Ice Protection System

12.1 Overview

Overview

• The Mi-8/17 anti-icing system is designed to prevent the formation of ice and to remove ice or water from the blades of the main and tail rotors, two cockpit windshields, dust-protection devices (DPD), engines, and engine inlets.

• The rotors and windshields are heated electrically.

• The dust-protection devices (DPD) are heated both electrically and with bleed air from the engine compressor section.

• The engines and engine inlet sections are heated with bleed air from the engine compressor section.

• To provide warning of ice formation the helicopter is equipped with an SO-121VM (СО-121ВМ) ice detector and a visual ice-warning indicator. Some older aircraft are equipped with the RIO-3 (РИО-3) ice detector instead of the SO-121VM.

• The anti-icing systems of the rotors , windshields, and the right engine dust protector and inlet section are activated automatically (signaled by the SO-121VM detector) or manually.

• The left engine, left dust-protection device (DPD) and left engine inlet section are only activated manually.

Ice Protection System

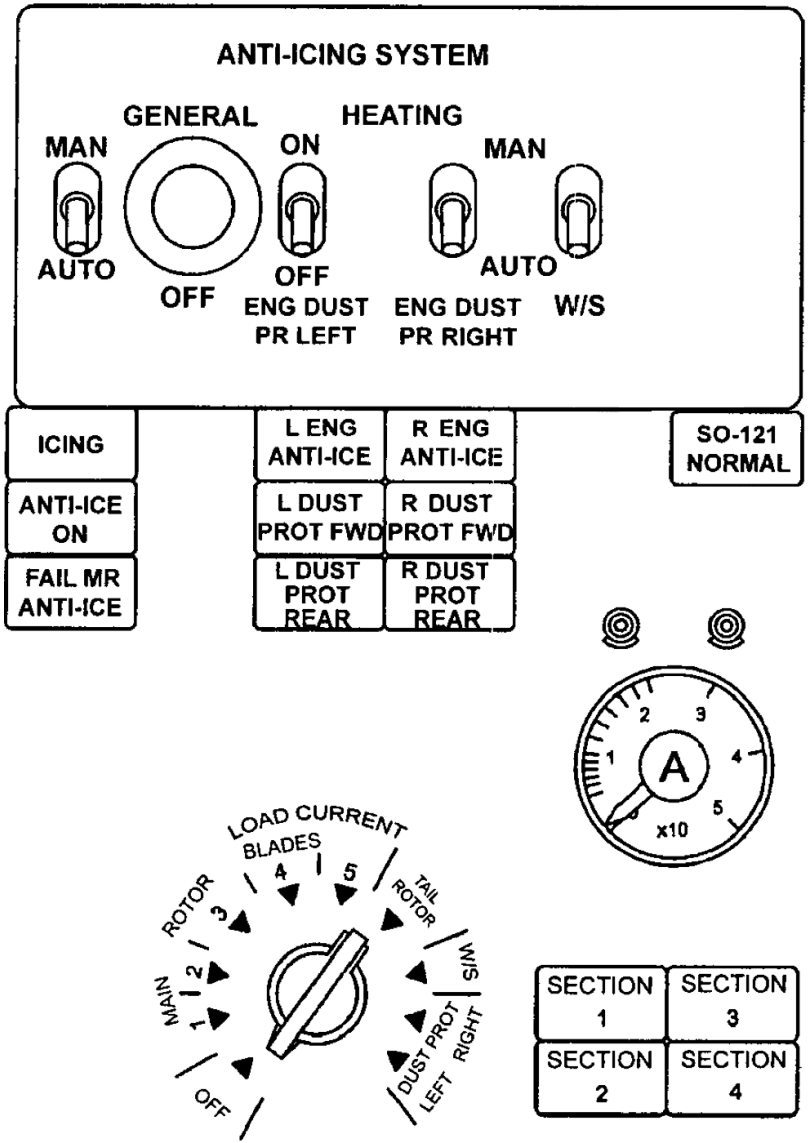
12.2 Ice Detection and Warning

Anti-Icing System Panel

• Control of the ice protection system, as well as annunciators and indications regarding the operation of the ice protection system, are found on the Anti-Icing System Panel located on the left side of the cockpit overhead panel.

• Aircraft equipped with the RIO-3 ice detector also have an ice detector heating switch and an ice detector heating test button on this panel.

• Some cockpit variants include “FLIGHT” and “PARKING” annunciators below the “SO-121 NORMAL” annunciator, which are not related to the operation of the ice protection system and are not covered in this presentation.

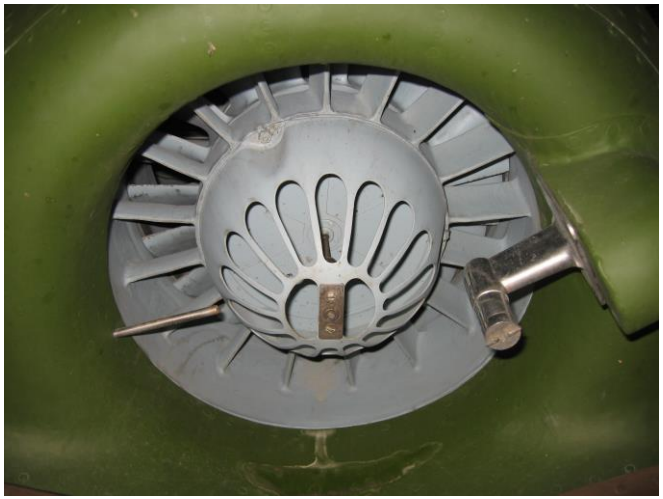


SO-121VM (CO-121BM) ice detector

• The SO-121VM ice detector set consists of a detector/transmitter and a control unit.

• The DSL-40T (ДСЛ-40Т) detector/transmitter is mounted in the oil cooler fan inlet.

• The control unit is mounted is mounted on the avionics rack behind the pilot's seat and consists of a PE-11M (ПЭ-11М) electronic converter mounted on an RM-5 (РМ-5) shock mount.



SO-121VM (CO-121BM) ice detector

• The SO-121VM ice detector set can be checked for proper operation using the “SIMULATION” (“ИМИТАЦИЯ”) button on the front of the control unit.

• The “SIMULATION” button is protected from inadvertent activation by a safety cover.

• With the “HEATING” (“ОБОГРЕВ”) light illuminated, the heating cycle for the ice detector head is in progress. With the “ICING” (“ОБЛЕД”) light illuminated, icing signals are being sent to other components in the system.

Visual Ice Detector

• The visual ice detector is a probe mounted on the pilot's sliding window.

• The probe is marked with red and black painted strips 5 mm wide each. These strips enable visual detection of ice accumulation on the probe.

• In case of ice detector failure, the pilot, watching the visual detector, can activate anti-icing system manually.

Ice Protection System

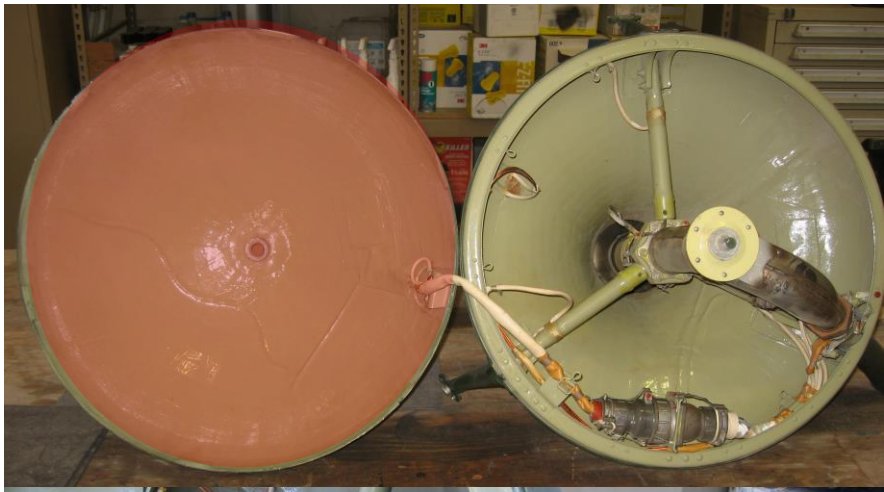
12.3 Dust-Protection Devices and Engine Inlets

DPD Heating - Electric

- Electric heating is applied to the following dust-protection device components:

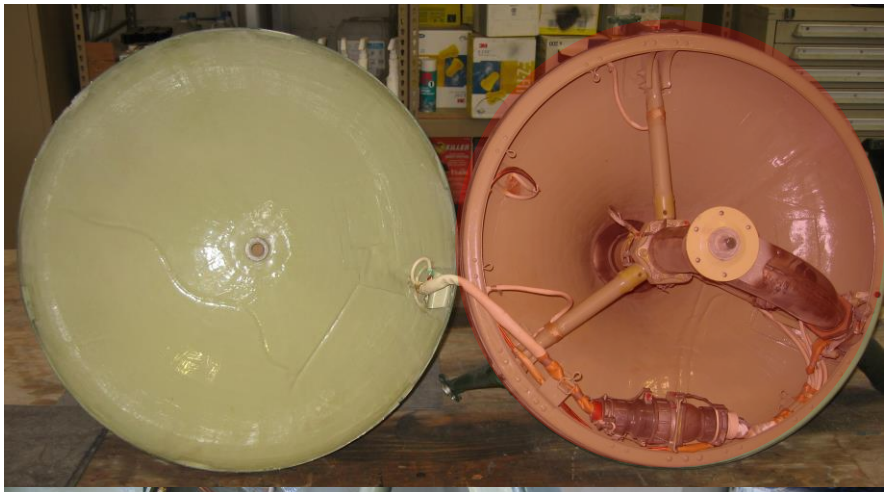
DPD Heating - Electric

- Electric heating is applied to the following dust-protection device components:
    - Front section of the fairing (cap)



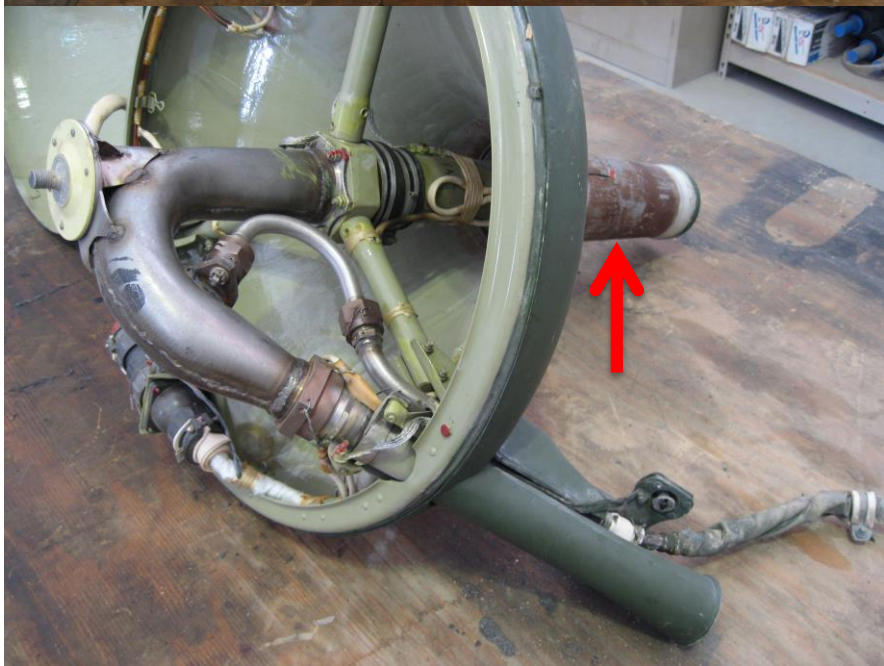
DPD Heating - Electric

- Electric heating is applied to the following dust-protection device components:
  - Front section of the fairing (cap)
  - Aft section of the fairing (tail piece)



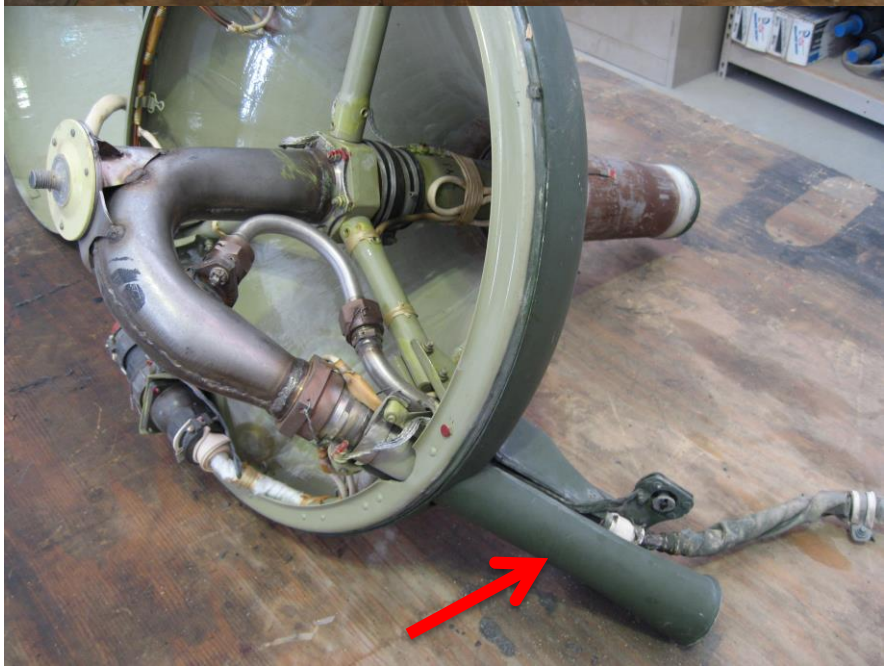
DPD Heating - Electric

- Electric heating is applied to the following dust-protection device components:
  - Front section of the fairing (cap)
  - Aft section of the fairing (tail piece)
  - Dust ejector pipeline housing



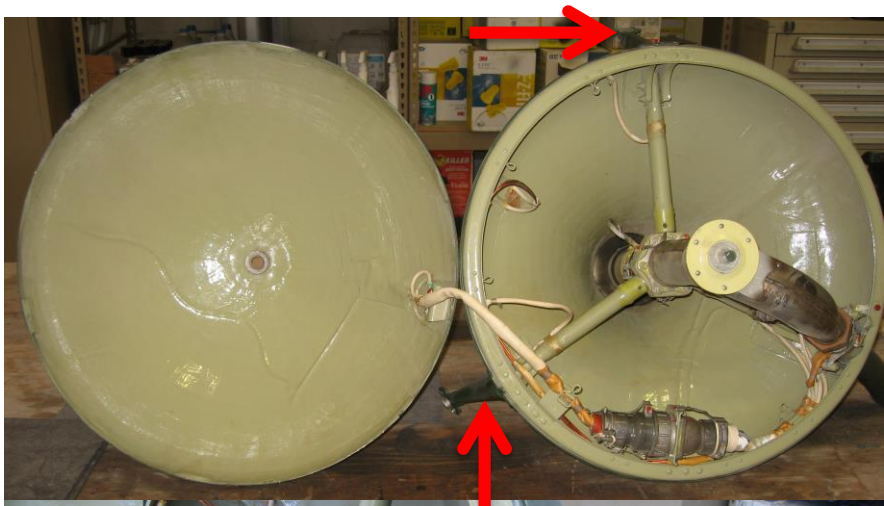
DPD Heating - Electric

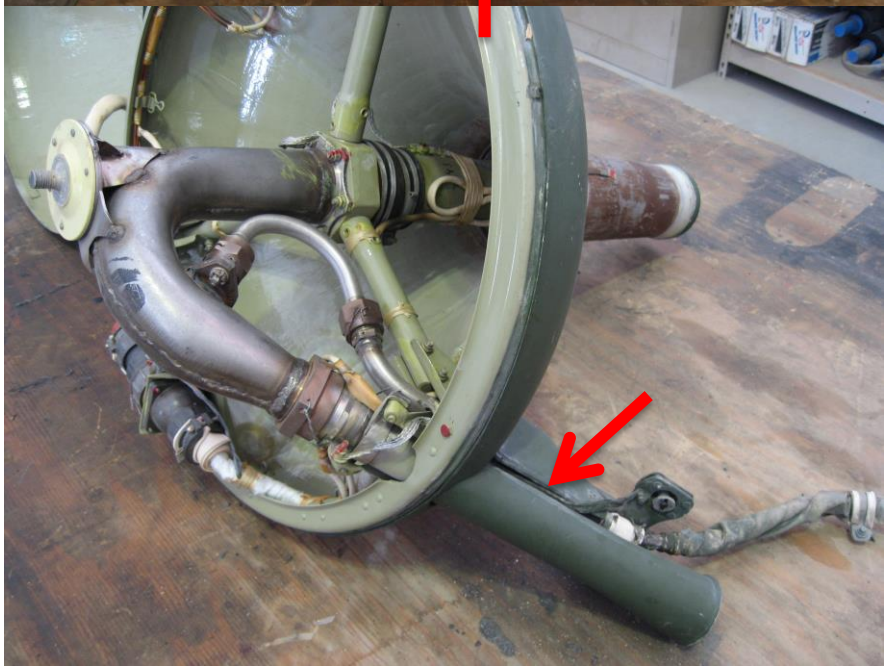
- Electric heating is applied to the following dust-protection device components:
  - Front section of the fairing (cap)
  - Aft section of the fairing (tail piece)
  - Dust ejector pipeline housing
  - Dust ejector bell mouth



DPD Heating - Electric

- Electric heating is applied to the following dust-protection device components:
  - Front section of the fairing (cap)
  - Aft section of the fairing (tail piece)
  - Dust ejector pipeline housing
  - Dust ejector bell mouth
  - Support strut leading edges





DPD Heating - Electric

- Electric heating is applied to the following dust-protection device components:
  - Front section of the fairing (cap)
  - Aft section of the fairing (tail piece)
  - Dust ejector pipeline housing
  - Dust ejector bell mouth
  - Support strut leading edges

- Heating is delivered by heating strips glued to the assemblies listed above. Probes monitor temperature and operate with four TER-1M (ТЭР-1М) temperature regulators to maintain a temperature of 70-80°C.

DPD Heating - Electric

• There are four TER-1M temperature regulators corresponding to the following anti-icing system panel lights: L DUST PROT FWD; L DUST PROT REAR; R DUST PROT FWD; R DUST PROT REAR.

• The TER-1M temperature regulators are mounted just forward of frame 4 in the cabin ceiling.

• The temperature regulators are set to turn off the heating elements of the dust-protection devices when the temperature probes reach a resistance of 141 ohms.

DPD Heating - Air

- Hot air is applied to the following dust protector components:

DPD Heating - Air

- Hot air is applied to the following dust protector components:
    - Inlet lip

DPD Heating - Air

- Hot air is applied to the following dust protector components:
    - Inlet lip
    - Inlet duct surface

DPD Heating - Air

- Hot air is applied to the following dust protector components:
  - Inlet lip
  - Inlet duct surface
  - Dust protector separator

DPD Heating - Air

- Hot air is applied to the following dust protector components:
    - Inlet lip
    - Inlet duct surface
    - Dust protector separator

- Hot air is delivered via pipelines connected to the engine combustion section.

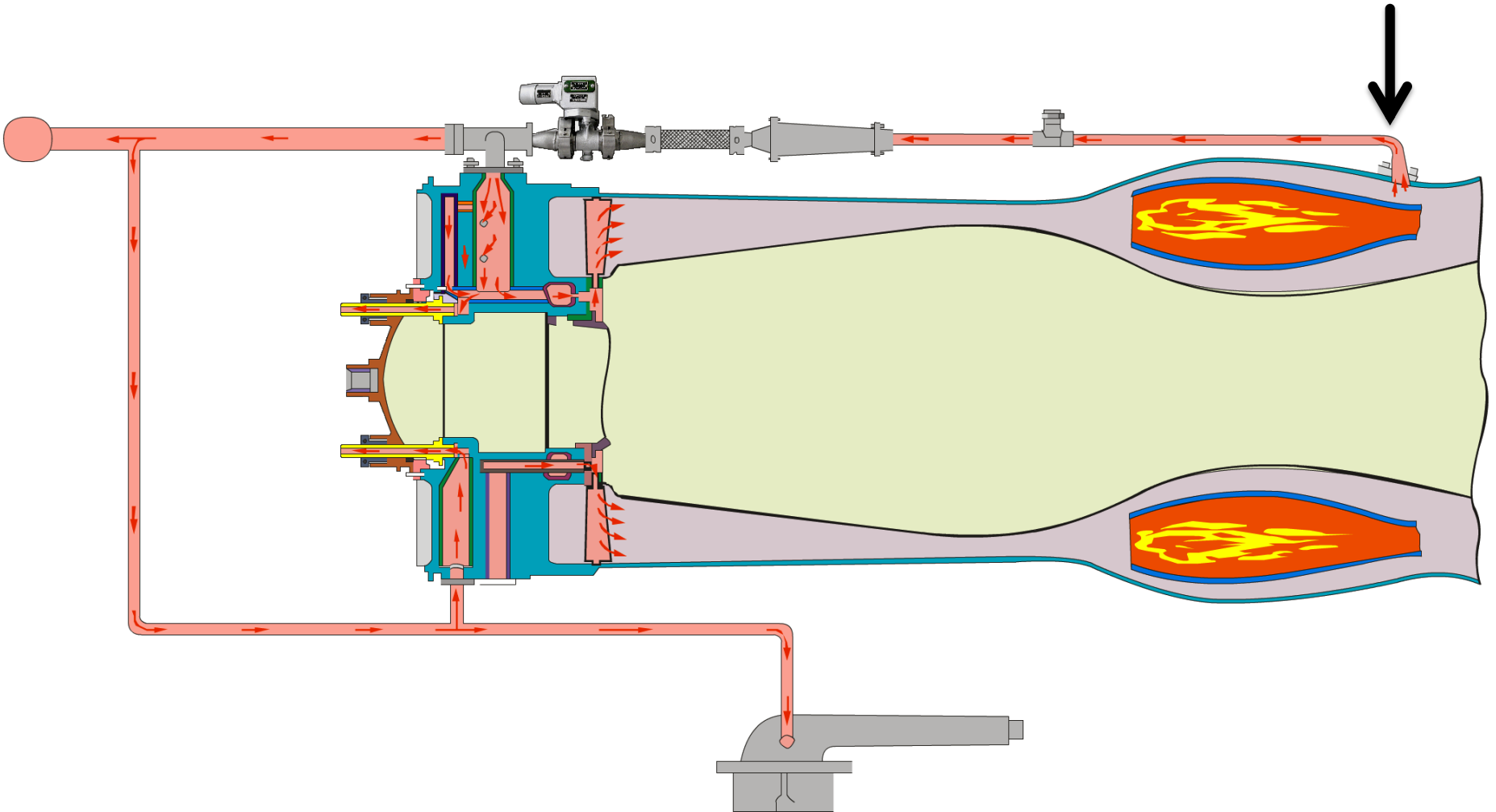
- Delivery of hot air is controlled by a 1919T hot air valve mounted on the right side of each engine. This same valve also delivers hot air to other engine components which will be discussed in the next section.

Ice Protection System

12.4 Engines

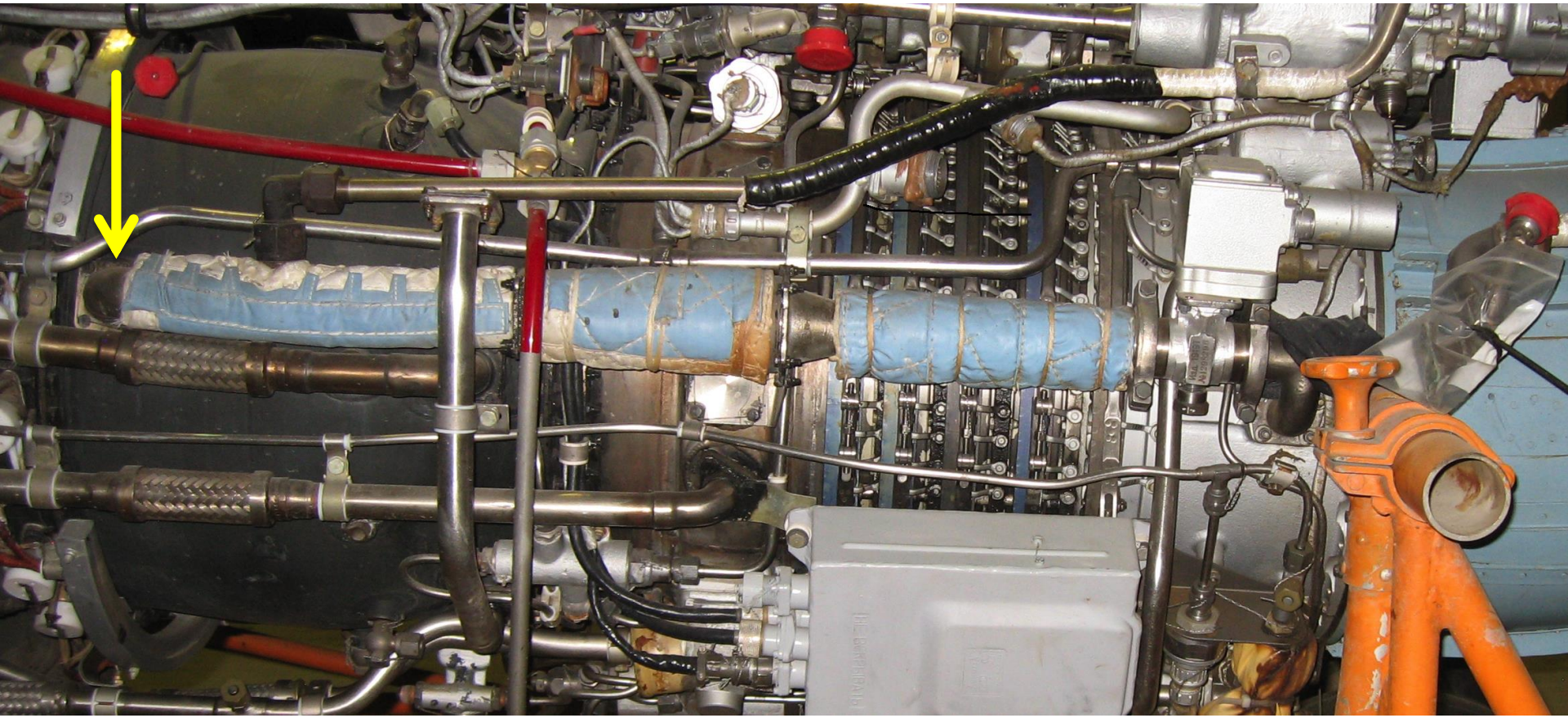
Engine Anti-Ice

- Hot air for engine anti-icing is tapped from the combustion chamber housing.



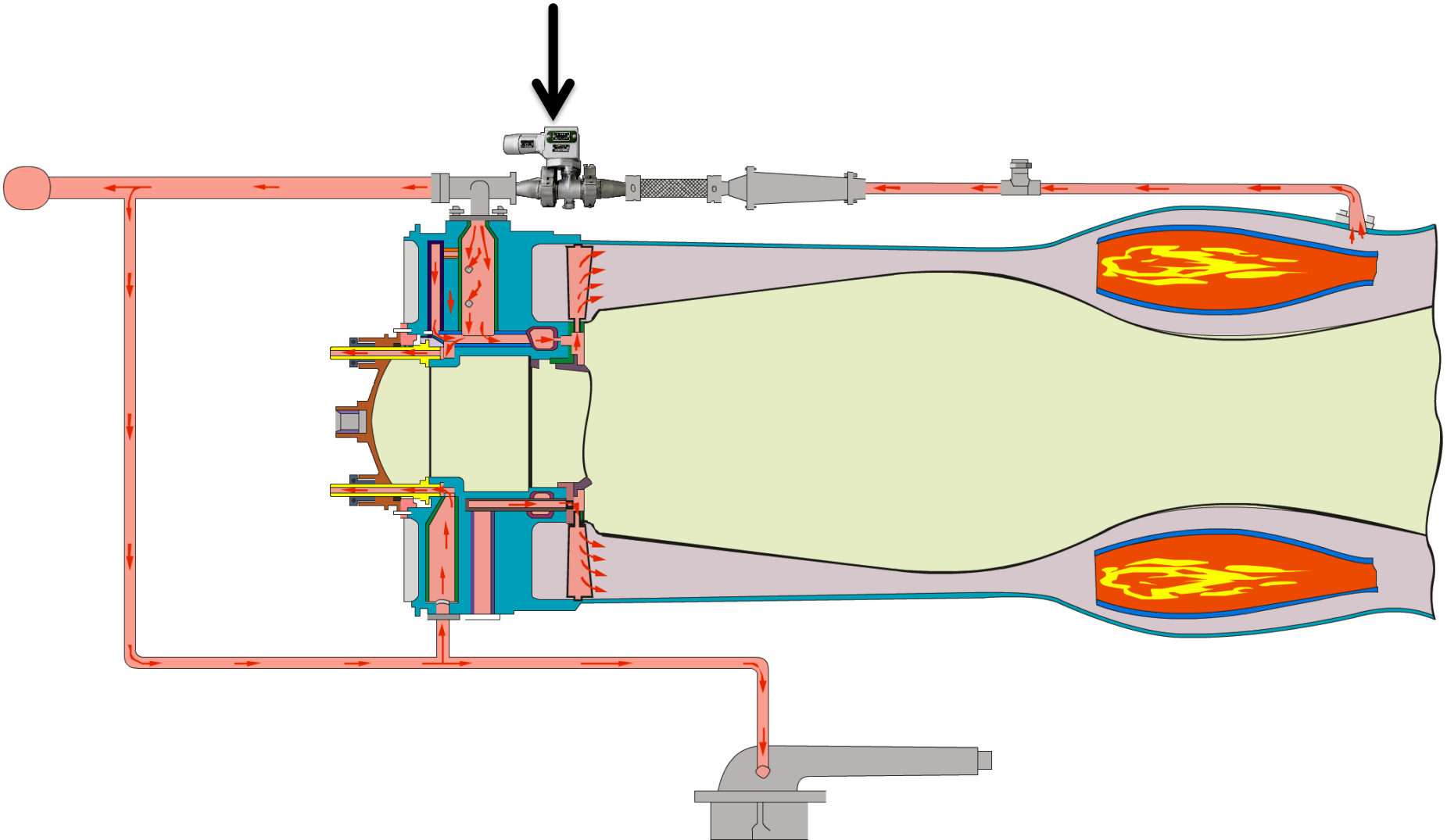
Engine Anti-Ice

- Hot air for engine anti-icing is tapped from the combustion chamber housing.



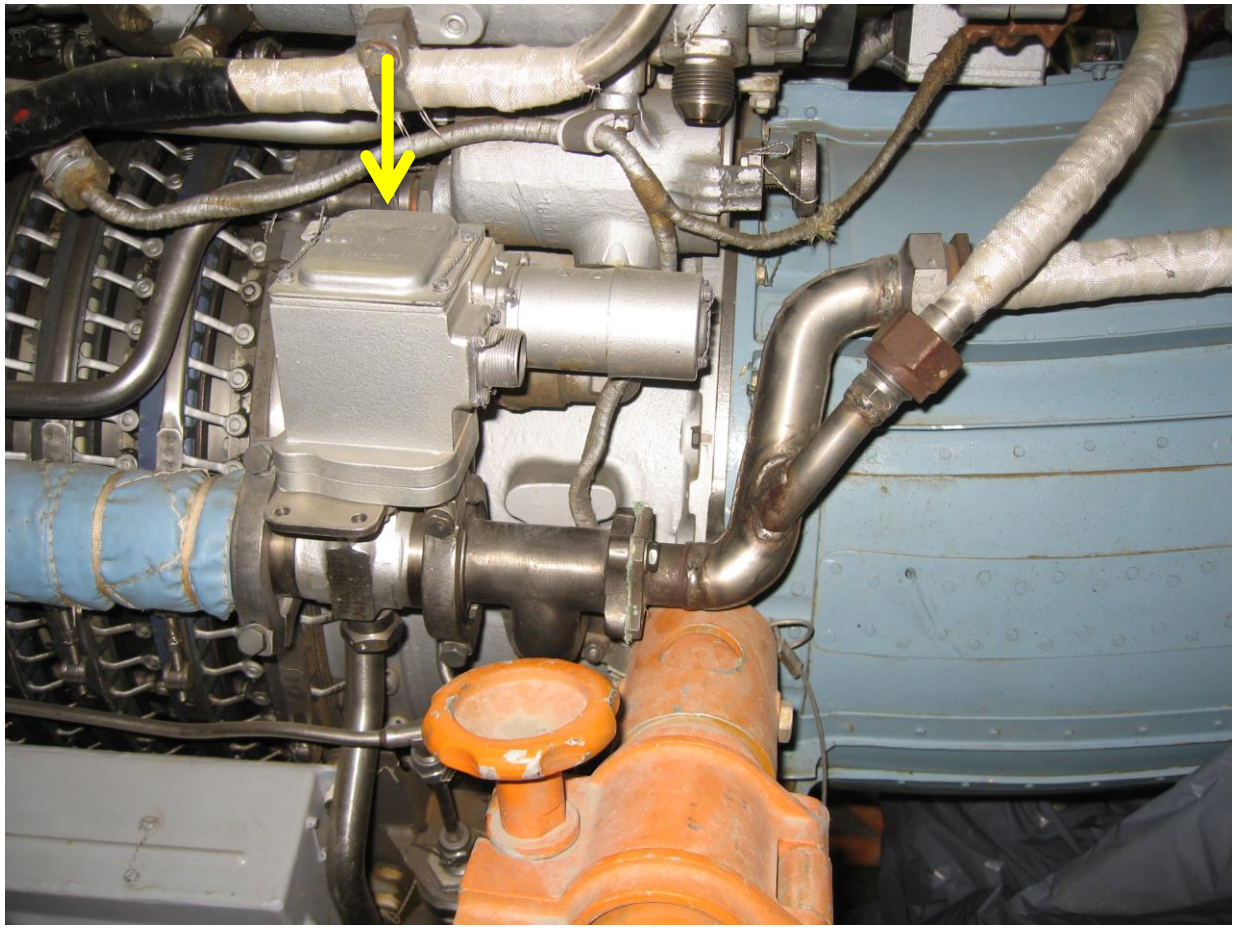
Engine Anti-Ice

- Hot air valve 1919T controls the delivery of hot air to the engine anti-icing system.



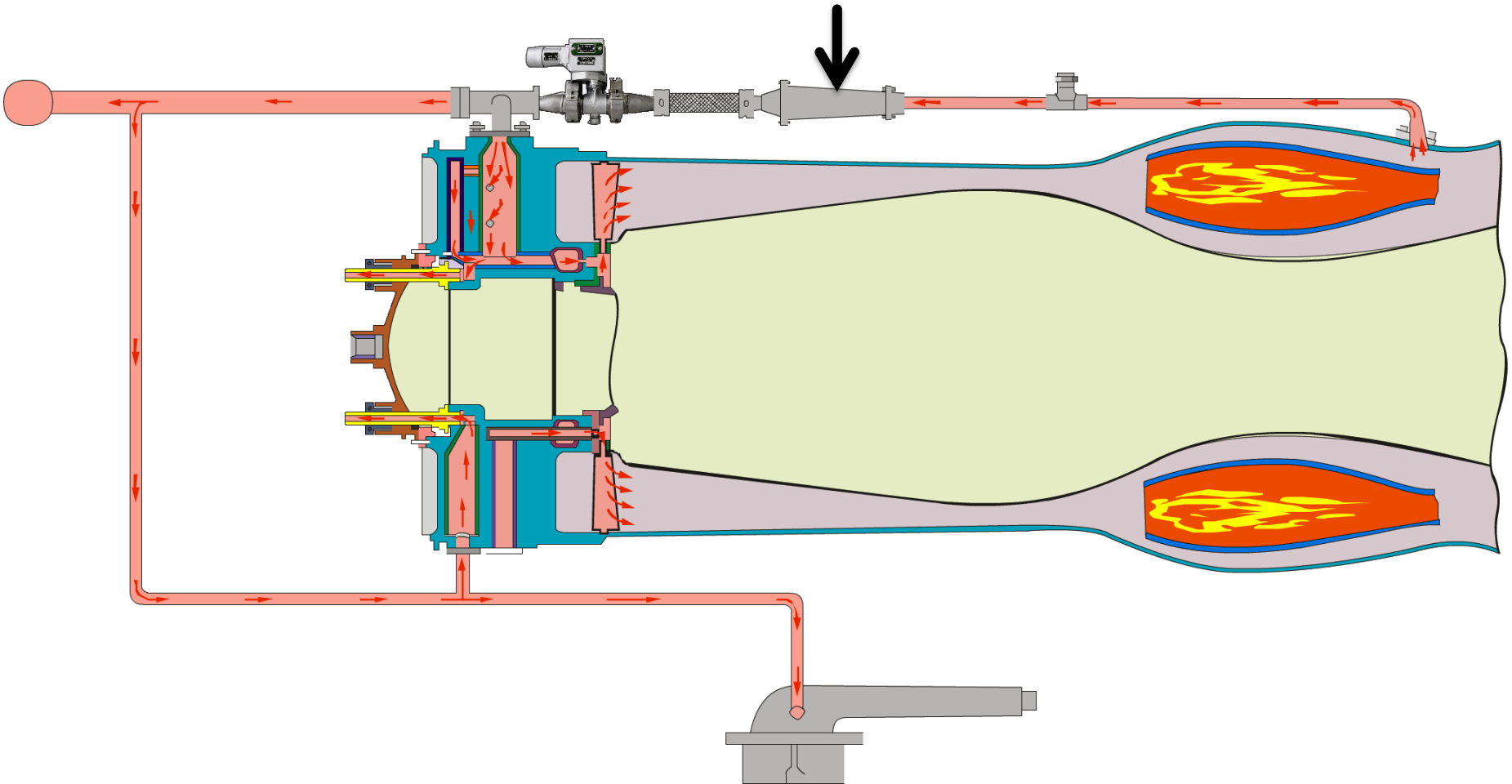
Engine Anti-Ice

- Hot air valve 1919T controls the delivery of hot air to the engine anti-icing system.



Engine Anti-Ice

• The flow of hot air is regulated by a temperature control device. This device contains a bimetallic spring and shutter that reduces the volume of air to the anti-icing system as the air temperature increases in order to minimize power loss.



Engine Anti-Ice

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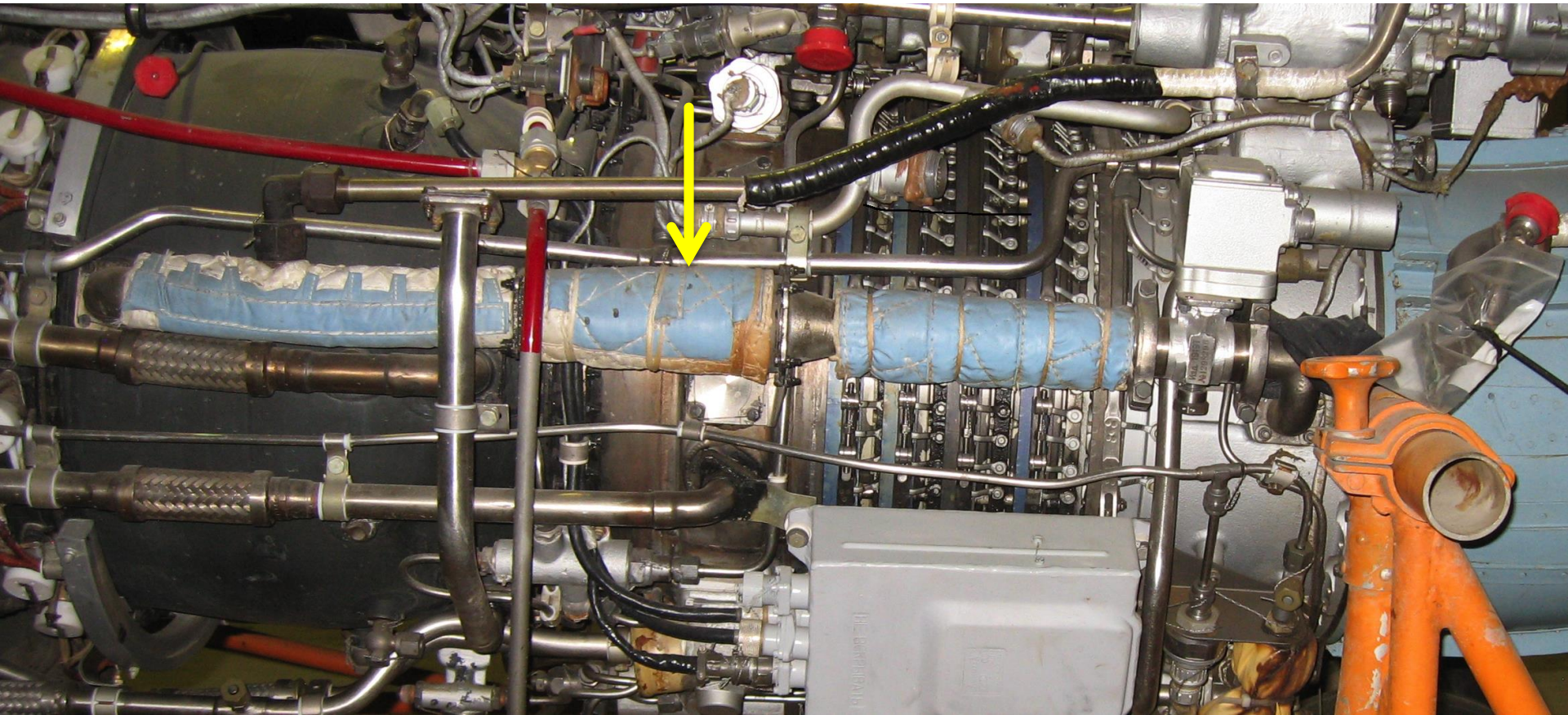
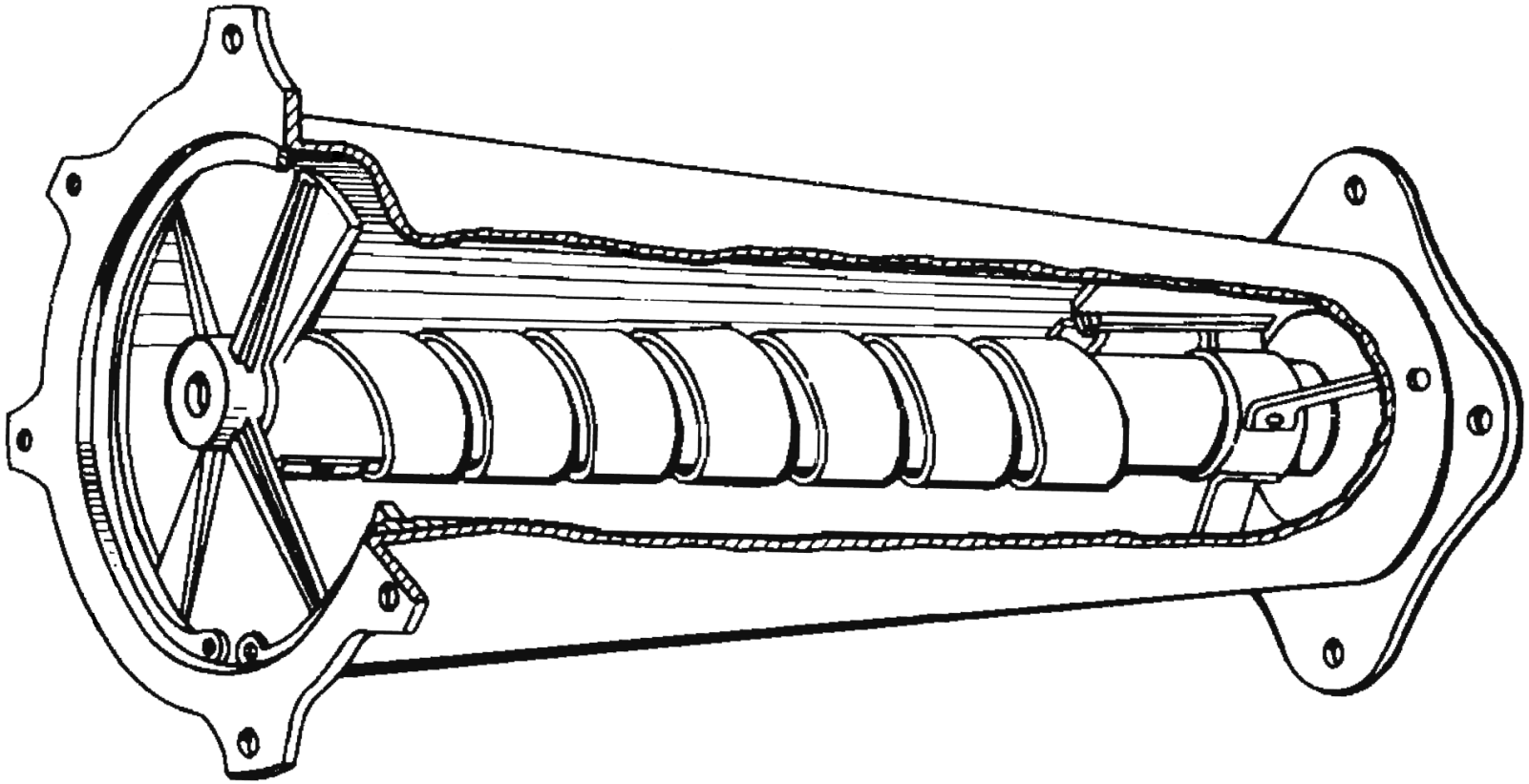


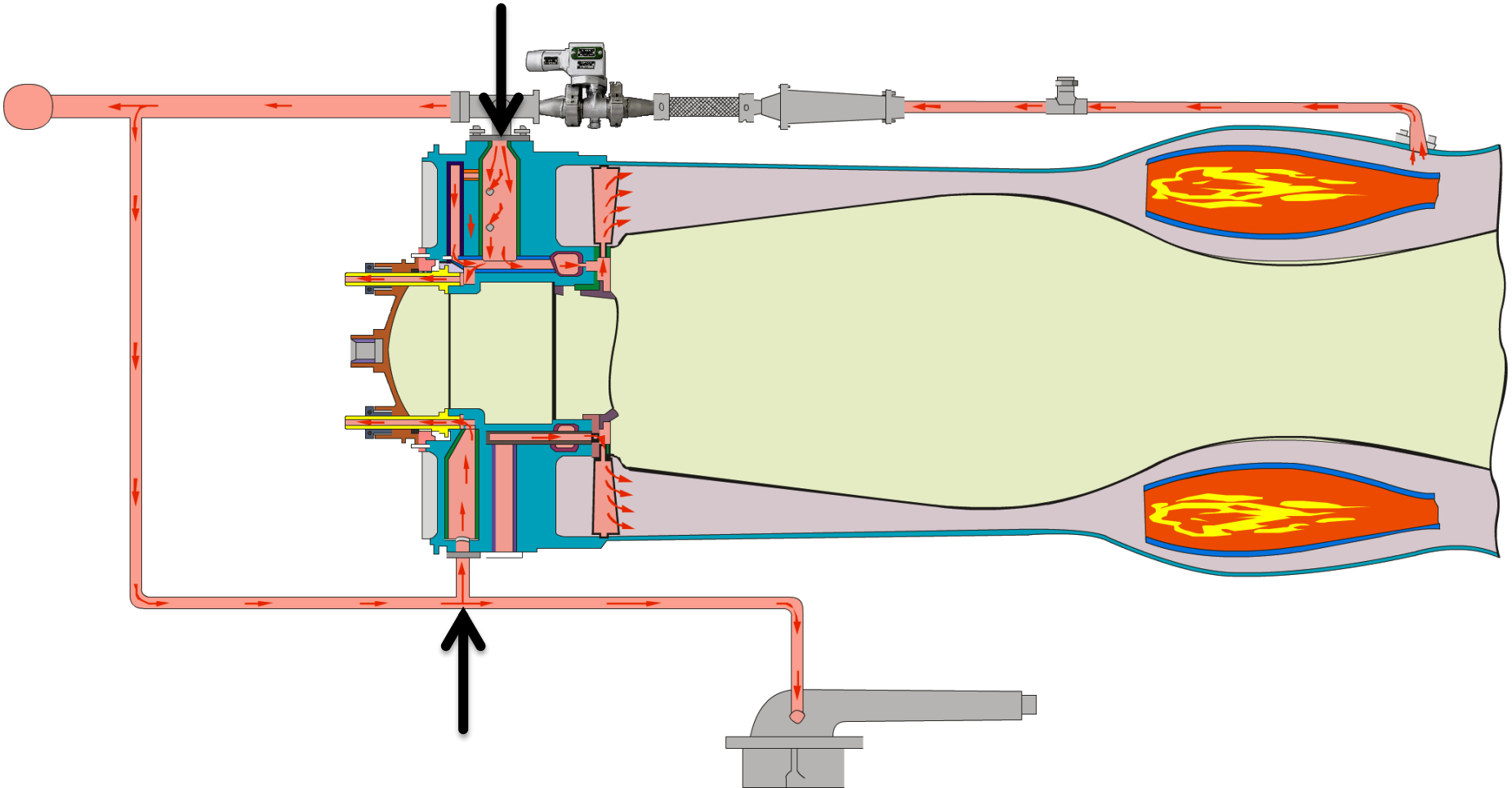
Engine Anti-Ice

• The flow of hot air is regulated by a temperature control device. This device contains a bimetallic spring and shutter that reduces the volume of air to the anti-icing system as the air temperature increases in order to minimize power loss.



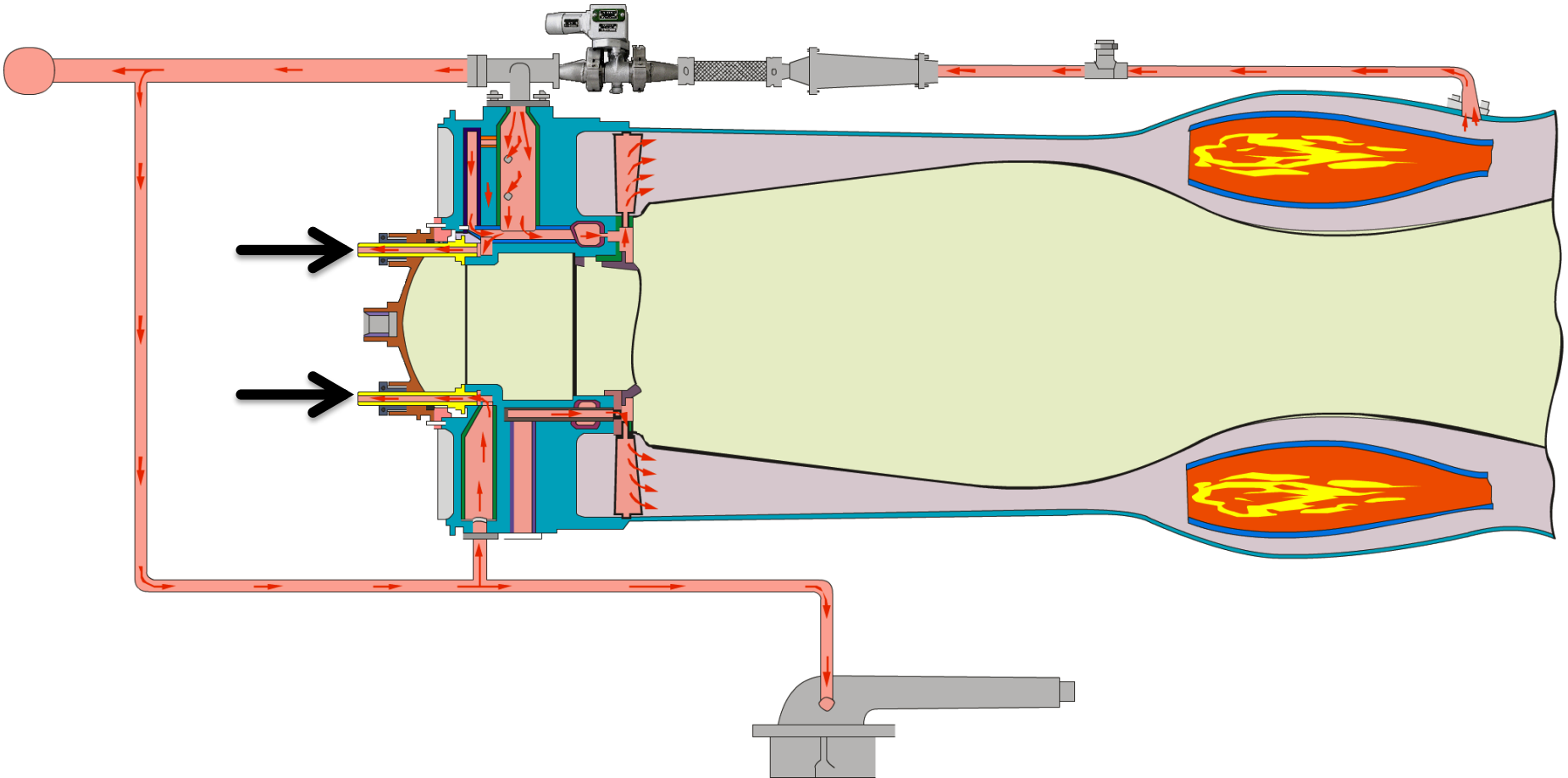
Engine Anti-Ice

• Hot air flows through the horizontal first stage supports. The vertical first stage supports are warmed with oil.



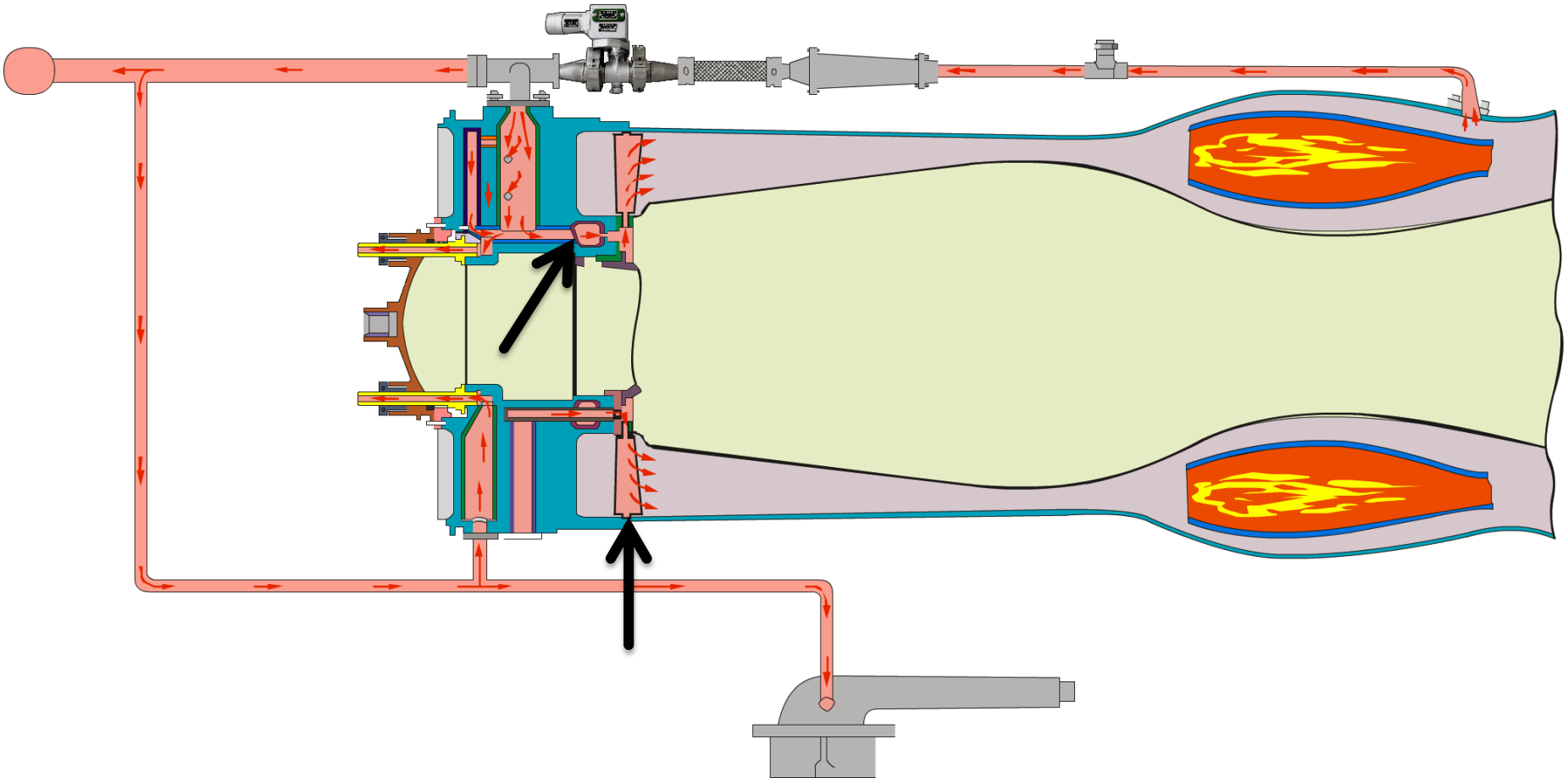
Engine Anti-Ice

• Hot air from the horizontal supports flows forward to the dust-protection device separator.



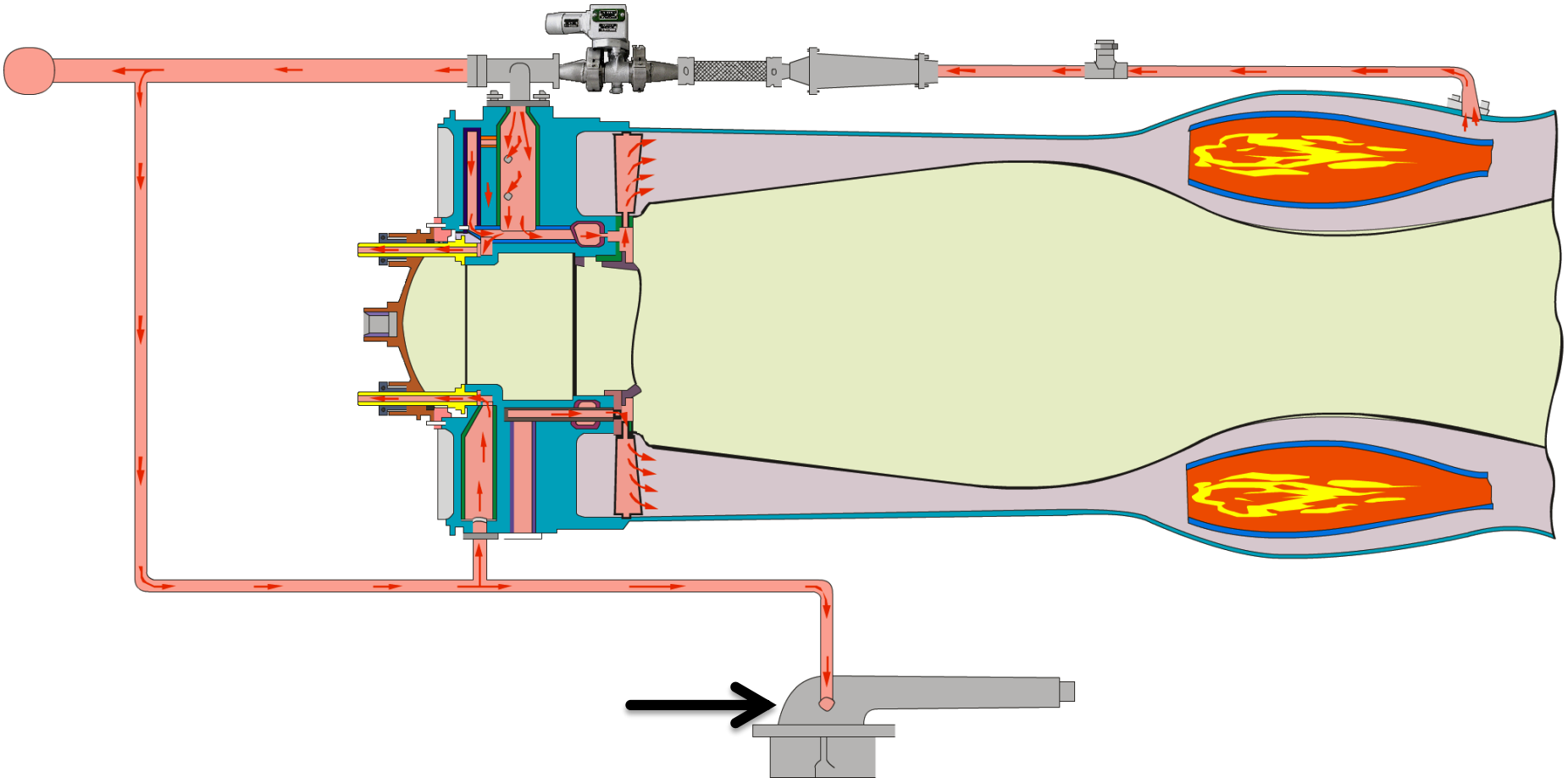
Engine Anti-Ice

• Hot air from the right side horizontal support flows into a chamber that supplies air to the variable inlet guide vanes (VIGV).



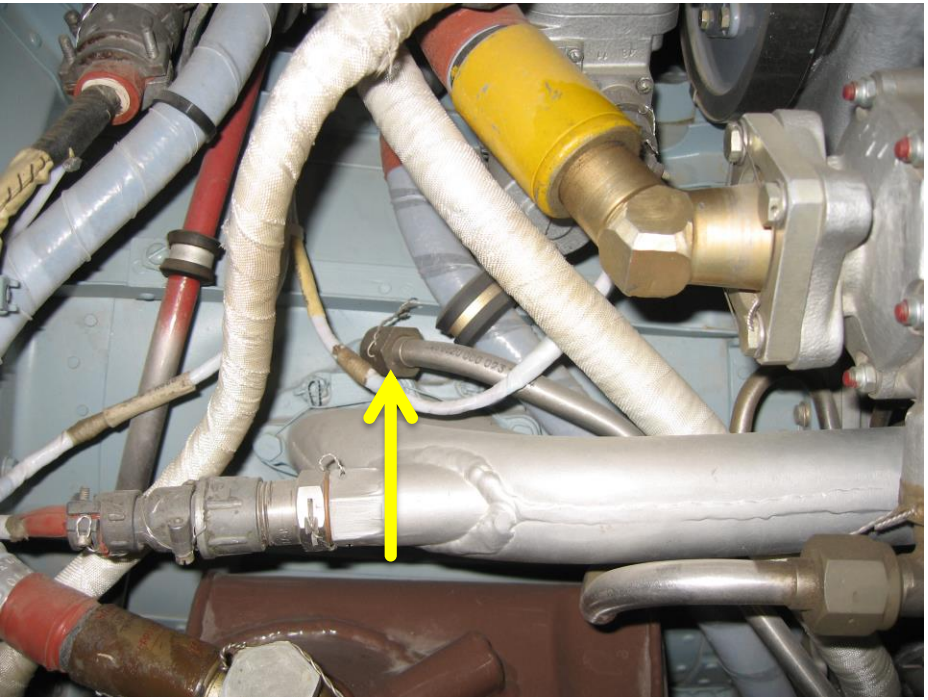
Engine Anti-Ice

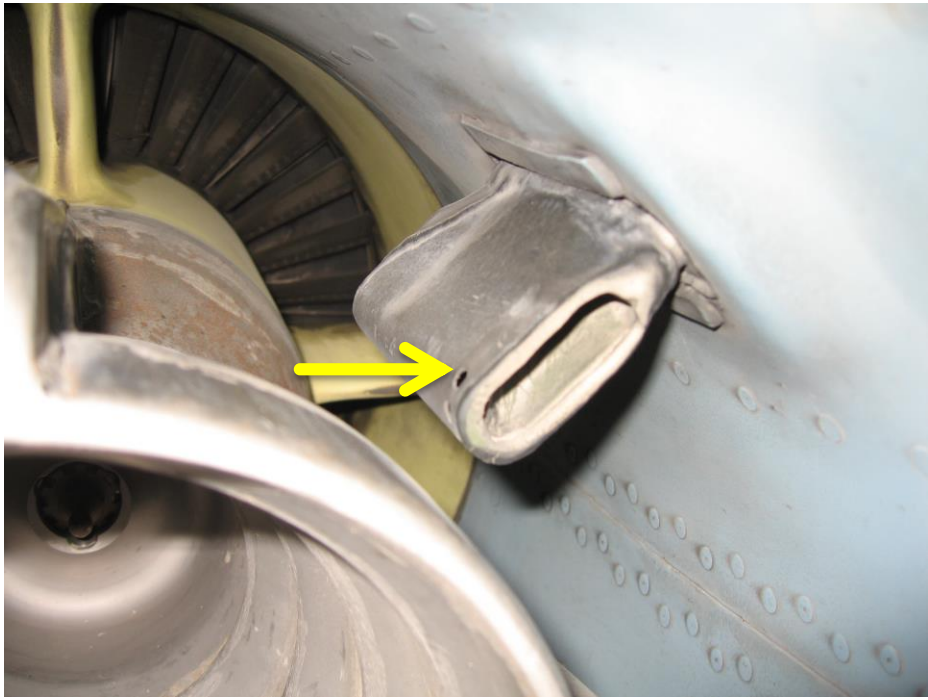
- Hot air is also supplied to the FCU temperature sensing probe inlet.



Engine Anti-Ice

- Hot air is also supplied to the FCU temperature sensing probe inlet.





Ice Protection System

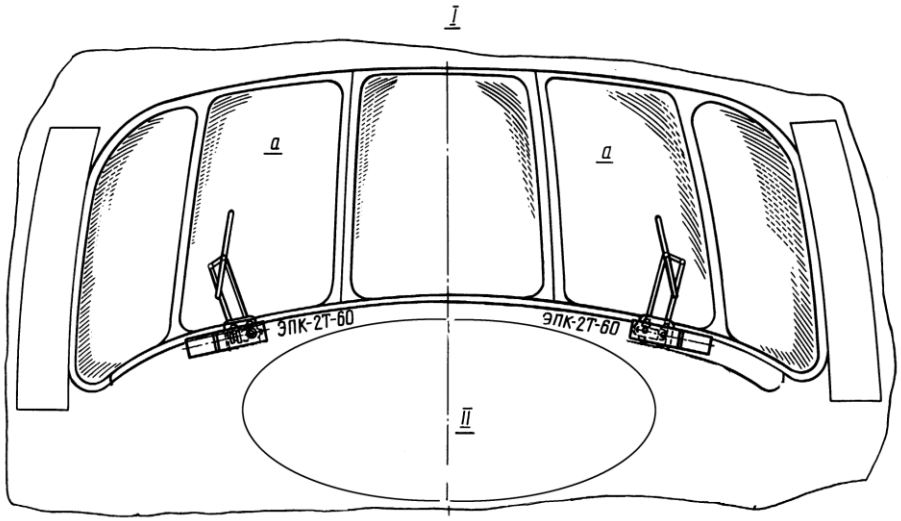
12.5 Windshields

Windshield Anti-Ice

• The windshield anti-icing system is made of up the following components:
    - Two windshield wipers
    - One automatic transformer
    - Two heated windshields
    - Two temperature regulators
    - Two temperature probes

• The TER-1M temperature regulators and AT-8-3 automatic transformer are mounted in the cockpit.

• The temperature regulators are set to turn off the heating elements of the windshields when the temperature probes reach 30°C.



Ice Protection System

12.6 Main and Tail Rotors

Main and Tail Rotor Anti-Ice

• The main and tail rotor anti-icing system is made of up the following components:
    • Cyclic timer
    • Main rotor slip ring (distributor)
    • Main rotor heating elements
    • Tail rotor slip ring
    • Tail rotor heating elements

• The РМК-21-ТV (ПМК-21-ТВ) cyclic timer is located on the right side of the cabin ceiling between frames 2 and 3.

• The cyclic timer controls the energizing sequence of main and tail rotor heating element sections.

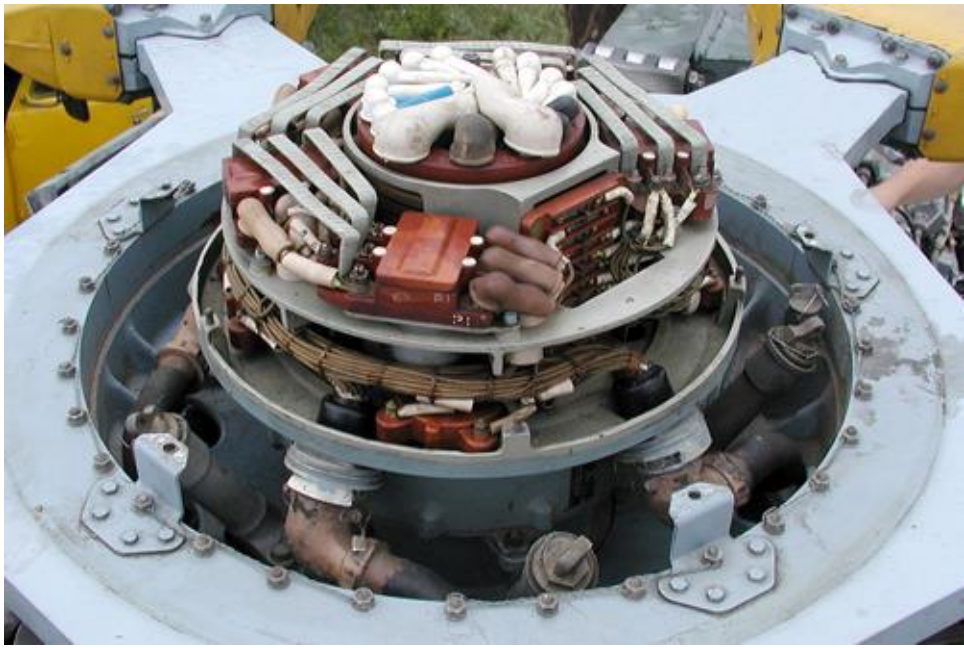
Main Rotor Anti-Ice

• Power is supplied to the main rotor blade heating elements through the TSV 36M313 (TCB 36M313) slip ring. It is also typically referred to as the de-ice distributor.

• The central portion of the slip ring mounts into a non-rotating stand pipe.

• The outer portion of the slip ring assembly rotates and is attached to main rotor hub.

• Mounted to the rotating portion of the slip ring are the brushes, transformers, and plugs to connect to each rotor blade.

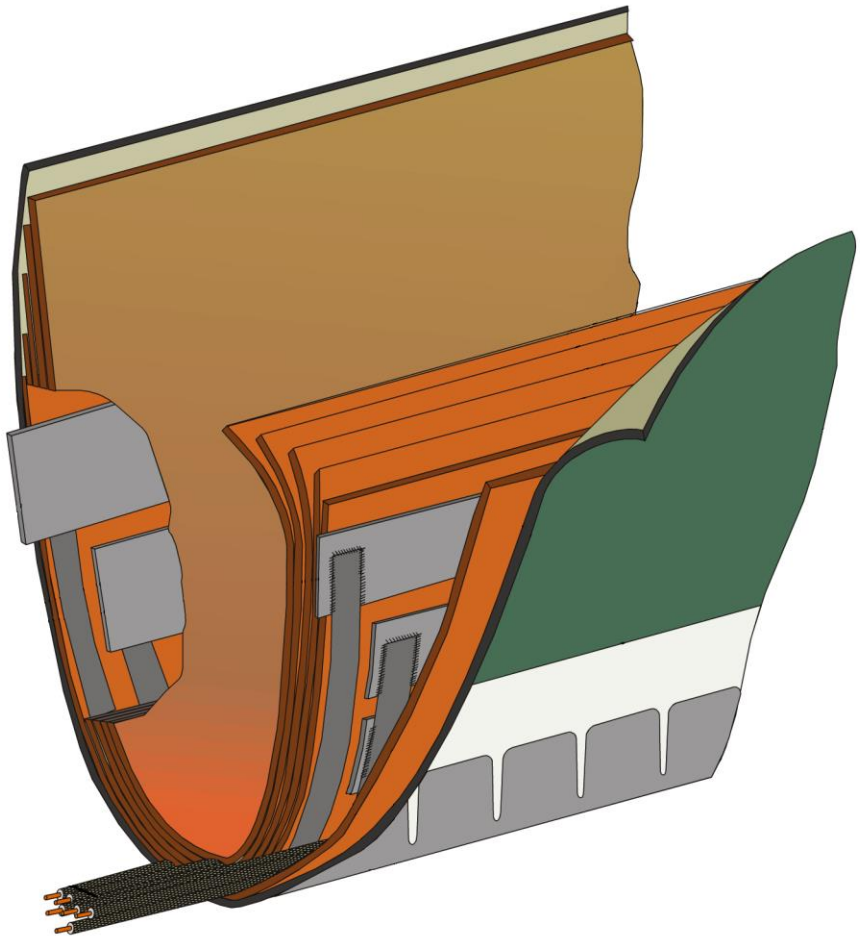


Main Rotor Anti-Ice

- Each main rotor blade contains four heating elements made of stainless steel and running the entire length of the rotor blade.

- The heating element of each blade consists of four sections:
    - Upper inboard (Section #1)
    - Upper outboard (Section #2)
    - Front (Section #3)
    - Lower (Section #4)

- During operation, the cyclic timer energizes each section in order for 38.5±2 seconds. One complete cycle lasts for approximately 154 seconds.



Tail Rotor Anti-Ice

• Power is supplied to the tail rotor blade heating elements through the 8AT-7420-100 slip ring.

• The slip ring unit consists of a casing and a brush-commutator assembly. The commutator is fastened to the gear box shaft and rotates together with the tail rotor.

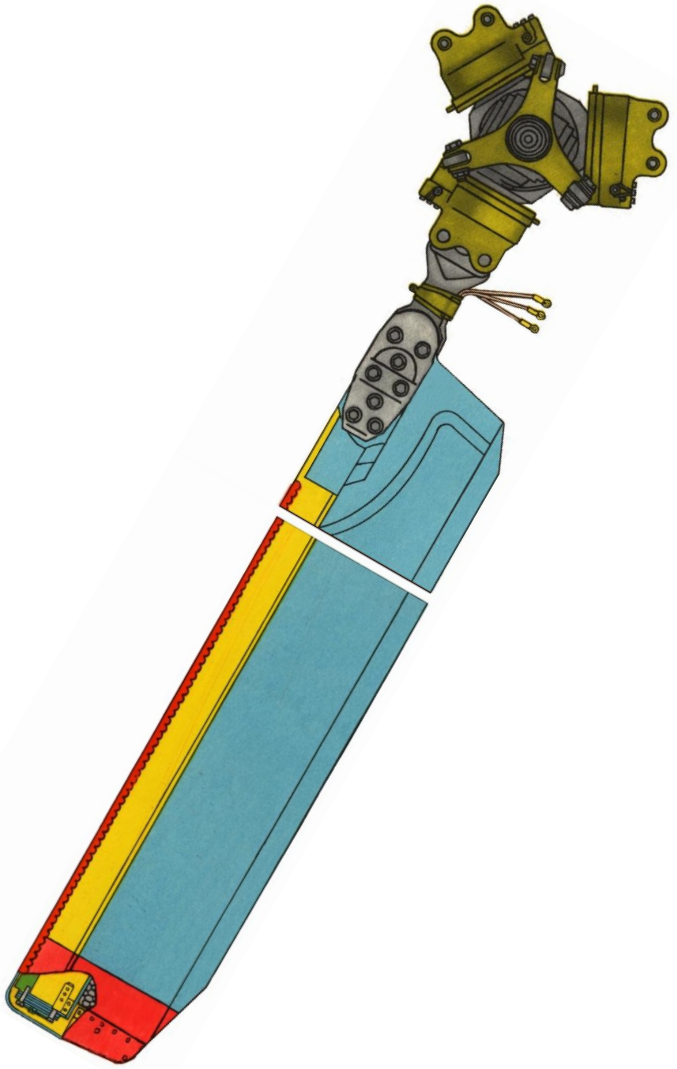
• The casing is fixed to the tail rotor gear box and does not rotate.

Tail Rotor Anti-Ice

• Each tail rotor blade contains two heating elements made of stainless steel and running the entire length of the rotor blade.

• The heating element of each blade comprises an upper section (facing outboard) and a lower section (facing inboard).

• During operation, the cyclic timer energizes each section in order for 38.5±2 seconds. Each section is energized twice during each 154 second cycle. The upper element is energized simultaneously with sections 1 and 3 of the main rotor, while the lower element is energized simultaneously with sections 2 and 4 of the main rotor.

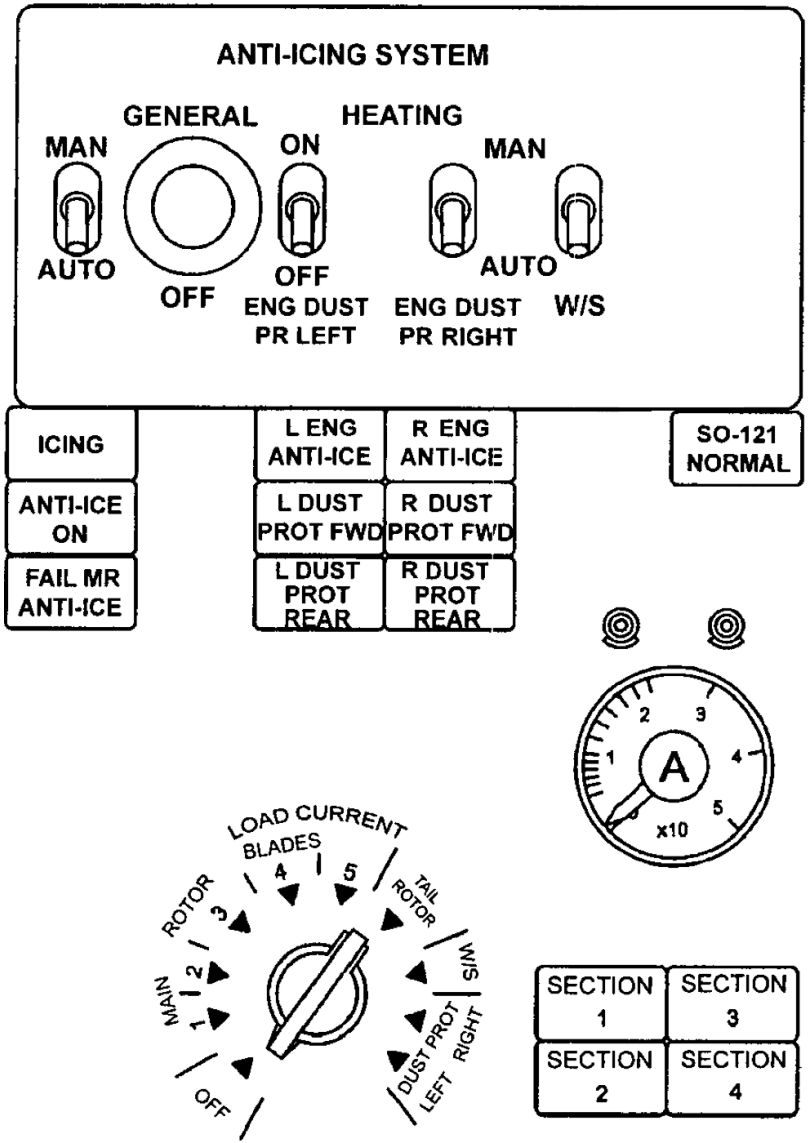


Ice Protection System

12.7 Operation

Automatic Operation

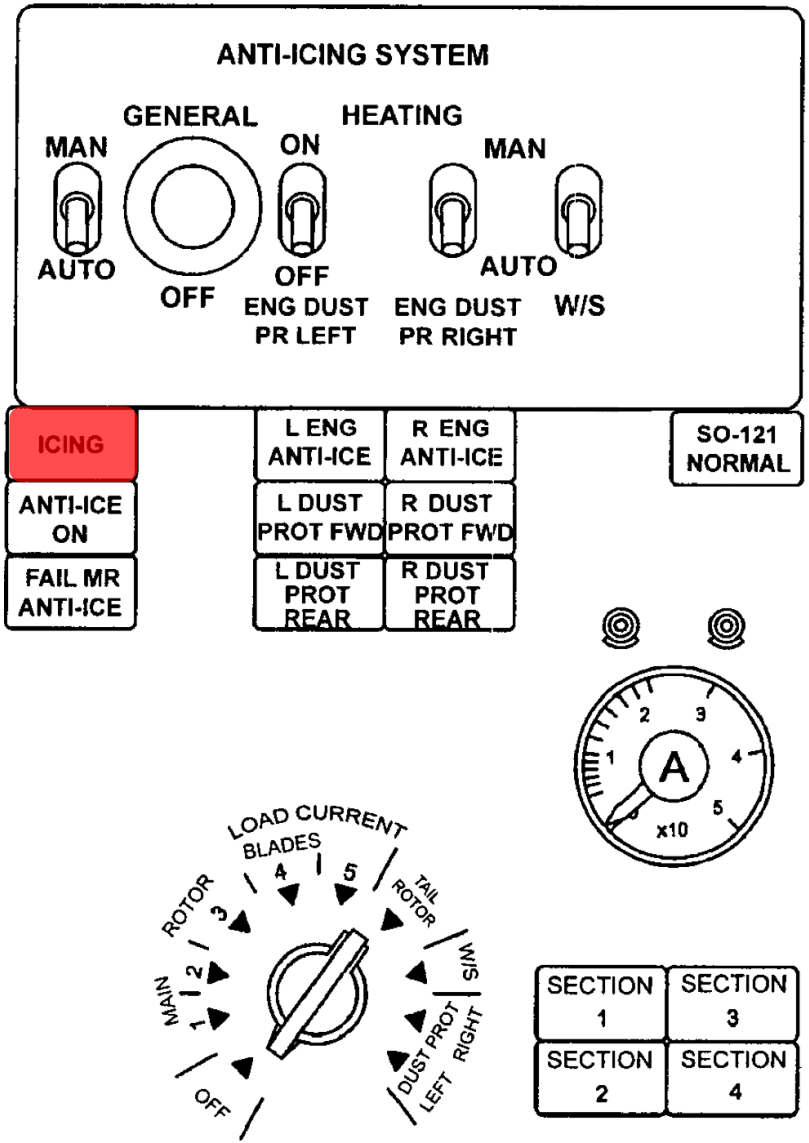
• During flight, the anti-icing system switches are all set to the “AUTO” position (except for the left engine, which is set to “OFF”), and all annunciators on the anti-icing system panel should be extinguished.



Automatic Operation

• During flight, the anti-icing system switches are all set to the “AUTO” position (except for the left engine, which is set to “OFF”), and all annunciators on the anti-icing system panel should be extinguished.

• An ice buildup of approximately 0.3mm on the ice detector will cause an ICING signal to be generated by the ice detector system, which will result in the illumination of the red “ICING” annunciator on the anti-icing system panel.

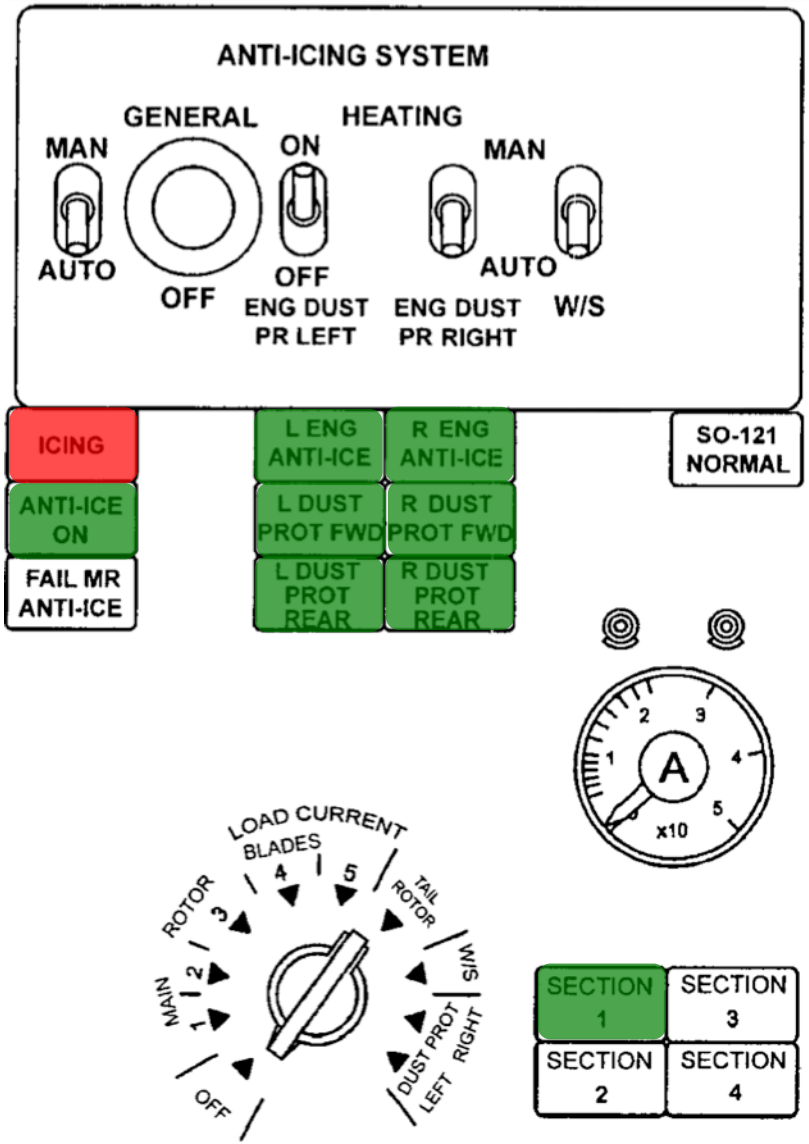


Automatic Operation

• At the same time that the ICING signal is generated, the following units are automatically actuated:

  • “ANTI-ICE ON” annunciator
  • Cyclic timer for rotor anti-icing
  • Right engine and DPD anti-icing
  • Windshield anti-icing

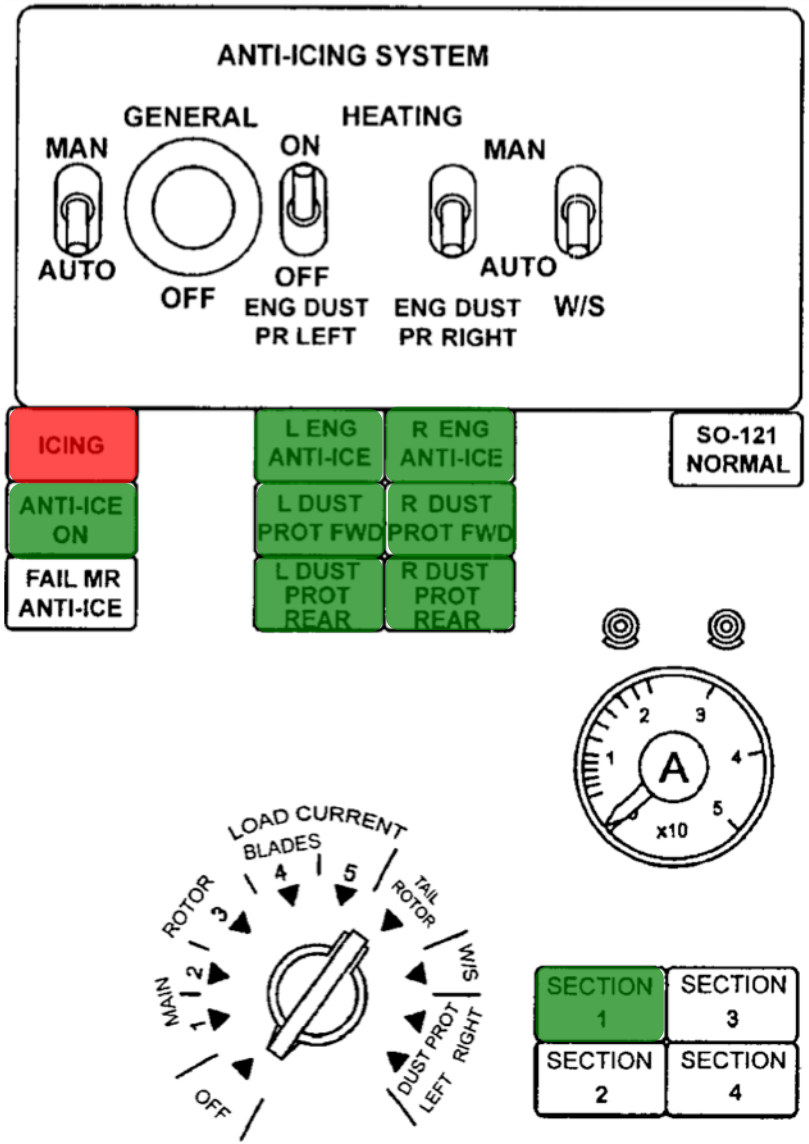
• The left engine and DPD anti-ice will not activate automatically. It should be turned on manually approximately 1 minute after the right engine anti-ice activates, and only if the right engine continues to operate normally (i.e. has not lost power due to ice ingestion).



Automatic Operation

• As the cyclic timer operates, the annunciators for the main rotor blade heating sections will cycle through sequentially every 38.5±2 seconds.

• Additionally, the DPD anti-ice annunciators will turn off and on as their associated temperature regulators energize and de-energize the heating elements as necessary to maintain their preset temperature.

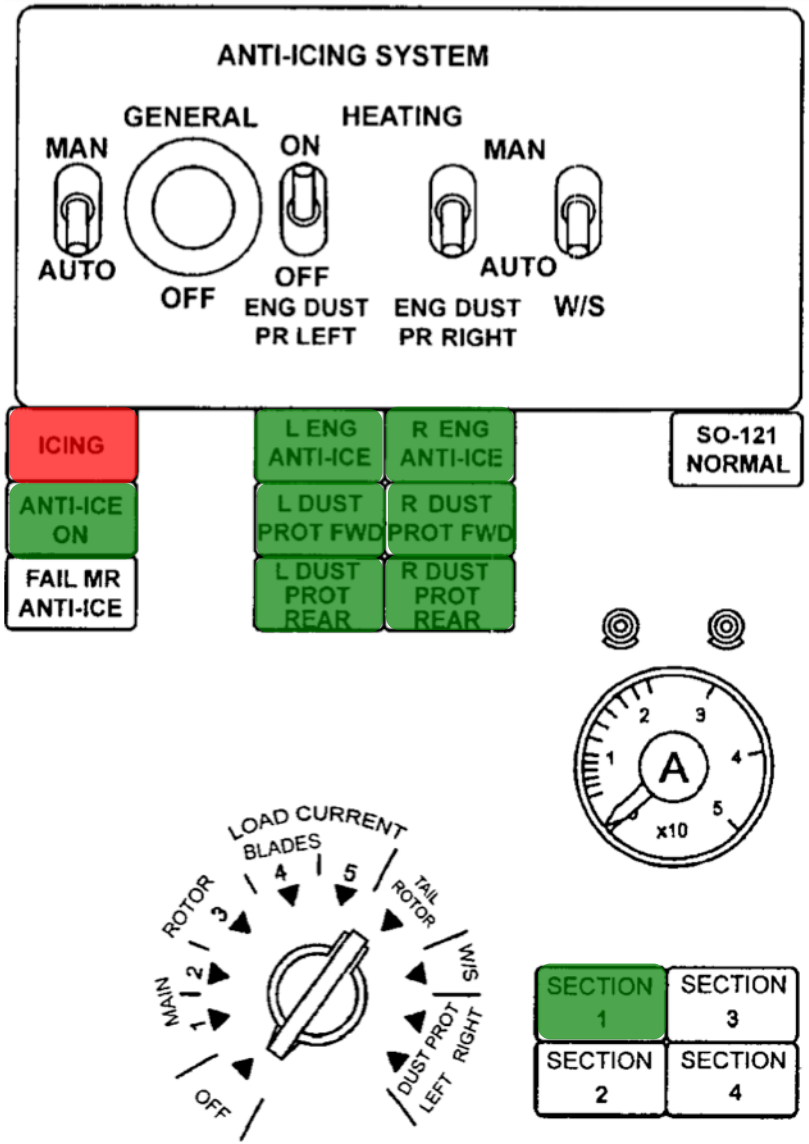


Automatic Operation

• When the ICING signal is generated, the vibrating head of the ice detector is heated for 8±2 seconds in order to remove ice buildup.

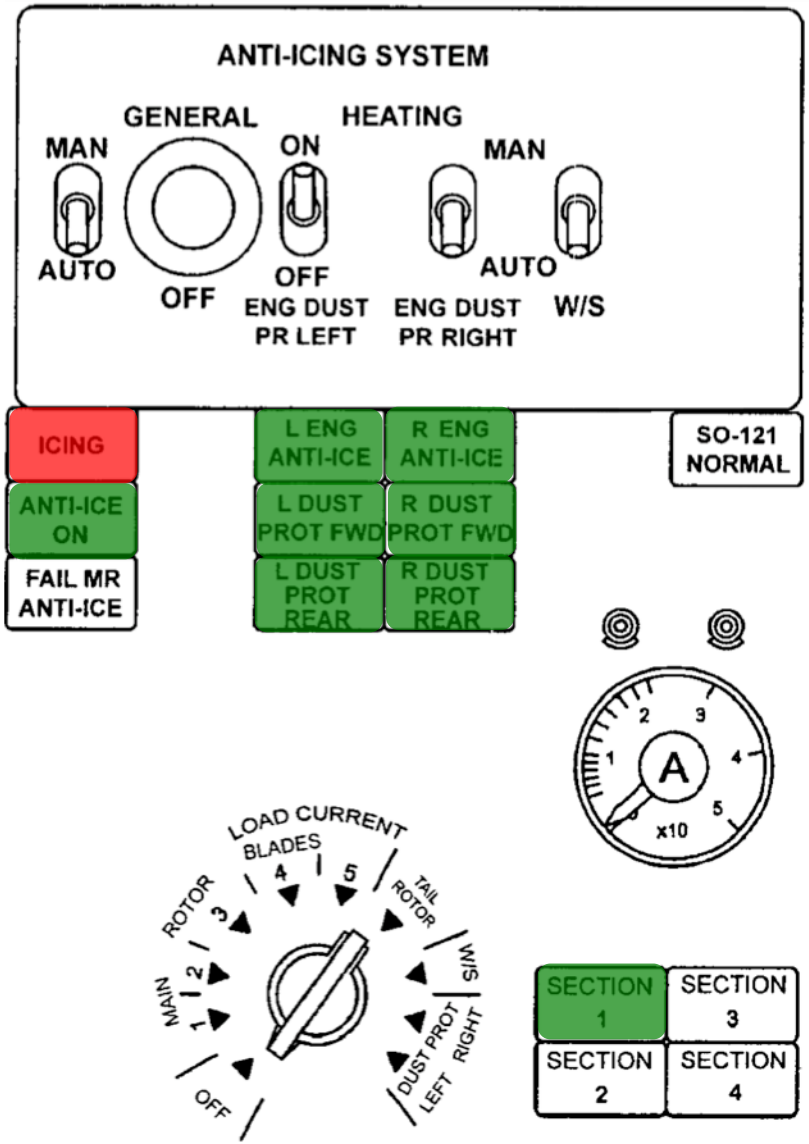
• After this time delay, the heating of the ice detector head will cease. If the aircraft remains in icing conditions, ice will once again begin to build up on the ice detector head.

• At the same time that the ICING signal is generated, another timer lasting 140±40 seconds is initiated. For the duration of this timer, the “ICING” annunciator will remain illuminated and automatic anti-icing will continue.



Automatic Operation

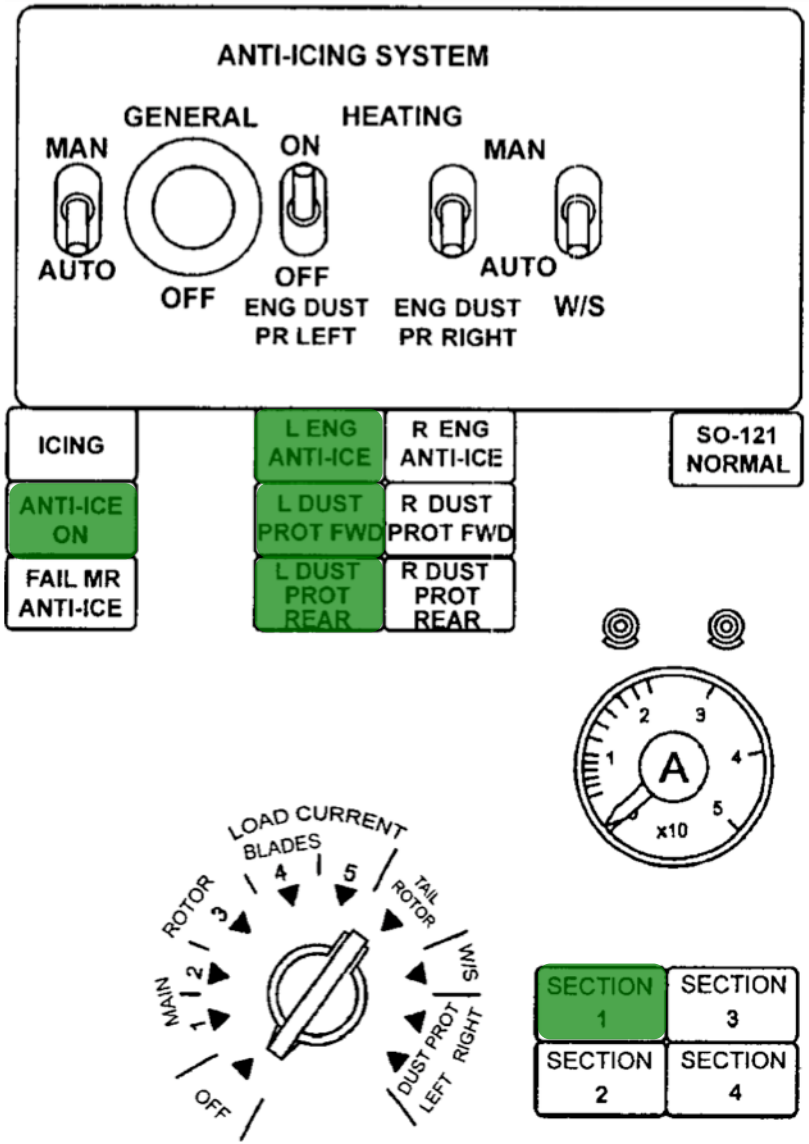
• If ice continues to accumulate on the ice detector head to a level of 0.3mm, another ICING signal is generated, the 140±40 second timer is restarted, and the ice detector head is again heated for 8±2 seconds to remove ice buildup. In this way, the “ICING” annunciator remains illuminated and the automatic anti-icing systems remain activated as long as the aircraft remains in icing conditions.



Automatic Operation

• If ice continues to accumulate on the ice detector head to a level of 0.3mm, another ICING signal is generated, the 140±40 second timer is restarted, and the ice detector head is again heated for 8±2 seconds to remove ice buildup. In this way, the “ICING” annunciator remains illuminated and the automatic anti-icing systems remain activated as long as the aircraft remains in icing conditions.

• If the 140±40 second timer expires before a new ICING signal is generated, the “ICING” annunciator will extinguish, and the automatic anti-icing of the right engine/DPD and windshields will cease.



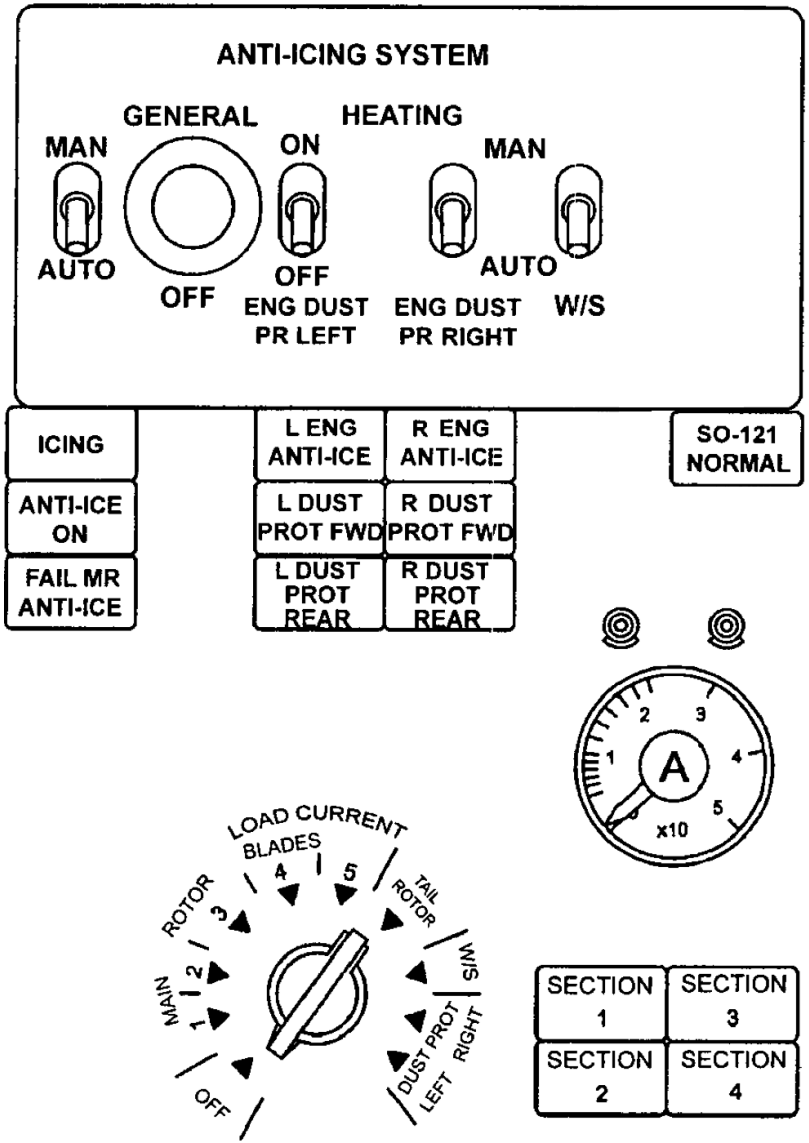
Automatic Operation

• The anti-icing system of the main and tail rotors, ice detector bracket, and left engine/DPD will continue to operate even after the ICING signal is removed.

• In order to deactivate the anti-icing systems for the main and tail rotors and the ice detector bracket, the “GENERAL OFF” button must be pressed.

• To deactivate the anti-icing systems for the left engine/DPD, the switch should be moved back to the “OFF” position.

• At this time, the anti-icing system annunciators are all extinguished and all anti-icing systems are de-energized.

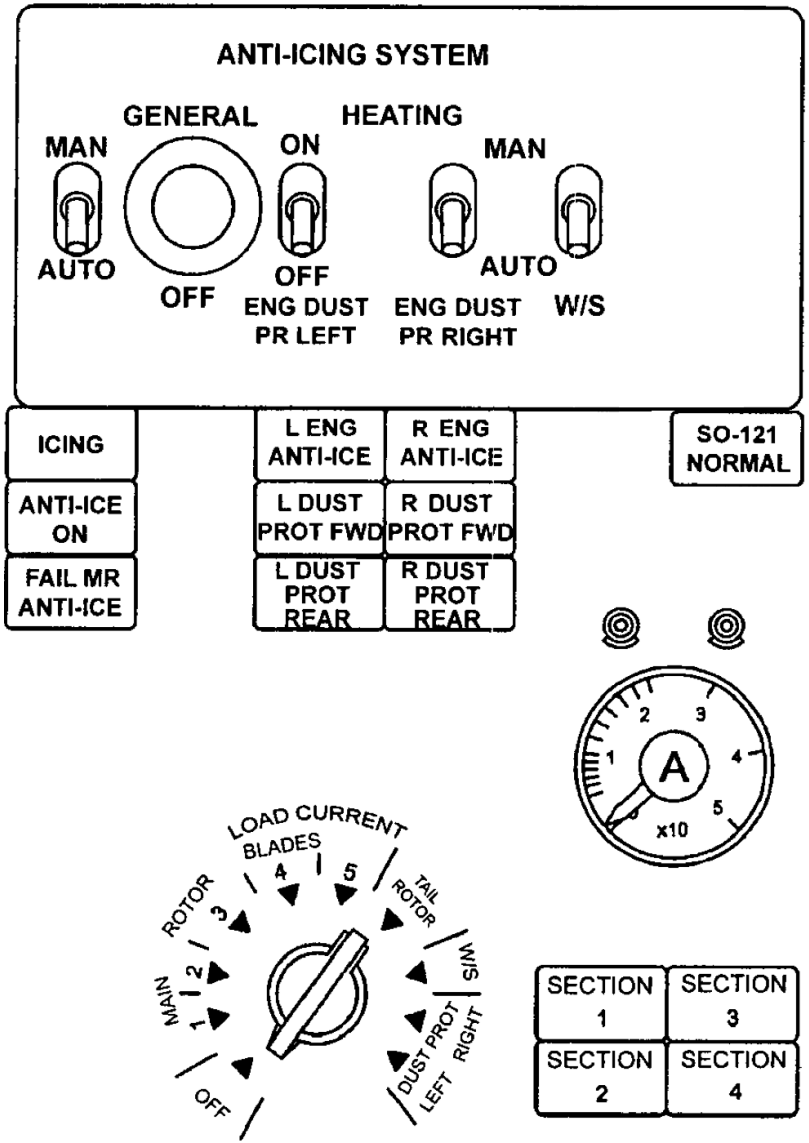


Manual Operation

• If manual system activation is required, place the GENERAL, ENG DUST PR RIGHT, and W/S switches to “MAN” and place the ENG DUST PR LEFT switch to “ON”.

• In this way, the system will remain in operation in the same way as if they were activated automatically, with the exception that they will not turn off automatically. Note: The main rotor section annunciators will illuminate in sequence and the DPD annunciators will cycle on and off as necessary.

• In order to deactivate the anti-icing systems after being activated manually, return all switches to their “AUTO” or “OFF” positions, and press the “GENERAL OFF” button.

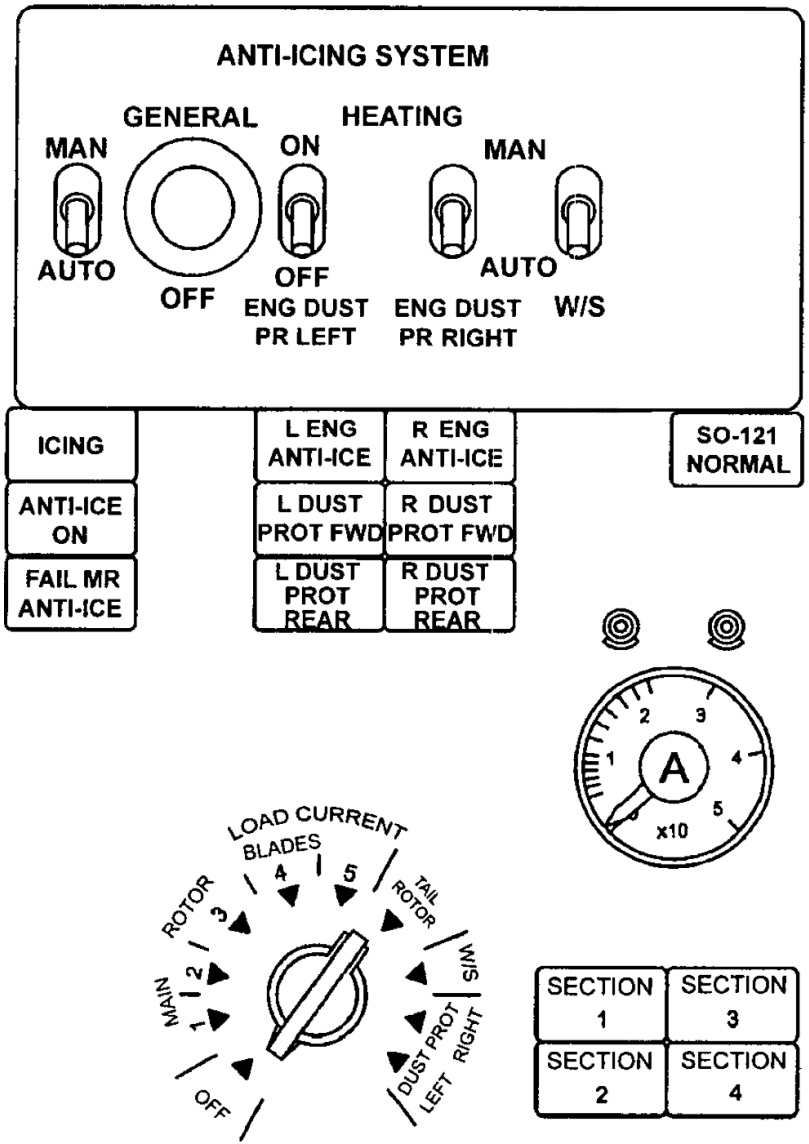


Generator Failure

• In the event of a failure of one of the AC generators, the rotor anti-icing system will not operate simultaneously with either engine/DPD anti-icing system.

• If one or both of the engine/DPD anti-icing systems is in operation, the main and tail rotor anti-icing system will automatically deactivate.

• If both engine/DPD anti-icing systems are off, the main and tail rotor anti-icing systems will function with only one operating generator.



Ice Protection System

End of Presentation