DEPARTMENT OF LABOR

Occupational Safety and Health Administration

[Docket No. OSHA-2012-0035]

Traylor Bros., Inc.; Grant of a Permanent Variance

AGENCY: Occupational Safety and Health Administration (OSHA), Labor.

ACTION: Notice.

SUMMARY: In this notice, OSHA grants a permanent variance to Traylor Bros., Inc., from the provisions of OSHA standards that regulate work in compressed-air environments at 29 CFR 1926.803.

DATES: The permanent variance specified by this notice becomes effective on [INSERT DATE OF PUBLICATION IN THE FEDERAL REGISTER] and shall remain in effect until it is modified or revoked.

FOR FURTHER INFORMATION CONTACT: Information regarding this notice is available from the following sources:

Press inquiries: Contact Mr. Frank Meilinger, Director, OSHA Office of Communications, U.S. Department of Labor, 200 Constitution Avenue, NW., Room N-3647, Washington, DC 20210; telephone: (202) 693-1999; email: Meilinger.francis2@dol.gov.

General and technical information: Contact Mr. Kevin Robinson, Director, Office of Technical Programs and Coordination Activities, Directorate of Technical Support and Emergency Management, Occupational Safety and Health Administration, U.S. Department of Labor, 200 Constitution Avenue, NW., Room N-3655, Washington, DC 20210; telephone: (202) 693-2110; email: Robinson.kevin@dol.gov. OSHA's web page

includes information about the Variance Program (see http://www.osha.gov/dts/otpca/variances/index.html).

SUPPLEMENTARY INFORMATION:

Copies of this Federal Register notice.

Electronic copies of this Federal Register notice are available at http://www.regulations.gov. This Federal Register notice, as well as news releases and other relevant information, also are available at OSHA's web page at http://www.osha.gov.

I. Notice of Application

On April 26, 2012, Traylor Bros., Inc., 835 N. Congress Ave., Evansville, IN 47715, and Traylor/Skanska/Jay Dee Joint Venture, Blue Plains Tunnel, 5000 Overlook, SW, Washington, DC 20032, submitted under Section 6(d) of the Occupational Safety and Health Act of 1970 ("OSH Act"; 29 U.S.C. 655) and 29 CFR 1905.11 ("Variances and other relief under section 6(d)"), an application for a permanent variance from several provisions of the OSHA standard that regulates work in compressed air at 29 CFR 1926.803. Subsequently, OSHA addressed this request as two separate applications: (1) Traylor Bros., Inc. ("Traylor" or "the applicant") request for a permanent variance for future tunneling projects; and (2) Traylor/Skanska/Jay Dee Joint Venture, Blue Plains Tunnel ("Traylor JV"). This notice only addresses the Traylor application for a permanent variance for future tunneling projects. This notice does not address Traylor JV's application for a permanent variance for the Blue Plains Tunnel project. On March 27, 2015, OSHA granted Traylor JV a permanent variance for completion of the Blue Plains Tunnel (80 FR 16440).

As previously indicated, this notice addresses grant of a permanent variance to Traylor applicable to future tunneling projects, from the provisions of the standard that: (1) prohibit compressed-air worker (CAW) exposure to pressures exceeding 50 pounds per square inch (p.s.i.) except in an emergency (29 CFR 1926.803(e)(5));[1] (2) require the use of the decompression values specified in decompression tables in Appendix A of the compressed-air standard for construction (29 CFR 1926.803(f)(1)); and (3) require the use of automated operational controls and a special decompression chamber (29 CFR 1926.803(g)(1)(iii) and .803(g)(1)(xvii), respectively).

According to its application, Traylor is a contractor that works on complex tunnel projects using newly developed advanced equipment and procedures for soft-ground tunneling. The applicant's workers engage in the construction of tunnels using advanced shielded mechanical excavation techniques in conjunction with an earth pressure balanced tunnel boring machine (EPBTBM).

Further, as stated in its application, Traylor is likely to be the sole contractor, as well as the general contractor in association with future Joint Venture partners for the construction of future tunnels at various sites throughout the nation. Traylor asserts that generally, it bores tunnels (i.e., Blue Plains, as well as future tunnels) below the water table through soft soils consisting of clay, silt, and sand.

Traylor employs specially trained personnel for the construction of the tunnel, and states that this construction will use shielded mechanical-excavation techniques. Traylor asserts that its workers perform hyperbaric interventions at pressures greater than 50

[1]The decompression tables in Appendix A of subpart S express the maximum working pressures as pounds per square inch gauge (p.s.i.g.), with a maximum working pressure of 50 p.s.i.g. Therefore, throughout this notice, OSHA expresses the 50 p.s.i. value specified by §1926.803(e)(5) as 50 p.s.i.g., consistent with the terminology in Appendix A, Table 1 of subpart S.

p.s.i.g. in the excavation chamber of the EPBTBM; these interventions consist of conducting inspections and maintenance work on the cutter-head structure and cutting tools of the EPBTBM.

Additionally, Traylor asserts that innovations in tunnel excavation, specifically with EPBTBMs, have, in most cases, eliminated the need to pressurize the entire tunnel. This technology negates the requirement that all members of a tunnel-excavation crew work in compressed air while excavating the tunnel. These advances in technology modified substantially the methods used by the construction industry to excavate subaqueous tunnels compared to the caisson work regulated by the current OSHA compressed-air standard for construction at 29 CFR 1926.803. Such advances reduce the number of workers exposed, and the total duration of exposure to hyperbaric pressure during tunnel construction.

Using shielded mechanical-excavation techniques, in conjunction with precast concrete tunnel liners and backfill grout, EPBTBMs provide methods to achieve the face pressures required to maintain a stabilized tunnel face through various geologies, and isolate that pressure to the forward section (the working chamber) of the EPBTBM. Interventions in the working chamber (the pressurized portion of the EPBTBM) take place only after halting tunnel excavation and preparing the machine and crew for an intervention. Interventions occur to inspect or maintain the mechanical-excavation components located in the working chamber. Maintenance conducted in the working chamber includes changing replaceable cutting tools and disposable wear bars, and, in rare cases, repairing structural damage to the cutter head.

In addition to innovations in tunnel-excavation methods, Traylor asserts that innovations in hyperbaric medicine and technology improve the safety of decompression from hyperbaric exposures. According to Traylor, the use of decompression protocols incorporating oxygen is more efficient, effective, and safer for tunnel workers than compliance with the decompression tables specified by the existing OSHA standard (29 CFR 1926, subpart S, Appendix A decompression tables). These hyperbaric exposures are made safe by advances in technology, a better understanding of hyperbaric medicine, and the development of a project-specific Hyperbaric Operations Manual (HOM) that requires specialized medical support and hyperbaric supervision to provide assistance to a team of specially trained man-lock attendants and hyperbaric workers or CAWs.

OSHA initiated a technical review of the Traylor's variance application and developed a set of follow-up questions that it sent to Traylor on September 17, 2012 (Ex. OSHA-2012-0035-0003). On October 26, 2012, Traylor submitted its response and a request for an interim order for the Blue Plains Tunnel Project, as well as future projects (Ex. OSHA-2012-0035-0013). In its response to OSHA's follow-up questions, Traylor indicated that the maximum pressure to which it is likely to expose workers during future project interventions is 75 p.s.i.g and may involve the use of trimix breathing gas (composed of a mixture of oxygen, nitrogen, and helium in varying concentrations used for breathing by divers and CAWs for compression and decompression when working at pressures exceeding 73 p.s.i.g.). Therefore, to work effectively on future projects, Traylor must perform hyperbaric interventions in compressed air at pressures higher than the maximum pressure specified by the existing OSHA standard, 29 CFR 1926.803(e)(5),

which states: "No employee shall be subjected to pressure exceeding 50 p.s.i.g. except in emergency" (see footnote 1).

As noted above, on March 27, 2015, OSHA published the Federal Register notice announcing the grant of a permanent variance to Traylor JV for completion of the Blue Plains Tunnel (80 FR 16440).

OSHA continued its technical review of Traylor's variance application focusing on the use of trimix breathing gas (proposed for use in future tunneling projects at pressures exceeding 73 p.s.i.g.) and developed a second set of follow-up questions that it sent to Traylor on December 18, 2013 (Ex. OSHA-2012-0035-0002). On January 21, 2014, Traylor submitted its response (Ex. OSHA-2012-0035-0009). In its response to OSHA's follow-up questions, Traylor provided additional technical and scientific information concerning successful trimix use on tunneling projects throughout the United States, as well as in Europe and Asia. Additionally, Traylor reaffirmed that the maximum pressure to which it is likely to expose workers during interventions for future tunneling projects is 75 p.s.i.g. and may involve the use of trimix breathing gas.

In reviewing Traylor's application for future tunneling projects, OSHA focused on the following important considerations:

- Variances are granted only to specific employers that submitted a properly completed and executed variance application. Traylor has met this requirement (for the single employer application);

- This notice announces only Traylor's (single employer) grant of a permanent variance dealing with future projects. It does not address Traylor's future hyperbaric tunneling projects in association with unnamed joint venture partners;

- The variance conditions require Traylor to submit for OSHA's review and approval a project-specific HOM at least one year prior to the start of work on any future project;

- The variance conditions require the HOM to demonstrate that the EPBTBM to be used on the project is designed, fabricated, inspected, tested, marked, and stamped in accordance with the requirements of ASME PVHO-1.2012 (or most recent edition of Safety Standards for Pressure Vessels for Human Occupancy) for the EPBTBM's hyperbaric chambers.

- This condition ensures that each future tunneling project can be comprehensively reviewed on a case-by-case basis prior to OSHA granting its approval to Traylor to proceed with its new project;

- Traylor may not begin hyperbaric interventions at pressures exceeding 50 p.s.i.g. until OSHA completes its review of the project-specific HOM and determines that the safety and health instructions and measures it specifies are appropriate, comply with the conditions of the variance, adequately protect the safety and health of CAWs, and so notifies the applicant; and

- Traylor is required to submit new applications requesting modification of its single employer variance and approval of its project-specific HOM [with sufficient lead time (at least one year prior to start of work on any future project), to allow OSHA to complete the variance modification process], upon forming any future joint ventures.

Further, on December 6, 2012, OSHA published a Federal Register notice (77 FR 72781) announcing a request for information (RFI) for its continuing regulatory reviews named standards improvement projects (SIPs). The Agency conducted similar regulatory reviews of its existing standards previously and issued this latest RFI to initiate another of these regulatory reviews, and naming this review the Standards Improvement Project—Phase IV (SIP–IV). The purpose of SIP–IV is to improve and streamline OSHA standards by removing or revising requirements that are confusing or outdated, or that duplicate, or are inconsistent with other standards. Additionally, the regulatory review also is designed to reduce regulatory burden while maintaining or enhancing employees' safety and health. SIP–IV will focus primarily on OSHA's construction standards.

As part of SIP-IV, OSHA is considering updating the decompression tables in Appendix A (1926.803(f)(1)) (77 FR 72783). This proposed action would permit

employers to use decompression procedures and updated decompression tables that take advantage of new hyperbaric technologies used widely in extreme hyperbaric exposures. If the planned SIP-IV revises Appendix A, Traylor (and similar tunneling contractors previously granted a variance) will still require hyperbaric tunneling variances to address portions of the standard not covered by SIP-IV (i.e., 29 CFR 1926.803(e)(5); .803(g)(1)(iii) and .803(g)(1)(xvii)).

If SIP-IV is completed (including the update of the decompression tables in Appendix A (1926.803(f)(1)), OSHA will modify Traylor's (single employer) and similar variances granted to other employers to include the applicable SIP-IV provisions as appropriate.

OSHA considered Traylor's application for a permanent variance and interim order for future tunneling projects. OSHA determined that Traylor proposed an alternative that provides a workplace at least as safe and healthful as that provided by the standard.

On July 27, 2015, OSHA published a Federal Register notice announcing Traylor's application for a permanent variance and interim order, grant of an interim order, and request for comments (80 FR 44386). The comment period expired August 26, 2015, and OSHA received no comments. Accordingly, through this notice, OSHA grants a permanent variance to Traylor.

II. The Variance Application

A. Background

Traylor asserts that the advances in tunnel excavation technology described in Section I of this notice modified significantly the equipment and methods used by contractors to construct subaqueous tunnels, thereby making several provisions of OSHA's compressed-air standard for construction at 29 CFR 1926.803 inappropriate for this type

of work. These advances reduce both the number of workers exposed, and the total duration of exposure to the hyperbaric conditions associated with tunnel construction.

Using shielded mechanical-excavation techniques, in conjunction with pre-cast concrete tunnel liners and backfill grout, EPBTBMs provide methods to achieve the face pressures required to maintain a stabilized tunnel face, through various geologies, while isolating that pressure to the forward section (working or excavation chamber) of the EPBTBM.

Interventions involving the working chamber (the pressurized chamber at the head of the EPBTBM) take place only after the applicant halts tunnel excavation and prepares the machine and crew for an intervention. Interventions occur to inspect or maintain the mechanical-excavation components located in the forward portion of the working chamber. Maintenance conducted in the forward portion of the working chamber includes changing replaceable cutting tools, disposable wear bars, and, in rare cases, repairs to the cutter head due to structural damage.

In addition to innovations in tunnel-excavation methods, research conducted after OSHA published its compressed-air standard for construction in 1971, resulted in advances in hyperbaric medicine. In this regard, the applicant asserts that the use of decompression protocols incorporating oxygen and trimix is more efficient, effective, and safer for tunnel workers than compliance with the existing OSHA standard (29 CFR 1926, subpart S, Appendix A decompression tables). According to the applicant, contractors routinely and safely expose employees performing interventions in the working chamber of EPBTBMs to hyperbaric pressures up to 75 p.s.i.g., which is 50%

higher than maximum pressure specified by the existing OSHA standard (see 29 CFR 1926.803(e)(5)).

The applicant contends that the alternative safety measures included in its application provide its workers with a place of employment that is at least as safe and healthful as they can obtain under the existing provisions of OSHA's compressed-air standard for construction. The applicant certifies that it provided employee representatives of affected workers with a copy of the variance application.[2] The applicant also certifies that it notified its workers of the variance application by posting at prominent locations where it normally posts workplace notices, a summary of the application and information specifying where the workers can examine a copy of the application. In addition, the applicant informed its workers and their representatives of their rights to petition the Assistant Secretary of Labor for Occupational Safety and Health for a hearing on the variance application.

B. Variance from Paragraph (e)(5) of 29 CFR 1926.803, Prohibition of Exposure to Pressure Greater than 50 p.s.i.g. (see footnote 1)

The applicant states that it may perform hyperbaric interventions at pressures greater than 50 p.s.i.g. in the working chamber of the EPBTBM; this pressure exceeds the pressure limit of 50 p.s.i.g. specified for nonemergency purposes by 29 CFR 1926.803(e)(5). The EPBTBM has twin man locks, with each man lock having two compartments. This configuration allows workers to access the man locks for compression and decompression, and medical personnel to access the man locks if required in an emergency.

[2]See the definition of "Affected employee or worker" in section III. D.

EPBTBMs are capable of maintaining pressure at the tunnel face, and stabilizing existing geological conditions, through the controlled use of propel cylinders, a mechanically driven cutter head, bulkheads within the shield, ground-treatment foam, and a screw conveyor that moves excavated material from the working chamber. As noted earlier, the forward-most portion of the EPBTBM is the working chamber, and this chamber is the only pressurized segment of the EPBTBM. Within the shield, the working chamber consists of two sections: the staging chamber and the forward working chamber. The staging chamber is the section of the working chamber between the man-lock door and the entry door to the forward working chamber. The forward working chamber is immediately behind the cutter head and tunnel face.

The applicant will pressurize the working chamber to the level required to maintain a stable tunnel face. Pressure in the staging chamber ranges from atmospheric (no increased pressure) to a maximum pressure equal to the pressure in the working chamber. The applicant asserts that most of the hyperbaric interventions will be around 14.7 p.s.i.g. However, the applicant maintains that they may have to perform interventions at pressures up to 75 p.s.i.g.

During interventions, workers enter the working chamber through one of the twin man locks that open into the staging chamber. To reach the forward part of the working chamber, workers pass through a door in a bulkhead that separates the staging chamber from the forward working chamber. The maximum crew size allowed in the forward working chamber is three. At certain hyperbaric pressures (i.e., when decompression times are greater than work times), the twin man locks allow for crew rotation. During crew rotation, one crew can be compressing or decompressing while the second crew is

working. Therefore, the working crew always has an unoccupied man lock at its disposal.

Further, the applicant asserts that it will develop a project-specific HOM for each future tunnel project that describes in detail the hyperbaric procedures and required medical examinations used during the planned tunnel-construction project. The HOM will be project-specific, and will discuss standard operating procedures and emergency and contingency procedures. The procedures will include using experienced and knowledgeable man-lock attendants who have the training and experience necessary to recognize and treat decompression illnesses and injuries. The attendants will be under the direct supervision of the hyperbaric supervisor and attending physician. In addition, procedures will include medical screening and review of prospective CAWs. The purpose of this screening procedure is to vet prospective CAWs with medical conditions (e.g., deep vein thrombosis, poor vascular circulation, and muscle cramping) that could be aggravated by sitting in a cramped space (e.g., a man lock) for extended periods or by exposure to elevated pressures and compressed gas mixtures. A transportable recompression chamber (shuttle) will be available to extract workers from the hyperbaric working chamber for emergency evacuation and medical treatment; the shuttle attaches to the topside medical lock, which is a large recompression chamber. The applicant believes that the procedures included in the variance application and in its project-specific HOM will provide safe work conditions when interventions are necessary, including interventions above 50 p.s.i.g. OSHA will comprehensively review the project-specific HOM for each of Traylor's future projects prior to granting its approval for Traylor to proceed with its new project. Therefore, Traylor may not begin hyperbaric

interventions at pressures exceeding 50 p.s.i.g. until OSHA completes its review of the project-specific HOM and determines that the safety and health instructions and measures it specifies are appropriate, conform with the conditions in the variance, and adequately protect the safety and health of the CAWs. OSHA will notify the applicant that: (1) its project-specific HOM was found to be acceptable; and (2) the applicant may begin hyperbaric interventions at pressures exceeding 50 p.s.i.g. by complying fully with the conditions of the variance (as an alternative to complying with the requirements of the standard).

C. Variance from Paragraph (f)(1) of 29 CFR 1926.803, Requirement to Use OSHA Decompression Tables

OSHA's compressed-air standard for construction requires decompression in accordance with the decompression tables in Appendix A of 29 CFR 1926, subpart S (see 29 CFR 1926.803(f)(1)). As an alternative to the OSHA decompression tables, the applicant proposes to use newer decompression schedules that supplement breathing air used during decompression with air, nitrox, or trimix (as appropriate). The applicant asserts decompression protocols using the 1992 French Decompression Tables for air, nitrox, or trimix as specified by the HOM are safer for tunnel workers than the decompression protocols specified in Appendix A of 29 CFR 1926, subpart S.

Accordingly, the applicant proposes to use the 1992 French Decompression Tables to decompress CAWs after they exit the hyperbaric conditions in the working chamber. Also, Traylor proposes to decompress with trimix gas, under certain conditions specific to and described in detail in the project-specific HOM associated with each future tunneling project. Depending on the maximum working pressure and exposure times, the

1992 French Decompression Tables provide for air decompression with or without oxygen or trimix. Traylor asserts that using the 1992 French Decompression Tables for air, nitrox, or trimix decompression has many benefits, including (1) keeping the partial pressure of nitrogen in the lungs as low as possible; (2) keeping external pressure as low as possible to reduce the formation of bubbles in the blood; (3) removing nitrogen from the lungs and arterial blood and increasing the rate of elimination of nitrogen; (4) improving the quality of breathing during decompression stops to reduce worker fatigue and to prevent bone necrosis; (5) reducing decompression time by about 33 percent as compared to air decompression; and (6) reducing inflammation. Traylor asserts that the 1992 French Decompression Tables, Appendix B provide for air decompression with trimix supplementation for staged decompression for pressures ranging from 58 to 75 p.s.i.g. As described in Section IV of this notice, OSHA's review of the use of air, nitrox, or trimix in several major tunneling projects completed in the past indicates that it contributed significantly to the reduction of decompression illness (DCI) and other associated adverse effects observed and reported among CAWs.

In addition, the project-specific HOM will require a physician certified in hyperbaric medicine to manage the medical condition of CAWs during hyperbaric exposures and decompression. A trained and experienced man-lock attendant also will be present during hyperbaric exposures and decompression. This man-lock attendant will operate the hyperbaric system to ensure compliance with the specified decompression table. A hyperbaric supervisor (competent person), trained in hyperbaric operations, procedures, and safety, will directly oversee all hyperbaric interventions, and ensures that staff follow the procedures delineated in the HOM or by the attending physician.

The applicant asserts that at higher hyperbaric pressures, decompression times exceed 75 minutes. The project-specific HOMs will establish protocols and procedures that provide the basis for alternate means of protection for CAWs under these conditions. Accordingly, based on these protocols and procedures, the applicant requests to use the 1992 French Decompression Tables for hyperbaric interventions up to 75 p.s.i.g. for future projects. The applicant is committed to follow the decompression procedures described in the project-specific HOM during these interventions.

D. Variance from Paragraph (g)(1)(iii) of 29 CFR 1926.803, Automatically Regulated Continuous Decompression

According to the applicant, breathing air under hyperbaric conditions increases the amount of nitrogen gas dissolved in a CAW's tissues. The greater the hyperbaric pressure under these conditions, and the more time spent under the increased pressure, the greater the amount of nitrogen gas dissolved in the tissues. When the pressure decreases during decompression, tissues release the dissolved nitrogen gas into the blood system, which then carries the nitrogen gas to the lungs for elimination through exhalation. Releasing hyperbaric pressure too rapidly during decompression can increase the size of the bubbles formed by nitrogen gas in the blood system, resulting in DCI, commonly referred to as "the bends." This description of the etiology of DCI is consistent with current scientific theory and research on the issue (see footnote 12 in this notice discussing a 1985 NIOSH report on DCI).

The 1992 French Decompression Tables proposed for use by the applicant provide for stops during worker decompression (i.e., staged decompression) to control the release of nitrogen gas from tissues into the blood system. Studies show that staged decompression,

in combination with other features of the 1992 French Decompression Tables such as the use of oxygen, result in a lower incidence of DCI than the OSHA decompression requirements of 29 CFR 1926.803, which specify the use of automatically regulated continuous decompression (see footnotes 9 through 18 in this notice for references to these studies).[3] In addition, the applicant asserts that staged decompression is at least as effective as an automatic controller in regulating the decompression process because:

1. A hyperbaric supervisor (a competent person experienced and trained in hyperbaric operations, procedures, and safety) directly supervises all hyperbaric interventions and ensures that the man-lock attendant, who is a competent person in the manual control of hyperbaric systems, follows the schedule specified in the decompression tables, including stops; and

2. The use of the 1992 French Decompression Tables for staged decompression offers an equal or better level of management and control over the decompression process than an automatic controller and results in lower occurrences of DCI.

Accordingly, the applicant is applying for a permanent variance from the OSHA standard at 29 CFR 1926.803(g)(1)(iii), which requires automatic controls to regulate decompression. As noted above, the applicant is committed to conduct the staged

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[3]In the study cited in footnote 10, starting at page 338, Dr. Eric Kindwall notes that the use of automatically regulated continuous decompression in the Washington State safety standards for compressed-air work (from which OSHA derived its decompression tables) was at the insistence of contractors and the union, and against the advice of the expert who calculated the decompression table and recommended using staged decompression. Dr. Kindwall then states, "Continuous decompression is inefficient and wasteful. For example, if the last stage from 4 p.s.i.g. . . . to the surface took 1 h, at least half the time is spent at pressures less than 2 p.s.i.g. . . . , which provides less and less meaningful bubble suppression . . . ." In addition, the report referenced in footnote 5 under the section titled, "Background on the Need for Interim Decompression Tables" addresses the continuous-decompression protocol in the OSHA compressed-air standard for construction, noting that "[a]side from the tables for saturation diving to deep depths, no other widely used or officially approved diving decompression tables use straight line, continuous decompressions at varying rates. Stage decompression is usually the rule, since it is simpler to control."

decompression according to the 1992 French Decompression Tables under the direct control of the trained man-lock attendant and under the oversight of the hyperbaric supervisor.

E. Variance from Paragraph (g)(1)(xvii) of 29 CFR 1926.803, Requirement of Special Decompression Chamber

The OSHA compressed-air standard for construction requires employers to use a special decompression chamber of sufficient size to accommodate all CAWs being decompressed at the end of the shift when total decompression time exceeds 75 minutes (see 29 CFR 1926.803(g)(1)(xvii)). Use of the special decompression chamber enables CAWs to move about and flex their joints to prevent neuromuscular problems during decompression.

As an alternative to using a special decompression chamber, the applicant notes that since only the working chamber of the EPBTBM is under pressure, and only a few workers out of the entire crew are exposed to hyperbaric pressure, the man locks (which, as noted earlier, connect directly to the working chamber) and the staging chamber are of sufficient size to accommodate the exposed workers during decompression. In addition, space limitations in the EPBTBM do not allow for the installation and use of an additional special decompression lock or chamber. Again, the applicant uses the existing man locks, each of which adequately accommodates a three-member crew for this purpose when decompression lasts up to 75 minutes. When decompression exceeds 75 minutes, crews can open the door connecting the two compartments in each man lock (during decompression stops) or exit the man lock and move into the staging chamber where additional space is available. The applicant asserts that this alternative

arrangement is as effective as a special decompression chamber in that it has sufficient space for all the CAWs at the end of a shift and enables the CAWs to move about and flex their joints to prevent neuromuscular problems.

F. Previous Tunnel Construction Variances

OSHA notes that it previously granted several sub-aqueous tunnel construction permanent variances from the same provisions of the standard that regulate work in compressed air (at 29 CFR 1926.803(e)(5), (f)(1), (g)(1)(iii), and (g)(1)(xvii)) that are the subject of the present application. These permanent variances were granted to: (1) Tully/OHL USA Joint Venture for the completion of the New York Harbor Syphon Tunnel [on May 23, 2014 (79 FR 29809)]; (2) Traylor JV for the completion of the Blue Plains Tunnel in Washington, DC [on March 27, 2015 (80 FR 16440)]; and (3) Impregilo Healy Parsons Joint Venture (IHP JV) for the completion of the Anacostia River Tunnel in Washington, DC [on August 20, 2015 (80 FR 50652)].

Generally, the conditions included in this notice are based on and very similar to the conditions of the previous permanent variances.

G. Multi-State Variance

Traylor stated that it performs construction of sub-aqueous tunnels using EPBTBM in compressed-air environments in a number of states that operate safety and health plans that have been approved by OSHA under Section 18 of the Occupational Safety and Health (OSH) Act of 1970 (29 U.S.C. 651 *et seq*.) and 29 CFR part 1952 ("Approved State Plans for Enforcement of State Standards"). Because Traylor performs tunnel construction work nationwide, OSHA processed Traylor's application as one for a permanent, multi-state variance covering all states.

Twenty-eight state safety and health plans have been approved by OSHA under Section 18 of the OSH Act.[4] As part of the permanent variance process, the Directorate of Cooperative and State Programs notified the State Plans of Traylor's variance application and grant of the interim order, and the states were provided the opportunity to comment. As previously noted, OSHA received no comments. Further, the Directorate of Cooperative and State Programs will notify the State Plans of Traylor's grant of a permanent multi-state variance.

Additionally, in consideration of Traylor's grant of this permanent multi-state variance, OSHA notes that four states have previously granted sub-aqueous tunnel construction variances and imposed different or additional requirements and conditions (California, Nevada, Oregon, and Washington). California also promulgated a different standard[5] for similar sub-aqueous tunnel construction work. In these states that previously granted variances or promulgated a different standard, Traylor has to continue meeting state-specific requirements, despite OSHA's grant of this permanent multi-state variance. Traylor must apply separately to these states for a variance for tunnel construction work addressing the same or similar conditions specified by this permanent multi-state variance.

Six State Plans (Connecticut, Illinois, Maine, New Jersey, New York, and the U.S. Virgin Islands) cover only public-sector workers and have no authority over the

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[4]Six State Plans (Connecticut, Illinois, Maine, New Jersey, New York, and the Virgin Islands) limit their occupational safety and health authority to state and local employers only. State Plans that exercise their occupational safety and health authority over both public- and private-sector employers are: Alaska, Arizona, California, Hawaii, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Nevada, New Mexico, North Carolina, Oregon, Puerto Rico, South Carolina, Tennessee, Utah, Vermont, Virginia, Washington, and Wyoming.

[5]See California Code of Regulations, Title 8, Subchapter 7, Group 26, Article 154, available at http://www.dir.ca.gov/title8/sb7g26a154.html.

private-sector workers addressed in this variance (i.e., that authority continues to reside with Federal OSHA).

III. Description of the Conditions Specified for the Permanent Variance

This section describes the alternative means of compliance with 29 CFR 1926.803(e)(5), (f)(1), (g)(1)(iii), and (g)(1)(xvii) and provides additional detail regarding the conditions that form the basis of Traylor's permanent variance.

Condition A: Scope

The scope of the permanent variance limits coverage to the work situations specified under this condition. Clearly defining the scope of the permanent variance provides Traylor, Traylor's employees, potential future applicants, other stakeholders, the public, and OSHA with necessary information regarding the work situations in which the permanent variance applies.

As previously indicated in this notice, according to 29 CFR 1905.11, an employer (or class or group of employers[6]) may request a permanent variance for a specific workplace or workplaces (multiple sites). When granted, the variance applies to the specific employer(s) that submitted the application. In this instance, the permanent variance applies to Traylor only. As a result, it is important to understand that Traylor's permanent variance **does not apply** to any other employers such as other joint ventures the applicant may undertake in the future. However, the variance rules of practice do contain provisions for future modification of permanent variances. Under the provisions

[6]A class or group of employers (such as members of a trade alliance or association) may apply jointly for a variance provided an authorized representative for each employer signs the application and the application identifies each employer's affected facilities.

of 29 CFR 1905.13, an applicant may submit an application to modify or amend a permanent variance to add or include additional employers (i.e., when future joint ventures are established).

Condition B: Application

This condition specifies the circumstances under which the permanent variance is in effect, notably only for hyperbaric work performed during interventions. The condition places clear limits on the circumstances under which the applicant can expose its employees to hyperbaric pressure.

Condition C: List of Abbreviations

This condition defines a number of abbreviations used in the permanent variance. OSHA believes that defining these abbreviations serves to clarify and standardize their usage, thereby enhancing the applicant's and its employees' understanding of the conditions specified by the permanent variance.

Condition D: Definitions

This condition defines a series of terms, mostly technical terms, used in the permanent variance to standardize and clarify their meaning. Defining these terms serves to enhance the applicant's and its employees' understanding of the conditions specified by the permanent variance.

Condition E: Safety and Health Practices

This condition requires the applicant to develop and submit to OSHA a project-specific HOM at least one year before using the EPBTBM for tunneling operations. The HOM will have to demonstrate that the EPBTBM planned for use in tunneling operations is designed, fabricated, inspected, tested, marked, and stamped in accordance with the

requirements of ASME PVHO-1.2012 (or most recent edition of Safety Standards for Pressure Vessels for Human Occupancy) for the TBM's hyperbaric chambers. These requirements ensure that the applicant develops hyperbaric safety and health procedures suitable for each specific project. The HOM enables OSHA to determine that the safety and health instructions and measures it specifies are appropriate to the field conditions of the planned future tunnel (including expected geological conditions), conform to the conditions of the variance, and adequately protect the safety and health of the CAWs. It also enables OSHA to enforce these instructions and measures. Additionally, the condition includes a series of related hazard prevention and control requirements and methods (e.g., decompression tables, job hazard analysis (JHA), operation and inspection checklists, investigations, recording and notification to OSHA of recordable hyperbaric injuries and illnesses, etc.) designed to ensure the continued effective functioning of the hyperbaric equipment and operating system.

Review of the project-specific HOM enables OSHA to: (1) determine that the safety and health instructions and measures it specifies are appropriate, conform to the conditions of the variance, and adequately protect the safety and health of CAWs; and (2) request the applicant to revise or modify the HOM if it finds that the hyperbaric safety and health procedures are not suitable for the specific project and do not adequately protect the safety and health of the CAWs. The applicant may not begin hyperbaric interventions at pressures exceeding 50 p.s.i.g. until OSHA completes its review of the project-specific HOM and notifies the applicant that: (1) its project-specific HOM was found to be acceptable; and (2) it may begin hyperbaric interventions at pressures exceeding 50 p.s.i.g. by complying fully with the conditions of the permanent variance.

Once approved, the project-specific HOM becomes part of this variance, thus enabling OSHA to enforce its safety and health procedures and measures.

Condition F: Communication

This condition requires the applicant to develop and implement an effective system of information sharing and communication. Effective information sharing and communication ensures that affected workers receive updated information regarding any safety-related hazards and incidents, and corrective actions taken, prior to the start of each shift. The condition also requires the applicant to ensure that reliable means of emergency communications are available and maintained for affected workers and support personnel during hyperbaric operations. Availability of such reliable means of communications enables affected workers and support personnel to respond quickly and effectively to hazardous conditions or emergencies that may develop during EPBTBM operations.

Condition G: Worker Qualification and Training

This condition requires the applicant to develop and implement an effective qualification and training program for affected workers. The condition specifies the factors that an affected worker must know to perform safely during hyperbaric operations, including how to enter, work in, and exit from hyperbaric conditions under both normal and emergency conditions. Having well-trained and qualified workers performing hyperbaric intervention work ensures that they recognize, and respond appropriately to, hyperbaric safety and health hazards. These qualification and training requirements enable affected workers to cope effectively with emergencies, as well as the

discomfort and physiological effects of hyperbaric exposure, thereby preventing injury, illness, and fatalities.

Paragraph (2)(e) of this condition also requires the applicant to provide affected workers with information they can use to contact the appropriate healthcare professionals if it is suspected that they are developing hyperbaric-related health effects. This requirement provides for early intervention and treatment of DCI and other health effects resulting from hyperbaric exposure, thereby reducing the potential severity of these effects.

Condition H: Inspections, Tests, and Accident Prevention

This condition requires the applicant to develop, implement, and operate a program of frequent and regular inspections of the EPBTBM's hyperbaric equipment and support systems, and associated work areas. This condition serves to: enhance worker safety, to ensure safe operation and physical integrity of the equipment and work areas necessary to conduct hyperbaric operations, and to reduce the risk of hyperbaric-related emergencies.

Paragraph (3) of this condition requires the applicant to document tests, inspections, corrective actions, and repairs involving the EPBTBM, and to maintain these documents at the job site for the duration of the job. This requirement provides the applicant with information needed to schedule tests and inspections, to ensure the continued safe operation of the equipment and systems, and to determine that the actions taken to correct defects in hyperbaric equipment and systems were appropriate, prior to returning them to service.

Condition I: Compression and Decompression

This condition requires the applicant to consult with its designated medical advisor regarding special compression or decompression procedures appropriate for any unacclimated CAW. This provision ensures that the applicant consults with and involves the medical advisor in the evaluation, development, and implementation of compression or decompression protocols appropriate for any CAW requiring acclimation to the hyperbaric conditions encountered during EPBTBM operations. Accordingly, CAWs requiring acclimation have an opportunity to acclimate prior to exposure to these hyperbaric conditions. OSHA believes this condition will prevent or reduce adverse reactions among CAWs to the effects of compression or decompression associated with the intervention work they perform in the EPBTBM.

Condition J: Recordkeeping

This condition requires the applicant to maintain records of specific factors associated with each hyperbaric intervention. The information gathered and recorded under this provision, in concert with the information provided under condition K (using OSHA 301 Incident Report form to investigate, record, and provide notice to OSHA of hyperbaric recordable injuries as defined by 29 CFR 1904.4, 1904.7, 1904.8 through 1904.12), enables the applicant and OSHA to determine the effectiveness of the permanent variance in preventing DCI and other hyperbaric-related effects.[7]

Condition K: Notifications

[7]See 29 CFR 1904 Recording and Reporting Occupational Injuries and Illnesses (http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9631); recordkeeping forms and instructions (http://www.osha.gov/recordkeeping/RKform300pkg-fillable-enabled.pdf); and updates to OSHA's recordkeeping rule and webpage ((79 FR 56130); http://www.osha.gov/recordkeeping2014/index.html).

Under the provisions of this condition, the applicant is required, within specified periods, to notify OSHA of: (1) any recordable injury, illness, in-patient hospitalization, amputation, loss of an eye, or fatality that occurs as a result of hyperbaric exposures during EPBTBM operations; (2) provide OSHA with a copy of the hyperbaric exposures incident investigation report (using OSHA 301 form) of these events within 24 hours of the incident; (3) include on the 301 form information on the hyperbaric conditions associated with the recordable injury or illness, the root-cause determination, and preventive and corrective actions identified and implemented; (4) provide its certification that it informed affected workers of the incident and the results of the incident investigation; (5) notify the Office of Technical Programs and Coordination Activities (OTPCA) and the OSHA Area Office closest to the tunnel project site within 15 working days should the applicant need to revise its HOM to accommodate changes in its compressed-air operations that affect its ability to comply with the conditions of the permanent variance; and (6) at the end of the project provide OTPCA and the OSHA Area Office closest to the tunnel project site with a report evaluating the effectiveness of the decompression tables.

It should be noted that the requirement of completing and submitting the hyperbaric exposure-related (recordable) incident investigation report (OSHA 301 form) is more restrictive than the current recordkeeping requirement of completing the OSHA 301 form within 7 calendar days of the incident (1904.29(b)(3)). This modified and more stringent incident investigation and reporting requirement is restricted to intervention-related hyperbaric (recordable) incidents only. Providing this type of notification is essential because time is a critical element in OSHA's ability to: (1) determine the continued

effectiveness of the variance conditions in preventing hyperbaric incidents; (2) identify and implement appropriate hyperbaric incident-related corrective and preventive actions; (3) determine the effectiveness of the variance conditions in providing the requisite level of safety to the applicant's workers; and (4) determine whether to revise or revoke said conditions. Timely notification enables OSHA to take whatever action may be necessary and appropriate to prevent further injuries and illnesses. Providing notification to employees also informs them of the precautions taken by the applicant to prevent similar incidents in the future.

Additionally, this condition also requires the applicant to notify OSHA if it ceases to do business, has a new address or location for its main office, or transfers the operations covered by the variance to a successor company. The condition also specifies that OSHA must approve the transfer of the permanent variance to a successor company, allows OSHA to communicate effectively with the applicant regarding the status of the variance, and serves to expedite the administration and enforcement of the variance provisions. Stipulating that an applicant is required to have OSHA's approval to transfer a variance to a successor company provides assurance that the successor company has knowledge of, and will comply with the conditions specified by the variance.

IV. Decision

As noted earlier, on July 27, 2015, OSHA published a Federal Register notice announcing Traylor's application for a permanent variance and interim order, grant of an interim order, and request for comments (80 FR 44386). The comment period expired August 26, 2015, and OSHA received no comments.

During the period starting with the July 27, 2015, publication of the preliminary Federal Register notice announcing grant of the interim order (80 FR 44386), until the

Agency modifies or revokes the interim order or makes a decision on its application for a permanent variance, the applicant was required to comply fully with the conditions of the interim order as an alternative to complying with the requirements of 29 CFR 1926.803 (hereafter, "the standard") that:

A. Prohibit employers using compressed air under hyperbaric conditions from subjecting workers to pressure exceeding 50 p.s.i.g., except in an emergency (29 CFR 1926.803(e)(5));

B. Require the use of decompression values specified by the decompression tables in Appendix A of the compressed-air standard (29 CFR 1926.803(f)(1)); and

C. Require the use of automated operational controls and a special decompression chamber (29 CFR 1926.803(g)(1)(iii) and .803(g)(1)(xvii), respectively).

After reviewing the proposed alternatives OSHA determined that:

D. Traylor developed, and proposed to implement, effective alternative measures to the prohibition of using compressed air under hyperbaric conditions exceeding 50 p.s.i.g. The alternative measures include use of engineering and administrative controls of the hazards associated with work performed in compressed-air conditions exceeding 50 p.s.i.g. while engaged in the construction of a subaqueous tunnel using advanced shielded mechanical-excavation techniques in conjunction with an EPBTBM. Prior to conducting interventions in the EPBTBM's pressurized working chamber, the applicant halts tunnel excavation and prepares the machine and crew to conduct the interventions. Interventions involve inspection, maintenance, or repair of the mechanical-excavation components located in the working chamber.

E. Traylor developed, and proposed to implement, safe hyperbaric work procedures, emergency and contingency procedures, and medical examinations for future tunneling projects' CAWs. The applicant will compile these standard operating procedures into a project-specific HOM. The HOM will discuss the procedures and personnel qualifications for performing work safely during the compression and decompression phases of interventions. The HOM will also specify the decompression tables the applicant will use. Depending on the maximum working pressure and exposure times during the interventions, the tables provide for decompression using the 1992 French Decompression Tables for air, nitrox, or trimix as specified by the HOM. The decompression tables also include delays or stops for various time intervals at different pressure levels during the transition to atmospheric pressure (i.e., staged decompression). In all cases, a physician certified in hyperbaric medicine will manage the medical condition of CAWs during decompression. In addition, a trained and experienced man-lock attendant, experienced in recognizing decompression sickness or illnesses and injuries will be present. Of key importance, a hyperbaric supervisor (competent person), trained in hyperbaric operations, procedures, and safety, will directly supervise all hyperbaric operations to ensure compliance with the procedures delineated in the project-specific HOM or by the attending physician.

F. Traylor developed, and proposed to implement, a training program to instruct affected workers in the hazards associated with conducting hyperbaric operations.

G. Traylor developed, and proposed to implement, an effective alternative to the use of automatic controllers that continuously decrease pressure to achieve decompression in accordance with the tables specified by the standard. The alternative includes using: (1)

the 1992 French Decompression Tables for guiding staged decompression to achieve lower occurrences of DCI; (2) decompression protocols of air, nitrox, or trimix again to achieve lower occurrences of DCI; (3) a trained and competent attendant for implementing appropriate hyperbaric entry and exit procedures, and (4) a competent hyperbaric supervisor and attending physician certified in hyperbaric medicine, to oversee all hyperbaric operations.

H. Traylor developed, and proposed to implement, an effective alternative to the use of the special decompression chamber required by the standard. EPBTBM technology permits the tunnel's work areas to be at atmospheric pressure, with only the face of the EPBTBM (i.e., the working chamber) at elevated pressure during interventions. The applicant limits interventions conducted in the working chamber to performing required inspection, maintenance, and repair of the cutting tools on the face of the EPBTBM. The EPBTBM's man lock and working chamber provide sufficient space for the maximum crew of three CAWs to stand up and move around, and safely accommodate decompression times up to 360 minutes. Therefore, OSHA determined that the EPBTBM's man lock and working chamber function as effectively as the special decompression chamber required by the standard.

OSHA conducted a review of the scientific literature regarding decompression to determine whether the alternative decompression method (i.e., the 1992 French Decompression Tables) Traylor proposed provides a workplace as safe and healthful as that provided by the standard. Based on this review, OSHA determined that tunneling

operations performed with these tables[8] resulted in a lower occurrence of DCI than the decompression tables specified by the standard.[9,10,11]

The review conducted by OSHA focused on the use of the 1992 French Decompression Tables with air, nitrox, or trimix and found several research studies supporting the determination that such use resulted in a lower rate of DCI than the decompression tables specified by the standard. For example, H. L. Anderson studied the occurrence of DCI at maximum hyperbaric pressures ranging from 4 p.s.i.g. to 43 p.s.i.g. during construction of the Great Belt Tunnel in Denmark (1992-1996);[12] this project used the 1992 French Decompression Tables to decompress the workers during part of the construction. Anderson observed 6 decompression sickness (DCS) cases out of 7,220 decompression events, and reported that switching to the 1992 French Decompression tables reduced the DCI incidence to 0.08%. The DCI incidence in the study by H. L. Andersen is substantially less than the DCI incidence reported for the decompression

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[8]In 1992, the French Ministry of Labour replaced the 1974 French Decompression Tables with the 1992 French Decompression Tables, which differ from OSHA's decompression tables in Appendix A by using: (1) staged decompression as opposed to continuous (linear) decompression; (2) decompression tables based on air or both air and pure oxygen; and (3) emergency tables when unexpected exposure times occur (up to 30 minutes above the maximum allowed working time).

[9]Kindwall, EP (1997). Compressed-air tunneling and caisson work decompression procedures: development, problems, and solutions. Undersea and Hyperbaric Medicine, 24(4), pp. 337-345. This article reported 60 treated cases of DCI among 4,168 exposures between 19 and 31 p.s.i.g. over a 51-week contract period, for a DCI incidence of 1.44% for the decompression tables specified by the OSHA standard.

[10]Sealey, JL (1969). Safe exit from the hyperbaric environment: medical experience with pressurized tunnel operations. Journal of Occupational Medicine, 11(5), pp. 273-275. This article reported 210 treated cases of DCI among 38,600 hyperbaric exposures between 13 and 34 p.s.i.g. over a 32-month period, for an incidence of 0.54% for the decompression tables specified by the Washington State safety standards for compressed-air work, which are similar to the tables in the OSHA standard. Moreover, the article reported 51 treated cases of DCI for 3,000 exposures between 30 and 34 p.s.i.g., for an incidence of 1.7% for the Washington State tables.

[11]In 1985, the National Institute for Occupational Safety and Health (NIOSH) published a report entitled, "Criteria for Interim Decompression Tables for Caisson and Tunnel Workers"; this report reviewed studies of DCI and other hyperbaric-related injuries resulting from use of OSHA's tables. This report is available on NIOSH's website: http://www.cdc.gov/niosh/topics/decompression/default.html.

[12]Anderson HL (2002). Decompression sickness during construction of the Great Belt Tunnel, Denmark. Undersea and Hyperbaric Medicine, 29(3), pp. 172-188.

tables specified in Appendix A. OSHA found no studies in which the DCI incidence reported for the 1992 French Decompression Tables were higher than the DCI incidence reported for the OSHA decompression tables, nor did OSHA find any studies indicating that the 1992 French Decompression Tables were more hazardous to employees than the OSHA decompression tables.[13]

OSHA also reviewed the use of trimix in tunneling operations. In compressed-air atmospheres greater than 73 p.s.i.g., it becomes increasingly more difficult to work due to increased breathing resistance, increased risk of DCI, and the adverse effects of the increased partial pressures of nitrogen and oxygen. Nitrogen narcosis occurs when a diver or CAW breathes a gas mixture with a nitrogen partial pressure greater than 2.54 ATA (i.e., 73 p.s.i.g.). Nitrogen narcosis compromises judgment, performance, and reaction time of divers and CAWs and can lead to loss of consciousness.[14] There is concern that nitrogen narcosis may impair CAWs leading to possible safety issues.[15] Exposure to oxygen at partial pressures greater than normal daily living may be toxic to the lungs and central nervous system under certain conditions. The higher the partial pressure of oxygen and the longer the exposure, the more severe the toxic effects. One way to reduce oxygen exposure is to alter the percentage of oxygen in the breathing mixture (see footnote 15). Trimix is a mixture of the inert gas helium, oxygen and nitrogen. Because helium is less dense than air, use of helium in compressed

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[13]Le Péchon JC, Barre P, Baud JP, Ollivier F (September 1996). Compressed-air work - French Tables 1992 - operational results. JCLP Hyperbarie Paris, Centre Medical Subaquatique Interentreprise, Marseille: Communication a l'EUBS, pp. 1-5 (see Ex. OSHA-2012-0036-0005).

[14]United States Navy. (2011) U.S. Navy Diving Manual, Revision 6. Department of the Navy.

[15]Van Rees, Vellinga T, Verhoevan A, Jan Dijk F, Sterk W (November-December 2006) Health and efficiency in trimix versus air breathing in CAWs. *Undersea Hyperbaric Medicine* 33 (6), pp 419-427. This article reported that during construction of the Western Scheldt Tunneling Project, there were 52 exposures to trimix at 81.2-84.1 p.s.i. with no reported cases of DCI. Three of 318 exposures to compressed air resulted in DCI in this study.

atmospheres decreases breathing resistance and allows for adjustment of the partial pressures of oxygen and nitrogen to reduce the incidence of nitrogen narcosis and oxygen toxicity.

Trimix has been successfully used in deep caisson work and tunneling projects including the construction of the Meiko West Bridge,[16] the Western Scheldt Tunnel (see footnote 15), and in the Seattle Brightwater Tunneling Project.[17] During the construction of the Western Scheldt Tunnel, there were fewer reported cases of DCIs in CAWs using trimix than in other CAWs using just compressed air, despite working at higher pressures (see footnotes 15 and 16). Additionally, the use of compressed air during the construction of the Western Scheldt Tunnel was also associated with a slower working pace and operational errors that the authors associated with the adverse effects of nitrogen at high pressure ((i.e., nitrogen narcosis) (see footnote 15)). Trimix decompression tables are proprietary so large studies of workers with specific pressure exposures for specific trimix schedules are not available. Additional concerns include the lack of a defined recompression protocol in the case of DCI and some studies have found evidence of cardiopulmonary strain in divers using trimix but at pressures greater than those submitted for this variance (see footnote 13).

Review of the literature and reports from presentations to professional societies support that the incidence of DCI with this technique is lower than the incidence of DCIs reported with the use of OSHA tables. In addition, use of trimix reduces the risk of

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[16]Takishima R, Sterk W, Nashimoto T (1996) Trimix breathing in deep caisson work for the construction of Pier (P2) for the Meiko West Bridge. Undersea and Hyperbaric Medical Society Meeting Abstract. During construction of the Meiko West Bridge, there were 11 cases of DCI in 2059 trimix exposures for a reported DCI rate of 1%.

[17]Hamilton R, Kay E (November 2008) Boring deep tunnels. Proceedings, 3rd of U.S.-Japan Panel on Aerospace-Diving Physiology and Technology, and Hyperbaric Medicine.

impairment from nitrogen narcosis and allows for the adjustment of oxygen partial pressure to reduce exposure to elevated oxygen partial pressures (see footnotes 15 and 17). Therefore, OSHA concludes that use of the 1992 French Decompression Tables protects workers at least as effectively as the OSHA decompression tables.

Based on a review of available evidence, the experience of State Plans that either granted variances (Nevada, Oregon, and Washington)[18] or promulgated a different standard (California)[19] for hyperbaric exposures occurring during similar subaqueous tunnel-construction work, and the information provided in the applicant's variance application, OSHA is granting this multi-state permanent variance for future tunneling projects.

Under section 6(d) of the Occupational Safety and Health Act of 1970 (29 U.S.C. 655(d)), and based on the record discussed above, the Agency finds that when the employer complies with the conditions of the variance, the working conditions of the employer's workers are at least as safe and healthful as if the employer complied with the working conditions specified by paragraphs (e)(5), (f)(1), (g)(1)(iii), and (g)(1)(xvii) of 29 CFR 1926.803. Therefore, under the terms of this variance Traylor must: (1) comply with the conditions listed below under section V of this notice ("Order") for the period between the date of this notice and until the Agency modifies or revokes this final order in accordance with 29 CFR 1905.13; (2) comply fully with all other applicable provisions of 29 CFR part 1926; and (3) provide a copy of this Federal Register notice to all employees affected by the conditions, including the affected employees of other

[18]These state variances are available in the docket: Exs. OSHA-2012-0035-0006 (Nevada), OSHA-2012-0035-0007 (Oregon), and OSHA-2012-0035-0008 (Washington).

[19]See California Code of Regulations, Title 8, Subchapter 7, Group 26, Article 154, available at http://www.dir.ca.gov/title8/sb7g26a154.html.

employers, using the same means it used to inform these employees of its application for a permanent variance.

V. Order

As of the effective date of this final order, OSHA is revoking the interim order granted to the employer on July 27, 2015 (80 FR 44386).

OSHA issues this final order authorizing Traylor Bros., Inc. ("Traylor" or "the applicant"), to comply with the following conditions instead of complying with the requirements of paragraphs 29 CFR 1926.803(e)(5), (f)(1), (g)(1)(iii), and (g)(1)(xvii). This final order applies to all employees of Traylor Bros., Inc. exposed to hyperbaric conditions. These conditions are:

A. Scope

The permanent variance applies only to work:

1. That occurs in conjunction with construction of future subaqueous tunnels using advanced shielded mechanical-excavation techniques and involving operation of an EPBTBM;
2. Performed under compressed-air and hyperbaric conditions up to 75 p.s.i.g;
3. In the EPBTBM's forward section (the working chamber) and associated hyperbaric chambers used to pressurize and decompress employees entering and exiting the working chamber;
4. Except for the requirements specified by 29 CFR 1926.803(e)(5), (f)(1), (g)(1)(iii), and (g)(1)(xvii), Traylor must comply fully with all other applicable provisions of 29 CFR part 1926; and

5. This final order will remain in effect until OSHA modifies or revokes it in accordance with 29 CFR 1905.13.

B. Application

The permanent variance applies only when Traylor stops the tunnel-boring work, pressurizes the working chamber, and the CAWs either enter the working chamber to perform interventions (i.e., inspect, maintain, or repair the mechanical-excavation components), or exit the working chamber after performing interventions.

C. List of Abbreviations

Abbreviations used throughout this permanent variance include the following:

1. ATA – Atmosphere Absolute
2. CAW – Compressed-air worker
3. CFR – Code of Federal Regulations
4. DCI – Decompression Illness
5. DCS – Decompression Sickness (or the bends)
6. EPBTBM – Earth Pressure Balanced Tunnel Boring Machine
7. HOM – Hyperbaric Operations and Safety Manual
8. JHA – Job hazard analysis
9. OSHA – Occupational Safety and Health Administration
10. OTPCA – Office of Technical Programs and Coordination Activities

D. Definitions

The following definitions apply to this permanent variance. These definitions supplement the definitions in each project-specific HOM.

1. Affected employee or worker – an employee or worker who is affected by the conditions of this proposed permanent variance, or any one of his or her authorized representatives. The term "employee" has the meaning defined and used under the Occupational Safety and Health Act of 1970 (29 U.S.C. 651 et seq.).

2. Atmospheric pressure – the pressure of air at sea-level, generally, 14.7 p.s.i.a., 1 atmosphere absolute, or 0 p.s.i.g.

3. Compressed-air worker – an individual who is specially trained and medically qualified to perform work in a pressurized environment while breathing air at pressures up to 75 p.s.i.g.

4. Competent person – an individual who is capable of identifying existing and predictable hazards in the surroundings or working conditions that are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.[20]

5. Decompression illness – an illness (also called decompression sickness (DCS) or the bends) caused by gas bubbles appearing in body compartments due to a reduction in ambient pressure. Examples of symptoms of decompression illness include (but are not limited to): joint pain (also known as the 'bends' for agonizing pain or the 'niggles' for slight pain); areas of bone destruction (termed dysbaric osteonecrosis); skin disorders (such as cutis marmorata, which causes a pink marbling of the skin); spinal cord and brain disorders (such as stroke, paralysis, paresthesia, and bladder dysfunction);

[20]Adapted from 29 CFR 1926.32(f).

cardiopulmonary disorders, such as shortness of breath; and arterial gas embolism (gas bubbles in the arteries that block blood flow).[21]

Note: Health effects associated with hyperbaric intervention but not considered symptoms of DCI can include: barotrauma (direct damage to air-containing cavities in the body such as ears, sinuses and lungs); nitrogen narcosis (reversible alteration in consciousness that may occur in hyperbaric environments and is caused by the anesthetic effect of certain gases at high pressure); and oxygen toxicity (a central nervous system condition resulting from the harmful effects of breathing molecular oxygen (O_2) at elevated partial pressures).

6. Earth Pressure Balanced Tunnel Boring Machine – the machinery used to excavate the tunnel.

7. Hot work – any activity performed in a hazardous location that may introduce an ignition source into a potentially flammable atmosphere.[22]

8. Hyperbaric – at a higher pressure than atmospheric pressure.

9. Hyperbaric intervention – a term that describes the process of stopping the EPBTBM and preparing and executing work under hyperbaric pressure in the working chamber for the purpose of inspecting, replacing, or repairing cutting tools and/or the cutterhead structure.

10. Hyperbaric Operations Manual – a detailed, project-specific health and safety plan developed and implemented by Traylor for working in compressed air during future hyperbaric tunnel projects.

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[21]See Appendix 10 of "A Guide to the Work in Compressed-Air Regulations 1996," published by the United Kingdom Health and Safety Executive available from NIOSH at http://www.cdc.gov/niosh/docket/archive/pdfs/NIOSH-254/compReg1996.pdf

[22]Also see 29 CFR 1910.146(b).

11. Job hazard analysis – an evaluation of tasks or operations to identify potential hazards and to determine the necessary controls.

12. Man lock – an enclosed space capable of pressurization, and used for compressing or decompressing any employee or material when either is passing into or out of a working chamber.

13. Nitrox – a mixture of oxygen and air and refers to mixtures which are more than 21% oxygen.

14. Pressure – a force acting on a unit area. Usually expressed as pounds per square inch (p.s.i.).

15. p.s.i. – pounds per square inch, a common unit of measurement of pressure; a pressure given in p.s.i. corresponds to absolute pressure.

16. p.s.i.a – pounds per square inch absolute, or absolute pressure, is the sum of the atmospheric pressure and gauge pressure. At sea-level, atmospheric pressure is approximately 14.7 p.s.i. Adding 14.7 to a pressure expressed in units of p.s.i.g. will yield the absolute pressure, expressed as p.s.i.a.

17. p.s.i.g. – pounds per square inch gauge, a common unit of pressure; pressure expressed as p.s.i.g. corresponds to pressure relative to atmospheric pressure. At sea-level, atmospheric pressure is approximately 14.7 p.s.i. Subtracting 14.7 from a pressure expressed in units of p.s.i.a. yields the gauge pressure, expressed as p.s.i.g.

18. Qualified person – an individual who, by possession of a recognized degree, certificate, or professional standing, or who, by extensive knowledge, training, and

experience, successfully demonstrates an ability to solve or resolve problems relating to the subject matter, the work, or the project.[23]

19. Trimix – a mixture of oxygen, nitrogen and helium that is used in hyperbaric environments instead of air to reduce nitrogen narcosis and the hazards of oxygen toxicity.

20. Working chamber – an enclosed space in the EPBTBM in which CAWs perform interventions, and which is accessible only through a man lock.

E. Safety and Health Practices

1. Traylor must develop and implement a project-specific HOM, and submit the HOM to OSHA at least one year before using the EPBTBM on the project for which the HOM applies. The HOM shall provide the governing requirements regarding expected safety and health hazards (including anticipated geological conditions) and hyperbaric exposures during the tunnel-construction project.

2. The HOM must demonstrate that the EPBTBM to be used on the project is designed, fabricated, inspected, tested, marked, and stamped in accordance with the requirements of ASME PVHO-1.2012 (or most recent edition of Safety Standards for Pressure Vessels for Human Occupancy) for the EPBTBM's hyperbaric chambers.

3. When submitting the project-specific HOM to OSHA for approval, Traylor must demonstrate that it informed its employees of the HOM and their right to petition the Assistant Secretary for a variance by:

a. giving a copy of the proposed project-specific HOM to the authorized employee representatives;

[23] Adapted from 29 CFR 1926.32(m).

b. posting a statement giving a summary of the proposed project-specific HOM and specifying where its employees may examine a copy of the proposed HOM (at the place(s) where the applicant normally posts notices to employees or, instead of a summary, posting the proposed HOM itself); or

c.using other appropriate means.

4. Traylor must not begin hyperbaric interventions at pressures exceeding 50 p.s.i.g. until OSHA completes its review of the project-specific HOM and determines that the safety and health instructions and measures it specifies are appropriate, comply with the conditions of the variance, and adequately protect the safety and health of CAWs. Traylor must receive a written acknowledgement from OSHA stating that: (1) OSHA found its project-specific HOM acceptable; and (2) OSHA determined that it can begin hyperbaric interventions at pressures exceeding 50 p.s.i.g. by complying fully with the conditions of the permanent variance (as an alternative to complying with the requirements of the standard). Once approved by OSHA, the HOM becomes part of this variance for the purposes of the project for which it was developed.

5. Traylor must implement the safety and health instructions included in the manufacturer's operations manuals for the EPBTBM, and the safety and health instructions provided by the manufacturer for the operation of decompression equipment.

6. Traylor must use air or trimix as the only breathing gas in the working chamber.

7. Traylor must use the 1992 French Decompression Tables for air, nitrox, and trimix decompression specified in the HOM, specifically, the extracted portions of the 1992 French Decompression tables titled, "French Regulation Air Standard Tables."

8. Traylor must equip man locks used by its employees with an air, nitrox, or trimix-delivery system as specified by the HOM approved by OSHA for the project. Traylor is required to not store oxygen or other compressed gases used in conjunction with hyperbaric work in the tunnel.

9. Workers performing hot work under hyperbaric conditions must use flame-retardant personal protective equipment and clothing.

10. In hyperbaric work areas, Traylor must maintain an adequate fire-suppression system approved for hyperbaric work areas.

11. Traylor must develop and implement one or more JHAs for work in the hyperbaric work areas, and review, periodically and as necessary (e.g., after making changes to a planned intervention that affects its operation), the contents of the JHAs with affected employees. The JHAs shall include all the job functions that the risk assessment[24] indicates are essential to prevent injury or illness.

12. Traylor must develop a set of checklists to guide compressed-air work and ensure that employees follow the procedures required by this permanent variance (including all procedures required by the HOM approved by OSHA for the project, which this variance incorporates by reference). The checklists shall include all steps and equipment functions that the risk assessment indicates are essential to prevent injury or illness during compressed-air work.

[24]See ANSI/AIHA Z10-2012, American National Standard for Occupational Health and Safety Management Systems, for reference.

13. Traylor must ensure that the safety and health provisions of each HOM adequately protect the workers of all contractors and subcontractors involved in hyperbaric operations for the project to which the HOM applies.[25]

F. Communication

1. Prior to beginning a shift, Traylor must implement a system that informs workers exposed to hyperbaric conditions of any hazardous occurrences or conditions that might affect their safety, including hyperbaric incidents, gas releases, equipment failures, earth or rock slides, cave-ins, flooding, fires, or explosions.

2. Traylor must provide a power-assisted means of communication among affected workers and support personnel in hyperbaric conditions where unassisted voice communication is inadequate.

a. Traylor must use an independent power supply for powered communication systems, and these systems shall have to operate such that use or disruption of any one phone or signal location will not disrupt the operation of the system from any other location.

b. Traylor must test communication systems at the start of each shift and as necessary thereafter to ensure proper operation.

G. Worker Qualifications and Training

Traylor must:

1. Ensure that each affected worker receives effective training on how to safely enter, work in, exit from, and undertake emergency evacuation or rescue from, hyperbaric conditions, and document this training.

[25]See ANSI/ASSE A10.33-2011, American National Standard for Construction and Demolition Operations – Safety and Health Program Requirements for Multi-Employer Projects, for reference.

2. Provide effective instruction, before beginning hyperbaric operations, to each worker who performs work, or controls the exposure of others, in hyperbaric conditions, and document this instruction. The instruction must include:

a. The physics and physiology of hyperbaric work;

b. Recognition of pressure-related injuries;

c. Information on the causes and recognition of the signs and symptoms associated with decompression illness, and other hyperbaric intervention-related health effects (e.g., barotrauma, nitrogen narcosis, and oxygen toxicity).

d. How to avoid discomfort during compression and decompression;

e. Information the workers can use to contact the appropriate healthcare professionals should the workers have concerns that they may be experiencing adverse health effects from hyperbaric exposure; and

f. Procedures and requirements applicable to the employee in the project-specific HOM.

3. Repeat the instruction specified in paragraph (G)(2) of this condition periodically and as necessary (e.g., after making changes to its hyperbaric operations).

4. When conducting training for its hyperbaric workers make this training available to OSHA personnel and notify the OTPCA at OSHA's National Office and OSHA's nearest affected Area Office before the training takes place.

H. Inspections, Tests, and Accident Prevention

1. Traylor must initiate and maintain a program of frequent and regular inspections of the EPBTBM's hyperbaric equipment and support systems (such as

temperature control, illumination, ventilation, and fire-prevention and fire-suppression systems), and hyperbaric work areas, as required under 29 CFR 1926.20(b)(2) by:

a. Developing a set of checklists to be used by a competent person in conducting weekly inspections of hyperbaric equipment and work areas; and

b. Ensuring that a competent person conducts daily visual checks and weekly inspections of the EPBTBM.

2. If the competent person determines that the equipment constitutes a safety hazard, Traylor shall remove the equipment from service until it corrects the hazardous condition and has the correction approved by a qualified person.

3. Traylor must maintain records of all tests and inspections of the EPBTBM, as well as associated corrective actions and repairs, at the job site for the duration of the job.

I. Compression and Decompression

Traylor must consult with its attending physician concerning the need for special compression or decompression exposures appropriate for CAWs not acclimated to hyperbaric exposure.

J. Recordkeeping

Traylor must maintain a record of any recordable injury, illness, in-patient hospitalization, amputation, loss of an eye, or fatality (as defined by 29 CFR part 1904 Recording and Reporting Occupational Injuries and Illnesses), resulting from exposure of an employee to hyperbaric conditions by completing the OSHA 301 Incident Report form and OSHA 300 Log of Work Related Injuries and Illnesses.

Note: Examples of important information to include on the OSHA 301 Incident Report form (along with the corresponding question on the form) must address the

following: the task performed (Question (Q) 14); an estimate of the CAW's workload (Q 14); the composition of the gas mixture (e.g., air or trimix (Q 14)); the pressure worked at (Q 14); temperature in the work and decompression environments (Q 14); did something unusual occur during the task or decompression (Q 14); time of symptom onset (Q 15); duration of time between decompression and onset of symptoms (Q 15); nature and duration of symptoms (Q 16); a medical summary of the illness or injury (Q 16); duration of the hyperbaric intervention (Q 17); any possible contributing factors (Q 17); the number of prior interventions completed by injured or ill CAW (Q 17); the number of prior interventions completed by injured or ill CAW at that pressure (Q 17); the contact information for the treating healthcare provider (Q 17); and the date and time of last hyperbaric exposure for this CAW.

In addition to completing the OSHA 301 Incident Report form and OSHA 300 Log of Work Related Injuries and Illnesses, Traylor must maintain records of:

1. The date, times (e.g., began compression, time spent compressing, time performing intervention, time spent decompressing), and pressure for each hyperbaric intervention.

2. The name of each individual worker exposed to hyperbaric pressure and the decompression protocols and results for each worker.

3. The total number of interventions and the amount of hyperbaric work time at each pressure.

4. The post-intervention physical assessment of each individual CAW for signs and symptoms of decompression illness, barotrauma, nitrogen narcosis, oxygen toxicity

or other health effects associated with work in compressed air or mixed gasses for each hyperbaric intervention.

K. Notifications

1. To assist OSHA in administering the conditions specified herein, Traylor must:

a.Notify the OTPCA and the nearest affected Area Office of any recordable injury, illness, in-patient hospitalization, amputation, loss of an eye, or fatality (by submitting the completed OSHA 301 Incident Report form[26]) resulting from exposure of an employee to hyperbaric conditions including those that do not require recompression treatment (e.g., nitrogen narcosis, oxygen toxicity, barotrauma), but still meet the recordable injury or illness criteria (of 29 CFR 1904). The notification must be made within 8 hours of the incident, or after becoming aware of a recordable injury or illness, and a copy of the incident investigation (OSHA 301) shall be provided within 24 hours of the incident, or after becoming aware of a recordable injury or illness. In addition to the information required by the OSHA 301, the incident-investigation report must include a root-cause determination, and the preventive and corrective actions identified and implemented.

b. Provide certification within 15 days of the incident that it informed affected workers of the incident and the results of the incident investigation (including the root-cause determination and preventive and corrective actions identified and implemented).

[26]See footnote 7

c.Notify the OTPCA and the nearest affected Area Office within 15 working days and in writing, of any change in the compressed-air operations that affects Traylor's ability to comply with the conditions specified herein.

d. Upon completion of each hyperbaric tunnel project, evaluate the effectiveness of the decompression tables used throughout the project, and provide a written report of this evaluation to the OTPCA and the neared affected Area Office. Note: The evaluation report must contain summaries of: (1) the number, dates, durations, and pressures of the hyperbaric interventions completed; (2) decompression protocols implemented (including composition of gas mixtures (air, oxygen, nitrox, and trimix), and the results achieved; (3) the total number of interventions and the number of hyperbaric incidents (decompression illnesses and/or health effects associated with hyperbaric interventions as recorded on OSHA 301 and 300 forms, and relevant medical diagnoses and treating physicians' opinions); and (4) root-causes, and preventive and corrective actions identified and implemented.

e.To assist OSHA in administering the conditions specified herein, inform the OTPCA and the nearest affected Area Office as soon as possible after it has knowledge that it will:

i. Cease to do business;

ii. Change the location and address of the main office for managing the tunneling operations specified by the project-specific HOM; or

iii. Transfer the operations specified herein to a successor company.

f. Notify all affected employees of this permanent variance by the same means required to inform them of its application for a variance.

2. OSHA must approve the transfer of the permanent variance to a successor company.

Authority and Signature

David Michaels, PhD, MPH, Assistant Secretary of Labor for Occupational Safety and Health, 200 Constitution Avenue, NW, Washington, DC 20210, authorized the preparation of this notice. Accordingly, the Agency is issuing this notice pursuant to Section 29 U.S.C. 655(6)(d), Secretary of Labor's Order No. 1-2012 (77 FR 3912, Jan. 25, 2012), and 29 CFR 1905.11.

Signed at Washington, DC, on March 7, 2016.

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David Michaels,
Assistant Secretary of Labor for Occupational Safety and Health.

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