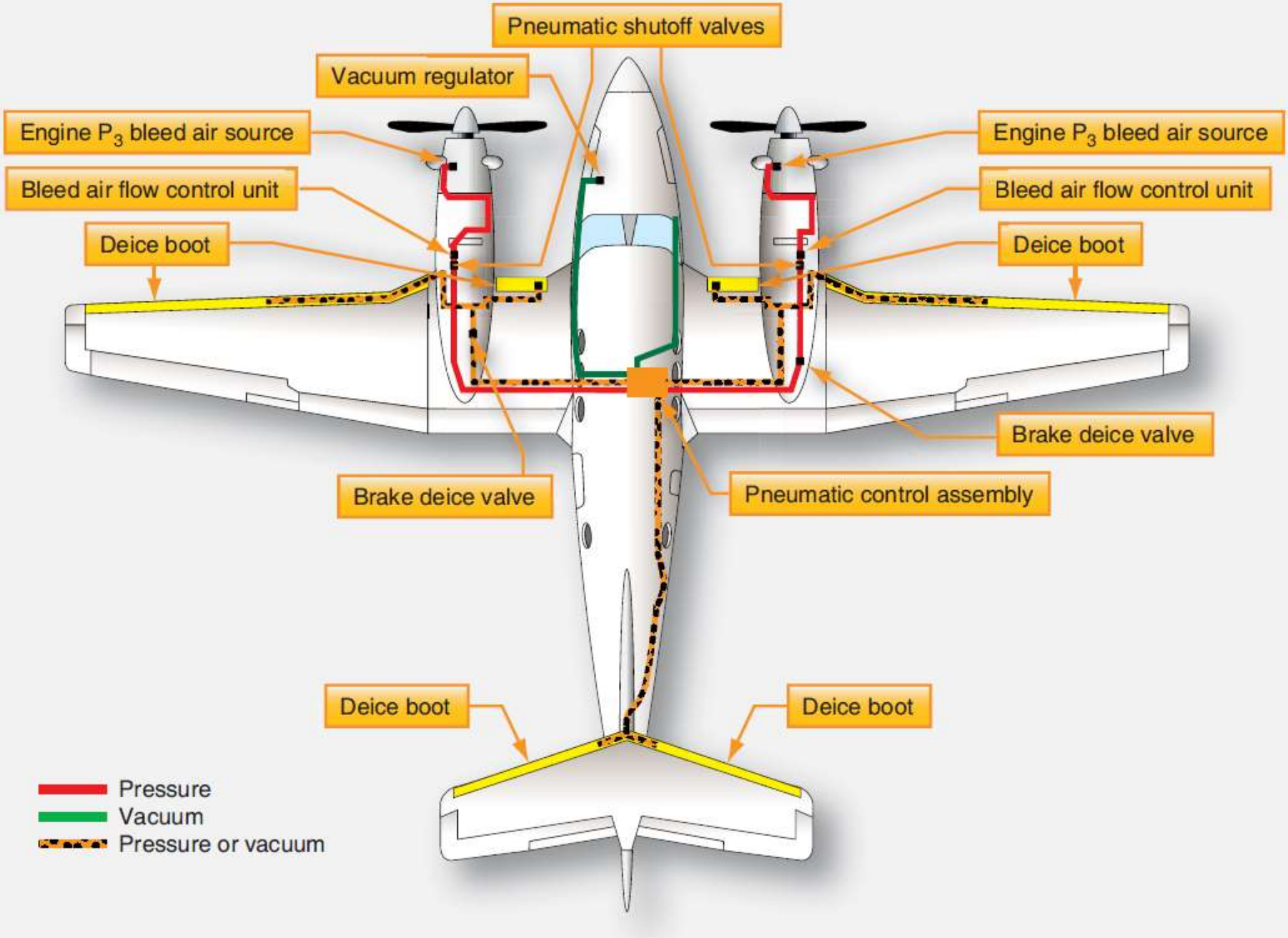

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LIGHTS
LANDING
TAXI
ICE
NAV
RECOG
DEFROST AIR
ICE PROTECTION
W/SHLD ANTI-ICE
NORMAL
AUTO
MANUAL
FUEL VENT
PILOT
COPILOT
OFF
PULL ON
DOWN LOCK REL
BRAKE DEICE
DEICE CYCLE SINGLE
STALL WARN
PITOT
LANDING GEAR
MANUAL
OFF
RELAY

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INSPECTION, MAINTENANCE, AND TROUBLESHOOTING

The aircraft maintenance usually consists of

1. Operational checks,
2. Adjustments,
3. Troubleshooting, and
4. Inspection.

Operational Checks

- **An operational check of the system can be made by operating the aircraft engines or by using an external source of air.**
- **Most systems are designed with a test plug to permit ground checking the system without operating the engines.**
- **When using an external air source, make certain that the air pressure does not exceed the test pressure established for the system.**
- **Before turning the de-icing system on, observe the vacuum operated instruments.**
- **If no movement of the instrument pointers occurs, turn on the de-icing system.**

- **With the de-icer system controls in their proper positions, check the suction and pressure gauges for proper indications.**
- **The pressure gauge fluctuates as the de-icer tubes inflate and deflate.**
- **A relatively steady reading should Be maintained on the vacuum gauge.**
- **It should be noted that not all systems use a vacuum gauge.**
- **If the operating pressure and vacuum are satisfactory observe the de-icers for actuation.**
- **With an observer stationed outside the aircraft, check the inflation sequence to be certain that it agrees with the sequence indicated in the aircraft maintenance manual.**

- **Check the timing of the system through several complete cycles.**
- **If the cycle time varies more than is allowable, determine the difficulty and correct it.**
- **Inflation of the de-icers must be rapid to provide efficient de-icing.**
- **Deflation of the boot being observed should be completed before the next inflation cycle.**

Adjustments

Adjustment can be done by

- Control cable linkages,
- Adjusting system pressure relief valves, and
- De-icing system vacuum(suction) relief valves.
- A pressure relief valve acts as a safety device to relieve excess pressure in the event of regulator valve failure.

- **To adjust this valve, operate the aircraft engines and adjust a screw on the valve until the de-icing pressure gauge indicates the specified pressure at which the valve should relieve.**
- **Vacuum relief valves are installed in a system that uses a vacuum pump to maintain constant suction during varying vacuum pump speeds.**
- **To adjust a vacuum relief valve, operate the engines. While watching the vacuum (suction) gauge, an assistant should adjust the suction relief valve adjusting screw to obtain the correct suction specified for the system.**

Troubleshooting

Problem	Causes (most of which can be identified with a 343 Test Kit)	Corrective action(s)
Boots do not inflate	• Open circuit breaker	• Reset circuit breaker
	• Faulty deflate valve	• Check deflate valves as follows:
	Solenoid inoperable:	Solenoid inoperable:
	1. Improper voltage at solenoid	1. Correct electrical system
	2. Blocked air vent in solenoid	2. Clean with alcohol or replace
	3. Inoperative plunger	3. Clean with alcohol or replace
	Diaphragm not seated	Diaphragm not seated
	1. Blocked vent orifice located in rivet bottom at center of diaphragm	1. Clean with .010 diameter wire and alcohol
	2. Dirty diaphragm seal area	2. Clean with blunt instrument and alcohol
	3. Diaphragm ruptured	3. Replace valve
	• Two faulty deice control valves of faulty two-stage regulators	• Clean or replace valve assembly as noted above
	• Faulty check valve	• Replace check valve
	• Relay not functioning	• Check wiring or replace relay
	• Leak in system boots	• Repair as needed

	• Leak in system boots	• Repair as needed
Slow boot inflation	• Lines blocked or disconnected • Low air pump capacity • One or more deice control valves not functioning properly • Deflate valve not fully closed • Ball check in deflate valve inoperative • Leaks in system or boots	• Check and replace lines • Replace air pump • Clean or replace valve assembly as noted above • Clean or replace valve assembly as noted above • Clean check valve or replace deflate valve

	• Leaks in system or boots	valve
System will not cycle	• Pressure in system not reaching specified psi to activate pressure switch • Leak in system or boots • Pressure switch on deflate valve inoperative	• Clean or replace deice control valve as noted above • Clean or replace deflate valve, as noted above • Repair as needed, tighten all hose connections • Replace switch
Slow deflation	• Low vacuum • Faulty deflate valve (indicated by temporary reduction in suction gauge reading)	• Repair as needed • Clean or replace valve assembly as noted above
No vacuum for boot hold down	• Malfunctioning deflate valve or deice valve • Leak in system or boots	• Clean or replace valve assembly as noted above • Repair as needed
Boots will not deflate during cycle	• Faulty deflate valve	• Check and replace valve
Boots appear to inflate on aircraft climb	• Vacuum source for boot hold down inoperative • Lines running through pressurized cabin loose or disconnected	• Check operation of ball check in deflate valve • Check for loose or disconnected vacuum lines and repair

Inspection

- **During each preflight and scheduled inspection, check the de-icer boots for cuts, tears, deterioration, punctures, and security; during periodic inspections, go a little further and check de-icer components and lines for cracks.**
- **If weather cracking of rubber is noted, apply a coating of conductive cement. The cement, in addition to sealing the boots against weather, dissipates static electricity so that it does not puncture the boots by arcing to the metal surfaces**

De- ice Boot Maintenance

1. **Do not drag gasoline hoses over the de-icers.**
2. **Keep de-icers free of gasoline, oil, grease, dirt, an other deteriorating substances.**
3. **Do not lay tools on or lean maintenance equipment against the de-icers.**
4. **Promptly repair or resurface the de-icers when abrasion or deterioration is noted.**
5. ***Wrap de-ice boots in paper or canvas when storing.***

Preventive maintenance can be done by

1. **Cleaning**

- **Cleaning should ordinarily be done at the same time the aircraft is washed, using a mild soap and water solution. Grease and oil can be removed with a cleaning agent**

1. **Resurfacing**

- **The resurfacing substance is a black, conductive neoprene cement**

1. **Repairing.**

The Ice-cream you see in ads is actually mashed potatoes because it will not melt during production


Any
Questions

धन्यवाद

Prepared By
Mr.Pankaj Salunkhe