5.07 Air Replenishment Systems

Reference: 2010 SFFC, Section 511.2

Definitions:

CERTIFIED COMPRESSOR. A compressor used by a contractor for maintenance and testing of air replenishment systems that is tested quarterly in accordance with Chapters 5, 6, and 7 of NFPA 1989, 2008 edition and Section 5144 of Title 8, California Code of Regulations.

RIC UAC (Rapid Intervention Crew/Company Universal Air Connection). A system that allows emergency replenishment of breathing air to the SCBA of disabled or entrapped fire or emergency services personnel.

a) **Purpose.** The purpose of this bulletin is to describe the requirements for air replenishment systems intended to be used to fill firefighters' self-contained breathing apparatus (SCBA) during firefighting operations in high-rise buildings or tunnels.

b) **Scope.** This bulletin applies to all new high-rise buildings as defined by the California Building Code and new underground transportation and pedestrian tunnels exceeding 300 feet in length, except as provided below, when the building permit application is submitted after the effective date of this bulletin. Air replenishment systems installed under the previous administrative bulletin, which applied when the building permit application was submitted after March 30, 2004, shall be maintained as installed, except as described in Section l) (Maintenance for Existing Systems) of this bulletin.

c) **Permit Required.** A building permit is required to install or modify an air replenishment system. A fire department issued operational permit is required to maintain or test air replenishment systems.

d) **Safety.** The air replenishment system shall provide a safe and reliable source of clean breathable air to firefighters and other first responders performing fire suppression, evacuation, search and rescue and other types of emergency response tasks at incidents requiring the use of self contained breathing apparatus. The air replenishment system allows firefighters to replenish empty breathing air cylinders within close proximity of the incident, reducing the amount of travel distance, time and personnel needed for logistical support. Bottle filling will normally occur in a staging area with the use of portable containment protective devices that are provided throughout the building.

The use of the RIC UAC (with the bottle still in the pack and on the user's back) is intended only for emergency situations. Emergency situations are defined as situations where the SCBA user believes the air in his or her airpack is insufficient to sustain him or her until he or she can reach a non-hazardous atmosphere. RIC UAC's shall not be used to fill bottles during drills.

e) **Submittal Requirements.** As part of the building permit process, two sets of plans stamped and signed by a California licensed design professional shall be submitted for review and approval. Plans shall demonstrate compliance with the requirements of this section and shall include calculations demonstrating that the design criteria for all pressure containing components is satisfied plus a minimum safety factor of 25%. The submittal shall include specifications, listing information, mill report, and manufacturer data sheets for all components of the system.

f) **Contractor Qualifications.** The air replenishment system shall be installed by a California licensed C-36 contractor with a San Francisco business license.

g) **Design Criteria.**

1. **Intent.** The system shall be designed so that the air supply is provided solely by the fire department's mobile air unit. After successful completion of the final acceptance test, the system shall be pressurized to 4500 psi and shall maintain this pressure until the system is actually used or retested. Before actual use, the operator shall bleed/purge the pressurized air from the system so that only new air from the mobile air unit will be used to refill the SCBA.

2. **Filling Capability.** The system shall be designed to fill a minimum of two (2) 45 cubic foot breathing air cylinders to 4500 psi simultaneously within two (2) minutes of the opening of the fill valve at the most remote filling panel in the building or tunnel**.**
3. **Operating Pressure.** All components used in the system shall be rated to operate at a minimum of 5000 PSIG at 70F.
4. **Marking.** All components of the air replenishment system shall be clearly identified by means of permanent labels or signage indicating their function. This shall include as a minimum all fire department connection panels, gauges, valves, air connections, air outlets, and enclosure doors where applicable. Fire department connection panels shall be clearly labeled FIREFIGHTER'S AIR SYSTEM in letters at least 2" in height with a minimum 3/8" brush stroke.
5. **Security.** To prevent unauthorized access to or tampering with the system, all fire department connection panels shall be maintained locked by an approved means. All air replenishment system locks shall be keyed to the approved San Francisco Fire Department key*.*
6. **Fire Department Key Box.** A fire department key box containing a key to the fire department connection panels shall be provided adjacent to the exterior fire department connection panel(s). Additional marked keys shall be provided with each firefighter phone.
7. **Exterior Fire Department Connection Panel.**
   A. **Location. High-rise buildings.** A fire department connection panel shall be surface mounted or flush mounted on the building exterior. The panel shall be within 50' of an approved access road or other location approved by the fire department. The enclosure shall be visible and accessible on approach to the building. Where the building has more than one street frontage, the fire department may require an additional connection panel on a case-by-case basis.
   B. **Tunnels**. A fire department connection panel shall be located in an approved location adjacent to each station or tunnel entrance in close proximity to the street.
   C. **Construction.** The fire department connection panel shall be installed in a cabinet constructed of minimum 18-gauge carbon steel with a coating to protect the cabinet from corrosion.
   D. **Vehicle Protection.** When the panel is located in an area subject to vehicle traffic, impact protection shall be provided.
   E. **Components.** The components of the base station panel shall include the following:
      I. One male fitting that is compatible with the SFFD mobile air unit.
      II. One downstream shutoff valve.
      III. One pressure gauge to read the pressure of the piping distribution system to air filling stations.
      IV. One pressure gauge to read the supply pressure from the SFFD mobile air unit.
      V. One pressure relief valve designed to limit the pressure that can be introduced to the system to not more than is necessary to achieve the bottle filling design criteria.
      VI. The relief valve, piping, pressure regulator, pressure gauges, fittings and connection hoses shall meet the requirement of the ASME Boiler and Pressure Code, Section VIII, Unified Pressure Vessel Code. The installation of the piping system, as a minimum, will be based on ASME B31.3-2004 Code.
      VII. Mechanical supports for piping, hoses, gauges, and pressure components shall be designed in accordance with the California Mechanical Code.
   8. **Interior Air Filling Panels.**
      A. **Location.** Air filling panels shall be installed in buildings and tunnels as follows:
         I. In buildings, interior air filling panels shall be located just outside of the stair and vestibule enclosure on floors as stated below. The panel shall be installed within 5 feet and adjacent to vestibule doors. Panels shall be located at every other floor commencing at the second floor or the first basement in one stair,

and at the third floor and the second basement in the second stair. If additional stair enclosures are provided, panel distribution shall follow the same rotation as above.

II. In tunnels, interior air filling panels shall be located at each end of the platform within stations, within 5' of standpipe outlets within tunnels, or as required by the fire department.

B. **Mounting Height.** The centerline of the panel shall be at a minimum height of 32" and a maximum of 48"**.**

C. **Construction**. Panels shall be constructed of minimum 18-gauge carbon steel. The depth of the cabinet shall not protrude more than 4 inches from the wall. All components shall be secured behind the locked cabinet door. The door of the cabinet shall have a tempered glass panel at the location of the door latch that will provide a means of emergency entry to the panel by breaking the glass. The thickness of the glass shall be no greater than 1/8". Panels within transportation tunnels shall be designed to resist the intrusion of dust and air.

D. **Components.** The cabinet shall contain the following components:

I. One isolation valve located between the air discharge line to the next air substation and the downstream line to the air base station supply or the air substation immediately below to the next substation above the air bas station.

II. The fill hoses and isolation valves shall be installed between the air bottle connection line and the fresh air supply.

III. Excess bleed valves shall be located between the air bottle fill hose and the next air substation.

IV. Each fill station shall contain two fill hoses/fittings that are provided with a pressure regulating valve to equalize pressure between two bottles. The filling of two bottles shall be controlled by a single control valve between the air supply and air bottle. The SCBA fill hoses shall be designed with two RIC UAC female fittings as well as two routine filling fittings. A protective cap shall be provided for each hose.

V. Mechanical supports for piping, hoses, gauges and pressure components shall be designed in accordance with the California Building Code.

E. Cylinder Filling Hose. The design of the cabinet shall provide a means for storing the hose to prevent kinking. When the hose is coiled, the brackets shall be installed so that the hose bend radius is maintained at 4 inches or greater. Each filling hose shall be a minimum length of 6 feet.

9. **Other System Components.**

A. **Piping Distribution, Materials, and Methods.**

I. **Tubing.** Tubing shall be stainless steel, compatible with high pressure breathing air, and shall at least meet ASTM A-269, Grade 316 or better. Stainless steel tubing shall be a minimum .375 outside diameter x 065 wall 316 fully annealed seamless. Routing of tubing and bends shall be such as to protect the tubing from mechanical damage. The use of other types of tubing or fittings is prohibited without the specific written approval of the San Francisco Fire Department. The tubing used shall be rated for a minimum pressure of 7500 psi.

II. **Gauges**. All system pressure gauges shall be rated for 10, 000 psi.

III. **Construction Requirements.** All components of the piping distribution system shall be protected by at least two hour fire resistive construction or be concealed inside 2 hour rated wall assemblies. The SFFD fire inspector shall witness test the pressure testing of piping prior to cover up. Tubing shall be supported in accordance with the California Mechanical Code and at intervals that do not exceed 5 feet.

IV. **Fittings.** Fittings shall be constructed of stainless steel and compatible with high pressure breathing air. Stainless steel fittings shall be at least Grade 316 and meet the requirements of ASTM A-479 or an equal standard.

V. **Assembly.** The system shall be all welded except where the tubing joints are readily accessible and at the individual air fill panels. When mechanical high pressure tube fittings are used, they shall be approved for the type of material to be joined and rated for the maximum pressure of the system.

Welding procedures shall meet ASME B31.1-1989, Part 4 and Chapter V (Exhibit VI). Prior to and during the welding of sections of tubing, a continuous regulated dry nitrogen or argon purge at three PSIG shall be maintained to eliminate contamination with products of the oxidation or welding flux. The purge shall commence a minimum of 2 minutes prior to welding operations and continue until the welded joint is at ambient temperature.

The installing contractor shall ensure that at all times, the system components are not exposed to contaminants, including but not limited to oils, solvents, dirt and construction materials. When contamination of the system has occurred, the affected component shall be removed from the system.

B. **Pressure Monitoring Switch**. An electric low pressure monitoring switch shall be installed in the piping system to monitor the air pressure. The pressure switch shall be connected to the building's fire alarm system via a monitor module. The pressure switch shall transmit a supervisory signal to the fire alarm control panel and the monitoring company when the pressure of the breathing air system is less than 3000 PSIG at 70 degrees Fahrenheit, $\pm$ 100 PSIG. The fire department and air system contractor shall be notified immediately when a low air alarm has been activated. Permanent signage shall be provided in the fire control room that provides instruction and contact numbers for the air system contractor. The supervisory signal shall be cleared only after the low air pressure problem is fixed and the system is pressurized again to 4500 psi.

C. **Portable Explosion Containment/Fragmentation Deflectors**. A minimum of two portable fragmentation deflectors shall be located in the fire control room. These devices shall be provided with a sturdy double unit handled carrying box and shall be stored in a marked cabinet within the fire control room. Additionally, a single portable fragmentation deflector with a sturdy handled carrying box shall be provided within a locked cabinet on every fifth floor. The distribution of the fragmentation deflectors shall be staggered so that they are located at the panel near one stair at the 5th floor, and at the panel near the other stair at the 10th floor, and so on. The deflector and carrying box shall be stored in a locked, marked cabinet at an approved location near the filling panel. All fragmentation deflectors shall have a minimum rating of Class 4 and shall be capable of containing a bottle with a minimum diameter of 6-1/2” and a height of 27” (one-hour bottle).

h) **Inspection and Testing.** Following fabrication, assembly, and installation of the piping distribution system, or after any system piping modification, the system shall undergo the following tests. The district inspector shall be notified prior to all testing.

1. **Contractor Pre-test**. Prior to scheduling the rough and final tests, the contractor shall provide the district fire inspector with a pre-test letter indicating that the system was successfully pre-tested at 7000 psi for at least one hour (soapy water leak test) and that the system is 100% functional, leak free, and installed in accordance with the approved plans.
2. **Rough Test**. The rough test shall be witnessed by the district fire inspector. Each system component shall be subjected to a test pressure of 7000 psi with clean dry air. This pressure shall be maintained until each joint has been examined for leakage by means of soapy water. The source valve shall be closed during the test. Any leaks shall be located, repaired, and retested.

3. **Final Test**. The final test shall be witnessed by the district fire inspector. The system shall be subjected to a 24 hour standing pressure test at 5500 psi with clean dry air. The source valve and all outlets shall be closed during this test. The piping system shall remain leak-free for 24 hours. The only allowable pressure changes during the 24 hour test period shall be those caused by variations in the ambient temperature. Any leaks shall be located, repaired, and retested.
4. **Calibration and Testing of the Low Pressure Monitoring Switch**. The low pressure monitoring switch shall be calibrated to not less than 3000 PSI descending and tested to verify that the signal is annunciated at the fire alarm control panel (supervisory signal) and at the LED or Graphic annunciator (LED indicator light indicating low pressure). The supervisory signal shall also be transmitted to the monitoring agency.
5. **Compatibility Testing.** Each exterior fire department connection panel shall be tested for compatibility with the SFFD mobile air unit.
   Each air filling panel shall be tested for compatibility with SFFD self contained breathing apparatus. This shall be accomplished by replenishing cylinders at each panel. The RIC UAC hose and fitting shall be provided, but will not be used until SFFD obtains new SCBA equipment.
6. **Criteria Testing.** The system shall be tested to verify that two 45 cubic foot cylinders may be filled simultaneously within two minutes at the two highest filling panels while the fire department's mobile air unit is supplying air to the system.
7. **Air Quality Testing**. During the system final test, after the system is pressurized with air from a certified compressor, two air samples shall be taken from the lowest and highest air filling panels, and submitted to an accredited testing laboratory that meets the requirements for air filling specified in Chapter 4 of NFPA 1989. Copies of laboratory testing reports shall be provided to the district fire inspector prior to the issuance of the Certification of Final Completion for the building.

i) **Special Inspection**. A special inspection is required for all new and modified air replenishment systems and shall be conducted by an approved person or agency. The special inspector shall be able to provide documentation of previous expertise in high pressure air systems or medical gas systems. The proposed special inspection procedure shall be submitted with the system plans.

j) **Reports.** A complete report of testing and inspection shall be prepared by the required special inspector or special inspection agency. The special inspector shall verify that all welding and installation is completed in a workmanlike manner and that precautions are taken to insure that contamination of the piping does not occur during installation. The special inspector shall witness all required testing and inspection and shall verify that components of the system are not subjected to inappropriate pressures. It is the contractor's responsibility to notify the special inspector that work is occurring and the appropriate inspections shall be completed prior to concealment of the system.

k) **Maintenance for New Systems.**

1. **Annual Testing**. At least annually, two samples of air shall be taken from the lowest and highest air filling panels and sent to an accredited laboratory for results. The samples shall be taken prior to any purging of the system. Copies of the results shall be provided to the SFFD annual high-rise inspector for the building by mail immediately upon receipt. After the samples have been obtained, the system shall be completely purged and refilled with air from a certified compressor.
2. **Other Requirements.**
   A. **Visual Inspection.** At least annually, a visual inspection shall be performed to insure that all system components, devices, including portable explosion containment devices are present and maintained in an operable condition.
   B. **Pressure Monitoring Test.** Semiannually, after notification of the fire alarm monitoring company, the low pressure monitoring switch shall be tested to verify that a supervisory signal is transmitted.

C. **Recordkeeping.** Records of testing and maintenance, including laboratory reports shall be sent to the high-rise inspector for the building immediately upon receipt. Additionally, copies of all records shall be maintained in the building and shall be available upon request of the fire department.

l) **Maintenance for Existing Systems.**

1. Systems installed under previous guidelines that were provided with an air compressor or other built-in air source shall be modified so that by no later than November 1, 2009 the built-in air source is removed from the system. The San Francisco Fire Department will not charge fees associated with the retesting of this equipment, however, the district inspector shall be involved in this retesting. Systems that undergo this modification shall be tested in accordance with the requirements for new systems.
2. Until systems are modified as stated in item 1, the building owner shall be responsible for the testing and maintenance of the system in accordance with all of the applicable sections of NFPA 1989, 2008 edition, and Section 5144 of Title 8, California Code of Regulations. The building owner shall ensure that air samples are taken quarterly and sent to an accredited laboratory for analysis.
3. **Other Requirements**.
   A. **Visual Inspection**. At least annually, a visual inspection shall be performed to insure that all system components, devices, including portable explosion containment devices are present and maintained in an operable condition.
   B. **Pressure Monitoring Test.** Semiannually, after notification of the fire alarm monitoring company, the low pressure monitoring switch shall be tested to verify that a supervisory signal is transmitted.
   C. **Record Keeping**. Records of testing and maintenance, including laboratory reports shall be sent to the high-rise inspector for the building immediately upon receipt. Additionally, copies of all records shall be maintained in the building and shall be available upon request of the fire department