2600SEG122
SAFETY STANDARD FOR UNDERGROUND CONSTRUCTIONS

1.0 PURPOSE

The purpose of this Standard is to establish guidelines to prevent employees from getting injured when executing underground constructions, such as tunnels, uptakes, galleries; as well as excavations being connected to any underground construction work.

2.0 BACKGROUND

The Panama Canal Authority (ACP) does not have a standard to regulate this activity.

3.0 SCOPE

This Standard applies to all ACP employees, contractors, and third parties performing work or activities related to the construction of tunnels, access shafts, galleries, pits, chambers, passage ways/access roads to the previously described works, cuts-and-fills, and other works physically connected to underground constructions executed in installations or areas under ACP responsibility.

This Standard does not apply to excavations and ditches over twenty (20) feet deep, or more than fifteen (15) feet wide, underground lines for power transmission or distribution.

4.0 LEGAL FOUNDATION

This Standard is established pursuant to Agreement No. 12 of the Board of Directors of the Panama Canal Authority (ACP), Chapter 1, Article 3, paragraphs 3 and 4, of the Regulation on Safety and Occupational Health occupational risks and health control regulation titled *Reglamento de Control de Riesgos y Salud Ocupacional*.

5.0 DEFINITIONS

For the purpose of this Standard, the following definitions apply:

5.1 Chute: Means through which materials, such as rock or soil are discharged.

5.2 Torque bolts: Metallic pins of variable lengths used to secure unstable walls or roofs in a tunnel.

5.3 Subsidence: Unexpected sinking of a mass or solid rock or subsoil.

5.4 RQD (Rock Quality Designation): Percentage relationship of the sum of the length of core samples greater than 10 cm. (l) retrieved from a perforation run, and such run's length (L).

5.5 SRF (Stress Reduction Factor): Mass stress reduction factor.

6.0 GENERAL

6.1 Safe access and exit means shall be provided at all work sites and stations.

6.2 Accesses and exists shall be constructed in such way that there is space provided so that employees are not impacted by moving machinery or equipment, such as excavators, load carrier trucks, railcars, or trains.

6.3 Access control shall be guaranteed so that unauthorized individuals do not enter work sites: at chute material discharge areas; openings, and hazardous sites. Warning signs, safety decks or barricades shall be placed.

6.4 A worker entry-exit count shall be implemented and maintained in order to ensure that a determination can be made of personnel working underground in the event of an emergency (refer to the Confined Space Policy).

6.5 The procedure for Confined Spaces shall not be required when the construction of underground facilities designed for human occupation or traffic has been sufficiently concluded, demonstrates permanent and effective environmental controls; and the work that remains to be concluded shall not cause structural or environmental dangers.

6.6 When beginning a new shift, employees shall be informed of any danger or condition that affects or could affect their safety, including gas releases, equipment malfunction, land or rock slides, cave-ins, floods, fire, or explosions.

6.7 Supervisors shall establish and maintain direct communication with all employees, in order to coordinate all activities which could affect the safety of employees working underground.

6.8 When unassisted natural communication is not effective, powerful communication resources shall be incorporated between the working front, pit bottom, and surface.

6.9 Two communication resources shall be provided, of which at least one shall be verbal and is to be used at all openings while personnel is underground or while lifting maneuvers of cargo or personnel are being performed.

6.10 Operation of the communication systems shall initiate from an independent power source, and shall be installed in such manner that there is no disturbance between the systems.

6.11 Any employee working alone underground in a dangerous location which is out of range for verbal communication, or for being observed by other individuals, shall have the available resources required to obtain assistance during an emergency.

6.12 Provisions for emergencies:

6.12.1 Lifting equipment shall be provided; it shall always be available when vertical openings (“shafts”) are used as exit means.

6.12.2 Personnel working underground shall be trained on rescue activities, and respirators shall be available for all employees at underground stations where smoke or gases could build up.

6.12.3 There shall be at least one person designated to provide first aid and keep count of personnel in an efficient manner, without other duties preventing him/her from doing so.

6.12.4 Each underground employee shall be provided with an acceptable personal illumination resource, be it a hand lamp, or hardhat lamp, for use in case of an emergency, at least until there is existing natural light or an emergency illumination system sufficient for escape.

6.12.5 Where there are twenty-five (25) or more employees working simultaneously in a location, they shall be provided with (or anticipated arrangements made for) rescue services, so that

there are at least two (2) rescue units made up of five (5) people; the first rescue unit shall be located at no more than thirty (30) minutes away from the underground entry; the second unit at no more than two (2) hours away from such entry. In locations where less than twenty-five (25) employees are simultaneously working, they shall be provided with (or anticipated arrangements made for) rescue services, so that there is one rescue unit made up of five (5) people.

6.12.6 The rescue units shall have the training and practice on rescue procedures, the use and limitations of the respiratory system, and on fire extinguishing equipment, with their qualifications being annually reviewed.

6.12.7 For worksites where flammable or toxic gases in dangerous quantities could be expected, the rescue unit shall have the training and monthly practice on the use of self-contained breathing apparatus.

6.13 All rescue units shall be familiar with the work site conditions.

6.14 All mobile equipment powered with diesel fuel shall be approved in accordance with the MSHA (Mining Safety and Health Administration) regulations. Any other equipment powered with a different fuel is prohibited.

6.15 The need shall be determined for monitoring the air quality and frequency of such monitoring based, when applicable, on the consideration of factors:

6.15.1 Proximity of fuel tanks, gas lines, drainage systems, former waste dumps, bunker tanks, and swamps.

6.15.2 Geological studies, particularly of soil types and permeability.

6.15.3 Historical presence of contaminants, or changes of concentrations before shifts.

6.15.4 Use of equipment that works with diesel fuel, use of explosives, use of fuel gas, volume and rate of ventilation, weather conditions, atmospheric decompression, cutting, welding, hot working and physical reactions of employees that work underground.

6.16 Smoking and possession of matches or lighters are prohibited in locations with dangerous atmospheres.

6.17 Continuous flammability monitoring shall be performed each time high- speed excavating machines are used by installing sensors located at the front of the excavation, whenever practical.

6.18 Fresh air shall be supplied in all underground work areas.

6.18.1 Mechanical ventilation shall be supplied in all work areas, unless it is demonstrated that the natural ventilation provides sufficient quality and volume.

6.18.2 A minimum of 200 cubic feet per minute of fresh air shall be supplied to each underground employee.

6.18.3 In tunnels, openings and other work sites where drilling and blasting is performed which produces dust, fumes, fog, steam, gases, the air flow linear speed shall be at least 30 feet per minute.

6.18.4 The air flow direction shall be reversible.

6.19 The equipment used in underground work shall have fire-resistant hydraulic hoses, unless the equipment is protected by its own firefighting system that is of sufficient capacity for the type and size of the hydraulic system involved, of at least 4A:40B:C.

6.20 All structures built underground or located at least 100 feet from its underground entry shall be constructed with fire-retardant materials of at least one (1) hour.

6.21 Underground storage of fuel gases, oxygen shall be allowed only in sufficient quantity to perform work having 24-hour duration.

6.22 Accesses or galleries shall be protected against cave-ins through screens, walls, or reinforcements which shall ensure safe access of employees and equipment.

6.22.1 Risk areas shall be scarified or secured to prevent fly-away materials, rock, or fractured material.

6.22.2 Subsoil stability shall be ensured in subsidence danger areas through reinforcements, barricades, or posting of notices to prevent entry.

6.22.3 A competent person shall inspect the walls, roof and work front at the beginning of each shift, and more frequently, depending on the soil stability.

6.23 Torque bolts may be used as reinforcements, provided that a competent person determines that they meet the objective, based on subsoil condition and the vibration source distance.

6.24 Protection shall be provided for all employees exposed to dangers while reinforcement systems are being installed.

6.25 All vertical openings over five (5) feet shall be protected and secured before employees enter them.

6.26 After a blast a competent person shall inspect the walls, stairs, and reinforcements in order to verify the need to perform repairs.

6.27 Blasting electric wiring shall be located away from power lines, piping or other conductive material.

6.28 Following a blast, nobody shall enter the work area, unless the air quality complies with the established requirements.

6.29 A competent person shall inspect all drilling and equipment, making sure that all safety aspects are identified.

6.30 Material-carrying equipment shall be inspected by a competent person, and shall not be put into service until any problems affecting safety have been corrected.

6.31 Material-carrying equipment, including trains, shall be provided with audible signaling devices which shall be activated every time the equipment starts moving and during all the time required during its travel.

6.32 Material-carrying equipment, including trains, shall be provided with lights at both ends, and if it uses windshields, they should be the safety type, and be free from visibility obstruction.

6.33 No employees shall drive a vehicle or remain in the cabin if there is no seat provided; for train travel, these shall have been approved.

6.34 Moving equipment shall not be left unattended, unless the switch is off and operation controls secured.

6.35 When wagons are unloaded, they shall have been previously secured.

6.36 Employees shall not position themselves in between connecting equipment.

6.37 Freight cars shall be secured with chains, in addition to the mechanical joint.

6.38 Berms, shock absorbers or guards shall be installed in dump sites to prevent the loss of control.

6.39 Oil transformers shall not be used in underground installations, unless they are confined within fireproof locations.

6.40 Each time repairs or maintenance is performed on equipment or machinery, all employees shall be informed.

6.41 All hoisting equipment shall be governed by the Standard on Crane Operations.

6.42 New underground constructions, or those which alter the stability of existing underground structures shall be performed taking into account strict geological studies that lead to the understanding of the massif or rocky body through its complete stability scheme, including aspects such as: Anisotropy and heterogeneity, discontinuities, situation, position, compressive strength, tensile strength, shearing strength, Rock Quality Designation (RQD), condition of diaclases, condition of triaxial tension, elasticity, ground water, geological structures, cohesion, Stress Reduction Factor (SRF), in such manner that soil mechanics and hydrodynamic aspects that guarantee their stability and caving-in prevention are identified and evaluated.

7.0 RESPONSIBILITIES

The responsibilities for guaranteeing compliance with this Standard are described in Section 1, Paragraph 1.5, of the ACP Safety Manual.

7.1 Training and Refresher Course Requirements:

7.1.1 Contractors shall provide training for their own employees.

7.1.2 All employees shall receive instruction regarding the identification and prevention of dangers associated with underground construction activities and, when applicable, shall be required to obtain training on the following aspects:

7.1.2.1 Atmospheric monitoring and confined spaces

7.1.2.2 Analysis of Safe Work

7.1.2.3 Ventilation

7.1.2.4 Illumination

7.1.2.5 Communications

7.1.2.6 Flood Control

7.1.2.7 Mechanical Equipment

7.1.2.8 Personal Protective Gear

7.1.2.9 Explosives

7.1.2.10 Fire Prevention and Protection

7.1.2.11 Emergency Procedures, including evacuation plans and entry control systems.

8.0 INQUIRIES

Any information or clarification of the content or application of this Standard must be requested in writing to the Safety and Industrial Hygiene Unit.

9.0 EXCEPTIONS

Any requests for changes or temporary exceptions to this Standard must be made in writing to the Safety and Industrial Hygiene Unit.

10.0 TERM

This Standard shall remain in force until amended or revised.

11.0 REFERENCES

11.1 Barton, N., R. & Lunde, J.: Analysis of rock quality and support practice in tunneling and guide for estimating support requirements.-Rock Mechanics, Vol. 6, No 4, pp. 189-236. (1975)

11.2 Barton, N., R. & Lunde, J.: Q-System. Norwegian Geotechnical Institute. (1974)

11.3 Bibliographical references may be printed or electronic documents.

11.4 *ACP Confined Space Manual / Manual de Espacios Confinados de la ACP*.