

# **SR-71 ENVIRONMENTAL CONTROL SYSTEM DEVELOPMENT CONTRIBUTIONS AND CREDITS**

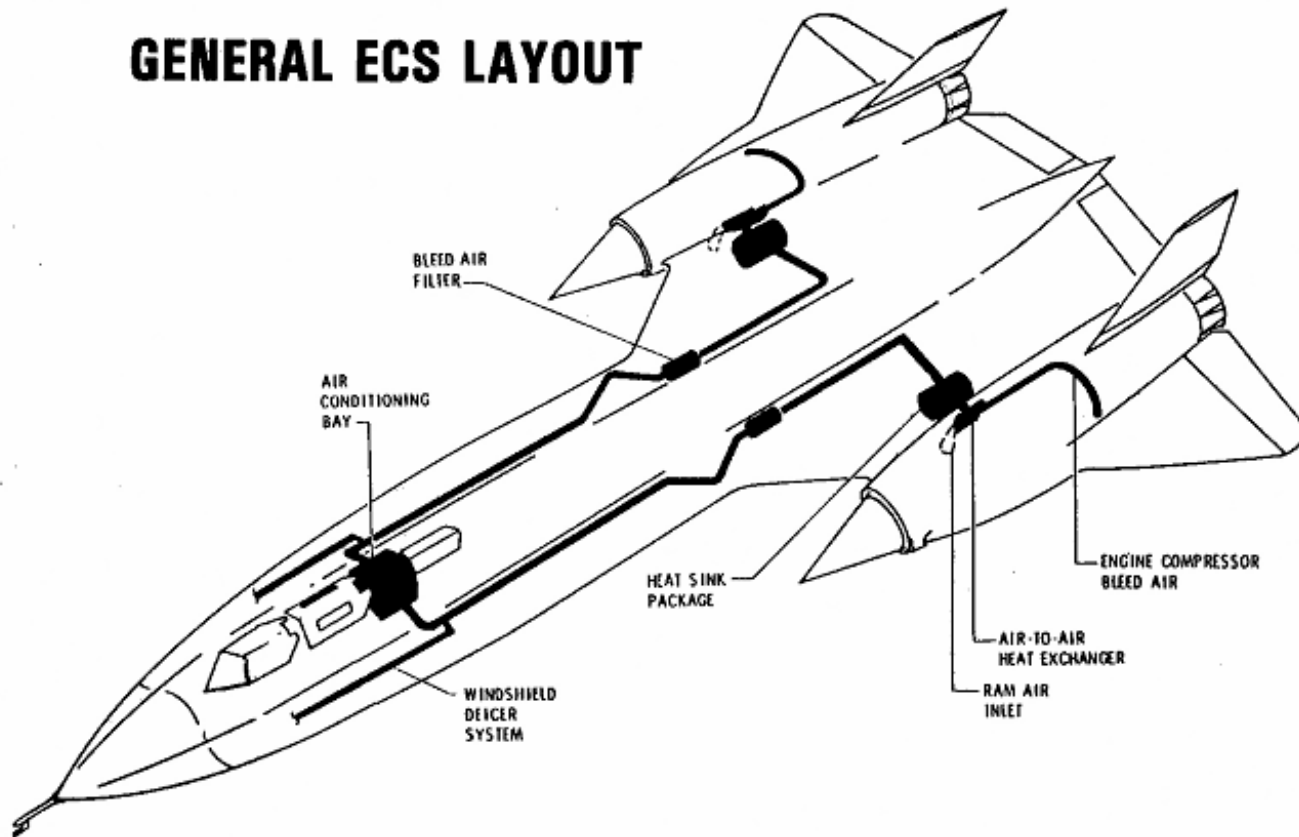
- **LOCKHEED**

- **KELLY JOHNSON - PROJECT LEADER - ALLOWED US TO INCORPORATE NEW AND UNIQUE IDEAS INTO VEHICLE**
- **BEN RICH AND PRATT & WHITNEY AIRCRAFT - ENGINE INLET DESIGN AND BLEED CONDITIONS FOR ECS DESIGN**
- **DOUG CONE - ECS INSTALLATION AND TESTING ON PRECESSOR TO YF 12As AND SR-71**
- **RUPE TRINIDAD - INSTALLATION ENGINEERING FOR SR 71 (WILLY CRANS, LEON KROOK, BERT SCATES, ALEX SIMAN)**
- **GENE GALLICK. PETE LAW, JOHN GARDNER - SYSTEM PERFORMANCE CALCULATIONS**

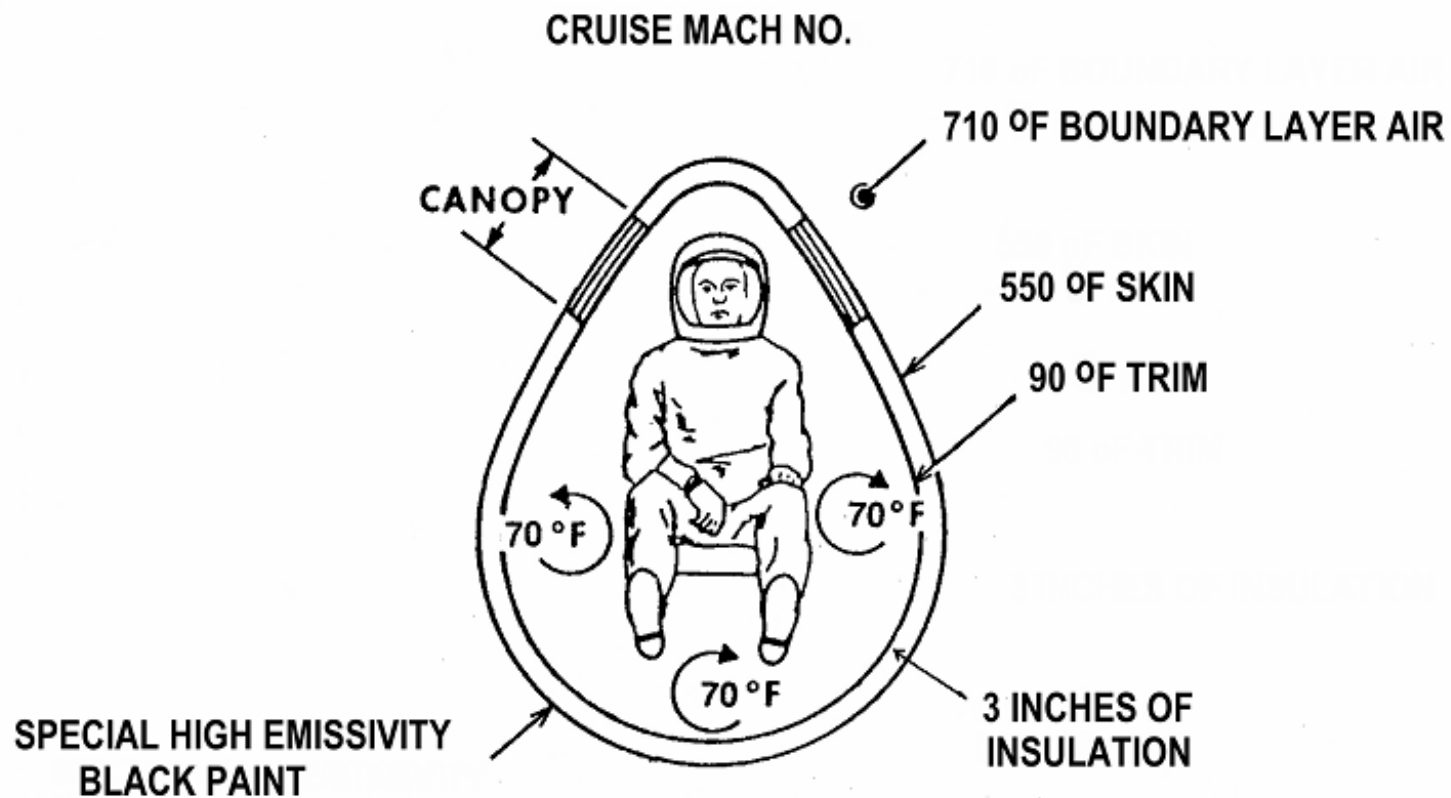
- **AIRESEARCH**

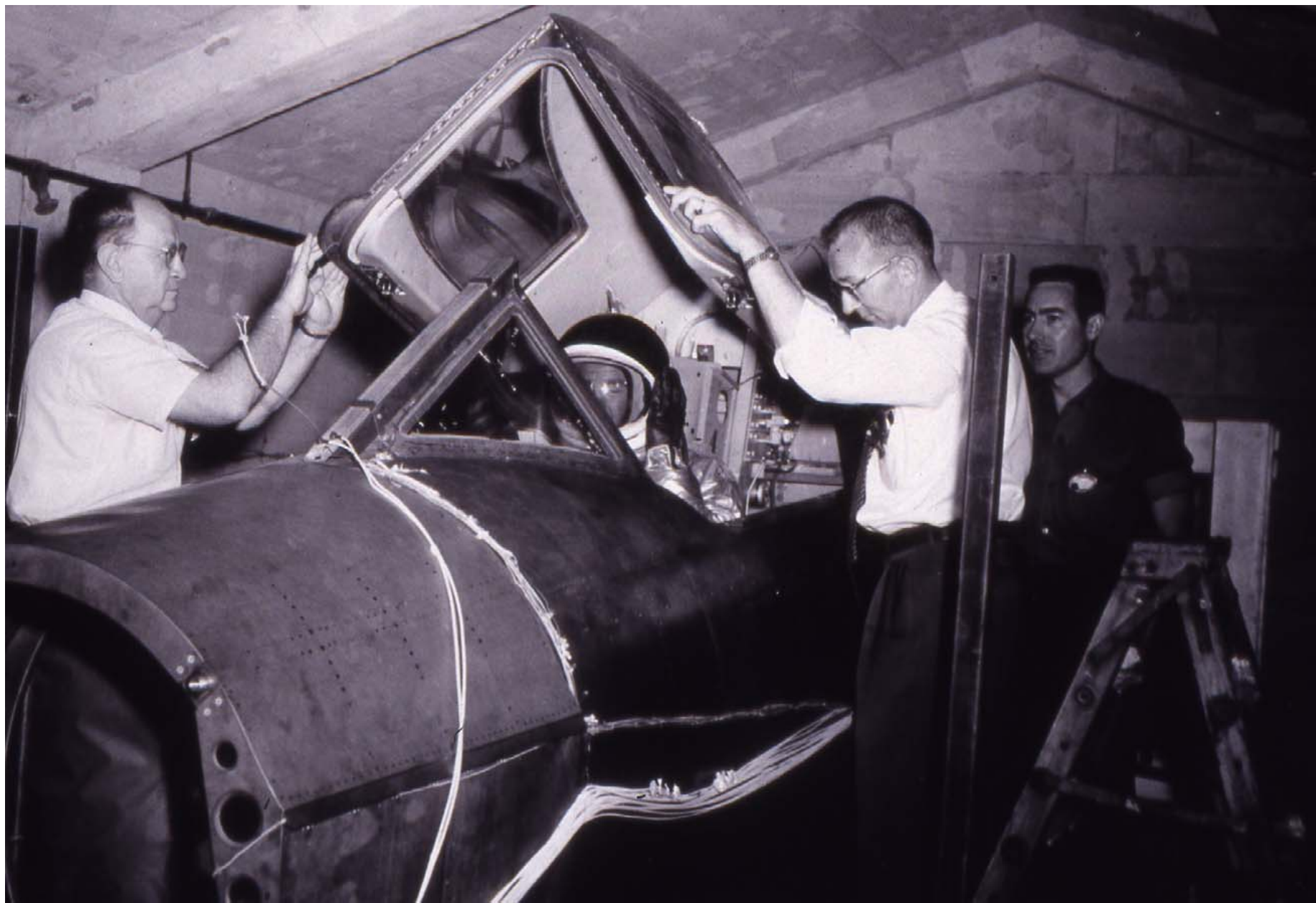
- **PAUL ELKINS - ECS PROJECT ENGINEER**
- **BOB MUELLER AND ERV AUSTIN - HEAT EXCHANGER DESIGN**
- **JIM COOPER - CONTRACTS**
- **RUDY RASMUSSEN - FIELD SERVICE ENGINEERING**
- **BOB BOSTICK - CONTINUED ENGINEERING SUPPORT**

# GENERAL ECS LAYOUT



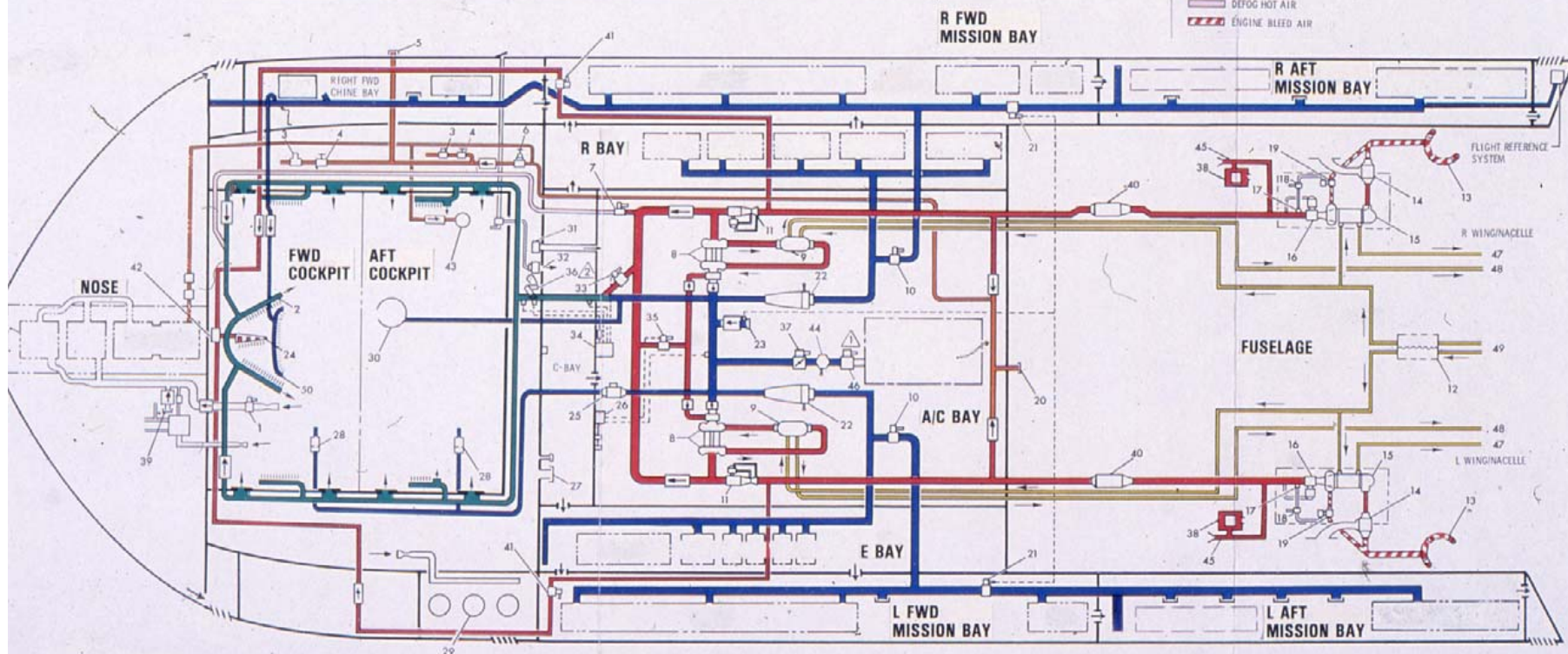
# COCKPIT THERMAL ENVIRONMENT





# SR-71 ENVIRONMENTAL CONTROL SYSTEM

- COND ITIONED AIR
- HOT COND ITIONED AIR
- COLD AIR
- PRESSURE
- FUEL
- DEFOG HOT AIR
- ENGINE BLEED AIR



# KEY TO ENVIRONMENTAL CONTROL SYSTEM SCHEMATIC

## COCKPITS and RADAR NOSE

1. Nose Air Shutoff Valve
2. Windshield Defog Manifold
3. Canopy Seal Pressure Switch
4. Canopy Seal Selector Valve
5. Canopy Seal Ground Test (LP)
6. Canopy Seal Pressure Regulator
24. Windshield Deicer
28. Suit Air Outlet and Valve
29. Oxygen Bottle Group
30. Viewsight
31. Safety Relief Valve
32. Cockpit Pressure Regulator
36. Cockpit Air Shutoff Valve
39. Radar Ground Air Cooling
42. Windshield Deicer Junction
43. Rain Remover Reservoir
50. Instrument Ground Cooling

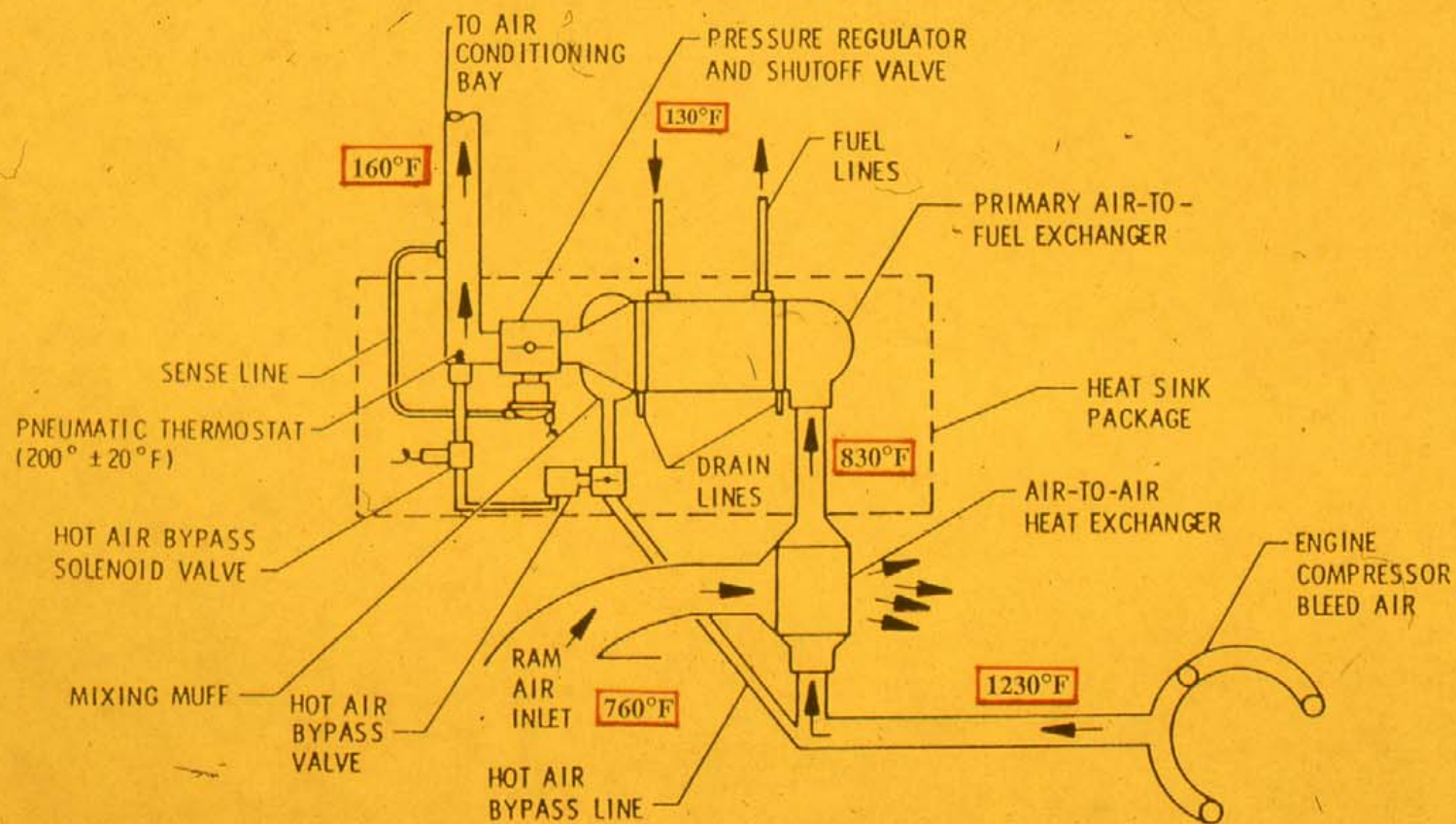
## Equipment and Mission Bays

7. Windshield, Defog Valve
8. Air Cycle Cooling Turbine
9. Air-Fuel Heat Exchanger
10. Bay Air Shutoff Valve
11. Hot Air Flow Control Valve
20. Canopy Seal Ground Test (HP)
21. Ground Air Shutoff Valve
22. Water Separator
23. Ground Cooling Connection
25. Suit Air Electric Heater
26. Temperature Controller
27. Ground Pressure Fitting
33. Cockpit Hot Air Valve
34. Cockpit Temperature Controller
35. Temperature Control Valve
37. ANS Airflow Uniting Valve
41. Deicer Control Valve
44. ANS Water Separator
46. ANS Ground Air Shutoff Valve

## Fuselage and Wing / Nacelle Area

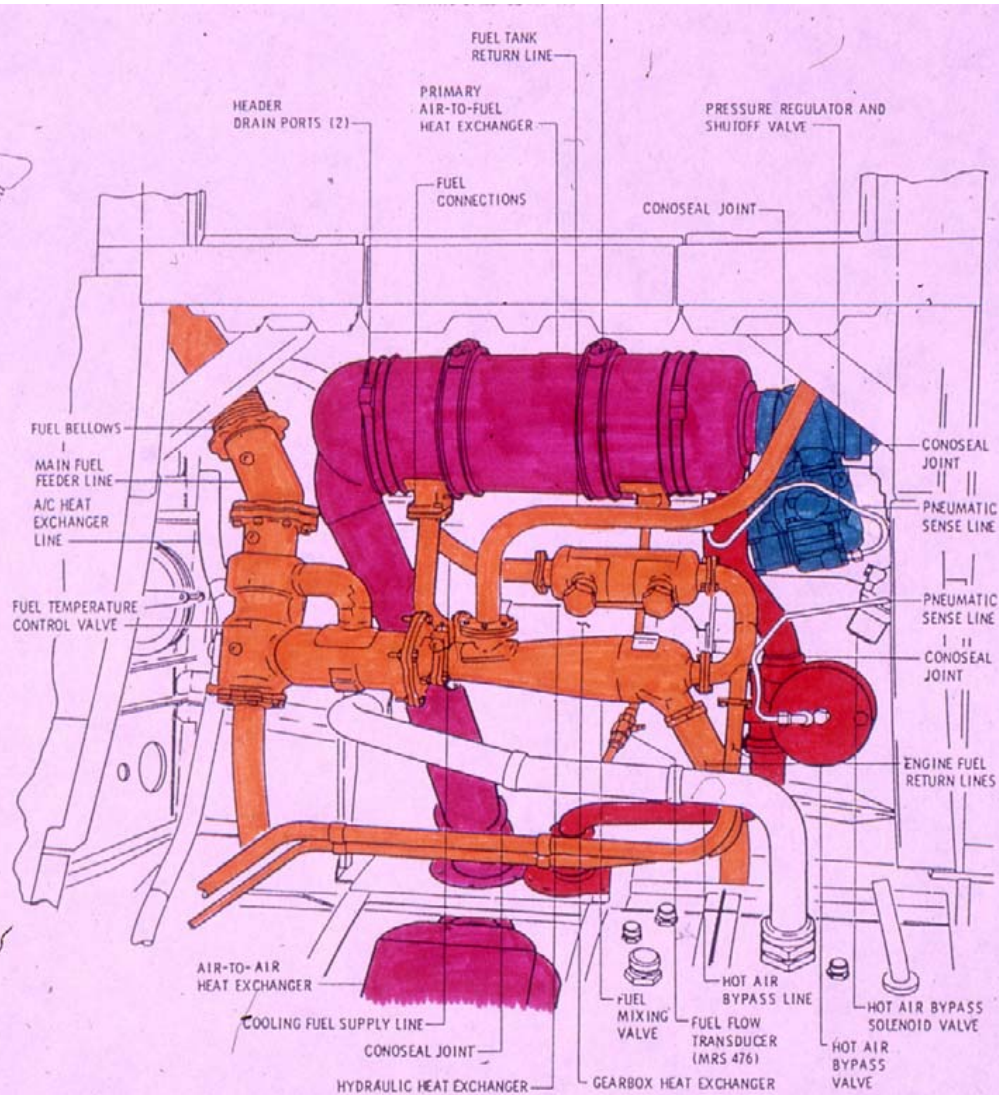
12. Fuel Temperature Equalizer
13. Engine Bleed Air Manifold
14. Air-Air Heat Exchanger
15. Air-Fuel Heat Exchanger
16. Pressure Regulator / S.O. Valve
17. Thermostat (Pneumatic)
18. Hot Air Bypass Solenoid
19. Hot Air Bypass Valve
45. Inlet Control Transducer
47. To Gearbox Oil Coolers
48. To Hydraulic Oil Coolers
49. From Circulation Pumps

# AFT ECS EQUIPMENT SCHEMATIC



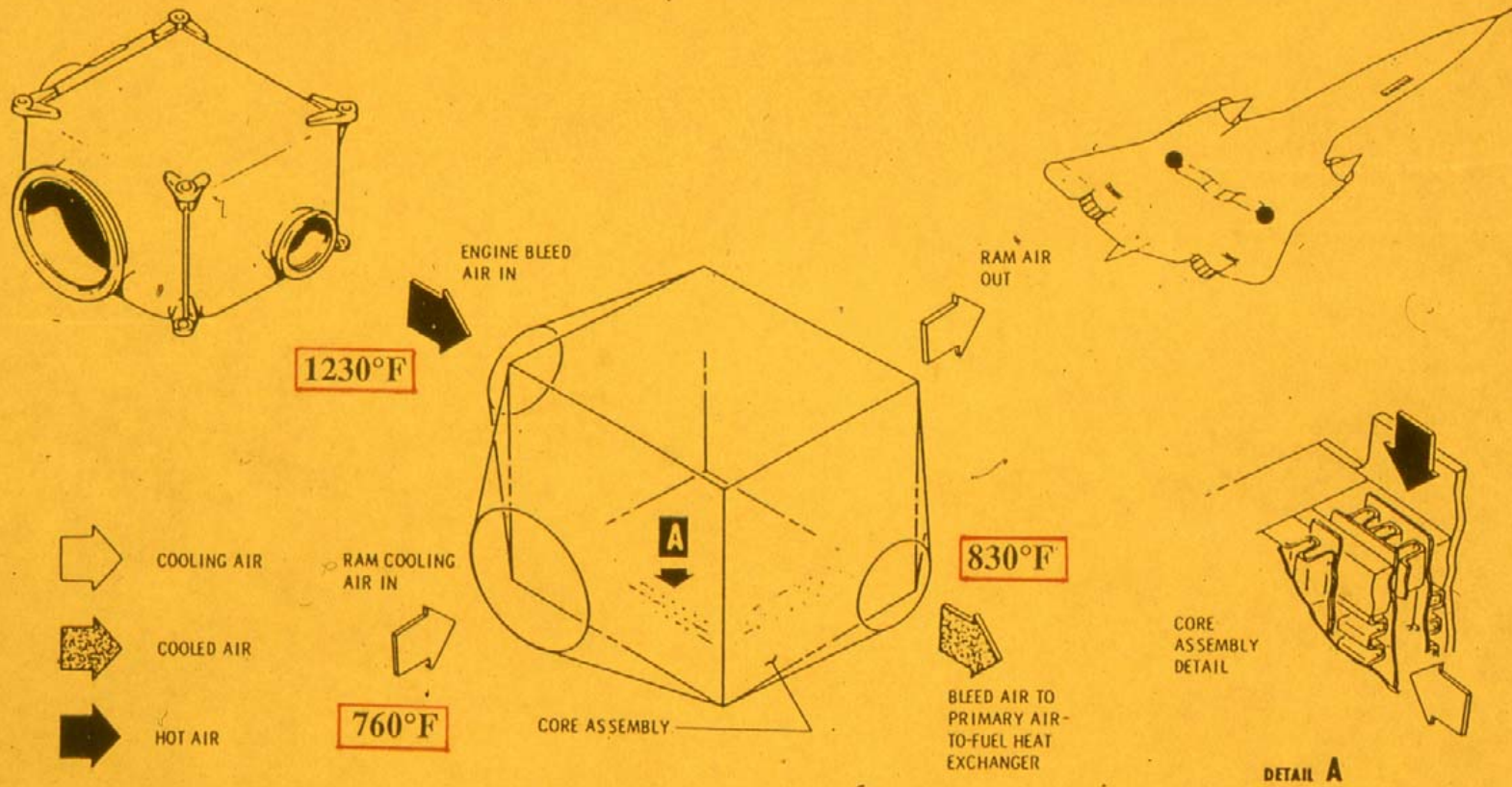
# HEAT SINK PACKAGE COMPONENTS

VIEW FROM BOTTOM

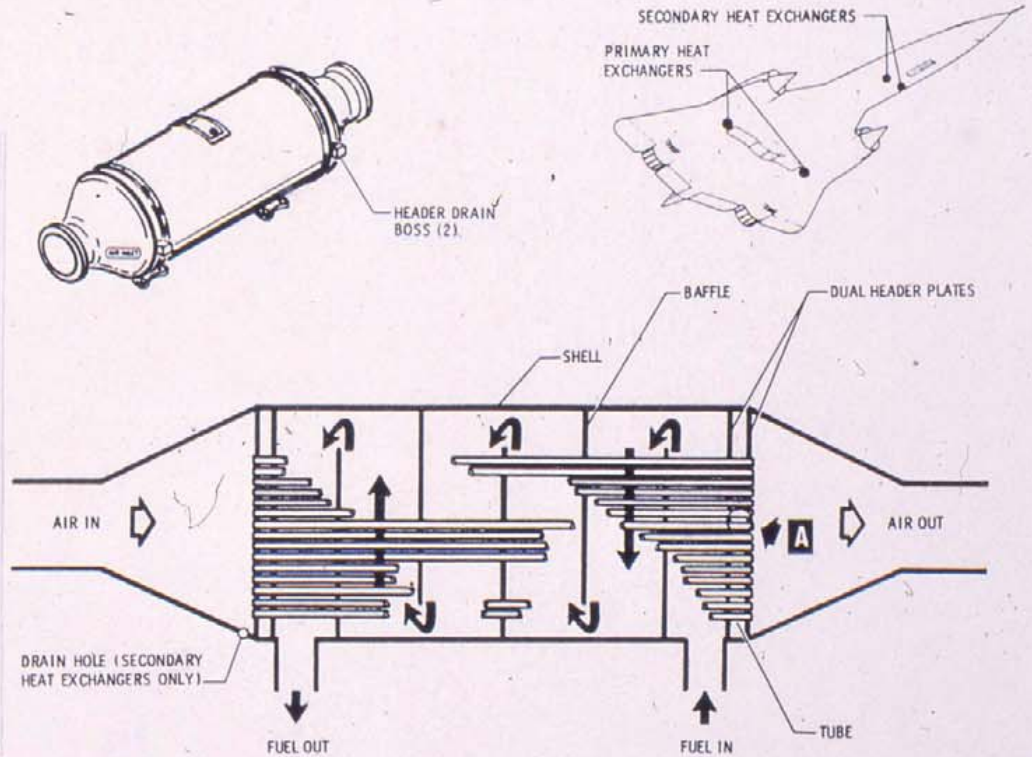
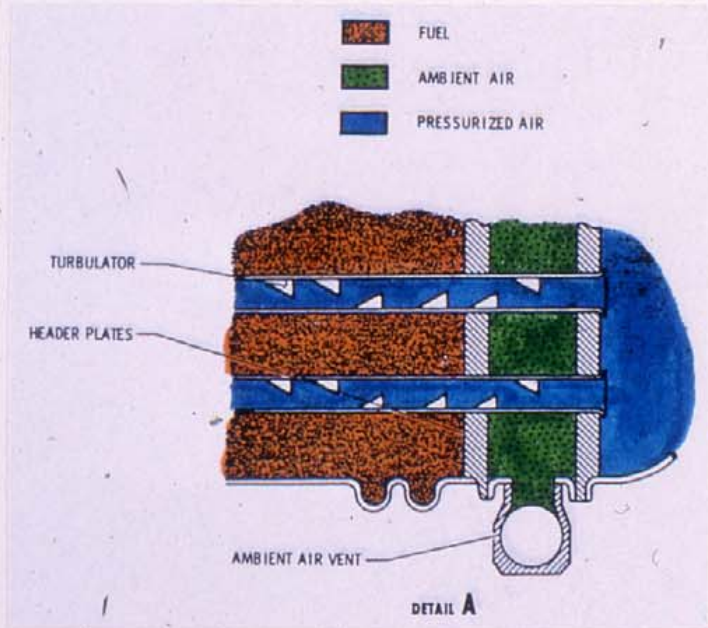




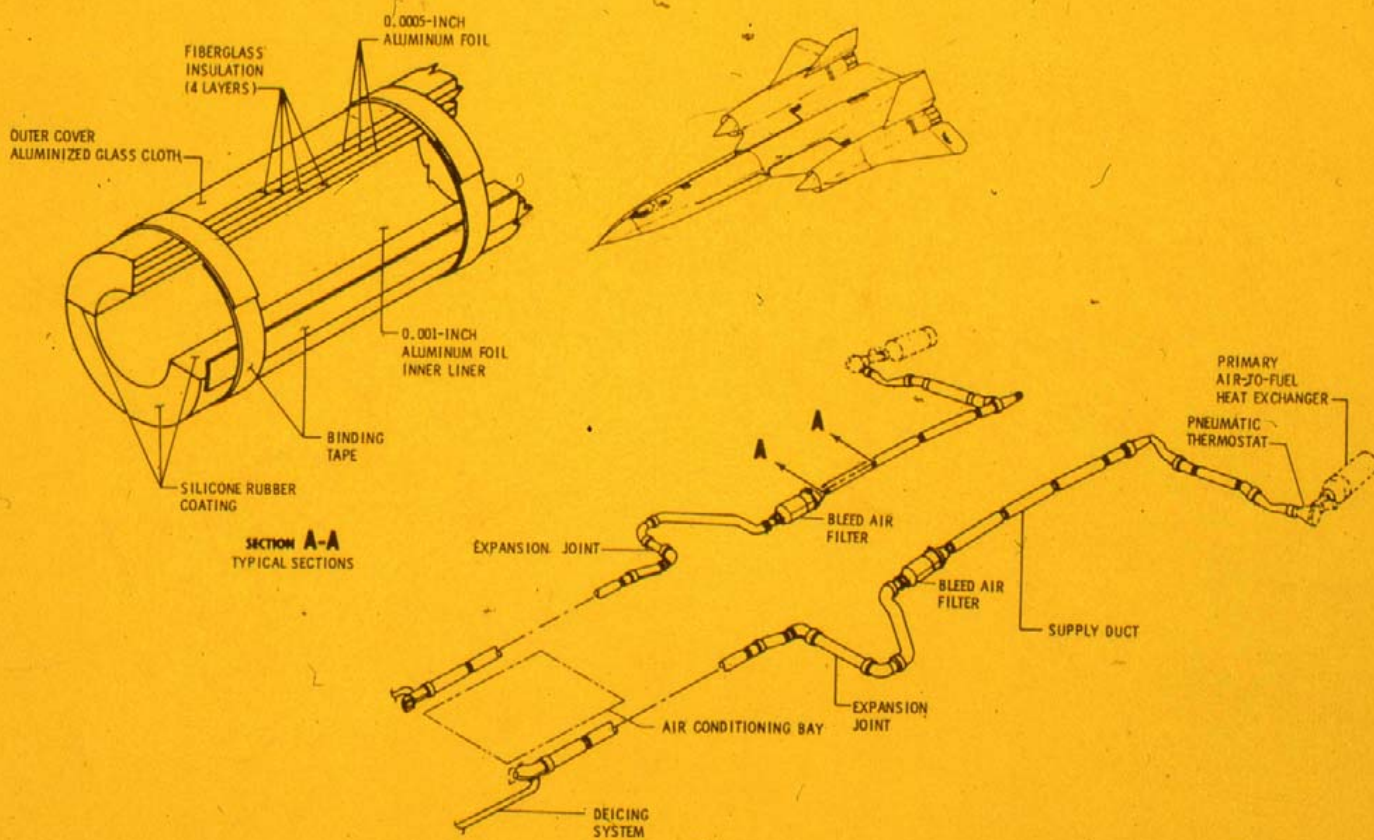
# PRIMARY AIR-TO-AIR HEAT EXCHANGER CONFIGURATION



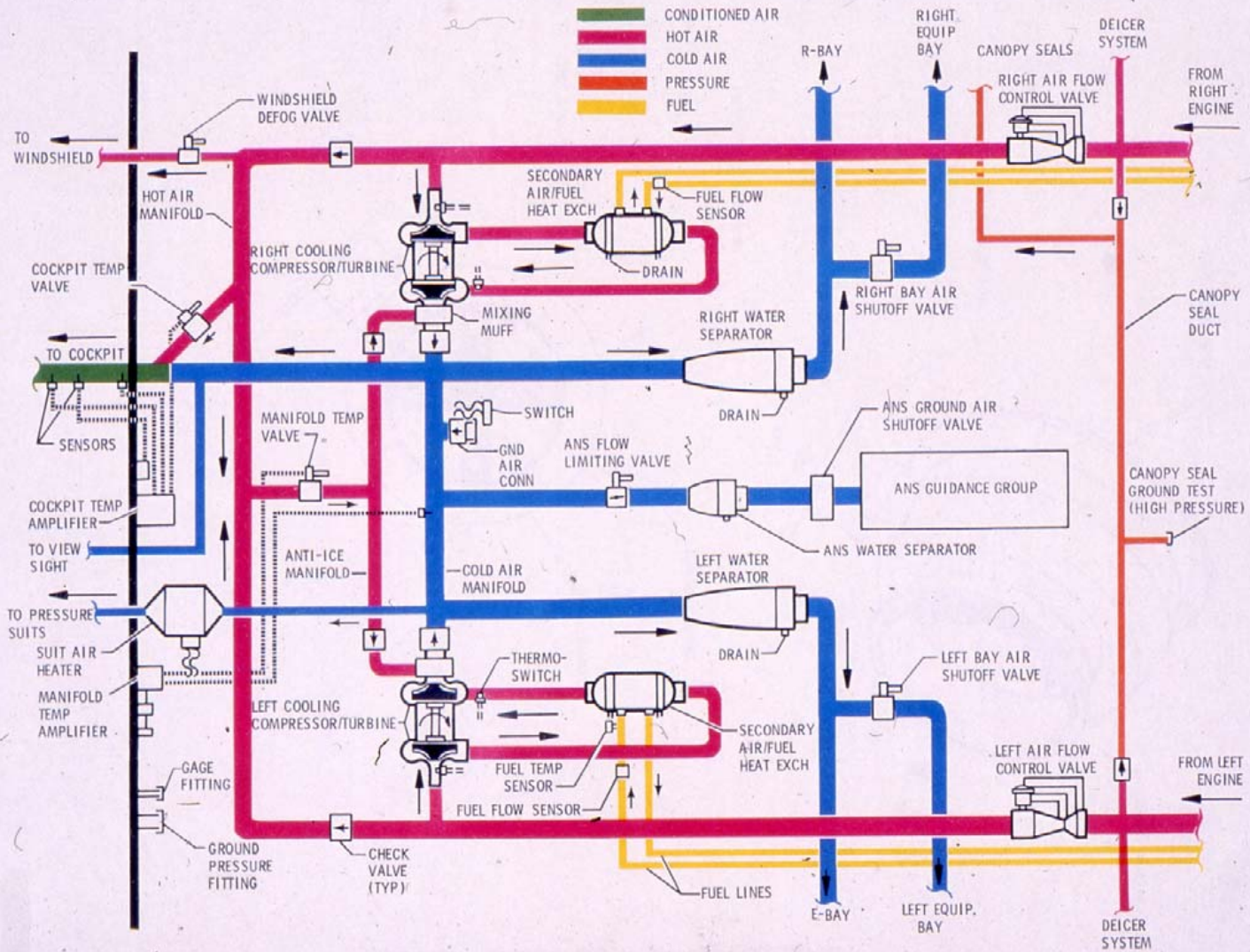
# AIR-TO-FUEL HEAT EXCHANGER CONFIGURATION



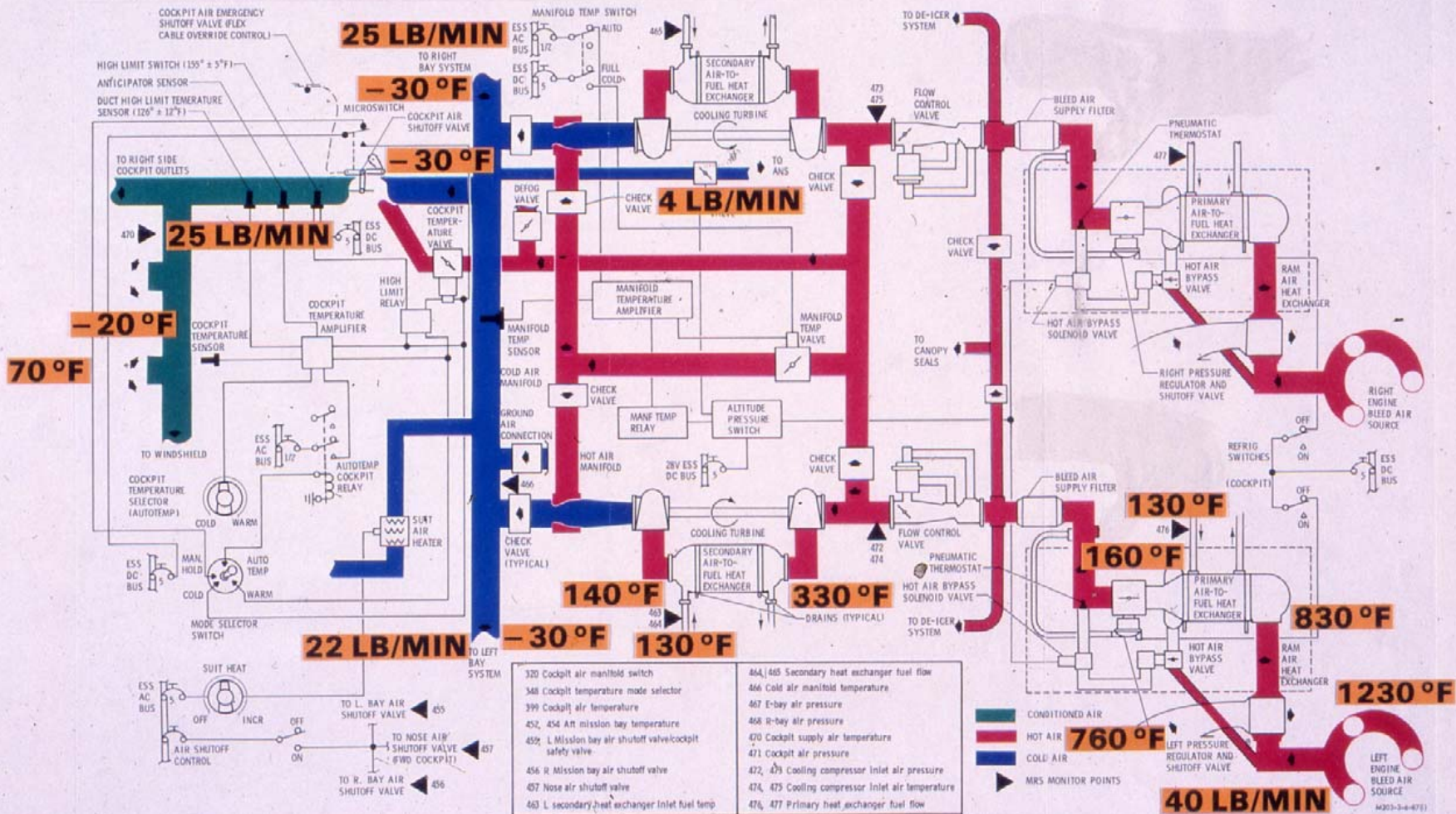
# BLEED DUCTING INSULATION



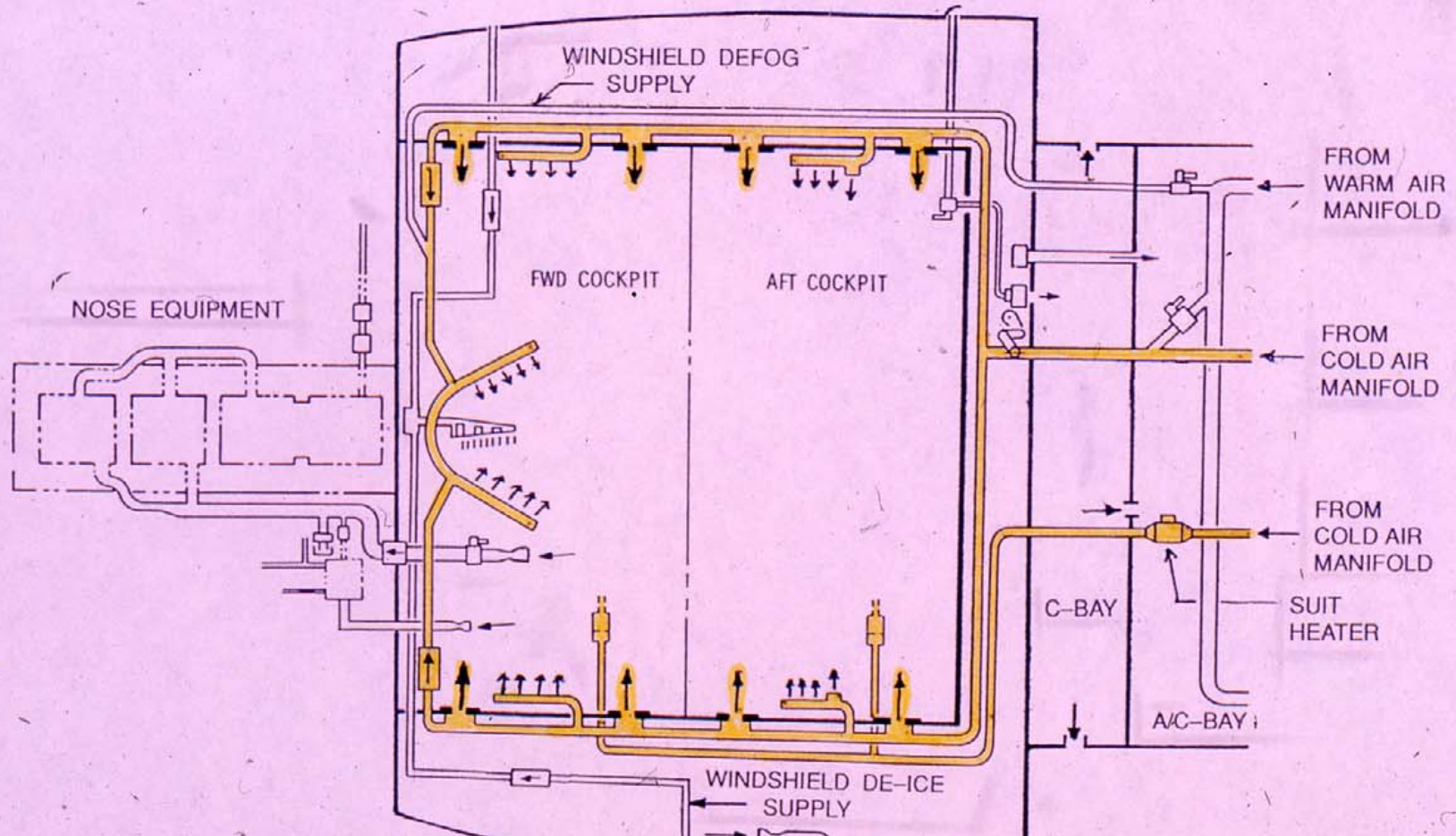
# AIR CONDITIONING BAY SCHEMATIC



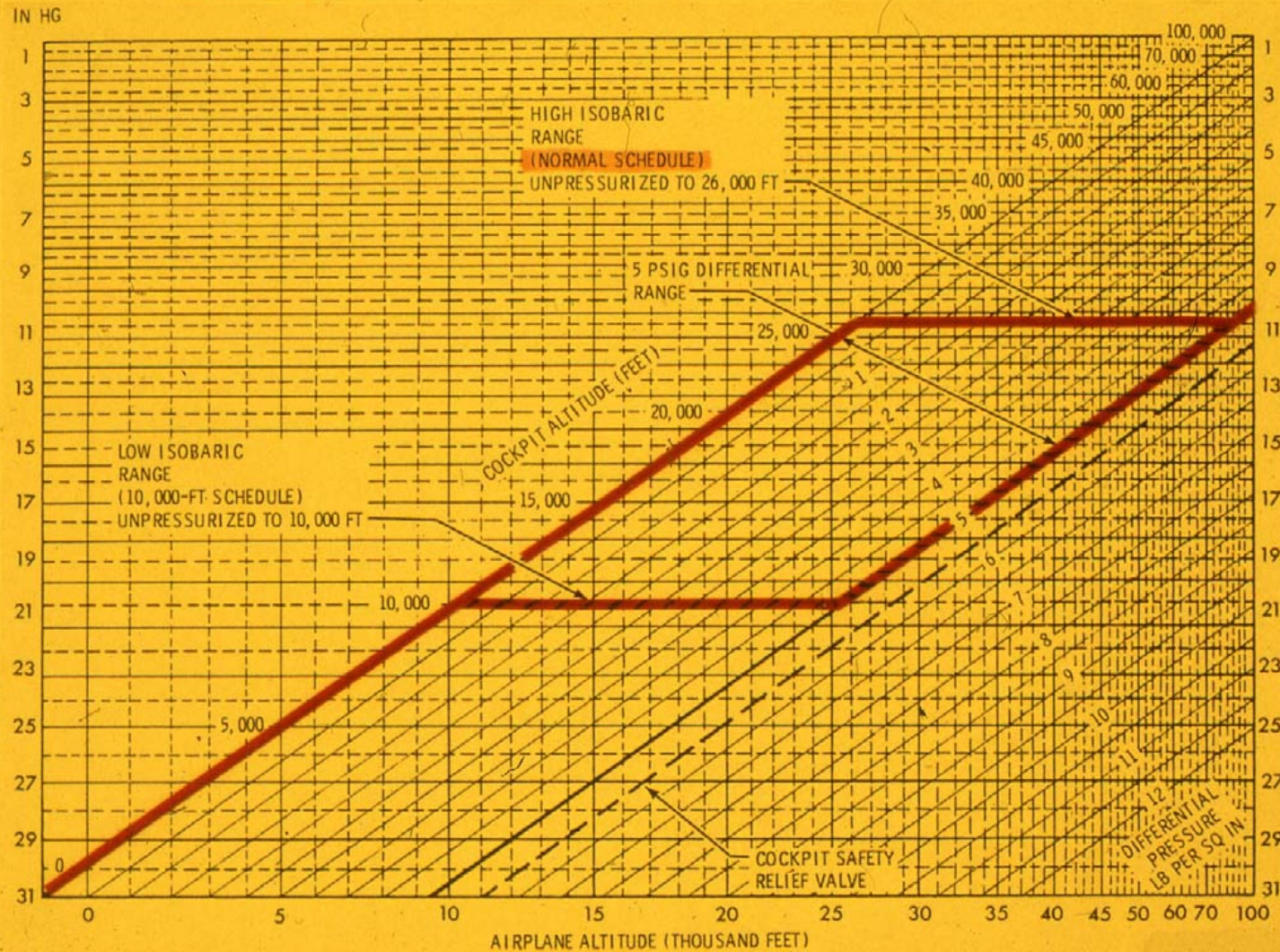
# ECS TEMPERATURE CONTROL METHODS



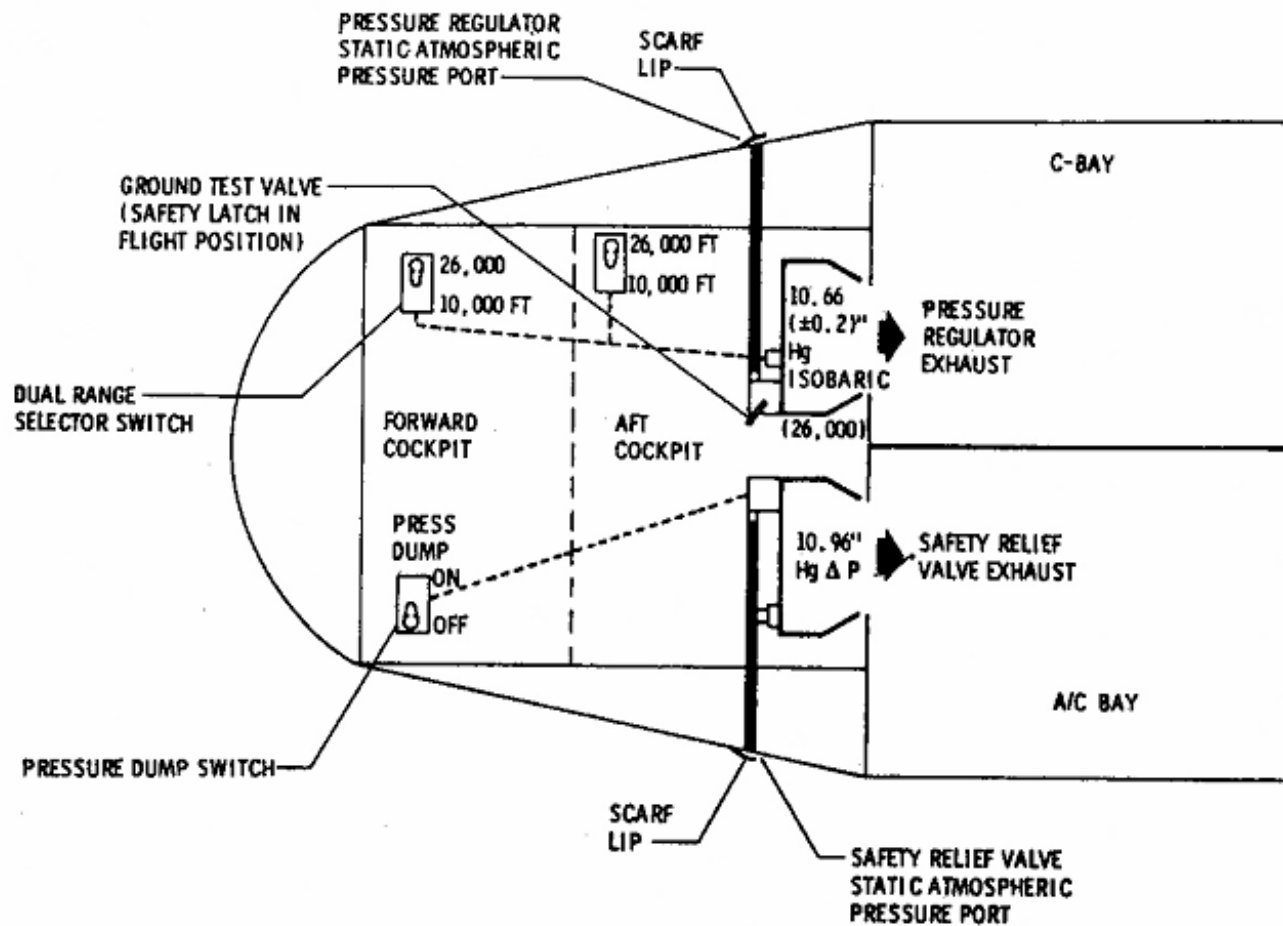
# COCKPIT COOLING AIR DISTRIBUTION SYSTEM



# COCKPIT PRESSURE SCHEDULE



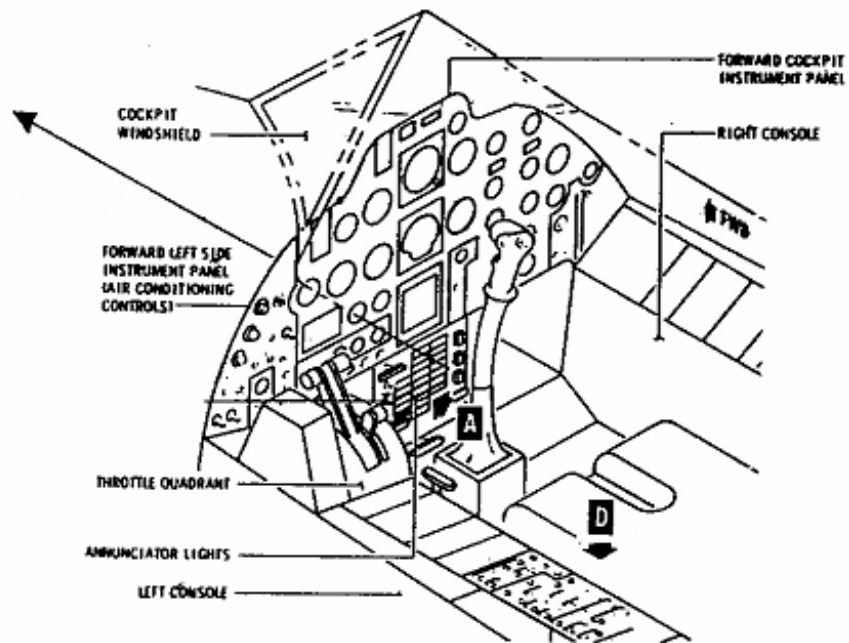
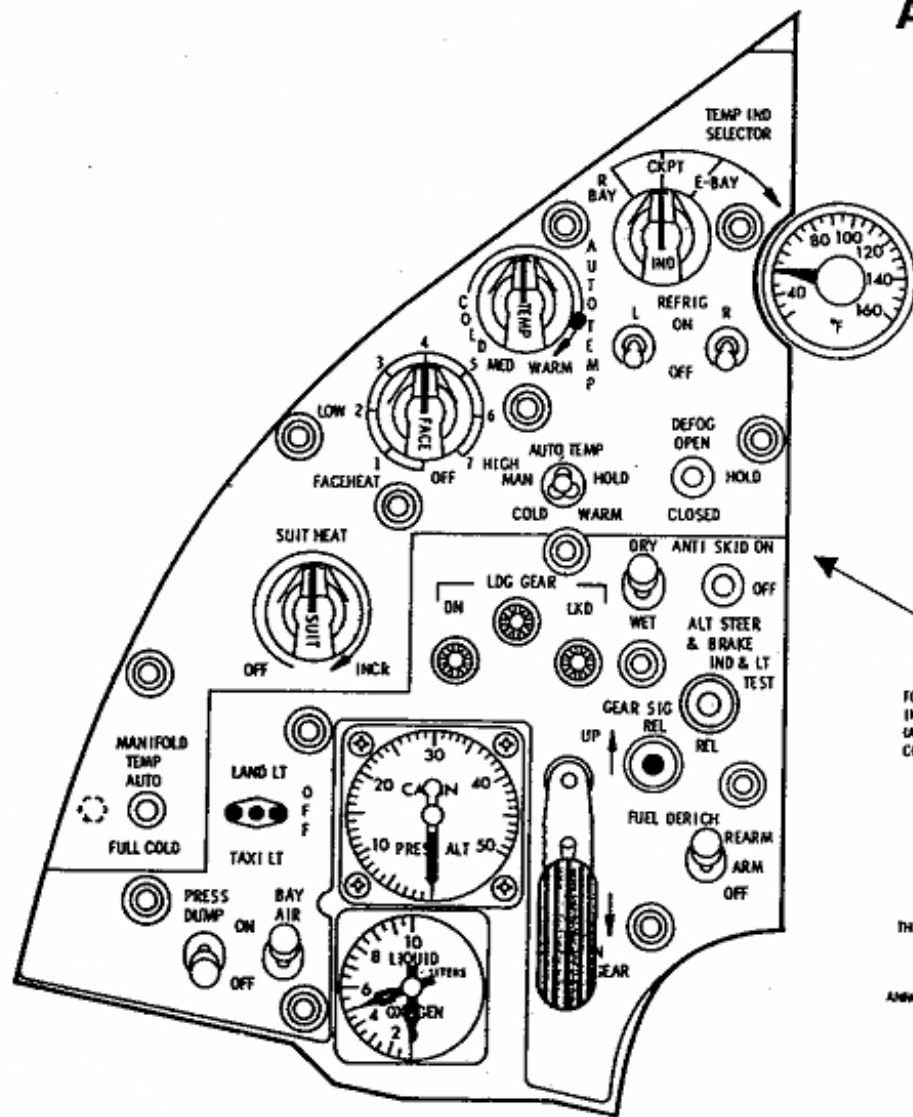
# COCKPIT PRESSURE CONTROL SYSTEM





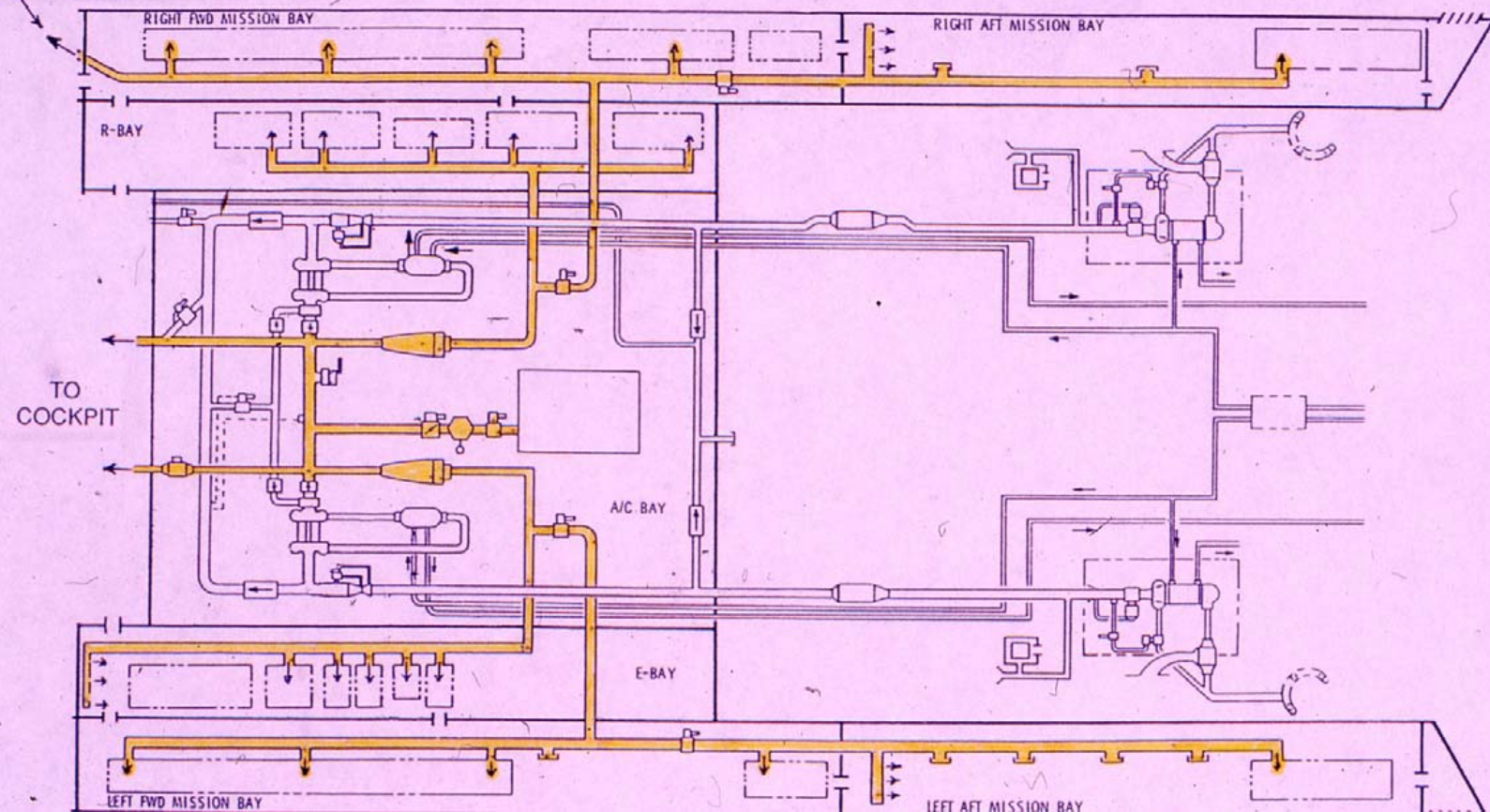
# AIR CONDITIONING SYSTEM CONTROL PANEL

FORWARD LEFT INSTRUMENT PANEL



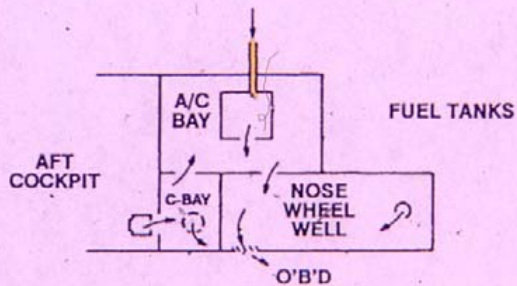
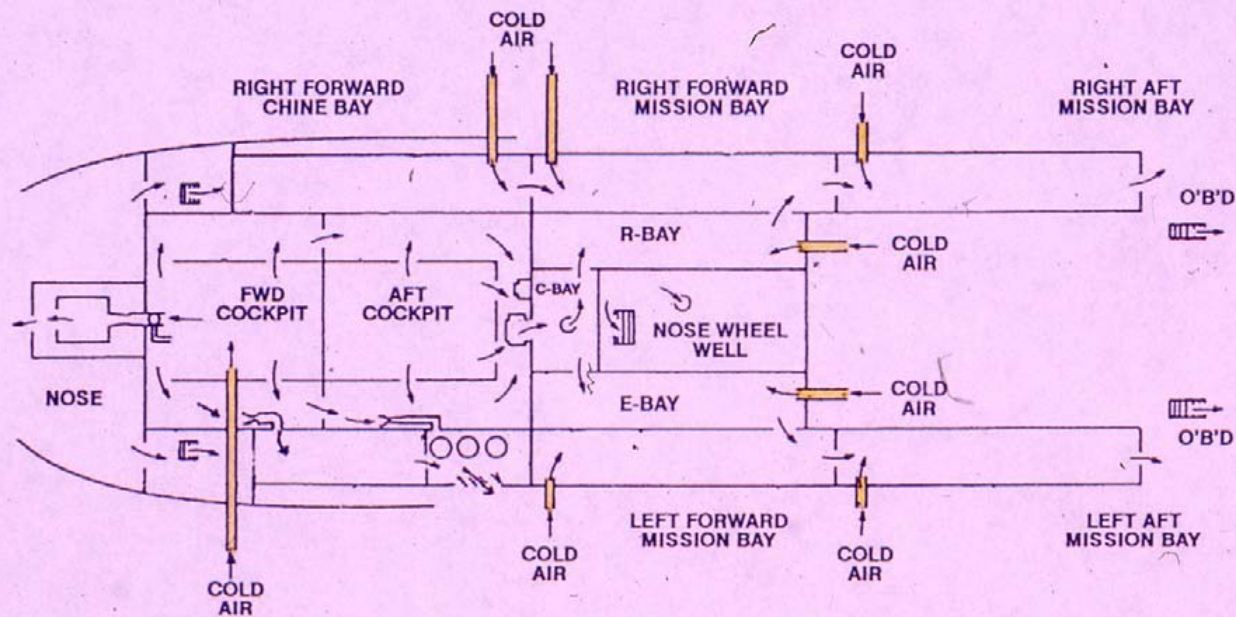
# COLD AIR DISTRIBUTION SYSTEM

TO RIGHT FORWARD CHINE  
BAY EQUIPMENT



# BAY ENVIRONMENTAL CONDITIONING METHODS

## CASCADING AIRFLOW



# ENVIRONMENTAL CONTROL SYSTEM SUMMARY

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- **ENVIRONMENTAL CONTROL SYSTEM COOLING CAPACITY, TO COOL BLEED AIR ONLY:**
  - CAPACITY REQUIRED TO COOL ENGINE BLEED AIR FROM 1250°F TO -30°F, WITH COOLING AIRFLOW OF 40 POUNDS/MINUTE/SIDE, OR 80 PPM TOTAL
  - COOLING IN AIR-TO-AIR HEAT EXCHANGER:  
(1250°F - 850°F)    7,700 BTU/MIN                    38 + TONS    135 + KW
  - COOLING IN AIR-TO-FUEL PRIMARY HX:  
(850°F-160°F)        13,250 BTU/MIN                    66 + TONS    233 KW
  - COOLING IN ECS PACKAGE:  
(160°F - -30°F)        3,650 BTU/MIN                    18 + TONS    64 + KW
  - TOTALS                    24,600 BTU/MIN                    123 TONS    433 KW
  
- **ENOUGH TO COOL 40 HOUSES @ 1500 SQUARE FEET EACH**
- **COOLING ACCOMPLISHED WITH THE 80 PPM OF -30°F AIR:**
  - AIR HEATED BY EQUIPMENT AND BAY WALLS  
FROM-30°F to 140°F:                    3260 BTU/MIN    16 TONS    57 KW
  - ENOUGH TO COOL 5 HOUSES ® 1500 SQUARE FEET EACH
- **APPROXIMATE WEIGHT OF HARDWARE REQUIRED TO ACCOMPLISH THE COOLING:**
  - WEIGHT IS ABOUT 400 POUNDS
  - WEIGHT IS EQUIVALENT TO THAT OF ABOUT 2 COMMERCIAL HOME REFRIGERATION UNITS FOR A 1500 SQUARE FOOT HOUSE

# **LESSONS LEARNED**

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- 1. OFF-THE-SHELF, PROVEN EQUIPMENT, WORKED WELL AND WAS ALWAYS VERY RELIABLE**
- 2. FUEL WAS SAFELY USED AS A HEAT SINK IN DIRECT CONTACT WITH AIR SUPPLIED TO CREW COMPARTMENTS AND VEHICLE EQUIPMENT**
- 3. MAINTENANCE RECORDING SYSTEM, TRACKING SEVERAL IMPORTANT PARAMETERS, WAS A USEFUL DIAGNOSTIC TOOL**