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APOLLO TRAINING

ENVIRONMENTAL CONTROL
SUBSYSTEM
STUDY GUIDE

COURSE NUMBER C2-A-712

FEBRUARY 18, 1966

FOR TRAINING PURPOSES ONLY



NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

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PREFACE

THIS STUDY GUIDE SUPPLEMENTS THE ORAL PRESENTATION OF THE ENVIRONMENTAL CONTROL SYSTEM, COURSE NUMBER C2-A-712. THE MATERIAL CONTAINED WITHIN THIS STUDY GUIDE IS UNCLASSIFIED AND CONFORMS TO THE NASA REQUIREMENT OF DOCUMENTATION OF ALL TRAINING INFORMATION.

IT IS ASSUMED BY THE TRAINING DEPARTMENT THAT PERSONNEL ATTENDING THE ENVIRONMENTAL CONTROL SYSTEM BRIEFING HAVE ATTENDED THE APOLLO FAMILIARIZATION BRIEFING AND HAVE SOME EXPERIENCE WITH SIMILAR EQUIPMENT.

THE SYSTEM AND EQUIPMENT DESCRIPTIONS, INFORMATION, AND DATA APPLY TO MANNED SPACECRAFT. THIS STUDY GUIDE PRIMARILY PERTAINS TO BLOCK I CONFIGURATION. BLOCK II INFORMATION WILL BE INCLUDED AS IT BECOMES AVAILABLE.

THIS DOCUMENT REFLECTS THE CURRENT STATUS OF THE ENVIRONMENTAL CONTROL SYSTEM. IT IS A TRAINING DOCUMENT AND THE ATTENDEES COPY WILL NOT BE REVISED.

QUESTIONS RELATIVE TO THE INFORMATION CONTAINED IN THIS DOCUMENT SHOULD BE DIRECTED TO:

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SECTION I

INTRODUCTION

1.1 GENERAL

THE ENVIRONMENTAL CONTROL SYSTEM (ECS) IS OPERATED CONTINUOUSLY THROUGHOUT ALL APOLLO MISSION PHASES. DURING THIS OPERATING PERIOD THE ECS PROVIDES THREE MAJOR FUNCTIONS, WHICH ARE REQUIRED FOR MISSION SUCCESS.

1.2 SPACECRAFT ATMOSPHERE CONTROL

IT IS ESSENTIAL THAT THE ENVIRONMENT IN WHICH THE FLIGHT CREW WILL OPERATE IS LIFE-SUPPORTING, AND IS AS COMFORTABLE AS POSSIBLE. THEREFORE, IT IS NECESSARY TO CONTROL THE PRESSURE, TEMPERATURE, HUMIDITY, AND THE LEVEL OF CONTAMINATION OF THE ATMOSPHERE IN THE SPACECRAFT CABIN, AND PRESSURE SUIT CIRCUIT, AT TOLERABLE LEVELS.

1.3 EQUIPMENT TEMPERATURE CONTROL

SOME ITEMS OF S/C EQUIPMENT ARE SENSITIVE TO TEMPERATURE VARIATION, WHILE OTHERS GENERATE HEAT AND ARE INTOLERANT OF HIGH TEMPERATURES. THEREFORE, IT IS NECESSARY TO PROVIDE TEMPERATURE CONTROL, AND HEAT TRANSPORT AND REJECTION CAPABILITY.

1.4 WATER MANAGEMENT

WATER IS PRODUCED BY TWO SOURCES DURING THE APOLLO MISSION. THE FUEL CELLS, IN GENERATING ELECTRICAL POWER, PRODUCE POTABLE WATER; AND THE FLIGHT CREW, THROUGH THE NORMAL BODY PROCESSES OF PERSPIRATION AND RESPIRATION ARE ADDING MOISTURE TO THE S/C ATMOSPHERE. SINCE THE FLIGHT CREW NEEDS WATER FOR METABOLIC AND HYGIENIC PURPOSES, AND A REQUIREMENT EXISTS FOR WATER FOR SUPPLEMENTAL COOLING, IT IS CONVENIENT TO PROVIDE A MEANS FOR COLLECTING, STORING, AND DISTRIBUTING THE POTABLE WATER FOR THE CREW, AND THE WASTE WATER FOR COOLING.

1.5 ECS SUBSYSTEM FUNCTIONS

FOUR SUBSYSTEMS OF THE ECS OPERATE IN CONJUNCTION TO SATISFY THE FUNCTIONAL REQUIREMENTS. THEY ARE, THE OXYGEN, PRESSURE SUIT, WATER AND WATER-GLYCOL SUBSYSTEMS.

1.5.1 OXYGEN

THE OXYGEN SUBSYSTEM CONTROLS THE O_2 INFLOW RATE FROM THE STORAGE TANKS; STORES A RESERVE SUPPLY

FOR USE DURING ENTRY, AND EMERGENCIES; REGULATES PRESSURE AND DISTRIBUTES O₂ TO OTHER COMPONENTS; REGULATES CABIN PRESSURE; PROVIDES HIGH O₂ FLOW RATES IN EMERGENCIES.

1.5.2 PRESSURE SUIT

THE PRESSURE SUIT SUBSYSTEM PROVIDES THE CREW WITH A CONTINUOUSLY CONDITIONED ATMOSPHERE. IT AUTOMATICALLY CONTROLS SUIT GAS CIRCULATION, PRESSURE, AND TEMPERATURE; AND REMOVES DEBRIS, EXCESS MOISTURE, AND CARBON DIOXIDE FROM BOTH THE SUIT AND CABIN GASSES.

1.5.3 WATER

THE WATER SUBSYSTEM (POTABLE SECTION) COLLECTS AND STORES POTABLE WATER; DELIVERS HOT AND COLD WATER TO THE CREW FOR METABOLIC AND HYGIENIC PURPOSES; AND AUGMENTS THE WASTE WATER SUPPLY FOR EVAPORATIVE COOLING. THE WASTE WATER SECTION COLLECTS AND STORES WATER EXTRACTED FROM THE SUIT HEAT EXCHANGER, AND DISTRIBUTES IT TO THE WATER INFLOW CONTROL VALVES OF THE EVAPORATORS, FOR EVAPORATIVE COOLING. THE SUPPLEMENTAL WATER SUPPLY PROVIDES ADDITIONAL WATER FOR EVAPORATIVE COOLING DURING EARTH ORBIT MISSIONS.

1.5.4 WATER-GLYCOL

THE WATER-GLYCOL SUBSYSTEM CIRCULATES COOLANT THROUGH A CLOSED FLUID LOOP. THE COOLANT ABSORBS HEAT FROM THE THERMAL LOAD, TRANSPORTS THE HEAT WHEREVER IT IS NEEDED, THEN REJECTS THE EXCESS TO SPACE.

SECTION 11

OXYGEN SUBSYSTEM

2.1 GENERAL

THE ENVIRONMENTAL CONTROL SYSTEM (SEE FIGURE 2-1) SHARES THE OXYGEN SUPPLY WITH THE ELECTRICAL POWER SYSTEM. THE OXYGEN IS STORED IN TWO CRYOGENIC TANKS IN THE SERVICE MODULE (S/M). HEATERS WITHIN THE TANKS CHANGE THE OXYGEN FROM A LIQUID TO A GASEOUS STATE, FOR DISTRIBUTION TO THE USING EQUIPMENT.

2.2 OXYGEN SUPPLY

OXYGEN ENTERS THE COMMAND MODULE (C/M) THROUGH TWO SEPARATE SUPPLY LINES, EACH OF WHICH TERMINATES AT AN OXYGEN INLET RESTRICTOR ASSEMBLY. EACH ASSEMBLY CONTAINS A FILTER, A CAPILLARY LINE, AND A CHECK VALVE. THE FILTERS PROVIDE FINAL FILTRATION OF GAS ENTERING THE C/M. THE CAPILLARIES, WHICH ARE WOUND AROUND THE HOT GLYCOL LINE, SERVE TWO PURPOSES; THEY RESTRICT THE TOTAL O_2 FLOW RATE (APPROXIMATELY 8.2 LBS/HR. @ 900 PSIG) TO PREVENT STARVATION OF THE FUEL CELLS, AND THEY PREVENT OXYGEN FROM ENTERING THE C/M ECS IN A LIQUID STATE. THE CHECK VALVES SERVE TO ISOLATE THE TWO SUPPLY LINES.

DOWNSTREAM OF THE INLET RESTRICTOR CHECK VALVES THE TWO LINES TEE TOGETHER AND A SINGLE LINE IS

ROUTED TO THE S/M O_2 SHUT-OFF VALVE. THIS VALVE IS USED DURING SERVICING AS AN ISOLATION VALVE, AND (AFTER C/M-S/M SEPARATION) AS A BACKUP FOR THE INLET CHECK VALVES.

2.2.1 HIGH PRESSURE O_2 DISTRIBUTION

DOWNSTREAM OF THE S/M O_2 SHUT-OFF VALVE THE HIGH PRESSURE (900 PSIG) OXYGEN IS SUPPLIED IN PARALLEL TO THE SURGE TANK AND BACKUP TANK IN THE LH EQUIPMENT BAY, AND TO THE PLSS SUPPLY VALVE AND THE S/M SUPPLY REGULATOR ON THE OXYGEN CONTROL PANEL.

THE SURGE TANK STORES APPROXIMATELY 3.7 LBS OF OXYGEN FOR USE DURING ENTRY, AND FOR AUGMENTING THE S/M SUPPLY WHEN THE OPERATIONAL DEMAND EXCEEDS THE FLOW CAPACITY OF THE INLET RESTRICTORS. A RELIEF AND SHUT-OFF VALVE PREVENTS OVERPRESSURIZATION OF THE SURGE TANK, AND PROVIDES A MEANS FOR SHUTTING OFF THE FLOW IN CASE OF RELIEF VALVE FAILURE. A SHUT-OFF VALVE PERMITS ISOLATION OF THE SURGE TANK FROM THE SYSTEM. A PRESSURE TRANSDUCER PUTS OUT A SIGNAL PROPORTIONAL TO SURGE TANK PRESSURE, FOR TELEMETRY AND FOR DISPLAY TO THE CREW. THIS SIGNAL SHARES THE INDICATOR USED FOR DISPLAYING O_2 SUPPLY TANK #1 PRESSURE. THE SIGNAL SOURCE IS SELECTED BY A SWITCH, WHICH IS LOCATED BENEATH THE INDICATOR ON THE MAIN DISPLAY CONSOLE (MDC) PANEL #13.

OXYGEN SUBSYSTEM

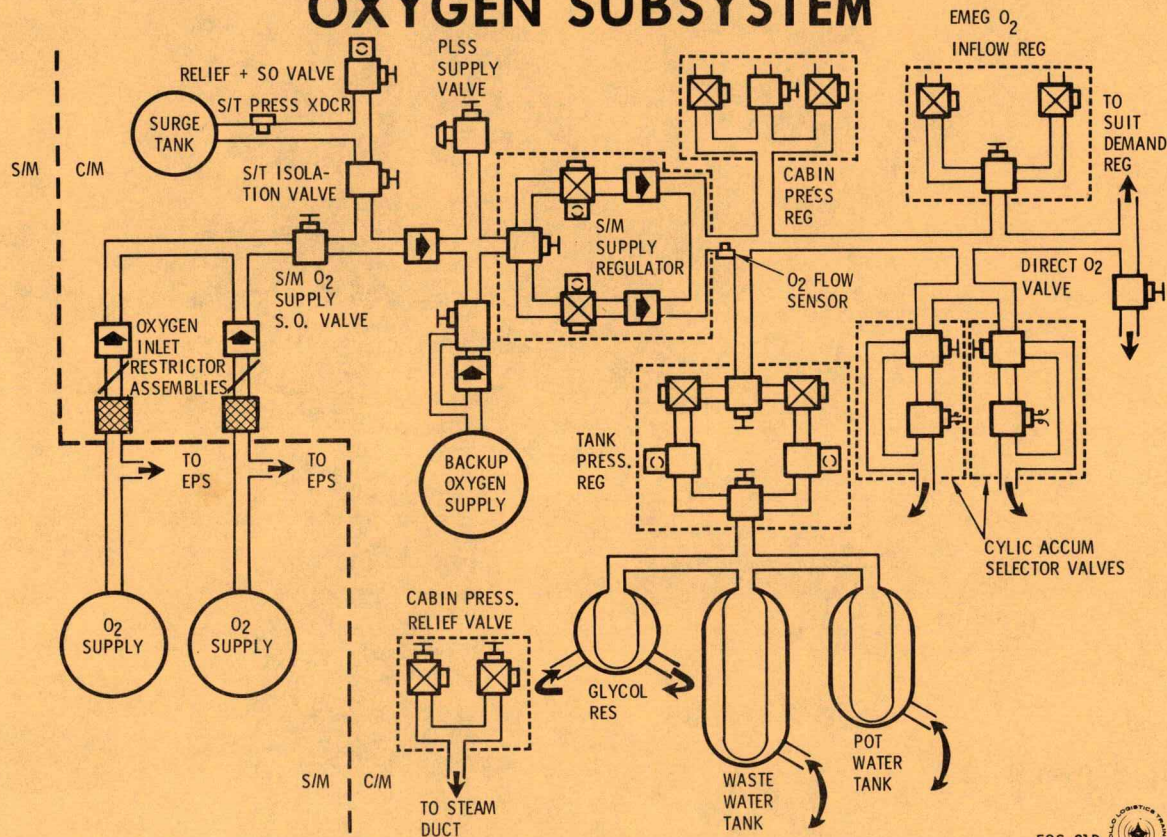


FIGURE 2-1

ECS-21D



THE BACKUP OXYGEN TANK REPLACES ONE OF THE FUNCTIONS FORMERLY PROVIDED BY THE PLSS (PORTABLE LIFE SUPPORT SYSTEM), WHICH HAS BEEN DELETED FROM BLOCK I SPACECRAFT. THE TANK STORES APPROXIMATELY ONE POUND OF OXYGEN AT 900 PSIG, FOR AUGMENTING THE SURGE TANK SUPPLY DURING ENTRY, AND IN EMERGENCIES. A THREE-WAY VALVE AND BY PASS LINE PROVIDES FOR PLACING THE TANK ON-LINE, FOR REFILLING, OR FOR ISOLATING THE TANK FROM THE SYSTEM.

THE PLSS SUPPLY VALVE, LOCATED ON THE OXYGEN CONTROL PANEL, WILL NOT BE USED DURING FLIGHT OPERATIONS ON BLOCK I SPACECRAFT. HOWEVER, IT WILL BE USED DURING PREPARATION AND CHECKOUT PRIOR TO FLIGHT.

THE S/M SUPPLY REGULATOR, LOCATED ON THE OXYGEN CONTROL PANEL, REDUCES THE O_2 SUPPLY PRESSURE TO 100 ± 10 PSIG FOR USE BY SUBSYSTEM COMPONENTS. THE REGULATOR ASSEMBLY IS A DUAL UNIT OPERATING IN PARALLEL. INTEGRAL RELIEF VALVES PREVENT OVERPRESSURIZATION OF THE EQUIPMENT DOWNSTREAM OF THE REGULATOR.

2.2.2 LOW PRESSURE O_2 DISTRIBUTION

OXYGEN FROM THE S/M SUPPLY REGULATOR PASSES THROUGH THE O_2 FLOW SENSOR, THEN IS DISTRIBUTED IN PARALLEL TO THE CABIN PRESSURE REGULATOR, THE EMERGENCY INFLOW REGULATOR, THE TANKS PRESSURE REGULATOR, THE CYCLIC ACCUMULATOR SELECTOR VALVES, AND TO THE SUIT DEMAND REGULATOR AND THE DIRECT O_2 VALVE WHICH ARE PART OF THE PRESSURE SUIT SUBSYSTEM.

THE O_2 FLOW SENSOR MEASURES THE MASS FLOW RATE AT THE OUTLET OF THE S/M SUPPLY REGULATOR. THIS INFORMATION IS DISPLAYED FOR THE CREW ON MDC PANEL #13, AND IS TELEMETERED TO THE GROUND. WHEN THE FLOW RATE REACHES 1.0 LB/HR, THE O_2 FLOW HI LIGHT ON THE CAUTION AND WARNING (C&W) PANEL ILLUMINATES. THE WARNING IS INTENDED TO ALERT THE CREW TO THE FACT THAT THE OXYGEN FLOW RATE IS GREATER THAN IS NORMALLY REQUIRED. IT DOES NOT NECESSARILY MEAN THAT A MALFUNCTION HAS OCCURRED, SINCE THERE ARE A NUMBER OF FLIGHT OPERATIONS IN WHICH A HIGH OXYGEN FLOW RATE IS NORMAL. THESE CASES WILL BE NOTED, WHEN APPLICABLE, IN THE DESCRIPTIONS THAT FOLLOW.

THE CABIN PRESSURE REGULATOR CONTROLS THE FLOW OF OXYGEN INTO THE CABIN TO MAKEUP FOR DEPLETION OF THE GAS DUE TO METABOLIC CONSUMPTION, NORMAL LEAKAGE, OR DEPRESSURIZATION. THE ASSEMBLY CONSISTS OF TWO ABSOLUTE PRESSURE REGULATORS OPERATING IN PARALLEL, AND A MANUAL REPRESSURIZING VALVE. THE REGULATOR IS DESIGNED TO MAINTAIN CABIN PRESSURE AT $5 \pm .2$ PSIA WITH LOSSES UP TO 1.4 LBS/HR. LOSSES IN EXCESS OF THIS VALUE WILL RESULT IN A CONTINUAL DECREASE IN CABIN PRESSURE. WHEN CABIN PRESSURE FALLS BELOW 3.7 PSIA, THE REGULATOR WILL AUTOMATICALLY SHUT-OFF TO PREVENT WASTING THE OXYGEN SUPPLY. FOLLOWING DEPRESSURIZATION, THE CABIN CAN BE REPRESSURIZED BY MANUALLY OPENING THE REPRESSURIZATION CONTROL VALVE ON THE REGULATOR.

THE EMERGENCY INFLOW REGULATOR PROVIDES EMERGENCY PROTECTION FOR THE CREW IN THE EVENT OF A SEVERE

LEAK IN THE CABIN. THE VALVE STARTS TO OPEN WHEN CABIN PRESSURE DECREASES TO 4.6 PSIA, AND AT 4.4 PSIA THE VALVE IS FULL-OPEN FOR FLOODING THE CABIN WITH OXYGEN. O₂ FLOW HI LIGHT WILL BE ON.

THE TANK PRESSURE REGULATOR REDUCES THE 100 PSI OXYGEN TO 20 PSID (RELATIVE TO CABIN) FOR PRESSURIZING THE POSITIVE EXPULSION BLADDERS IN THE WASTE AND POTABLE WATER TANKS, AND IN THE GLYCOL RESERVOIR. INTEGRAL RELIEF VALVES LIMIT THE DOWNSTREAM PRESSURE TO 25 PSI ABOVE CABIN PRESSURE. INLET AND OUTLET SELECTOR VALVES ARE PROVIDED FOR SELECTING EITHER OR BOTH REGULATORS AND RELIEF VALVES, OR FOR SHUTTING THE UNIT OFF.

THE CYCLIC ACCUMULATOR SELECTOR VALVES CONTROL THE FLOW OF 100 PSI OXYGEN TO THE CYCLIC ACCUMULATORS IN THE WATER SUBSYSTEM.

2.3 CABIN PRESSURE REGULATION

CABIN PRESSURE IS CONTROLLED NORMALLY BY THE CABIN PRESSURE REGULATOR AND THE CABIN RELIEF VALVE. PRIOR TO LAUNCH, THE CABIN PRESSURE IS THE SAME AS AMBIENT (SEA LEVEL) PRESSURE. AFTER LAUNCH, AS THE VEHICLE ASCENDS, THE CABIN PRESSURE WILL REMAIN CONSTANT UNTIL THE AMBIENT PRESSURE HAS DECREASED 6 PSIA, AT WHICH TIME THE CABIN RELIEF VALVE WILL BEGIN VENTING CABIN PRESSURE TO MAINTAIN THE 6 PSI DIFFERENTIAL. WHEN AMBIENT PRESSURE REACHES ZERO THE RELIEF VALVE CLOSES. HOWEVER, CABIN PRESSURE WILL CONTINUE TO DECREASE BECAUSE OF NORMAL LEAKAGE. WHEN THE PRESSURE REACHES

APPROXIMATELY 5 PSIA THE CABIN PRESSURE REGULATOR WILL BEGIN METERING OXYGEN INTO THE CABIN TO MAINTAIN THE PRESSURE AT 5 ± 0.2 PSIA. CABIN PRESSURE IS DISPLAYED ON MDC PANEL #13.

2.3.1 DEPRESSURIZATION

DURING OPERATIONS IN WHICH THE CABIN IS DEPRESSURIZED INTENTIONALLY, THE EMERGENCY INFLOW REGULATOR IS SHUT-OFF, THEN THE CABIN IS VENTED BY MANUALLY OPENING THE CABIN PRESSURE RELIEF VALVE. THE CABIN PRESSURE REGULATOR WILL CONTINUE TO OPERATE UNTIL THE PRESSURE DROPS TO 3.7 PSIA AT WHICH TIME IT SHUTS OFF AUTOMATICALLY. THE O₂ FLOW HI LIGHT WILL BE ON DURING DEPRESSURIZATION UNTIL THE REGULATOR SHUTS OFF.

2.3.2 REPRESSURIZATION

FOLLOWING FULL DEPRESSURIZATION, THE CABIN CAN BE REPRESSURIZED AT CONTROLLED FLOW RATES BY THE REPRESSURIZATION RATE CONTROL. THIS CONTROL IS MANUALLY SET TO PROVIDE CABIN INFLOW RATES UP TO 0.12 POUNDS PER MINUTE, WHICH IS SUFFICIENT TO REPRESSURIZE THE CABIN FROM 0 TO 5 PSIA IN LESS THAN ONE HOUR. WHEN CABIN PRESSURE REACHES 3.7 PSIA UPON REPRESSURIZATION, THE TWO PRESSURE REGULATORS REOPEN AND ADMIT ADDITIONAL OXYGEN INTO THE CABIN. AFTER THE CABIN IS REPRESSURIZED, THE REPRESSURIZATION CONTROL IS THEN MANUALLY CLOSED, AND THE REGULATORS AGAIN MAINTAIN CABIN PRESSURE AT $5.0 \pm .2$ PSIA. DURING REPRESSURIZATION THE O₂ FLOW HI LIGHT WILL BE ON.

2.3.3 CABIN PRESSURE RELIEF

THE CABIN PRESSURE RELIEF VALVE LIMITS CABIN PRESSURE TO A NOMINAL VALUE OF 6.0 PSIA ABOVE THE SENSED SPACECRAFT AMBIENT PRESSURE. WHEN THE CABIN PRESSURE IS LOWER THAN THE EXTERNAL AMBIENT PRESSURE, IT LIMITS THE DIFFERENTIAL PRESSURE TO A MAXIMUM VALUE OF 25 INCHES OF WATER. MANUAL OVERRIDE IS ACCOMPLISHED BY CABLES CONNECTED TO A CABIN CONTROL PANEL. THE OVERRIDE OPEN MECHANISM, WHICH OPENS ONE RELIEF VALVE, IS USED TO INTENTIONALLY VENT THE CABIN. THE OVERRIDE-CLOSED MECHANISM, WHICH CLOSES BOTH RELIEF VALVES, IS USED DURING GROUND LEAKAGE TESTS OF THE CABIN. IN THE EVENT THE COMMAND MODULE LANDS IN WATER AND THE CABIN PRESSURE RELIEF VALVE IS SUBMERGED, THE VALVE WILL REMAIN CLOSED TO PREVENT WATER ENTRY UNTIL THE EXTERNAL WATER PRESSURE EXCEEDS EIGHT INCHES OF WATER PRESSURE. WATER ENTRY CAN BE PREVENTED BY THE USE OF THE OVERRIDE CLOSE MECHANISM. AN INTERMEDIATE POSITION ON THE MANUAL CONTROL LIMITS THE OUT FLOW RATE OF THE VALVE WITHOUT INTERFERING WITH THE NORMAL RELIEF FUNCTION.

2.3.4 EMERGENCY OXYGEN FLOW

THE EMERGENCY INFLOW REGULATOR SUPPLIES OXYGEN TO THE CABIN AT HIGH FLOW RATES UP TO 0.7 LB/MIN (O₂ FLOW HI LIGHT ON) TO PREVENT RAPID DECOMPRESSION IN CASE OF CABIN PUNCTURE. THE VALVE IS CAPABLE OF PROVIDING FLOW RATES WHICH WILL MAINTAIN CABIN PRESSURE ABOVE 3.5 PSIA FOR A PERIOD OF 5 MINUTES, AGAINST A LEAKAGE RATE EQUIVALENT TO A CABIN PUNCTURE ONE HALF

INCH DIAMETER. THE VALVE IS NORMALLY USED DURING SHIRTSLEEVE OPERATIONS, AND IS INTENDED TO PROVIDE TIME FOR DRESSING PRESSURE SUITS BEFORE CABIN PRESSURE DROPS BELOW 3.5 PSIA. DURING PRESSURE SUIT OPERATIONS, THE VALVE IS SHUT-OFF TO PREVENT UNNECESSARY LOSS OF OXYGEN IN CASE OF UNPLANNED CABIN DEPRESSURIZATION.

2.4 FLUID TANK PRESSURIZATION

THE TANK PRESSURE REGULATOR, PROVIDES OXYGEN AT A REGULATED PRESSURE FOR POSITIVE EXPULSION OF LIQUIDS IN THE GLYCOL RESERVOIR, WASTE WATER TANK, AND POTABLE WATER TANK. TWO REGULATOR AND RELIEF VALVES ARE USED IN PARALLEL FOR REDUNDANCY. EACH UNIT IN THE FLUID TANK PRESSURE REGULATOR CONSISTS OF A DIFFERENTIAL PRESSURE REGULATOR AND A RELIEF VALVE. THE PRESSURE REGULATOR CONTAINS A DIAPHRAGM WHICH CONTROLS NORMALLY OPEN METERING VALVE TO MAINTAIN THE DOWNSTREAM PRESSURE AT 20 ± 2 PSID (RELATIVE TO CABIN). THE RELIEF VALVE IS INCORPORATED IN THE OUTLET CHAMBER OF THE UNIT AND VENTS EXCESS PRESSURE INTO THE CABIN TO LIMIT DOWNSTREAM PRESSURE IN THE FLUID TANKS, TO 25 ± 2 PSID (RELATIVE TO CABIN). OPERATION OF THE RELIEF VALVE IS SIMILAR TO THE PRESSURE REGULATOR EXCEPT THE VALVE IS NORMALLY CLOSED. EACH FLUID TANK CONTAINS A BLADDER TO PROVIDE POSITIVE EXPULSION OF STORED LIQUIDS. WHEN LIQUIDS ARE PUMPED INTO THE TANKS FOR STORAGE, THE BLADDER IS COLLAPSED BY THE LIQUID, AND PRESSURE OF THE OXYGEN IN THE TANK IS INCREASED. IF THE OXYGEN PRESSURE EXCEEDS 25 ± 2 PSIG, THE RELIEF VALVE OPENS AND VENTS THE EXCESS OXYGEN PRESSURE TO THE CABIN. THE

RELIEF VALVE ALSO OPERATES DURING THE LAUNCH PHASE. BEFORE LAUNCH, THE CABIN IS PRESSURIZED APPROXIMATELY 14.7 PSIA (SEA LEVEL AMBIENT), AND THE BLADDERS ARE PRESSURIZED TO APPROXIMATELY 34.7 ± 2 PSIA (20 ± 2 PSID RELATIVE TO CABIN). DURING THE ASCENT PHASE, CABIN PRESSURE GRADUALLY DROPS TO APPROXIMATELY 6 PSIA BE VENTING CABIN GASSES OVERBOARD TO SPACE THROUGH THE CABIN PRESSURE RELIEF VALVE. AS CABIN PRESSURE DROPS, THE RELIEF VALVE OF THE TANKS LIMITS BLADDER PRESSURE (RELATIVE TO CABIN) TO MAXIMUM OF 25 ± 2 PSID.

2.5 PRESSURE SUIT OXYGEN SUPPLY

OXYGEN CAN BE SUPPLIED DIRECTLY FROM THE OXYGEN SUPPLY LINE TO THE SUIT INLETS BY TWO DIFFERENT MEANS, ONE AUTOMATIC AND ONE MANUAL. THE AUTOMATIC MEANS IS THROUGH THE SUIT DEMAND PRESSURE REGULATOR. THE MANUAL METHOD IS TO OPEN THE DIRECT O_2 VALVE UNTIL THE DESIRED OXYGEN FLOW IS SUPPLIED TO THE SUITS. THE FLOW RATE CAN BE MONITORED ON THE O_2 FLOW INDICATOR ON MDC PANEL #13.

2.6 DESCRIPTION OF COMPONENTS

2.6.1 PLSS SUPPLY VALVE

THE PLSS SUPPLY VALVE (FIGURE 2-3) IS A MANUALLY OPERATED METERING VALVE, USED FOR RECHARGING THE O_2 TANK OF THE PORTABLE LIFE SUPPORT SYSTEM.

THE VALVE CONSISTS OF A BODY, THREADED SHAFT ASSEMBLY, RING GEAR, RETAINER, AND AN ELASTIC SEAL WHICH

IS MOLDED TO BOTH THE RETAINER AND THE LOWER PORTION OF THE SHAFT ASSEMBLY. WHEN THE UPPER PORTION OF THE SHAFT ASSEMBLY IS ROTATED CW THE LOWER SHAFT IS SCREWED INTO THE UPPER SHAFT, THUS REDUCING THE EFFECTIVE LENGTH OF THE ASSEMBLY. THIS ACTION SQUEEZES THE MOLDED SEAL AGAINST THE WALL OF THE VALVE, SHUTTING OFF THE FLOW OF GAS. ROTATING THE SHAFT CCW INCREASES THE SHAFT LENGTH, WHICH STRETCHES THE SEAL, PULLING IT AWAY FROM THE WALL AND OPENING THE VALVE. EXCESSIVE ROTATION OF THE VALVE IS PREVENTED BY A GEARED TRAVEL STOP CONSISTING OF AN INTEGRAL SPUR GEAR ON THE UPPER SHAFT WHICH MESHES WITH A RING GEAR HAVING AN INCOMPLETE SET OF TEETH.

2.6.2 OXYGEN SYSTEM CHECK VALVE

THE CHECK VALVE SHOWN IN FIGURE 2-4 IS SIMILAR TO THOSE USED IN THE ENVIRONMENTAL CONTROL SYSTEM. THEY ARE IDENTICAL IN FUNCTION, OPERATION, AND DESIGN, BUT DIFFER IN SIZE AND MATERIALS ACCORDING TO THE SERVICE FOR WHICH THEY ARE USED.

THE VALVE CONSISTS OF A BODY, AN UMBRELLA SHAPED VALVE OF SILICONE RUBBER, A METAL BACKUP PLATE, A PERFORATED FLAT METAL SEAT, AND A RETAINING THIMBLE.

DURING FLOW CONDITIONS, THE UMBRELLA AND BACKUP PLATE ARE FORCED AWAY FROM THE SEAT BY THE FLOWING THROUGH THE PERFORATIONS. THE THIMBLE PREVENTS THE FLOW FROM COLLAPSING THE UMBRELLA. WHEN FLOW STOPS, THE ELASTICITY OF THE UMBRELLA MATERIAL CAUSES IT TO RESUME ITS ORIGINAL SHAPE AND POSITION OVER THE SEAT.

PLSS SUPPLY VALVE

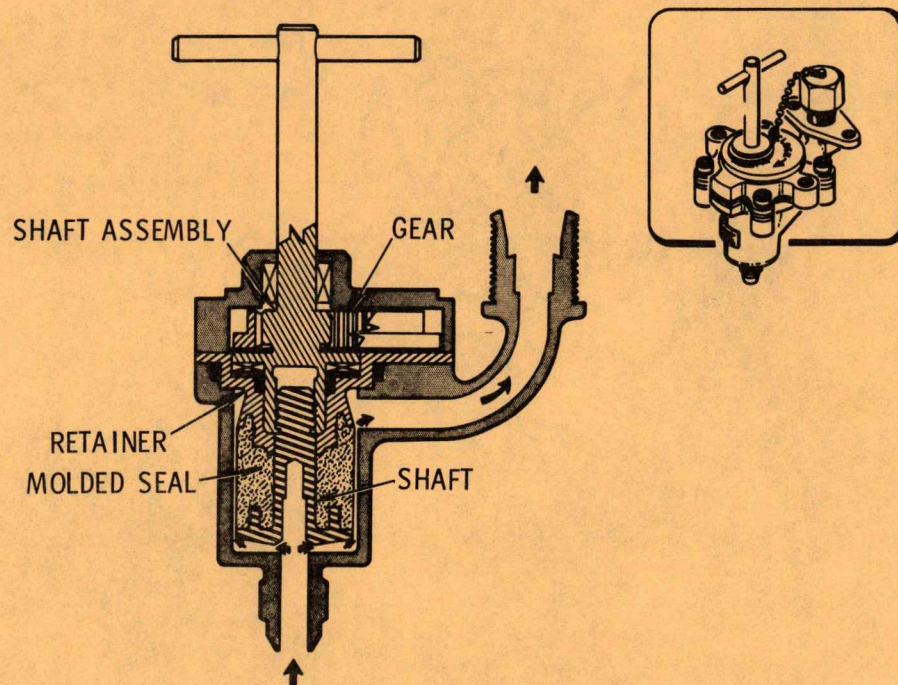



FIGURE 2-3

ECS-62A 

OXYGEN SYSTEM CHECK VALVE

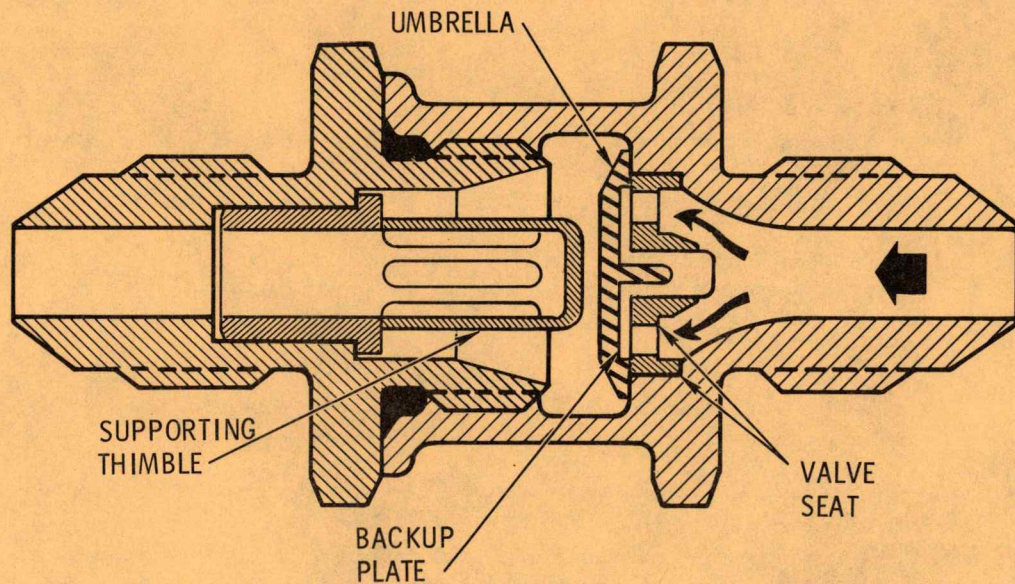


FIGURE 2-4

ECS-110



IN REVERSE FLOW CONDITIONS, THE FLUID PRESSURE ON THE BACK SIDE OF THE UMBRELLA FLATTENS IT AGAINST THE SEAT SO THAT IT COVERS THE PERFORATIONS AND BLOCKS FLOW. THE BACKUP PLACE PREVENTS THE HIGH PRESSURE OXYGEN FROM FORCING THE UMBRELLA THROUGH THE PERFORATIONS.

2.6.3 S/M SUPPLY REGULATOR

THE S/M SUPPLY REGULATOR REDUCES THE HIGH PRESSURE OXYGEN FROM THE MAIN SUPPLY TO 100 ± 10 PSIG FOR USE IN THE ECS. THE REGULATOR ASSEMBLY (FIGURE 2-5) CONSISTS OF TWO INDEPENDENTLY OPERATING, PARALLEL CIRCUITS, EACH CONTAINING A PRESSURE REGULATOR, A RELIEF VALVE, AND A CHECK VALVE. A FOUR WAY SELECTOR VALVE ASSEMBLY PROVIDES A MEANS FOR SELECTING EITHER OR BOTH REGULATORS, OR SHUTTING OFF THE SYSTEM. THE VALVE ASSEMBLY IS MADE UP OF AN UPPER AND A LOWER MANIFOLD, SEPARATED BY A VALVE PORT PLATE. SELECTION OF THE DESIRED OPERATING MODE IS ACCOMPLISHED BY ROTATING THE CONTROL KNOB, WHICH CHANGES THE POSITION OF THE PLATE PORTS WITH RESPECT TO THE MANIFOLD PORTS. THE UPPER CHAMBER OF EACH REGULATOR HOUSING CONTAINS A METERING VALVE, DIAPHRAGM, AND A CALIBRATION SPRING. HIGH PRESSURE OXYGEN FLOWS THROUGH THE METERING VALVE, LOWER CHAMBER, AND INTO THE SYSTEM. THE GAS CONTINUES TO FLOW UNTIL THE SYSTEM PRESSURE, ACTING ON THE BOTTOM SIDE OF THE DIAPHRAGM, IS SUFFICIENT TO OVERCOME THE BOTTOM SIDE OF THE DIAPHRAGM, IS SUFFICIENT TO OVERCOME THE SPRING TENSION AND CLOSE THE METERING VALVE. A RELIEF VALVE IN THE LOWER CHAMBER LIMITS DOWNSTREAM PRESSURE TO 140 PSIG IN THE EVENT A REGULATOR FAILS IN

THE OPEN POSITION. THE SELECTOR VALVE, AND THE CHECK VALVES INSTALLED IN THE OUTLET PORTS, PERMIT ISOLATION OF THE FAILED REGULATOR TO PREVENT UNNECESSARY LOSS OF OXYGEN.

2.6.4 CABIN PRESSURE REGULATOR

THE CABIN PRESSURE REGULATOR CONTROLS THE FLOW OF OXYGEN INTO THE COMMAND MODULE INTERIOR, TO MAKE UP FOR DEPLETION OF THE GAS DUE TO METABOLIC CONSUMPTION, AND NORMAL LEAKAGE. THE REGULATOR ASSEMBLY (FIGURE 2-6) CONSISTS OF TWO ABSOLUTE PRESSURE REGULATORS OPERATING IN PARALLEL, A MANUAL REPRESSURIZATION CONTROL VALVE, AND A RESTRICTOR WHICH LIMITS THE FLOW OF GAS THROUGH EACH REGULATOR ASSEMBLY TO .7 POUND PER HOUR. EACH REGULATOR CONTAINS AN ANEROID (FOR SENSING THE ABSOLUTE PRESSURE WITHIN THE CABIN) AND A SPRING LOADED, DUAL SEAT POPPET VALVE WHICH IS CONTROLLED BY THE ANEROID.

DURING NORMAL OPERATION BEFORE LAUNCH, THE ANEROID IS COMPRESSED BY AMBIENT PRESSURE ALLOWING THE SPRING TO FORCE THE POPPET AGAINST THE UPPER SEAT, STOPPING THE FLOW OF GAS THROUGH THE REGULATOR. AS THE CABIN PRESSURE DECREASED DURING THE ASCENT PHASE, THE ANEROID EXPANDS. AT APPROXIMATELY 5 PSIA IT FORCES THE POPPET OFF THE UPPER SEAT, ALLOWING OXYGEN TO FLOW INTO THE CABIN. THE DISTANCE THE POPPET IS MOVED OFF ITS SEAT IS INVERSELY PROPORTIONAL TO THE CABIN ABSOLUTE PRESSURE.

S/M SUPPLY REGULATOR

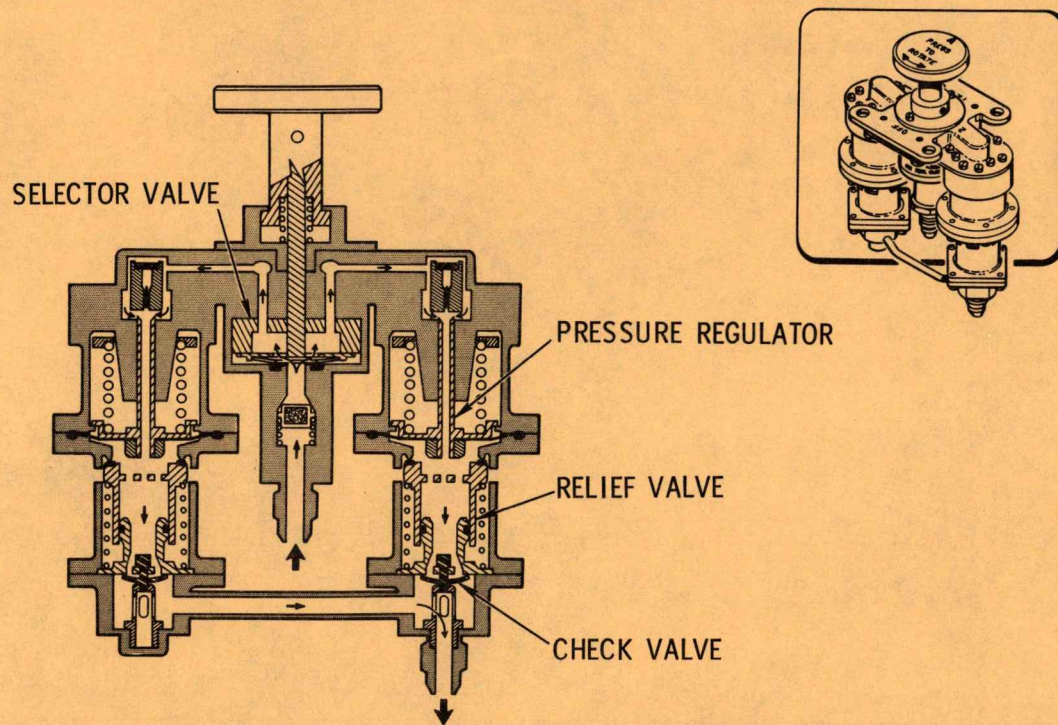


FIGURE 2-5

ECS-43B



CABIN PRESSURE REGULATOR

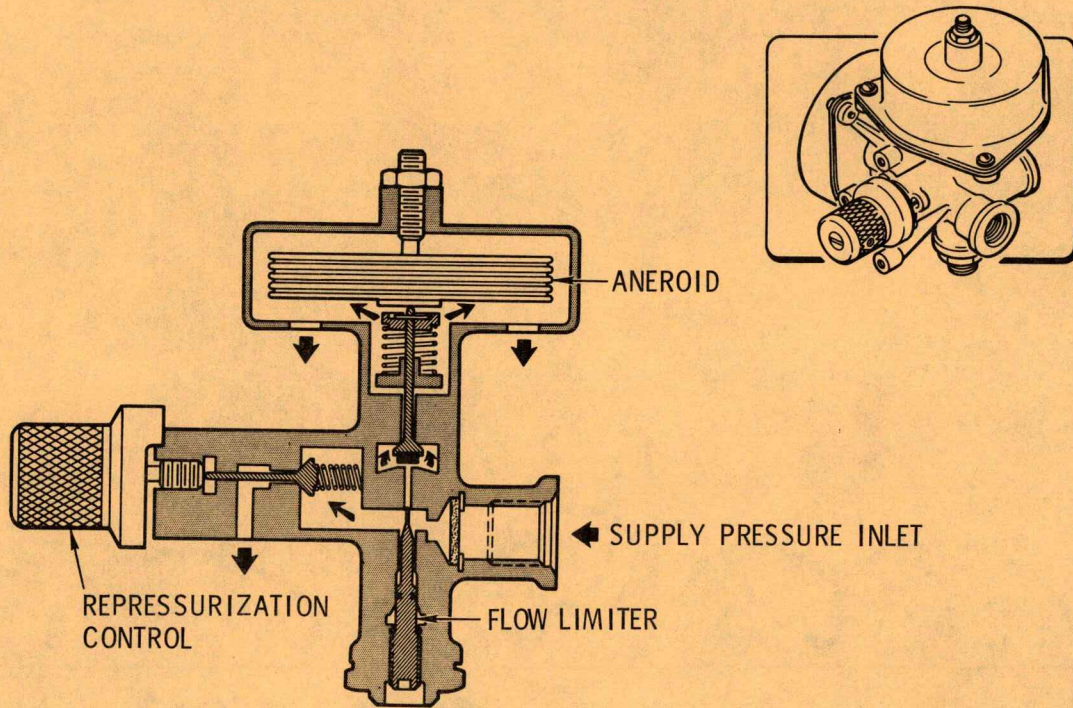



FIGURE 2-6

ECS-24A 

THE REGULATOR IS CAPABLE OF MAINTAINING CABIN PRESSURE AT FLOW RATES UP TO 1.3 LBS PER HOUR. DEMANDS IN EXCESS OF THIS VALUE WILL RESULT IN A CONTINUAL DECREASE IN CABIN PRESSURE, WITH A CORRESPONDING EXPANSION OF THE ANEROID. AT APPROXIMATELY 3.7 PSIA, THE ANEROID WILL HAVE EXPANDED SUFFICIENTLY TO FORCE THE POPPET AGAINST THE LOWER SEAT, SHUTTING OFF THE FLOW. THIS FEATURE PREVENTS EXCESSIVE LOSS OF OXYGEN DURING DEPRESSURIZATION OPERATIONS, OR IN THE EVENT THE CABIN IS PUNCTURED.

FOLLOWING DEPRESSURIZATION, OR REGULATOR LOCK-UP, THE CABIN CAN BE REPRESSURIZED AT A FLOW RATE OF 7.2 POUNDS PER HOUR BY OPENING THE REPRESSURIZATION CONTROL VALVE. THIS VALVE IS A MANUALLY CONTROLLED POPPET VALVE.

2.6.5 CABIN PRESSURE RELIEF VALVE

THE CABIN PRESSURE RELIEF VALVE (FIGURE 2-7) PROVIDES FOR NORMAL RELIEF OF CABIN PRESSURE DURING ASCENT, AND NORMAL INFLOW OF ATMOSPHERIC GASSES DURING DESCENT. IN ADDITION, THE VALVE CAN BE MANUALLY OPENED TO DUMP CABIN PRESSURE (IN CASE OF CONTAMINATION OF THE CABIN ATMOSPHERE), AND IT CAN BE MECHANICALLY OVERRIDDEN TO PREVENT INFLOW (IN CASE OF EXTERNAL ATMOSPHERE IS CONTAMINATED.)

THE CABIN PRESSURE RELIEF VALVE CONSISTS OF TWO INDEPENDENTLY OPERATING OUTFLOW VALVES WITH MANUAL OVERRIDES. EACH OUTFLOW VALVE IS AN ASSEMBLY CONSISTING

OF A CALIBRATED DIFFERENTIAL CONTROL AND A SPRING-LOADED CLOSED POPPET VALVE. THE DIFFERENTIAL CONTROL SENSES BOTH CABIN AND EXTERNAL PRESSURES AND CONTROLS THE REFERENCE PRESSURE APPLIED TO THE CONTROL CHAMBER SIDE OF THE OUTFLOW VALVE DIAPHRAGM. THE OTHER SIDE OF THE OUTFLOW POPPET VALVE DIAPHRAGM SENSES CABIN INTERNAL PRESSURE. DURING NORMAL OPERATION, AN ORIFICE INBLEED PERMITS CABIN PRESSURE TO BE SENSED WITHIN THE OUTFLOW VALVE CONTROL CHAMBER. THIS PLACES CABIN INTERNAL PRESSURE ON BOTH SIDES OF THE OUTFLOW VALVE DIAPHRAGM, CAUSING IT TO REMAIN SPRING-LOADED CLOSED. SHOULD CABIN INTERNAL-TO-EXTERNAL DIFFERENTIAL PRESSURE EXCEED THE CALIBRATED VALUE OF THE DIFFERENTIAL CONTROL, THE DIFFERENTIAL CONTROL OPENS THE DIFFERENTIAL METERING VALVE WHICH VENTS THE OUTFLOW VALVE CONTROL CHAMBER. THIS PERMITS THE CABIN PRESSURE ON THE OTHER SIDE OF THE OUTFLOW VALVE DIAPHRAGM TO OVERRIDE THE SPRING FORCE ON THE POPPET, WHICH OPENS AND PERMITS THE CABIN TO VENT OVERBOARD THROUGH THE STEAM DUCT, PROVIDING POSITIVE PRESSURE RELIEF FOR THE CABIN.

CABIN PRESSURE RELIEF FLOW CONTINUES UNTIL A DIFFERENTIAL OF APPROXIMATELY $6.0 \pm .2$ PSI IS RE-ESTABLISHED, AT WHICH TIME THE DIFFERENTIAL CONTROL METERING VALVE CLOSES. CABIN INTERNAL PRESSURE IS THEN RESTORED IN THE OUTFLOW VALVE CONTROL CHAMBER, PERMITTING THE SPRING-LOAD TO CLOSE THE POPPET. THIS ACTION STOPS THE PRESSURE RELIEF FLOW. DURING INITIAL SPACECRAFT DESCENT, CABIN EXTERNAL PRESSURE INCREASES, WHILE CABIN INTERNAL PRESSURE REMAINS AT 5 PSIA. THE

CABIN PRESSURE RELIEF VALVE

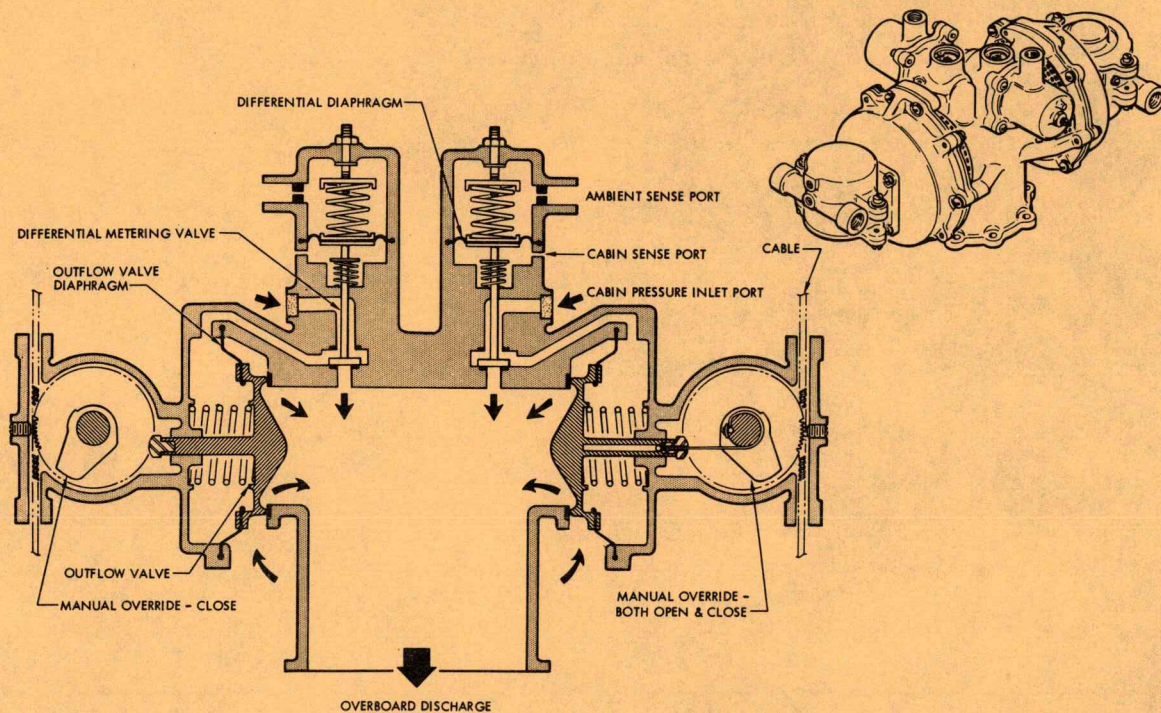


FIGURE 2-7

RESULTANT PRESSURE DIFFERENTIAL HOLDS THE DIFFERENTIAL CONTROL ON ITS SEAT, MAINTAINING THE OUTFLOW CONTROL CHAMBER AT 5 PSIA. THE HIGHER SPACECRAFT EXTERNAL PRESSURE ACTING ON THE DISCHARGE SIDE OF THE POPPET VALVE, OVERCOMES THE FORCE OF THE POPPET RETURN SPRING AT A NEGATIVE DIFFERENTIAL PRESSURE OF APPROXIMATELY 10 TO 25 INCHES OF WATER PRESSURE. THIS PROVIDES NEGATIVE PRESSURE RELIEF FOR THE CABIN. DURING THE REMAINDER OF THE SPACECRAFT DESCENT, CABIN INTERNAL PRESSURE WILL INCREASE AT THE SAME RATE AS SPACECRAFT EXTERNAL PRESSURE.

BOTH OUTFLOW VALVES CAN BE MANUALLY CLOSED BY MEANS OF CABLE ACTUATED CAMS. DIRECT LINKAGE BETWEEN ONE OUTFLOW VALVE STEM, AND THE OVERRIDE MECHANISM, ALLOWS THAT VALVE TO BE OPENED MANUALLY.

2.6.6 EMERGENCY INFLOW REGULATOR

THE EMERGENCY INFLOW REGULATOR (FIGURE 2-8) SUPPLIES OXYGEN TO THE CABIN AT HIGH FLOW RATES TO PREVENT RAPID DECOMPRESSION IN CASE OF CABIN WALL RUPTURE. THE REGULATOR CONSISTS OF TWO REDUNDANT DEMAND-TYPE REGULATOR SECTIONS. THE REGULATOR SECTIONS ARE FUNCTIONALLY IDENTICAL AND ARE BOTH NORMALLY IN OPERATION.

EACH REGULATOR SECTION CONSISTS OF AN ANEROID-TYPE ABSOLUTE PRESSURE CONTROL AND A DEMAND VALVE, WHICH IS ACTUATED BY A DIAPHRAGM. THE VALVE DIAPHRAGM SENSES

REFERENCE CHAMBER PRESSURE ON ONE SIDE AND CABIN PRESSURE ON THE OTHER. A SELECTOR VALVE IS PROVIDED TO SHUT-OFF EITHER OR BOTH REGULATOR SECTIONS.

UNDER NORMAL OPERATING CONDITIONS, WHEN CABIN PRESSURE IS MAINTAINED AT 5.0 PSIA BY THE CABIN PRESSURE REGULATOR, THE TWO EMERGENCY REGULATOR SECTIONS DO NOT OPERATE. IN CASE CABIN LEAKAGE EXCEEDS THE FLOW CAPACITY OF THE CABIN PRESSURE REGULATOR, CABIN PRESSURE WILL DROP BELOW 5.0 PSIA.

AS THE DECREASING CABIN PRESSURE APPROACHES 4.5 PSIA, THE REGULATOR FLOODS THE CABIN WITH OXYGEN TO ALLOW CREW MEMBERS SUFFICIENT TIME TO DON PRESSURE SUITS BEFORE CABIN PRESSURE FALLS BELOW 3.5 PSIA. EACH ANEROID ELEMENT CONTROLS THE REFERENCE PRESSURE AT 4.5 ± 0.1 PSIA. AS THE SENSED CABIN PRESSURE DROPS, THE DIAPHRAGM MOVES TO OPEN THE DEMAND VALVE AND ALLOW OXYGEN TO ENTER THE CABIN.

EACH REGULATOR SECTION IS DESIGNED TO MAINTAIN CABIN PRESSURE AT 3.5 ± 0.1 PSIA WITH CABIN GAS LOSSES UP TO 0.7 LB/PER MIN AS LONG AS THERE IS SUFFICIENT FLOW FROM THE SPACECRAFT OXYGEN SUPPLY TO MEET THE DEMAND. THE DEMAND VALVES REMAIN OPEN AS LONG AS A NEED FOR CABIN PRESSURE MAKEUP EXISTS, AND REMAIN OPEN UNTIL SHUT-OFF BY THE CREW AFTER THE PRESSURE SUITS HAVE BEEN PUT ON.

EMERGENCY INFLOW REGULATOR

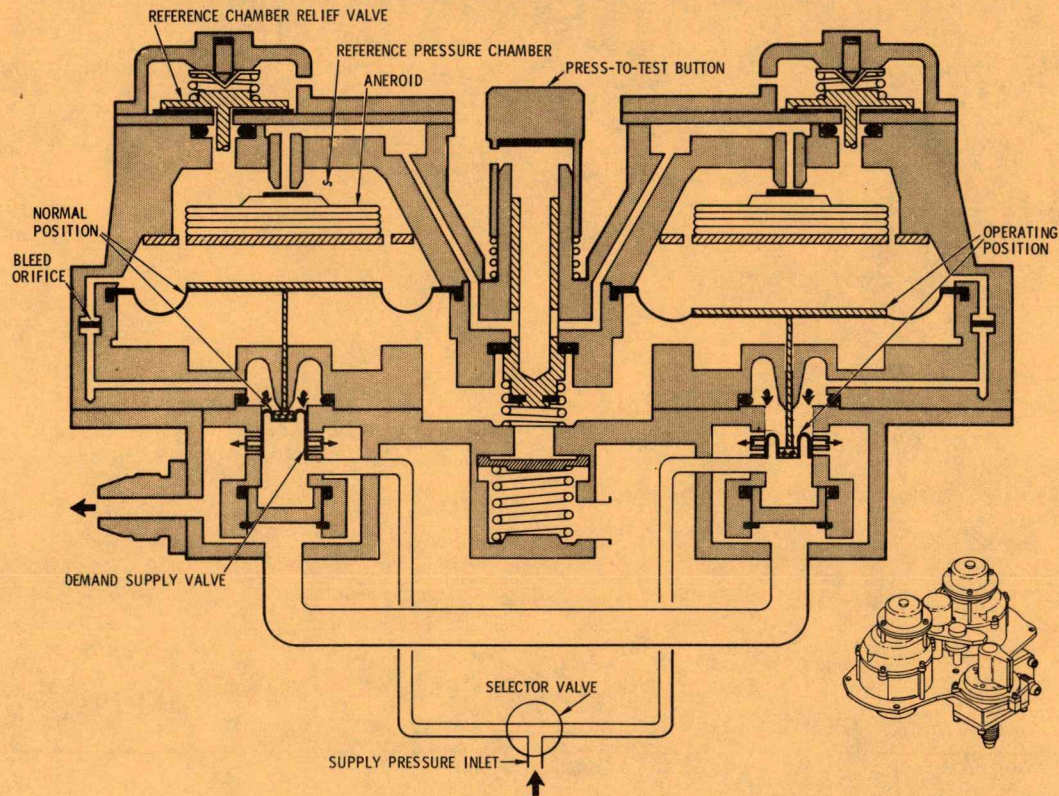


FIGURE 2-8

2.6.7 TANK PRESSURE REGULATOR

THE TANK PRESSURE REGULATOR (FIGURE 2-9) SUPPLIES OXYGEN AT REGULATED PRESSURE TO THE POSITIVE EXPULSION TANKS IN THE ECS.

THE VALVE ASSEMBLY CONSISTS OF TWO DIFFERENTIAL PRESSURE REGULATORS AND TWO RELIEF VALVES OPERATING IN PARALLEL. EACH PRESSURE REGULATOR CONTAINS A NORMALLY OPEN, DIAPHRAGM-OPERATED, POPPET TYPE METERING VALVE. AS PRESSURE IS APPLIED TO THE NORMALLY OPEN VALVE, THE DOWNSTREAM PRESSURE OF THE VALVE IS SENSED ACROSS THE DIAPHRAGM WHICH THROTTLES THE METERING VALVE TO MAINTAIN DOWNSTREAM PRESSURE TO 20 ± 2 PSID (RELATIVE TO CABIN).

A RELIEF VALVE IS INCORPORATED IN EACH OUTLET CHAMBER OF THE VALVE ASSEMBLY, AND VENTS PRESSURE IN EXCESS OF 25 ± 2 PSID INTO THE CABIN. THE OPERATION OF THE RELIEF VALVE IS SIMILAR TO THAT OF THE PRESSURE REGULATOR EXCEPT THE VALVE IS NORMALLY CLOSED.

AN INLET SELECTOR VALVE PERMITS SELECTION OF EITHER OR BOTH REGULATORS. AN OUTLET SELECTOR VALVE PERMITS SELECTION OF EITHER, OR BOTH, RELIEF VALVES.

2.6.8 DIRECT O₂

THE DIRECT O₂ VALVE (FIGURE 2-10) IS A METERING TYPE POPPET VALVE, IN WHICH THE POPPET IS CONTROLLED BY A SCREW MECHANISM, INSTEAD OF A CAM, WHICH ALLOWS IT TO BE POSITIONED AT ANY POINT BETWEEN FULL OPEN AND CLOSED.

TANK PRESSURE REGULATOR

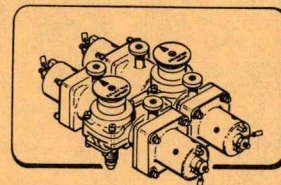
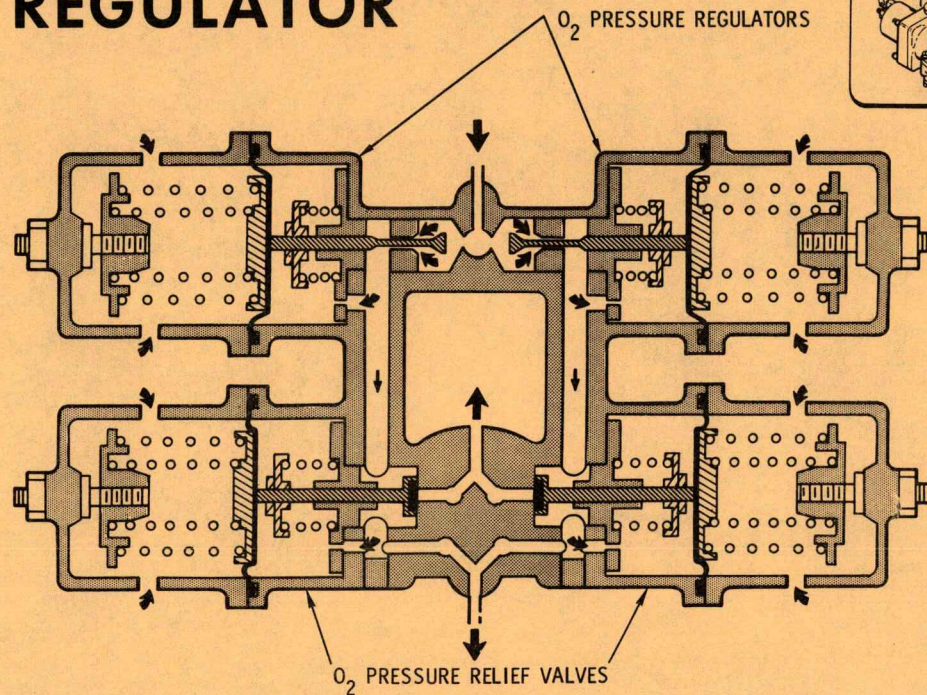


FIGURE 2-9

DIRECT O₂ VALVE

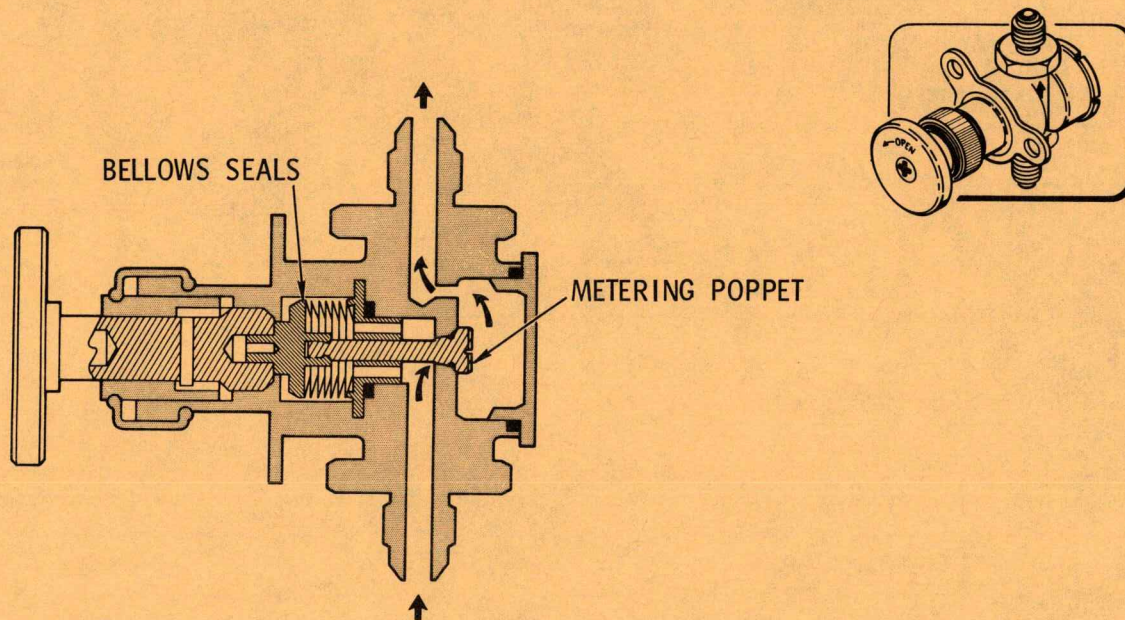


FIGURE 2-10

OXYGEN CONTROL PANEL

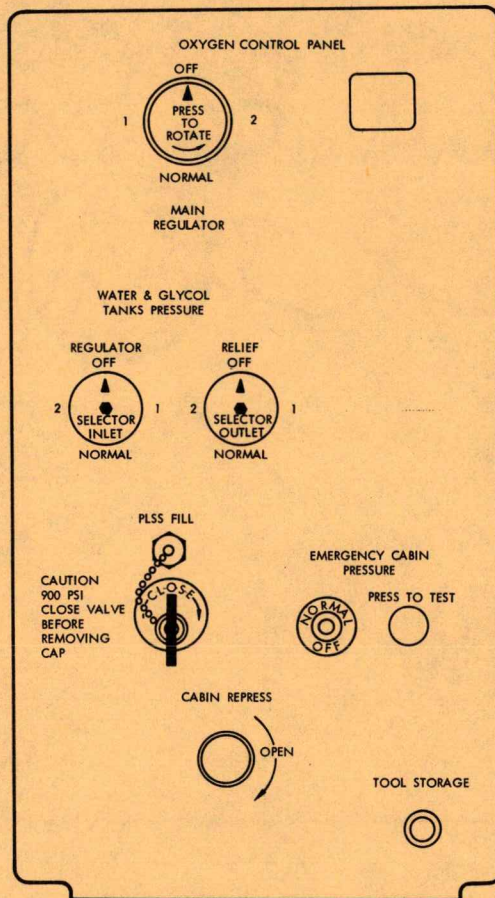


FIGURE 2-11

SECTION III

PRESSURE SUIT SUBSYSTEM

3.1 GENERAL

THE PRESSURE SUIT SUBSYSTEM (FIGURE 3-1) IS A CIRCULATING GAS LOOP, WHICH PROVIDES THE CREW WITH A CONTINUOUSLY CONDITIONED ATMOSPHERE THROUGHOUT THE APOLLO MISSION. THE SUBSYSTEM AUTOMATICALLY CONTROLS THE SUIT GAS FLOW, PRESSURE, TEMPERATURE, AND HUMIDITY. IT ALSO REMOVES DEBRIS, CARBON DIOXIDE, AND ODORS FROM THE SUITS AND THE C/M INTERIOR.

THE PRESSURE SUIT SUBSYSTEM (HEREAFTER REFERRED TO AS THE SUIT CIRCUIT) CONSISTS ESSENTIALLY OF A SUIT COMPRESSOR, CO₂ AND ODOR ABSORBER ASSEMBLY, HEAT EXCHANGER, SUIT CONNECTORS, SUIT OXYGEN RETURN VALVE, AND A DEBRIS TRAP. TWO OTHER VALVES ARE ASSOCIATED WITH THE SUIT CIRCUIT, BUT ARE USED ONLY DURING EMERGENCIES OR DEPRESSURIZATION OPERATIONS. THEY ARE THE MANUAL OXYGEN METERING VALVE AND THE SUIT DEMAND REGULATOR.

3.2 SUBSYSTEM OPERATION

DURING NORMAL PRESSURE SUIT ENVIRONMENT OPERATIONS, THE SUIT GAS IS CIRCULATED BY THE SUIT COMPRESSOR. THE GAS LEAVING THE COMPRESSOR FLOWS THROUGH THE CO₂ AND ODOR ABSORBER ASSEMBLY WHERE THE CO₂ IS REMOVED BY REACTING CHEMICALLY WITH THE LITHIUM HYDROXIDE IN THE FILTERPACK. AMONG THE BY-PRODUCTS OF THE REACTION ARE WATER, AND HEAT. ODORS IN THE

CIRCULATING GAS ARE REMOVED BY ADSORPTION ON THE ACTIVATED CHARCOAL OF THE FILTERPACK. PARTICULATE MATTER, TOO SMALL TO BE REMOVED BY THE DEBRIS TRAP, WILL BE CAUGHT BY THE ORLON FELT PADS ON THE INLET SIDE OF THE FILTERPACKS.

AFTER LEAVING THE FILTER, THE GAS PASSES THROUGH THE SUIT HEAT EXCHANGER (H/E) WHERE IT IS COOLED TO 50°F, AND DEHUMIDIFIED. COOLING IS ACCOMPLISHED PRIMARILY BY TRANSFERRING THE HEAT CONTENT OF THE GAS TO THE COOLANT CIRCULATING THROUGH THE HEAT EXCHANGER. WHEN THE COOLANT LOOP IS INCAPABLE OF ACCEPTING THE HEAT LOAD, SECONDARY COOLING IS PROVIDED BY EVAPORATING WATER IN THE SUIT H/E, AND DUMPING THE STEAM THUS GENERATED OVERBOARD. DURING THE COOLING PROCESS, THE WATER CONTENT OF THE GAS IN EXCESS OF A 50°F DEW POINT, CONDENSES ON THE PLATES OF THE HEAT EXCHANGER AND IS REMOVED.

3.3 SUBSYSTEM COMPONENTS

3.3.1 SUIT CIRCUIT DUAL CHECK VALVE

THE SUIT CIRCUIT DUAL CHECK VALVE (FIGURE 3-2) PERMITS CABIN GASES TO ENTER THE SUIT CIRCUIT FOR REMOVAL OF CARBON DIOXIDE, WATER VAPOR, AND ODORS. IT ALSO PREVENTS LOSS OF SUIT CIRCUIT GASES UNDER EMERGENCY CONDITIONS. THE VALVE ASSEMBLY CONTAINS TWO

PRESSURE SUIT SUBSYSTEM

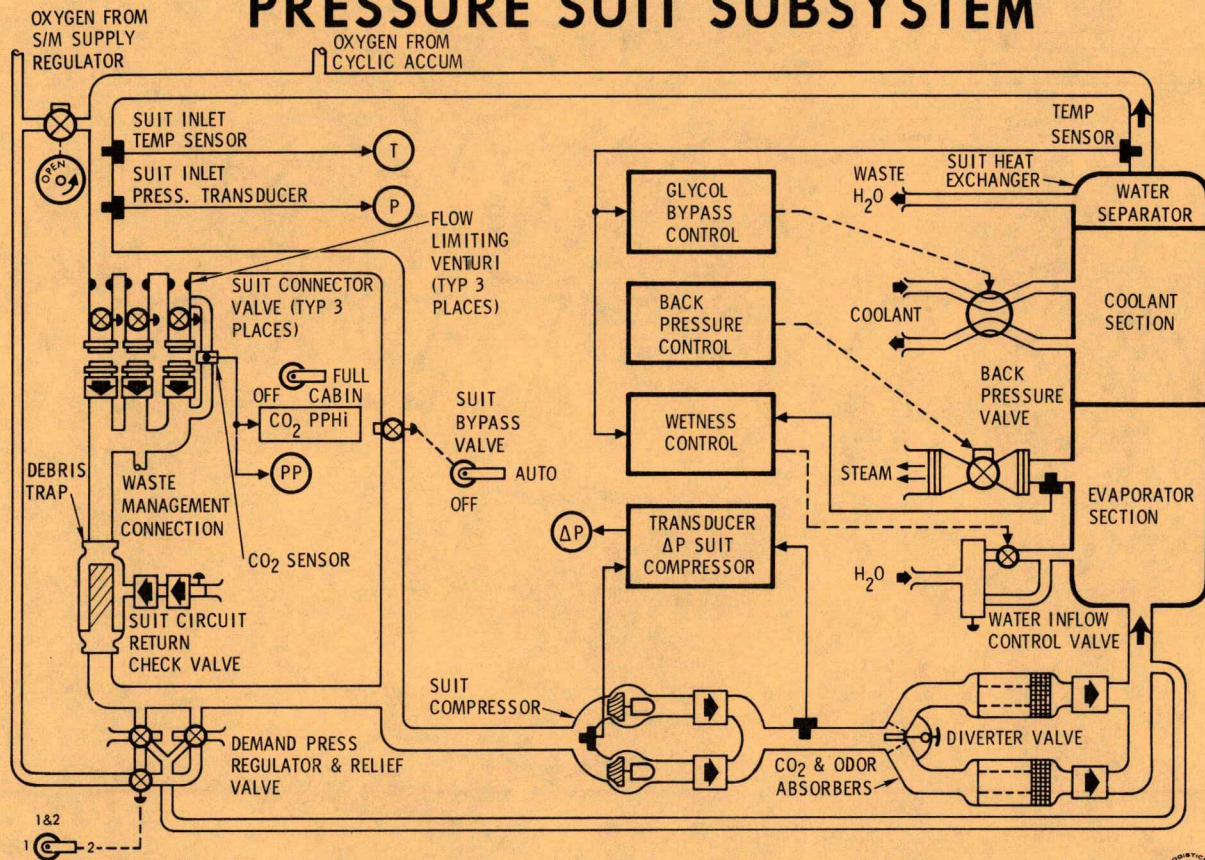


FIGURE 3-1

SUIT CIRCUIT DUAL CHECK VALVE

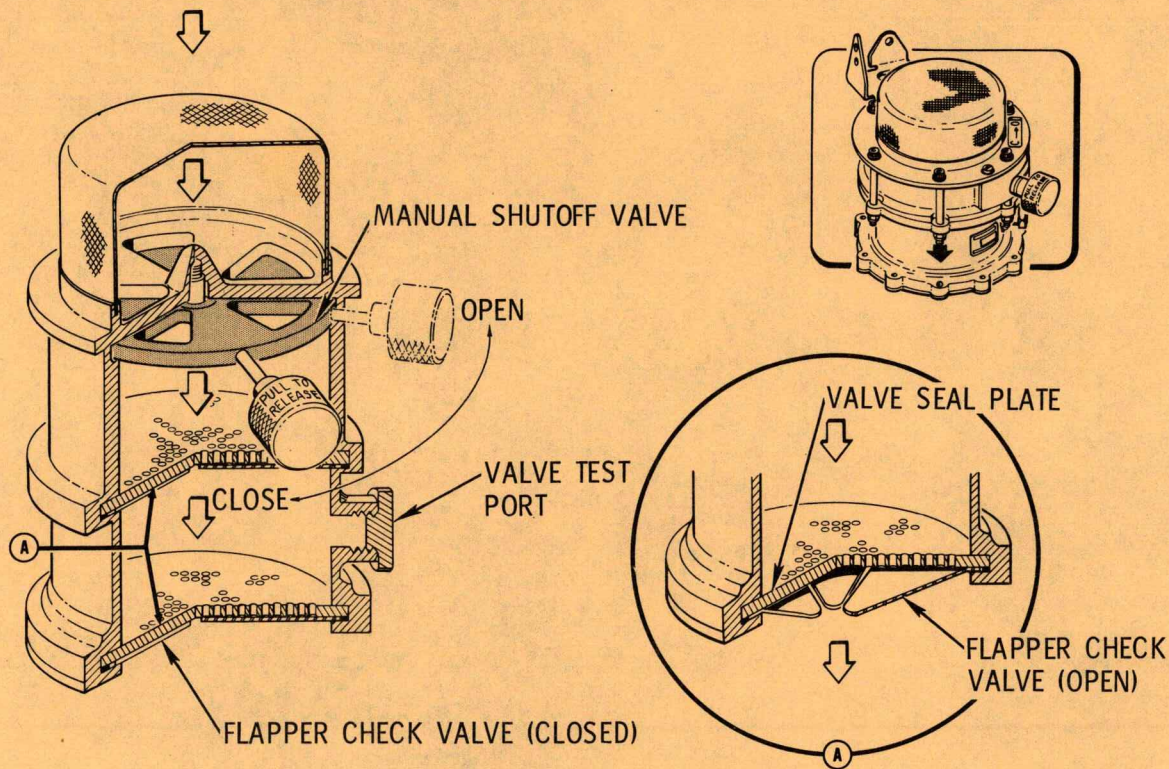


FIGURE 3-2

ECS-31A



CHECK VALVES IN SERIES. EACH VALVE CONSISTS OF A CIRCULAR RUBBER DISC RETAINED BY THE VALVE HOUSING AT ITS PERIPHERY. THE DISC IS CROSS CUT IN THE CENTER TO FORM FOUR HINGED FLAPPERS WHICH ARE BACKED BY A PERFORATED METAL DISC. WHEN PRESSURE IS APPLIED IN THE FREE FLOW DIRECTION, THE FLAPPERS ARE FORCED AWAY FROM THE PERFORATED DISC ALLOWING GAS TO PASS THROUGH THE PERFORATIONS. IF PRESSURE IS APPLIED IN THE REVERSE DIRECTION, THE FLAPPERS ARE FORCED AGAINST THE PERFORATED DISC, PREVENTING FLOW THROUGH THE VALVE. DURING NORMAL OPERATION, THE VALVE IS OPEN TO ALLOW CABIN GASES TO ENTER THE SUIT CIRCUIT.

AN INTEGRAL SHUTOFF VALVE PROVIDES A MEANS FOR ISOLATING THE SUIT CIRCUIT FROM THE CABIN, MANUALLY. THIS IS DONE TO PREVENT INDUCTING CABIN GASSES INTO THE SUIT CIRCUIT, IN THE EVENT THE CABIN GASSES BECOME CONTAMINATED.

THE SUIT CIRCUIT RETURN CHECK VALVE IS LOCATED IN THE SUIT CIRCUIT AT A POINT NORMALLY A FEW INCHES OF WATER PRESSURE BELOW CABIN PRESSURE. THE DIFFERENTIAL PRESSURE CAUSES CABIN GASES TO FLOW INTO THE SUIT CIRCUIT. THE RECONDITIONED CABIN GASES ARE RECIRCULATED THROUGH THE SUITS AND/OR CABIN. DURING EMERGENCY OPERATION, THE VALVE PREVENTS GASES FROM FLOWING INTO THE DEPRESSURIZED CABIN FROM THE SUIT CIRCUIT.

3.3.2 DEBRIS TRAP

THE DEBRIS TRAP IS A MECHANICAL FILTER FOR SCREENING OUT SOLID MATTER THAT MIGHT OTHERWISE CLOG OR DAMAGE THE SYSTEM. THE TRAP CONSISTS OF A STAINLESS STEEL SCREEN DESIGNED TO BLOCK PARTICLES LARGER THAN .040 INCH, AND A FILTER BYPASS VALVE WHICH WILL OPEN AT .5" WATER DIFFERENTIAL PRESSURE IN THE EVENT THE SCREEN BECOMES CLOGGED. (FIGURE 3-3 FOR GENERAL DESIGN FEATURES).

3.3.3 SUIT DEMAND PRESSURE REGULATOR

THE SUIT DEMAND PRESSURE REGULATOR (FIGURE 3-4) CONTROLS SUIT CIRCUIT PRESSURE IN NORMAL AND EMERGENCY MODES. IT SUPPLIES OXYGEN TO THE SUITS WHENEVER THE SUIT CIRCUIT IS ISOLATED FROM THE CABIN, AND DURING DEPRESSURIZED OPERATIONS. IT ALSO RELIEVES EXCESS GAS TO PREVENT OVERPRESSURIZING THE SUITS.

THE REGULATOR CONSISTS ESSENTIALLY OF TWO REDUNDANT DEMAND REGULATORS, AND A RELIEF VALVE. A SELECTOR VALVE IS PROVIDED FOR SELECTING EITHER OR BOTH REGULATORS. NORMALLY BOTH ARE IN OPERATION.

EACH REGULATOR SECTION CONSISTS OF AN ANEROID CONTROL, AND A DIFFERENTIAL DIAPHRAGM HOUSED IN A REFERENCE CHAMBER. THE DIAPHRAGM IS CONNECTED BY A ROD TO THE DEMAND VALVE. THE DEMAND VALVE WILL

DEBRIS TRAP

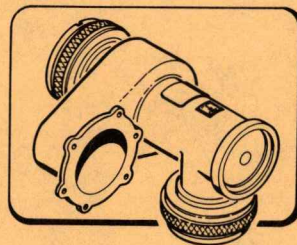
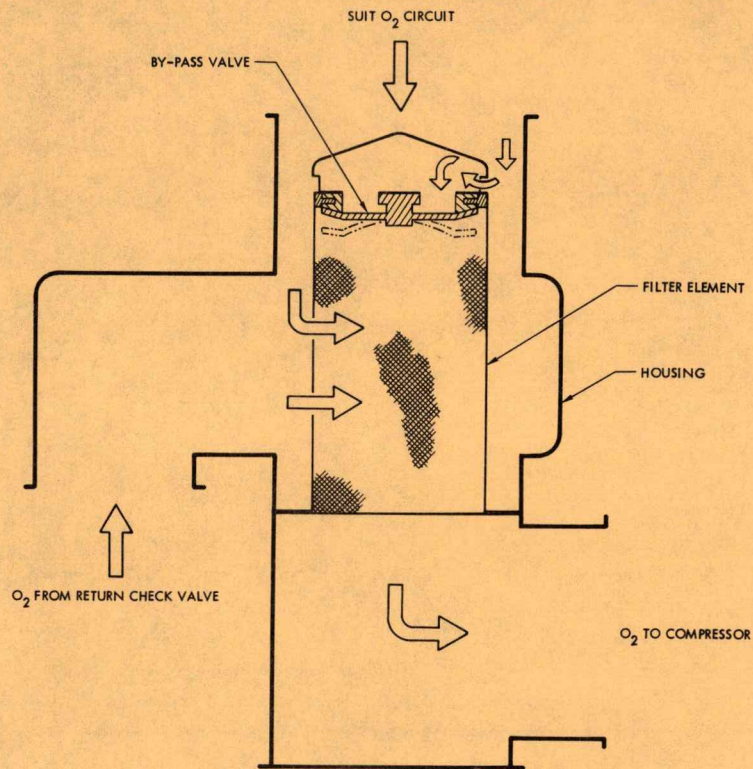


FIGURE 3-3

ECS-27



SUIT DEMAND PRESSURE REGULATOR

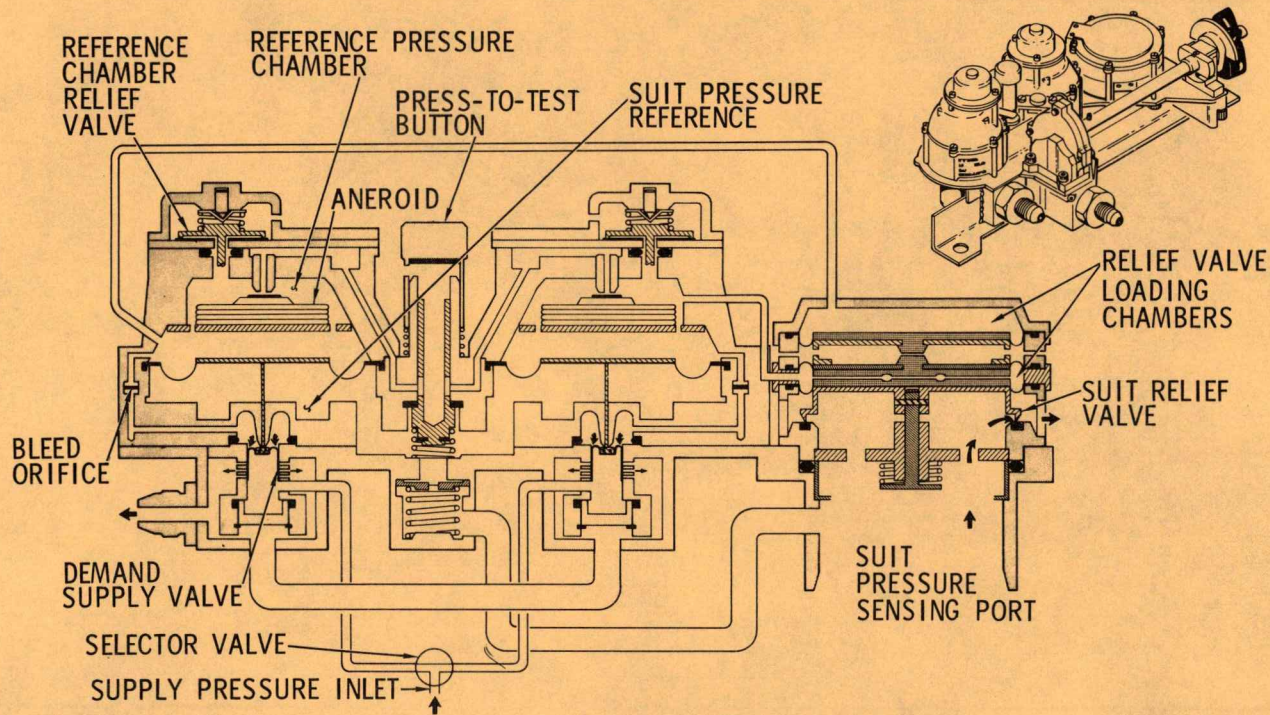


FIGURE 3-4

ECS-50B



BE OPENED WHENEVER A PRESSURE DIFFERENTIAL IS SENSED ACROSS THE DIAPHRAGM. IN OPERATION THERE IS A CONSTANT BLEED FLOW OF OXYGEN FROM THE SUPPLY INTO THE REFERENCE CHAMBER, AROUND THE ANEROID, AND OUT THROUGH THE CONTROL PORT INTO THE CABIN. AS LONG AS THE CABIN PRESSURE IS GREATER THAN 3.75 PSIA THE FLOW OF OXYGEN THROUGH THE CONTROL PORT IS VIRTUALLY UNRESTRICTED, SO THAT THE PRESSURE WITHIN THE REFERENCE CHAMBER IS ESSENTIALLY THAT OF THE CABIN. THIS PRESSURE ACTS ON THE UPPER SIDE OF THE DIAPHRAGM, WHILE SUIT PRESSURE IS APPLIED TO THE UNDERSIDE. THE DIAPHRAGM CAN BE MADE TO OPEN THE DEMAND VALVE BY EITHER INCREASING THE REFERENCE CHAMBER PRESSURE, OR BY DECREASING THE SENSED SUIT PRESSURE.

THE INCREASED PRESSURE MODE OCCURS DURING DEPRESSURIZED OPERATIONS. AS THE CABIN PRESSURE DECREASES THE ANEROID EXPANDS. AT 3.75 PSIA THE ANEROID WILL HAVE EXPANDED SUFFICIENTLY TO RESTRICT THE OUTFLOW OF OXYGEN THROUGH THE CONTROL PORT, THUS INCREASING THE REFERENCE CHAMBER PRESSURE.

DECREASED SUIT PRESSURE MODE OCCURS WHENEVER THE SUIT CIRCUIT IS ISOLATED FROM THE CABIN, AND CABIN PRESSURE IS ABOVE 5 PSIA. IN THE PROCESS OF RESPIRATION THE CREW WILL EXHALE CARBON DIOXIDE AND WATER VAPOR. IN CIRCULATING THE SUIT GASSES THROUGH THE CO₂ AND ODOR ABSORBER, AND THE SUIT HEAT EXCHANGER, THE CO₂ AND WATER ARE REMOVED. THE REMOVAL REDUCES THE PRESSURE, IN THE SUIT CIRCUIT, WHICH IS SENSED BY THE REGULATOR

ON THE UNDERSIDE OF THE DIAPHRAGM. WHEN THE PRESSURE DROPS APPROXIMATELY 2" H₂O PRESSURE BELOW CABIN THE DIAPHRAGM WILL OPEN THE DEMAND VALVE.

THE REGULATOR ASSEMBLY CONTAINS A POPPET TYPE RELIEF VALVE WHICH IS INTEGRAL WITH THE SUIT PRESSURE SENSE PORT. DURING OPERATIONS WHERE THE CABIN PRESSURE IS ABOVE 3.75 PSIA THE RELIEF VALVE IS LOADED BY A COIL SPRING, WHICH ALLOWS EXCESS SUIT GAS TO BE VENTED WHENEVER SUIT PRESSURE RISES TO 2"-9" H₂O ABOVE CABIN PRESSURE. WHEN THE CABIN PRESSURE DECREASES TO 3.75 PSIA THE REFERENCE CHAMBER PRESSURE IS INCREASED BY THE THROTTLING EFFECT OF THE EXPANDING ANEROID. THE REFERENCE CHAMBER PRESSURE IS APPLIED, THROUGH DUCTS, TO TWO RELIEF VALVE LOADING CHAMBERS WHICH ARE ARRANGED IN TANDEM ABOVE THE RELIEF VALVE POPPET. THE PRESSURE IN THE LOADING CHAMBERS ACTS ON TANDEM DIAPHRAGMS WHICH ARE FORCED AGAINST THE RELIEF VALVE POPPET. THE RELIEF VALVE OF THE VALVE IS THUS INCREASED TO 3.75 PSIA PLUS 2"-9" H₂O.

3.3.4 SUIT COMPRESSOR

THE SUIT COMPRESSOR (FIGURE 3-5) PROVIDES CONTINUOUS CIRCULATION OF GASES IN THE SUIT CIRCUIT. THE COMPRESSOR IS A SINGLE STAGE UNIT CONSISTING OF A SHROUDED CENTRIFUGAL IMPELLER DRIVEN BY A TWO POLE, 200 VOLT, 3 PHASE, 400 CYCLE INDUCTION MOTOR. THE UNIT OPERATES AT A NOMINAL SPEED OF 22,500 RPM. TWO COMPRESSORS ARE PROVIDED IN THE SUIT CIRCUIT FOR

SUIT COMPRESSOR

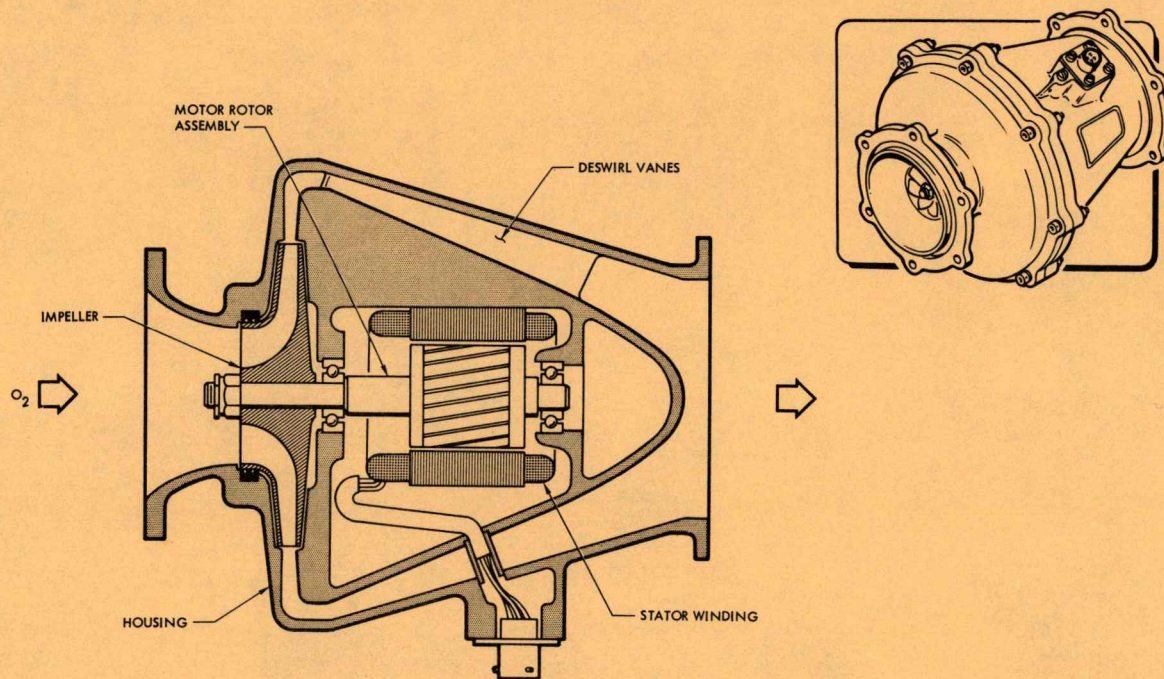


FIGURE 3-5

ECS-28



REDUNDANCY. THE COMPRESSORS ARE LOCATED DOWNSTREAM OF THE PRESSURE SUITS BETWEEN THE DEBRIS TRAP AND CO₂ AND ODOR ABSORBER PACKAGE. ONE COMPRESSOR IS EMPLOYED FOR CIRCULATION OF GASES WITHIN THE SUIT CIRCUIT, THE OTHER COMPRESSOR IS FOR STAND BY USE IN THE EVENT OF FAILURE OF THE OPERATING COMPRESSOR. THE COMPRESSORS ARE OPERATED SEPARATELY BY MEANS OF A SINGLE POWER SWITCH LOCATED ON MDC PANEL #21. COMPRESSOR OUTPUT IS DEPENDENT ON THE MODE OF OPERATION. IN NORMAL SPACE OPERATIONS, THE OPERATING COMPRESSOR DELIVERS APPROXIMATELY 35 CUBIC FEET PER MINUTE OF SUIT GAS AT A PRESSURE RISE OF 10 INCHES OF WATER WITHIN THE CONDITIONS OF 4.93 PSIA AND 88°F. UNDER EMERGENCY OPERATING CONDITIONS, THE OPERATING COMPRESSOR DELIVERS APPROXIMATELY 34.5 CUBIC FEET PER MINUTE SUIT GAS AT A PRESSURE RISE OF 6.9 INCHES OF WATER WITH INLET CONDITIONS OF 3.51 PSIA AND 81°F.

3.3.5 CHECK VALVE AND SCREEN ASSEMBLY

THE SUIT COMPRESSOR CHECK VALVE (FIGURE 3-6) PREVENTS SUIT CIRCUIT GASES FROM FLOWING IN REVERSE DIRECTION THROUGH THE STANDBY COMPRESSOR. THE VALVE ASSEMBLY CONSISTS OF A RUBBER CYLINDER FORMING A RING AT THE RETAINER END, AND TAPERING TO A FLATTENED CROSS SECTION AT THE FREE END. THE VALVE IS SUPPORTED INTERNALLY BY A TAPERED SCREEN, WHICH PREVENTS THE VALVE FROM COLLAPSING UNDER BACKPRESSURE CONDITIONS.

3.3.6 CO₂ AND ODOR ABSORBER CANISTER

THE CO₂ AND ODOR ABSORBER CANISTER PACKAGE (FIGURE 3-7) HOUSES TWO REPLACEABLE FILTERS WHICH RE

REMOVE CARBON DIOXIDE AND ODORS FROM THE CIRCULATING SUIT AND CABIN GASES. THE UNIT IS AN INTEGRATED ASSEMBLY CONSISTING OF TWO FILTER CANISTERS, A DIVERTER VALVE, AND TWO CANISTER OUTLET CHECK VALVES. THE ABSORBER PACKAGE IS LOCATED IN THE SUIT CIRCUIT IMMEDIATELY DOWNSTREAM OF THE TWO SUIT COMPRESSOR CHECK VALVES TO TAKE ADVANTAGE OF THE HIGH PRESSURE LEVEL AT THIS POINT. THE TWO FILTER CANISTERS IN THE ABSORBER PACKAGE ARE ARRANGED IN PARALLEL TO ENABLE THE EXPENDABLE FILTER TO BE REPLACED WITHOUT INTERRUPTING GAS FLOW IN THE SUIT CIRCUIT. THE DIVERTER VALVE (FIGURE 3-8), LOCATED IN THE PACKAGE INLET, IS NORMALLY POSITIONED TO ALLOW GAS FLOW THROUGH BOTH CANISTERS. WHEN FILTER REPLACEMENT IS REQUIRED, THE DIVERTER VALVE IS POSITIONED TO BLOCK GAS FLOW TO THE CANISTER CONTAINING THE EXPENDED FILTER. BACK FLOW INTO THIS CANISTER IS PREVENTED BY ITS OUTLET CHECK VALVE. TO INSURE THAT THE CANISTER IS COMPLETELY ISOLATED FROM THE SUIT CIRCUIT PRIOR TO FILTER REMOVAL, IT IS VENTED TO THE CABIN AND CHECKED TO SEE THAT INTERNAL AND EXTERNAL PRESSURES HAVE BEEN EQUALIZED.

CABIN AND SUIT GASES FLOW THROUGH THE TWO CO₂ AND ODOR FILTERS AS ILLUSTRATED IN FIGURE 3-9. GASSES ENTER THROUGH THE INLET AND ARE FREE TO FLOW THROUGH BOTH FILTERS AND FLAPPER TYPE CHECK VALVES INTO THE LOWER MANIFOLD. FROM THE MANIFOLD, GASES FLOW THROUGH THE INLET DUCT TO THE SUIT HEAT EXCHANGER.

3.3.7 CO₂ ABSORBER FILTER ASSEMBLY

THE CO₂ ABSORBER FILTER ASSEMBLY (FIGURE 3-10) REMOVES CARBON DIOXIDE AND ODOR FROM THE

CHECK VALVE AND SCREEN ASSY.

SUIT CIRCUIT

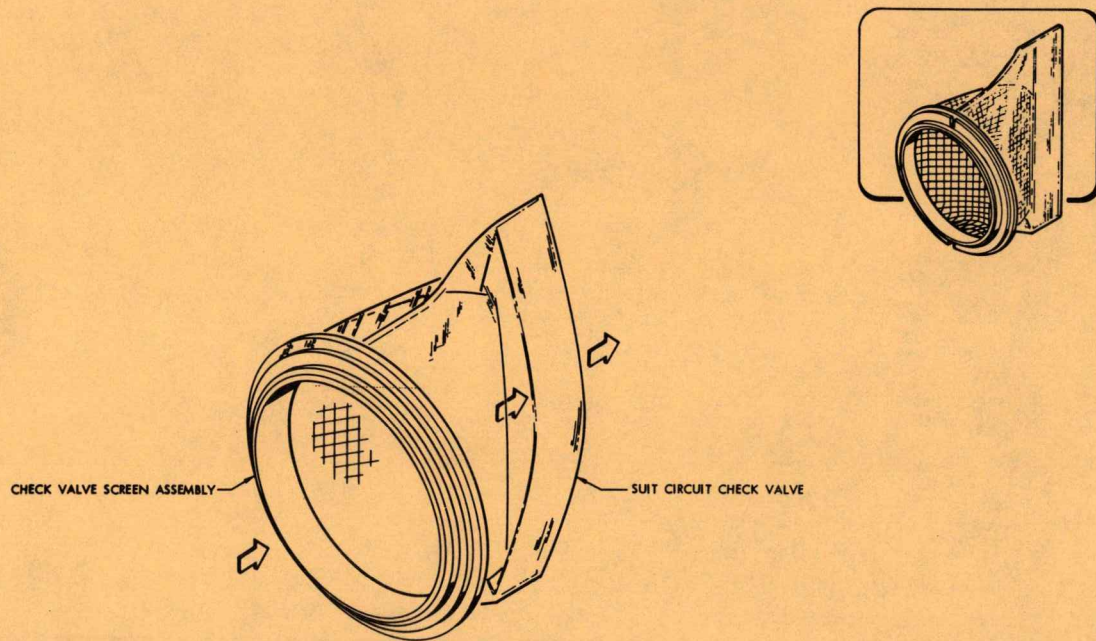


FIGURE 3-6

ECS-39



CO₂ AND ODOR ABSORBER

OPERATIONAL SCHEMATIC

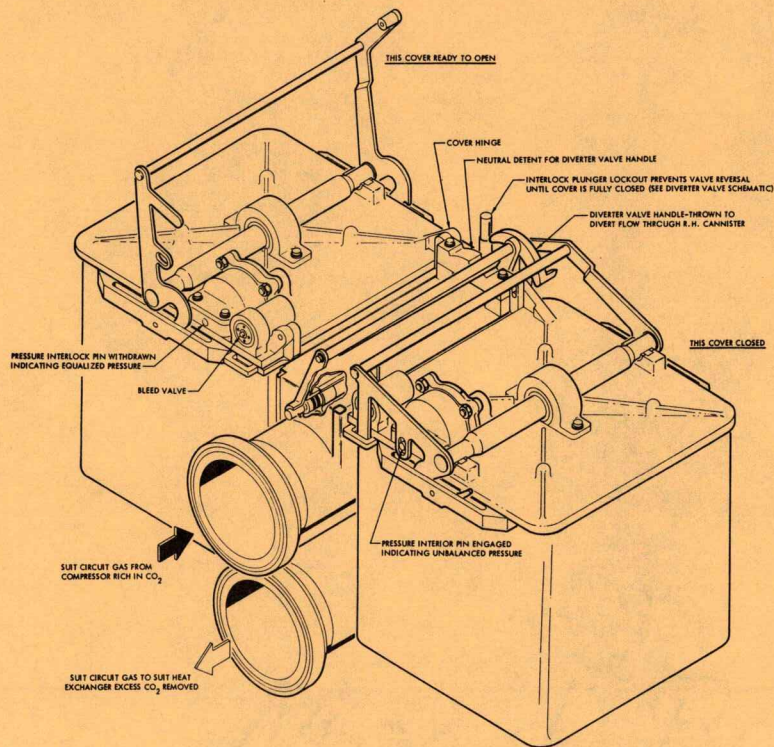


FIGURE 3-7

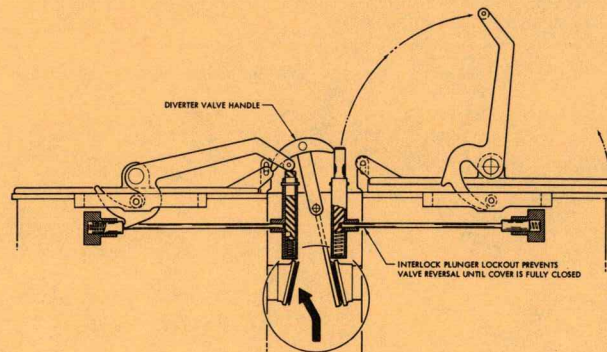
ECS-45



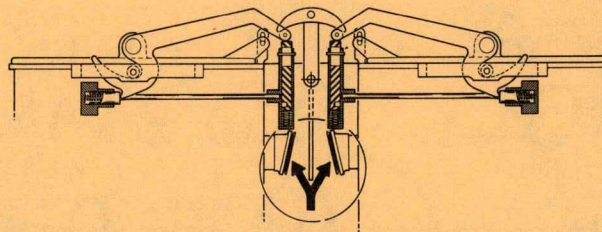
3-11

CO₂ AND ODOR ABSORBER

DIVERTER VALVE SCHEMATIC



DIVERTER VALVE AND COVER INTERLOCKS IN POSITION TO DIVER
ALL FLOW THROUGH LEFT SIDE WHILE RIGHT SIDE DOOR IS OPENED
TO REPLACE LIQH CONTAINER



DIVERTER VALVE AND COVER INTERLOCKS IN NORMAL FLOW POSITION

FIGURE 3-8

ECS-47



CO₂ AND ODOR ABSORBER

FLOW SCHEMATIC

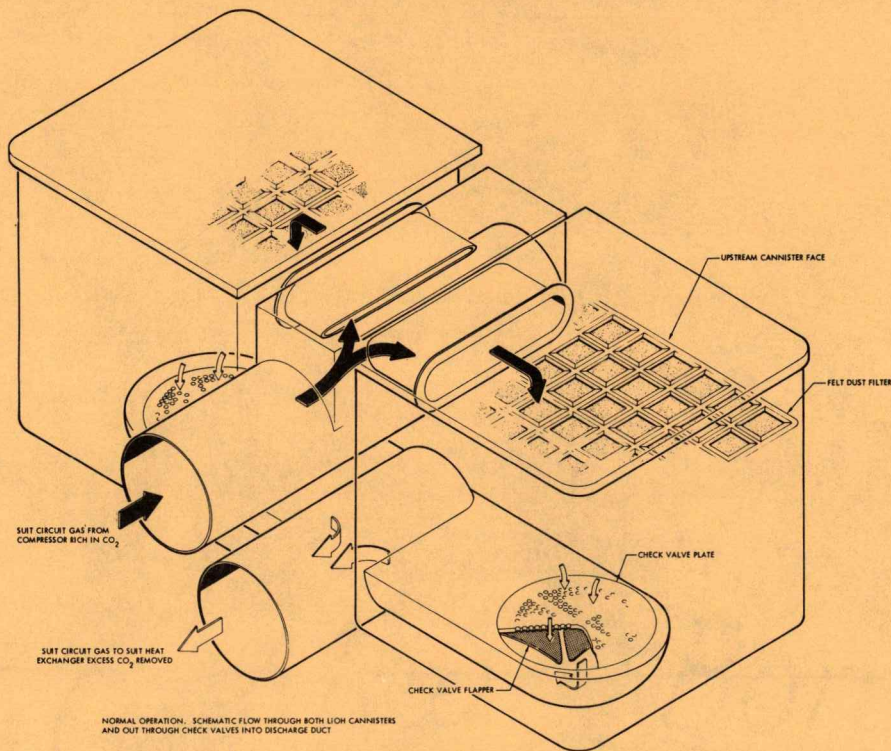


FIGURE 3-9

ECS-46



CO2 ABSORBER FILTER ASSEMBLY

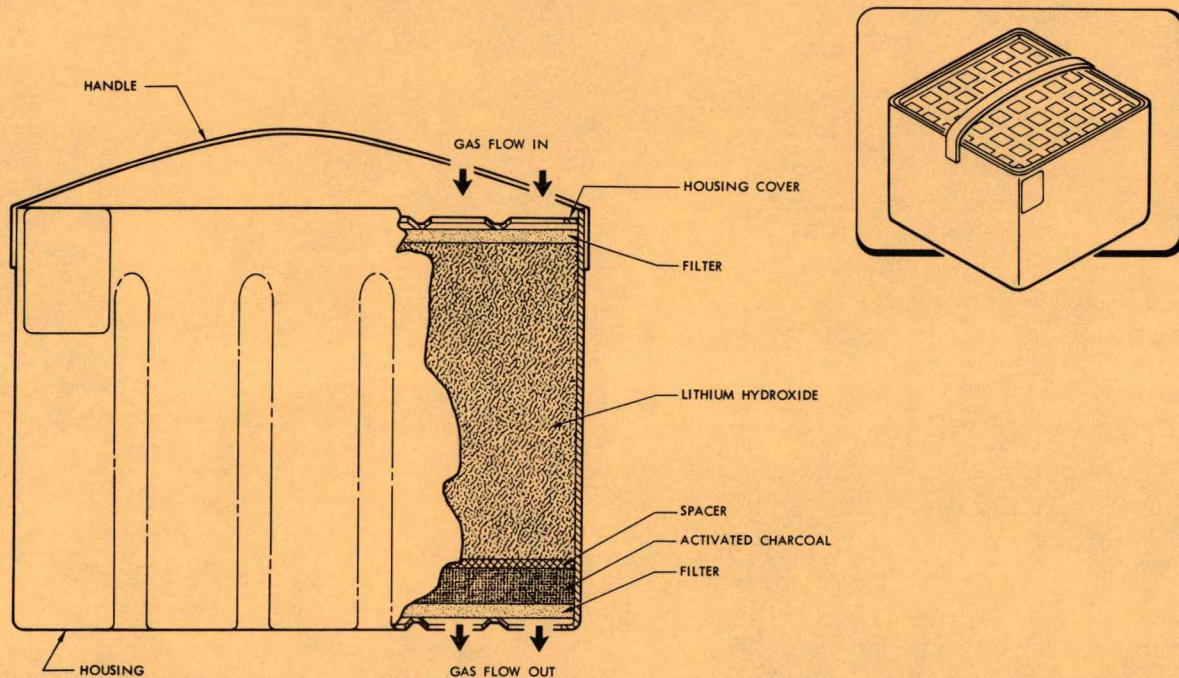


FIGURE 3-10

RECIRCULATING SUIT AND CABIN GASES. THE FILTER CONSISTS OF A LITHIUM HYDROXIDE BED AND AN ACTIVATED CHARCOAL BED CONTAINED IN A METAL CARTON WITH OPENINGS AT EACH END. THE TWO BEDS ARE SEPARATED BY GLASS CLOTH AND ARE COVERED AT EACH END WITH ORLON PADS TO PREVENT LOOSE PARTICLES FROM ENTERING THE GAS STREAM. CARBON DIOXIDE PASSING THROUGH THE FILTER IS REMOVED BY CHEMICAL REACTION WITH THE LITHIUM HYDROXIDE FORMING LITHIUM CARBONATE AND WATER, AND RELEASING HEAT. ODOR REMOVAL IS ACCOMPLISHED BY FILTRATION OF THE GAS MIXTURE THROUGH THE ACTIVATED CHARCOAL BED. TWO OF THE CO₂ AND ODOR FILTERS, EACH SUFFICIENT FOR 1.5 MAN DAYS OF OPERATION ARE HOUSED IN THE CO₂ AND ODOR ABSORBER CANISTER. THE CO₂ ABSORBER FILTER IS ALTERNATELY REPLACED AT 12 HOUR INTERVALS, EACH FILTER REMAINING IN THE PACKAGE FOR A 24 HOUR PERIOD.

3.3.8 SUIT HEAT EXCHANGER ASSEMBLY

THE HEAT EXCHANGER ASSEMBLY (FIGURE 3-11) REMOVES HEAT AND WATER VAPOR FROM THE SUIT GAS, USING COLD WATER-GLYCOL AS A HEAT TRANSFER MEDIUM AND WATER AS AN EVAPORANT. THE PACKAGE CONSISTS OF AN INTEGRATED, CROSS-COUNTERFLOW HEAT EXCHANGER FUNCTIONING AS A COOLER, CONDENSER, AND WATER SEPARATOR WITH DUAL CYCLIC ACCUMULATORS FOR REMOVING THE COLLECTED WATER.

NORMALLY, THE WARM, MOIST, SUIT GAS ENTERING THE HEAT EXCHANGER IS COOLED BY COLD WATER GLYCOL TO 55°F. IF THE COOLANT IS UNABLE TO MAINTAIN THE DESIRED SUIT GAS TEMPERATURE, THE PRESSURE SUIT TEMP CONTROL

LOOP WILL ACTIVATE THE BACK PRESSURE AND WETNESS CONTROLS. THE TWO CONTROLS, WITH THEIR RESPECTIVE VALVES, PROVIDE EFFECTIVE SUPPLEMENTAL COOLING BY CONTROLLING THE WATER INFLOW AND THE RATE OF EVAPORATION.

WHEN THE SUIT GAS IS COOLED TO 55°F, THE EXCESS WATER VAPOR CONDENSES ON THE COLD INSIDE SURFACES OF THE HEAT EXCHANGER AND IS COLLECTED BY ABSORPTION ON A WICK-TYPE MATERIAL SANDWICHED BETWEEN THE COOLING SURFACES. THE ABSORBED WATER IS TRANSFERRED BY CAPILLARY ACTION FROM THE WICKING TO A SINTERED PLATE FROM WHICH IT IS DRAINED BY THE SUCTION APPLIED BY THE DUAL CYCLIC ACCUMULATORS.

THE CYCLIC ACCUMULATORS (FIGURE 3-12) ARE SELF-CYCLING RECIPROCATING PUMPS, ACTUATED BY 100 PSIG OXYGEN ON THE EXPULSION STROKE AND BY A RETURN SPRING ON THE SUCTION STROKE. ONLY ONE CYCLIC ACCUMULATOR OPERATES AT ONE TIME, WITH THE OTHER ACTING AS A STANDBY UNIT. EACH ACCUMULATOR IS PROVIDED WITH AN OXYGEN SUPPLY SHUTOFF VALVE, LOCATED ON THE COOLANT CONTROL PANEL. IN OPERATION, WATER IS DRAWN INTO AN ACCUMULATOR THROUGH ONE CHECK VALVE AND IS EXPELLED THROUGH ANOTHER CHECK VALVE TO THE WASTE WATER TANK. THE EXPENDED OXYGEN IS EXHAUSTED TO THE SUIT CIRCUIT AS MAKEUP GAS.

SUIT CIRCUIT HEAT EXCHANGER

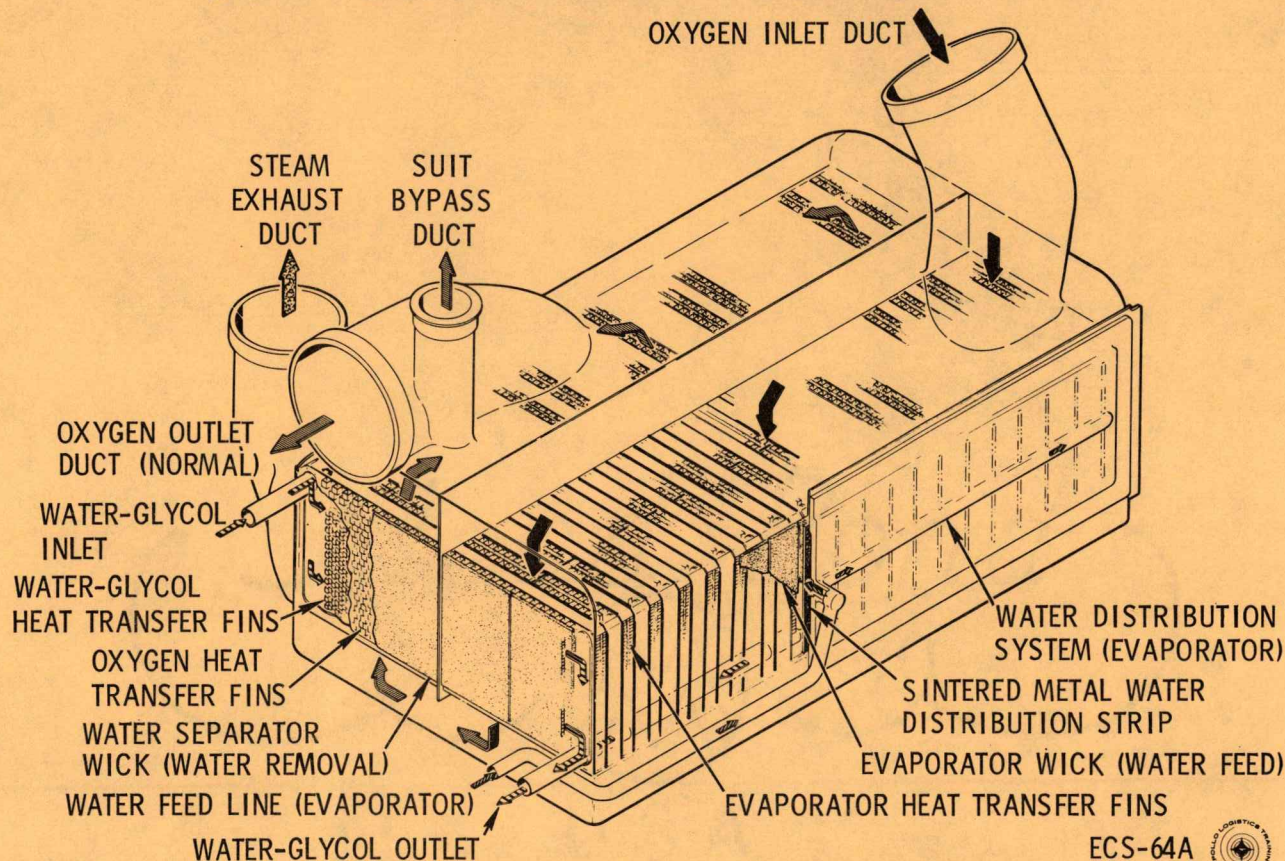


FIGURE 3-11

WATER ACCUMLATOR CONTROL

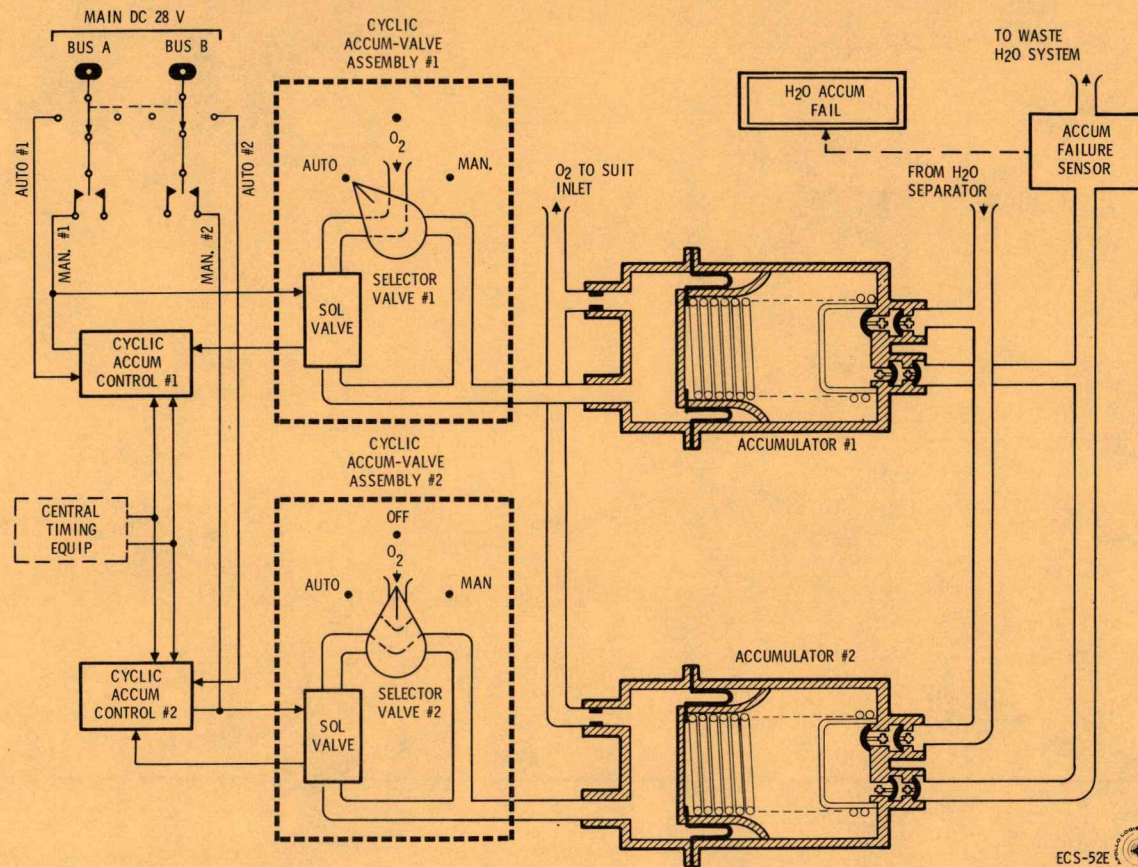


FIGURE 3-12

3.3.9 SUIT FLOW LIMITER

A SUIT FLOW LIMITER (FIGURE 3-13) IS INSTALLED IN EACH SUIT SUPPLY DUCT TO RESTRICT THE GAS FLOW RATE THROUGH ANY ONE SUIT. THE FLOW LIMITER IS A SHEET METAL TUBE, WITH A VENTURI SECTION SIZED TO LIMIT FLOW TO .7 POUND PER MINUTE. THE LIMITER OFFERS MAXIMUM RESISTANCE TO GAS FLOW THROUGH A TORN SUIT, WHEN CABIN PRESSURE IS NEAR ZERO PSIA.

3.3.10 SUIT BY-PASS VALVE

THE SUIT BY-PASS VALVE (FIGURE 3-14) ALLOWS EACH CREW MEMBER TO ADJUST THE OXYGEN FLOW THROUGH HIS PRESSURE SUIT WITHOUT AFFECTING THE FLOWRATES THROUGH THE OTHER TWO SUITS.

THE VALVE IS A SPRING LOADED, POPPET TYPE RELIEF VALVE SET TO OPEN AT A DIFFERENTIAL PRESSURE OF APPROXIMATELY 4.8 INCHES OF WATER. A MANUAL OVERRIDE CONTROL PERMITS THE CREW TO LOCK THE VALVE IN THE CLOSED POSITION. THE VALVE IS LINE-MOUNTED BETWEEN THE SUIT HEAT EXCHANGER OUTLET AND THE COMPRESSOR INLET.

THE SUIT COMPRESSOR MAINTAINS AN ESSENTIALLY CONSTANT VOLUMETRIC FLOW THROUGH THE SUIT CIRCUIT. DURING PRESSURE SUIT OPERATION, THE TOTAL FLOW PASSES THROUGH THE PRESSURE SUITS UNLESS THE INFLOW IS REDUCED BY PARTIAL CLOSING OF A SUIT FLOW CONTROL VALVE. THIS REDUCTION IN FLOW CREATES AN INCREASE IN UPSTREAM PRESSURE WHICH IS SENSED AT THE INLET SIDE OF THE BY-PASS VALVE. WHEN THE PRESSURE DIFFERENTIAL ACROSS THE

VALVE INCREASES TO APPROXIMATELY 4.8 PSI, THE POPPET IS FORCED OPEN, RELIEVING THE EXCESS PRESSURE. THIS RELIEF ACTION HAS THE EFFECT OF MAINTAINING A NEARLY CONSTANT SUIT INLET PRESSURE, AND PRESSURE DIFFERENTIAL ACROSS THE SUIT CIRCUIT.

SUIT FLOW LIMITER

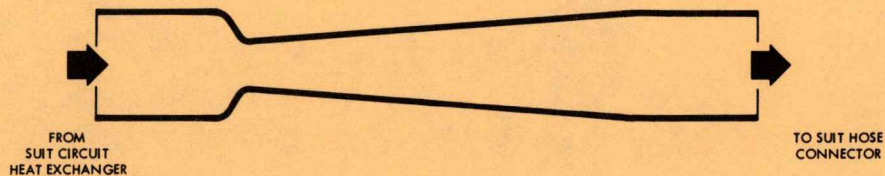
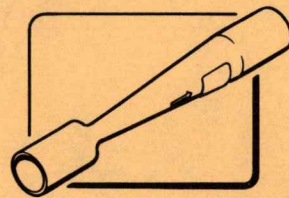


FIGURE 3-13

PRESSURE SUIT BYPASS VALVE

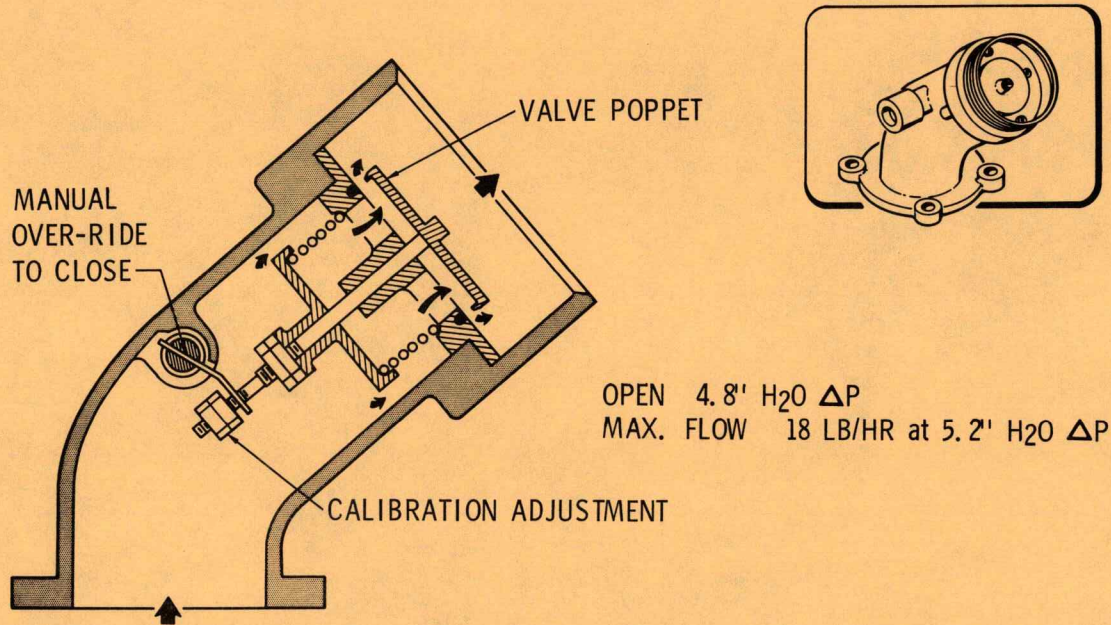


FIGURE 3-14

ECS-41A



SECTION IV

WATER SUBSYSTEM

4.1 GENERAL

THE WATER SUBSYSTEM (FIGURE 4-1) CONSISTS OF TWO INDIVIDUAL FLUID MANAGEMENT NETWORKS WHICH CONTROL THE COLLECTION, STORAGE, AND DISTRIBUTION OF POTABLE AND WASTE WATER; AND A SUPPLEMENTAL WATER SUPPLY IN THE SERVICE MODULE. THE POTABLE WATER IS USED PRIMARILY FOR METABOLIC AND HYGIENIC PURPOSES. THE WASTE WATER IS USED SOLELY FOR EVAPORATIVE COOLING IN THE SUIT HEAT EXCHANGER AND THE GLYCOL EVAPORATOR. THE SUPPLEMENTAL WATER SUPPLY AUGMENTS THE WASTE SUPPLY DURING HIGH DEMAND PERIODS. ALTHOUGH THE POTABLE AND WASTE NETWORKS OPERATE, AND ARE CONTROLLED, INDEPENDENTLY THEY ARE INTERCONNECTED THROUGH A RELIEF AND SHUTOFF VALVE WHICH ALLOWS POTABLE WATER TO BE UTILIZED FOR EVAPORATIVE COOLING.

4.2 POTABLE WATER MANAGEMENT

POTABLE WATER, PRODUCED BY THE FUEL CELLS IN THE PROCESS OF GENERATING ELECTRICAL POWER, IS PUMPED INTO THE COMMAND MODULE AT APPROXIMATELY 1.5 POUNDS PER HOUR, AT A TEMPERATURE BETWEEN 80° - 100°F. WATER ENTERING THE C/M FLOWS THROUGH A CHECK VALVE AND A SHUTOFF VALVE, AND IS DISTRIBUTED TO THE POTABLE WATER TANK, THE WATER CHILLER, AND THE POTABLE WATER SUPPLY

ASSEMBLY. CHILLED WATER IS MADE AVAILABLE TO THE CREW FOR DRINKING THROUGH THE WATER DISPENSER ASSEMBLY (FIGURE 4-2). BOTH HOT AND COLD WATER ARE AVAILABLE FOR FOOD RECONSTITUTION FROM METERING VALVES IN THE POTABLE WATER SUPPLY ASSEMBLY (FIGURE 4-3).

WHEN THE POTABLE WATER TANK IS FULL, EXCESS WATER FLOWS THROUGH THE WASTE WATER S/M SUPPLY SHUTOFF VALVE (FIGURE 4-4, WATER CONTROL PANEL), INTO THE WASTE WATER NETWORK. THIS VALVE FUNCTIONS AS A RELIEF VALVE BETWEEN THE NETWORKS (POTABLE TO WASTE), WITH A MANUAL SHUTOFF FEATURE IN CASE THE RELIEF VALVE FAILS.

WHEN THE WASTE WATER TANK IS FULL, EXCESS POTABLE WATER IS DUMPED OVERBOARD THROUGH THE OVERBOARD PRESSURE RELIEF VALVE.

4.3 WASTE WATER MANAGEMENT

THE WATER THAT IS CONDENSED IN THE SUIT HEAT EXCHANGER (H/E) DURING THE COOLING PROCESS, IS ABSORBED BY THE WICKING MATERIAL AND IS CARRIED BY CAPILLARY ACTION TO THE WATER EXTRACTION PLATE AT THE BASE OF THE H/E (FIGURE 4-5). THE WATER IS DRAWN OFF THROUGH THE COLLECTION MANIFOLD BY SUCTION GENERATED BY THE CYCLIC ACCUMULATOR. ON THE EXPULSION STROKE, THE

WATER SUBSYSTEM

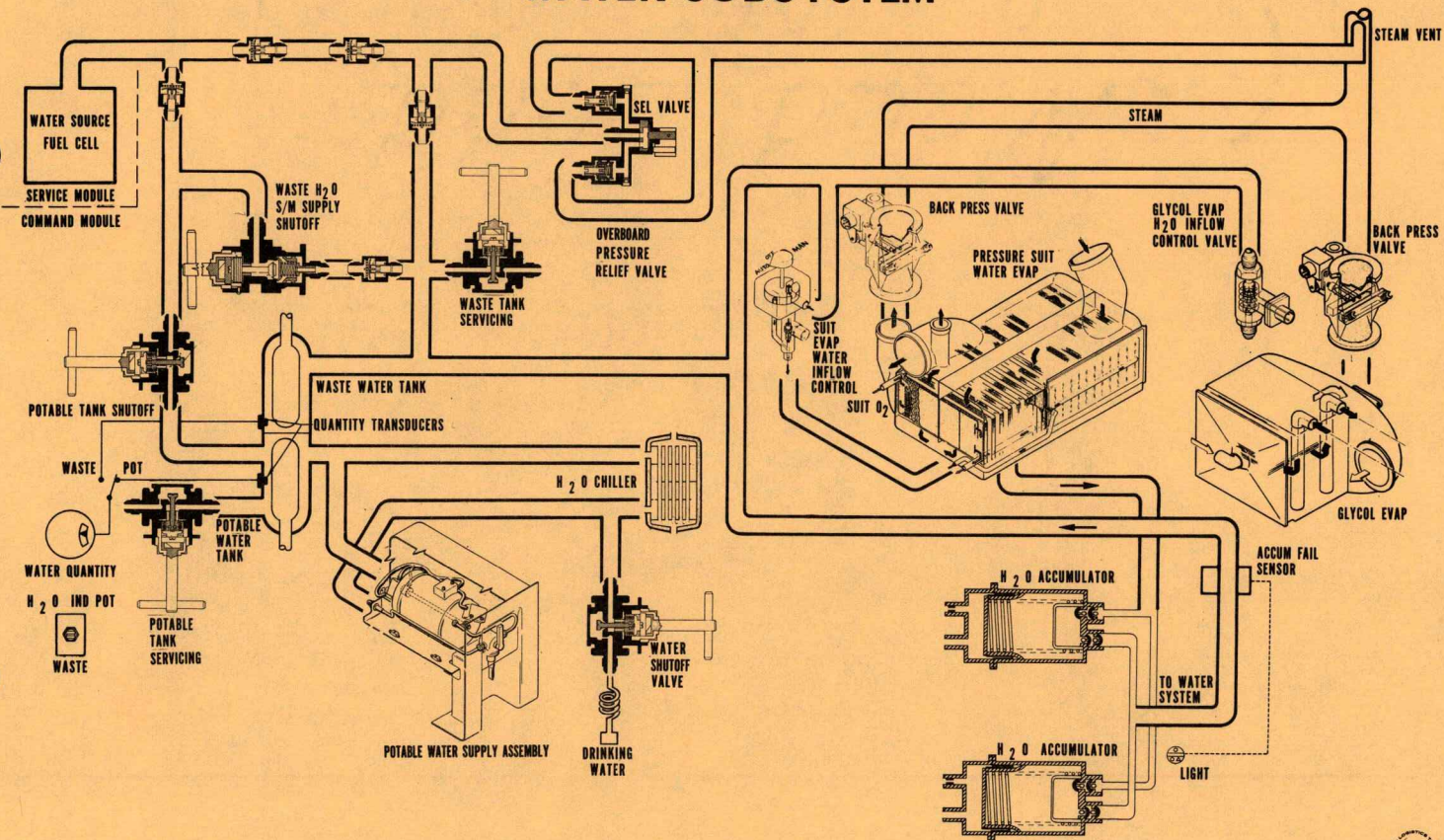
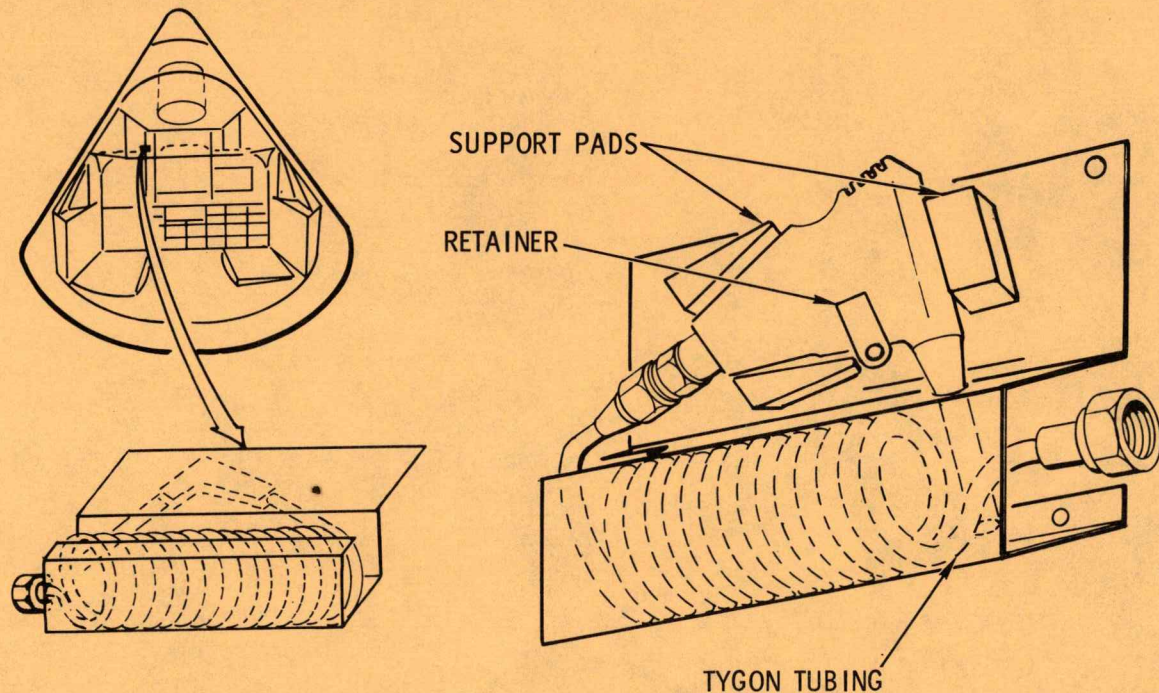



FIGURE 4-1

CREWMAN WATER DISPENSER ASSEMBLY



REV FEB 65

FIGURE 4-2

CS-4101B 

POTABLE WATER SUPPLY ASSY.

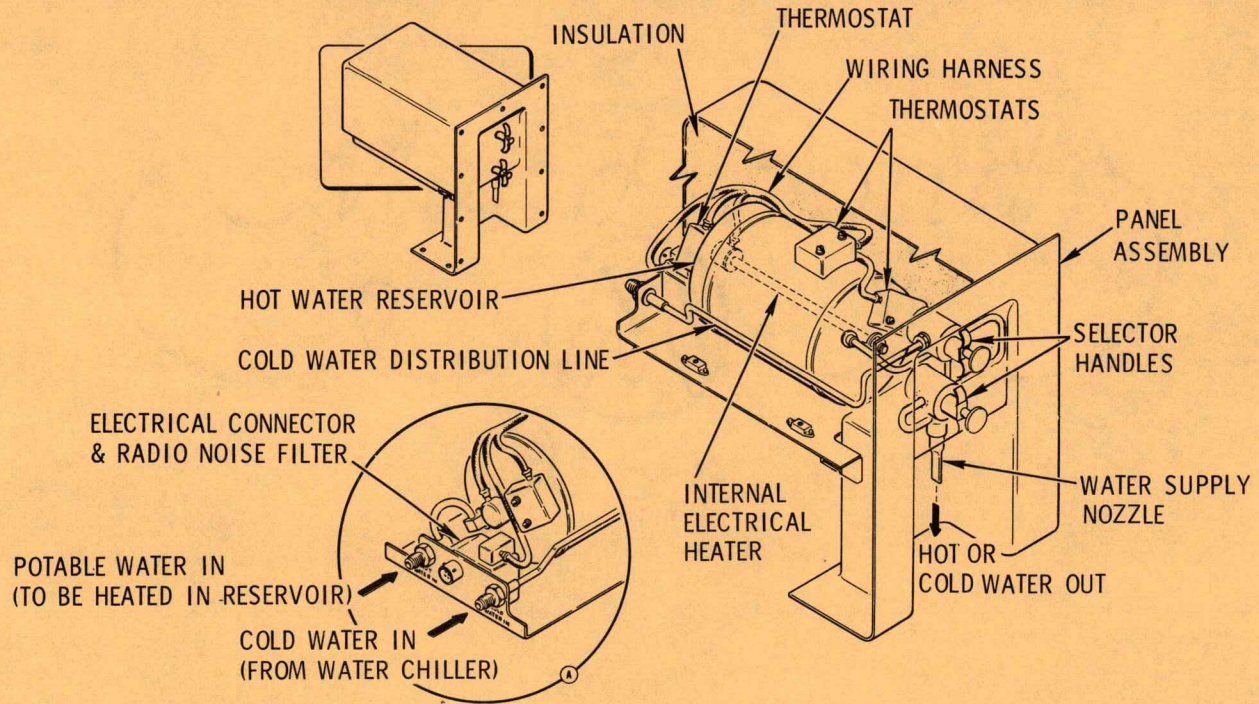



FIGURE 4-3

ECS-49B 

WATER CONTROL PANEL

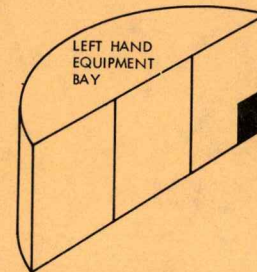
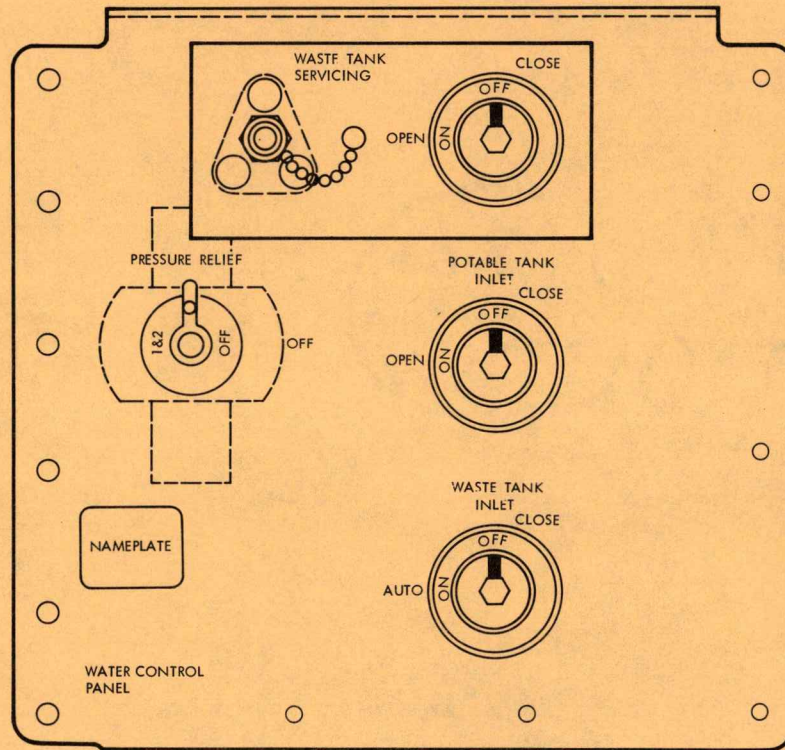


FIGURE 4-4

WATER REMOVAL

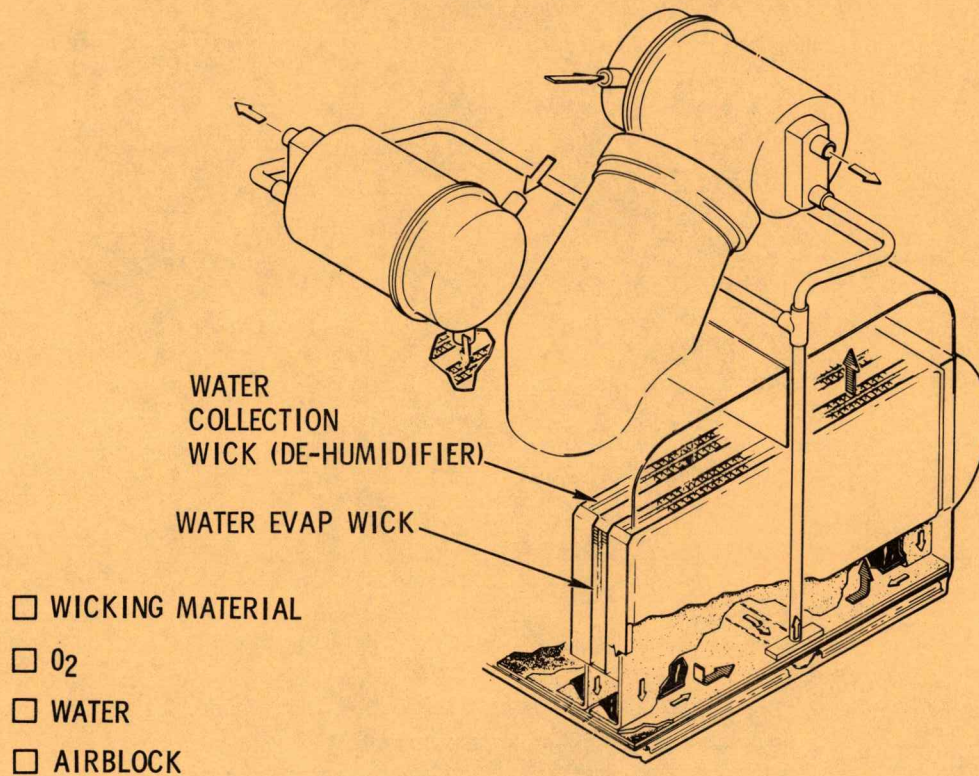


FIGURE 4-5

ACCUMULATOR PUMPS THE WATER INTO THE WASTE TANK WHERE IT IS STORED UNDER PRESSURE UNTIL REQUIRED.

WASTE WATER IS DISTRIBUTED TO THE WATER INFLOW CONTROL VALVES OF THE SUIT HEAT EXCHANGER AND THE GLYCOL EVAPORATOR. EXCESS WASTE WATER IS DUMPED OVERBOARD THROUGH THE WATER PRESSURE RELIEF VALVE. GROUND SERVICING OF THE WASTE WATER SYSTEM IS ACCOMPLISHED BY THE SHUTOFF VALVE AND CAP LOCATED ON THE WATER VALVE PANEL (FIGURE 4-4).

4.4 SUPPLEMENTAL WATER SUPPLY

THE SUPPLEMENTAL WATER SUPPLY (FIGURE 4-6), LOCATED IN THE SERVICE MODULE, PROVIDES ADDITIONAL WATER FOR EVAPORATIVE COOLING DURING EARTH ORBIT MISSIONS. THE WATER IS STORED IN TWO TANKS OF THE SAME SIZE AND TYPE AS THE WASTE WATER TANK. PRESSURIZATION OF THE EXPULSION BLADDERS IS OBTAINED FROM A SINGLE SOURCE OF GASEOUS NITROGEN. WATER TRANSFER IS THROUGH THE FUEL CELLS WATER DISCHARGE LINE INTO THE COMMAND MODULE POTABLE WATER NETWORK. SINCE OVERFLOW (FROM POTABLE TO WASTE NETWORKS) NORMALLY OCCURS ONLY AFTER THE POTABLE TANK IS FULL, IT WILL BE NECESSARY TO CLOSE THE POTABLE TANK SHUTOFF VALVE IN ORDER TO TRANSFER WATER DIRECTLY TO THE WASTE TANK.

4.5 SUBSYSTEM COMPONENTS

4.5.1 WATER TANKS

WASTE WATER AND POTABLE WATER ARE STORED IN CYLINDRICAL, POSITIVE EXPULSION TANKS (FIGURE 4-7).

WITH THE EXCEPTION OF CAPACITY, THE TANKS ARE IDENTICAL IN FUNCTION, OPERATION, AND DESIGN. THE POSITIVE EXPULSION FEATURE IS OBTAINED BY AN INTEGRALLY SUPPORTED BLADDER INSTALLED LONGITUDINALLY IN THE TANK. WHEN THE TANK IS EMPTY, THE PRESSURIZING GAS EXPANDS THE BLADDER TO THE WALLS OF THE TANK. WHEN THE TANK IS FULL, THE WATER PRESSURE COLLAPSES THE BLADDER OVER THE SUPPORT. WATER COLLECTOR CHANNELS, INTEGRAL WITH THE TANK WALLS, PREVENT WATER FROM BEING TRAPPED WITHIN THE TANK BY THE EXPANDING BLADDER.

4.5.2 WATER CHILLER ASSEMBLY

THE WATER CHILLER (FIGURE 4-8) COOLS AND STORES A LIMITED QUANTITY OF POTABLE WATER FOR CREW CONSUMPTION. THE WATER CHILLER IS DESIGNED TO SUPPLY 8 OZ. OF 50°F WATER EVERY 5 MINUTES. THE UNIT CONSISTS OF AN INTERNALLY BAFFLED RESERVOIR CONTAINING A COILED TUBE ASSEMBLY WHICH IS USED AS THE COOLANT CONDUIT. THE BAFFLES ARE USED TO PREVENT THE INCOMING HOT WATER FROM MIXING WITH AND RAISING THE TEMPERATURE OF THE PREVIOUSLY CHILLED WATER.

4.5.3 POTABLE WATER SUPPLY ASSEMBLY

THE POTABLE WATER SUPPLY ASSEMBLY (FIGURE 4-3) HEATS POTABLE WATER FOR USE BY THE CREW AND ALLOWS MANUAL SELECTION OF HOT OR COLD POTABLE WATER. THE COLD POTABLE WATER IS SUPPLIED BY THE WATER CHILLER. THE UNIT CONSISTS OF AN ELECTRICALLY HEATED WATER RESERVOIR AND TWO MANUALLY OPERATED VALVES WHICH METER WATER IN 1 OZ. INCREMENTS.

SUPPLEMENTAL WATER SUPPLY

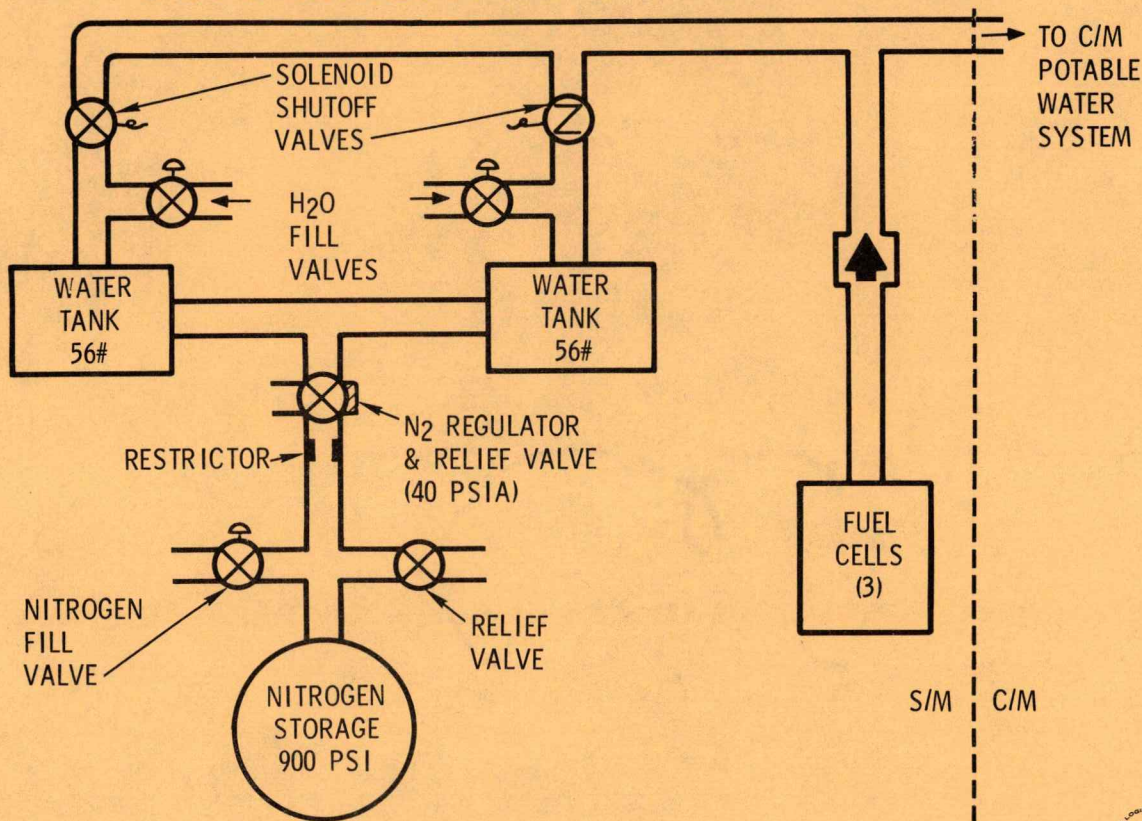



FIGURE 4-6

ECS-114 

WATER TANKS

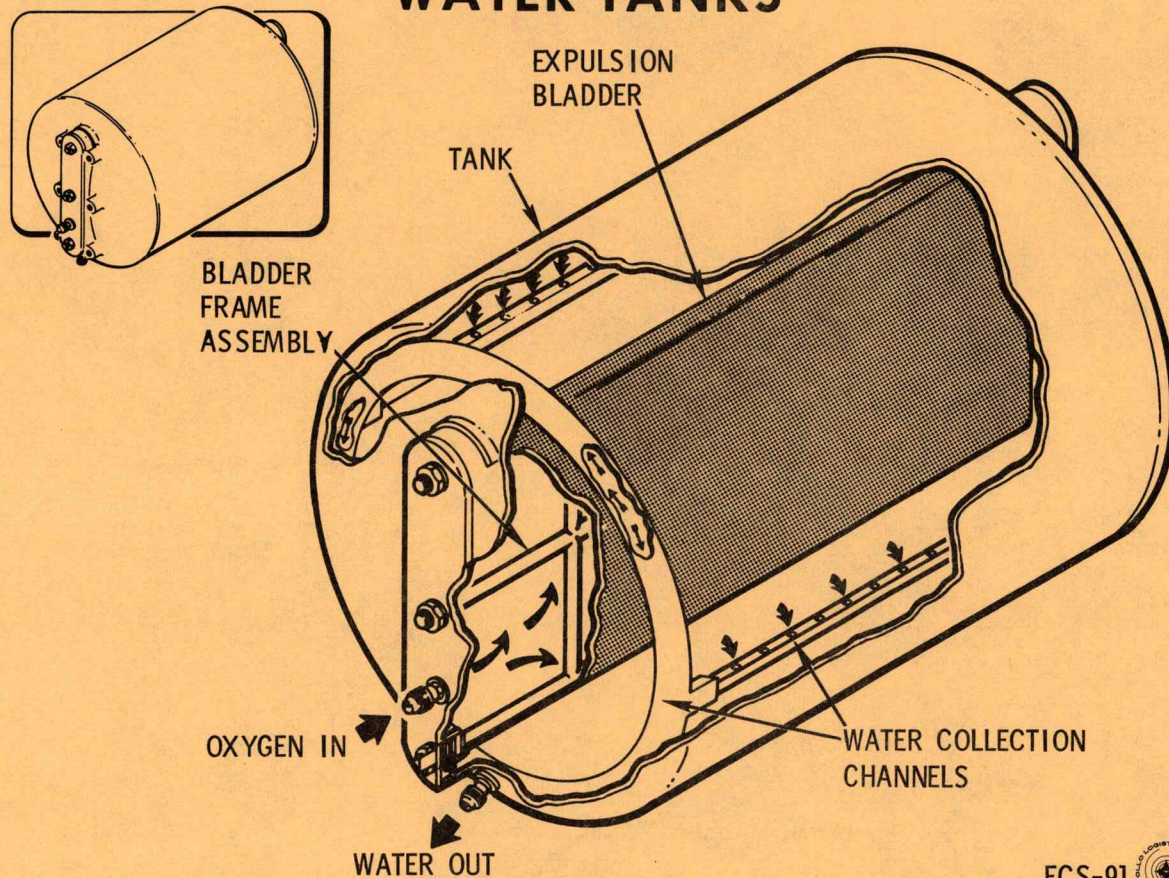


FIGURE 4-7

WATER CHILLER

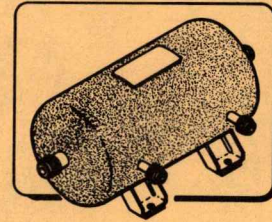
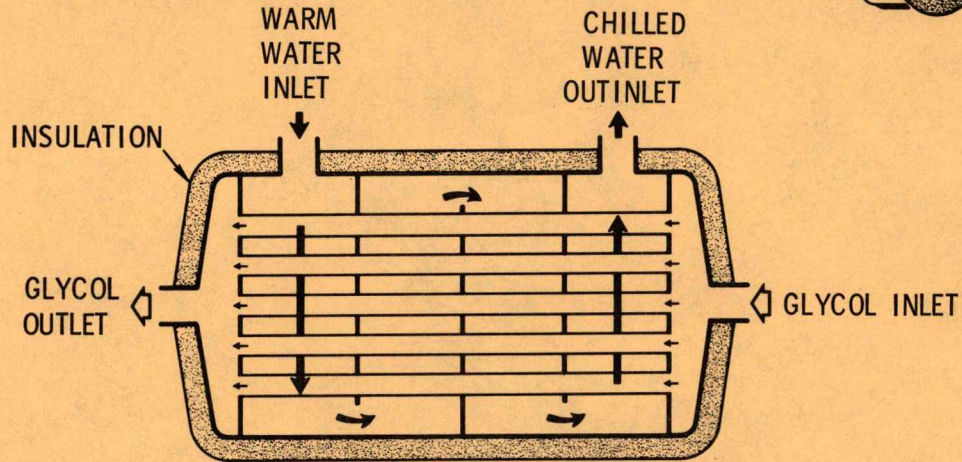



FIGURE 4-8

ECS-36A 

THE INSULATED RESERVOIR HAS A CAPACITY OF 2.5 LBS. OF WATER. THERMOSTATICALLY CONTROLLED HEATING ELEMENTS IN THE RESERVOIR HEAT THE WATER AND MAINTAIN IT AT THE REQUIRED TEMPERATURE. WHEN WATER IS DRAWN OFF BY THE CREW, WATER FROM THE POTABLE WATER TANK ENTERS THE RESERVOIR INLET AT A TEMPERATURE OF APPROXIMATELY 80°F. THE INLET PORT AREA IS DESIGNED TO PRODUCE A LAMINAR FLOW OF THE WATER THROUGH THE RESERVOIR WHICH PROVIDES MORE EFFICIENT CONTACT WITH THE HEATING ELEMENTS. THE HEATING ELEMENTS HAVE A CAPACITY OF 45 WATTS FOR HEATING 2-1/2 LBS. OF WATER TO $154 \pm 4^\circ\text{F}$ IN LESS THAN 2 HOURS. AFTER THE MAKE-UP WATER IS HEATED, A 10 WATT HEATING ELEMENT MAINTAINS THE STORED WATER AT THE REQUIRED TEMPERATURE.

THE METERING VALVES ARE LOCATED ON THE FRONT OF THE UNIT WHERE THEY ARE ACCESSIBLE TO THE CREW. THE WATER IS DELIVERED THROUGH A COMMON NOZZLE LOCATED BENEATH THE TWO VALVES. THE DISCHARGE OPENING OF THE NOZZLE IS FLATTENED TO PROVIDE THE REQUIRED SHAPE FOR INSERTION INTO THE FOOD CONTAINERS USED BY THE CREW. THE FLATTENED AREA ALSO PROVIDES A CAPILLARY ACTION, WHICH UNDER ZERO GRAVITY CONDITIONS PREVENTS LOSS OF WATER REMAINING IN THE OUTLET SECTION WHEN THE VALVES ARE RETURNED TO THE OFF POSITION.

4.5.4 MANUAL SHUTOFF VALVE

THE WATER SHUTOFF VALVE (FIGURE 4-8A) PROVIDES A MANUAL MEANS OF CONTROLLING WATER FLOW. THE VALVE

CONTAINS A MANUALLY OPERATED POPPET, LOCATED BETWEEN THE INLET AND OUTLET PORTS. THE POPPET IS INTEGRALLY CONNECTED TO A BELLOWS, WHICH PROVIDES A STATIC AND DYNAMIC SEAL TO PREVENT LEAKAGE. THE VALVE IS OPENED BY ROTATING THE CAM AGAINST THE BELLOWS, WHICH FORCES THE POPPET OFF ITS SEAT. THE POPPET IS CLOSED BY PRESSURE WITHIN THE BELLOWS WHEN THE VALVE IS POSITIONED CLOSED. FOUR MANUAL SHUTOFF VALVES ARE USED IN THE WATER SUPPLY SUBSYSTEM. THEY ARE THE POTABLE TANK SHUTOFF AND SERVICING VALVES, WASTE TANK SERVICING, AND THE SHUTOFF VALVE FOR THE DRINKING FIXTURE.

4.5.5 WATER SYSTEM CHECK VALVE

THE CHECK VALVES (FIGURE 4-9) ARE USED TO PREVENT REVERSE FLOW OF WATER AT CRITICAL POINTS IN THE WATER SUPPLY SYSTEM. THE UNIT CONSISTS OF A RUBBER UMBRELLA SHAPED VALVE IN A FLAT METAL SEAT. THIS SEAT HAS A SERIES OF HOLES ARRANGED IN A CIRCLE OF THE LESSER DIAMETER THAN THE VALVE. WHEN INSTALLED, THE VALVE IS SLIGHTLY PRELOADED TO SEAL AT ITS OUTER PERIPHERY. IF PRESSURE IS APPLIED IN THE FLOW DIRECTION, THE VALVE IS FORCED AWAY FROM THE SEAT, ALLOWING WATER TO PASS THROUGH THE HOLES IN THE SEAT. IF PRESSURE IS APPLIED IN THE REVERSE DIRECTION, THE VALVE IS FORCED AGAINST THE SEAT, CHECKING THE FLOW BY COVERING THE HOLES IN THE SEAT. A RETAINER PREVENTS THE VALVE FROM TEARING AWAY FROM ITS SEAT IN THE EVENT A HIGH TRANSIENT PRESSURE OCCURS IN THE FLOW DIRECTION. THE VALVE IS DESIGNED FOR A LOW PRESSURE DROP IN THE

MANUAL SHUTOFF VALVE

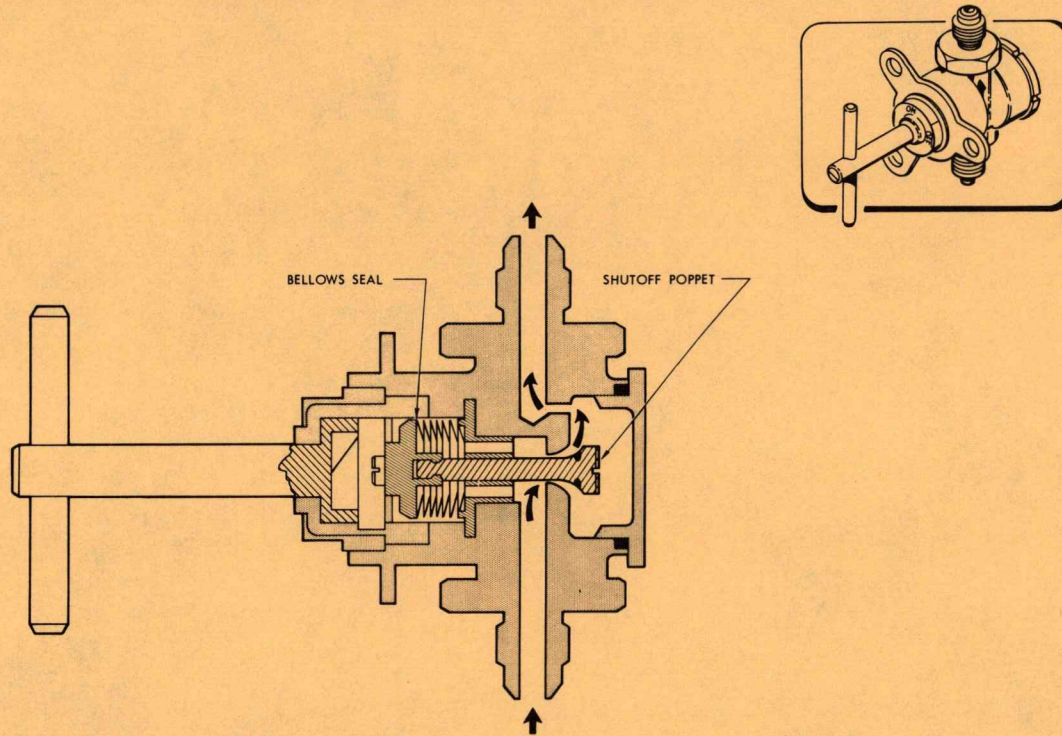


FIGURE 4-8A

ECS-37



CHECK VALVE

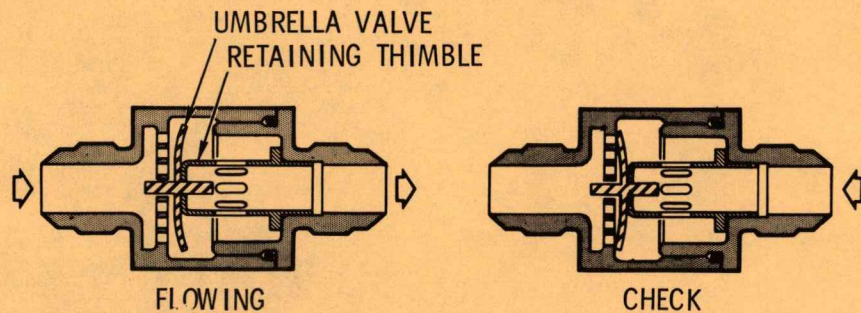
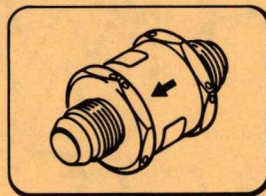



FIGURE 4-9

ECS-44A 

FLOW DIRECTION AND NEGLIGIBLE LEAK IN THE CHECK DIRECTION.

4.5.6 WASTE H₂O S/M SUPPLY SHUTOFF VALVE

THE WASTE H₂O S/M SUPPLY SHUTOFF VALVE (FIGURE 4-10) IS A CAM ACTUATED POPPET VALVE, WITH A RELIEF MECHANISM INCORPORATED IN THE OUTLET PASSAGE. DURING NORMAL OPERATIONS, THE POPPET IS OPEN, ALLOWING EXCESS POTABLE WATER TO PASS THROUGH THE RELIEF VALVE TO THE WASTE WATER SYSTEM. IN THE EVENT THE RELIEF VALVE FAILS OPEN, THE POPPET VALVE MAY BE CLOSED TO PREVENT LOSS OF POTABLE WATER.

4.5.7 OVERBOARD PRESSURE RELIEF VALVE

THE OVERBOARD PRESSURE RELIEF VALVE (REFER TO FIGURE 4-10A) PREVENTS OVERPRESSURIZATION OF THE WATER SYSTEM. THE UNIT CONSISTS OF TWO REDUNDANT PRESSURE RELIEF VALVES ARRANGED IN PARALLEL AND PACKAGED AS A SINGLE ASSEMBLY. EACH VALVE CONTAINS A SPRING-LOADED POPPET WHICH ALLOWS FLOW THROUGH THE VALVE WHEN A DIFFERENTIAL PRESSURE OF 35 PSI IS SENSED BY THE VALVE. AN INTEGRAL SELECTOR VALVE IS PROVIDED TO ALLOW BOTH VALVES TO OPERATE SIMULTANEOUSLY OR TO ISOLATE EITHER OR BOTH VALVES.

4.5.8 CYCLIC ACCUMULATOR SELECTOR VALVE

THE CYCLIC ACCUMULATOR VALVE (FIGURE 4-11) CONSISTS OF TWO VALVES IN A COMMON HOUSING. ONE IS A

THREE POSITION SELECTOR VALVE AND THE OTHER A SOLENOID SHUTOFF VALVE. THE SELECTOR VALVE HAS THREE (3) POSITIONS - AUTOMATIC, MANUAL, AND OFF. THE MANUAL POSITION ROUTES 100 PSI OXYGEN DIRECTLY TO THE ACCUMULATOR. WHEN IN THE AUTOMATIC POSITION, THE VALVE ROUTES OXYGEN TO THE SOLENOID VALVE ALLOWING ELECTRICAL CONTROL OF THE OXYGEN FLOW BY EITHER THE CYCLIC ACCUMULATOR CONTROL, OR BY THE MANUAL SWITCH ON MDC PANEL #13.

4.5.9 CYCLIC ACCUMULATOR CONTROL

THE CYCLIC ACCUMULATOR CONTROLS REGULATE THE OPERATIONAL CYCLE OF THE ACCUMULATORS (REFER TO FIGURE 4-11A). THE POWER OUTPUT OF THE CONTROL IS USED TO ENERGIZE THE SOLENOID VALVES, WHICH CONTROL THE OXYGEN FLOW TO THE CYCLIC ACCUMULATORS. A TIMER WITHIN THE CONTROL REGULATES THE DURATION OF THE ON-POWER, OFF-POWER PORTIONS OF THE OPERATIONAL CYCLE. THE TIMER IS TRIGGERED BY A CLOCK PULSE, TRANSMITTED EVERY 10 MINUTES BY THE CENTRAL TIMING EQUIPMENT, AND PUTS OUT A 10 SECOND DURATION SIGNAL TO THE SOLENOID VALVE.

4.5.10 WATER SEPARATOR SYSTEM CYCLIC ACCUMULATORS

THE WATER SEPARATOR CYCLIC ACCUMULATORS ARE RECIPROCATING PUMPS, ACTUATED BY 100 ± 10 PSIG OXYGEN ON THE EXPULSION STROKE AND BY A RETURN SPRING ON THE SUCTION STROKE. ONLY ONE ACCUMULATOR OPERATES AT A TIME, THE OTHER ACCUMULATOR SERVES AS A STAND-BY UNIT. EACH ACCUMULATOR IS PROVIDED WITH A CYCLIC ACCUMULATOR SELECTOR VALVE LOCATED ON THE COOLANT CONTROL PANEL.

WASTE WATER S/M SUPPLY SHUTOFF VALVE

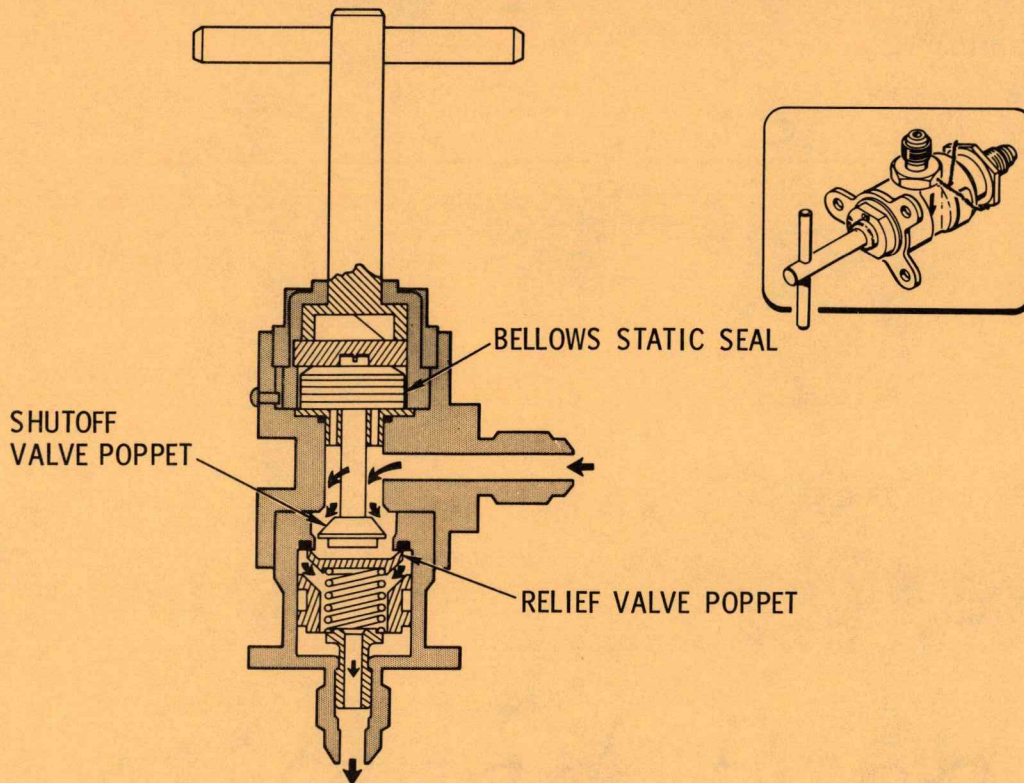


FIGURE 4-10

OVERBOARD PRESSURE RELIEF VALVE

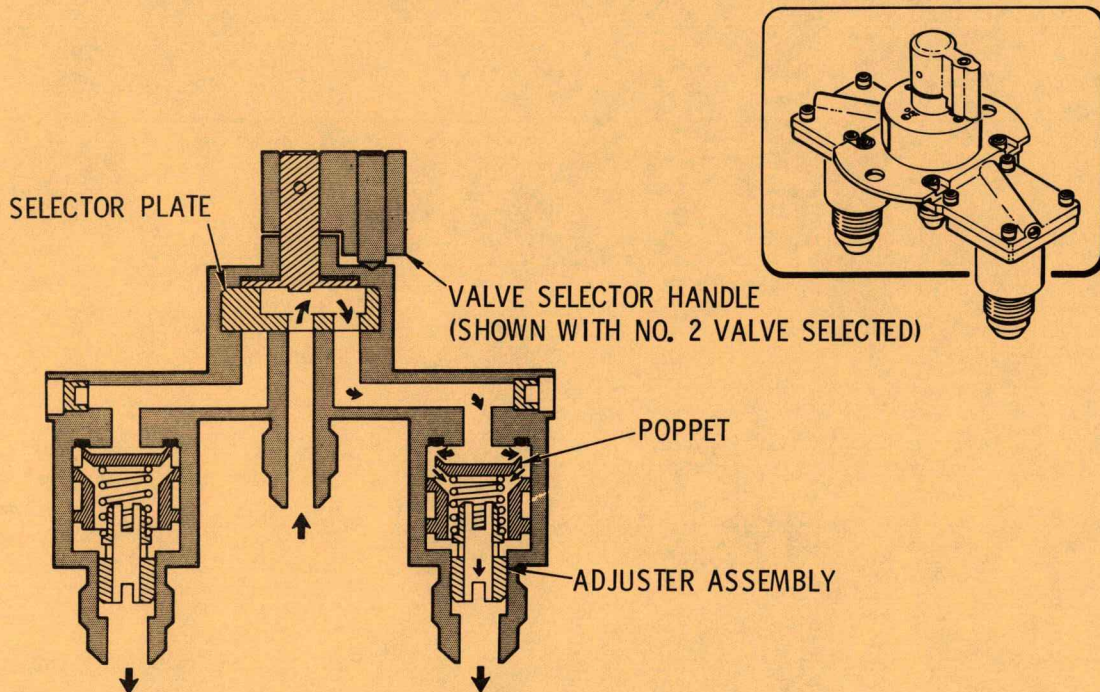



FIGURE 4-10A

ECS-40B 

CYCLIC ACCUMULATOR SELECTOR VALVE

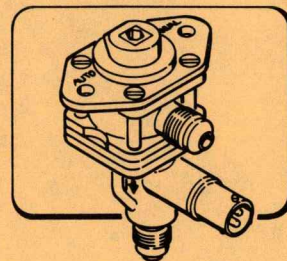
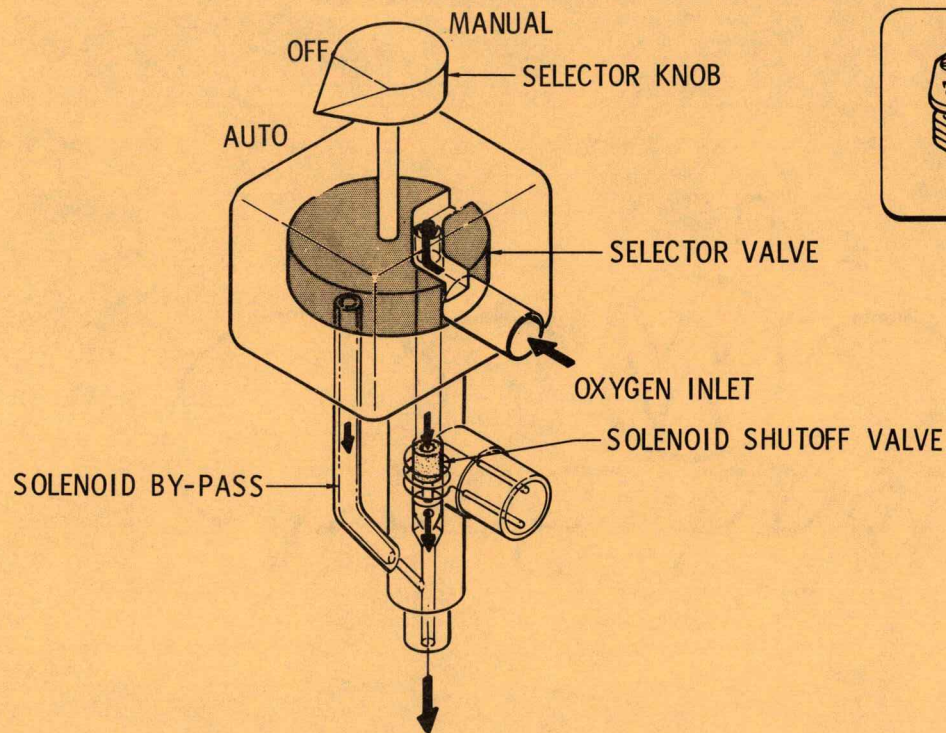


FIGURE 4-11

WATER ACCUMULATOR CONTROL

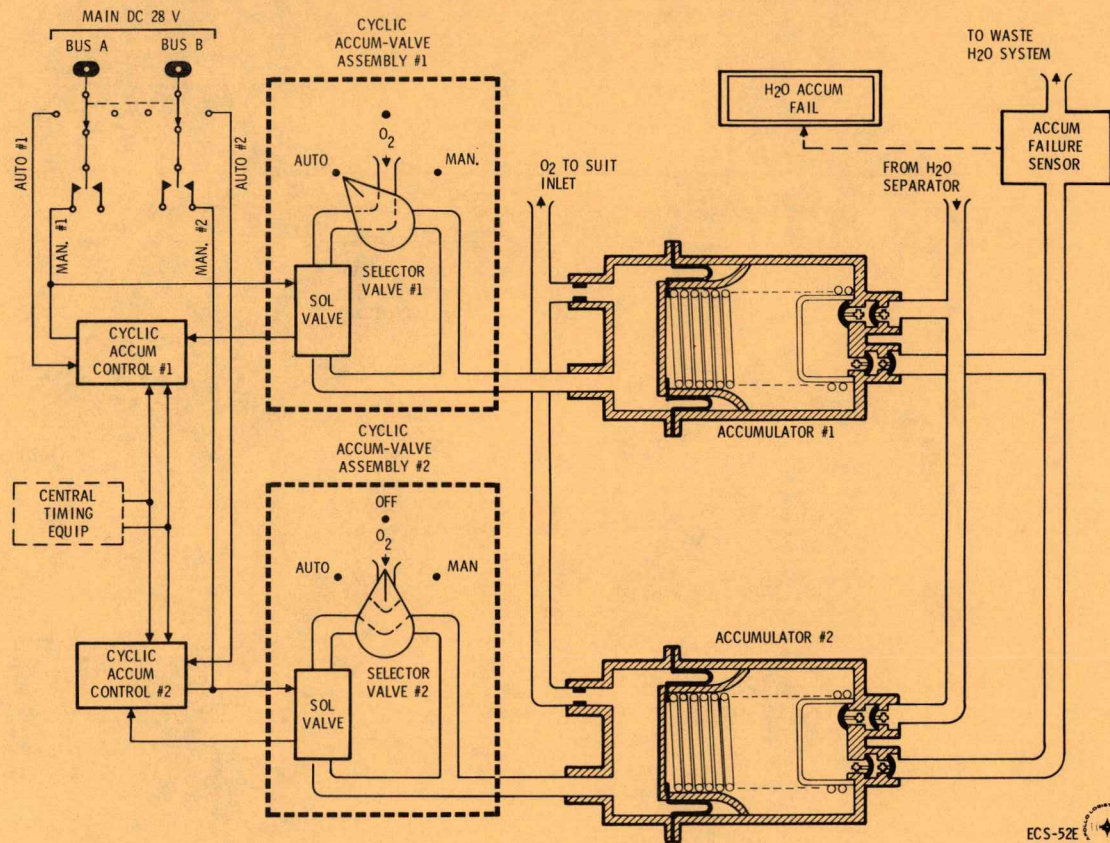


FIGURE 4-11A

IN OPERATION, WATER IS DRAWN INTO AN ACCUMULATOR THROUGH ONE SET OF CHECK VALVES AND IS EXPELLED THROUGH ANOTHER SET OF CHECK VALVES TO THE WASTE WATER TANK. THE EXPENDED OXYGEN IS EXHAUSTED TO THE SUIT CIRCUIT AS MAKE-UP GAS.

SECTION V

WATER GLYCOL SUBSYSTEM

5.1 GENERAL

THE WATER GLYCOL SUBSYSTEM (FIGURE 5-1) IS A CLOSED LOOP HEAT TRANSFER SYSTEM THROUGH WHICH AQUEOUS ETHYLENE GLYCOL IS CIRCULATED CONTINUOUSLY. THE SUBSYSTEM PROVIDES THERMAL CONTROL FOR THE SUIT AND CABIN GASSES, AND THE SPACECRAFT EQUIPMENT.

OPERATION OF THE SUBSYSTEM VARIES ACCORDING TO THE OPERATIONAL REQUIREMENTS IMPOSED BY EACH MISSION PHASE. THE OPERATING MODES, AND COOLANT FLOW PATHS, ARE CHANGED PRIMARILY TO ACCOMMODATE THE HEAT TRANSFER MODE AVAILABLE AT ANY PARTICULAR TIME, AND TO SATISFY THE NEEDS OF THE CREW. THE OPERATIONAL REQUIREMENTS, AND THE OPERATING MODES OF THE MAJOR TEMPERATURE CONTROL LOOPS ARE DESCRIBED BELOW.

5.2 OPERATION

5.2.1 PRELAUNCH/ASCENT

PRIOR TO LAUNCH, THE WATER-GLYCOL COOLANT IS CHILLED AND CIRCULATED THROUGH THE SYSTEM BY THE GROUND SUPPORT EQUIPMENT (GSE). AT THIS TIME, THE RESERVOIR INLET AND OUTLET VALVES ARE OPEN AND THE RESERVOIR BY-PASS VALVE IS CLOSED. THIS PROVIDES A

ONE GALLON RESERVE OF COLD WATER-GLYCOL WHICH IS USED AS A HEAT SINK DURING THE ASCENT PHASE.

ADDITIONAL HEAT SINK CAPABILITY IS OBTAINED BY SELECTING MAXIMUM COOLING ON THE CABIN TEMPERATURE CONTROL, AND PLACING BOTH CABIN FANS IN OPERATION. THIS COLD-SOAKS THE COMMAND MODULE INTERIOR STRUCTURE AND EQUIPMENT.

THE COOLANT LEAVING THE RESERVOIR PASSES THROUGH THE GLYCOL EVAPORATOR AND FLOWS TO THE SUIT HEAT EXCHANGER, AND THE INERTIAL MEASUREMENT UNIT. FROM THE SUIT HEAT EXCHANGER, THE GLYCOL FLOWS THROUGH THE CABIN TEMPERATURE CONTROL VALVE (WHICH IS IN THE MAX COOL POSITION), THE CABIN HEAT EXCHANGER, AND INTO THE COLDPLATE NETWORK WHERE IT JOINS THE COOLANT FLOW FROM THE INERTIAL MEASUREMENT UNIT. FROM THE COLDPLATES, THE COOLANT FLOWS THROUGH THE GLYCOL PUMP ASSEMBLY, THE S/M GLYCOL SHUTOFF VALVE, THE SPACE RADIATORS, AND OUT THE GSE RETURN LINE TO THE FSE WHERE IT IS COOLED AND RECIRCULATED.

DURING ASCENT, THE RADIATORS WILL BE HEATED BY AERODYNAMIC FRICTION. TO PREVENT THIS HEAT FROM BEING ADDED TO THE C/M THERMAL LOAD, THE S/M GLYCOL SHUTOFF VALVE IS CLOSED BEFORE LAUNCH, AND THE COOLANT IS BYPASSED DIRECTLY FROM THE PUMP TO THE RESERVOIR.

WATER GLYCOL SUBSYSTEM

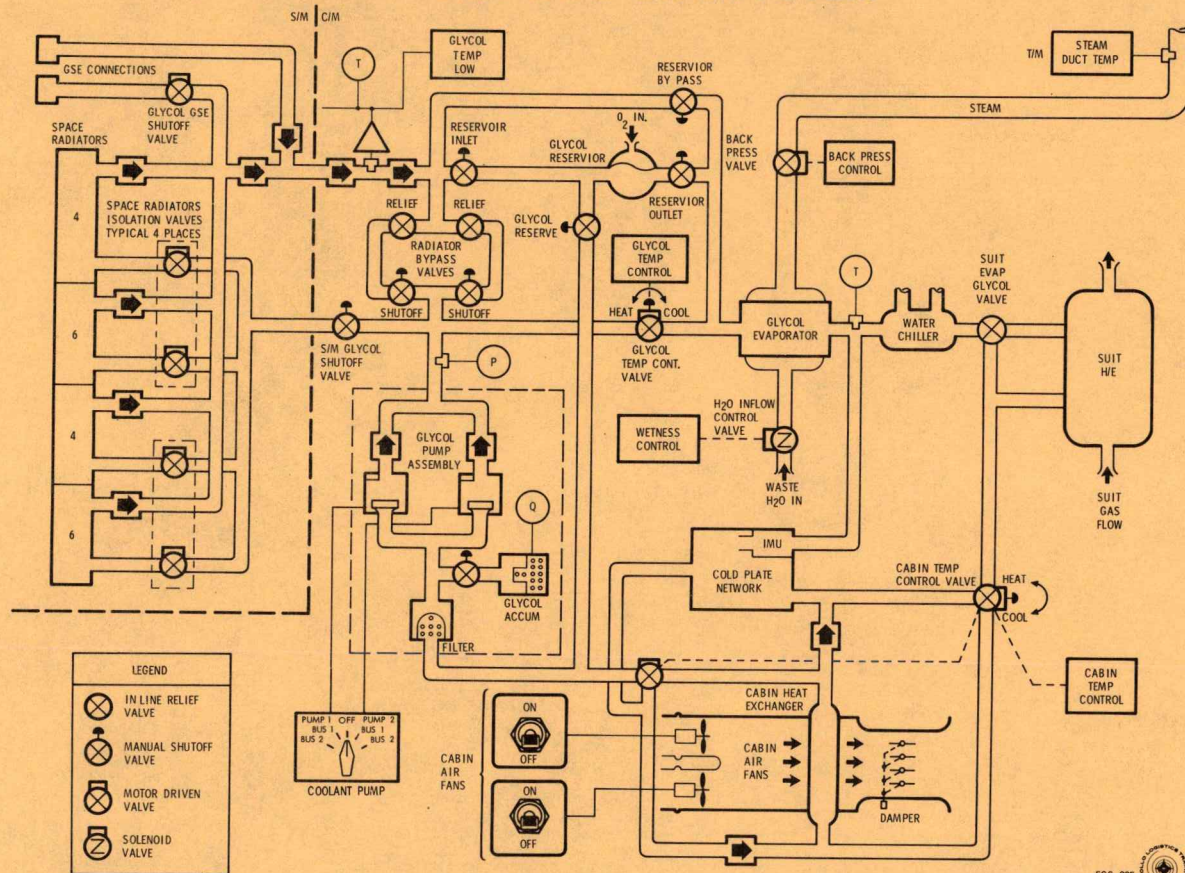


FIGURE 5-1

FROM THE TIME OF GSE DISCONNECT UNTIL THE SPACECRAFT PASSES LOOK FEET, THE HEAT GENERATED IS ABSORBED BY THE COOLANT AND THE PRE-CHILLED STRUCTURE. ABOVE LOOK FEET IT WILL BE POSSIBLE TO REJECT THE EXCESS HEAT BY EVAPORATING WATER IN THE GLYCOL EVAPORATOR AND THE SUIT HEAT EXCHANGER. PRIOR TO LAUNCH, THE GLYCOL TEMPERATURE CONTROL IS DEACTIVATED AND THE VALVE IS CLOSED MANUALLY. THIS PREVENTS THE AUTOMATIC CONTROL FROM CHANGING THE COOLANT FLOW CONFIGURATION REQUIRED FOR THE ASCENT PHASE. ALSO, THE EVAPORATORS ARE FILLED WITH AN EXCESS QUANTITY OF WATER AND THE WETNESS CONTROLS ARE DEACTIVATED. THIS ENSURES A SUFFICIENT QUANTITY OF WATER FOR EVAPORATIVE COOLING DURING ASCENT AND PREVENTS OVERFLOODING THE EVAPORATORS. AT ABOUT 275K FEET THE WETNESS CONTROLS ARE REACTIVATED.

5.2.2 EARTH ORBIT

AFTER ATTAINING ORBIT THE RESERVOIR IS ISOLATED FROM THE LOOP BY OPENING THE BYPASS VALVE AND CLOSING THE INLET AND OUTLET VALVES. THIS PROVIDES A RESERVE QUANTITY OF COOLANT FOR REFILLING THE SYSTEM IN CASE OF LOSS OF FLUID BY LEAKAGE.

THE S/M GLYCOL SHUTOFF VALVE IS OPENED, TO ALLOW CIRCULATION THROUGH THE RADIATORS, THE GLYCOL TEMPERATURE CONTROL IS REACTIVATED, AND THE CABIN TEMPERATURE SELECTOR IS POSITIONED AS DESIRED.

5.2.3 ENTRY

SEVERAL HOURS BEFORE C/M - S/M SEPARATION THE SUBSYSTEM IS SET UP FOR COLD-SOAK OPERATION. THE PRESSURE SUIT TEMPERATURE CONTROL IS TRANSFERRED TO THE BACK PRESSURE CONTROL FOR EVAPORATIVE COOLING FOR THE REMAINDER OF THE MISSION. THE CABIN TEMPERATURE CONTROL IS POSITIONED FOR MAXIMUM COOLING, AND BOTH FANS ARE PLACED IN OPERATION. THE GLYCOL RESERVOIR VALVES ARE POSITIONED FOR THROUGH-FLOW OPERATION. PRIOR TO SEPARATION, THE S/M GLYCOL SHUTOFF VALVE IS CLOSED.

5.2.4 WATER GLYCOL TEMPERATURE CONTROL

THE WATER-GLYCOL TEMPERATURE CONTROL (FIGURE 5-2) REGULATES THE TEMPERATURE AT THE OUTLET OF THE EVAPORATOR AT 45° - 48°F. TEMPERATURE CONTROL IS ACCOMPLISHED BY EMPLOYING THREE CONTROL SUBSYSTEMS. THESE ARE THE GLYCOL TEMP CONTROL, WHICH CONTROLS THE TEMPERATURE AT THE INLET TO THE EVAPORATOR AT 45°F; THE BACKPRESSURE CONTROL, WHICH REGULATES THE EVAPORATIVE COOLING PROCESS TO CONTROL THE TEMPERATURE AT THE OUTLET OF THE EVAPORATOR TO 46°F; AND THE WETNESS CONTROL, WHICH REGULATES THE FLOW OF WATER TO THE EVAPORATOR.

GLYCOL TEMPERATURE CONTROL

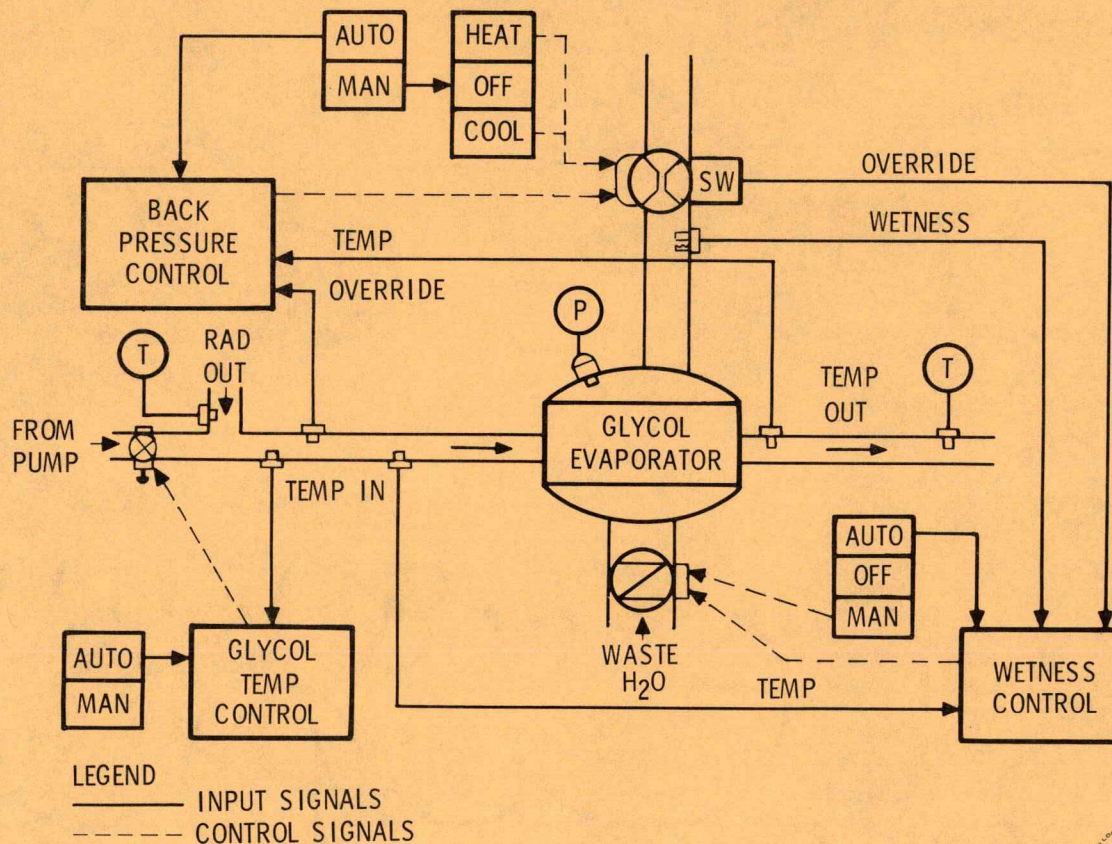


FIGURE 5-2

DURING SPACE OPERATIONS THE WATER-GLYCOL IS COOLED IN THE SPACE RADIATORS. THE TEMPERATURE OF THE RETURNING FLUID IS SENSED BY THE GLYCOL TEMP CONTROL AT THE INLET TO THE EVAPORATOR. IF THE TEMPERATURE IS LESS THAN 45°F THE GLYCOL TEMP CONTROL VALVE WILL BE OPENED TO ALLOW SOME OF THE HOT GLYCOL FROM THE PUMP TO MIX WITH THE RETURNING COLD GLYCOL TO OBTAIN 45°F AT THE EVAPORATOR INLET. WHEN THE TEMPERATURE AT THE INLET TO THE EVAPORATOR RISES ABOVE 45°F THE GLYCOL TEMP CONTROL VALVE CLOSES.

WHEN THE INLET TEMPERATURE RISES ABOVE 48°F THE OVERRIDE SIGNAL IS REMOVED FROM THE BACKPRESSURE CONTROL. THIS ALLOWS THE CONTROL TO OPEN THE BACKPRESSURE VALVE, THUS STARTING THE EVAPORATIVE PROCESS BY WHICH THE GLYCOL WILL BE COOLED. DURING THE EVAPORATIVE MODE OF COOLING THE TEMPERATURE OF THE GLYCOL IS MAINTAINED AT 46°F AS SENSED AT THE OUTLET OF THE EVAPORATOR.

WHEN THE BACKPRESSURE VALVE OPENS AN INTEGRAL SWITCH REMOVES AN OVERRIDE SIGNAL FROM THE WETNESS CONTROL. THIS ENABLES THE CONTROL TO OPEN THE WATER INFLOW CONTROL VALVE. WATER IS ALLOWED TO FLOW INTO THE EVAPORATOR UNTIL THE WETNESS SENSOR IN THE STEAM MANIFOLD DETECTS A WET STEAM, AT WHICH TIME THE CONTROL CLOSES THE WATER VALVE.

5.2.5 PRESSURE SUIT TEMPERATURE CONTROL

THE PRESSURE SUIT TEMPERATURE CONTROL (FIGURE 5-3) IS ACCOMPLISHED BY EMPLOYING THREE CONTROL

SUBSYSTEMS WHICH ARE THE GLYCOL BYPASS CONTROL SUBSYSTEM, THE BACKPRESSURE CONTROL SUBSYSTEM, AND THE WATER CONTROL SUBSYSTEM. DURING NORMAL COOLING OPERATION WITH NOMINAL 167 LBS/HR. 45°F WATER-GLYCOL ENTERING THE HEAT EXCHANGER ASSEMBLY, THE GLYCOL BYPASS CONTROL SUBSYSTEM MAINTAINS THE OTHER SUBSYSTEM IN THE OVERRIDE CONDITION, PREVENTING WATER MAKEUP OR BOILING IN THE EVAPORATOR SECTION. WHENEVER THE GLYCOL CANNOT COOL THE SUIT GAS BELOW REQUIRED TEMPERATURE LIMITS, THE GLYCOL BYPASS CONTROL ACTIVATES THE SUBSYSTEM TO THE EVAPORATIVE MODE AND SIMULTANEOUSLY PREVENTS CIRCULATION OF GLYCOL THROUGH THE HEAT EXCHANGER.

THE GLYCOL BYPASS CONTROL IS USED WITH THE GLYCOL INLET TEMPERATURE SENSOR, THE SUIT GAS TEMPERATURE SENSOR, THE SELECTOR SWITCH, AND THE GLYCOL BYPASS VALVE TO INITIATE AUTOMATIC TRANSITION TO THE EVAPORATIVE MODE. UNDER GLYCOL COOLING OPERATION, THE SUIT GAS IS MAINTAINED BETWEEN 50 AND 55°F. IF EITHER THE SUIT GAS TEMPERATURE EXCEEDS 60°F, OR THE INLET GLYCOL TEMPERATURE EXCEEDS 52°F, THE BYPASS CONTROL ACTUATES THE BYPASS VALVE IN THE BYPASS DIRECTION TO DIVERT GLYCOL AWAY FROM THE HEAT EXCHANGER ASSEMBLY. ONCE THE BYPASS VALVE IS IN THE FULL BYPASS POSITION, AN OVERRIDE SWITCH WITHIN THE VALVE PLACES THE TEMPERATURE CONTROL SUBSYSTEM IN THE LOW PRESSURE BOILING MODE WITH AUTOMATIC OPERATION OF THE WATER CONTROL SUBSYSTEM.

THE RETURN TO THE GLYCOL COOLING MODE COMMENCES WHEN EITHER (A) THE SUIT GAS TEMPERATURE DROPS BELOW 60°F WHILE THE INLET GLYCOL TEMPERATURE IS LESS THAN 49°F, OR (B) THE INLET GLYCOL TEMPERATURE DROPS BELOW 49°F WHILE THE SUIT GAS TEMPERATURE IS LESS THAN

PRESSURE SUIT TEMPERATURE CONTROL

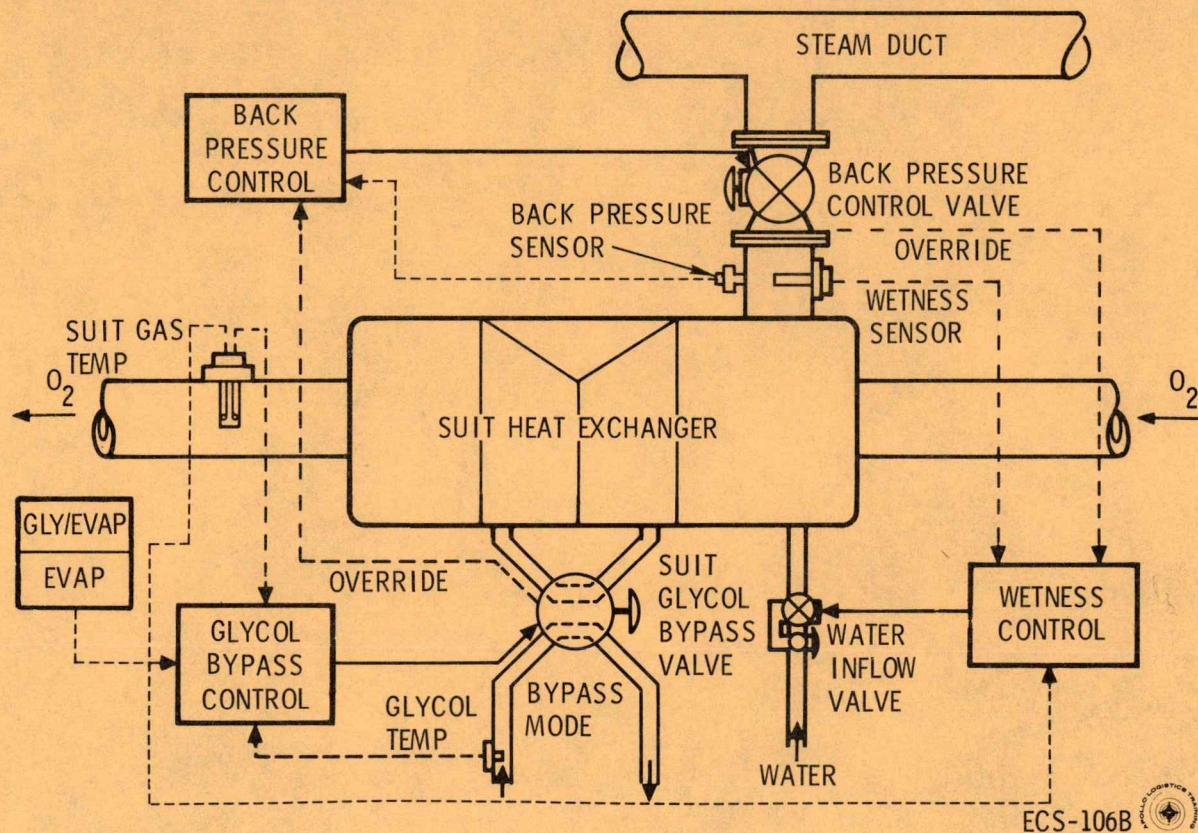


FIGURE 5-3

60°F. IN THE LATTER CASE, A 3°F GLYCOL TEMPERATURE HYSTERESIS BAND OF 52°F TO 49°F MUST BE TRAVERSED BEFORE THE CONTROL SUBSYSTEMS CAN REVERT BACK TO THE GLYCOL MODE.

THE REMOTE SELECTOR SWITCH IS USED TO PROVIDE MANUAL SELECTION OF WATER BOILING OPERATION OF THE HEAT EXCHANGER ASSEMBLY AT ANY TIME DURING THE MISSION. IN THE NORMAL (OFF) POSITION, THE SWITCH ALLOWS THE GLYCOL BYPASS CONTROL TO RESPOND TO SIGNALS RECEIVED FROM THE GLYCOL INLET AND SUIT GAS TEMPERATURE SENSORS. HOWEVER, WHEN THE SWITCH IS IN THE EVAPORATIVE (ON) POSITION, THE TEMPERATURE SIGNALS ARE OVERRIDEN AND THE CONTROL ACTUATES THE DIVERTER VALVE TO THE BYPASS POSITION. DURING OPERATION WITH REDUCED FLOW OF 45°F GLYCOL TO THE HEAT EXCHANGER, THE SWITCH IS SET TO THE EVAPORATIVE POSITION TO ELIMINATE OSCILLATION OF THE SUIT GAS TEMPERATURE.

THE BACKPRESSURE CONTROL IS USED WITH THE OUTLET STEAM PRESSURE TRANSDUCER, AND THE SUIT EVAPORATOR BACKPRESSURE VALVE. IN THE GLYCOL COOLING MODE, AN OVERRIDE SWITCH (IN CLOSED POSITION) ON THE GLYCOL BYPASS VALVE CAUSES THE BACKPRESSURE CONTROL TO MAINTAIN THE BACKPRESSURE VALVE IN THE CLOSED POSITION. WHEN THE EVAPORATIVE MODE IS IN OPERATION AND THE BYPASS VALVE OVERRIDE SWITCH IS IN THE OPEN POSITION, THE BACKPRESSURE CONTROL REPOSITIONS THE BACKPRESSURE VALVE AS NECESSARY TO MAINTAIN A CONSTANT STEAM BACKPRESSURE.

THE STEAM PRESSURE TRANSDUCER SENSES THE BACKPRESSURE AND FURNISHES A PROPORTIONAL OUTPUT SIGNAL TO THE BACKPRESSURE CONTROL WHERE THE SIGNAL IS COMPARED WITH A PRESET REFERENCE PRESSURE SIGNAL. THE RESULTANT

PRESSURE ERROR SIGNAL CAUSES THE CONTROL TO REPOSITION THE BACKPRESSURE VALVE UNTIL THE ERROR SIGNAL IS ESSENTIALLY ZERO AND THE SENSED PRESSURE IS WITHIN A CONTROL DEAD BAND ABOUT THE REFERENCE PRESSURE. THE REFERENCE BACKPRESSURE SELECTED TO INSURE THAT THE SUIT GAS TEMPERATURE DOES NOT EXCEED 55°F IS 5.48 MM H₂O ABS.

THE EVAPORATOR WETNESS CONTROL IS USED WITH THE STEAM TEMPERATURE SENSOR, THE SUIT GAS TEMPERATURE SENSOR, AND THE EVAPORATOR WATER CONTROL VALVE TO CONTROL THE APPLICATION OF WATER TO THE SUIT HEAT EXCHANGER ASSEMBLY. THE WETNESS CONTROL IS ACTIVATED TO THE WATER MAKEUP MODE BY AN OVERRIDE SWITCH LOCATED ON THE EVAPORATOR BACKPRESSURE VALVE. WHEN THIS VALVE OPENS, THE OVERRIDE SWITCH OPENS CAUSING THE WETNESS CONTROL TO OPEN OR CLOSE THE WATER VALVE IN RESPONSE TO THE SENSED STEAM TEMPERATURE. THE CONTROL OPENS THE WATER VALVE WHENEVER THE STEAM TEMPERATURE RISES ABOVE A REFERENCE SIGNAL LEVEL ESTABLISHED BY THE SUIT GAS TEMPERATURE. BECAUSE OF THE OPERATING CHARACTERISTICS OF THE EVAPORATOR SECTION OF THE HEAT EXCHANGER ASSEMBLY, THE REFERENCE SIGNAL VARIES AS AN INVERSE FUNCTION OF THE HEAT LOAD AS REPRESENTED BY THE SUIT GAS TEMPERATURE.

5.3 SUBSYSTEM COMPONENTS

5.3.1 GLYCOL GSE SHUTOFF VALVE

THE GLYCOL GSE SHUTOFF VALVE (FIGURE 5-4) IS AN INLINE SOLENOID VALVE, SPRING LOADED TO THE CLOSED POSITION. THE VALVE IS ACTUATED TO THE OPEN POSITION DURING GROUND COOLING OPERATIONS TO PROVIDE A RETURN

GLYCOL GSE SHUTOFF VALVE

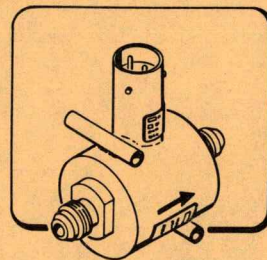
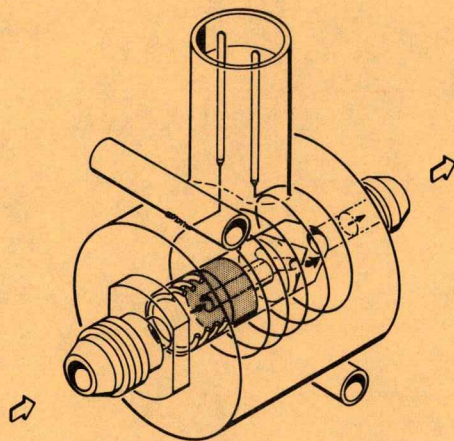


FIGURE 5-4

PATH FOR THE GSE SUPPLIED COOLANT. THE VALVE IS DE-ENERGIZED PRIOR TO LAUNCH, AND OPERATES IN CONJUNCTION WITH THE GLYCOL DRAIN CONNECTION TO PREVENT LOSS OF COOLANT OVERBOARD DURING THE MISSION.

5.3.2 WATER-GLYCOL RESERVOIR

THE WATER-GLYCOL RESERVOIR (FIGURE 5-5) IS USED FOR STORING A RESERVE SUPPLY OF COOLANT. THE RESERVOIR CONSISTS OF TWO HEMISPHERICAL TANK SECTIONS WITH AN EXPULSION BLADDER SEPARATING THE TWO HALVES. THE PRESSURIZING SIDE OF THE TANK HAS INTEGRAL GAS DISTRIBUTION CHANNELS TO ENSURE AN EVEN APPLICATION OF GAS PRESSURE TO THE BLADDER. THE OTHER HALF OF THE TANK HAS INTEGRAL FLUID COLLECTION CHANNELS TO PREVENT COOLANT FROM BEING TRAPPED WITHIN THE TANK BY THE EXPANDING BLADDER.

5.3.3 GLYCOL TEMPERATURE CONTROL VALVE

THE GLYCOL TEMPERATURE CONTROL VALVE (FIGURE 5-6), LOCATED BETWEEN THE PUMP DISCHARGE AND THE GLYCOL EVAPORATOR, CONTROLS THE AMOUNT OF HOT WATER-GLYCOL WHICH IS ALLOWED TO MIX WITH THE COLD WATER-GLYCOL RETURNING FROM THE RADIATORS BEFORE ENTERING THE GLYCOL EVAPORATOR. THE AMOUNT OF MIXING IS A FUNCTION OF THE MAGNITUDE OF THE SENSED TEMPERATURE ERROR.

THE CONTROL VALVE CONSISTS OF A MOTOR DRIVEN ROTARY ACTUATOR AND METERING VALVE EQUIPPED WITH A MANUAL OVERRIDE CONTROL. THE ACTUATOR PRODUCES ROTARY MOTION TO A CAM, WHICH IN TURN POSITIONS THE METERING VALVE.

OPERATING POWER FOR THE MOTOR ACTUATOR IS PROVIDED BY A MOTOR CONTROL SIGNAL FURNISHED BY THE GLYCOL TEMPERATURE CONTROL UNIT. THE MOTOR CONTROL SIGNAL CONSISTS OF A SERIES OF POWER PULSES, WITH A PULSE REPETITION RATE PROPORTIONAL TO THE MAGNITUDE OF THE TEMPERATURE ERROR. THE POWER PULSES RESULT IN INCREMENTAL ROTATION OF THE ACTUATOR FOR SMALL TEMPERATURE ERRORS, AND SWEEPING ROTATION FOR LARGE TEMPERATURE ERRORS.

5.3.4 GLYCOL EVAPORATOR

THE GLYCOL EVAPORATOR (FIGURE 5-7) REMOVES HEAT FROM THE RECIRCULATING WATER-GLYCOL TRANSPORT FLUID USING WATER AS THE EVAPORANT. THE EVAPORATOR EMPLOYS PLATE FIN, SANDWICH CONSTRUCTION IN A CROSS COOLING CAPACITY OF 7620 BTU'S PER HOUR WITH WATER-GLYCOL INLET CONDITIONS OF 100°F AND A WATER-GLYCOL FLOW RATE OF 200 LB/HR. THE WATER-GLYCOL MAKES TWO PASSES AS IT IS COOLED IN THE EVAPORATOR, WHILE THE EVAPORANT MAKES ONLY ONE PASS.

WATER GLYCOL RESERVOIR

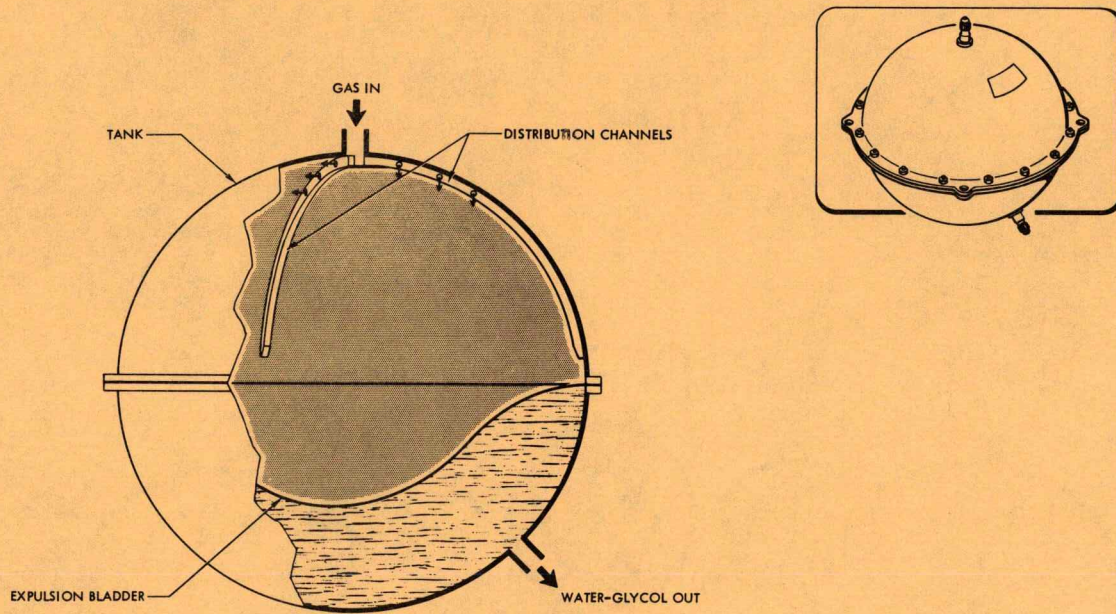


FIGURE 5-5

GLYCOL TEMP CONTROL VALVE

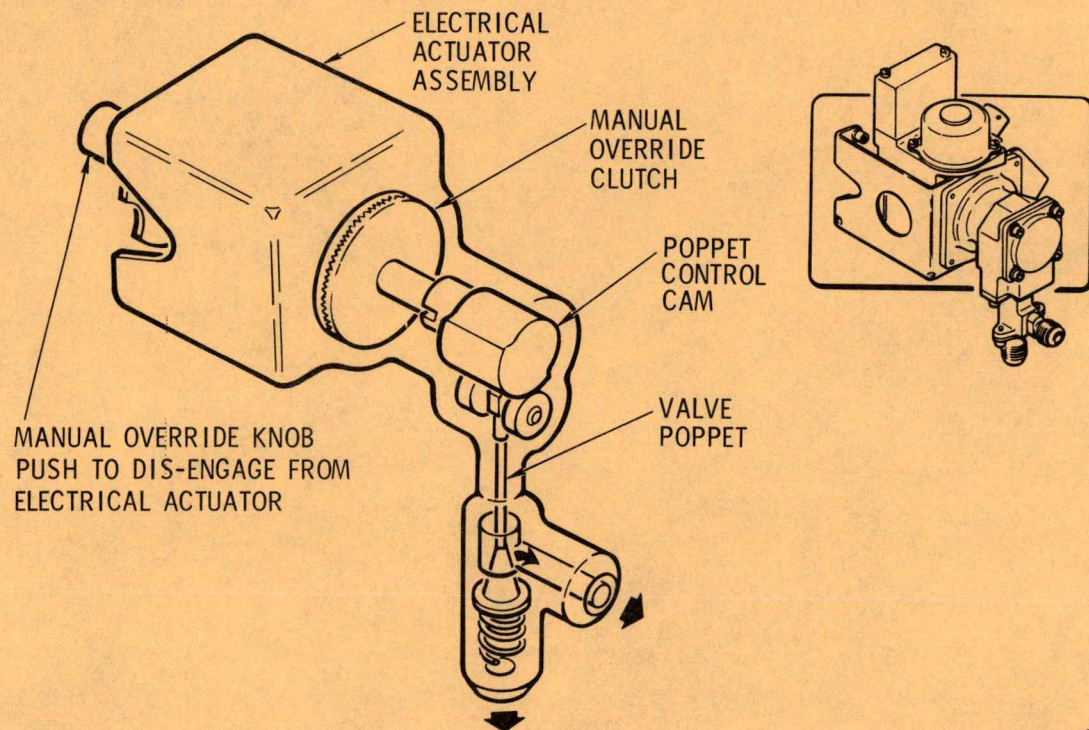



FIGURE 5-6

ECS-82A 

GLYCOL EVAPORATOR

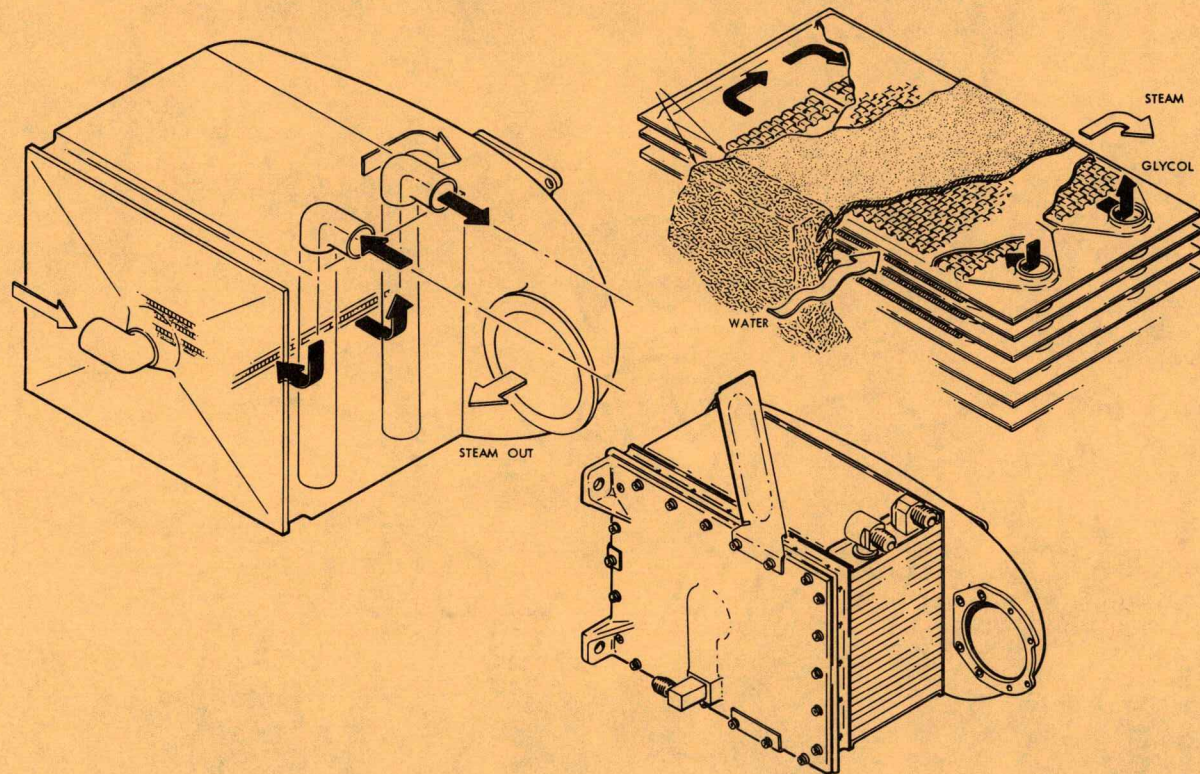


FIGURE 5-7

DURING SPACE OPERATION, COOLING OF THE WATER-GLYCOL IS PROVIDED PRIMARILY BY THE SPACE RADIATOR CIRCUIT. IF ADDITIONAL COOLING IS REQUIRED, WASTE WATER, IS BOILED IN THE EVAPORATOR.

5.3.5 GLYCOL EVAPORATOR WATER CONTROL VALVE

THE GLYCOL EVAPORATOR WATER CONTROL VALVE (FIGURE 5-8) IS A SOLENOID OPERATED POPPET VALVE, SPRING LOADED TO THE CLOSED POSITION. THE VALVE OPERATES IN RESPONSE TO SIGNALS ORIGINATING IN THE WETNESS CONTROL.

5.3.6 BACKPRESSURE VALVE

THE BACKPRESSURE VALVE CONTROLS THE PRESSURE WITHIN THE GLYCOL EVAPORATOR STEAM MANIFOLD, FOR THE PURPOSE OF ACHIEVING THE OPTIMUM EVAPORATION RATE OF COOLING WATER.

THE BACKPRESSURE VALVE (FIGURE 5-9) EMPLOYS A FLEXIBLE TUBULAR LINER RUNNING THE LENGTH OF THE VALVE BODY. A "SQUEEZE" MECHANISM CONSISTING OF A FIXED ANVIL AND A MOVABLE DAMPER, OPERATING IN A PLANE NORMAL TO THE LINER AXIS, IS USED FOR CONTROLLING THE VALVE APERTURE. A MOTOR DRIVEN LINEAR ACTUATOR, OPERATING IN RESPONSE TO SIGNALS ORIGINATING IN THE BACKPRESSURE CONTROLLER, CONTROLS THE POSITION OF THE DAMPER. ICING OF THE VALVE IS PREVENTED BY CIRCULATING HOT WATER-GLYCOL THROUGH A PASSAGE IN THE ANVIL.

5.3.7 CABIN TEMPERATURE CONTROL VALVE

THE CABIN TEMPERATURE CONTROL VALVE (FIGURE 5-10) REGULATES THE QUANTITY OF HOT, OR COLD, WATER-GLYCOL FLOWING THROUGH THE CABIN HEAT EXCHANGER (H/E). THE VALVE IS A MOTOR DRIVEN, SINGLE SPOOL, DUAL, THREE-WAY VALVE, WITH MANUAL OVERRIDE PROVISIONS.

OPERATING POWER FOR THE MOTOR IS FURNISHED BY THE CABIN TEMPERATURE CONTROLLER, WHICH PUTS OUT A SERIES OF 115 VOLT, 400 CYCLE PULSES WHOSE REPETITION RATE IS PROPORTIONAL TO THE MAGNITUDE OF THE TEMPERATURE ERROR. THE PULSED SIGNAL RESULTS IN INCREMENTAL ROTATION OF THE ACTUATOR FOR CORRECTING SMALL ERRORS, AND IN SWEEPING ROTATIONS FOR LARGE ERRORS.

THE CABIN TEMP CONTROL VALVE IS ESSENTIALLY TWO THREE-WAY VALVES WHICH OPERATE SIMULTANEOUSLY IN RESPONSE TO A SINGLE CONTROL. THE DESIGN IS SUCH THAT THE TWO VALVE SECTIONS ARE EFFECTIVELY 90° OUT OF PHASE, SO THAT ROTATING THE VALVE CONTROL THROUGH 180° WILL CAUSE ONE SECTION TO MODULATE THROUGH THE FIRST 90° OF ROTATION AND THE SECOND SECTION TO MODULATE THROUGH THE REMAINING 90° ROTATION. THIS FEATURE, IN CONJUNCTION WITH THE MANNER IN WHICH THE VALVE IS PLUMBED INTO THE LOOP, MAKES IT POSSIBLE TO VARY THE QUANTITY OF EITHER HOT, OR COLD, WATER-GLYCOL FLOWING THROUGH THE CABIN H/E WITHOUT VARYING THE QUANTITY FLOWING THROUGH THE THERMAL LOAD. THE OPERATION IS ILLUSTRATED BY THE GRAPH IN FIGURE 5-10.

GLYCOL EVAPORATOR

WATER CONTROL VALVE

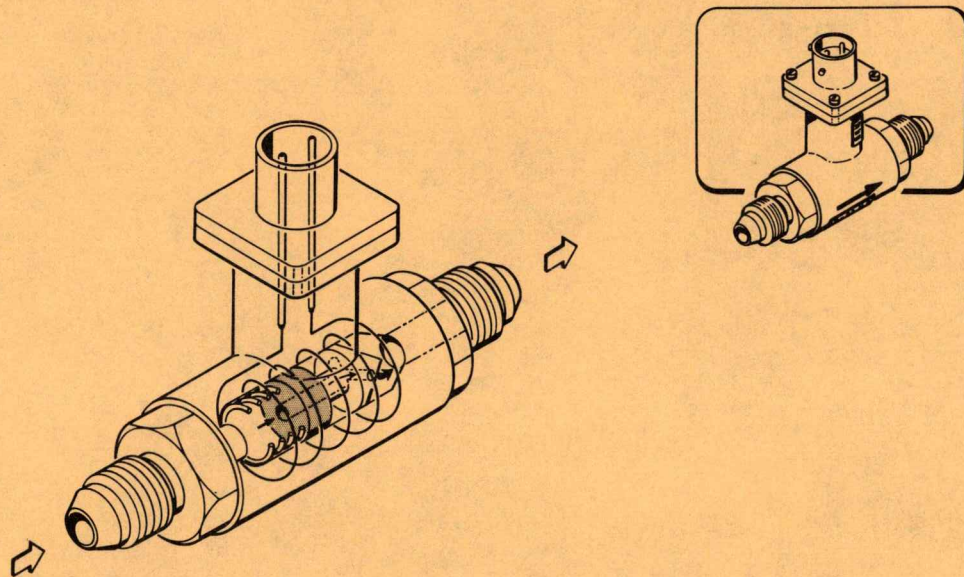


FIGURE 5-8

BACK PRESSURE VALVE

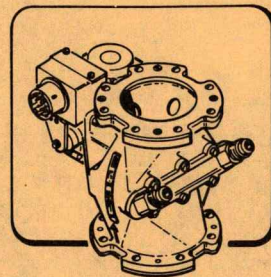
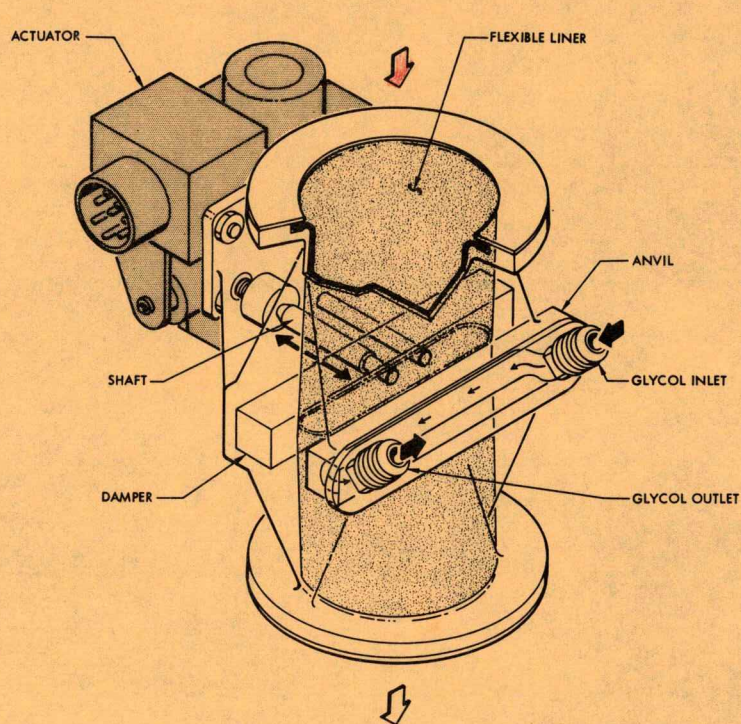
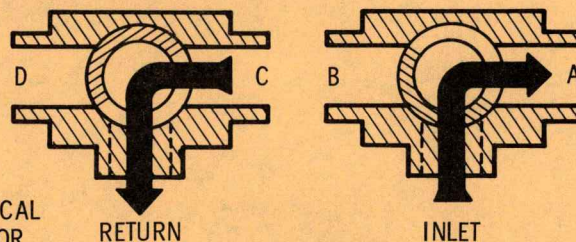
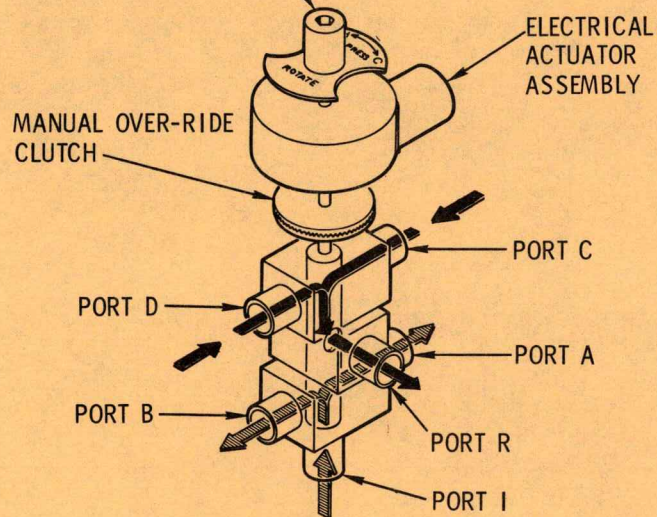


FIGURE 5-9

CABIN TEMP CONTROL VALVE

MANUAL OVER-RIDE KNOB
PUSH TO DIS-ENGAGE FROM
ELECTRICAL ACTUATOR



VALVE SECTIONS
SHOWN IN FULL
CW POSITION

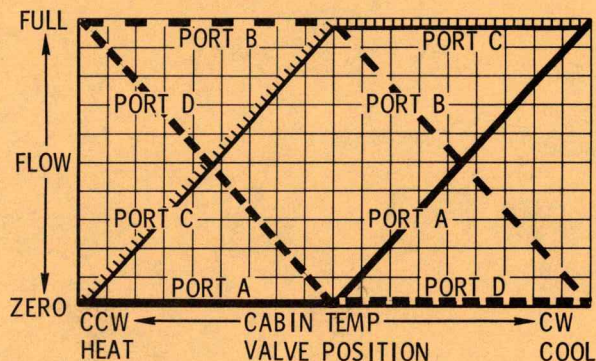


FIGURE 5-10

ECS-42A

THE FOLLOWING PARAGRAPH GIVES AN EXAMPLE OF VALVE OPERATION.

WHEN THE VALVE IS IN THE MAXIMUM COOLING POSITION (FULL CW), 167 LBS OF COLD WATER-GLYCOL FLOWS THROUGH THE CABIN H/E FIRST, THEN THROUGH THE THERMAL LOAD WHERE IT JOINS THE 33 LBS FROM THE IMU, AND THE TOTAL 200 LBS FLOWS OUT THE RETURN SECTION OF THE VALVE TO THE PUMP. IF AN INCREASE IN TEMPERATURE IS NEEDED, THE VALVE IS DRIVEN TOWARD THE HEAT POSITION (CCW ROTATION). ROTATING THE VALVE SPOOL CCW STARTS CLOSING OFF PORT A AND OPENING PORT B WHILE THE RELATION BETWEEN PORTS C & D REMAINS UNCHANGED. THIS ACTION REDUCES THE AMOUNT OF COOLANT FLOWING TO THE CABIN H/E, AND ALLOWS SOME OF THE COOLANT TO BEGIN FLOWING DIRECTLY TO THE THERMAL LOAD. AT APPROXIMATELY 45° FROM THE FULL CW POSITION, THE INLET FLOW IS EVENLY DIVIDED BETWEEN THE CABIN H/E AND THE THERMAL LOAD. WHEN THE VALVE REACHES THE 90° POSITION, PORT A IS FULLY CLOSED AND PORT B FULLY OPEN. AT THIS POINT, THE TOTAL INLET COOLANT FLOW IS THROUGH THE THERMAL LOAD AND NO COOLANT FLOWS THROUGH THE CABIN H/E.

FURTHER CCW ROTATION OF THE VALVE RESULTS IN MODULATION OF THE RETURN SECTION OF THE VALVE. THIS ALLOWS SOME OF THE COOLANT, WHICH HAS BEEN HEATED IN THE THERMAL LOAD, TO FLOW THROUGH THE CABIN H/E AND THEN TO RETURN, WHILE THE REMAINDER FLOWS DIRECTLY TO RETURN. AT A VALVE POSITION APPROXIMATELY 45° FROM FULL CCW, HALF OF THE COOLANT LEAVING THE THERMAL LOAD IS DIRECTED THROUGH THE CABIN H/E. AT FULL CCW POSITION (MAX HEATING), THE TOTAL COOLANT FLOW IS THROUGH THE THERMAL LOAD FIRST, THEN THROUGH THE CABIN H/E.

5.3.8 CABIN HEAT EXCHANGER

THE CABIN HEAT EXCHANGER (FIGURE 5-11) TRANSFERS HEAT TO AND FROM THE CABIN GASSES, USING TEMPERATURE CONTROLLED WATER-GLYCOL AS THE HEAT TRANSPORT FLUID. THE CABIN HEAT EXCHANGER IS A PLATE FIN TYPE, EMPLOYING SANDWICH CONSTRUCTION IN A CROSS COUNTERFLOW ARRANGEMENT. CABIN GASSES ARE FORCED THROUGH THE HEAT EXCHANGER IN A SINGLE PASS BY THE CABIN RECIRCULATING BLOWER. WATER-GLYCOL MAKES TWO PASSES THROUGH THE HEAT EXCHANGER.

5.3.9 CABIN RECIRCULATING BLOWER

THE CABIN RECIRCULATING BLOWER (FIGURE 5-12) PROVIDES THE MEANS FOR VENTILATING THE COMMAND MODULE INTERIOR. THE BLOWER IS A SINGLE STAGE, MOROT DRIVEN AXIAL FLOW FAN OPERATED BY 200 VOLTS, 3-PHASE, 400 CYCLE AC POWER SOURCE. THE FAN EMPLOYS A FIVE VANE IMPELLER, ROTATING AT A NOMINAL SPEED OF 11,000 RPM.

IN NORMAL OPERATION, TWO BLOWERS ARE AVAILABLE FOR CABIN VENTILATION. EACH BLOWER IS CONTROLLED BY A CABIN BLOWER SELECTOR SWITCH LOCATED ON PANEL 22 OF THE MAIN CONTROLS AND DISPLAYS PANEL. BLOWERS MAY BE OPERATED INDIVIDUALLY OR TWO AT A TIME. THEY ARE MOUNTED INSIDE A DUCT IMMEDIATELY UPSTREAM OF THE CABIN HEAT EXCHANGER. THE TWO BLOWERS FORCE THE CABIN GASSES THROUGH THE CABIN HEAT EXCHANGER, WHERE THE GASSES ARE EITHER HEATED OR COOLED.

CABIN HEAT EXCHANGER

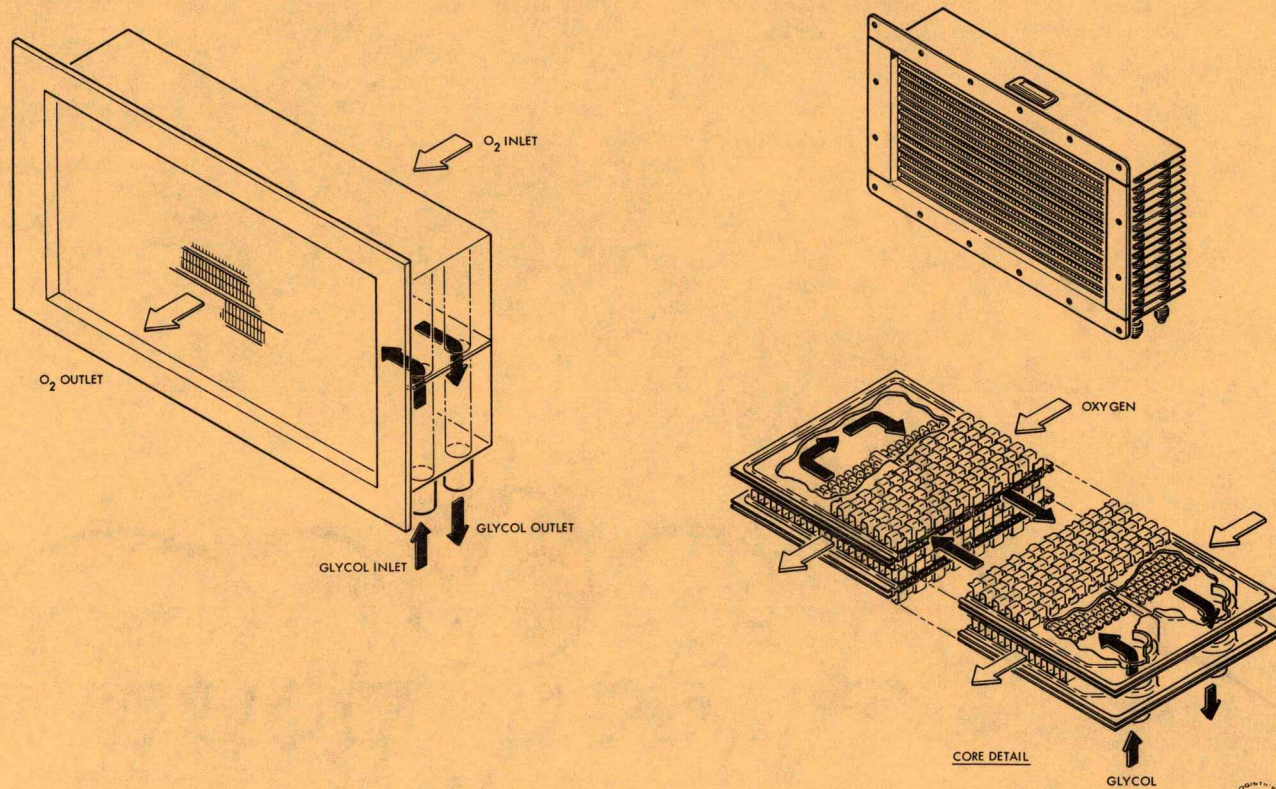


FIGURE 5-11

ECS-78

5-18

CABIN AIR FAN

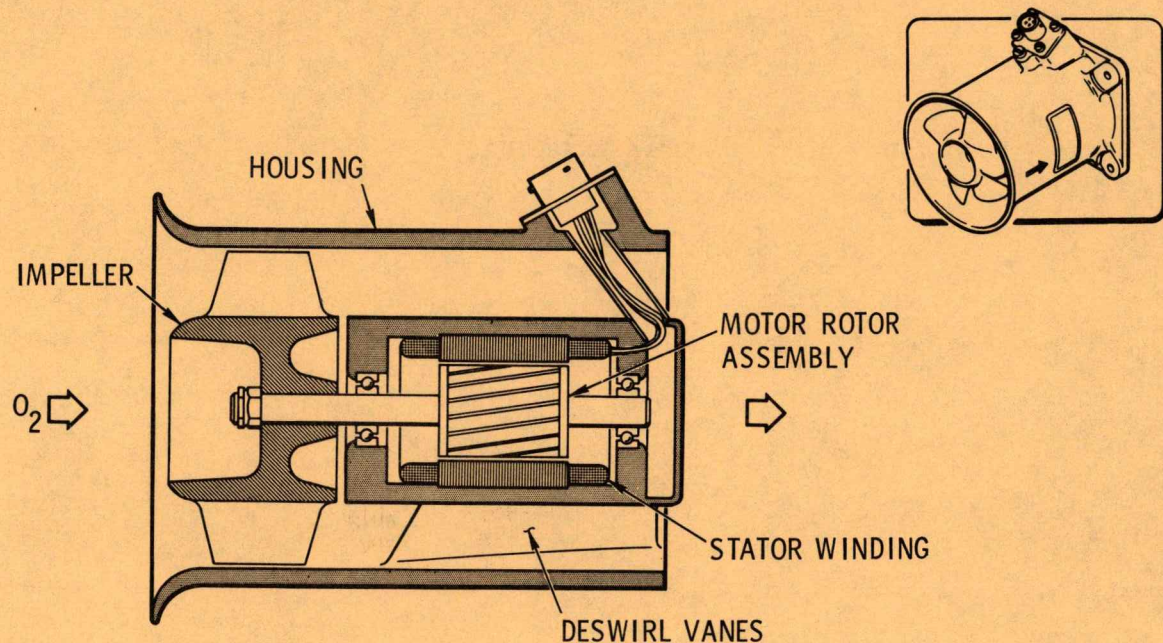


FIGURE 5-12

ECS-34A



5.3.10 GLYCOL PUMP ASSEMBLY

THE GLYCOL PUMP ASSEMBLY (FIGURE 5-13) PROVIDES CONTINUOUS CIRCULATION OF COOLANT IN THE WATER-GLYCOL SUBSYSTEM. THE ASSEMBLY CONSISTS OF TWO CENTRIFUGAL PUMPS, AN ACCUMULATOR WITH AN ISOLATION VALVE, THE DISCHARGE CHECK VALVES, AND A FULL FLOW FILTER.

EACH PUMP IS DRIVEN BY A 200V, 400 CPS 3-PHASE MOTOR, THROUGH A MAGNETIC COUPLING. SPRING LOADED FLAPPER TYPE CHECK VALVES INSTALLED IN THE PUMP DISCHARGE PORTS PREVENT RECIRCULATION OF COOLANT THROUGH THE STAND-BY PUMP. THE ACCUMULATOR COMPENSATES FOR THERMAL CONTRACTION AND EXPANSION OF THE COOLANT, AND MAINTAINS A POSITIVE PUMP INLET PRESSURE TO ENSURE PROPER OPERATION OF THE PUMP. A FULL FLOW FILTER, INSTALLED IN THE PUMP INLET, TRAPS PARTICLES LARGER THAN 50 MICRONS.

5.3.11 GLYCOL PRESSURE RELIEF VALVE

THE GLYCOL PRESSURE RELIEF VALVES (FIGURE 5-14) ARE UTILIZED TO BYPASS THE SPACE RADIATORS WHEN THE PRESSURE DIFFERENTIAL ACROSS THE RADIATORS EXCEEDS 16 PSI. THE RELIEF VALVE CONTAINS A SPRING LOADED POPPET WHICH ALLOWS FLOW THROUGH THE VALVE WHEN A DIFFERENTIAL PRESSURE OF 16 PSI IS SENSED ACROSS THE POPPET. THE RESEAT PRESSURE IS 15.5 PSI.

GLYCOL PUMP ASSEMBLY

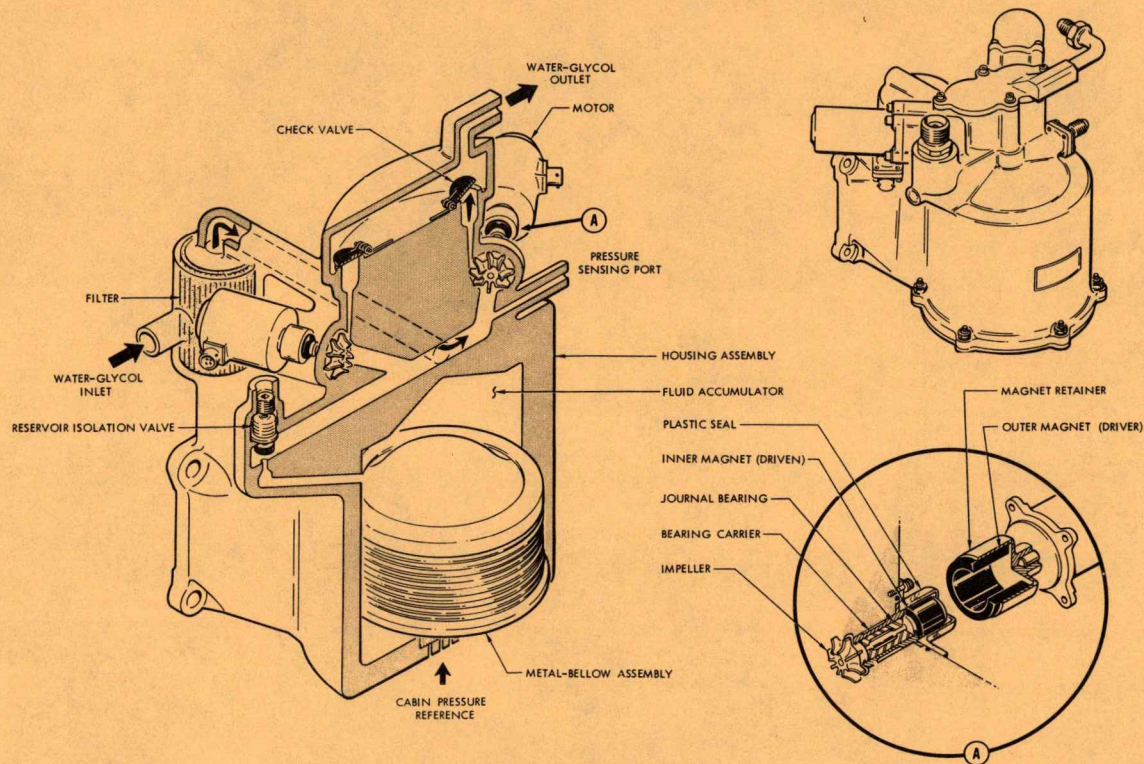


FIGURE 5-13

ECS-48



RELIEF VALVE

GLYCOL PRESSURE

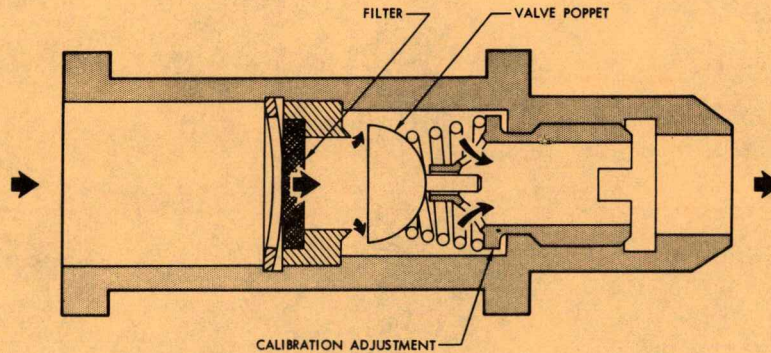
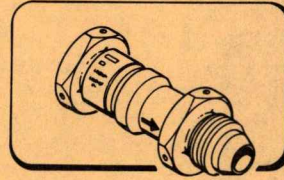


FIGURE 5-14

ECS-38



COOLANT CONTROL PANEL

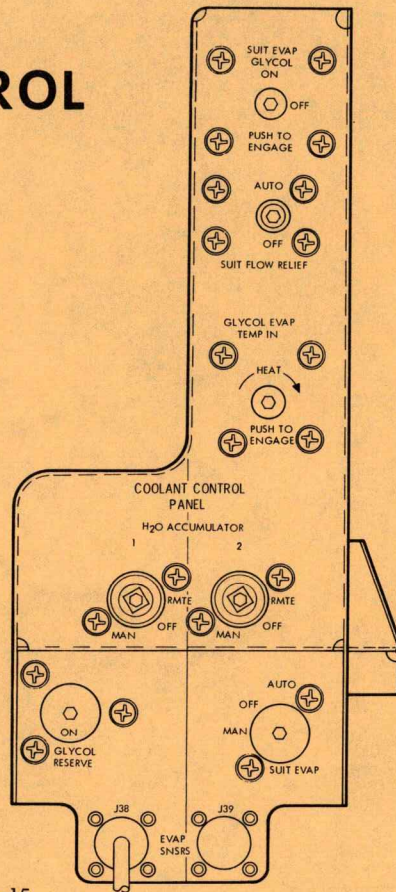
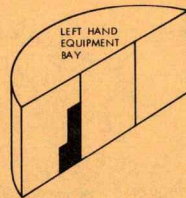


FIGURE 5-15

SECTION VI
CONTROLS & DISPLAYS

THE CONTROLS AND DISPLAYS FOR THE ENVIRONMENTAL CONTROL SYSTEM ARE DESIGNED TO ALLOW MAXIMUM UTILIZATION OF MAN IN THE CONTROL LOOP. HE IS PROVIDED WITH THE MEANS FOR MONITORING AND EVALUATING THE AUTOMATIC CONTROL OF THE SYSTEM, AND FOR EFFECTING MANUAL CONTROL WHEN DEEMED NECESSARY. THE CONTROLS AND DISPLAYS ARE ARRANGED ACCORDING TO TYPE AND THE PERTINENT DATA IS PRESENTED IN THE FOLLOWING TABLES.

TABLE 6-1 APOLLO ENVIRONMENTAL CONTROL SYSTEM WARNING AND CAUTION LIGHTS TABLE

<u>LIGHT NOMENCLATURE</u>	<u>DESCRIPTION</u>	<u>PANEL NO.</u>
CO ₂ PP HI*	PROVIDES AN INDICATION WHEN THE CO ₂ PARTIAL PRESSURE OF THE CABIN ATMOSPHERE BECOMES DANGEROUS FOR CREW EXISTENCE.	10
GLYCOL TEMP LO*	PROVIDES AN INDICATION WHEN THE GLYCOL IN THE SYSTEM REACHES A TEMPERATURE OF -20°F.	11
O ₂ FLOW HI**	PROVIDES AN INDICATION WHEN THE OXYGEN FLOW IS HIGH, MAY INDICATE EXCESSIVE USAGE DUE TO A PUNCTURE IN THE COMMAND MODULE, EQUIPMENT MALFUNCTION, ETC.	11
H ₂ O SEP PUMP FAIL*	INDICATION OF O ₂ FLOW THROUGH THE WATER SEPARATORS WHICH INDICATES A RUPTURED OR FAILED DIAPHRAGM.	11
O ₂ PRESS* - MAIN STORAGE TANKS, SERVICE MODULE	PROVIDES AN INDICATION OF EITHER HIGH OR LOW O ₂ PRESSURE. THIS LIGHT WILL BE ON WHEN THE O ₂ IS OUT OF TOLERANCE FOR NORMAL OPERATION.	11

* COLOR AVIATION YELLOW

** COLOR RED

TABLE 6-2. APOLLO ENVIRONMENTAL CONTROL SYSTEM DISPLAYS TABLE

<u>GAGE NOMENCLATURE</u>	<u>DESCRIPTION</u>	<u>RANGE</u>	<u>PANEL</u>
EVAPORATOR BACKPRESSURE	MEASURES THE GLYCOL EVAPORATOR STEAM PRESSURE	.05 .25 PSIA	13
PRESSURE GLYCOL DISCHARGE	MEASURES GLYCOL PUMP OUTLET PRESSURE	0 60 PSIA	13
FLOW O ₂ (OXYGEN)	INDICATES THE AMOUNT OF OXYGEN BEING USED IN THE CABIN AND SUIT CIRCUITS.	.2 1.LB/HR.	13
P COMPRESSOR	INDICATES THE DIFFERENCE IN PRESSURE ACROSS THE SUIT COMPRESSOR.	0 1 PSI	13
TEMP RADIATOR OUT	INDICATES THE TEMPERATURE OF THE WATER-GLYCOL COOLANT AT THE OUTLET OF THE SPACE RADIATOR.	-50° F +100° F	13
TEMP EVAPORATOR LIQUID	INDICATES THE TEMPERATURE OF THE WATER-GLYCOL AT THE OUTLET OF THE GLYCOL EVAPORATOR.	25° F 75° F	13
GLYCOL ACCUMULATOR	INDICATES THE VOLUME OF WATER GLYCOL COOLANT STORED IN THE GLYCOL ACCUMULATOR.	0 100%	13
WATER	INDICATES THE QUANTITY OF WATER STORED IN THE POTABLE OR WASTE WATER TANKS.	0 100%	13
PRESSURE-SUIT	INDICATES THE SUIT SUPPLY MANIFOLD OUTLET PRESSURE.	0 17 PSIA	13

TABLE 6-2. APOLLO ENVIRONMENTAL CONTROL SYSTEM DISPLAYS TABLE (CONT)

<u>GAGE NOMENCLATURE</u>	<u>DESCRIPTION</u>	<u>LOW</u>	<u>HIGH</u>	<u>PANEL</u>
PRESSURE-CABIN	INDICATES CABIN PRESSURE.	0	17 PSIA	13
TEMPERATURE-SUIT	PROVIDES A TEMPERATURE INDICATION OF THE GASSES FLOWING THROUGH THE SUIT SUPPLY INLET MANIFOLD.	20° F	95° F	13
TEMPERATURE-CABIN	PROVIDES A TEMPERATURE INDICATION OF THE CABIN GASSES.	45°F	125°F	13
PART-PRESSURE CO ₂	INDICATES THE CO ₂ CONTENT OF THE ATMOSPHERE IN THE COMMAND MODULE.	0	30 MM Hg.	13
O ₂ TANK PRESSURE (No. 1 & No. 2)	INDICATES THE PRESSURE OF THE OXYGEN IN THE STORAGE TANKS. THIS INSTRUMENT ON THE NO. 1 SIDE IS TIME SHARED WITH THE O ₂ SURGE TANK.	50 PSIA	1050 PSIA	13
O ₂ TANK QUANTITY (No. 1 & No. 2)	INDICATES THE QUANTITY OF THE OXYGEN REMAINING IN THE TANKS.	0	320 LBS.	13

TABLE 6-3. APOLLO ENVIRONMENTAL CONTROL SYSTEM CONTROLS TABLE

<u>SWITCH NOMENCLATURE</u>	<u>DESCRIPTION</u>	<u>SWITCH POSITIONS</u>		<u>PANEL NO.</u>	<u>NUMBER OF POSITIONS</u>
CABIN AIR FAN (NO. 1)	CONTROLS THE ELECTRICAL POWER (200V 3 ϕ , 400 AC) TO CABIN AIR FAN NO. 1.	OFF	ON	22	2 TOGGLE

TABLE 6-3. APOLLO ENVIRONMENTAL CONTROL SYSTEM CONTROLS TABLE

<u>SWITCH NOMENCLATURE</u>	<u>DESCRIPTION</u>	<u>SWITCH POSITIONS</u>	<u>PANEL NO.</u>	<u>NUMBER OF POSITIONS</u>
CABIN AIR FAN (NO. 2)	CONTROLS THE ELECTRICAL POWER (200V 3 ϕ , 400 AC) TO CABIN AIR FAN NO. 2.	OFF ON	22	2 TOGGLE
COOLANT PUMP (GLYCOL PUMPS)	THIS SWITCH CONTROLS THE ELECTRICAL POWER (200V 3 ϕ , 400 AC) TO THE GLYCOL PUMPS. (ONLY ONE PUMP WILL BE IN OPERATION AT ANY ONE TIME, THESE PUMPS DO NOT OPERATE TOGETHER.)	OFF AC 1 AC 1 AC 2 AC 2 PUMP 1 PUMP 2	21	5 ROTARY CENTER-OFF
SUIT COMPRESSOR	CONTROLS THE ELECTRICAL POWER (200V 3 ϕ , 400 AC) TO THE SUIT COMPRESSORS. (ONLY ONE SUIT COMPRESSOR WILL BE OPERATING AT ANY ONE TIME.)	OFF AC 1 AC 1 AC 2 AC 2 COMP 1 COMP 2	21	5 ROTARY CENTER-OFF
SUIT EVAPORATOR SELECTOR	SELECT EITHER GLY/EVAP OR EVAP FOR THE AMOUNT OF COOLING TO TAKE PLACE IN THE SUIT EVAPORATOR.	GLY/ EVAP UP EVAP DOWN	13	2 MAINTAINING
H ₂ O INDICATOR (POTABLE-WASTE)	SELECTS EITHER THE POTABLE OR THE WASTE WATER TANK QUANTITY TO BE DISPLAYED ON THE WATER QUANTITY GAGE.	POTABLE UP WASTE DOWN	13	2 MAINTAINING
H ₂ O FLOW MAN-AUTO	SELECTS EITHER AUTOMATIC OR ELECTRO MANUAL CONTROL OF THE GLYCOL EVAPORATOR WATER INFLOW CONTROL VALVE. AUTOMATIC OPERATION IS VIA THE WETNESS CONTROL.	AUTO UP OFF CENTER	13	3 MAINTAINING

TABLE 6-3. APOLLO ENVIRONMENTAL CONTROL SYSTEM CONTROLS TABLE (CONT)

<u>SWITCH NOMENCLATURE</u>	<u>DESCRIPTION</u>	<u>SWITCH POSITIONS</u>		<u>PANEL NO.</u>	<u>NUMBER OF POSITIONS</u>
H ₂ O FLOW MAN-AUTO (CONT)	ELECTRO MANUAL OPERATION EITHER OPENS OR CLOSES THE VALVE. (NO MANUAL OPERATION OF THIS VALVE.)				
BACK PRESS. MAN-AUTO	SELECTS EITHER AUTOMATIC OR ELECTRO MANUAL OPERATION OF THE BACK PRESSURE VALVE. WORKS IN CONJUNCTION WITH THE BACK PRESS. HEAT-COOL SWITCH. (NO MANUAL OPERATION OF THIS VALVE.)	AUTO MANUAL	UP DOWN	13	2 MAINTAINING
BACK PRESS. HEAT-COOL	OPENS OR CLOSES THE BACK PRESSURE VALVE, TO INCREASE OR DECREASE THE WATER EVAPORATION RATE. OPERATES WHEN THE BACK PRESS. MAN-AUTO SWITCH IS IN THE MAN POSITION.	HEAT OFF COOL	UP CENTER DOWN	13	3 MAINTAINING
TEMP IN MAN-AUTO	SELECTS EITHER AUTOMATIC OR MANUAL OPERATION OF THE GLYCOL TEMPERATURE CONTROL VALVE.	AUTO MANUAL	UP DOWN	13	2 MAINTAINING
CABIN TEMP (MANUAL- AUTOMATIC)	SELECTS EITHER AUTOMATIC OPERATION OR MANUAL FOR THE AMOUNT OF COOLING TO TAKE PLACE IN THE CABIN, BY CONTROLLING THE CABIN TEMPERATURE CONTROLLER.	AUTO MAN	UP DOWN	13	2 MAINTAINING

TABLE 6-3. APOLLO ENVIRONMENTAL CONTROL SYSTEM CONTROLS TABLE (CONT)

<u>SWITCH NOMENCLATURE</u>	<u>DESCRIPTION</u>	<u>SWITCH POSITIONS</u>	<u>PANEL NO.</u>	<u>NUMBER OF POSITIONS</u>
CABIN TEMP AUTO (THUMB WHEEL)	PROVIDES FOR AUTOMATIC TEMPERATURE CONTROL OF THE CABIN BY CHANGING THE REFERENCE ON THE CABIN TEMPERATURE CONTROL.	ROTATING	13	VARIABLE
H ₂ O ACCUM	SELECTS AUTOMATIC OPERATION OF EITHER WATER ACCUMULATOR 1 OR 2 OR ELECTRO-MECHANICAL OPERATION WHEN IN THE CENTER POSITION.	AUTO 1 MANUAL AUTO 2	UP CENTER DOWN	13
H ₂ O ACCUM	SELECTS ELECTRO MANUAL OPERATION OF EITHER WATER ACCUMULATOR 1 OR 2. OFF IN CENTER POSITION. (AUTOMATIC SWITCH MUST BE IN "MANUAL" POSITION.)	MAN 1 OFF MAN 2	UP CENTER DOWN	13
PRESSURE INDICATOR	SELECTS EITHER NO. 1 O ₂ TANK OR THE SURGE TANK TO BE DISPLAYED ON THE NO. 1 O ₂ PRESSURE GAGE.	TANK 1 SURGE	UP DOWN	13
POTABLE H ₂ O HEATER	CONTROLS ELECTRICAL POWER TO THE H ₂ O HEATER.	MN A OFF MN B	UP DOWN	21

TABLE 6-4. APOLLO ENVIRONMENTAL CONTROL SYSTEM VALVE TABLE

<u>VALVE NOMENCLATURE</u>	<u>DESCRIPTION</u>	<u>VALVE POSITIONS</u>		<u>LOCATION</u>	<u>POSITIONS</u>
S/M O ₂ SHUT-OFF VALVE	PERMITS ISOLATION OF THE COMMAND MODULE O ₂ SYSTEM PRIOR TO ENTRY.	OPEN	CLOSED	ECU	2
SURGE TANK SHUT-OFF VALVE	PERMITS ISOLATION OF THE SURGE TANK FROM THE O ₂ SUPPLY SYSTEM.	OPEN	CLOSED	ECU	2
BACK PACK SUPPLY SHUT-OFF VALVE AND CAP	CONTROLS THE FLOW OF OXYGEN INTO INDIVIDUAL CREW MEMBER BACK PACKS.	OPEN	CLOSED	OXYGEN PANEL	VARIABLE
S/M SUPPLY REGULATOR	REDUCES HIGH PRESSURE OXYGEN FROM THE MAIN OXYGEN SUPPLY TO A REGU- LATED LEVEL. THE MANUAL SHUT-OFF VALVE AND CHECK VALVES PERMIT A FAILED REGULATOR OR RELIEF VALVE TO BE INSOLATED.	1, 1 & 2, 2, OFF		OXYGEN PANEL	4
CABIN PRESSURE REGULATOR	CONTROLS THE FLOW OF OXYGEN INTO THE CABIN DURING SPACE OPERATION TO MAKE UP FOR CABIN GAS DEPLETION DUE TO METABOLIC USAGE, NORMAL LEAKAGE, OR DEPRESSURIZATION.	PRESSURE REGULATOR NONE		OXYGEN PANEL	NONE
	THE REPRESSURIZATION RATE CONTROL IS SET TO PROVIDE CABIN IN- FLOW OXYGEN TO REPRESSURIZE THE CABIN AFTER DECOMPRESSION OR FOR PURGING PURPOSES.	REPRESS VALVE OPEN	CLOSED		2

TABLE 6-4. APOLLO ENVIRONMENTAL CONTROL SYSTEM VALVE TABLE (CONT)

<u>VALVE NOMENCLATURE</u>	<u>DESCRIPTION</u>	<u>VALVE POSITIONS</u>	<u>VALVE LOCATION</u>	<u>NUMBER OF POSITIONS</u>
EMERGENCY INFLOW REGULATOR	SUPPLIES OXYGEN TO THE CABIN TO PREVENT RAPID DECOMPRESSION IN CASE OF CABIN WALL PUNCTURE. THE MANUAL SHUT-OFF VALVE PERMITS THE VALVE TO BE SHUT-OFF ONCE THE ASTRONAUTS ARE IN THEIR PRESSURE SUITS OR A FAILED REGULATOR TO BE ISOLATED.	1, 1 & 2, 2, OFF	OXYGEN PANEL	4
CABIN PRESSURE RELIEF VALVE	PROVIDES FOR POSITIVE AND NEGATIVE PRESSURE RELIEF OF THE CABIN THROUGH- OUT THE VARIOUS PHASES OF THE SPACE- CRAFT MISSION.	DUAL VALVES 1 OPEN, AUTO, CLOSE 2 AUTO, CLOSE	ECU	3
TANK PRESSURE REGULATOR	THIS REGULATOR PROVIDES OXYGEN PRES- SURE FOR POSITIVE-EXPULSION OF LIQUIDS USED IN THE ECS.	INLET REGULATOR 1, 1 & 2, 2, OFF OUTLET 1, 1 & 2, 2, OFF	OXYGEN PANEL	4
CYCLIC ACCUMULATOR CONTROL VALVE (2 EACH)	CONTROLS OXYGEN FLOW TO THE WATER SEPARATOR PUMP. PROVIDES FOR ISOLATION OF ONE OF THE ACCUMULATORS IN THE EVENT OF DAMAGE.	AUTOMATIC, OFF MANUAL	ECU	3

TABLE 6-4. APOLLO ENVIRONMENTAL CONTROL SYSTEM VALVE TABLE (CONT)

<u>VALVE NOMENCLATURE</u>	<u>DESCRIPTION</u>	<u>VALVE POSITIONS</u>	<u>VALVE LOCATION</u>	<u>NUMBER OF POSITIONS</u>
DIRECT O ₂ VALVE	THE OXYGEN METERING VALVE PERMITS MANUAL CONTROL OF OXYGEN FLOW INTO THE SUIT CIRCUIT, FOR ADDITIONAL O ₂ REQUIREMENTS OR FOR PURGING.	OPEN CLOSED	CONTROL DISPLAYS PANEL #24	METERING
SUIT HOSE CONNECTOR (3)	THE CONNECTORS PROVIDE FOR CONNECTING THE PRESSURE SUIT SUPPLY AND RETURN HOSES TO THE PRESSURE CIRCUIT AND FOR CONTROLLING THE INDIVIDUAL SUIT VENTIL- ATION RATE. THE PRESSURE SUIT FLOW CONTROL VALVE PERMITS INDIVIDUAL ADJUSTMENT OF SUIT VENTILATION RATE FROM NO FLOW TO MAXIMUM FLOW.	OFF CABIN FLOW SUITS FULL (FLOW VARIABLE BETWEEN CABIN FLOW AND FULL FLOW)		VARIABLE
SUIT CIRCUIT RETURN CHECK VALVE	PERMITS CABIN GASSES TO ENTER SUIT CIRCUIT. PREVENTS LOSS OF SUIT CIR- CUIT GASSES UNDER EMERGENCY CONDITIONS. PERMITS ISOLATION OF SUIT CIRCUIT FROM THE CABIN IN THE EVENT OF CONTAMINATION.	CIRCULAR PULL-HANDLE AND OPEN CLOSED	ECU	2
SUIT BYPASS VALVE	THIS VALVE PERMITS EACH CREW MEMBER TO VARY THE OXYGEN INFLOW RATE TO HIS PRESSURE SUIT, WITHOUT AFFECTING THE INFLOW RATE TO THE OTHER TWO PRESSURE SUITS.	AUTOMATIC RELIEF MANUAL CLOSED	COOLANT CONTROL PANEL	2

TABLE 6-4. APOLLO ENVIRONMENTAL CONTROL SYSTEM VALVE TABLE (CONT)

<u>VALVE NOMENCLATURE</u>	<u>DESCRIPTION</u>	<u>VALVE POSITIONS</u>	<u>VALVE LOCATION</u>	<u>NUMBER OF POSITIONS</u>
DEMAND PRESSURE REGULATOR	CONTROLS THE SENSED SUIT CIRCUIT PRESSURE TO A PRESSURE SLIGHTLY BELOW CABIN, LIMITS SUIT CIRCUIT PRESSURE TO A MINIMUM OF 3.5 PSIA, AND RELIEVES SUIT CIRCUIT PRESSURE TO PREVENT EXCESSIVE PRESSURE BUILD- UP. INLET SELECTOR VALVE ALLOWS SELECTION OF REGULATOR SECTION.	1, 1 & 2, 2	ECU (COMPRESSOR INLET MANIFOLD)	3
CO ₂ & ODOR ABSORBER ASSEMBLY	THE MANUALLY OPERATED DIVERTER VALVE PERMITS ISOLATION OF A CANISTER OR FULL FLOW EQUALLY DIVIDED THROUGH BOTH CANISTERS. IT PERMITS CANISTER BLEED DOWN TO CABIN CONDITIONS PRIOR TO OPENING AND RECHARGING WITH A FRESH FILTER ASSEMBLY. THE SAFETY INTERLOCK PREVENTS OPENING OF MORE THAN ONE CANISTER AT A TIME.	HANDLE - OPEN CLOSED (PERMITS REPLACE- MENT OF EITHER FILTER BUT NOT BOTH)		2
SUIT EVAPORATOR WATER INFLOW CONTROL VALVE	CONTROLS THE FLOW OF WATER INTO THE SUIT EVAPORATOR FOR COOLING.	AUTO OFF MAN	COOLANT CONTROL PANEL	3

TABLE 6-4. APOLLO ENVIRONMENTAL CONTROL SYSTEM VALVE TABLE (CONT)

<u>VALVE NOMENCLATURE</u>	<u>DESCRIPTION</u>	<u>VALVE POSITIONS</u>	<u>VALVE LOCATION</u>	<u>NUMBER OF POSITIONS</u>
POTABLE WATER SHUT-OFF VALVE	PERMITS ISOLATION OF THE POTABLE WATER TANK FROM THE NORMAL WATER SOURCE (FUEL CELLS) IN THE EVENT OF CONTAMINATION NORMALLY OPEN (CLOSED DURING RE-ENTRY).	OPEN CLOSED	WATER CONTROL PANEL	2
FOOD RECONSTITUTION WATER VALVE	LOCATED ON THE POTABLE WATER SUB- ASSEMBLY. THIS VALVE DELIVERS EITHER HOT AND/OR COLD WATER TO THE CREW FOR FOOD RECONSTITUTION.	HOT OFF COLD	NEXT TO CABIN HEAT EXCHANGER	3
FLEX HOSE DRINKING ASSEMBLY	PERMITS CREW CONSUMPTION UPON DEMAND OF COLD POTABLE WATER WHILE ALL THREE ASTRONAUTS ARE IN THEIR COUCHES.	ON OFF	BEHIND CONTROLS & DISPLAYS PANEL L/H SIDE	2

TABLE 6-4. APOLLO ENVIRONMENTAL CONTROL SYSTEM VALVE TABLE (CONT)

<u>VALVE NOMENCLATURE</u>	<u>DESCRIPTION</u>	<u>VALVE POSITIONS</u>		<u>VALVE LOCATION</u>	<u>NUMBER OF POSITIONS</u>
WASTE WATER S/M SUPPLY SHUT-OFF	DIVERTS WATER GENERATED BY THE FUEL CELLS TO THE WASTE-WATER TANK AFTER THE POTABLE WATER TANK IS FILLED. ALLOWS WATER TO FLOW FROM THE POTABLE-WATER TANK TO THE EVAPORATORS WHENEVER THE WASTE-WATER TANK IS EMPTY. IS AN INLINE RELIEF VALVE.	OPEN	CLOSED	WATER CONTROL PANEL	2
WASTE WATER SERVICING VALVE	PERMITS GROUND SERVICING OF THE WASTE WATER TANK SUPPLY.	OPEN	CLOSED	WATER CONTROL PANEL	2
WATER PRESSURE RELIEF VALVE	PREVENTS OVERPRESSURIZATION OF THE WATER SYSTEM. SELECTOR VALVE ALLOWS EITHER RELIEF VALVE TO BE SELECTED BOTH, OR BOTH VALVES CLOSED, THE WATER WHICH PASSES THROUGH THE VALVE IS VENTED OVERBOARD.	1, 1 & 2, 2 OFF		WATER CONTROL PANEL	4

2

TABLE 6-4. APOLLO ENVIRONMENTAL CONTROL SYSTEM VALVE TABLE (CONT)

<u>VALVE NOMENCLATURE</u>	<u>DESCRIPTION</u>	<u>VALVE POSITIONS</u>		<u>VALVE LOCATION</u>	<u>NUMBER OF POSITIONS</u>
WATER/GLYCOL RESERVOIR INLET	PROVIDES FOR NORMAL FLOW ISOLATION OF THE WATER/GLYCOL AT THE INLET OF THE RESERVOIR. NORMALLY CLOSED (OPEN DURING PRE-LAUNCH, ASCENT, & ENTRY, WHILE THE RESERVOIR IS BEING USED AS A HEAT SINK).	OPEN	CLOSED	GIRTH SHELF	2
WATER/GLYCOL RESERVOIR OUTLET	PROVIDES FOR NORMAL FLOW ISOLATION OF THE WATER/GLYCOL AT THE OUTLET OF THE WATER/GLYCOL RESERVOIR. NORMALLY CLOSED (OPEN DURING PRE-LAUNCH, ASCENT, & ENTRY, WHILE THE RESERVOIR IS BEING USED AS A HEAT SINK).	OPEN		GIRTH SHELF	2
WATER/GLYCOL RESERVOIR BYPASS	PROVIDES FOR BYPASSING THE NORMAL FLOW OF WATER/GLYCOL AROUND THE RESERVOIR. NORMALLY OPEN (CLOSED DURING PRE-LAUNCH ASCENT AND ENTRY.)	OPEN	CLOSED	GIRTH SHELF	2
GLYCOL TEMPERATURE CONTROL VALVE	THIS VALVE IS USED TO MIX HOT WATER/GLYCOL FROM THE PUMP WITH COLD WATER/GLYCOL FROM THE SPACE RADIATORS TO MAINTAIN THE CALIBRATED TEMPERATURE. (ELECTRICALLY OPERATED FROM THE CONTROLLER OR MANUALLY AT THE VALVE.)	FULL-OPEN FULL-CLOSED VARIABLE		COOLANT CONTROL PANEL	VARIABLE

TABLE 6-4. APOLLO ENVIRONMENTAL CONTROL SYSTEM VALVE TABLE (CONT)

<u>VALVE NOMENCLATURE</u>	<u>DESCRIPTION</u>	<u>VALVE POSITION</u>		<u>VALVE LOCATION</u>	<u>NUMBER OF POSITIONS</u>
GLYCOL EVAPORATOR WATER CONTROL VALVE	CONTROLS THE WATER FLOW INTO THE GLYCOL EVAPORATOR. THIS WATER IS EVAPORATED INTO SPACE & AUGMENTS THE SPACE RADIATORS IN MAINTAINING THE CALIBRATED TEMPERATURE VALUE. IS OPERATED BY THE WETNESS CONTROLLER & HAS AN ELECTRICAL/MANUAL OVERRIDE.	OPEN	CLOSED	ECU	2
BACKPRESSURE CONTROL VALVE	THIS VALVE IS USED TO CONTROL THE BOILING TEMPERATURE WITHIN THE WATER/GLYCOL EVAPORATOR. THE VALVE IS LOCATED IN THE STEAM VENT DUCT & CONTROLS THE PRESSURE WITHIN THE WATER/GLYCOL EVAPORATOR. IT IS MOTOR OPERATED, CONTROLLED FROM THE BACK PRESSURE CONTROL SYSTEM, & HAS AN ELECTRICAL/MANUAL OVERRIDE.	VARIABLE MOTOR OPERATED		ECU	VARIABLE
SUIT EVAPORATOR WATER/GLYCOL BYPASS	PROVIDES FOR BYPASSING GLYCOL AROUND THE SUIT EVAPORATOR DURING HIGH HEAT LOAD PERIODS, AND DURING RE-ENTRY FOR MAXIMUM CABIN COOLING.	OPEN	BYPASS	COOLANT CONTROL PANEL	2
CABIN TEMPERATURE CONTROL VALVE	THIS VALVE CONTROLS THE FLOW RATE OF HOT OR COLD WATER-GLYCOL ENTERING THE CABIN HEAT EXCHANGER FOR THE PURPOSE OF HEATING OR COOLING THE CABIN GASES.	COLD	HOT	CABIN HEAT EXCHANGER PANEL	VARIABLE

TABLE 6-4. APOLLO ENVIRONMENTAL CONTROL SYSTEM VALVE TABLE (CONT)

<u>VALVE NOMENCLATURE</u>	<u>DESCRIPTION</u>	<u>VALVE POSITIONS</u>		<u>VALVE LOCATION</u>	<u>NUMBER OF POSITIONS</u>
CABIN TEMPERATURE CONTROL VALVE (CONT)	THIS VALVE IS OPERATED ELECTRICALLY BY THE CABIN TEMPERATURE CONTROL, OR IT MAY BE OPERATED MANUALLY.				
GLYCOL RESERVE VALVE	PERMITS REFILLING THE GLYCOL PUMP ACCUMULATOR FROM THE GLYCOL RESERVOIR. (NORMALLY CLOSED).	OPEN	CLOSED	COOLANT CONTROL PANEL	2
GLYCOL ACCUMULATOR ISOLATION VALVE	PERMITS ISOLATION OF THE GLYCOL ACCUMULATOR IN THE EVENT OF A LEAK.	OPEN	CLOSED	ECU	2
S/M GLYCOL SHUT- OFF VALVE	PROVIDES A MEANS OF ISOLATING THE SPACE RADIATORS FROM THE GLYCOL SYSTEM.	OPEN	CLOSED	GIRTH SHELF	2
GLYCOL RELIEF VALVES AND SHUT-OFF VALVES	THESE VALVES PERMIT EXCESSIVE PRESSURE IN THE SUPPLY LINES TO THE SPACE RADIATORS TO BE BY-PASSED INTO THE INLET LINE GOING TO THE GLYCOL EVAPORATOR. THE SHUT-OFF VALVES PERMIT ISOLATION OF A RELIEF VALVE.	OPEN	CLOSED	ECU	
SPACE RADIATOR ISOLATION VALVES	PROVIDES REMOTE CONTROL OF WATER- GLYCOL FLOW TO THE SPACE RADIATORS.	OPEN	CLOSED	SERVICE MODULE (SWITCH ON PANEL #21)	2

*ECU - ENVIRONMENTAL CONTROL UNIT

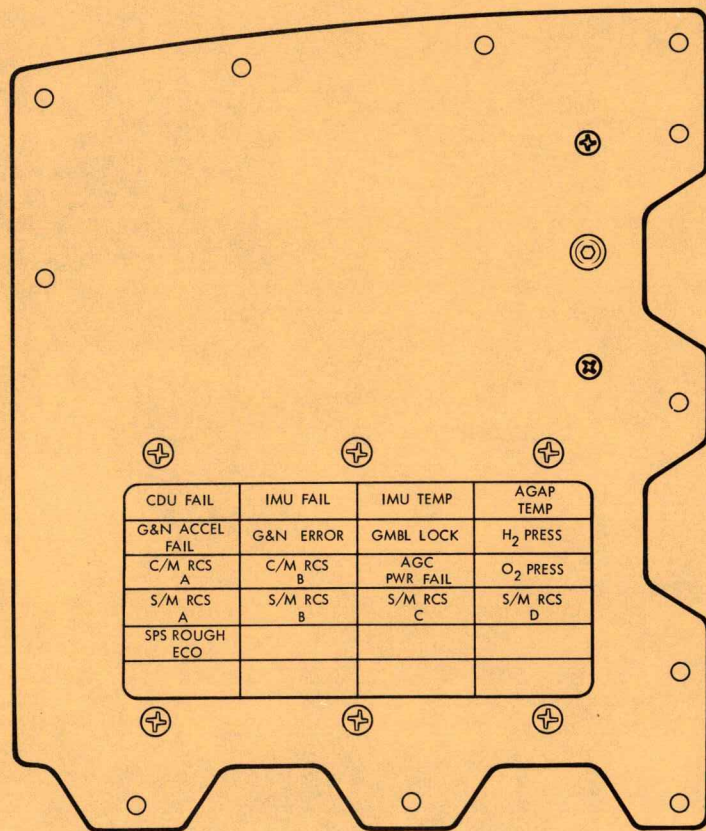


FIGURE 6-1

FAM-6210C



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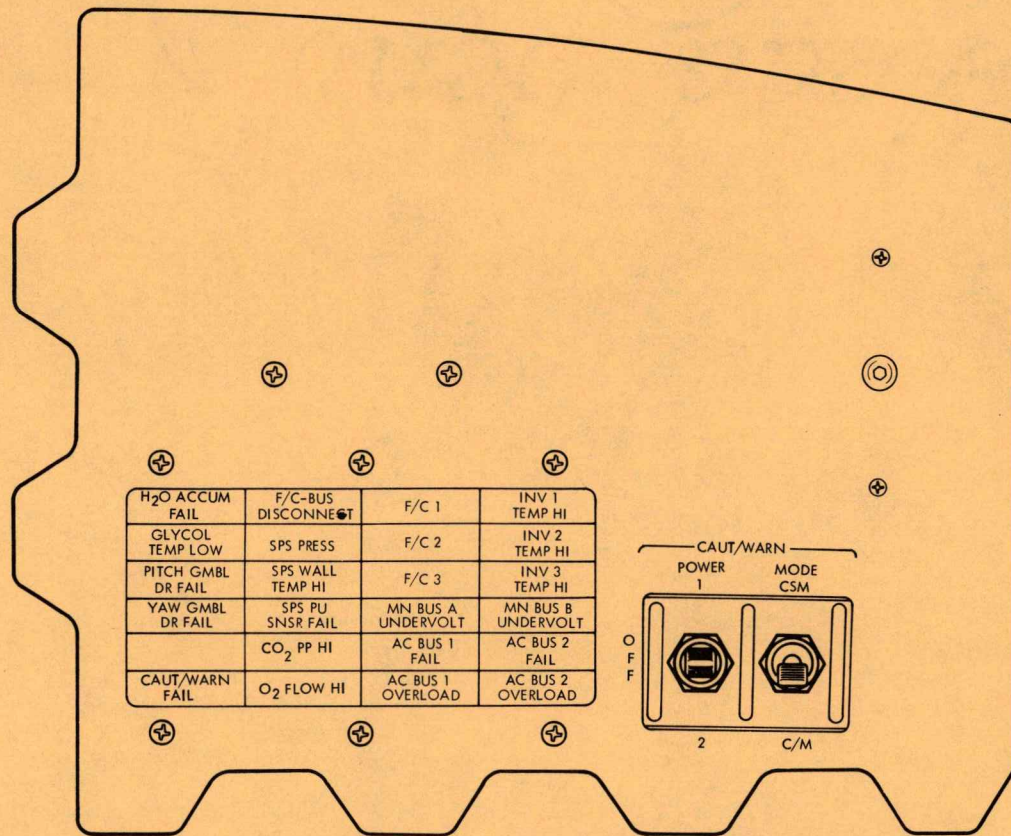


FIGURE 6-2

FAM-6211B



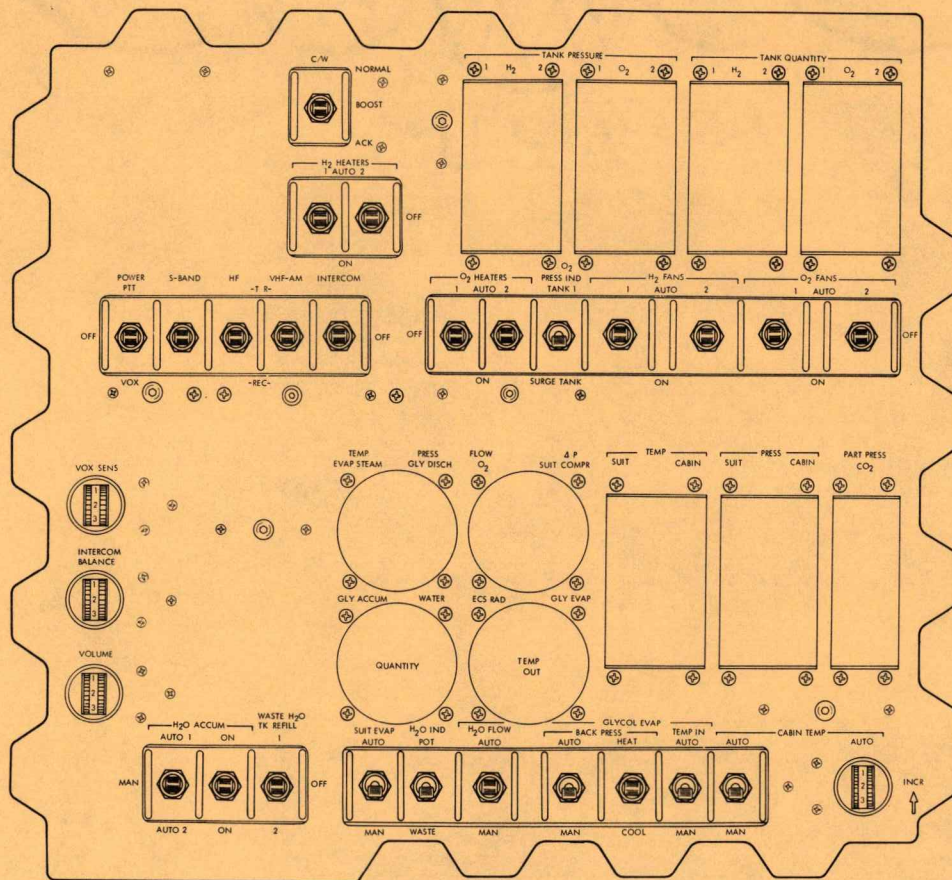
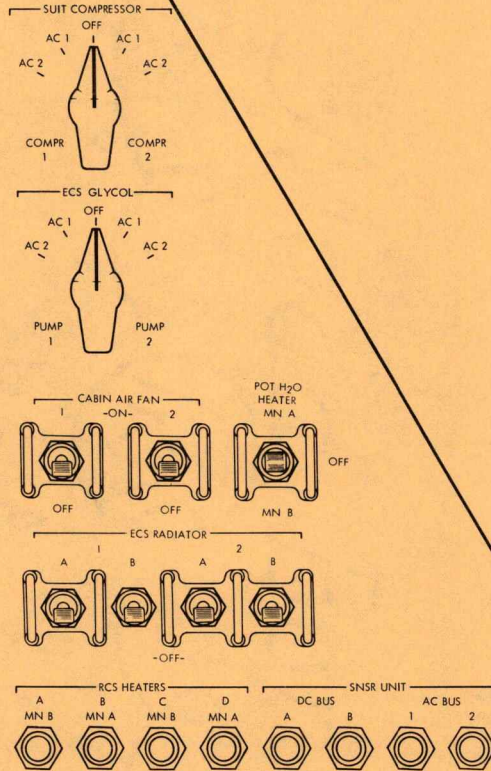


FIGURE 6-3

FIGURE 6-4



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FAM-6221A

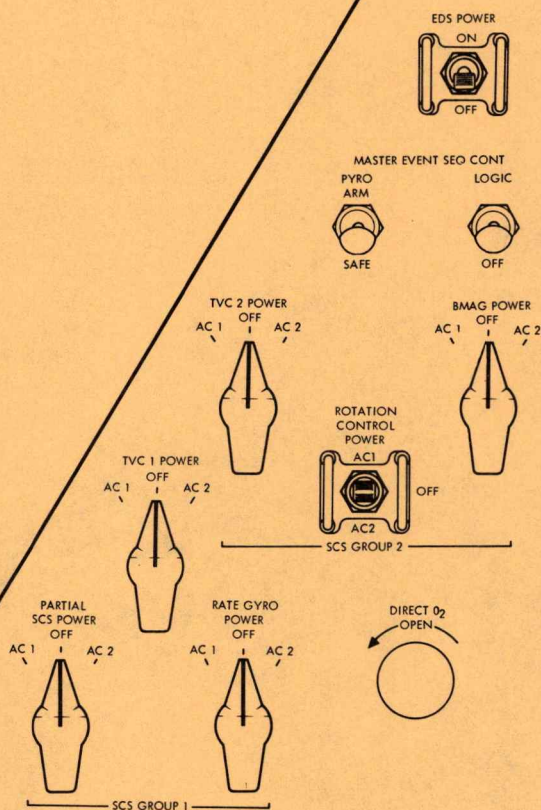




6-21

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FIGURE 6-6



OXYGEN CONTROL PANEL

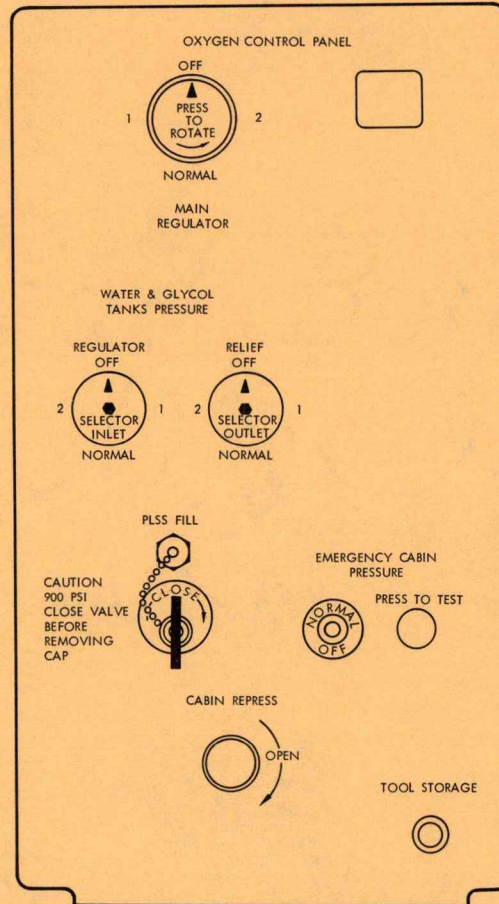


FIGURE 6-7

WATER CONTROL PANEL

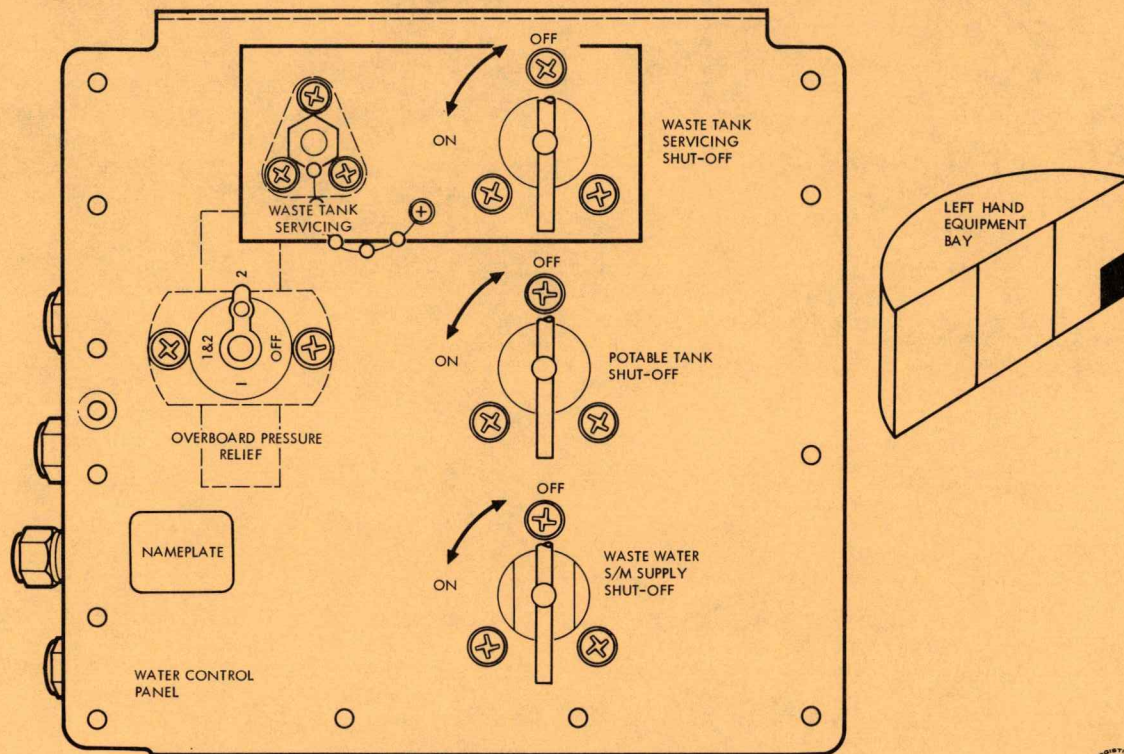


FIGURE 6-8

COOLANT CONTROL PANEL

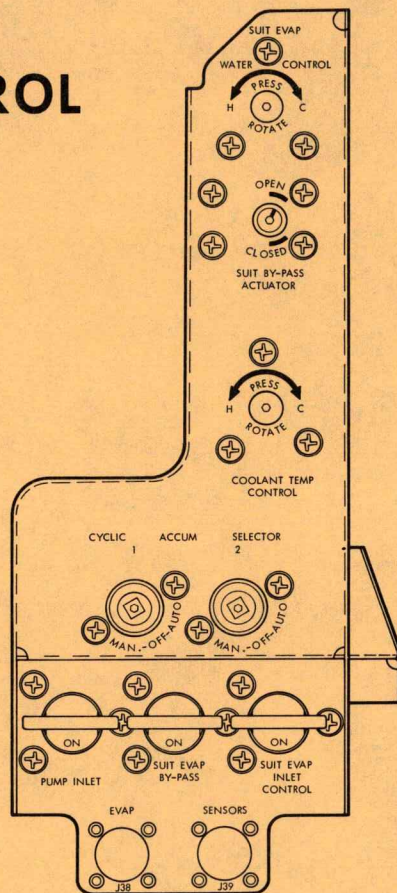
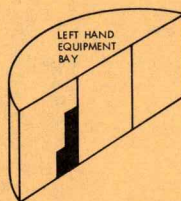


FIGURE 6-9

ENVIRONMENTAL CONTROL UNIT

INSIDE

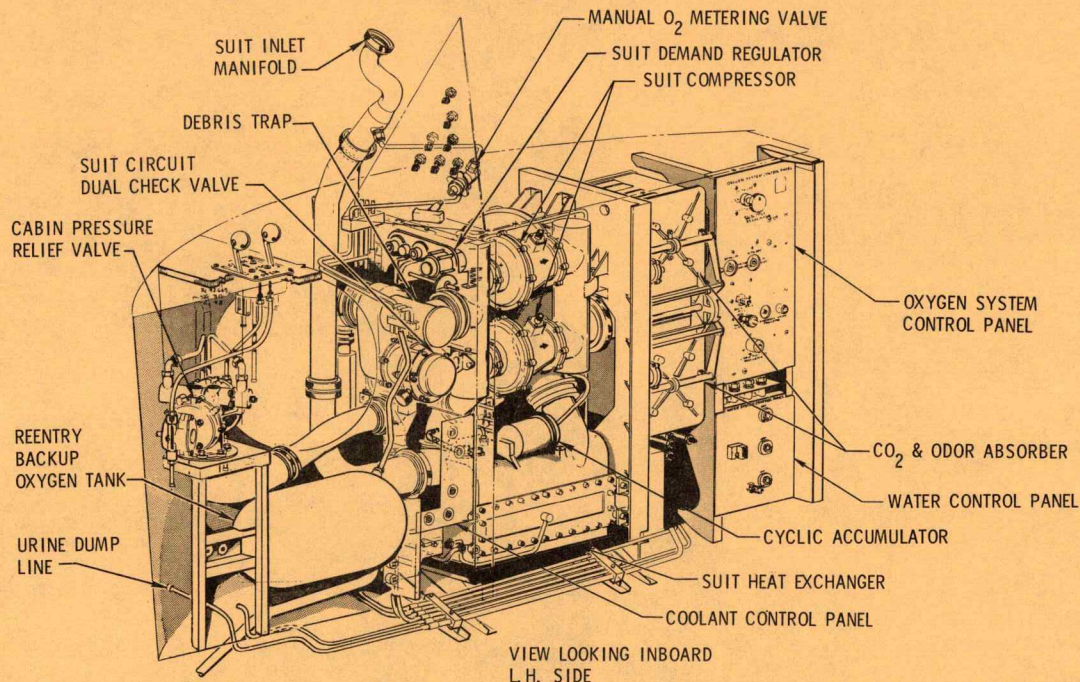


FIGURE 6-10

ENVIRONMENTAL CONTROL UNIT

OUTSIDE

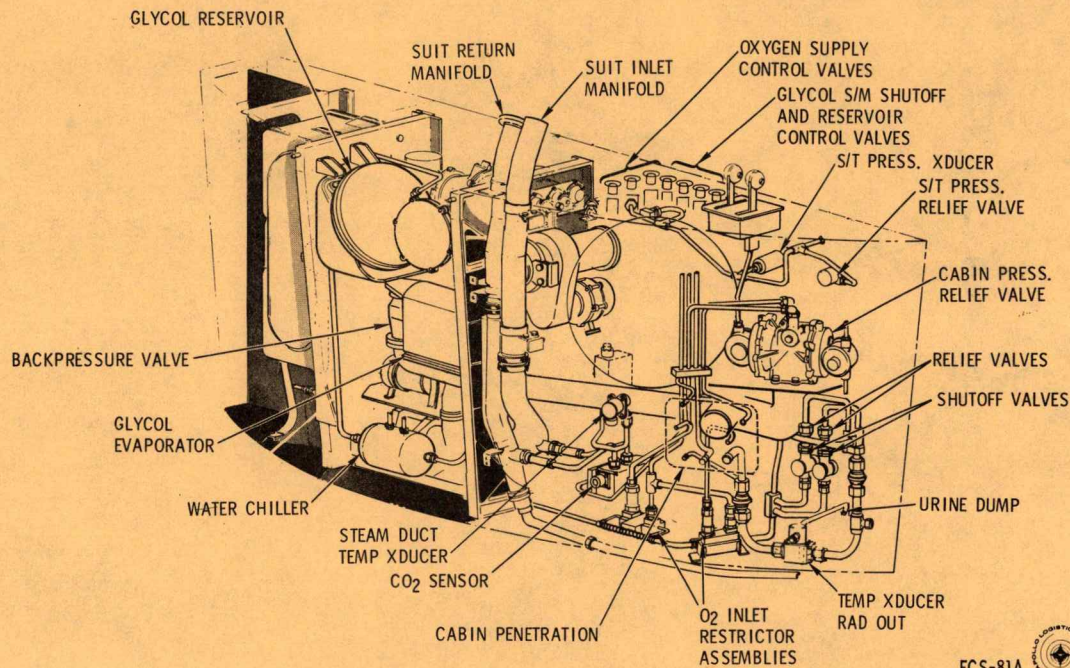


FIGURE 6-11