SERVICE LETTER

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SUBJECT

Low Pressure Flexible Oxygen Hoses

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INTRODUCTION

This Service Letter (SL) is being issued in regards to the O2 Corporation Low Pressure Flexible Oxygen Hoses, herein referred to as "hoses". Some hoses have been discovered that have leak points in them through structural cracks or breaks, and may have become rigid or brittle at some areas. To date, the hoses in question were manufactured in 2001 and include the base part numbers O2C20T1 and O2C20T3. All of O2 Corp's hoses contain the same type of polyurethane tubing, internal stainless steel spring, and Nomex braided cover, all of which make up the body of the hose. Due to these similarities, this SL could be relevant to all hose part numbers manufactured by O2 Corp, and include the following base part numbers:

O2C20T1	O2C20T14
O2C20T3	O2C20T15
O2C20T5	O2C20T16
O2C20T13	

O2 Corp's investigation has provided some direction toward both the cause and the solution for this issue. The most apparent cause has been the lack of information provided regarding the use, maintenance, and limitations of these hoses. This could unintentionally help some end users to develop an unrealistic perception that these hoses:

- do not have limited storage conditions;
- do not have limited exposure conditions;
- do not have limited installation conditions;
- do not have limited operational conditions;
- have an established operational life.

These types of perceptions could lead to an outlook for these hoses as "install it and forget it." By providing the appropriate information for these hoses, O2 Corp intends to better educate the end users, and should reduce the opportunity for this issue to occur again. Whether the issue is eliminated or not will ultimately be dependent upon the **use** and **implementation** of this information by the aircraft operators.

O2 Corp's goal is to further provide information that is relevant to our hoses for storage, installation, and maintenance into a single document that will be made available to all of our customers. Until this

document is established, approved, and released, this SL will include as much information as possible that is relevant to the current issue.

HOSE INFORMATION

The essential information that an end user of a hose should have, retain, and implement into their documentation that controls the storage, installation, and maintenance of the hoses, are the life limits of the hose, installation and maintenance practices, and the storage and operational conditions that the hose is intended for.

Life Limits

Flexible hoses that contain age-sensitive elastomeric materials are controlled by two defined life limits, shelf life (also referred to as storage life) and operational life (also referred to as service life). O2 Corp has defined each of these life cycles based on industry standards:

> Shelf Life / Storage Life – the period of time from acceptance by the "user" until installed for service. The hose may be stored under proper conditions and still retain a reasonable operational life.
>
> Operational Life / Service Life – the period of time after installation is complete until retirement of the hose. Retirement of a hose is determined by the operator or the party responsible for the inspection and maintenance of the hose.

Shelf Life

O2 Corp's hoses do not currently have an established shelf life. The reason for this is that our hoses were developed for installation and not necessarily for storage. The majority of the demand for our hoses is for installation purposes. Our current process was developed in agreement with this demand, including a short lead time and that each hose is built to order. However, this only represents the majority of our demand and therefore does not suggest that we would disregard shelf life requirements.

To our knowledge, the most applicable document that references shelf life requirements for this specific application is SAE AS1933, Age Controls for Hose Containing Age-Sensitive Elastomeric Material. AS1933 specifies that the maximum age for a hose at the time of acceptance by the user is 32 quarters (8 years). Our interpretation of AS1933 suggests that it does not specify a minimum shelf life requirement. Because we build our hoses to order, an 8 year shelf life prior to acceptance should not be an issue.

Operational Life

Establishing an operational life for a hose containing age-sensitive elastomeric materials is not an industry practice for one main reason, operational conditions. Hose manufacturers do not control the conditions under which the hose will be installed and used. It is also very common for the hose manufacturer not to have, or be provided with, detailed knowledge or visibility regarding the conditions under which the hose will be installed and used. Rather than declaring an operational life, the more common practice is to recommend periodic maintenance inspections with repair or replacement upon condition. Maintenance inspections are the responsibility of the operator, however, hose manufacturers

should offer their recommendations regarding inspection criteria for their hoses, and we will provide our recommendations in the “Maintenance” section of this SL.

Installation

These hoses should always be handled with care and installed properly so as to avoid excessive twisting and/or bending. Use gradual curves when routing and do not force a hose to a sharp bend or angle, especially near the end fittings.

When a hose is installed, one end should be mated by finger tightening only so that the hose will be free to turn during routing and mating of the opposing end of the hose. This will help to prevent the hose from becoming unintentionally twisted or bent during installation. Final installation, or mating of the end fittings should be accomplished using two wrenches, one wrench should support the mating fitting while the other wrench should be used to tighten the nut on the hose. Double check the hose routing/configuration to ensure that the hose did not twist or bend during final installation.

If clamps are used to support a hose, take precautionary measures to ensure that the clamps used are properly sized so that it does not restrict travel or cause the hose to be exposed to shear stress, torsion, or tension. Do not use undersized clamps to support these hoses as this will cause compression (stress concentration) at the clamp locations.

Maintenance

The maintenance requirements and schedules are established by the aircraft OEM.

O2 Corp recommends that our hoses should be repaired or replaced upon condition. The recommended inspection criteria should include, but is not limited to:

- Proper installation and routing;
- Inspect for worn or damaged hoses, if found replace hose.
  This includes:
  - Chafed hose caused by abrasion;
  - Chafed hose caused by improper clamping;
  - Breaks in the outer Nomex cover;
  - Breaks in the internal tubing;
- Inspect the hose condition, if any of the below is found replace hose:
  - Check flexibility, the hose should not be rigid or brittle;
  - If hose is rigid or brittle, verify that there are not any heat sources that are near or in contact with the hose;
  - Check that the hose has not taken a set shape*;
- If clamps have been used, ensure proper clamping and that:
  - Clamp has not chafed the hose;
  - Clamp has not compressed the hose;
  - Clamp has not restricted travel or cause any sharp bends or twists;
- Check for moisture or corrosion on or around the hose, if found the hose is suspect to contamination and should be replaced.

*All hoses that contain age-sensitive elastomeric materials will take a set at some point in time. This means that after a period of being maintained in a particular configuration, the hose will permanently adhere to this fixed shape. Hoses that have taken a set have lost its elasticity. Any hose that has taken a set, or shows indication that it may be taking a set, should be replaced immediately.

Storage Conditions

O2 Corp hoses are not fabricated with the intent for extended storage. AS1933, Section 4.1 states "Hose assemblies should not be fabricated for extended storage." When the hoses are in storage between receipt/acceptance and installation, optimal storage conditions should be used when possible to prevent any deterioration of the hose. This includes protecting the hose from environmental conditions such as water, dust, circulating air, sunlight, fuel, oil, ozone, etc. Maintaining the hose in its original packaging will help prevent contaminants from contacting the hose, pending that the barrier has been maintained intact.

Care should be taken to keep the hoses stored at a reasonable temperature (70 °F ± 10 °F). AS1933, Section 4.1 states the following in regards to storage conditions: "The storage temperature shall not exceed 125 °F." Similar language can also be found in MIL-STD-1523, Section 5.1(b). O2 Corp does not recommend that our hoses are stored at or above a temperature of 100 °F. Should a storage environment require such conditions, the user should exercise caution by procuring hoses as needed for installation or by seeking an additional storage solution that is more appropriate for this application.

MIL-HDBK-695E is a handbook for the recommended shelf life of rubber products, however, it is not intended for aerospace bulk hoses and hose assemblies (1.2.2 d). The reason for its reference in this SL is that it provides the most adequate amount of information pertaining to storage conditions for elastomeric products. Section 4.3.2 addresses storage, with further details outlined in sections 4.3.2.1 – 4.3.2.5. Section 4.3.2.2 addresses humidity and recommends storage in an atmosphere of less than 75% relative humidity.

Operational Conditions

Flexible hose assemblies contain age-sensitive elastomeric materials that produce limitations on the operational life of any hose. The extent of these limitations depend greatly upon the conditions that the hoses experience after the final hose configuration is produced, delivered, accepted, and installed.

Reference documents have suggested contributing factors that could directly impact the operational life of an age-sensitive elastomeric material, which include, but are not limited to:

- **Temperature**
- Circulating air
- Dust
- **Liquid agents**
  - Water (moisture/condensation)
  - Fuel
  - Oil
  - Solvents
- Corrosive vapors

- **Mechanical stress**
- Ozone
- **Standing pressure**
- Oxygen
- Light
    - Sunlight
    - Fluorescent lamps
    - Ultra-violet light

The above items shown in bold font are possible contributing factors that we believe could have the most realistic and detrimental impact on the structural integrity of our hoses, based on the most common assumed conditions.

NOTE: We must use assumptions concerning the storage and operational conditions due to the lack of details regarding actual conditions provided to us, however, these assumptions are based on the knowledge that any aircraft, with our hoses installed, could be located throughout any part of the world.

Oxygen was not identified as a concerned factor due to the fact that the tubing used in our hoses is rated as “Excellent” for chemical resistance to oxygen, as offered by the tubing manufacturer.

Temperature

Temperature can have an impact on a hose whether during storage or operational conditions. At low temperatures, age-sensitive elastomeric materials will stiffen as the ambient temperature is reduced. At high temperatures, age-sensitive elastomeric materials will become more flexible as the ambient temperature is increased, and physical properties such as tensile strength will become lower.

Per the design requirements, our hoses are rated for temperatures of -65 °F to +185 °F for exposure conditions, and -40 °F to +165 °F for operating conditions. O2 Corp has conducted successful temperature testing on its hoses, based on requirements listed in RTCA/DO-160 for temperature variation and temperature exposure using the temperature values referenced in the respective drawing. What the design requirements, and the testing, cannot address are the hoses’ ability to resist degradation due to temperature over time, or more specifically prolonged exposure to the infinite variances in temperature environments.

If an operator is located in an environment that includes challenging temperature conditions, consideration of inspection frequency should be examined and modified to suit the specific needs that the environment produces.

Liquid Agents

Some fluids can be absorbed by some tubing materials, and prolonged exposure tends to cause swelling, loss of normal tensile strength, and reduced pressure resistance.

O2 Corp has limited knowledge as to the types of materials that could be in contact with our hoses since this information would most likely be known to the parties responsible for the installation, as well as the parties responsible for the maintenance of the hoses. To date, O2 Corp is not aware of any types of fluids that have, or may have, been in contact with any of our hoses.

There is one assumption that pertains to fluids that could occur on some aircraft, but has never been confirmed by an operator that utilizes our hoses. The assumption is related to the so-called "rain in the plane" issue. This occurs when frost forms on the inside of the skin due to condensation during flight at high altitude. Following subsequent descent and landing, the frost melts and the melt water could drip on various interior areas. If this occurred over an extended period of time it might promote degradation of the hose. The term "might" is used in that there is not any scientific data available that would demonstrate that this would actually happen under these circumstances using this specific type of hose.

Mechanical Stress

Mechanical stress can occur due to multiple factors, but are most likely initiated through improper handling or installation. Please refer to the "Installation" section of this SL for the proper methods used to install the hoses and to prevent any unintentional mechanical stress.

Standing Pressure

Hoses that contain age-sensitive elastomeric materials were not designed to be used with standing pressure. This means that if the hose is not in operation, whether through inspection/testing or operational use, the hose is not supposed to be pressurized. SAE ARP1532, Aircraft Oxygen System Lines, Fabrication, Test and Installation, Section 3.8, states that "oxygen lines pressurized at all times while on the ground or in the air shall be metallic."

CONCLUSIONS

The discovery of hose failures in the field has alarmed those involved and has essentially resulted in a universal inquiry, is there a need to be concerned regarding the design of these hoses? O2 Corp has been working and researching to determine the most accurate answer to this question, and to date has not obtained any information that would suggest that there is an issue with the materials required by the design, and therefore does not raise a concern in regards to the suitability of these hoses.

Another inquiry is what do the customers need to do about the situation? Our response includes utilizing the information in this SL, review current inspection and maintenance procedures and ensure that they are consistent with this SL, and replace any hose that is suspect to degradation. Whether the issue is eliminated or not will ultimately be dependent upon the **use** and **implementation** of this information by the aircraft operators.

What O2 Corp is doing in response to this situation is providing further information pertaining to our hoses to better educate the users of our hoses. The information contained in this SL should be sufficient for users to implement any immediate changes to their installation, inspection, and maintenance methods, and could prevent hoses from reaching structural failure before being replaced.

Reference documents pertaining to hoses that contain age-sensitive elastomeric materials do not provide, or even attempt to suggest, that life limits can be objectively established for this type of application. Further research did not yield any evidence that life limits have been established throughout the industry as well. The unlimited number of operational conditions makes the feat of establishing an objective life limit very challenging, if not impossible. Because of this, it is standard practice within the industry to inspect, test, and maintain hoses in order to determine when a hose

should be retired from service. All hoses that contain age-sensitive elastomeric materials will degrade over time and will need to be replaced in order to avoid structural failure of the hose. A hose may experience structural failure as a result of time (age) and the rate of degradation. The rate at which a hose will degrade is dependent upon the exposure and operational conditions in which the hose endures.

All of the information contained in this SL is based on reference standards and industry practices. The reason for this is that users are not providing us with information in regards to storage conditions, installation practices, inspection and maintenance practices and/or data, or operational conditions. If an OEM, maintenance facility, or operator provided such information it could prove to be useful in our investigation.

WARRANTY

O2 Corporation hoses are covered under O2 Corp's warranty policy, document number O2-WTY-01. O2 Corp's warranty policy may be obtained by request or through our website using the following link: http://www.o2corporation.com/warranty.html.

There were some hoses that were found to have been altered by the customer and/or operators. Unauthorized alterations to any of O2 Corp's products are not covered under O2 Corp's warranty policy.

REFERENCES

SAE ARP1532, Rev A, Aircraft Oxygen System Lines, Fabrication, Test and Installation

SAE AS1933, Rev A, Age Controls for Hose Containing Age-Sensitive Elastomeric Material

MIL-STD-1523A, Age Controls of Age-Sensitive Elastomeric Material (For Aerospace Applications)

MIL-HDBK-695E, Rubber Products, Recommended Shelf Life

Saint-Gobain Performance Plastics, A Comprehensive Guide to Tygon Tubing Formulations