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AEROSPACE INFORMATION REPORT

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TRANSFILLING & MAINTENANCE OF OXYGEN CYLINDERS

1. INTRODUCTION

Recharging of small portable oxygen cylinders by the user is a practice both condemned and discouraged by the Compressed Gas Association and the National Fire Protection Association. Their condemnation is based on the firm conviction of the majority of the Association members that "transfilling" an oxygen cylinder by "unqualified" personnel is basically unsafe and should not be performed. By logic, therefore, it must be deduced that all personnel assigned to transfilling must be qualified. The purpose of this document is to list the best available information and guide lines for the qualification of personnel.

It is a matter of record that the commercial air lines, aircraft manufacturers, and aircraft service stations have been involved in, and will continue to follow, the practice of filling the small portable oxygen units and fixed oxygen cylinders in commercial and general aviation. This practice has developed over the last twenty years and, while there have been occasional accidents, the practice will not be stopped. The lost time, paper work, cost, etc., involved in sending cylinders to a commercial gas supplier is economically unsound. As this is the case, it logically follows that a standardized procedure should be established for charging high pressure oxygen cylinders in those aviation facilities which are required by circumstances to perform oxygen cylinder filling. This document is intended primarily as a guide to the aviation industry for the filling of fixed or portable aircraft cylinders.

2. GENERAL HIGH PRESSURE INFORMATION

2.1 Pressures - Gases under pressure present a potential hazard in the form of stored energy. Accidents are caused when this energy is improperly controlled or admitted to equipment which is not designed for the pressures encountered. In general, the available energy increases as the pressure increases. Compressed oxygen is available in ICC (Interstate Commerce Commission) approved cylinders at pressures up to 2640 pounds per square inch gage.

2.2 Oxygen is an oxidizing gas and, in itself, is not flammable. Oxygen does, and is required to, support combustion. High oxygen concentrations can accel-

erate the combustion of flammable materials even to the point of explosion. Almost all materials are combustible in the presence of pure (100% oxygen atmosphere) oxygen. Spontaneous combustion of oil and other organic materials may occur in the presence of oxygen-rich environments, particularly when heat is also involved.

2.3 The compression of a gas results in the release of considerable energy in the form of heat. Should compression occur quickly in a container or a closed section of piping, the heat generated will cause a sharp rise in temperature. This temperature rise, in a pure oxygen system, can be high enough to cause ignition of oil, grease, solvents, and/or such materials as dust, lint, metal chips, or many organic materials.

Oxygen flowing at high velocity through piping systems can propel particles of foreign material with such force that friction or impact can raise the particles' temperature to the ignition point. Ignition of particles can be sufficient to ignite heavier metal sections, thus causing an accident.

The probability of a temperature rise increases with the differential pressure, as is present when rapidly filling an almost empty oxygen cylinder from a full high pressure cylinder. Spontaneous combustion of materials combustible in oxygen is less likely to occur at near atmospheric pressure conditions. It can be promoted, however, by external sources of heat.

2.4 Transfilling System Material - Materials used in the construction of all components of a piping system must be compatible with, and shall not combine chemically with, oxygen under the conditions of pressure and temperature which will be encountered. Many materials which are considered to be non-reactive at low pressures and normal temperatures may react with oxygen at high pressure and high temperature. For example, common steel is a satisfactory material for high pressure oxygen cylinders at normal ambient temperatures. Common steel is NOT recommended for oxygen piping system components at high pressure where heat may be generated by friction, compression, or external sources. For proper materials a local oxygen supplier should be consulted. Small diameter, clean, heavy-wall copper or stainless steel tubing is considered safe by most authorities for pressures up to 3000 psi.

Special attention must be given to the selection of valve seats, packings, hose linings, and gaskets, as many

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of these materials react chemically with high pressure oxygen. High pressure flexible hose, used in filling systems, shall, in addition to the requirements above, be free from objectionable odor.

2.5 Rules

2.5.1 Only components designed, built, and cleaned for oxygen service should be used.

2.5.2 Only materials suited for the anticipated temperature condition should be selected for the system.

2.5.3 All components should be suitable for the pressure to which they may be subjected.

3. STORAGE

3.1 Cylinders should not be subjected to extremes of heat and cold.

3.2 Cylinders should be protected from corrosive atmospheres.

3.3 Cylinders should be handled so as to avoid dropping or physical abuse to the attachments.

3.4 Cylinders or equipment for handling oxygen should be stored in a clean area, free of grease, oil, and other contaminants.

4. CONTAINERS

Compressed gases are commercially available in cylinders manufactured to ICC specifications. Such containers are filled, maintained, and shipped in accordance with appropriate ICC regulations. ICC cylinders are marked to indicate the specification number and the "service pressure" for which the cylinders are designed. This marking is normally located immediately below the neck ring, and consists of a combination of numbers and letters. For example, the designation ICC3A1800 indicates that the cylinder was fabricated and tested in accordance with ICC Specification 3A for a service pressure of 1800 psig. Additional marks, normally located beneath the above marking, include an identifying mark of the cylinder owner and a serial number. In addition, the date of original manufacture and a symbol identifying the manufacturer are also located on the shoulder of the cylinder. For example, 9D65 indicates the cylinder was manufactured in September, 1965, by the Doe Company. ICC cylinders must be periodically retested to assure their qualification for continued service. The dates of these "retests" are stamped into the cylinder near the date of original manufacture. These retests are required (a) every five years for Specification 3A and 3AA cylinders, and (b) every three years for Specification 3HT cylinders. In the case of 3HT cylinders, after 4380 refills, or twelve years (whichever comes first), the cylinder must be scrapped.

5. CONTAINER VALVES AND REGULATORS

Oxygen valves in ICC specification cylinders are normally supplied with Compressed Gas Association standard outlets. Only oxygen regulators or other fittings having corresponding thread forms shall be attached to the valve. Proper connecting fittings can be obtained from the gas supplier. Such valves normally are equipped with a safety relief device in accordance with the ICC regulations. This device is normally located on the back of the valve, and has the appearance of a hexagonal nut with several small holes in it. This device is subject to the internal cylinder pressure at all times. Under no circumstances should any attempt be made to loosen or tighten this nut while the cylinder is pressurized. Valves in special applications, such as in aircraft or military equipment, are frequently supplied with outlets which do not conform to the Compressed Gas Association standard. Only fittings which correspond to these outlets should be used. Such fittings can be obtained from the supplier of the equipment in which the special valve is used. Regulators are devices used for the control of pressure and flow rate when withdrawing gas from storage containers. They are designed and fabricated for use with specific gases and at specific maximum pressures. Only regulators for the gas and pressure to be controlled should be used. A regulator should never be changed from one gas service to another.

6. RESUME

The material which has been presented herein is for information purposes, and is presented to call attention to some of the most important points to be considered when handling oxygen. No attempt has been made to specify the equipment to be used, as this is the joint responsibility of the consumer and the suppliers of gas and equipment. Additional valuable information is available in pamphlet form from the Compressed Gas Association, 500 Fifth Avenue, New York, New York, 10036.

The suggested filling or "transfilling" procedure which follows sets forth the most important points to be observed in transferring oxygen from one container to another. It is believed that careful attention and adherence to this procedure will greatly reduce the frequency of accidents associated with the transfer of oxygen.

7. SOURCE OF SUPPLY

7.1 The source of supply will normally consist of one or more cylinders containing oxygen gas under high pressure. They may be individual cylinders to be connected to the supply manifold as required, or they may be permanently mounted in a portable bank or cart.

7.1.1 Only cylinders which are marked for the same pressure service should be attached to the supply manifold at the same time.

7.1.2 Only cylinders which have their contents clearly identified as "Aviators Breathing Oxygen" should be used.

7.1.3 Supply cylinders should be equipped with valves having outlet connections conforming to Compressed Gas Association No. 540. (See Appendix I for other CGA Publications.)

7.2 Manifolds and piping used to interconnect supply cylinders being filled should have been manufactured for oxygen service and at the pressure to be contained. Such manifolds normally terminate at a control valve and pressure controlling device which can be connected to the filling hose and the container to be filled. Pressure gages should be provided which will make possible the reading of pressure on both sides of the control valve or device.

7.3 A typical manifolded source of supply is illustrated in Fig. 1.

8. CONTAINERS TO BE FILLED

Cylinders offered for filling should be carefully examined to determine:

8.1 That they are identified for oxygen service.

8.2 That the valves are free of dirt, oil, grease, etc.

NOTE: Cylinders which are unidentified or which have contained gases other than oxygen, or which show evidence of dirt, grease, etc., in or about the valves should not be filled. Contaminated cylinders and valves should be disassembled, cleaned, and reassembled suitable for oxygen use by an ICC authorized facility. Hydrostatic testing at this time may be economical if the test date is several years old.

8.3 That they are free of defects such as dents, arc burns, excessive corrosion, or evidence of fire damage. Any evidence of damage requires a retest by an ICC authorized test facility.

8.4 That they have been retested within the appropriate time (see Section 4).

NOTE: Cylinders which show evidence of damage or have not been properly retested should not be filled.

8.5 The proper pressure to which the container may be safely filled (see Section 4).

NOTE: Containers which are not marked to indicate a safe working pressure should not be filled.

8.6 The presence of residual gas.

NOTE 1: If residual gas is present, it is desirable, when possible, to determine that it is oxygen before any attempt is made to evacuate the container.

NOTE 2: All cylinders should be evacuated prior to refilling.

9. CONNECTION TO SUPPLY MANIFOLD

9.1 Only cylinders found to be acceptable for oxygen service in accordance with Section 8 should be connected to the supply manifold for filling.

9.2 Filling hoses, lines, adapters, etc., must be for oxygen service and suitable for the pressure to be contained. Such devices should be marked "For High Pressure Oxygen Service."

NOTE: When not in use, all such filling devices should be stored in a clean area, or otherwise protected against contamination by dirt, oil, grease, etc.

9.3 Threaded ends or other attachment means should match the fitting on the cylinder to be filled (see Section 5).

NOTE 1: Adapters suitable for oxygen service at the pressure to be contained may be used.

NOTE 2: Under no conditions should force be used in attempting to make a connection.

9.4 The cylinders being filled should be properly supported in a manner that will not induce any stress on the filling hose, fittings, or supply system.

10. TRANSFERRING OF OXYGEN

(Recharging or Filling) (See AS 1065. Aviator Breathes Oxygen)

10.1 Connect only cylinders which are acceptable (see Section 8) to the filling device (see Section 9).

10.2 Slowly open the valve full-open on the cylinder to be filled.

10.3 Observe the service pressure to which the cylinder should be filled.

10.4 With all supply cylinder valves closed, open the final manifold control valve full-open.

10.5 Select the supply cylinder having the lowest residual oxygen pressure and slightly open the valve to permit a flow of oxygen. Adjust the valve position so that the oxygen pressure on the filling gauge increases at a rate not to exceed 200 psig per minute.

10.6 As the pressure approaches the final working pressure of the cylinder being filled, gradually close the valve on the supply cylinder. Close the supply cylinder valve completely when the pressure in the cylinder being filled reaches a value approximately 10% above its prescribed working pressure.

NOTE 1: If the pressures in the cylinder being filled and in the supply cylinder equalize before the desired pressure is reached, close the valve on the supply cylinder which has been used and repeat the procedure using the supply cylinder having the next higher contained pressure.

NOTE 2: Do not release the pressure in the filling connection until final filling has been accomplished.

10.7 When the filling has been accomplished as described in Section 10.6, close the supply cylinder valve. Close the valve on the filled cylinder. Close the manifold control valve (if any) and disconnect the filling attachment from the filled cylinder. Allow the cylinder to cool to room temperature.

NOTE: Check the valve outlet for evidence of any leakage after removal of the filling attachment. Cylinders with defective or leaking valves shall not be returned to service.

10.8 After cooling, the pressure should be checked to assure that it is in accordance with the marked service pressure. Marked service pressure is, unless otherwise stated, the pressure in the container at a temperature of 70 F. If the cylinder temperature, after cooling to a stabilized condition varies above or below 70 F, the correction factors in Table I may be applied to determine the correct final pressure.

10.9 When all cylinders have been filled, store the charging manifold fittings in a clean area.

10.10 Tag or otherwise identify all filled cylinders.

10.11 All defective cylinders or cylinders found to be unacceptable under Section 8 should be scrapped or

TABLE I

At Room Temperature °F	Fill to Working Pressure x Figure Below	At Room Temperature °F	Fill to Working Pressure x Figure Below
110	1.10	70	1.000
105	1.0875	65	0.9875
100	1.075	60	0.975
95	1.0625	55	0.9625
90	1.05	50	0.95
85	1.0375	45	0.9375
80	1.025	40	0.925
75	1.0125		

NOTE: These factors are not exact, but are sufficiently accurate for practical purposes for working pressures between 1800 and 2400 psig.

forwarded to a cylinder manufacturer or an ICC authorized reconditioning facility for repairs.

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