Chapter 10 OXYGEN SYSTEM

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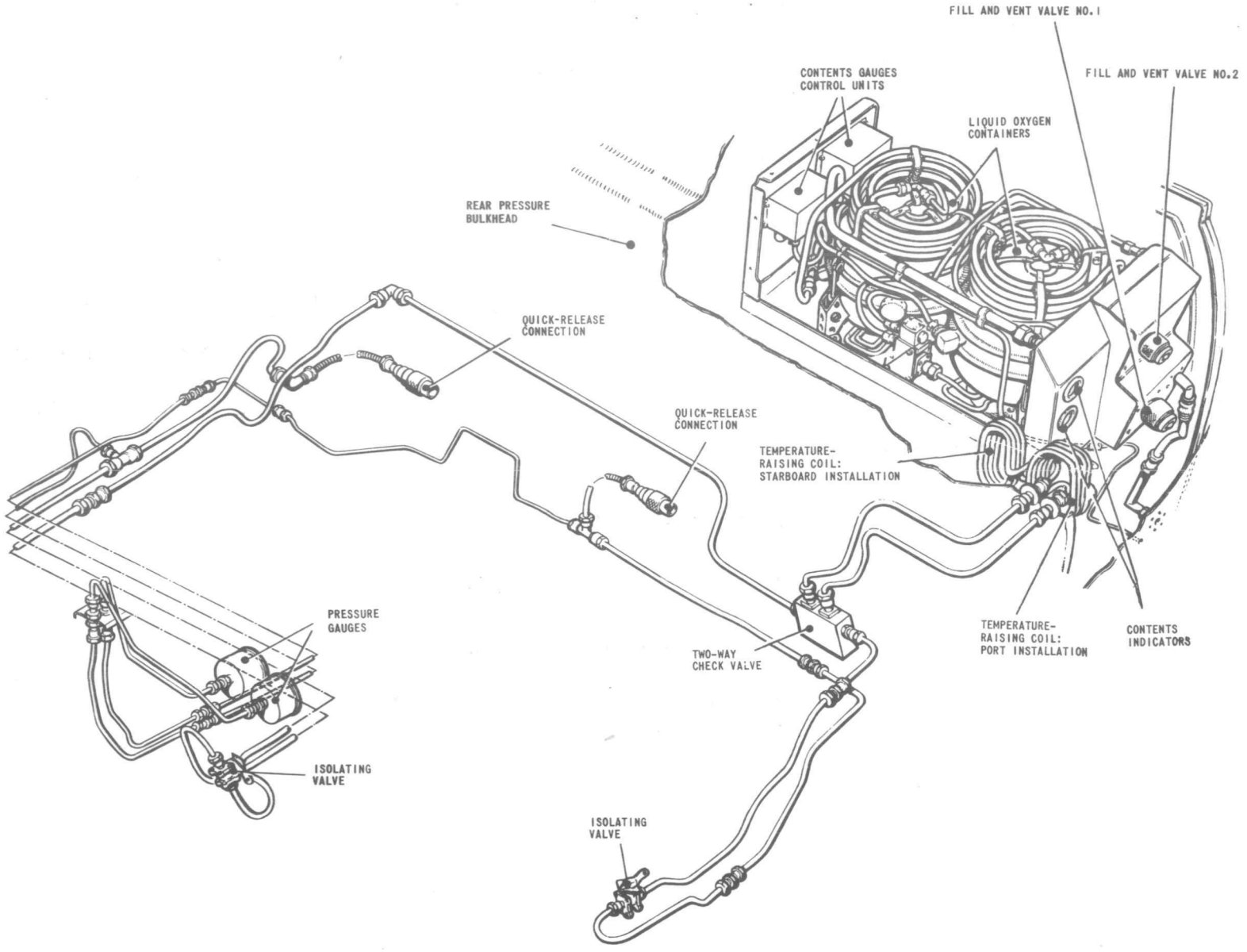

FIG. I. ARRANGEMENT OF SYSTEM

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DESCRIPTION

General information

1. Both systems (main and emergency) are the pressure-demand type and are used with face masks or partial pressure helmets and pressure jerkins. Oxygen for the main system is stored in liquid form in two 3½-litre containers and is vaporized by transfer of ambient heat to supply the regulators mounted on the ejection seats. Low-pressure pipes conduct oxygen from the regulators to a personal equipment connector (P.E.C.) and flexible pipes connect the P.E.C. to the pilot's masks and jerkins. A 70-litre emergency-oxygen cylinder and a demand regulator are mounted on each ejection seat for use if the main system fails or a crew member abandons the aircraft. Replacing instructions are given in Sect. 2, Chap. 2.

MAIN SYSTEM

General information

2. The main system consists of two similar installations based on a twin-container liquid oxygen package unit fitted in the main equipment bay aft of the pressure bulkhead (the unit also contains certain of the components of the two installations, para. 3). From the bulkhead forward, the installations are contained in the cockpit. A demand regulator and a P.E.C. are mounted on each seat and are connected to the associated installation. A contents gauge, pressure gauge, flow indicator, Airmix control, ground test valve and oxygen failure warning indicator are provided for each system. The two installations operate independently, but in a case of failure of either installation the serviceable installation will supply, by way of the two-way check valve, the failed one. If the failure is temporary and pressure is restored in the failed installation the check valve operates and the supply is resumed as an independent installation.

Liquid oxygen package unit *(fig.1)*

3. The liquid oxygen package unit consists of:-

(a) Two insulated 3½-litre containers, each one comprising three concentric stainless steel shells, the space between the middle and outer pair being highly evacuated. The inner shell is perforated and, in conjunction with the middle shell, acts as the electrical capacitor for the contents-indicating system.

(b) Two check valves, which are fully-floating non-return valves and control the flow of liquid oxygen from the associated container to meet any demands made on the system.

(c) Two pressure control valves, which control their associated system pressure and also incorporate relief and economy functions.

(d) Two fill and vent valves, each one incorporating a non-return valve in its filling line, and a change-over valve connected to the gas, balance and filling-vent lines, the valves being operated by the connection and disconnection of the dispenser hose.

(e) Two pressure-raising coils, which use ambient heat to raise and maintain pressure in their associated installation.

(f) Two stabilizing coils, using ambient heat to vaporize and superheat the liquid oxygen in the fill line and coil of their associated installation.

(g) Two contents indicator control units, which measure the electrical capacity of their associated containers; this alters in accordance with the quantity of liquid in the container.

(h) Two contents indicators.

The complete assembly is mounted on a drip tray which is fitted with mounting feet for attachment to the airframe structure.

Fill and vent valves *(fig.1)*

4. Two fill and vent valves, accessible behind access panel 14AP, are used to fill the two liquid oxygen containers. ◀ They are labelled FILL 2 and FILL 1 ▶ and serve the port and starboard installations respectively. The inlet connection of each valve is protected by a screwed cap which must be removed before the dispenser hose can be connected. Each valve is an assembly comprising a fill valve and a vent valve connected in tandem by a spindle, and connection of the dispenser hose auto-

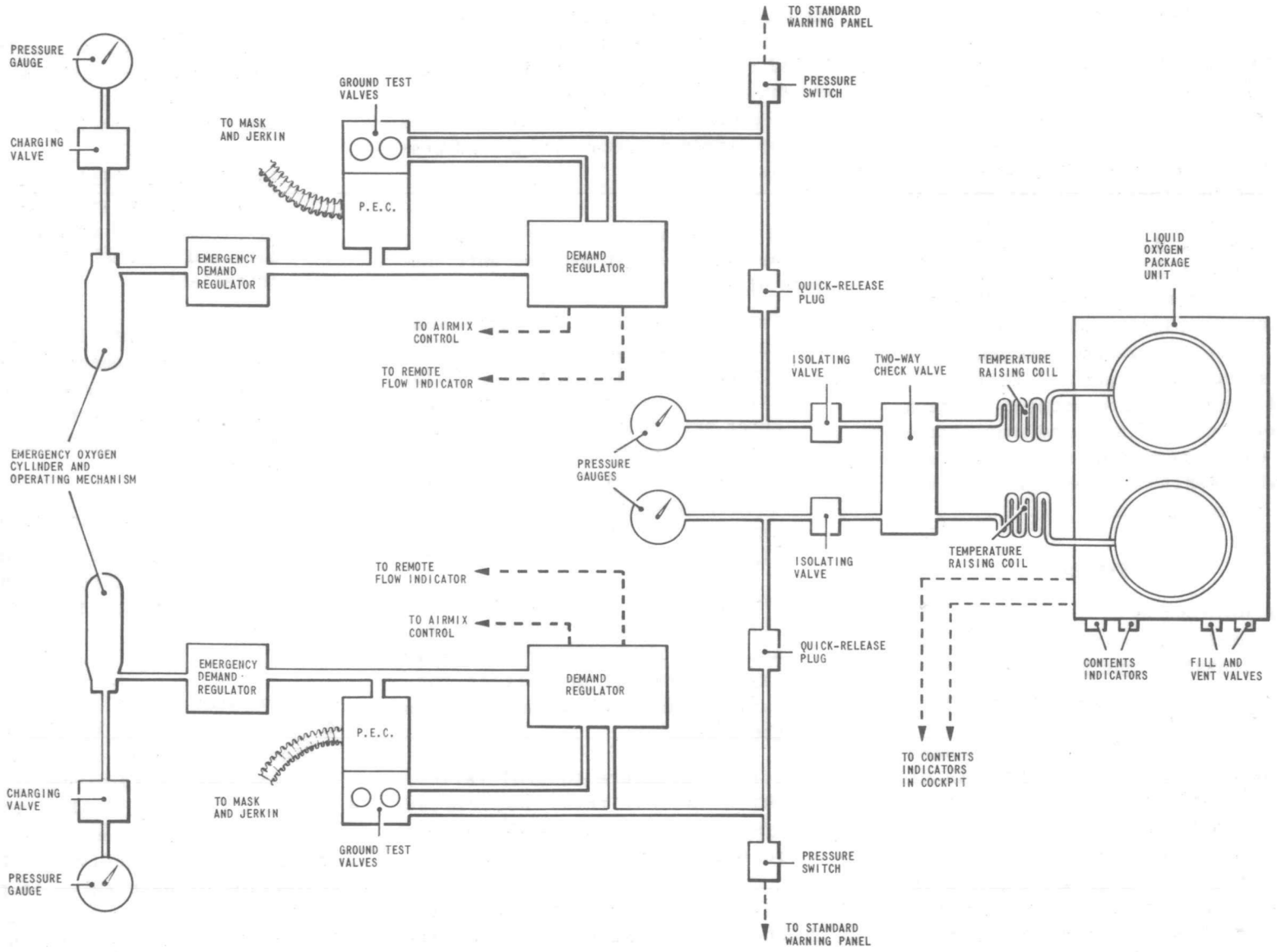

FIG.2. SYSTEM DIAGRAM

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matically opens the fill valve, closes the balance line from the pressure-control valve and connects system pressure to atmosphere. When the dispenser hose is disconnected the fill valve closes, the balance line is connected to the gas line and the vent valve closes. This arrangement ensures that the system is never pressurized when filling takes place.

Contents indicators

5. Four contents indicators are fitted, two near the fill and vent valves (access panel 14AP) for use when servicing, and two in the cockpit for crew information *(Sect.1, Chap.1, fig.9)*. The indicators are calibrated 0 – ¼ – ½ – ¾ – F, and at the top and bottom ends of the scale are red arcs to which the needle points if there is a capacitance or power failure respectively. The indicators on the package unit each have a cursor and the lining-up of the indicator needle with the cursor during filling of the containers indicates that the operation is complete and the filling hose can be disconnected.

Two-way check valve *(fig.1)*

6. A two-way check valve, fitted on the front face of the pressure bulkhead behind the port ejection seat, enables the two oxygen containers to be linked via its differential pressure chamber to ensure an oxygen supply to both open members in case of failure of either installation. All components of the valve are duplicated and oxygen from each container enters the valve through its associated inlet port, past a lightly loaded non-return valve, into a divided differential pressure chamber and through an outlet port to the associated regulator. Two differential pressure valves in the chamber remain closed as long as the pressures in the two halves of the chamber remain in equilibrium. If pressure in either installation fails the associated differential pressure valve opens and admits oxygen into the failed installation.

Pressure gauges

7. Two pressure gauges *(Sect.1, Chap.1, fig.9)* indicate the pressure at which oxygen is being supplied to the regulators.

Isolating valves

8. Two isolating valves *(Sect.1, Chap.1, fig.9)* serve the port and starboard installations respectively. The valves are interposed between the two-way check valve and the regulator in each installation and are marked OPEN/SHUT, the selection being made by means of a lever handle which is retained in the OPEN position by a spring loaded safety flap. The valves enable the supply to the associated regulator to be turned off in case of a regulator malfunction.

Seat-mounted group assembly

9. The components comprising the seat-mounted group assembly are attached to a detachable tray which is mounted on the starboard side of each ejection seat. The assembly is described in A.P. 1275G, Vol.1 (2nd Edn.), Part 2, Sect.6, Chap.1.

Demand regulators

10. A Type 120 remote control demand and inflation regulator, with certain other components of the installation *(Sect.1, Chap.1, fig.3)*, is mounted on a detachable panel on the starboard side of each seat. The regulators supply a ratio of oxygen to air which is related to cockpit altitude. Airmix switches *(para.13)* give provision for selecting 100 per cent oxygen, irrespective of altitude. An isolating valve in each installation admits oxygen from the pressure supply and two gauges indicate the pressure at which oxygen is being supplied to each regulator.

Personal equipment connectors (P.E.C.)

11. A P.E.C. is mounted on a detachable panel on the starboard side of each seat and consists of three main parts – aircraft component, seat component and personal component. When the user connects his personal component to the seat component the associated oxygen installation is completed. A dust cover, stowed on the port and starboard consoles respectively, must always be fitted to the seat component when the personal component is disconnected. The P.E.C. is described in A.P.4288A, Vol.1, Sect.6, Chap.1.

Remote flow-indicators

12. Remote flow-indicators *(Sect.1, Chap.1, fig.9)* provide an indication of oxygen flow through the regulators. The indicators are in electrical circuit with contacts in their respective regulators, the contacts opening and closing in response to movement of a diaphragm during each breathing cycle.

Airmix controls

13. Two Airmix electrical controls, one on the port and one on the starboard

windscreen sills *(Sect.1, Chap.1, fig.9)*, serve the port and starboard installations respectively. Normally the Airmix switch is pushed in and the regulator automatically delivers the oxygen/air mixture appropriate for the cockpit altitude. If the regulator malfunctions or a toxic hazard arises in the cockpit, 100 per cent oxygen is made available at any altitude by pulling out the Airmix switch. Electrical failure de-energizes the control solenoid in the regulator and 100 per cent oxygen is supplied. A lamp integral with the switch is illuminated when 100 per cent oxygen is selected.

Ground test valves

14. A ground test valve, fitted at the end of each P.E.C., is used for applying the face mask and pressure jerkin tests during ground checks of the associated regulator. Depressing the port button on the valve gives mask test; lifting the flap over the starboard button and depressing both buttons simultaneously gives jerkin test. The valve is described in A.P.1275G, Vol.1 (2nd Edn.), Part 2, Sect.5, Chap.14.

Failure warning indicators

15. Two oxygen failure warning indicators are fitted in the standard warning panel *(Sect.1, Chap.3, fig.2)*. The indicators are labelled OXY 1 and OXY 2 and serve the port and starboard installations respectively. Each indicator is in circuit with a pressure switch, fitted on the ejection seat, upstream of the regulator in its associated installation. If oxygen pressure drops below approximately 50 lb/in^2 the associated indicator is illuminated, the attention lights *(Sect.1, Chap.3, fig.2)* flash and an audio warning sounds in the crew's headsets. The circuit can be tested by depressing the switch marked T on the standard warning panel.

Gas generation

Stabilization

16. It is necessary, for immediate stable operation of the system after replenishing, that the temperature of the liquid oxygen in the aircraft containers is rapidly raised. Stabilization commences the moment the dispenser hose is disconnected from the fill and vent valve. Liquid oxygen in the uninsulated fill line expands, due to transfer of ambient heat, and passes through the stabilizing coil to be superheated into gas. The gas is forced into the bottom of the container and through the liquid oxygen which condenses it back to a liquid, this process raising the temperature of the container contents sufficiently to allow the system to function automatically.

Pressure build-up

17. As stabilization takes place, liquid oxygen leaks past the check valve and into the temperature- and pressure-raising coils where it is vaporized and the pressure increased. From the pressure-raising coil the vapour passes, via the pressure control valve, balance line, fill and vent valve and gas line, to the top of the container. This process continues until a pressure of approximately 60 lb/in^2 is attained and this causes the bellows in the pressure control valve to contract and the pressure closing valve to seat. This action isolates the gas and liquid phases of the system and the pressure holds the check valve on its seat to prevent any further flow of liquid oxygen into the system. If pressure falls due to user demand or wastage the check valve opens sufficiently to allow liquid oxygen into the system until pressure is restored.

Pressure venting

18. When no demand is made on the system transfer of ambient heat continues to evaporate oxygen in the containers, the resultant increase in balance pressure being matched in the pressure-raising coils by slight liquid leakage through the check valves. The continuing increase in balance pressure compresses the bellows in the control valves until, at 95 lb/in^2, the pressure relief valves are lifted from their seats allowing excess pressure to relieve to atmosphere.

Economizer circuit

19. In either installation the reduction in balance pressure affected by leakage of liquid through the check valve during demand, would normally be insufficient to allow the pressure relief valve *(para.18)* to seat, resulting in continuing wastage. To eliminate this wastage an economy relief valve is incorporated. During pressure increase *(para.17)* the bellows are sufficiently compressed, at 75 lb/in^2, to lift the pressure closing valve from its seat and allow balance pressure to be applied to one side of the economizer relief valve through a by-pass passage. As long as balance pressure and supply pressure are equal, the economizer relief-valve

spring holds the valve closed. Immediately a demand is placed on the system, however, the valve opens and gaseous oxygen from the balance line flows into the pressure-raising coil to help satisfy the demand and to reduce balance pressure below its venting value.

Pressure relief

20. If at any time either system pressure is above 60 lb/in^2 and a heavy demand is placed on that system and then removed, a rapid increase in pressure occurs due to the evaporation of excess liquid which has entered the pressure-raising coil. If this pressure exceeds balance pressure by 10.15 lb/in^2 the differential pressure relief valve opens until balance is restored.

EMERGENCY SYSTEMS

General information

21. A demand emergency gas oxygen system (part of the seat-mounted group assembly) is installed on the starboard side of each ejection seat and is connected to its associated P.E.C. The systems provide an emergency oxygen supply capable of meeting both pressure jerkin and breathing requirements of the user in failure of the main supply or when abandoning the aircraft. The equipment is described in A.P.107D-0601-1, Part 2, Sect.6, Chap.1, and A.P.109B-0103-1, Chap.1.

Selection

22. If the main supply fails the emergency supply is made available by pulling a yellow-and-black striped knob at the front of each ejection seat *(Sect.1, Chap.1, fig.3)* which is connected by cable to the emergency oxygen cylinder release lever.

Supply upon ejection

23. When ejection occurs the emergency system is automatically brought into use by a trip mechanism on the back of the ejection seat. The main supply quick-release plug and socket connection on the side of the ejection seat is broken by the locking sleeve being restrained by a static line as the seat moves up the rail.

Oxygen demand regulator

24. A demand regulator is mounted on the starboard side of each ejection seat and operates in conjunction with a 70-litre emergency gas oxygen cylinder. The regulator is not capable of providing an air/oxygen mixture or of indicating oxygen flow. When the oxygen in the emergency cylinder is exhausted the air inlet valve opens with each breathing cycle to allow the user to breathe air.

SERVICING

WARNING

The relevant safety precautions detailed on the LETHAL WARNING marker card must always be observed before entering the cockpit or performing any operations upon the aircraft.

Oil and grease combine explosively with undiluted oxygen. To prevent injury to personnel or equipment, do not use these materials on or near the oxygen system.

General information

25. The servicing necessary to maintain the system in an efficient working condition consists of keeping the installation free from oil, grease and moisture, checking that the containers are full and testing the system for leaks. Examination of the system should also be made for damage and security and to check that the flexible hoses to the P.E.C. are fitted correctly. The emergency cylinders should be checked to ensure that the tell-tale wire is intact and the lever is undisturbed; if the wire is found to be broken and the lever disturbed refer to A.P.107D-0601-1, Part 2, Sect.4, Chap.11, for resetting instructions. The testing of standard component is described in A.P.107D-0601-1. The precautions to be observed, and protective equipment to be used when handling liquid oxygen, are given in A.P.4765A, Vol.1 and 6.

Replenishing

26. The replenishing procedure is described in Sect.2, Chap.2.

Topping-up

27. The topping-up procedure is similar to that for replenishing but the following points must be noted:-

(1) The bowser liquid valve must be OPEN before the bowser is connected to either installation. Failure to do this may result in pressure surge causing failure of the bowser rupture discs.

(2) Gas will be discharged through the vent (frame 17-18 port) when the bowser connection to the installation is made.

(3) During filling, the associated contents gauge readings may fall before starting to rise, due to container contents being forced into the system, and the gauging units being affected by the drop in temperature.

Emptying

28. If it is necessary to break down either installation at any point between the two-way check valve and the seat quick-release connection all liquid oxygen must be removed from both installations by either of two methods.

Method 1

This method is slow and is suitable only if the container content is less than 1/8th on the contents indicators.

(1) With the personal component connected to both P.E.C., select MASK TEST on both ground test valves (port button in each case) and wait until gas ceases to flow from the breathing tubes.

Note...

Do not select JERKIN TEST (both buttons depressed) as frosting of the regulator with consequent release of water will be caused thereby.

(2) Release the ground test valve button on both P.E.C.

Method 2

Observe the precautions detailed in A.P.4765A, Vol.1 and 6.

(1) Blank off the vent (between frames 17 and 18, port side) with an expanding plug.

(2) Remove access panel 14AP.

(3) Remove the fill and vent valve sealing caps.

(4) Fit to each fill and vent valve in turn emptying cap Ref.No.6C/3038 to which has been fitted about 18 in. of metal hose and a stop valve of at least ¼ in. bore. Keep the stop valve closed.

WARNING

The operator must keep well clear of the vent (sub.para.(1)) as the plug is subject to system pressure and may be blown out followed by spillage of oxygen.

(5) Direct the stop valve towards the ground, away from personnel and equipment, and open the stop valve. Refer to A.P.4765A, Vol.1 and Sect.1, Chap.1.

(6) When the system is empty, remove the vent plug and emptying cap assembly and refit the sealing cap on the fill and vent valve.

Note...

If, during the emptying operation, the vent plug is dislodged, system pressure will be lost and the system will slowly empty by gravity.

REMOVAL AND ASSEMBLY

Liquid oxygen package unit

Removal

29. To remove the package unit:-

(1) Isolate all aircraft electrical supplies.

(2) Empty both oxygen containers *(para. 28)*.

(3) Remove access panel 14AP *(Sect.2, Chap.4)*.

(4) Disconnect the electrical connection at the front panel of the package unit.

(5) Disconnect the two oxygen supply connections from the unit.

(6) Disconnect the vent pipe at the hose connection.

(7) Disconnect the drain pipe at the union; retain the nipple.

(8) Remove the M.R.G. electronic unit, the AI 23D marker unit and the fibreglass cable cover secured to the roof of the bay. Remove the two bolts securing the marker unit tray.

(9) Remove the four bolts securing the package unit to the structure (washers are fitted with the front two bolts only) and withdraw the package unit.

Assembly

30. Assembly of the package unit is the reversal of the removal procedure. After assembly refill the oxygen containers and test the system and other services which have been disturbed.

TABLE 1

List of components

Component	Ref. No.	Part No.	Qty.	A.P. Reference
Package unit, liquid oxygen	6D/—	814384	1	1275G, Vol.1 (2nd Edn.), Part 3, Sect.3
Seat-mounted group assembly	6D/2789	OP7190	2	1275G, Vol.1 (2nd Edn.), Part 2, Sect.6, Chap.1
Valve, two-way check	6D/2265	801421	1	1275G, Vol.1, Sect.5, Chap.6, App.3
Valve, isolating	6D/2912	OP7810 (handle modified by B.A.C.	2	1275G, Vol.1, (2nd Edn.), Part 2, Sect.5
Gauge, oxygen contents (cockpit)	6D/114660	84900.0045	2	1275G, Vol.1 (2nd Edn.), Part 3, Sect.2
Gauge, oxygen contents (package unit)	6D/2605			1275G, Vol.1 (2nd Edn.), Part 3, Sect.2, Chap.2
Cursor, for contents gauge	6D/2709	802874	2	
Gauge, oxygen pressure	6D/2708	OP5750	2	1275G, Vol.1 (2nd Edn.), Part 2, Sect.2, Chap.7
Indicator, magnetic, Type C1	5CZ/5003	EL1810	2	4343E, Vol.1, Sect.18, Chap.18
Switch, push, airmix control	5CW/6630	C181/B/5	2	4343C, Vol.1, Book 1, Sect.1, Chap.25