DEVELOPING AND IMPLEMENTING A NEW SELF CONTAINED BREATHING APPARATUS (SCBA) MAINTENANCE PROGRAM FOR THE RENO FIRE DEPARTMENT AND THE VOLUNTEER DEPARTMENTS IT ADMINISTERS

LEADING COMMUNITY RISK REDUCTION

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Appendices Not Included. Please visit the Learning Resource Center on the Web at http://www.lrc.dhs.gov/ to learn how to obtain this report in its entirety through Interlibrary Loan.

ABSTRACT

Reno Fire Department's old SCBA Maintenance Program did not meet the demands of the new more complex organization. Reno Fire had gone through major organizational changes in the past three years including: consolidation with the country fire district, an SCBA brand change, and a FIRE Grant up-grading the 12 volunteer departments, which Reno Department administers, to the same brand SCBA.

The purpose of this applied research was to develop and implement a new Self Contained Breathing Apparatus (SCBA) Maintenance Program for the Reno Fire Department.

The research method used in this applied research project was Action Research. The research approach reviewed available literature and technical material on the subject, accessed the Departments physical assets and personnel resources available for SCBA maintenance, and identified Departmental limitations regarding SCBA maintenance. This information was used to develop and implement a new program.

Project research questions:

1. What are the National and Scott Aviation standards and requirements for SCBA Maintenance?
2. What are the Reno Fire Department assets and limitations regarding SCBA Maintenance?
3. What information can be applied from published literature and information from other selected fire departments on SCBA maintenance programs and facilities?

Procedures included a review of materials to obtain a basic understanding of SCBA maintenance. Objectives were established to answer each research question. Questions were answered from the review of the research materials and through a number of personal interviews

with government and industry representatives, Reno Fire Department personnel, and representatives of other fire departments.

The recommendation from this research was that the City of Reno Fire Department, in order to ensure safe reliable SCBA equipment to its members, comply with federal SCBA maintenance requirements, and closely follow national standards on SCBA maintenance, must develop and implement a new SCBA Maintenance Program as soon as possible.

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INTRODUCTION

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The information gained through this research was used to develop and implement a new SCBA maintenance program for the City of Reno Fire Department.

BACKGROUND AND SIGNIFICANCE

Reno Fire Department's old, primarily non-written, SCBA Maintenance Program did not meet the demands of the new, more complex organization. The Reno Fire Department had gone through major organizational changes from 1999 to 2003. These changes included a contractual consolidation between the City of Reno Fire Department and the Truckee Meadows Fire Protection District (TMFPD) on July 1, 2000. The consolidation increased the jurisdictional area from approximately 65 square miles to over 600 square miles. Additionally, from the consolidation and the existing TMFPD contract with Washoe County, over 1500 square miles area of structural protection, code enforcement, and investigation responsibilities were added in the outlying county which is primarily a volunteer area. This increase of area also increased the distance between the farthest stations from 25 miles to over 125 miles.

Just prior to the consolidation, December of 1999, the Reno Fire Department switched from Intersprio to Scott brand SCBA. In 1997 TMFPD had switched from Survair to Scott brand SCBA. Finally, in the fall of 2003, through a federal FIRE grant, the 12 volunteer fire departments switched from Survair to Scott brand SCBA.

Prior to consolidation and switching to Scott, the Reno Fire Department actively maintained approximately 160 Intersprio SCBA units. Following the consolidation and switching the 12 volunteer departments to Scott, the Reno Fire Department now had the responsibility to maintain 349 Scott SCBA units and all the Scott SCBA equipment associated with the Department's technical rescue teams and rapid intervention program. Additionally, the Reno Fire Department, when changing to Scott, changed policy and issued personal face masks and second

stage regulators to all career individuals. This added an additional 210 face masks and regulators needing maintenance.

Contractual language between the Reno Fire Department and Reno Firefighters IAFF Local 731 specified that Reno Fire Department SCBA equipment maintenance be performed by career individuals stationed at Reno Fire Department station 8 on A shift (…). With an almost a four fold increase in SCBA equipment to be maintained, the large increase in geographic distances between both career and volunteer station, and the manpower limitations of station 8, A shift, it was obvious that the old SCBA maintenance program could not adequately maintain the Department's present SCBA equipment to the new national requirements and standards and that a new program was needed.

Developing and implementing a new SCBA maintenance program for the Reno Fire Department relates to section 5 "Action Planning" of the Leading Community Risk Reduction curriculum in the Executive Fire Officer Program (U.S. Fire Administration, 2003).

The applied research project's purpose, of developing and implementing a new SCBA maintenance program for the Reno Fire Department supports the United States Fire Administration's operational objective of reducing the loss of life by fire (U.S. Fire Administration, 2003).

LITERATURE REVIEW

The literature review for this research project is divided into three sections. Each section will address one of the research questions and the literature review pertaining to that question.

1. What are the National and Scott Health and Safety standards and requirements for SCBA Maintenance?

The national standards for SCBA maintenance can be found in National Fire Protection Association (NFPA), American National Standards Institute (ANSI), and Compressed Gas Association (CGA) documents. National requirements for SCBA maintenance can be found in Occupational Safety and Health Administration (OSHA), Department of Transportation (DOT), and National Institute for Occupational Safety and Health (NIOSH) documents.

The NFPA documents include:

NFPA 1404, *Standard for Fire Service Respiratory Protection Training, 2002 Edition.* This document's reference to SCBA maintenance is addressed in Chapter 8, *Maintenance,* and states that all training SCBA equipment shall be inspected, serviced, and repaired in accordance with NFPA 1852, *Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus* (NFPA, 2002).

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program, 2002 edition.* This document establishes the standard for a written respiratory protection program for a fire department. It specifies that all SCBA equipment shall be inspected, serviced and repaired in accordance with NFPA 1852, *Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus* (NFPA, 2002).

NFPA 1852, *Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA) 2002 Edition.* This is the primary NFPA document that directly addresses SCBA care and maintenance. It gives extensive information on needed program components of an SCBA maintenance program and has specific chapters on both care and maintenance. Annex B and C give instructions for external examination and the requalification of SCBA cylinders (NFPA, 2002).

NFPA 1981 *Standard on Open-Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services, 2002 Edition.* This document specifies the minimum requirements for the design, performance, and testing for NFPA certification of SCBA equipment (NFPA, 2002).

The ANSA documents include:

ANSI Z88.2-1992 *American National Standard for Respiratory Protection*. This document is a comprehensive standard that covers the entire respiratory protection spectrum and references sections on maintenance and care of equipment (ANSI, 1992).

The CGA documents include:

CGA C-6.2-2003 *Guidelines for Visual Inspection and Requalification of Fiber Reinforced High Pressure Cylinders.* This guide gives specific information on how to conduct a visual inspection of SCBA bottles of the types used by Reno Fire. It also classifies bottle damage into three levels and determines if a damaged bottle can continue to be used, must be repaired/requalified, or condemned (CGA, 2003).

CGA G-7.1-1997 *Commodity Specification for Air.* This document describes the specification requirements for breathing air, and provides data concerning quality verification systems, sampling, and analytical procedures, for qualified breathing air testing laboratories (CGA, 1997).

The OSHA documents include:

Standard 29 Code of Federal Regulations (CFR) 1910.134 *Respiratory Protection Program.* Section (h), establishes the requirements for maintenance and care of SCBA, including sections on cleaning and disinfecting, storage, inspection, and repairs. Section (I) establishes the requirements for breathing air quality and use, and gives test requirements for breathing air and breathing air bottles (OSHA,1998).

The DOT documents include:

Standard 49 Code of Federal Regulations (CFR), Part 178 *Shipping Container Specification Regulations.* This document gives the specifications for testing of breathing gas cylinders (DOT, 1999).

The NIOSH documents include:

Standard 42 Code of Federal Regulations (CFR), Part 84 *Requirements Of Respiratory Protection Devices.* This is an extensive document which outlines how an SCBA becomes NIOSH certified. It includes the certification process of the maintenance program. The maintenance program must be followed to keep an SCBA in an approved condition to maintain the NIOSH approval (NIOSH, 1999).

NIOSH Fire Fighter Fatality Investigation Report 99F-48. This is NIOSH *Death in the Line of Duty…* report on a December 1999 warehouse fire that claimed the life of a battalion chief in Missouri. In this report, in a letter to the chief of the department on the NIOSH evaluation of the department's SCBA maintenance program, an extensive list of the national maintenance requirements and standards were listed. Additionally, an explanation was given on how each of these requirements and standards applied to the specific part of an SCBA maintenance program (NIOSH, 2000).

The Scott Health and Safety requirements for SCBA maintenance on the SCBA equipment used by the Reno Fire Department can be found in the following Scott documents:

Scott SKA-PAK Operating and Maintenance Instructions

This document was included with the Scott SKA-PAK equipment on initial shipping from Scott. For maintenance and care, this document covers cleaning and disinfecting the facepiece, 2nd stage regulator, and additional components, cylinder charging procedures, user basic field maintenance, and periodic testing at least every two years by a Scott Authorized Service Center (Scott, 1994).

Scott Air-Pak 2.2/4.5 Overhaul Service Manual.

This document was provided to our Scott Certified Service Technicians during the certification class and is the main service manual used by Scott Certified Service Technicians to perform technician level service and repair of Scott 2.2/4.5 Air-Paks. The manual has six sections: general information, overhaul level repair, field level maintenance, product information, price lists, and reference materials (Scott, 1998).

Scott Operating and Maintenance Instructions for AIR-PAK 2.2/3.0/4.5 Self-Contained Breathing Apparatus (SCBA) Intergrated with Scott PAK-Alert SE Distress Alarm

This document was included with the Scott model 4.5 equipment on initial shipping from Scott. For maintenance and care, this document covers cleaning procedures and battery replacement (Scott, 1999).

Scott Operating & Maintenance Instructions Scott Air-Pak Pressure-Demand Self Contained Breathing Apparatus (SCBA) NFA-1981 (1997Edition) Compliant Models 2.2/3.0/4.5 Incorporating Dual Redundant Alarms.

This document was included with the Scott model 4.5 equipment on initial shipping from Scott. Like the *Scott SKA-PAK operating and maintenance instructions* document for maintenance and care, this documents covers cleaning and disinfecting the facepiece, 2nd stage regulator, and additional components, user basic field maintenance, and periodic testing, at least every two years, by Scott Authorized Service Center (Scott, 1999).

Scott Operating & Maintenance Instructions Scott RIT-PAK Portable Air Supply

This document was included with the Scott RIT-PAK equipment on initial shipping from Scott. For maintenance and care, this document covers cleaning and disinfecting and periodic testing, at least every two years, by Scott Authorized Service Center (Scott, 1999).

Scott Cleaning and Maintenance Instructions for AV-2000 Full Facepiece

This document was included with each Scott AV-2000 facepiece on initial shipping from Scott. For maintenance and care, this document covers cleaning, disinfecting, and complete maintenance and replacement of all parts. However, it did not cover if this maintenance was to be performed by the user or at the technician level (Scott, 1999).

2. What are the Reno Fire Department assets and limitations regarding SCBA Maintenance?

The SCBA maintenance assets of the Reno Fire Department were not available in any form of literature. This information was obtained through the author's personal knowledge and through interviews with Department personnel and will be covered in the procedures section of the research.

Limitations of SCBA maintenance within the Reno Fire Department can be found in negotiated contracts and grievance resolutions between the Reno Fire Department and the

International Association of Firefighters (IAFF) local 731 Union. In the section on seniority bid system of the contract between the Department and the Local 731, the language states that SCBA maintenance for the Department shall be performed by all local 731 members assigned to station 8 on A shift (City of Reno, 2000). In further negotiations it was agreed that, due to expanded work load on the SCBA technicians at station 8 caused by consolidation, the number of SCBA technicians would be expanded so that all three shifts (A, B, and C) would have at least two (2) SCBA technicians per shift (personal interview Reno Fire Department Chief Lowden). Additionally, a grievance resolution established that maintenance of volunteer SCBA equipment performed by the station 8 SCBA technicians would be conducted on overtime (Reno Firefighters Local 731, 2004).

Further limitations can be found in the negotiated contract for service between the City of Reno and TMFPD that states that volunteer and auxiliary personnel shall not occupy career fire stations (City of Reno, 2000).

3. What information can be applied from published literature and information from other selected Fire Departments on SCBA maintenance programs and facilities?

Published literature from NFPA, OSHA, NIOSH, DOT, CGA, ANSI, and Scott Health and Safety was reviewed under research question one of this section.

The majority of the periodical literature used by the author was acquired at the National Fire Academy's Learning Resource Center in Emmitsburg, Maryland. The author was surprised by the lack of current periodicals on the subject of SCBA maintenance. The following is a review of periodical materials.

In an article in Fire Engineering, Joseph McDonagh made the point that a good SCBA maintenance program is necessary and also provides a level of confidence to users of the

apparatus. He pointed out that the influence of dew point is extremely important in filling air bottles, air purification systems, and air compressors. If dew point is not factored into an SCBA maintenance system, it can cause serious problems with regulator performance. He recommended that the fire service needs a national SCBA failure reporting system. This reporting system would bring common failures and flaws, that presently are known only at the local department level, to be known at the national level, which would drive needed improvements nationally. McDonagh made the claim that the fire service needed its own standards for SCBA, not just NIOSH. Additionally, he pointed out the weakness of the NIOSH SCBA certification system as it related to the needs of the fire service. He hinted to the fact that OSHA may need to adopt additional requirements for SCBA use (McDonagh, 1980).

Author's note: Mr. McDonagh's article was way ahead of its time and truly addressed the need, at that time, for fire service national standards and requirements for SCBA certification, use, and maintenance. It is also interesting that it has taken almost twenty years for these standards and requirements to be finally in effect, and that there still is no national system for the reporting of SCBA failures.

Wesley Melo wrote an interesting article on the Frankfurt Fire Department in West Germany, and their breathing apparatus safety system. At the Frankfurt Fire Department, an SCBA is sent to the in-house SCBA laboratory for a full inspection after very use. A tested unit is exchanged for the used unit. Additionally, the department has a mobile laboratory, with 45 additional units on board, that is sent to fires to exchange and test units and fill bottles (Melo, 1981).

Frank Brown wrote an article on breathing apparatus maintenance at the Fort Lauderdale fire department. Fort Lauderdale's breathing apparatus is maintained by on duty fire fighters on

all three shifts at station four. They have established a color coding system for identifying where SCBA units are assigned. They perform maintenance on the SCBA packs and the air bottles. His article also included a very informative diagram showing their SCBA maintenance room layout, and the flow of SCBA equipment as it goes through the testing, maintenance, and repair process (Brown, 1988).

Robert Eddy wrote on breathing apparatus maintenance at the St. Paul, Minnesota, fire department. He stated that SCBA maintenance can be divided into two levels. Level one is light routine maintenance that is performed by users. Level two is heavy maintenance that is performed at a factory authorized service center. The two levels apply to SCBA packs, air bottle maintenance and air compressor maintenance. He also stated how important it was have a controlled dust-free environment while performing heavy maintenance on SCBA equipment. He stated that a service center should contain current information on SCBA design, construction, and comparisons of the different brands. The center should contain a literature reference library with current manuals, product bulletins, legal safety and procedural updates, and a correspondence file. He went on, comparing the feasibility of an in-house heavy maintenance center versus sending equipment out for repair and maintenance at a factory service center, recommending an in-house center if possible (Eddy, 1983).

Rob Scott, in his article on SCBA maintenance, broke down SCBA maintenance into three levels. The three levels are: (a) routine maintenance completed by the user; (b) maintenance after each use; (c) periodic maintenance performed at a facility authorized by the manufacturer. He stated that all maintenance, regardless of level, should be completed to the manufacturer’s recommendation. He identified reference materials on standards and requirements to follow for an effective program. However, this list was a little out dated, due to

the date of publication. He made the excellent point that an effective SCBA maintenance program begins with the user. Success of the program lies with the user's level of training in the use and care of the SCBA unit and the user's attitude. He closed by stating SCBA maintenance is a fact of life, and that an effective maintenance program will instill confidence in the SCBA user (Scott, 1992).

Dennis Rubin wrote that, although there are many excellent SCBA training programs, the weakest link in the respiratory protection chain lies in adequate routine inspections and maintenance of SCBA equipment as shown in the annual death and injuries data (Rubin, 1983).

Chief Bearden, in his article on SCBA maintenance at the Dallas Fire Department, identified that the Dallas Fire Department had four major problems areas with their SCBA equipment: (a) scheduled preventive maintenance; (b) no daily or routine check procedure; (c) problems with obtaining timely repair parts; (d) abuse when using and storing SCBA units. Of interest to this research is the solution to problem three. In order to ensure timely repair, enough parts are always kept on hand to service all the SCBA units (Bearden, 1981).

Bill Reed wrote an excellent article on the color coding of breathing air bottles to assist in keeping track of when a bottle needs to be requalified. Reed's department was using metal cylinders with a five year requalification schedule and therefore had five different color codes (Reed, 1986).

Ray Lambert wrote that a fire department has three basic choices when deciding how to properly maintain their breathing apparatus at the technician level. The three choices are: (a) have the work done at factory; (b) have the work done at the dealer or repair center; (c) develop an in-house repair center. He then continued on with the pros and cons of each of the three options (Lambert, 1984).

In another article, Ray Lambert stated that an in-house SCBA repair center may be very appealing to most fire departments. However, an in-house center is very expensive in personnel time, training, tools, inventory, equipment, and location needs. Like any other skill, an SCBA repairmen must continually work on the SCBA equipment to remain proficient (Lambert, 1983).

In a unknown authored article in Fire Chief, the Phoenix Fire Department has saved money by using a specially-designed vehicle which travels from station to station to perform full service SCBA maintenance on the department's equipment. The vehicle covers 40 fire stations in a 400 square mile area. In addition to conducting the SCBA equipment maintenance, the personnel who staff this vehicle also train department personnel on SCBA use, care, and maintenance. At the time of the article, the department was considering expanding the program to include departments that they had mutual aid contracts with, and to include annual fit testing to be conducted by personnel from the vehicle (Fire Chief, 1989).

In another article by an unknown author in Fire Chief on the Phoenix Fire Department's SCBA maintenance program, it was stated that the program was staffed by three full time civilian employees and three part time firefighters. The department, at the time of the article, had a "no compromise" policy on SCBA use (Fire Chief, 1980, p. 90). All of the department's SCBA equipment was tracked on a large status board and checked at the technician level every three months. This program provided a high level of confidence to department personnel using the equipment (Fire Chief, 1980).

Chief Calderone's article on the mask service units used by the New York City Fire Department, gave a brief history of how SCBA use made its way into the fire service following World War II military technology developments. He also described how the SCBA maintenance and breathing air needs of the New York Fire Department are fulfilled by four mask service unit

vehicles. These vehicles go from station to station performing technician level maintenance, training of department personnel on SCBA use, care, and maintenance, providing air bottle maintenance and hydro-testing, and filling air bottles. They also provide an air bottle cache at emergency scenes (Calderone, 1999).

PROCEDURE

The purpose of this applied research was to develop and implement a new Self Contained Breathing Apparatus Maintenance Program for the Reno Fire Department. The research procedure used was action research. In order to accomplish this purpose the following objectives were developed:

1. Gather and research the general subject of SCBA maintenance.
2. Determine what are the National and Scott Aviation standards and requirements for SCBA Maintenance?
3. Determine what are the Reno Fire Department assets and limitations regarding SCBA Maintenance?
4. Determine what information can be applied from published literature and information from other selected Fire Departments on SCBA maintenance programs and facilities

The information obtained from the above objectives was used to develop the written procedure (see Appendix A) that will be used to implement a new Self Contained Breathing Apparatus Maintenance Program for the Reno Fire Department.

To accomplish objective one; gather and research the general subject of SCBA maintenance, the following was done. A search began with gathering available materials at the National Emergency Training Center, Learning Resource Center. The Learning Resource Center provided primarily periodical articles. A search of the Reno Fire Department library produced NFPA and OSHA documents, Scott Health and Safety documents that came with SCBA equipment. Labor contracts, letters of agreement, and grievance resolutions between the Reno Fire Department and Reno Fire Fighters IAFF local 731, and Reno Fire Department policy and procedures. Printed literature was purchased from NFPA, CGA, and ANSI. An internet search

was made that produced additional information from NFPA, OSHA, NIOSH, and DOT. A review of the materials was conducted.

To accomplish objective two; determine what are the National and Scott Aviation standards and requirements for SCBA Maintenance, an in depth review of the materials obtained in question one from the federal agencies, national code organizations and Scott Health and Safety was completed. A telephone conversation held with Curt Johnson from Nevada OSHA Safety and Consultation assisted in clarifying requirements issues (personal communications, January 13, 2004).

To accomplish objective three; determine what are the Reno Fire Department assets and limitations regarding SCBA Maintenance, the following was done. A list of the Reno Fire Department, and Reno Fire administered volunteer department, physical and personnel SCBA assets was compiled (see Appendix B). A review of all labor contracts, letters of agreement, and grievance resolutions between the Reno Fire Department and Reno Fire Fighters IAFF local 731, and Reno Fire Department policy and procedures relating to SCBA maintenance was conducted. Additionally, a personal interview was conducted with Bob Buttner, President of Reno Fire Fighters IAFF local 731, regarding the use of IAFF local 731 members to conduct SCBA maintenance on department and volunteer SCBA equipment (personal communications, February 3, 2004).

To accomplish objective four; what information can be applied from published literature and information from other selected fire departments on SCBA maintenance programs and facilities, the follow was done. An in depth review of all periodical literature obtained was conducted. From the review, it was determined whether or not the information in the periodicals could be applied or related to the new Reno Fire Department's SCBA maintenance program. If

the information applied or was related, it was included in the literature review. A number of telephone interviews were conducted with different fire departments to gain information on their SCBA maintenance programs. The departments interviewed were selected in two ways: (a) departments identified or referenced in the reviewed literature; (b) departments recommended by Craig Sax, Scott Health and Safety Western Regional Sales Representative, as departments with in the region having excellent SCBA maintenance programs (personal communications, February 11, 2004).

Assumptions and Limitations

It was assumed that the Reno Fire Department's written respiratory protection program, part of the *City Of Reno Fire Department Occupational Safety And Health Program* (Reno Fire Department, 2003), adequately addressed all other components of an OSHA compliant respiratory protection program, other than care, maintenance, and repair. Therefore, this applied research project was limited only to developing and implementing a new SCBA maintenance program.

The majority of the periodical literature found by the author was at the National Fire Academy's Learning Resource Center in Emmitsburg, Maryland. The author was surprised by the lack of current periodicals on the subject of SCBA maintenance. There was a large number of periodicals dated from the 1980's and early 1990's. After an exhaustive search, the author found that very little in the fire service periodicals had been written on the subject since then. Many articles were reviewed and not used because the material was of out of date or did not apply. Material from this period included in the literature review of this project, in the author's opinion, still had relevant data that applied today. It is also the author's opinion and personal experience that, during the 1980's and into the 1990's, SCBA use within the career fire service was in a

period of cultural acceptance. During that period there were no clear standards or requirements for SCBA maintenance (McDonagh, 1980). With the current OSHA respiratory protection requirements, NFPA comprehensive standards on respiratory protection programs, and the cultural acceptance and adoption of SCBA use within the career fire service, SCBA use and maintenance is no longer the "hot topic" that it was in the 1980's and 1990's. This, the author believes, is the reason for the lack of current periodicals on the subject.

Definition of Terms

Maintenance - Procedures for inspection, repair, and removal from service of protective clothing and equipment (NFPA 1852, 2002, p. 6).

Posi-Check 3 - A computer based SCBA breathing test machine manufactured by Biosystems. It is the only breathing machine that meets NFPA 1852, 2002 standards.

Self contained breathing apparatus (SCBA) - An atmosphere-supplying respirator that supplies a respirable atmosphere to the user from a breathing air source that is independent of the ambient environment and designed to be carried by the user. (NFPA 1852, 2002, p. 6).

Requirement - A document or code that is law, produced by an governmental agency with enforcement powers to ensure compliance.

Standard - A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard (NFPA 1852, 2002, p. 6).

Technician - An individual qualified and authorized by the compliant product manufacturer to provide specified care and maintenance to the product, and perform inspection, repair, and testing beyond the level classified as “user repair” (NFPA 1852, 2002, p7).

RESULTS

Using action research, four (4) objectives were established to accomplish the purpose of developing and implementing a new SCBA Maintenance Program for the Reno Fire Department.

The first objective; gather and research the general subject of SCBA maintenance, was easily accomplished by a review of the many forms of information available on the subject. Excluding the lack of current periodical material available, the author found an enormous amount of literature on the subject. The volume of material available was so large and from so many agencies and organizations that it was difficult to determine what actually applied specifically to SCBA maintenance at the Reno Fire Department.

The second objective and first research question; determine what are the National and Scott Aviation standards and requirements for SCBA Maintenance, was accomplished through review of the material and personal communications, with the following findings.

The national standards for SCBA maintenance were found in the documents from NFPA, CGA, ANSI, and NIOSH. It was found that NFPA 1852 *Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA)* (NFPA 1852, 2002) provided the most comprehensive standard on SCBA maintenance. NFPA 1852 was the most current standard and referenced all the applicable standards of CGA, ANSI, NIOSH, and many other NFPA documents regarding SCBA maintenance.

National requirements for SCBA maintenance were found in OSHA Standard 29 CFR 1910.134, *Respiratory Protection* (OSHA, 1998), DOT Standard 49 CFR 178 *Shipping Container Specification Regulations* (DOT, 1999), and NIOSH Standard 42 CFR 84 *Requirements of Respiratory Protection Devices* (NIOSH, 1999). During the research, between the many agency and organization standards and codes reviewed, the author found it difficult to

determine the actual requirements that the Reno Fire Department needed, by law, to follow. A telephone conversation with Curt Johnson from Nevada OSHA Safety and Consultation assisted in clarifying the requirements. Mr. Johnson stated that OSHA was the enforcement arm of the federal government in regards to occupational safety and health issues and that OSHA actively enforces the federal laws for both OSHA and NIOSH regarding SCBA maintenance. He further pointed out that organizations like NFPA, CGA and ANSA have excellent standards that can and should be followed. However, their standards are not enforceable (personal communications, January 13, 2004). In further research on this requirements question, Jakubowski & Morton (2001) pointed out "Fire departments must be familiar with their [NFPA] publications, as they are nationally recognized and accepted standards. NFPA documents can and have been utilized in civil cases to indicate what a "reasonable person" would do in a given fire situation" (p. 31).

Scott Aviation standards were found in the Scott documentation that came with the Scott equipment and received at the Scott Certified Service Technician training. The documents contained specific and very helpful information on the required SCBA maintenance. It was also found, in order for the SCBA equipment to remain NIOSH certified, that the recommended manufacturer's maintenance and care schedule must be followed (NIOSH, 2000).

The third objective and second research question; determine what are the Reno Fire Department assets and limitations regarding SCBA Maintenance, was completed using personal knowledge of the author and Reno Fire Department personnel, reviewing labor contracts, letters of agreement, and grievance resolutions between the Reno Fire Department and Reno Fire Fighters IAFF local 731, and by reviewing Reno Fire Department policy and procedures relating to SCBA maintenance. The following are the findings.

A list of the Reno Fire Department and Reno Fire administered department physical and personnel SCBA assets (see Appendix B) was compiled from the author's personal files on SCBA purchases and equipment, and an interview with the Reno Fire Department Supply Officer Kenny Deburg (personal communications, December 12, 2003).

Limitations of SCBA maintenance within the Reno Fire Department was found in negotiated contracts and grievance resolutions between the Reno Fire Department and International Association of Firefighters (IAFF) Local 731 Union. Limitations were found to be: (a) SCBA maintenance for the Department shall be performed by only local 731 members assigned to station 8 on A shift (City of Reno, 2000); (b) only two 731 members, per shift, assigned to station 8 are required to be Scott Certified Service Technicians. However, all personnel assigned station 8 will be offered the training (personal interview Fire Chief Lowden, November 11,2003); (c) maintenance of Volunteer SCBA equipment performed by the station 8 Scott Certified Service Technician will be conducted on overtime (Reno Firefighters Local 731, 2004); (d) volunteer and auxiliary personnel shall not occupy career fire stations. In short, this prevents volunteer and auxiliary personnel from directly exchanging SCBA equipment at station 8, and establishes a need for an equipment exchange procedure (City of Reno, 2000).

The fourth objective and third research question; what information can be applied from published literature and information from other selected fire departments on SCBA maintenance programs and facilities, was researched with the following results.

In the published periodical literature, it was found that a good SCBA maintenance program is necessary and also provides a level of confidence to users of the apparatus. Dew point is extremely important in filling air bottles, air purification systems, and air compressors. If dew point is not factored into an SCBA maintenance system, it can cause serious problems with

regulator performance. The fire service needs a national SCBA failure reporting system (McDonagh, 1980).

SCBA maintenance can be broken down into three levels: (a) routine maintenance completed by the user; (b) maintenance after each use; (c) periodic maintenance performed at a facility authorized by the manufacturer. All maintenance, regardless of level, should be completed to the manufacturer's recommendations. An effective SCBA maintenance program begins with the user. Success of a program lies with the user's level of training in the use and care of the SCBA unit and the user's attitude. SCBA maintenance is a fact of life, and an effective maintenance program instills confidence in the SCBA user (Scott, 1992).

Technician level SCBA maintenance can be performed in three basic ways: (a) have the work done at the factory; (b) have the work done at the dealer or repair center; (c) develop an in-house repair center (Lambert, 1984).

In-house SCBA repair centers are very appealing to most fire departments, but are very expensive in personnel time, training, tools, inventory, equipment, and location needs. All costs need to be considered before a decision is made for an in-house center. Like any other skill, an SCBA repairmen must continually work on the SCBA equipment to remain proficient (Lambert, 1983). Many fire departments successfully use in-house technician level maintenance programs, and a good layout for an SCBA maintenance room helps with the flow of SCBA equipment as it goes through the testing, maintenance, and repair process (Brown, 1988). It is important is to have a controlled dust-free environment at an SCBA service. A service center should contain current information on SCBA design, construction, and comparisons of the different brands, a literature reference library with current manuals, product bulletins, legal safety and procedural

updates, and a correspondence file (Eddy, 1983). In order to ensure timely repair, enough parts should always be kept on hand to service all the SCBA units (Bearden, 1981).

Color coding of breathing air bottles can be used to assist keeping track of when a bottles needs to be requalified (Reed, 1986).

Specially-designed vehicles, traveling from station to station used to performing full service SCBA maintenance on the department's equipment, train department personnel on SCBA use, care and maintenance, and conduct annual fit testing have saved the Phoenix Fire Department money (Fire Chief, 1989). Phoenix Fire Department's SCBA maintenance program was staffed by three full time civilian employees and three part time firefighters. Phoenix's program provided a high level of confidence to department personnel using the SCBA equipment (Fire Chief, 1980). New York City Fire Department uses four mask service unit vehicles that go from station to station performing technician level maintenance, training department personnel on SCBA use, care and maintenance, providing air bottle maintenance and hydro-testing, and filling air bottles. They also provide an air bottle cache at emergency scenes (Calderone, 1999).

Information found from other selected fire departments on SCBA maintenance programs and facilities follows. As stated in the Procedures section, a number of telephone interviews were conducted with different fire departments to gain information on their SCBA maintenance programs. The departments interviewed were selected in two ways: (a) departments identified or referenced in the reviewed literature; (b) departments recommended by Craig Sax, Scott Health and Safety Western Regional Sales representative, as departments, within the region, that had excellent SCBA maintenance programs (personal communications, February 11, 2004). All department interviewed used Scott SCBA equipment.

Phoenix Fire Department was referenced in the periodical literature (Fire Chief, 1980, 1989). It was found that Phoenix Fire still has three civilians and two part time firefighters performing the technician level SCBA maintenance it their in-house program. They service over 800 SCBA units and have individually issued 2nd stage regulators. They have a fixed testing lab. However, most of the department SCBA maintenance is done with a mobile SCBA maintenance vehicle. This vehicle goes from station to station performing all technician level SCBA maintenance, except bottle recertification/hydro-testing. While at the station, training on SCBA use and needed fit testing is conducted by the individuals assigned to the mobile SCBA maintenance vehicle. This basic program has been in place and working successfully for over 15 years. Because of growth in the number of stations and equipment serviced, Phoenix Fire is considering placing another mobile SCBA maintenance vehicle in service. They use a Posi-Check 3 testing device for flow tests and keep meticulous records. They believe they are NFPA 1852 and OSHA compliant. They presently are considering moving their flow testing of all equipment from every 6 months to every 3 months. Phoenix does have a respiratory protection policy and some written SCBA procedures on SCBA maintenance (personal communications, Steve Shuksta February 3, 2004).

The City of Sacramento Fire Department in California has an in-house maintenance program. They service over 300 SCBA units and share 2nd stage regulators. Sacramento's in-house technician level maintenance is performed by one civilian employee named Jackie Joe. Jackie is a full time mechanic in the department's utility shop. Records management includes use of the Posi-Check 3 software for flow checks and paper files for all other records. They engrave ID numbers into the 2nd stage regulators. Bottle requalification/hydro testing and air quality testing is contracted out. They keep a log for every fill of an SCBA bottle, including date, bottle

ID, and compressor. SCBA units are assigned to an apparatus and stay on that apparatus. A loaner unit is placed on the apparatus only for the required testing. Flow checks are performed every two years. At one time they had an in-house SCBA maintenance performed by on-duty firefighters. They reported that quality control was a problem, causing the switch to the single individual maintenance program. They believe they are OSHA compliant but do not meet all the records and track requirements in NFPA 1582. Sacramento Fire does have a respiratory protection policy but has no written procedures on SCBA maintenance (personal communications, Captain Chris Costamagna, February 16. 2004). Due to the increase in number of SCBA units and size of the jurisdiction, Jackie Joe is considering developing a mobile SCBA maintenance vehicle. The new vehicle will assist in more efficient time management and will reduce the number of loaner SCBA units needed (personal communications, Mechanic Jackie Joe, February 17. 2004).

Contra Costa County Fire Protection District (CCCFPD) in California, like Sacramento Fire, had an in-house SCBA maintenance program, but has now gone to contracting all technician level maintenance out to a local testing contractor. The in-house used a mobile SCBA maintenance vehicle with a Posi-Check 3. The main reason for this switch was economic. It cost the district less to contract out for this service. The CCCFPD is fortunate that within the industrial refinery area of their district, there is a testing lab that has the full capabilities to do all of their SCBA related testing: flow testing, air quality testing, and bottle requalification/hydro-testing. The contractor provides the District with all records of testing. The District does it own fit testing. CCCFPD services about 325 SCBA units and has personal issue 2nd stage regulators. They engrave ID numbers into the 2nd stage regulators. CCCFPD does have a respiratory

protection policy BUT no written procedures on SCBA maintenance (personal communications, Battalion Chief Henry Warren, February 19. 2004).

Unexpected Findings

It was found that all of the fire departments interviewed believed they were in compliance with the Scott and OSHA SCBA maintenance requirements. However, only one, Phoenix Fire, believed they came close or complied with NFPA 1852 *Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA).*

It was found that other fire departments were engraving their 2nd stage regulators with ID numbers because the Scott serial numbers were wearing off. The author called Scott Health and Safety Technical Support to determine Scott's position on engraving. Scott's Technical Support would neither recommend nor discourage the engraving and stated that they were aware of a large number of fire departments that engraved ID numbers on 2nd stage regulators (personal communication, January 13, 2004, Scott Health and Safety Technical Support).

By using action research, the four (4) objectives and the three (3) research questions in this applied research project were completed and answered. The information gained in the process was used to accomplish the purpose, to develop and implement a new Self Contained Breathing Apparatus Maintenance Program for the Reno Fire Department (see Appendix A).

DISCUSSION

Discussion is divided into (3) sections. The sections will address each research question.

1. What are the National and Scott Aviation standards and requirements for SCBA Maintenance?

The national standards for SCBA maintenance were found in the documents from NFPA, CGA, ANSI, and NIOSH. It was found that NFPA 1852, *Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA)* (NFPA 1852, 2002) provided the most comprehensive standard on SCBA maintenance. NFPA 1852 was the most current standard and referenced all the applicable standards of CGA, ANSI, NIOSH, and many other NFPA documents regarding SCBA maintenance. It is the author's conclusion that, when developing a new SCBA maintenance program, the best standard to follow is NFPA 1852

CGA C-6.2-2003 *Guidelines for visual inspection and requalification of fiber reinforced high pressure cylinders,* the author concludes, had an excellent and useful inspection procedure to use when filling SCBA bottles (CGA, 2003).

National requirements for SCBA maintenance were found in OSHA Standard 29 CFR 1910.134, *Respiratory Protection* (OSHA, 1998), DOT Standard 49 CFR 178 *Shipping Container Specification Regulations* (DOT, 1999), and NIOSH Standard 42 CFR 84 *Requirements of Respiratory Protection Devices* (NIOSH, 1999). Curt Johnson from Nevada OSHA Safety and Consultation assisted in clarifying requirements. Mr. Johnson stated that OSHA was the enforcement arm of the federal government in regards to occupational safety and health issues and that OSHA actively enforces the federal laws for both OSHA and NIOSH regarding SCBA maintenance (personal communications, January 13, 2004).

In reviewing these requirements, it was the conclusion of the author that OSHA Standard 29 CFR 1910.134, *Respiratory Protection* (OSHA, 1998) provided the most useful information on requirements in developing an SCBA maintenance program.

The author found that all Scott Health and Safety documents that came with the Scott equipment and instruction provided excellent procedures for the use, care, and maintenance of the equipment by the user and the maintenance technicians (Scott, 1994a, 1998b, 1999c, 1999d, 1999e, 1999f). It was also found that in order for the SCBA equipment to remain NIOSH certified, the recommended manufacturer's maintenance and care schedule must be followed (NIOSH, 2000). It is the author's conclusion that these documents must be included in any SCBA policy or procedure, and must be followed.

By following the NFPA, OSHA, and Scott documents listed above in developing a new SCBA maintenance program, the organizational implication for the Reno Fire Department is that the new program will be as current as possible to the national standards and meet all the national requirements.

2. What are the Reno Fire Department assets and limitations regarding SCBA Maintenance?

The Reno Fire Department SCBA assets regarding equipment, facilities, and personnel were listed in Appendix B.

Following review of the negotiated contracts and grievance resolutions between the Reno Fire Department and International Association of Firefighters (IAFF) local 731 Union, limitations to SCBA maintenance within the Reno Fire Department were found to be: (a) SCBA maintenance for the Department shall be performed by only local 731 members assigned to station 8 on A shift (City of Reno, 2000); (b) only two 731 members, per shift, assigned to

station 8 are required to be Scott Certified Service Technicians. However, all personnel assigned to station 8 will be offered the training (personal interview Fire Chief Lowden, November 11,2003); (c) maintenance of Volunteer SCBA equipment performed by the station 8 Scott Certified Service Technician will be conducted on overtime (Reno Firefighters Local 731, 2004); (d) volunteer and auxiliary personnel shall not occupy career fire stations. In short, this prevents volunteer and auxiliary personnel from directly exchanging SCBA equipment at station 8, and establishes a need for an equipment exchange procedure (City of Reno, 2000).

It is the author's conclusion that the organizational implications to the Reno Fire Department due to the above limitations are as follows: (a) an in-house maintenance program based out of station 8 is the only program option available at this time; (b) only two members assigned to station 8 are required to be Scott Certified Service Technicians. How these individuals are selected is not addressed, and there is no mention of selection by rank; (c) maintenance of volunteer SCBA equipment will be done by off duty Scott Certified Service Technicians on overtime; (d) volunteer and auxiliary personnel being prohibited to occupying a career station requires that an equipment exchange procedure be established.

3. What information can be applied from published literature and information from other selected Fire Departments on SCBA maintenance programs and facilities?

In the published periodical literature, it was found that a good SCBA maintenance program is necessary and also provides a level of confidence to users of the apparatus. The fire service needs a national SCBA failure reporting system (McDonagh, 1980). An effective SCBA maintenance program begins with the user, and the success of a program lies with the user's level of training in the use and care of the SCBA unit as well as the user's attitude. SCBA

maintenance is a fact of life, and an effective maintenance program instills confidence in the SCBA user (Scott, 1992).

SCBA maintenance can be broken down into levels and all maintenance, regardless of level, should be completed to the manufacturer's recommendation (Scott, 1992). Technician level SCBA maintenance can be performed three basic ways: (a) have the work done at the factory; (b) have the work done at the dealer or repair center; (c) develop an in-house repair center (Lambert, 1984). In-house SCBA repair centers are very appealing to most fire departments, but are very expensive in personnel time, training, tools, inventory, equipment, and location needs. SCBA repairmen must continually work on the SCBA equipment to remain proficient (Lambert, 1983).

Many fire departments successfully use in-house technician level maintenance programs In-house SCBA service centers should have a good layout to help with the flow of SCBA equipment as it goes through the testing, maintenance, and repair process (Brown, 1988). It is important is to have a controlled dust-free environment in the service center. A service center should contain current information on SCBA design, construction and comparison of the different brands, a literature reference library with current manuals, product bulletins, legal safety and procedural updates, and a correspondence file (Eddy, 1983).

Color coding of breathing air bottles can be used to assist keeping track of when a bottles needs to be requalified (Reed, 1986).

Specially-designed SCBA maintenance vehicles, traveling from station to station used for performing full service SCBA maintenance on the department's equipment, training department personnel on SCBA use, care and maintenance, and conducting annual fit testing can save fire department money (Fire Chief, 1989). Some of the specially-designed SCBA maintenance

vehicles are used to fill air bottles and provide an air bottle cache at emergency scenes (Calderone, 1999).

The author's interpretation of the periodical data includes: (a) in order for an SCBA program to be successful and instill confidence in the equipment users, it must be a well run program that ensures that the users are well trained on use and care of the equipment, and that the equipment is maintained in excellent manufacturer's recommended condition; (b) SCBA maintenance should be broken into, at least, the user and technician levels; (c) in-house SCBA repair centers are very appealing and effective, and due to Reno Fire Department's contractual language and assets, appears to be the best and only choice for the Reno Fire Department; (d) an in-house SCBA repair center needs to be well laid out to be efficient and should contain a comprehensive library of SCBA related materials; (e) color coding systems for bottle testing and other SCBA related maintenance procedures can be effective; (f) specially-designed SCBA maintenance vehicles can save money and have proven to be an effective tool to provide in-house SCBA maintenance, training and fit testing. The organizational implications for the Reno Fire Department in developing a new SCBA maintenance program are that the above information should be considered and/or used in development of the new program.

In the interviews with other fire departments, the author's interpretation of the data includes: (a) there are a number of ways to successfully perform technician level SCBA maintenance; (b) all departments contacted complied with the OSHA requirements, and only one believed they were compliant with NFPA 1852; (c) all departments either use or have used Posi-Check 3 flow testing machine; (d) all departments had written respiratory protection programs, but only one had written procedures on SCBA maintenance; (e) two departments engraved ID numbers on second stage regulators; (f) all departments contracted out air bottle

requalification/hydro-testing; (g) all departments either used, had used or expressed the desire to use a specially-designed SCBA maintenance vehicle. Organizational implications for the Reno Fire Department are, in developing a new SCBA maintenance program, the above information should be considered and/or used.

RECOMMENDATIONS

This applied research project addressed the problem of the Reno Fire Department's old SCBA Maintenance Program not meeting the demands of the new more complex organization. The purpose of this research was to develop and implement a new SCBA Maintenance Program for the Reno Fire Department by: (a) determining what were the National and Scott Aviation standards and requirements for SCBA Maintenance; (b) determining what were the Reno Fire Department assets and limitations regarding SCBA Maintenance; (c) determining what information could be applied from published literature and information from other selected fire departments on SCBA maintenance programs and facilities.

The recommendation from this research is that the City of Reno Fire Department, in order to ensure safe reliable SCBA equipment to its members, comply with federal SCBA maintenance requirements, and closely follow national standards on SCBA maintenance, must develop and implement a new SCBA Maintenance Program as soon as possible.

In developing the new SCBA Maintenance Program for the Reno Fire Department, it is recommended that NFPA 1852, *Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA)* (NFPA 1852, 2002) be used as the primary guideline in developing the program. Additionally, OSHA Standard 29 CFR 1910.134, *Respiratory Protection* (OSHA, 1998) must be followed in order to comply with the federal SCBA maintenance requirements. At all times, the Scott Health and Safety recommended procedures for maintenance, care, and repair (Scott, 1994a, 1998b, 1999c, 1999d, 1999e, 1999f) must be followed to keep the Department's SCBA equipment in NIOSH certified condition (NIOSH, 2000).

The following are additional recommendations gained from this research that should be used in developing the new SCBA Maintenance Program for the Reno Fire Department.

- The Scott Health and Safety documents on recommended procedures for maintenance, care, and repair should be part of the Reno Fire Department's SCBA maintenance program.
- Reno Fire Department's SCBA maintenance program, by contract, needs to be an in-house program based out of station 8.
- Develop a selection process for individuals assigned to station 8 that will be required to be Scott Certified Service Technicians.
- Develop an SCBA equipment exchange procedure for volunteer and auxiliary equipment.
- The in-house SCBA service center should have a good layout to help with the flow of SCBA equipment and have a controlled dust-free environment.
- The in-house SCBA service center should have a literature reference library with current information on SCBA design, construction and comparison of the different brands, current manuals, product bulletins, legal safety and procedural updates, and a correspondence file.
- Color coding or similar marking systems should be used to assist with tracking of tested SCBA equipment.
- CGA C-6.2-2003 *Guidelines for Visual Inspection and Requalification of Fiber Reinforced High Pressure Cylinders* should be given to, and followed by, all personnel filling air bottles.
- Explore the possibility of using a specially-designed SCBA maintenance vehicle to deliver SCBA maintenance, train department personnel on SCBA use, care and

maintenance, and conduct annual fit testing to all career and volunteer stations and personnel.

The following issue was discovered during this research and could be a subject for future study by organizations or future readers. The research did not produce conclusive data to support the following observation, and more research would be needed to confirm if the observation is true. It is the author's observation and opinion that most fire departments performing SCBA maintenance are compliant with the OSHA requirements. However, very few fire departments performing SCBA maintenance are totally compliant with NFPA 1852, *Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus.* NFPA 1852 may be too restrictive for most fire departments to totally comply with.

The following are a few of examples of how NFPA 1852 can be overly restrictive: (a) NFPA 1852 calls for all SCBA units to be flow tested at least annually (NFPA 1852, 2002, p. 13), while Scott Health and Safety requires flow testing at least every two years (Scott Health and Safety, 1999, March). The Scott flow test interval is part of the NIOSH certified manufacturer's recommended maintenance (NIOSH, 2000); (b) NFPA 1852 requires that all cylinders, parts, and components be identified and tracked from initial receipt until removed from the organization (NFPA 1852, 2002, p. 9). Tracking is possible with most major SCBA components that can be identified by serial number. However, tracking is next to impossible for smaller SCBA parts such as springs, o-rings and other components that have no serial number or means to track.

These are a few of the many examples in which NFPA 1582 is too restrictive for most fire departments to comply with. The author supports and is a member of NFPA. NFPA is

attempting to lead the American fire service with modern standards. However, if fire departments are going to be held to NFPA standards in civil cases (Jakubowski & Morton, 2001), these standards should at least be reasonably attainable by the majority of fire departments in the country.

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