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# AIR CONDITIONING SYSTEM

The image shows the interior of a commercial airplane cabin. Passengers are seated in rows, and a flight attendant is standing in the aisle. The cabin is brightly lit, and the overhead luggage bins are visible. The text "AIR CONDITIONING SYSTEM" is overlaid in a green banner at the top.

Air cycle Air conditioning System

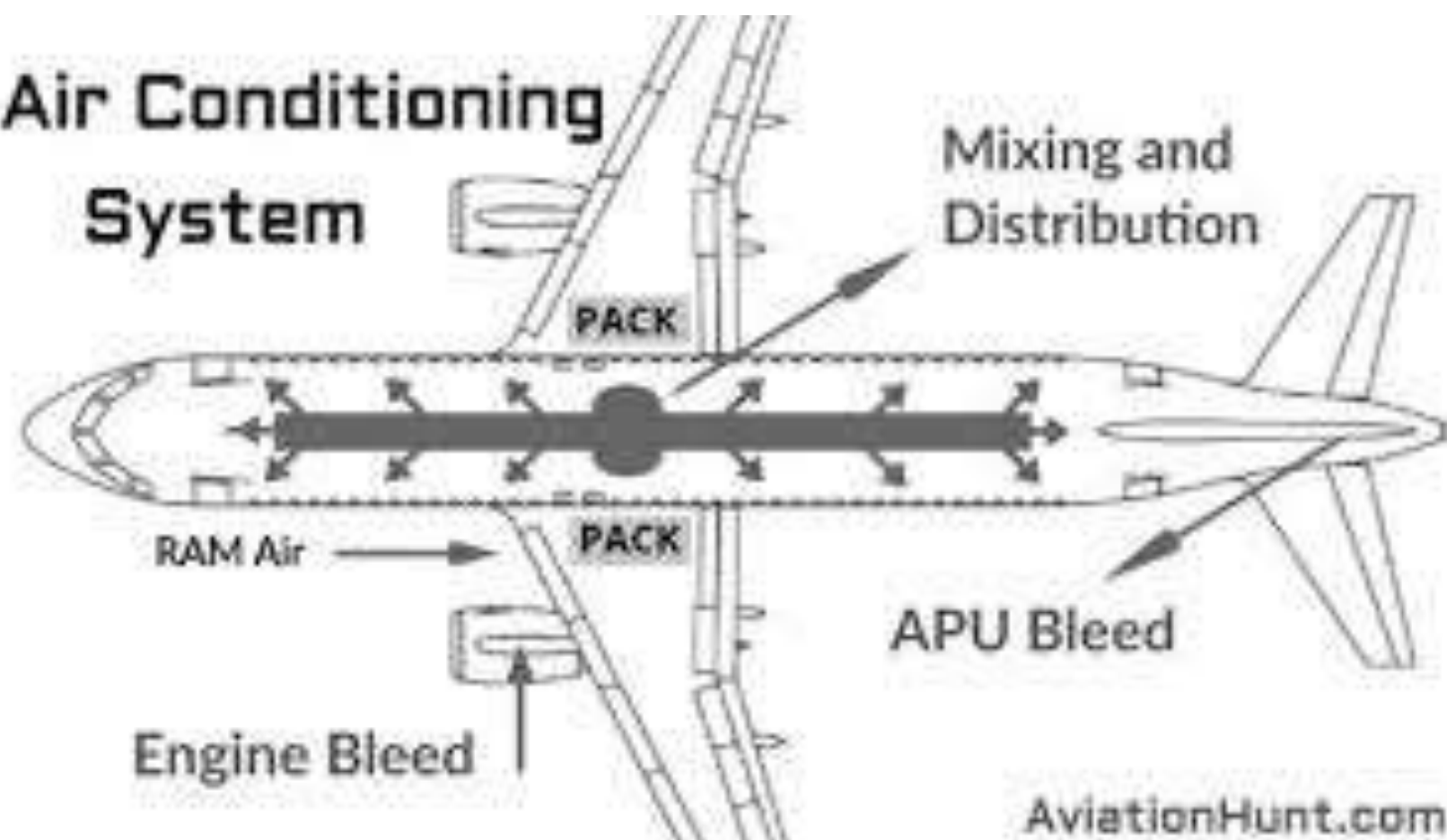
- **There are two types of air conditioning systems commonly used on aircraft.**
  - 1. Air cycle air conditioning ( Air conditioning package or pack)** is used on most turbine-powered aircraft. It makes use of engine bleed air or APU pneumatic air during the conditioning process.
  - 2. Vapor cycle air conditioning systems** are often used on reciprocating aircraft. This type system is similar to that found in homes and automobiles.

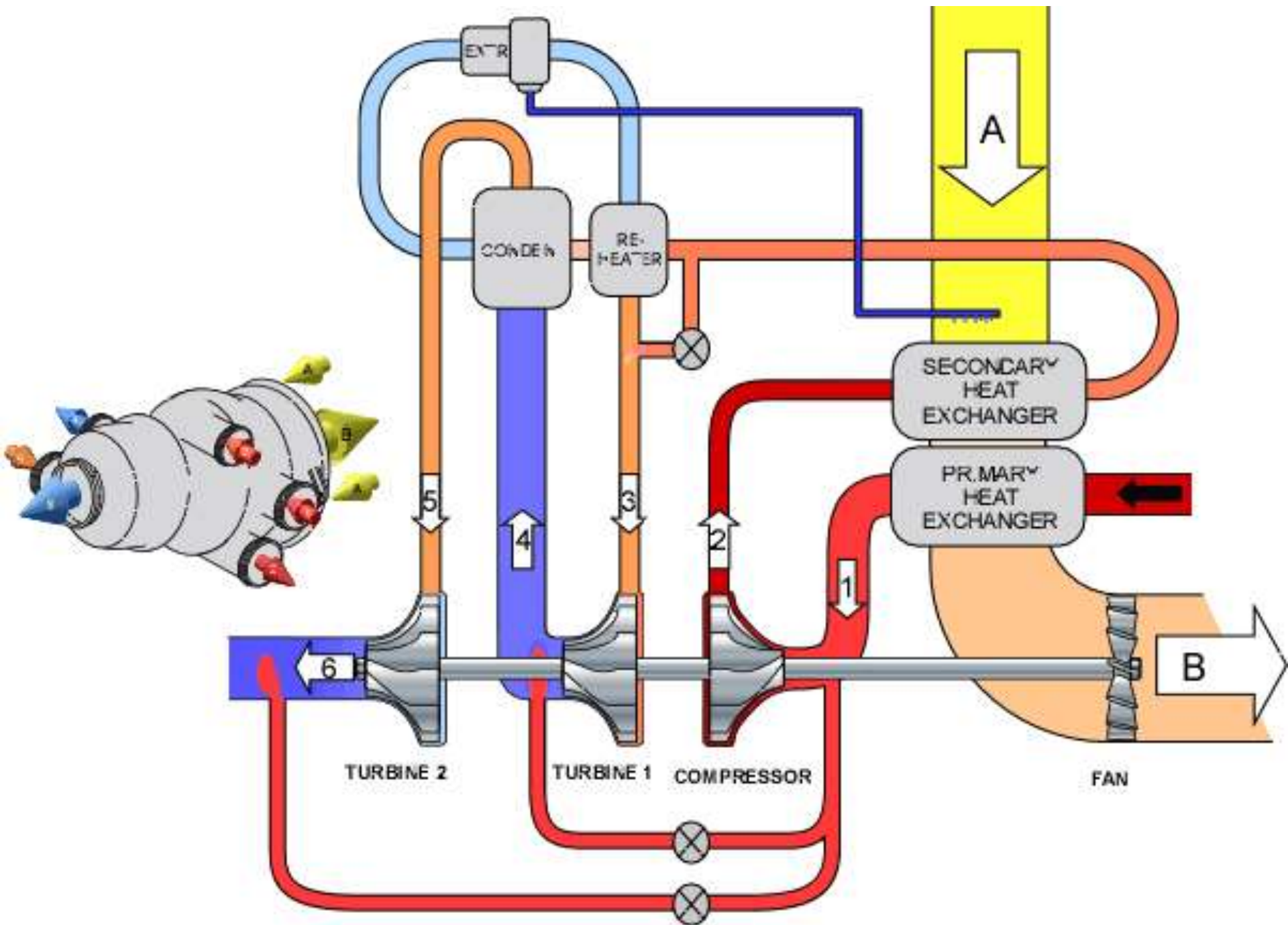
# **AIR CYCLE AIR CONDITIONING**

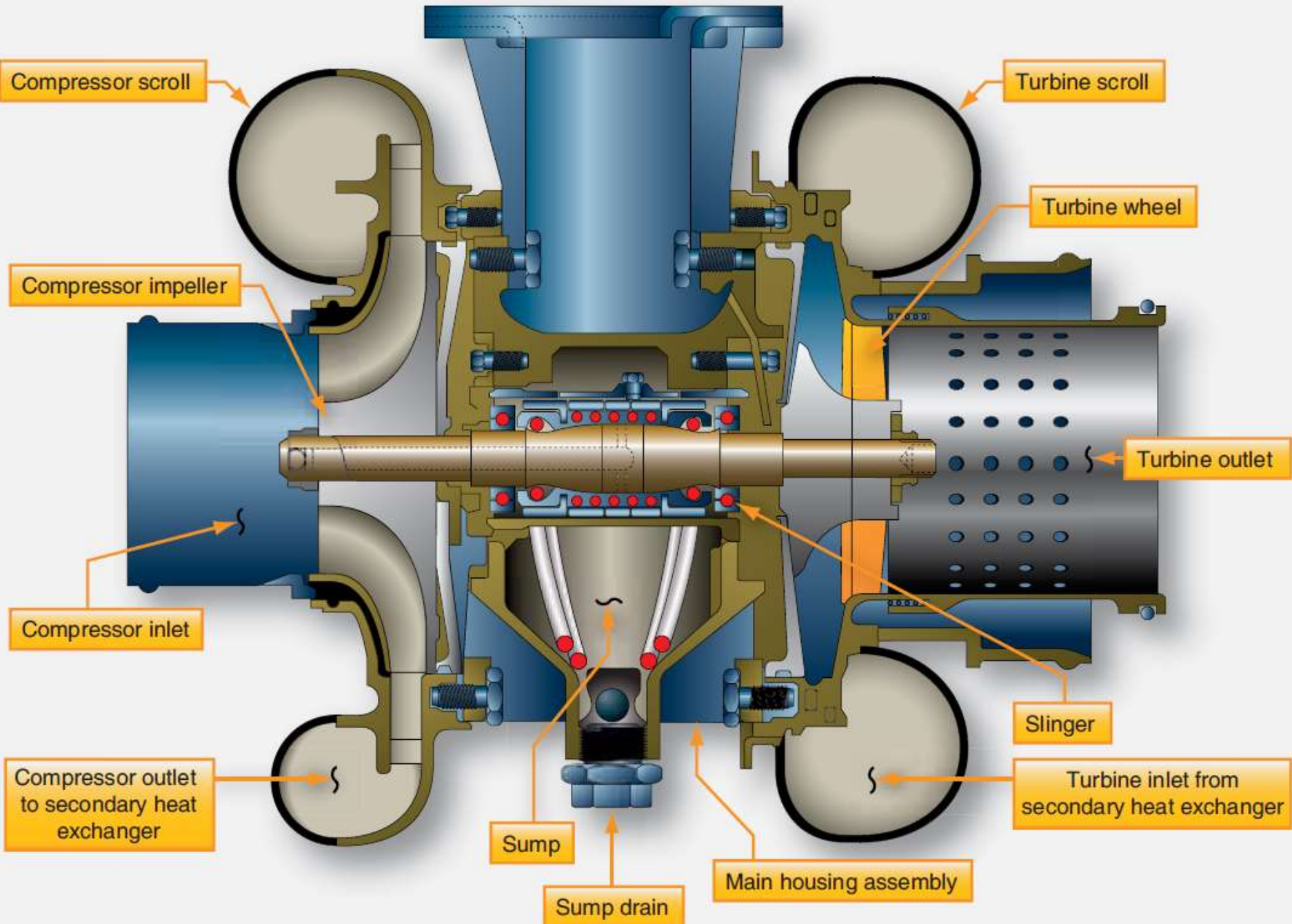
# SYSTEM OPERATION

- Even with the frigid temperatures experienced at high altitudes, bleed air is too hot to be used in the cabin without being cooled.
- It enters the air cycle system and is routed through a heat exchanger where ram air cools the bleed air.
- This cooled bleed air is directed into an air cycle machine.
- There, it is compressed before flowing through a secondary heat exchanger that cools the air again with ram air.
- The bleed air then flows back into the air cycle machine where it drives an expansion turbine and cools even further.
- Water is then removed and the air is mixed with bypassed bleed air for final temperature adjustment.
- It is sent to the cabin through the air distribution system. By examining the operation of each component in the air cycle process, a better understanding can be developed of how bleed air is conditioned for cabin use.

# Air Conditioning System









# PNEUMATIC SYSTEM SUPPLY

- During normal flight, the pneumatic system is supplied
- by bleed air tap offs located on each engine compressor section.
- It consists of a pneumatic manifold, valves, regulators and ducting.
- Typically, a pneumatic system manifold contains hot air between 30 and 75 psi.
- The air conditioning packs are supplied by this manifold as are other critical airframe systems, such as the anti-ice and hydraulic pressurization system.

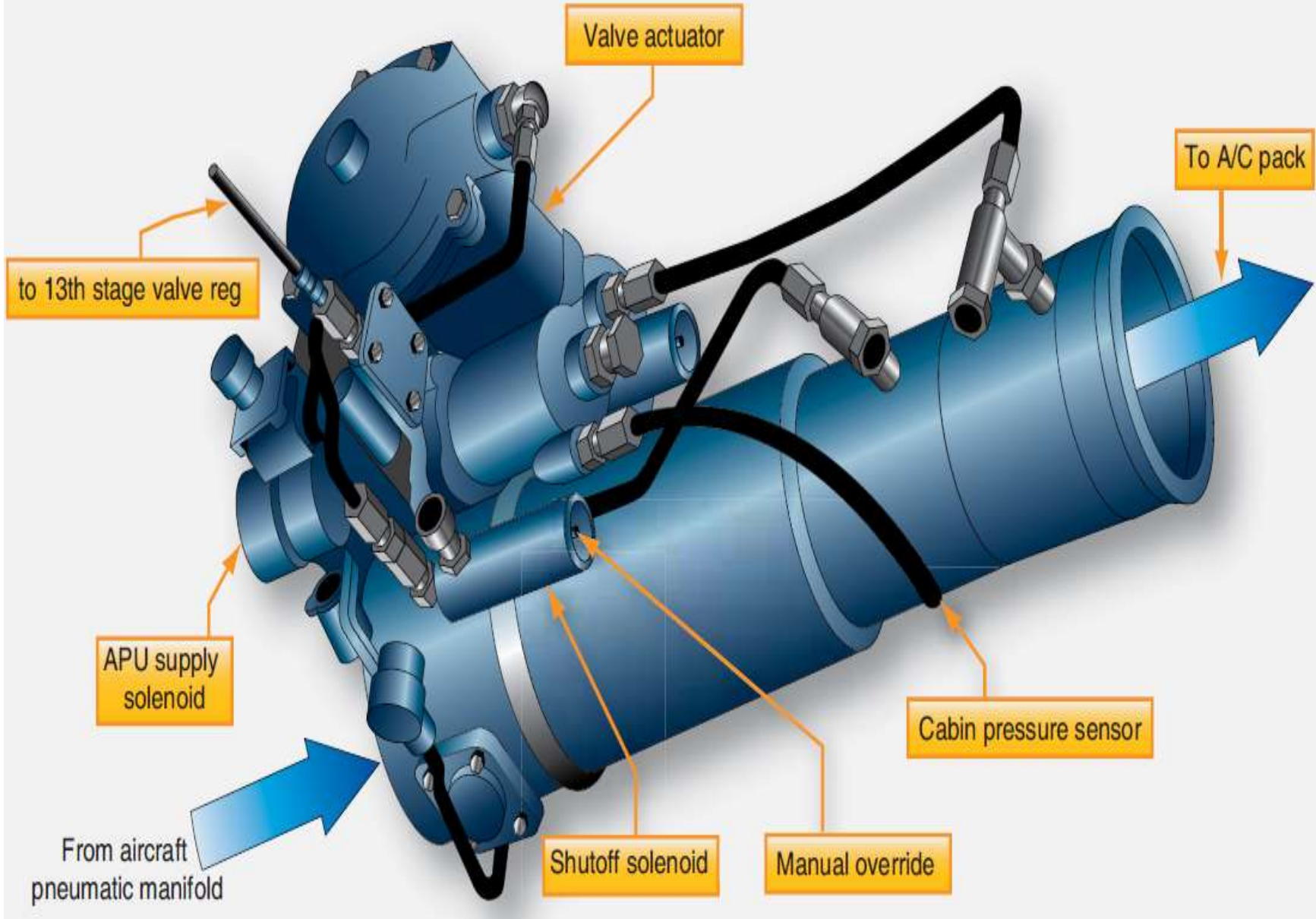


**Pneumatic Manifold Valve**

# **COMPONENT OPERATION**

# 1.Pack Valve

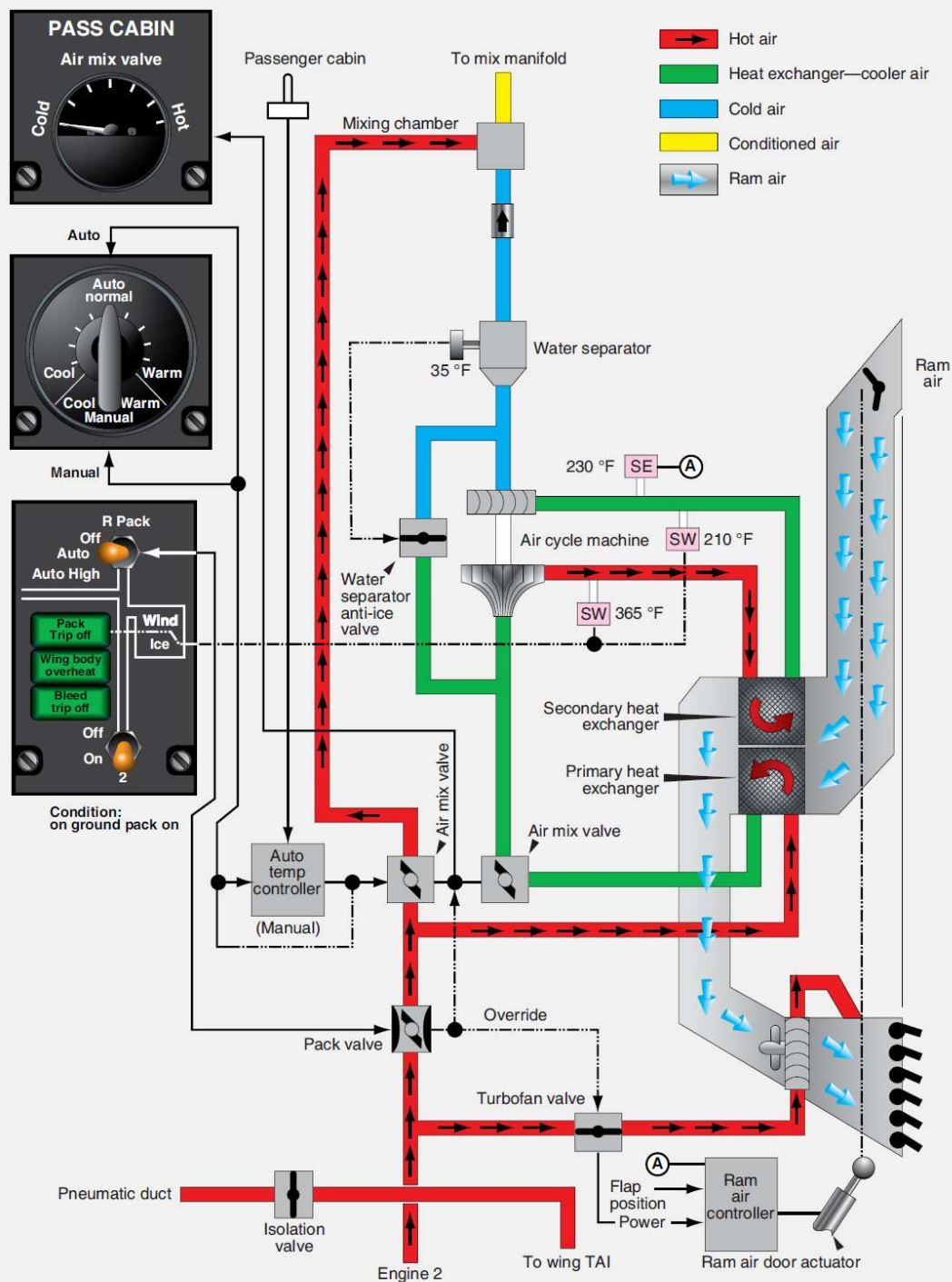
- The pack valve is the valve that regulates bleed air from the pneumatic manifold into the air cycle air conditioning system.
- It is controlled with a switch from the air conditioning panel in the cockpit.
- Many pack valves are electrically controlled and pneumatically operated. Also known as the supply shutoff valve, the pack valve opens, closes, and modulates to allow the air cycle air conditioning system to be supplied with a designed volume of hot, pressurized air.
- When an overheat or other abnormal condition requires that the air conditioning package be shut down, a signal is sent to the pack valve to close.



**Pack Valve**

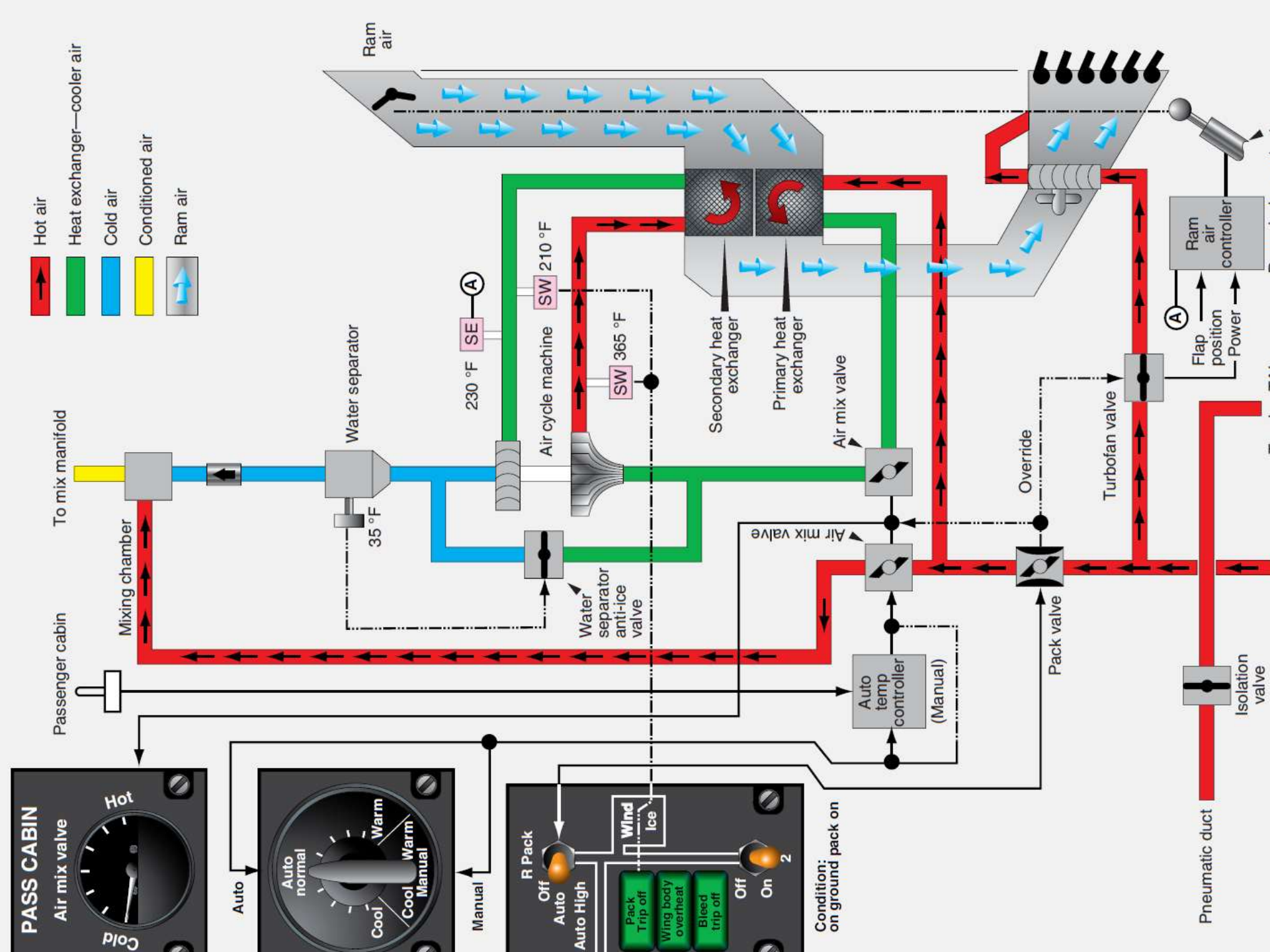
## 2. Bleed Air Bypass

- A means for bypassing some of the pneumatic air supplied to the air cycle air conditioning system around the system is present on all aircraft.
- This warm bypassed air must be mixed with the cold air produced by the air cycle system so the air delivered to the cabin is a comfortable temperature.
- It simultaneously controls the flow of bypassed air and air to be cooled to meet the requirements of the auto temperature controller.
- It can also be controlled manually with the cabin temperature selector in manual mode.
- Other air cycle **systems may refer** to the valve that controls the air bypassed around the air cycle cooling system as **a temperature control valve, trim air pressure regulating valve, or something similar.**



See the Air Mixture valve

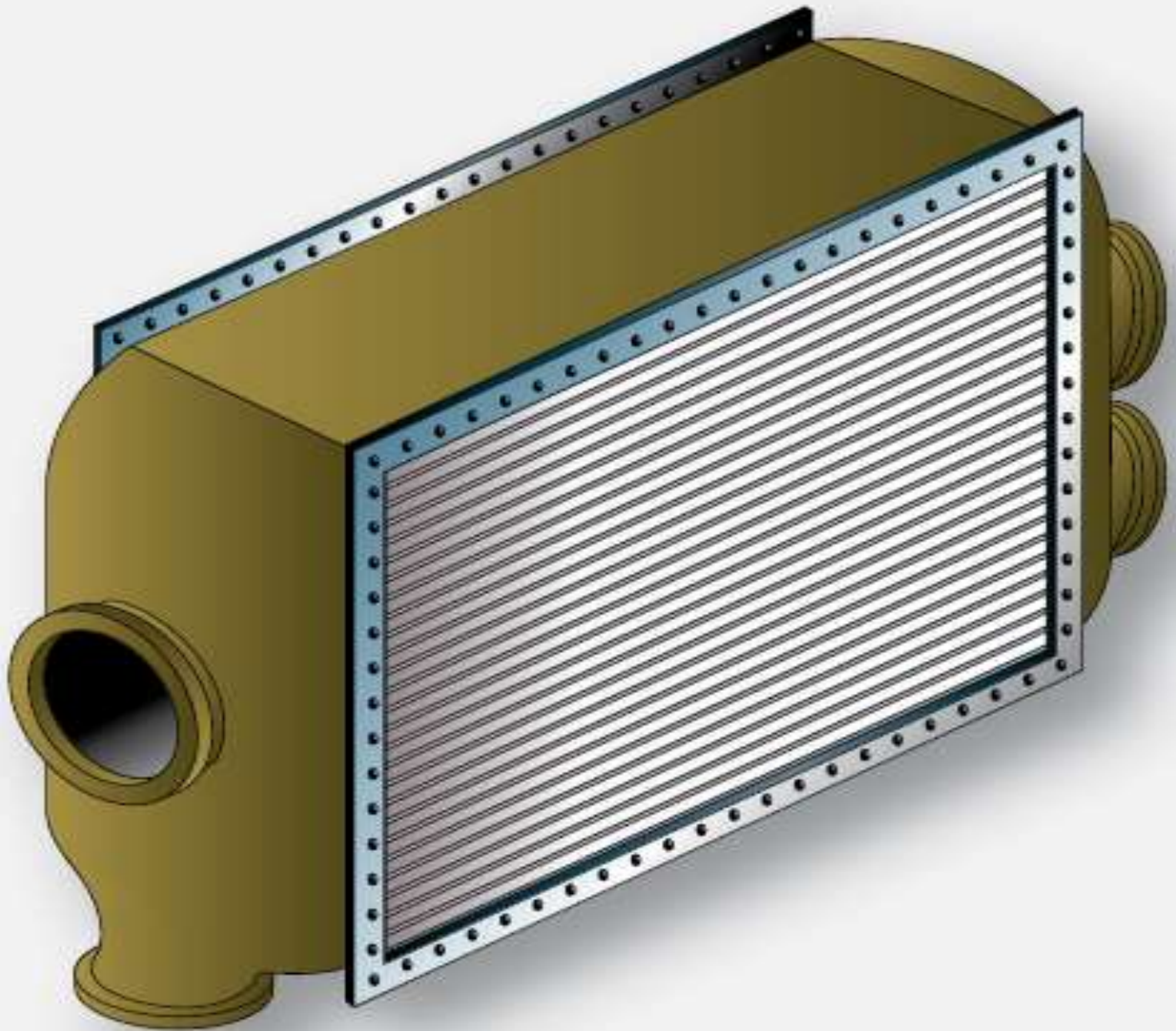
See the Larger View in next slide





### **3.Primary Heat Exchanger**

- **Generally, the warm air dedicated to pass through the air cycle system first passes through a primary heat exchanger.**
- **It acts similarly to the radiator in an automobile.**
- **A controlled flow of ram air is ducted over and through the exchanger, which reduces the temperature of the air inside the system.**
- **fan draws air through the ram air duct when the aircraft is on the ground so that the heat exchange is possible when the aircraft is stationary.**
- **In flight, ram air doors are modulated to increase or decrease ram air flow to the exchanger according to the position of the wing flaps.**
- **During slow flight, when the flaps are extended, the doors are open. At higher speeds, with the flaps retracted, the doors move toward the closed position reducing the amount of ram air to the exchanger.**
- **Similar operation is accomplished with a valve on smaller aircraft**





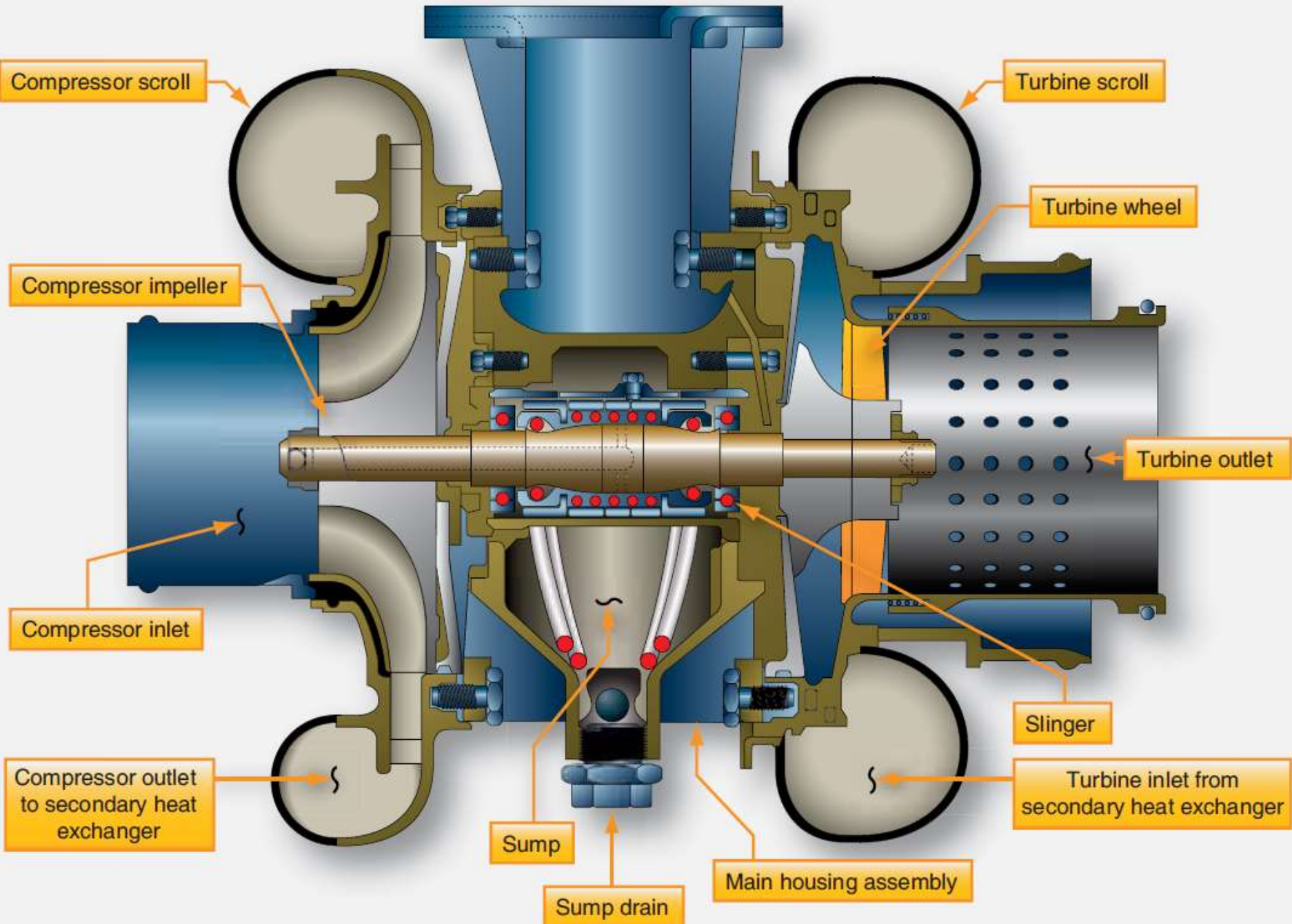




# Refrigeration Turbine Unit or Air Cycle Machine and Secondary Heat Exchanger

- The heart of the air cycle air conditioning system is the refrigeration turbine unit, also known as the air cycle machine (ACM).
- It is comprised of a compressor that is driven by a turbine on a common shaft.
- System air flows from the primary heat exchanger into the
- compressor side of the ACM.
- As the air is compressed,
- its temperature rises. It is then sent to a secondary heat exchanger, similar to the primary heat exchanger located in the ram air duct.
- The elevated temperature of the ACM compressed air facilitates an easy exchange of heat energy to the ram air.

- **The cooled system air, still under pressure from the continuous system air flow and the ACM compressor, exits the secondary heat exchanger.**
- **It is directed into the turbine side of the ACM.**
- **The steep blade pitch angle of the ACM turbine extracts more energy from the air as it passes through and drives the turbine.**
- **Once through, the air is allowed to expand at the ACM outlet, cooling even further.**
- **The combined energy loss from the air first driving the turbine and then expanding at the turbine outlet lowers the system**
- **air temperature to near freezing.**





# 4. Water Separator

- The cool air from the air cycle machine can no longer hold the quantity of water it could when it was warm.
- A water separator is used to remove the water from the saturated air before it is sent to the aircraft cabin.
- The separator operates with no moving parts. Foggy air from the ACM enters and is forced through a fiberglass sock
- That condenses and coalesces the mist into larger water drops.
- The convoluted interior structure of the separator swirls the air and water.
- The water collects on the sides of the separator and drains down and out of the unit, while the dry air passes through. A bypass valve is incorporated in case of a blockage.

fiberglass sock



# 5.Refrigeration Bypass Valve

- As mentioned, air exiting the ACM turbine expands and cools. It becomes so cold, it could freeze the water in the water separator, thus inhibiting or blocking airflow.
- A temperature sensor in the separator controls a refrigeration bypass valve designed to keep the air flowing through the water separator above freezing temperature.
- The valve is also identified by other names such as a **temperature control valve, 35° valve, anti-ice valve,** and similar.
- It bypasses warm air around the ACM when opened.
- The air is introduced into the expansion ducting, just upstream of the water separator, where it heats the air just enough to keep it from freezing.
- Thus, the refrigeration bypass valve regulates the temperature of the ACM discharge air so it does not freeze when passing through the water separator.

**An octopus has three hearts, nine brains, and blue blood**





Any

Questions?

# धन्यवाद

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