

CRITERION 411

COMPRESSED AIR SYSTEMS/EQUIPMENT

SIGNATURES

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RECORD OF REVISIONS

Revision No.	Date	Description
0		Initial Issue

AIR COMPRESSOR SYSTEMS/EQUIPMENT

1.0 PURPOSE

It is the intent of this document to establish the minimum requirements and best practices for the operation and maintenance program for the LANL air compressors and their appurtenant equipment. This document addresses the requirements of LIR 230-05-01, "Operation and Maintenance." (Reference 10.3)

2.0 SCOPE

There are approximately 1,800 compressed air systems in the LANL complex. This Criterion addresses those LANL facility and programmatic compressed air systems with an operating pressure higher than 15 psig and less than 175 psig. Specifically, this criterion addresses: rotary screw and reciprocating compressors (stationary and mobile), mechanical air/water separators, refrigerated and regenerative air dryers, pre-filters, after-filters, receiver tanks, and automatic blow-down valves.

Breathing air compressors/systems, high-pressure air systems, electric motors, and fans and blowers are not included in the scope of this document.

3.0 ACRONYMS AND DEFINITIONS

3.1 Acronyms

ABS	Acrylonitrile Butadiene Styrene (plastic)
DP	Dew Point
ISA	Instrument Society of America
JCNNM	Johnson Controls of Northern New Mexico
PMI	Preventive Maintenance Instruction
PP&PE	Personal Property and Programmatic Equipment
RP&IE	Real Property and Installed Equipment
SSC	Structures, Systems and Components

3.2 Definitions

Air Quality. There are four elements for the quality of instrument air for use in pneumatic instruments.

- **Contaminants:** Consists of oil, particulate, corrosive contaminants and hazardous gases, flammable or toxic. (ISA-S7.3, Reference 10.1)
- **Oil Content:** The oil or hydrocarbon content of an air stream (ISA-S7.3, Reference 10.1)

- **Particle Size:** Refers to the size of contaminants in the air stream. (ISA-S7.3, Reference 10.1)
- **Dew Point.** The temperature at which water vapor will condense out of the gas. In this context, the dew point is measured down stream of the air dryers to determine the systems operational efficiency. (ISA-S7.3, Reference 10.1)

Torpedo. ABS plastic pipe device, which is used to separate water and oil mixtures from the air stream that are generated by lubricated air compressors. The Torpedo media retains the oil compounds and allows accumulated clean water condensate to escape to sewer drains.

4.0 RESPONSIBILITIES

4.1 FWO-System Engineering and Maintenance(SE&M)

4.1.1 Responsible for the technical content of this Criterion and assessing the proper implementation across the Laboratory. FWO-SE&M shall also provide technical assistance in support for implementation of this Criterion.

4.2 Facility Manager

4.2.1 Responsible for operations and maintenance of institutional, or Real Property and Installed Equipment (RP& IE), in accordance with the requirements of this document.

4.2.2 Responsible for operations and maintenance of those Personal Property and Programmatic Equipment (PP& PE) systems and equipment addressed by this document which may be assigned to the FM in accordance with the FMU specific Facility/Tenant Agreement.

4.3 Group Leader

4.3.1 Responsible for implementing operational and maintenance surveillance programs including the preparation and maintenance of required procedures and documentation for PP&PE under their jurisdiction that is covered by this Criterion.

5.0 PRECAUTIONS AND LIMITATIONS

5.1 Precautions

This section is not intended to identify all applicable precautions necessary for implementation of this Criterion (e.g., lock-out/tag-out, confined space entry, PPE, etc.). It is intended only to assist the user in the identification of hazards/precautions that may not be immediately obvious.

- 5.1.1** Stored energy, such as electrical voltage and air pressure may need to be dissipated prior to performing maintenance work. Prior to performing maintenance or repair on compressors, dryers, filters or airlines, all components of the system must be vented to atmospheric pressure to minimize hazards. Vent valves should be locked in the open position. Turning off the air supply to the users must be coordinated with the users to negate problems with their operations.
- 5.1.2** Due to the amount of machinery background noise in the vicinity of the air compressors and dryers, hearing protection may be required.
- 5.1.3** Extreme care must be used when restarting a rotary screw compressor. The manufacturers' instructions must be followed. Internal oil mist flash fires and deflagration have been attributed to poor maintenance practices and procedures with this type of compressor. (Lessons Learned, 1996-RL-WHC-0030, Reference 10.12)

5.2 LIMITATIONS

The intent of this Criterion is to identify the minimum generic requirements and recommendations for SSC operation and maintenance across the Laboratory. Each user is responsible for the identification and implementation of additional facility specific requirements and recommendations based on their authorization basis and unique equipment and conditions, (e.g., equipment history, manufacturer warranties, operating environment, vendor O&M requirements and guidance, etc.). As a minimum, nuclear facilities and moderate to high hazard non-nuclear facilities will typically have additional facility specific requirements beyond those presented in this Criterion which are contained in their Authorization Basis (e.g., Safety Analysis Report, Technical Safety Requirements, or Facility Safety Plans), as applicable.

6.0 REQUIREMENTS

Minimum requirements that Criterion users must follow are specified in this section. Requested variances to these requirements must be prepared and submitted to FWO-SE&M in accordance with LIR301-00-02, "Exceptions or Variances to Laboratory Operations Requirements" (Reference 10.5) for review and approval.

6.1 Operations Requirements

- 6.1.1** No requirements identified.

6.2 Maintenance Requirements

6.2.1 Pressure systems, including receiver tanks, shall be maintained per the latest revision of LIR402-1200-01, “Pressure, Vacuum, and Cryogenic Systems” (Reference 10.14), as applicable.

Basis: Compliance with LIRs is required by clauses [5.14 (B)(1), and 6.7] of the DOE/UC contract.

7.0 RECOMMENDATIONS AND GOOD PRACTICES

The information provided in this section is recommended based on acceptable industry practices and should be implemented by each user based on their unique application and operating history of the subject systems/equipment.

7.1 Operations Recommendations

7.1.1 Where a compressed air system has two compressors in a parallel configuration, it is recommended that one compressor be selected as the on-line (i.e. lead) compressor and the other as the standby (i.e., lag) compressor until the lead compressor requires corrective maintenance.

Basis: Engineering Judgement. This operating philosophy would allow the lag compressor to be in relatively good condition to provide system functionality while the other compressor is being repaired or replaced.

7.2 Maintenance Recommendations

7.2.1 Monthly

7.2.1.1 Air Compressors

The following inspections and functional checks should be performed for rotary screw and reciprocating compressors:

- Visually check the drive V-belts for wear, tension, and alignment.
- Check that the oil pressure gauges are in normal range with the compressor running.
- Check for correct oil level.
- Verify that the ON / OFF set points are functioning as designed.
- Verify that the compressor indicating/running lights are functional and in normal position.
- For rotary screw compressors only, verify the ON/OFF, LOAD and UNLOAD controls are functioning as designed.

Basis: Based on LANL operating experience and a review of typical vendor recommendations and manuals (References 10.4, 10.13, and 10.15), the

recommended practice will provide reasonable assurance of efficient and reliable compressor operation.

7.2.1.2 Air Dryers

7.2.1.2.1 Refrigerated

7.2.1.2.1.1 Verify that the automatic water drain valve is operational.

Basis: ASME B19.1, 1995, "Safety Standard for Air Compressor Systems", (Reference 10.9) recommends this activity.

7.2.1.2.1.2 Check the pressure differential indicating devices for excessive readings on the after-filter assemblies. If the pressure exceeds the manufacturers' recommendations, the filter cartridge should be changed.

Basis: Based on LANL operating experience and a review of typical vendor recommendations and manuals (References 10.4, 10.13, and 10.15), the recommended practice will provide reasonable assurance of efficient and reliable dryer operation and protection of downstream equipment.

7.2.1.2.2 Regenerative

7.2.1.2.2.1 On the air pre-filters, after-filters, receiver-tanks and mechanical separators, verify that the blow-down devices are functional and that the torpedo separators show no oil in the discharge area.

Basis: Factory Mutual 7-95 (Reference 10.11) recommends this activity.

7.2.1.2.2.2 Observe the condition of the moisture-indicating device located down-stream of the dryer. The normal color of the internal desiccant is blue. If the desiccant is discolored (normally a light pink color), it indicates that the dryer system is contaminated with oil or water and corrective maintenance is required.

Basis: Based on LANL operating experience and a review of typical vendor recommendations and manuals (References 10.4, 10.13, and 10.15), the recommended practice will provide reasonable assurance of efficient and reliable dryer operation and protection of downstream equipment.

7.2.1.2.2.3 Check the pressure differential indicating devices for excessive readings on the pre and after filter assemblies. If the pressure exceed the manufacturers' recommendations, the filter cartridges should be changed.

Basis: Based on LANL operating experience and a review of typical vendor recommendations and manuals (References 10.4, 10.13, and 10.15), the recommended practice will provide reasonable assurance of efficient and reliable dryer operation and protection of downstream equipment.

7.2.1.3 Torpedos

7.2.1.3.1 Torpedo maintenance activities vary due to loads and the age of the compressor. They should be checked for signs of oil or hydrocarbons penetrating the media and accumulating on the exterior of the housing. They should be replaced or rebuilt with first indications of external oil.

Basis: Engineering Judgement. Based on LANL high usage, long term experience with Torpedos and to prevent oil from entering the sanitary sewer system.

7.2.2 Semi-Annually**7.2.2.1** Air Compressors

7.2.2.1.1 The following maintenance and inspections should be performed for rotary screw and reciprocating compressors:

- Change the oil with a type recommended by the manufacturer.
- Inspect the valves for leakage and carbon build-up.
- Inspect and clean the oil sump screen.
- Verify that the mechanical separator, usually installed between the compressor and the receiver tank, is functional and the separator drain valve is operational.
- Verify that the low-level oil switch is functional.

Basis: Based on LANL operating experience and a review of typical vendor recommendations and manuals (References 10.4, 10.13, and 10.15), the recommended practice will provide reasonable assurance of reliable compressor operation and optimization of its service life.

7.2.2.1.2 For the water cooled intercoolers and aftercoolers, verify that the temperature and control valves are operational.

Basis: Factory Mutual 7-95 (Reference 10.11) recommends this activity.

7.2.2.1.3 Inspect and clean or replace suction air filters to prevent clogging and reduction of airflow.

Basis: Whereas the air compressors may be candidates for run to failure in some instances, the components that receive compressed air may not. It is therefore necessary to supply clean air to these components.

7.2.2.1.4 Verify that the intercooler and aftercooler coils are clean and free of debris.

Basis: ASME B19.1, 1995 (Reference 10.9, page 13) recommends this activity.

7.2.2.2 Air Dryers

7.2.2.2.1 Refrigerated

7.2.2.2.1.1 Perform the following inspections:

- Visually inspect the exterior of the dryer for air leaks, valve malfunctions, and pressure gauge damage.
- Visually inspect the heat exchanger grills for dirt and dust accumulation and clean as necessary.

Basis: Based on LANL operating experience and a review of typical vendor recommendations and manuals (References 10.4, 10.13, and 10.15), the recommended practice will provide reasonable assurance of reliable and efficient equipment operation and optimization of its service life.

- Measure the discharge pressure dew point (DP). The dew point should measure between +35⁰ and +40⁰ F.

Basis: Instrument Society of America, ISA-RP7.7 (Reference 10.2) recommends this activity.

7.2.2.2.2 Regenerative

7.2.2.2.2.1 Perform the following measurements:

- Measure the cycle time for tower switching and monitor the tower pressure gauges to insure that each tower is pressurized in sequence.
- Measure the discharge pressure dew point (DP). Normal DP temperatures are less than -40⁰ F.

Basis: Instrument Society of America, ISA-RP7.7 (Reference 10.2) recommends this activity.

7.2.2.2.2.2 Perform the following inspections:

- Visually inspect exterior of air dryer for air and desiccant leaks, valve malfunctions, pressure gauge damage, or overheating of towers.
- Verify that the dryer purge-flow system is operational. Verify that the purge rate matches the required air usage conditions as recommended by the dryer manufacturer.

Basis: Based on LANL operating experience and a review of typical vendor recommendations and manuals (References 10.4, 10.13, and 10.15), the recommended practice will provide reasonable assurance of reliable and efficient equipment operation.

7.2.3 Annually

7.2.3.1 Air Compressors

7.2.3.1.1 Perform the following activities:

- Change oil filters.
- Change drive belts.
- Lubricate motor bearings, if applicable.
- Visually inspect the electrical controls, wiring and components.
- Install new suction air filters.
- Verify that the safety shutdown system is functional.
- Check all hoses for wear, aging and cracking.
- Visually inspect the electrical controls, wiring, overloads alternators, disconnects for potential problems.
- Inspect the receiver tank in accordance with the recommendations of LIR 402-1200-01. (Reference 10.14).
- Check all piping and fittings for leaks, signs of corrosion and excessive vibration.
- Test pressure-relief devices. This requires manually opening valves and verifying that the valve reseats with no leakage. Any leakage will require valve replacement or repair.

Basis: Factory Mutual 7-95 (Reference 10.11) recommends this activity.

7.2.3.2 Air Dryers

7.2.3.2.1 Regenerative

7.2.3.2.1.1 Perform the following activities:

- Replace the purge muffler element and the control air filter element.
- If there are no pressure differential indicating devices on the pre-filter and after-filter assemblies, install new filter cartridges.
- For regenerative heatless dryers, verify that the automatic condensate drain valves are operational. Automatic drains must be disassembled and cleaned if they are not operational. Electronic drain valves have a “test position” and can be cycled with this mechanism to verify operational status.
- Visually inspect the exterior of the filter housings for air leaks; valve malfunctions; and pressure gauge damage.

Basis: ASME B19.1, 1995, “Safety Standard for Air Compressor Systems” (Reference 10.9) recommends this activity.

7.2.3.3 Torpedos

7.2.3.3.1 After one year of operation, the Torpedo should be replaced.

Basis: Based on LANL experience, the external surfaces and the mat which retains the hydrocarbons, become so contaminated with dirt, that the assembly should be replaced.

8.0 GUIDANCE**8.1 Operations Guidance**

8.1.1 No implementing guidance available.

8.2 Maintenance Guidance**8.2.1 Air Compressors**

8.2.1.1 A maintenance program similar to JCNNM PMI 40-25-004, "Air Compressor Equipment Maintenance and Repair" (Reference 10.6) is acceptable. FWO-SE&M will review and concur with any other maintenance program.

8.2.2 Air Dryers

8.2.2.1 A maintenance program similar to JCNNM PMI 40-40-006, "Air Dryers, Desiccant and Refrigerated" (Reference 10.7) is acceptable. FWO-SE&M will review and concur with any other maintenance program.

8.2.3 Torpedos

8.2.3.1 A maintenance program similar to JCNNM PMI 40-40-017, "Torpedo Installation, Testing and Maintenance" (Reference 10.8). is acceptable. FWO-SE&M will review and concur with any other maintenance program.

9.0 DOCUMENTATION

9.1 As-found data from inspection, testing and maintenance should be recorded and controlled in equipment history files, e.g., CMMS. The recorded equipment history information should be suitable to support maintenance activities, upgrade maintenance programs, optimize equipment performance, and improve equipment reliability.

Basis: This is a good maintenance practice that is recommended by DOE Order 4330.4B (Reference 10.10, Section 3.4.9).

10.0 REFERENCES

- 10.1** Instrument Society of America: ISA-S7.3-1981: Quality Standard for Instrument Air.
- 10.2** Instrument Society of America: ISA-RP7.7-1984: Producing Quality Instrument Air.
- 10.3** LIR 230-05-01, Operations and Maintenance Manual.
- 10.4** Van Air Systems Inc.: Installation, Operation and Maintenance Instructions for Refrigerated Compressed Air Dryers. 1996, PN: 32-0238.
- 10.5** LIR 301-00-02, Exceptions or Variances to Laboratory Operations Requirements.
- 10.6** JCNNM, PMI Number 40-25-004: Air Compressor Equipment Maintenance and Repair.
- 10.7** JCNNM, PMI Number 40-40-006: Air Dryers, Desiccant and Refrigerated.
- 10.8** JCNNM, PMI Number 40-40-017: "Torpedo" Installation, Testing and Maintenance.
- 10.9** ASME B19.1, 1995: Safety Standard for Air Compressor Systems.
- 10.10** DOE Order 4330.4B, Maintenance Implementation Plan.
- 10.11** Factory Mutual 7-95.
- 10.12** Lessons Learned, I.D. 1996-RL-WCH-0030: Air Compressor Deflagration during Start-up.
- 10.13** Van Air Systems Inc.: Installation, Operation and Maintenance Manual for Heatless Regenerative Dryers, PN 32-0259, June, 1997.
- 10.14** LIR 402-1200-01: Pressure, Vacuum, and Cryogenic Systems.
- 10.15** Quincy Compressor Instruction Manual, PN: 50236-101; 1988 and PN: 52201-104,1994.

11.0 APPENDICES

None.