

SAE
AERONAUTICAL INFORMATION
REPORT
NO. 4A

OXYGEN EQUIPMENT FOR AIRCRAFT



February 1, 1949

PREPARED BY

Committee A-9, Aircraft Air Conditioning Equipment

SOCIETY OF AUTOMOTIVE ENGINEERS, INC.
29 West 39th Street New York 18, N.Y.

Section 7C of the SAE Technical Board rules provides that: "All technical reports, including standards approved and practices recommended are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and approving technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against liability for infringement of patents."



Documents

Document Sharing Hub

AERONAUTICAL INFORMATION REPORT NO. 4A

SUPPLEMENTAL DATA SHEET

REFERENCE SECTION 4.1.6.

This portable system (system 6) is intended for supplying supplemental oxygen through a continuous flow regulator and mask. It differs in principle from the system described in Section 4.1.5 (system 5) which supplies all of the oxygen being used by the wearer, through its non-diluter demand regulator and proper mask.

REFERENCE SECTION 4.1.7.

The system shown in Figure VI (system 7) does not have an automatic regulator but makes use of a sonic-velocity orifice in the outlet to limit flow to a continuous flow mask or pipe stem. Thus the flow varies only slightly with bottle pressure.

REFERENCE SECTIONS 6.1 AND 6.2.

Those cylinders listed in Section 6.1 are approved by the Interstate Commerce Commission, but those shown in Section 6.2 are not approved by the I.C.C. for the pressure of 400 psi.

The I.C.C. regulations, with respect to oxygen cylinders, apply only to those cylinders that are shipped as cargo or non-fixed equipment while containing oxygen under pressure. Bottles that are securely attached to the airframe as an item of its equipment are not required to comply with the I.C.C. regulations. Since the I.C.C. is concerned, in this regard, only with pressure containers being handled separately in the manner of cargo, its regulations include safety factors intended to provide safety even after a certain amount of handling damage. Fixed bottles, which are not subject to such damage, normally may make use of lower factors of safety.

REFERENCE CHART 3.

Typical Problem: Determine the oxygen supply required for 2 crew members and 7 passengers for a 2 hour flight at 15,000 feet.

$$Q_o = \frac{N \times F \times T \times 60}{.95 \times 28.32}$$

Q_o = Amount of oxygen required, in cubic feet.

N = Number of oxygen users.

F = Flow requirements for the conditions involved, in liters/minute.

T = Time of flight at altitude requiring oxygen, in hours (assumed to include climb and descent between the minimum altitude at which oxygen will be used and the cruise altitude.)

REFERENCE CHART 3. (Cont'd.)

Typical Problem: (Cont'd.)

60 = Minutes/Hour.

28.32 = Number of liters in a cubic foot.

.95 = Correction Factor for system efficiency.

Reading from Chart 3, for 15,000 feet:

F = 1.7 Liters/Minutes

$$Q_0 = \frac{(2 + 7) \times 1.7 \times 2 \times 60}{.95 \times 28.32} = 68.24 \text{ cubic feet (Standard Conditions at Sea Level.)}$$

To determine the number and type of oxygen bottles to be used, refer to Section 6.1. A single bottle of 73.0 cubic feet capacity, or two bottles of 38.4 cubic feet capacity each may be used.

OXYGEN EQUIPMENT FOR AIRCRAFT

INTRODUCTION

This report has been prepared as a revision of the previous Aeronautical Information Report No. 4 dated May 1, 1944 in order to bring that report up to date by including the latest information available on the design and use of aircraft oxygen systems. It accordingly supersedes AIR 4 dated May 1, 1944.

SOCIETY OF AUTOMOTIVE ENGINEERS, INC.

Committee A-9, Aircraft Air Conditioning Equipment

W. W. Reaser, Chairman
Douglas Aircraft Co., Inc.

J. W. Ashby
Surface Combustion Corp.

Dale Moeller
Stratos Corp.

Robert L. Berner
Glenn L. Martin Co.

Charles W. Morris
Versatile Engineering

Earl Cannady
Trans World Airlines, Inc.

D. A. Potter
Stewart-Warner Corp.

F. D. Enfield
Pan American Airways, Inc.

P. C. Scofield
Airesearch Mfg. Co.

Vincent Gill
Republic Aviation Corp.

W. C. Shaw
United Air Lines, Inc.

Willis H. Gille
Minneapolis-Honeywell Regulator Co.

Myron Tribus
University of Calif.

S. D. Browne
Barber-Colman Co.

B. J. Vierling
Aircraft Supply Corp.

A. Lambert
Consolidated-Vultee Aircraft Corp.

W. E. Spearman
American Airlines, Inc.

B. L. Messinger
Lockheed Aircraft Corp.

APPROVED BY SAE AERONAUTICS COMMITTEE

Arthur Nutt, Chairman
Aircraft Engine Div.,
Packard Motor Car Co.

Arthur E. Raymond, Vice Chairman
Douglas Aircraft Co., Inc.

W. C. Lawrence
American Airlines, Inc.

Wright A. Parkins
Pratt & Whitney Aircraft

J. B. Johnson
USAF Air Materiel Command

Erle Martin
Hamilton Standard Propellers

R. D. Kelly
United Air Lines, Inc.

C. E. Mines
Packard Motor Car Co.

OXYGEN EQUIPMENT FOR AIRCRAFT

* TABLE OF CONTENTS *

	<u>Page No.</u>
1. PURPOSE	1
2. SCOPE	1
3. GENERAL	1
3.2 Source of Supply	1
3.3 Distribution System	2
3.4 Regulators	2
3.5 Means for Inhaling Oxygen	2
4. OXYGEN SYSTEMS IN USE IN UNITED STATES	3
4.1 Characteristics of Various Systems	3
4.2 Oxygen Supply Pressure	5
4.3 Airline Oxygen Systems	5
5. AVAILABLE SPECIFICATIONS	6
6. STANDARD CYLINDER SIZES	7
6.1 High Pressure	7
6.2 Low Pressure	8
7. PROPERTIES OF OXYGEN	8
7.1 Density	8
7.2 Weight of Oxygen in Supply Cylinders	9
7.3 Weight in Pounds of Oxygen Flow	9
7.4 Oxygen in Tank Supply to Produce Required Mixtures of Oxygen and Air at Mask	9
8. DESIGN CRITERIA	10
9. BIBLIOGRAPHY	10
Figure No. 1 - System 1	Figure No. V - System 6
Figure No. II- System 3	Figure No. VI- System 7
Figure No. III-System 4	Chart 1 - Equivalent Altitudes
Figure No. IV -System 5	Chart 2 - Oxygen Flow Recommended by USAF
	Chart 3 - Requirements Set Forth in CAR

AERONAUTICAL INFORMATION REPORT NO. 4A

OXYGEN EQUIPMENT FOR AIRCRAFT

1. PURPOSE: To present a resume of available information on the design and use of aircraft oxygen systems.
2. SCOPE: This information Report covers high and low pressure oxygen systems, both fixed and portable.
3. GENERAL:
 - 3.1 Physiological Requirements: Oxygen should be supplied in an increasing percentage of the total inhaled mixture as the partial pressure of the gas is decreased by increasing altitude. The resultant increasing availability of oxygen acts to counteract the decreasing pressure potential available for forcing the gas through the membranes of the lungs to a position where it may be picked up by the red corpuscles of the blood. The supplementation of free air by oxygen is considered to be advisable above 8,000 feet for active persons such as crew members, and 10,000 feet for inactive passengers. It is considered necessary above 8000 feet for active persons and above 10,000 feet for inactive passengers. Oxygen may be required at much lower altitudes for therapeutic use with various lung and heart disorders. It is necessary to supply undiluted oxygen at altitudes above 30,000 feet. The use of undiluted oxygen without supplemental pressure is considered acceptable only to 37,000 feet.
 - 3.2 Source of Supply consisting of some or all of the following items:
 - 3.2.1 Supply cylinders containing compressed oxygen carried on the aircraft. These are of two types:
 - 3.2.1.1 High Pressure cylinders (1800 psi).
 - 3.2.1.2 Low Pressure cylinders (400 psi).
 - 3.2.2 Check valves to isolate individual cylinders.
 - 3.2.3 Safety valves to prevent over pressure in cylinder from overcharging or heating.
 - 3.2.4 Warning signal to indicate dangerous depletion of supply.
 - 3.2.5 Pressure gage to indicate quantity of oxygen available.
 - 3.2.6 Manually operated shut-off valve to conserve supply when not in use and to permit replacement of individual cylinders.
 - 3.2.7 Valves for isolating portion of the system for crew or therapeutic use.
 - 3.2.8 Provisions for replenishing supply either by external filler or by removing and recharging the supply cylinders.

3.3 Distribution System - comprising one or more lines of metal tubing with suitable fittings and outlets to distribute the oxygen to various stations. Pressure in these lines may be that of the supply cylinder or it may be reduced by a reducing valve to some uniform low pressure. Those lines passing through a potential fire zone should be of stainless steel.

3.4 Regulators, comprising mechanical means for proportioning the amount of oxygen required by each individual. They may be permanently installed at individual stations, they may be portable, or they may be at one master station. Portable regulators may be attached to low pressure outlets or they may be attached to portable cylinders.

3.4.1 Regulators may be of the following types:

3.4.1.1 Continuous flow type with or without automatic or manual means for increasing the flow with altitude. With this regulator the flow is fixed for any given adjustment and does not vary automatically to suit work or rest conditions.

3.4.1.2 Demand type which allows oxygen to flow only when a suction is applied as by inhaling through a mask or tube. This regulator may feed only pure oxygen or may have automatic means for mixing air with oxygen to maintain the partial pressure of oxygen in the lungs at approximately sea level conditions up to some predetermined high altitude. An emergency valve for full continuous flow of oxygen is provided.

3.4.1.3 A rebreather type, in which air is continuously rebreathed and the oxygen consumed is replenished. Chemicals are provided to absorb water and carbon dioxide.

3.4.1.4 A pressure breathing demand regulator, which, when used with the proper mask imposes a pressure of from 6 to 8 inches of water upon the lungs, thus raising the safety ceiling to as high as 43,000 feet and the emergency ceiling to 47,000 feet. Below 30,000 feet the regulator functions as an ordinary dilute demand regulator.

3.4.2 Flow indicators can be usefully employed with demand regulators to insure the operator that he is actually getting the oxygen. These devices should operate by a means responsive to the flow of oxygen only.

3.4.3 Flow indicators should be used with all oxygen systems to insure proper oxygen supply. They may be in the form of pressure gages calibrated to the altitude, or in the form of flow meters.

3.4.4 Regulators are responsive to the ambient pressure and therefore are satisfactory for use in either pressurized or unpressurized airplanes.

3.4.5 Emergency overrides should be provided on all automatic regulators to permit administration of pure oxygen for therapeutic purposes at any altitude.

3.5 Means for Inhaling Oxygen:

3.5.1 At altitudes above 16,000 feet a mask or hood is essential to prevent excessive dilution of oxygen with air. Below 16,000 feet, a simple mouthpiece can be used or even a direct application of oxygen into the mouth through a pipe stem, although such a system is inefficient. Masks are commonly employed at all elevations where oxygen is required, as they are more efficient.