Peer Reviewed

Respirator Maintenance Program Recommendations for the Fire Service

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Proper inspection, maintenance and service procedures are an important part of a self-contained breathing apparatus (SCBA) program. These procedures have often been found to be deficient during NIOSH investigations and may adversely affect the performance of an SCBA, placing users at increased risk of injury or death. This document is intended to serve as an aid to the fire service in developing SCBA maintenance programs for individual fire departments. It is intended for all fire departments from the largest municipal department to the smallest volunteer department. This document should also be equally useful to non-fire service SCBA users such as emergency responders, municipal and utility workers, chemical, industrial, and confined space entry workers.

The document presents the requirements of the *National Fire Protection Association (NFPA) 1404 Standard for a Fire Department Self-Contained Breathing Apparatus Program, 1989 Edition,* and the *American National Standard Practices for Respiratory Protection for the Fire Service Z88.5-1981* in a format that an SCBA maintenance or repair person can easily understand and from it develop his or her own written SCBA maintenance program.

Introduction

SCBA service and maintenance procedures must be developed, documented, and distributed to personnel responsible for each level of maintenance by the fire department maintenance program administrator. These procedures must be rigidly enforced to ensure that SCBA are properly operating and dependable. In many cases, maintenance should be performed at more frequent rates than recommended by the manufacturer in order to intercept problems that could be identified before a normally scheduled review. Maintenance programs are usually divided into three levels:

- End-user Maintenance
- Intermediate Level Maintenance
- Advanced Level Maintenance

End-user Maintenance consists of those functions that an individual fire fighter with the proper training can perform to guard against failure of the SCBA such as recognizing potential maintenance problems including: difficulty in breathing, loose or broken components, performing a pressure tightness test to insure that the exhalation valve is not leaking or hearing strange noises emanating from the regulator. Correct cleaning and inspection of the SCBA should also take place at this level. In establishing an SCBA maintenance program, the users must be trained to recognize their responsibilities for ensuring that equipment is operating properly by following fire department procedures.

Intermediate Level Maintenance involves removal and replacement of damaged or defective parts of the facepiece, harness and regulator with tools and spare parts which are provided exclusively by the manufacturer. Routine monthly inspections and flow testing is also done at this level. Thus, Intermediate level maintenance requires training which is provided by the SCBA manufacturer. It is a good idea for each department to have at least two

individuals who are certified in Intermediate level repairs. This may not be feasible in all departments; however, resources could be shared among several smaller departments or provided on a county, mutual aid basis or by a manufacturer's regional or private service center.

Advanced Level Maintenance requires service and maintenance of the high pressure areas of the SCBA which may require complete disassembly and rebuilding of the SCBA. This level requires more specialized training and equipment than needed for the Intermediate Level, making it impractical and expensive for volunteer departments to provide this level of service by its personnel. Most volunteer departments will find it more convenient and less costly to utilize regional service centers provided by or certified by the manufacturer for advanced level maintenance.

Maintenance programs vary with the size and technology of each department; but the principles of the SCBA maintenance program must remain the same:

- Persons delegated to supervise and perform maintenance activities must be adequately trained and provided with the proper resources to accomplish program goals.
- Written policies for periodic testing and inspection and records which indicate completion, test results, and other pertinent information must be kept on file as well as a complete inventory of all SCBA.
- Scheduled preventive maintenance activities must be performed with an emphasis on the quality and completeness of work.
- Replacement, rebuilding and updating of SCBA must occur on a regular basis.

It is important to realize that the type or level of SCBA maintenance that should be performed varies with the design of the SCBA and therefore varies from manufacturer to manufacturer and from department to department. Departments making fewer responses that utilize SCBA less frequently can afford to perform preventative maintenance less often than departments that utilize SCBA on a daily basis. Thus the manufacturer should be contacted to ascertain individual maintenance policies or this document may be utilized to set guidelines for initiating an adequate SCBA maintenance program.

Training and Resources

The SCBA program administrator, ideally, should be responsible for SCBA maintenance and have no involvement in other firefighting operations. However, due to cost and minimum manning requirements this concept may not be a feasible option and may be tailored to fit into each department's organizational structure. The SCBA Maintenance Program Administrator should ensure that all operations which he/she oversees is carried out by trained repair technicians and should have the authority to halt emergency operations where there is any danger of serious personal injury due to respiratory hazards or faulty respiratory protection equipment. The Program administrator should also develop and maintain written repair records, annual review summaries, Standard Operating Procedures, and policy statements in the following areas of the maintenance program:

- SCBA Maintenance Training
- SCBA Inspection
- SCBA Maintenance
- Air Quality Program
- Recharging Cylinders
- Record Keeping

He/she will also ensure that all SCBA in service are open-circuit, pressure-demand SCBA which meet the requirements of the most current edition of NFPA 1981, Title 42 Code of Federal Regulations (CFR) Part 84 and that all training related to the inspection and maintenance of SCBA at the departmental level be performed by instructors meeting the objectives of Level I of NFPA 1401; NFPA 1500, Chapter 3; and ANSI Z88.5-1981, Chapter 6.

SCBA will only perform as well as they are maintained. Since they are expected to function and perform properly each time they are used, possibly in environments immediately dangerous to life or health, it is important that the personnel responsible for performing SCBA maintenance are adequately trained and qualified to perform such maintenance. The purpose of this section is to specify the minimum requirements for training to ensure that fire department personnel responsible for SCBA maintenance are adequately trained and qualified to perform the necessary maintenance. The personnel should be trained on all aspects of SCBA maintenance from routine preventative maintenance to corrective

maintenance and troubleshooting according to the level to which the department is certified by the SCBA manufacturer so that SCBA can be kept in an approved condition at all times.

Training specific to the maintenance of SCBA should be unique and in accordance with the requirements of NFPA 1404, Chapter 4; ANSI Z88.5-1981, Chapter 6.4; NFPA 1500, Chapter 3 (especially 3-1.3 and 3-1.4); and other applicable regulations or consensus standards. It should be a separate function from any other job related training that the individual receives. It is understood that SCBA maintenance personnel will also receive routine training in SCBA operation, donning and doffing, safe use practices, practical applications, limitations, inspection, cleaning, storage, and other general areas as part of their fire fighter training.

Personnel responsible for SCBA maintenance should be **retrained** and **recertified** at intervals of time not to exceed that recommended by the SCBA manufacturer. If no time interval is recommended, personnel should, at a minimum, be retrained and recertified in their ability to perform such maintenance work every three years. Detailed records should be kept for each individual responsible for SCBA maintenance that identify the individual's name, social security number, required training, competency examinations, the level of training attained, specific certifications received, dates of training, and due date for next retraining or recertification. The training records should serve to identify the specific areas the individual is trained to work in, and is competent in.

Inspection

The purpose of this section is to specify the minimum acceptable routine and pre/post use inspection requirements needed to ensure that SCBA will operate properly during emergency operations. Each SCBA user should be required to demonstrate knowledge of SCBA and skill in proper inspection procedures to ensure that preventative or corrective maintenance is performed on equipment as needed. Each fire fighter must be familiar with the written procedures specific to his/her department for ensuring that defective or nonfunctioning equipment should be tagged "out of service" and removed from the fire apparatus in service inventory until repaired by a qualified individual.

Written department inspection policies and procedures and record keeping forms should be provided to all fire fighters and other personnel responsible for maintaining SCBA. Records of inspections should contain, as a minimum, the model and serial numbers of the SCBA, inspection dates, findings, test data, actions taken, and name of the individual performing the inspection or action taken.

SCBA on fire apparatus or in service for use in emergency operations should be inspected at the beginning of each shift for paid or partial paid departments, and at least once a week for volunteer departments. This inspection should include checks of the following:

- Gages on cylinders of breathing gas should indicate that the content is not less than 90% of the rated pressure stamped on the cylinder. Cylinders containing less than 90% of the rated pressure should be taken out of service and replaced by cylinders with an adequate pressure, or recharged according to the manufacturer's specifications.
- Each cylinder should be inspected for physical damage according to the manufacturer's recommendations. This includes inspection for cuts, nicks, dents, gouges, fire damage, and other defects that could weaken the cylinder. Cylinders that do not meet the manufacturer's conditions for safe use should be tagged and removed from service.
- Hose connectors, hoses, face pieces, head harnesses, backpack components and gages should be inspected for defects with particular attention to signs of corrosion from water or chemical exposure. When in doubt, contact the SCBA manufacturer for specific details.
- Alarms should be checked in accordance with the manufacturer's procedures and the apparatus taken out of service if the alarm does not function properly.

Each SCBA should be examined after each use by the user for any defective or deteriorating parts. Special examination should be made for torn, worn or wrinkled exhalation valves, exhalation valve seats, speaking diaphragms and high pressure hose. Rubber and elastomer parts should be inspected for

pliability and signs of deterioration by stretching the material. Other parts should also be inspected for defects.

SCBA should be inspected at least monthly for the following according to manufacturer's specifications by qualified personnel:

- Breathing gas cylinders, face pieces, breathing tubes, and harness assemblies should be examined for defects.
- Breathing apparatus cylinders and cylinder valves should be tested for airtightness using a procedure recommended by the manufacturer.
- Make sure that cylinder gauge and remote gauge indicate the same pressure.
- The operation of the regulator should be tested by either a dynamic flow testing device or by donning the device and operating it in a normal manner. If a pressure relief valve vents, if air continues to flow through the regulator while the wearer is not inhaling, or if air does not freely flow through the regulator when the wearer inhales, the regulator needs to be repaired and should be taken out of service immediately.
- The operation of the remaining-end-of-service-life indicator or alarm should be checked for proper function. If the alarm does not sound, or if the sound is muffled, irregular, weak, or otherwise gives an indication of a problem, the alarm needs to be repaired and should be taken out of service immediately.
- Each cylinder should be inspected for a valid hydrostatic test date and date of manufacture. The cylinder should be hydrostatically tested within the periods specified by the manufacturer and the appropriate government agencies (i.e., USDOT in the United States). If the dates are not current, the cylinder is to be immediately placed out of service until hydrostatic retesting can be performed. Different cylinder models have different service lives and hydrostatic test requirements. Consult the manufacturer and the appropriate government agencies for the specific service life and hydrostatic test requirements of your model cylinder(s).
- Each cylinder should be inspected for physical damage according to the manufacturer's recommendations. This includes inspection for cuts, nicks, dents, gouges, fire damage, and other defects that could weaken the cylinder. Cylinders that do not meet the manufacturer's conditions for safe use should be tagged and removed from service.
- Gages on cylinders of breathing gas should indicate that the content is not less than 90% of the rated pressure stamped on the cylinder. Cylinders containing less than 90% of the rated pressure should be taken out of service and replaced by cylinders with an adequate pressure, or recharged according to the manufacturer's specifications.

Maintenance

Since SCBA are expected to function and perform properly each time they are used, it is important that they are properly maintained and kept ready for use. Adequate SCBA maintenance is necessary to ensure that SCBA are maintained in a condition as approved and will function as approved when needed. This section specifies the minimum requirements necessary to ensure that SCBA are properly and adequately maintained so that the SCBA are kept in an approved and useable condition at all times and do not present a threat to the user's health or safety.

Preventative maintenance procedures should be established by the Program Administrator for all SCBA in the organization. These procedures should consist of a set schedule of routine maintenance activities and quality checks and should insure that performance has not degraded with use so that damaged or inoperative SCBA can be removed form service prior to the need for emergency use. The program should be set up to ensure that each SCBA is inspected in accordance with the manufacturer's instructions by a certified technician on a regular basis not to exceed every six months. A cycle may also be set up based upon a selected number of fire ground uses, such as every 20 uses. This cycle is to be selected based upon the amount of actual use the SCBA receives, manufacturer recommendations, and departmental needs. At these scheduled maintenance checks the device should at a minimum be thoroughly inspected for physical damage, flow tested, cleaned and disinfected. If the initial flow test shows that adjustments or repairs need to be made to

the unit, those adjustments or repairs must be made and the unit flow tested again before being placed back in service. Repairs must be made using tools, exact replacement parts, lubricants and other materials specified by and obtained exclusively from the manufacturer unless the manufacturer specifies generic replacement parts, lubricants, etc., are available. Written procedures for conducting specific maintenance actions should also be developed by the Program Administrator and be provided to all personnel responsible for maintaining SCBA. Failure to comply with any of the manufacturer's listed maintenance practices or procedures will void the NIOSH approval. Accurate records should be kept of all maintenance actions on each individual SCBA that include SCBA model and serial number, inspection dates, findings, performance test data before and after repair, repairs made, and spare parts used or replaced.

Frequency of rebuilding should be carried out in accordance with the manufacturer's recommendation, or every 3 years if no recommendation is given, even if the equipment has not been used since the last overhaul. Complete overhaul, or rebuilding of SCBA assemblies and components should be conducted by the manufacturer or by a person trained and certified to the Advanced Level of maintenance by the manufacturer to do such rebuild work. The rebuilding process should include the complete disassembly of the SCBA and replacement of all regulator parts that may wear, even if they do not appear to be worn. Exact replacement parts, lubricants, and other materials specified by and obtained from the manufacturer should be used. Replacement items from other sources may not be substituted. Use of replacement parts other than those specified by the manufacturer voids the NIOSH approval.

Completely assembled SCBA and component parts should be stored in such a way that they are protected from exposure to water, sunlight, chemicals, dirt or other substances that could affect the performance or safe use of the apparatus or parts. Manufacturer's recommended storage practices should be followed as much as possible, with special attention given to recommended procedures for valve and gauge position, facepiece position, etc.

Air Quality Monitoring

The purpose of this section is to specify the minimum requirements necessary to ensure that the air quality in SCBA cylinders are of the highest quality and nonhazardous to human health. Compressed gaseous air in the SCBA cylinder should meet the requirements of ANSI/CGA G7.1 *Commodity Specification for Air*, with a minimum air quality of Grade D and a maximum dew point of –65%F (–54%C) or dryer. Liquid or compressed gaseous oxygen should meet the requirements of the United States Pharmacopoeia for medical or breathing oxygen. Chemical generated oxygen should meet the requirements of U.S. Department of Defense Military Specification MIL-E-85252, Emergency Oxygen Supply, Chlorate Candle Aircraft CRU-74/P, or Military Specification MIL-O-15632c, Oxides, Oxygen Producing. Compressed oxygen should not be used in open-circuit SCBA that have previously used compressed air because COMPRESSED air MAY contain low concentrations of oil. If high pressure oxygen passes through an oil or grease-coated orifice, an explosion or fire may occur.

When the fire department makes its own breathing air or transfers purchased breathing air from vendor cylinders into other storage cylinders, the air quality from compressors, cascade system cylinders, storage receivers, and other such breathing air manufacturing or storage equipment used for filling SCBA cylinders should be tested at least every three months by an accredited laboratory. Laboratories should notify the fire department immediately of air not meeting ANSI/CGA requirements. Vendor supplied compressed air should meet the requirements of ANSI/CGA G7.1, GRADE D OR HIGHER. The vendor should provide documentation to demonstrate that the air quality has been tested by A laboratory accredited by the American Industrial Hygiene Association, the American Association for Laboratory Accreditation, or the National Voluntary Laboratory Accreditation Program. Records should be maintained for each air quality test. Any air cylinders filled with air that is suspected of not meeting air quality standards should be emptied and purged.

Recharging SCBA Cylinders

A documented process for filling and inspecting SCBA cylinders should be established and maintained as part of the SCBA maintenance program to insure that SCBA cylinders are safely and adequately filled so as to prevent the possibility of

injury or death to the SCBA user, as well as to the personnel filling the cylinder. This process should be followed both on a routine basis and also at the scene of an incident. The purpose of this section is to specify the minimum requirements for establishing and maintaining a documented procedure for filling SCBA cylinders. This procedure should be followed to insure that cylinders are filled in a safe manner that does not present a hazard to either the SCBA user or the personnel filling the cylinder.

Training specific to the inspection and filling of SCBA cylinders should be given before personnel perform any aspect of filling cylinders. All cylinders should be examined for the appropriate service life date (date of manufacture) and hydrostatic test date before filling. No cylinder should be filled that has exceeded the service life or is outside the hydrostatic test date requirement. Consult the SCBA manufacturer and US Department of Transportation specifications for the specific cylinder model you are using. Cylinders should be inspected at least weekly per the manufacturer's recommendations and determined to be free from defects that would disqualify the cylinder for use. This inspection will include a determination of cylinder pressure, nicks, cuts, gouges and other physical damage as well as evidence of exposure to high radiant heat, flame, physical impact, or abuse to the cylinder, valve assembly, and pressure gauge. Cylinders used on a daily basis should be inspected on a daily basis for cylinder pressure by means of the cylinder pressure gauge. A cylinder that is filled to less than 90 percent of the rated pressure as indicated on the cylinder label should be taken out of service until such time as the cylinder can be filled to the proper pressure. The cylinder pressure (as indicated on the cylinder gauge) should be recorded as part of the daily SCBA inspection process.

SCBA cylinders should be filled to the pressure specified by the manufacturer as being full with compressed gaseous breathing air meeting the minimum grade requirements for Type I gaseous air set forth in the Compressed Gas Association Commodity Specification for Air G-7.1 (Grade D or higher quality) only. The proper operating procedures and safety precautions should be posted in a conspicuous manner at each cylinder filling station. All components of breathing air compressor systems, cascade and other filling systems, and filtration and other air purifying systems should be inspected, serviced, and maintained in accordance with the manufacturer's specifications and should be equipped with outlet threads or adaptors specified by the American Standards Association, Compressed Gas Cylinder Valve Outlet and Inlet Connections, B57.1-1965 and monitoring systems to detect the presence of carbon monoxide contamination in the compressed air, and should be designed to automatically shut down the compressor system when a level of 20 PPM of carbon monoxide or higher is detected in the compressed air.

Records should be maintained at each filling station which include the date of hydrostatic testing of each cylinder in service, date of next hydrostatic testing, maintenance required, and the date of manufacture of each cylinder. A record should also be established and maintained for each breathing gas compressor, cylinder fill station, cascade cylinder, air filtration/purification system, and other equipment related to the filling of cylinders. This record should include the name of the equipment, manufacturer, date of purchase, date of installation, location of installation and a description of each inspection, service, maintenance, and testing of the device.

Record Keeping Requirements

Record keeping is an important means of tracking equipment inventory, respirator equipment history and individual training records. These records provide a means of measuring trends and program effectiveness. Legal counsel should also be contacted concerning the length of time records and/or reports need to be kept on hand. Some documents need to be maintained for as long as an individual or apparatus is with the organization and still others must be kept only for specific lengths of time. Inspection and maintenance records, air quality records, filling station records, SOPs and policies should be maintained in a written or electronic format and should be accessible to those individuals responsible for maintenance within the department.

Personal training records should indicate the level of training completed. Records should include dates, subjects covered, and any certifications achieved. Training records of personnel involved in respirator maintenance should also be documented.

Inspection and maintenance records should be maintained for each SCBA unit. Each unit should be inspected daily/weekly, monthly, and annually. A record should be maintained for each SCBA regulator and harness assembly, cylinder, and facepiece. The regulator and harness assembly record should include inventory or serial numbers, date of purchase, date of manufacture, date placed in service, location, maintenance, and repairs, replacement parts, upgrading, and test performance. The facepiece record should include inventory or serial number, date of purchase, location, maintenance and repairs, replacement parts, upgrading, and test performance. The cylinder record should include inventory or serial numbers, date of purchase, location, maintenance and repairs, replacement parts, upgrading, and test performance.

Records should be maintained for each air quality test. If required air quality is not being achieved, the use of the system should be discontinued until repairs are made and verified before testing. Air quality testing should meet the requirements of the Compressed Gas Association G7.1 *Commodity Specification for Air.* Records should also be maintained for equipment used to produce and store air for SCBA including air compressor, fill station, cascade cylinder, and purification system. Records should indicate the date of purchase, location, inspection, maintenance, and testing of the device.

Annual Review

An annual review of the SCBA MAINTENANCE PROGRAM policies and procedures is necessary to ensure that the SCBA maintenance program is adequate to ensure that the SCBA provide the necessary level of protection to fire fighters. The effectiveness of the SCBA maintenance program should be evaluated and corrective actions taken at least annually. Program evaluations are necessary to determine whether each SCBA is SELECTED, FITTED, USED, and MAINTAINED in a safe and approved manner. Fire fighter training and recertification in the performance of SCBA maintenance should be included in the program evaluations.

An annual review of the SCBA maintenance program policies and procedures should be conducted by the fire department administration and safety committee to ensure that they are being followed, and to make the necessary upgrades or adjustments for the continued effective operation of the program. The program review will include areas involving personnel, equipment, inspections, maintenance, repair schedules, resources and other applicable areas. Actions should be taken to correct all defects or problem areas found in the program on a timely basis. Findings should be documented and corrective plans that preclude the reoccurrence of additional problems should be listed with target dates for their implementation.

A report of the annual review process will be generated and forwarded to the appropriate authority. This report will describe the annual review, the problem areas noted as well as conforming areas, the necessary corrective actions and outline a proposed schedule to implement corrective actions.

Summary

This document provides the minimum acceptable requirements for implementing and maintaining an acceptable SCBA maintenance program.

References

1. Technical Committee of Fire Service Training. NFPA 1404—Standard for a Fire Department Self-Contained Breathing Apparatus Program, 1989 Edition, National Fire Protection Association, Batterymarch Park, Quincy, MA, NFPA 1404-1989.

2. American National Standard Practices for Respiratory Protection for the Fire Service—1981 Edition, American National Standards Institute, New York, NY, ANSI Z88.5-1981.

3. Technical Committee on Fire Service Protective Clothing and Equipment. NFPA 1981—Open Circuit Self-Contained Breathing Apparatus for Fire Fighters, 1992 Edition, National Fire Protection Association, Batterymarch Park, Quincy, MA, NFPA 1404-1989

4. Title 42 Code of Federal Regulations (CFR) Part 84.

5. Technical Committee on Fire Service Training. NFPA 1401—Standard for a Fire Department Training Reports and Records, 1989 Edition, National Fire Protection Association, Batterymarch Park, Quincy, MA, NFPA 1401-1989.

6. Technical Committee on Fire Occupational Safety and Health. NFPA 1500—Standard on Fire Department Safety and Health Program, 1992 Edition, National Fire Protection Association, Batterymarch Park, Quincy, MA, NFPA 1500-1992.

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