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Torch Operating Company
Santa Maria, California

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PREFACE

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

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Health Hazard Evaluation Report 96–0138–2691
Torch Operating Company
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SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) received a request for technical assistance from the Department of the Interior, Mineral Management Services (MMS), located in Santa Maria, California. According to the request, inspectors of Offshore Operations and Safety were concerned about respiratory protection against hydrogen sulfide (H_2S). Specific concerns were with the Robertshaw (air capsule) 5–minute, hooded, continuous–flow, escape self-contained breathing apparatus (ESCBA) and the general use of hooded ESCBAs.

On August 11 and 12, 1996, NIOSH investigators conducted a site visit on platform "Irene," an offshore drilling rig owned and operated by Torch Operating Company (TOC). Platform Irene is located on the Outer Continental Shelf of the Pacific Ocean, 5–7 miles off the coast of Santa Maria, California. It is designed to support both drilling and production operations. At the time of the NIOSH site visit, platform Irene was in the production phase and accommodated 15 workers.

The site visit began with a walk–through inspection of the platform to become familiar with the layout, to identify respirator equipment locations and safe briefing areas, and to observe various job tasks and locations. On the second day, the Whittaker escape pods were observed and a drill was simulated so NIOSH investigators could observe platform workers don respirator equipment and escape to a safe briefing area.

Based on the information obtained during the NIOSH site visit, hooded, continuous flow, ESCBAs should not be used on offshore platforms; they can be over–breathed, do not have airline capabilities, and the user's vision can be impaired. Although a respiratory protection program was in place, deficiencies (lack of a written program and respirator fit testing) were identified. Recommendations are made to replace hooded, continuous flow, ESCBAs with pressure demand, full facepiece, SCBAs, and to improve the respiratory protection program by designing a comprehensive written program which includes quantitative respirator fit testing.

Keywords: SIC 1311 (Crude Petroleum and Natural Gas) offshore drilling rig, offshore platform, hydrogen sulfide, oil and gas production, escape self-contained breathing apparatus (ESCBA), self contained breathing apparatus (SCBA), Whittaker escape pod, mineral management services.

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INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a request for technical assistance from the Department of the Interior, Mineral Management Services (MMS), located in Santa Maria, California. According to the request, inspectors of offshore operations and safety were concerned about appropriate respiratory protection against hydrogen sulfide (H_2S). Specific concerns were with the adequacy of Robertshaw (air capsule) 5–minute, hooded, continuous–flow, escape self–contained breathing apparatus (ESCBA) and the general use of hooded ESCBAs.

On August 11 and 12, 1996, NIOSH investigators conducted a site visit on platform "Irene," an offshore drilling rig owned and operated by Torch Operating Company (TOC). Prior to the site visit, NIOSH investigators were given mandatory H_2S training and experience with respirator donning procedures. The training was provided by Secorp Industrials, a contract company which also maintained the respirator equipment, respiratory protection program, and the H_2S monitoring equipment. Upon completing H_2S training, NIOSH investigators, accompanied by representatives from TOC, Secorp, and MMS, conducted a walk–through survey of the platform to become familiar with the layout, to identify respirator equipment locations and safe briefing areas, and to observe various job tasks and locations.

BACKGROUND

Platform Irene is located on the Outer Continental Shelf of the Pacific Ocean, 5–7 miles off the coast of Santa Maria, California. The platform is approximately 400 feet high (250 feet below water and 150 above water) and has three decks above water: the drilling deck (83 feet above the water with dimensions of 150 feet by 150 feet), the production deck (56 feet above the water and similar dimensions to the drilling deck), and the sub deck (41 feet above the water and much smaller than the other decks). The platform produces an average of 70,000 barrels of emulsion (20% oil and 80% water) per day and 4.3 million cubic feet of gas per day. The oil portion is sour crude oil which contains high levels of H_2S. The average H_2S concentration in the pipeline is approximately 8500 parts per million (ppm).

Offshore drilling rigs operate in various phases including exploration, drilling, and production. Platform Irene is designed to support both drilling and production operations. During simultaneous operations, platform Irene employees 50–60 workers (30–40 on the drilling deck and 15–20 on the production deck). During the production phase, there are 15–20 workers on the production deck. At the time of the NIOSH site visit, platform Irene was in the production phase. During production, crude oil and gas, along with contaminants (i.e., H_2S and saltwater) are produced from the oil reserve below the surface of the ocean floor and processed on the platform (separate gas and oil/water). The crude oil, along with production water, is then piped to shore for further processing. Gas is compressed for transportation (through pipe) to the shore for processing.

According to representatives from MMS and TOC, an H_2S release on the production deck is mostly from maintenance work on piping, storage tanks, compressors, etc., or leaks in the compressors, well heads (well room), and production/storage tanks. On the drilling deck, an H_2S release can be from the mud pit, shaker pit, drilling platform (bell and nipple), or a blow–out, which occurs when the bottom hole pressure (from oil and gas reserve) is greater than the column pressure (from drilling mud and/or gas) and the drilling mud, oil, and gas are forced upward toward the platform under tremendous pressure. In most cases, blow–out preventers will stop the fluid/gas mixture from reaching the platform.

On platform Irene, ambient H_2S concentrations are monitored with continuous direct–reading instruments. The fixed H_2S sensors are strategically placed throughout the platform with emphasis in those areas where an H_2S release is most likely to occur. In the event of an H_2S release that results in an ambient air concentration of 10 ppm or more at any given H_2S sensor, an audible alarm will sound throughout the platform and a visual alarm (amber light) will flash at the specific activated H_2S sensor. A person in the control room will inform all personnel, via PA system, of the location of the alarm. At that point, all personnel are to note the nearest ESCBA. If ambient air concentrations reach or exceed 20 ppm, the audible alarm will sound platform–wide, but the visual alarm will change to a flashing red light. A person in the control room will inform all personnel of the location of the H_2S alarm, to what safe briefing area they should go (usually safe briefing area upwind of H_2S release), and what route should be taken. At that point, all essential personnel designated to address the H_2S release are to assemble at the production deck fire locker, don the appropriate personal protective equipment, and wait for instructions from the supervisor in charge. All other personnel are to secure ESCBAs, proceed to the designated safe briefing area, and await instructions. Portable direct reading H_2S monitors are located at each safe briefing area to monitor ambient air concentrations.

The platform is equipped with two blowers which can be used to create air movement if the wind is calm. If the platform should be abandoned because H_2S concentrations in the safe briefing area and living quarters reach or exceed 10 ppm, all non–essential personnel will board the platform escape pod (Whittaker capsule) and await instructions. If H_2S concentrations around the Whittaker reach or exceed 10 ppm, the Whittaker is sealed and its cascade air system activated. The Whittaker is then lowered to the ocean and moved upwind of the platform. Essential personnel not only address the H_2S release, but also deploy visual signs to alert helicopter and water craft in the immediate vicinity of the platform, and notify various agencies (MMS, United States Coast Guard, and medical facilities) of the H_2S release. If essential personnel must abandon the platform, a second Whittaker capsule is available. It should be noted that the activities described above regarding an H_2S release are very general and do not include all duties that essential and non–essential personnel may perform. Only information pertinent to the NIOSH investigation is discussed.

Minor localized H_2S releases that require workers to escape to safe briefing areas generally occur one to two times per year. The last H_2S release on platform Irene occurred approximately 18 months prior to the NIOSH site visit. Platform workers were repairing/replacing a section of pipe. After purging the pipe of airborne contaminants (i.e., H_2S), workers began cutting the pipe. Because the pipe was partially obstructed, all contaminants were not purged, which resulted in a localized H_2S release. Major H_2S releases or blow–outs are events that occur infrequently. To date, no major H_2S releases or blow–outs have occurred on platform Irene. The last major H_2S release in the MMS Santa Maria District occurred several years ago. During the beginning stage of drilling a new well, the operator drilled into an existing closed well, containing compressed gas, about 1000 feet below the surface of the ocean. Because the new well was so shallow, the blow–out preventer did not have time to respond resulting in a release of gas, water, drilling mud, and H_2S. However, workers were not exposed to H_2S because the mixture was diverted overboard and downwind of the platform. Prior to this, the last blow–out in the Pacific Outer Continental Shelf Region was in 1969.

EVALUATION CRITERIA

H_2S is a colorless, flammable gas with a strong odor of rotten eggs. It can be encountered in the production and processing of gas and crude oil. Acute exposure to H_2S at airborne concentrations above 10 ppm has been associated with the development of conjunctivitis and keratitis.[1] One hour exposure to H_2S concentrations between 50 and 100 ppm can produce mild eye and respiratory irritation which becomes markedly worse when the concentrations are in the 200 to 300 ppm range. At H_2S concentrations between 500 and 700 ppm, exposures for 0.5– to 1–hour can result in unconsciousness and death, and between 1000 to 2000 ppm or more, unconsciousness and death can occur within minutes. Conclusive evidence of adverse health effects from chronic exposure to H_2S at concentrations below 20 ppm is lacking.[1,2,3,4] However, there is some evidence that H_2S alone at low concentrations, or in combination with other chemical substances (e.g. petroleum products or carbon disulfide), is associated with the development of nervous system, cardiovascular, and gastrointestinal disorders, and it affects the eyes. Repeated exposure to H_2S results in increased susceptibility, so that eye irritation, cough, and systemic effects may result from concentrations previously tolerated without effect. H_2S has an odor threshold between 0.002 and 0.003 ppm for humans.[3] The smell is faint, but easily perceptible at 0.77 ppm and offensive at 3 to 5 ppm. Up to about 30 ppm, H_2S smells of rotten eggs, but at about 30 ppm the smell is described as sweet or sickening sweet. At 150 ppm, H_2S causes olfactory–nerve paralysis and the smell is no longer perceptible. The smell of H_2S therefore is not a reliable warning of its presence, especially at high concentrations.

In a recent study, Bhambhani, et al.[5] compared the effects of inhalation of 5 ppm H_2S on the physiological and hematological responses of healthy men and women during exercise. Subjects included in the study completed two 30–minute exercise tests on a cycle ergometer at 50% of their predetermined maximal aerobic power while breathing medical air or 5 ppm H_2S from a specially designed flow system. The results indicated that there were no significant differences between the two exposures for the metabolic (oxygen uptake, carbon dioxide production, respiratory exchange ratio), cardiovascular (heart rate, blood pressure, rate pressure production), arterial blood (oxygen and carbon dioxide tensions, pH), or perceptual (rating of perceived exertion) responses in either sex. None of the subjects reported any adverse health effects subsequent to the H_2S exposure. These results suggest that healthy men and women can safely perform moderate intensity work in environments contaminated with 5 ppm H_2S or lower. The device used to deliver H_2S to the subjects fits in their mouths and did not result in exposure to the subjects' eyes. This is important since adverse effects on the eyes are what NIOSH and the Occupational Safety and Health Administration (OSHA) exposure limits are based on.

The NIOSH REL for H_2S is a 10–minute ceiling concentration of 10 ppm.[6] When there is a potential for exposure to H_2S at a concentration of 50 ppm or higher, continuous monitoring is recommended by NIOSH. The OSHA standard for H_2S is a 10–minute ceiling concentration of 20 ppm or a maximum allowable peak of 50 ppm for 10–minutes once, if no other measurable exposures occur.[7] The American Conference of Governmental Industrial Hygienists (ACGIH®) recommends a threshold limit value (TLV®) of 10 ppm as a 8–hour time–weighted average (TWA) and a short–term exposure limit (STEL) of 15 ppm.[8]

RESPIRATORY PROTECTION

Under Code of Federal Regulation (CFR) 30 part 250.67 (Hydrogen sulfide),[9] the MMS requires that when exploring or developing zones classified as H_2S present or H_2S unknown:

all personnel, including contractors and visitors on a facility, must be provided with immediate access to pressure–demand–type (PD) respirators with hoseline capability and breathing time of at least 15 minutes. Design, select, use, and maintain respirators to conform to American National Standard Institute (ANSI) Z88.2, Practices for Respiratory Protection.

The American Petroleum Institute (API) has written a standard with respect to oil and/or gas producing and gas processing facilities. Recommended practice number 55 (RP55), Recommended Practices for Oil and Gas Producing and Gas Processing Plant Operations Involving Hydrogen Sulfide,[10] requires:

site specific contingency plans shall be prepared to specify the quantity and location of breathing equipment to be available. Respirators shall meet *the requirements of the Occupational Safety and Health Administration's Respiratory Protection Standard (29 CFR Part 1910.134) and be approved under procedures outlined in ANSI Z88.2. The following types of breathing equipment with full facepiece meet these requirements and should be used where the work area atmospheric concentration exceeds 10 parts per million (ppm) for hydrogen sulfide or 2 ppm for sulfur dioxide:*

A. Self–contained, positive-pressure/pressure-demand breathing equipment that provides respiratory protection in any atmospheric concentration of hydrogen sulfide or sulfur dioxide.

B. Positive–pressure/pressure–demand air–line breathing equipment coupled with a self contained breathing apparatus (SCBA) equipped with a low pressure warning alarm and rated for 15 minutes (minimum). This equipment permits the wearer to move from one work area to another.

C. Positive–pressure/pressure–demand, air–line breathing equipment, with auxiliary self–contained air supply (rated for a minimum of 5 minutes). This type of unit can be used for entry as long as the air line is connected to a source of breathing air. The auxiliary self–contained air supply (rated for less than 15 minutes) is suitable only for escape or self–rescue use.

In addition to the required PD–type SCBAs, MMS has allowed offshore platforms to use hooded ESCBA respirators for emergency escape to safe briefing areas. In the event of an H_2S release, all personnel considered essential (address H_2S release) must don personal protective equipment required to enter into H_2S contaminated areas, *i.e.*, PD–type SCBAs with airline capability. On platform Irene, like many large Outer Continental Shelf facilities, the workforce includes personnel that are employed temporarily under contract. In the event of an H_2S release, only a portion of the personnel are considered essential when addressing an H_2S release. The remaining non–essential personnel are to proceed directly to the designated safe briefing area. Because of the increased size of the platforms, the increased number of non– essential personnel, and the fact that personnel do not work in one specific area, MMS feels that one respirator per person may not be protective enough and allows the use of hooded ESCBAs to escape to safe briefing areas. Furthermore, contract workers may only be on the platform for a few days and the simplicity of the hooded ESCBAs is advantageous. By allowing companies to utilize hooded ESCBAs, the distribution of respirator protection on the platform is increased. Lastly, hooded ESCBAs can be used on a platform as long as the quantity, location, and specific use of all breathing equipment are described in the H_2S Contingency Plan and approved by MMS.

RESULTS

On the day of the NIOSH site visit, there were 15 workers on platform Irene. Most job tasks and activities were performed on the production deck since the platform was in production phase. Platform operations continue 24 hours a day with work shifts consisting of seven consecutive 12–hour workdays (stay on platform) followed by seven days off (flown to shore via helicopter).

Concerns expressed in the request were with the use of the air capsule (coil reservoirs) 5–minute, hooded, continuous–flow, ESCBAs on platform Irene and the general use of hooded ESCBAs on offshore drilling rigs. According to MMS inspectors, deficiencies identified with the air capsule respirators included a low air flow rate (breathing air supplied to the hood) ranging from 17 to 25 liters per minute (Lpm), various leaks in the air capsule coils, no airline hookup, and a service life of 5–minutes or less (due to leaks). At the time of the NIOSH site visit, TOC was in the process of removing these ESCBAs from the drill and production decks and replacing them with other hooded continuous flow ESCBAs (with a flow rate of 40 Lpm) and PD–type ESCBAs. Since the air capsule ESCBAs were no longer in use on platform Irene, NIOSH did not evaluate them.

The respirator distribution points on platform Irene are identified in Figures 1 and 2. On the production deck, there were 45 SCBAs including 12 full facepiece (FF), PD–type, ESCBAs with airline capabilities and a service life of five minutes (5–min., FF, PD, ESCBAs); 8 full facepiece, PD–type, SCBAs with airline capabilities and a service life of thirty minutes (30–min. FF, PD, SCBAs); and 25 hooded (HH), continuous–flow (CF), ESCBAs with a service life of ten minutes (10–min. HH, CF, ESCBAs). The distribution of respirators was such that the 10–min. hooded ESCBAs were placed throughout the production deck and immediately available for workers to don and escape to the designated safe briefing area in the event of an H_2S release. Most 5–min. ESCBAs were centrally located at safe briefing area # 2 and were available for those workers who did not secure a 10–min. hooded ESCBA while escaping to the safe briefing area or who ran out of air with the 10–min. hooded ESCBA. It should be noted that hooded ESCBAs (approved by NIOSH) do not have airline capabilities; therefore, if a worker runs out of breathing air with a hooded ESCBA, then the worker must don another respirator or board the Whittaker escape capsule. Most 30–min. SCBAs were located in the fire locker, near change room, where essential personnel assemble in the event of an H_2S release. Other 30–min. SCBAs were located in the control room. On the drill deck, there were 41 SCBAs including 27 – 5 min., FF, PD, ESCBAs; 10 – 30 min. FF, PD, SCBAs; and 4 – 10 min. HH, CF, ESCBAs. Most respirators on the drill deck were located in the living quarters and safe briefing area #1. All respirators were stored in either a hard plastic case or a sealed plastic bag.

The cascade air system, breathing air manifolds, air–supply lines, and detachable couplings were inspected during the NIOSH site visit. There were five cascade air systems on platform Irene which served a total of 16 breathing air manifolds. Each cascade air system had eight cylinders with a total air volume of 2400 cubic feet (300 cubic feet per cylinder). Breathing air manifolds were located at various sites throughout the platform (Figures 1 and 2). Each manifold was able to support five airlines. During the walk–through survey, NIOSH investigators found that most manifolds on the production floor had at least two airlines except in the safe briefing areas where the manifolds had five air–lines. It should be noted that each safe briefing area had only one breathing air manifold and, therefore, only five workers would be able to hookup to the breathing air manifold. Two high pressure breathing air compressors, one at each safe briefing area, were used to fill all cascade air systems, including those in the Whittakers, and to refill all SCBAs and ESCBAs.

Respiratory protection on the platform was manufactured by several different companies. Airlines and detachable couplings were the same throughout the platform and compatible with SCBAs and ESCBAs that had airline capabilities. However, the airlines and detachable couplings were not manufactured by the same company as the respirators.

On the platform, two escape Whittakers, one at each safe briefing area, were used to evacuate the platform. Each Whittaker was capable of accommodating 50 individuals. According to TOC, breathing air was supplied to the Whittaker by two different air systems. As long as the Whittaker remained attached to the platform and was not lowered from the boarding deck, a cascade system on the platform was used to purge the Whittaker of air contaminates and supply approximately 30 minutes of breathing air for 50 individuals. If the Whittaker was lowered from the boarding deck, the cascade system in the Whittaker was manually activated and would provide enough air to maintain positive pressure inside the escape pod and ensure approximately 10 minutes of engine operation while sustaining personnel breathing requirements. Once launched, the Whittaker captain would maneuver the escape pod upwind or crosswind of the platform to insure reaching an uncontaminated atmosphere. Currently, there are no design specifications for breathing air systems or minimum standards for breathing air supply for the Whittaker escape pods.

NIOSH investigators observed a simulated drill where workers escaped to a safe briefing area. Two individuals (platform worker and safety coordinator) volunteered to perform the simulation. Both men were between 35–45 years old, approximately six feet tall and weighed over 200 pounds. The simulation consisted of donning an ESCBA near the gas skid (southeast corner of production deck) and escaping to safe briefing area #1 (northwest corner of the drill deck) via the center corridor of the production deck and finally up the northwest stairs. This route was chosen because it is most likely the longest distance non–essential personnel would have to travel to reach a safe briefing area. During the simulation, the platform worker donned a 5–min., FF, PD, ESCBA, and the safety coordinator donned a 10–min. HH, CF, ESCBA.

During the simulation several noteworthy conditions were observed. To don the respirators and escape to the primary safe briefing area, it took the workers approximately 48 seconds. Workers did not run during the simulation but moved at a pace between a brisk walk and a jog. When both men reached the safe briefing area, NIOSH investigators observed the safety coordinator's hooded ESCBA slightly inflating/deflating with each breath. This was likely a result of over–breathing (air consumption rate greater than the ESCBA air supply rate of 40 Lpm) in the hooded respirator. Also, vision, which was already distorted because of the polyurethane hood, was further distorted because of fogging (moisture in exhaled breath) and the continuous inflation/deflation of the hood. The 5–min., FF, PD, ESCBA donned by the platform workers appeared to perform well during the simulation but, as with the hooded respirator, the full facepiece was slightly fogged.

Initial observations of the ESCBAs revealed that the platform worker used approximately 50% of the breathing air in the 5 min., FF, PD, ESCBA and the safety coordinator used approximately 25% of the breathing air in the 10 min. HH, CF, ESCBA during the 48 second drill. However, when reviewing the video tape, it was found that, although the H_2S simulation lasted 48 seconds, the workers kept the respirators donned for one minute and thirty seconds. Based on this information and the assumption that the ESCBAs air pressure gauges were accurate (both gauges indicated that the air tanks were full), the 10–min. HH, CF, ESCBAs would have lasted approximately six minutes and the 5 min., FF, PD, ESCBA would have lasted approximately three minutes (assuming same air consumption rate).

Inspection of the respiratory protection program revealed strengths and weaknesses. Strengths of the program included initial worker/visitor orientation (video tapes and written materials) and training of respiratory protection equipment (donning procedures and respirator use) and refresher training (weekly simulated drills). Another important strength of the respirator program was the inspection and maintenance of all respirator equipment and cascade air systems were conducted by a contractor that specialized in respiratory protection devices. Weaknesses included the lack of a written program and the absence of qualitative or quantitative respirator fit testing other than a respirator fit check.

DISCUSSION/CONCLUSION

It is important to choose the proper respiratory protection and instruct the worker in the correct donning and maintenance procedures to prevent health effects associated with exposure to the air contaminate of concern. Because of the potential adverse health effects of H_2S exposures, only the most protective respiratory protection should be used. This includes any SCBA with a full facepiece and operated in a PD mode or any supplied–air respirator equipped with a full facepiece operated in a PD mode in combination with an auxiliary SCBA operated in a PD mode. Although MMS regulations require offshore rigs to provide personnel with this level of respiratory protection, MMS also allows offshore facilities to use hooded, continuous flow ESCBAs to increase the distribution of respirators on the platforms.

Based on the information obtained during the NIOSH site visit, it is recommended that the hooded, continuous flow, ESCBAs should not be used on offshore platforms. The ESCBA can be over–breathed which can result in serious adverse health effects. The wearer's vision, which is slightly distorted because of the polyurethane hood, can be further distorted because of fogging of the hood (moisture in exhaled breath) and the continuous inflation/deflation of the hood (from over–breathing). Lastly, NIOSH–approved hooded, ESCBAs do not have airline capabilities. Therefore, if a worker dons a 10–min. HH, CF, ESCBA during an H_2S release and cannot escape to a safe briefing area for any reason (i.e., injury, blocked escape route, etc.), then the worker will have to don another respirator when the breathing air runs out. Also, if the worker reaches the safe briefing area but does not board the Whittaker, then the worker will have to don another respirator when the breathing air runs out. Changing respiratory protection for any reason during an H_2S release is not advised and should be discouraged. In the event of an H_2S release, platform workers should don only one respirator which will provide the highest level of protection and function as a airline respirator.

The only instance where hooded, continuous flow, ESCBAs may be appropriate is when there are visitors on the platform for less than 24 hours. Visitor orientation and training of these respirators require a minimal amount of time; and the simplicity of donning these respirators can be advantageous in an emergency situation because visitors likely do not have advanced respirator training.

The air capsule respirators have several deficiencies that were identified by MMS inspectors. Those deficiencies include a limited air flow rate (breathing air supplied to the hood) ranging from 17 to 25 Lpm, air leaks in the air capsule coils, no airline hookup, and a limited service life of 5–minutes or less (due to leaks). Based on these deficiencies and the deficiencies of other hooded ESCBAs identified by NIOSH, the air capsule HH, CF, ESCBAs should not be used on platform Irene (or any other platform) for respiratory protection.

Full facepiece, PD, SCBAs are designed so that as a worker's air consumption rate increases (platform worker walking up steps to safe briefing area during an H_2S release), the air supply rate to the facepiece also increases (maintaining positive pressure within the facepiece). However, this could be viewed as a disadvantage when using PD, SCBAs with a service life of only five minutes. Since individual air consumption rates are based on body dimensions, age, sex, health, and fitness level and can differ from person to person, respirator service life can differ from person to person. The service time of an SCBA is approved by NIOSH using a breathing machine with 24 respirations per minute and a minute volume of 40 liters.[11] Therefore, if an individual's air consumption rate is greater than 40 Lpm, the service life of the respirator will decrease. For example, the estimated air consumption rate of an average 160 pound person walking up steps at a normal pace (116 steps per minute) is approximately 60 Lpm.[12,13] A NIOSH–approved 5 min., FF, PD, SCBA contains approximately 200 liters of breathing air (40 Lpm X 5 min. = 200 Liters of air). Based on a 60 Lpm air consumption rate, the service life of the 5 min. ESCBA would be approximately three minutes and twenty seconds, assuming a constant air consumption rate (200 liters / 60 Lpm = 3.33 min.). A 15 min. FF, PD, ESCBA contains approximately 600 liters of air. Based on a 60 Lpm air consumption rate, the service life of the 15 min. ESCBA would be approximately 10 minutes, assuming a constant air consumption rate (600 liters / 60 Lpm = 10 min.). It should be noted that the estimated air consumption rate described above is only an approximation and is meant merely as a general guide. A larger person moving at the same rate will most likely have a greater air consumption rate thus further decreasing the respirator service life (assuming similar fitness levels, age, and sex). Based on the above information and the fact that individual air consumption rate vary from person to person, the minimum service life of ESCBAs should be 15 minutes.

All respiratory protection used on offshore platforms should be NIOSH–approved. Currently, NIOSH is the only agency that approves/certifies the performance of respiratory protection. MMS regulation cites the ANSI standard Z 88.2 for respiratory protection selection which requires that all respiratory protection used should be NIOSH–approved (or certified).

Although the airlines and detachable couplings were compatible with SCBAs and ESCBAs that had airline capabilities, they were not manufactured by the same company as the respirators. When NIOSH approves an SCBA (with airline capabilities), the respirator is approved with the airline submitted by the manufacturer. Therefore, the only airline used for a specific SCBA should be from the same manufacturer as the SCBA (i.e., MSA airline should be used with MSA SCBA). If another airline or couplings are used, then the NIOSH certification is voided.

During the survey, MMS inspectors expressed concerns about the Whittaker and the ability of the platform's cascade system to maintain positive pressure inside the escape pod when personnel board. According to TOC, the current system provides enough air so that the Whittaker is maintained under positive pressure with the portal both open and closed. Since this was not the focus of the NIOSH site visit, investigators did not collect air flow measurements or characterize air flow patterns in the Whittaker. However, there may be a potential for air (outside of Whittaker) to be entrained with personnel into the Whittaker by various air currents (eddy currents) created when entering the escape pod. If air outside of the Whittaker is contaminated with H_2S, then it may be possible for H_2S to migrate inside the Whittaker. However, concentrations would most likely be low because of the continuous supply of air to the Whittaker. According to TOC, H_2S concentrations in the Whittaker are measured with a portable monitor before personnel board. At the current time, H_2S has not been detected inside the Whittaker during any H_2S release.

NIOSH investigators accompanied MMS inspectors on a second platform that was owned and operated by the Chevron Company to observe the Whittaker breathing air systems and the respiratory protection devices. The breathing air systems were similar with the exception that the Whittaker cascade system on the Chevron platform supplies breathing air to personnel via airline, instead of into the general environment of the Whittaker. This configuration seems to be a safe and effective design that can be used as a guide. Most respirator devices were PD, FF, SCBAs and ESCBAs with service lives of 30 minutes and 5 minutes, respectively. A few HH, CF, ESCBAs were utilized in remote locations on the platform.

In an attempt to gather more information on the use of HH, CF, ESCBAs on offshore drilling rigs, representatives from companies operating in the Gulf of Mexico were contacted including Exxon and Chevron. According to these companies, HH, CF, ESCBAs are rarely used on offshore rig except in remote locations were PD, FF, SCBAs are too large to store and/or don.

RECOMMENDATIONS

The following recommendations are offered to provide guidance in the development of a comprehensive respiratory protection program and to ensure that the highest level of respiratory protection is provided to all personnel on platform Irene.

1. Only PD–type, FF, SCBAs with airline capabilities and a service time of at least 15 minutes should be used on platform Irene as well as other platforms. Respirators should be distributed throughout the platform in sufficient quantities to ensure immediate access for all personnel.

2. Although a respiratory protection program was in place on platform Irene, certain elements (e.g., writtern program and quantitative fit testing), were deficient. A respiratory protection program should include a written respiratory protection program, regular worker training, airborne exposure monitoring, routine procedures for maintenance, proper storage of respirators, and quantitative fit testing. It should also include a provision that restricts workers from having any facial hair that comes between the sealing surface of the facepiece and the face. Furthermore, workers should not be allowed to manipulate facial hair to create a good

facepiece to face seal (i.e., folding a long mustache while donning a respirator so a good seal can be maintained). Publications developed by NIOSH and OSHA can also be referenced when developing an effective respirator program including the NIOSH Respirator Decision Logic, the NIOSH Guide to Industrial Respiratory Protection, and the OSHA Respiratory Protection Standard (code of federal regulation 1910.134).[14, 15, 16]

3. The number of breathing air manifolds (five airlines per breathing air manifold) should be increased at each safe briefing area. The quantity should be determined by the number of non–essential personnel who play an administrative role during platform evacuation procedures. These roles may include, and should not be limited to, director of operations at safe briefing area, first aid setup, communication and role call, H_2S portable monitoring equipment operator, and all Whittaker operators.

4. TOC should investigate the potential problem of H_2S being entrained with personnel into the Whittaker when boarding the escape pod. If this is in fact a problem, then an effective solution may be to install airline hookups as was observed on the Chevron platform.

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