STATE OF CALIFORNIA, DEPARTMENT OF INDUSTRIAL RELATIONS
Division of Occupational Safety and Health

Memorandum

To: Marley Hart, Executive Officer
Occupational Safety and Health Standards Board
2520 Venture Oaks Way, Suite 350
Sacramento, CA 95833

Date: April 25, 2017

From: Juliann Sum, Chief
Division of Occupational Safety and Health
Department of Industrial Relations

Re: Petition No. 561 for amendment of Title 8 Section 1735

1.0 INTRODUCTION AND BACKGROUND

On January 27, 2017, the Division of Occupational Safety and Health (Cal/OSHA) received a petition from Michael Gunlund (petitioner) to request a change to the Title 8 Construction Safety Orders. The applicant amended their proposal to clarify the requested changes on March 13, 2017.

The petitioner requests a change to Title 8, Article 31, *Demolition,* section 1735, *Demolishing Buildings.* This regulation contains requirements for demolishing buildings and other structures.

2.0 PETITIONER'S REQUESTS

The petitioner requests an addition to subsection 1735(v). Subsection (v) currently requires the use of curbs or stop-logs[1] around floor openings to prevent mechanical equipment from falling into floor openings during demolition operations. The requested change to subsection 1735(v) would allow wire rope protective systems to be used around floor openings on demolition projects instead of curbs or stop-logs.

3.0 PROPOSED ADDITIONS TO SECTION 1735

Additions and renumbering of existing section 1735(v), proposed by the petitioner, are shown below in underline-strikeout format.

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Subchapter 4. Construction Safety Orders
Article 31. Demolition
§1735. Demolishing Buildings.
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[1] A type of stop usually composed of wood secured to a floor or concrete deck with a bolted connection or anchor.

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(v) Where mechanical equipment is used for demolition work, floor openings shall ~~have curbs or stop-logs to prevent equipment from running over the edge.~~meet one of the following requirements:
(1) Curbs or stop-logs shall be installed to prevent equipment from running over the edge, or

(2) A cable system consisting of two wire ropes shall be designed by a registered professional engineer, and of such construction to prevent the equipment from falling into the opening.

(A) Calculations for a cable system must include;

1. The specific location in a structure, and for a specified equipment traveling at a certain speed.

2. The size of the wire ropes for each specific location in a structure to satisfy the requirement that the equipment is prevented from falling over.

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4.0 APPLICABLE TITLE 8 REGULATIONS

In addition to subsection 1735(v), the following Title 8 regulation is applicable to use of equipment for disposal of waste material over the edges of buildings or structures during demolition operations. Specifically, this subsection addresses the hazard of vehicles running over the edges of buildings or structures equipped with disposal chutes.

Subchapter 4. Construction Safety Orders
Article 31. Demolition
§1736. Disposal of Waste Material.

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(i)(1) Where the material is dumped from mechanical equipment or wheelbarrows, a securely attached toeboard or bumper, not less than six inches thick and six inches high, shall be provided at each chute opening.

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5.0 HAZARDS TO EMPLOYEES CONDUCTING DEMOLITION WORK

Hazards to employees working in proximity to floor openings when conducting demolition work are well documented in Cal/OSHA investigative records. Employees may suffer serious injuries or death when falling through or driving mechanical equipment over the edge of unprotected edges of buildings or floor openings. Additionally, workers may be struck by portions of the buildings being demolished on the same level or from above when materials fall through floor openings. Potential injuries include:

1. Concussions
2. Fractures

3. Impalement
4. Lacerations
5. Burns
6. Contusions
7. Crushing
8. Asphyxiation

6.0 APPLICABLE FEDERAL OSHA REGULATIONS

The safety requirements for the use of equipment for disposal of waste material during demolition operations are regulated by federal OSHA in the Code of Federal Regulations (CFR), title 29, sections 1926.852(f) and 1926.856(b), in subpart T of the Safety and Health Regulations for Construction.

29 CFR Part 1926. Safety and Health Regulations for Construction

Subpart T. Demolition

* * * * *

1926.852 Chutes.

1926.852(f)

Where the material is dumped from mechanical equipment or wheelbarrows, a securely attached toeboard or bumper, not less than 4 inches thick and 6 inches high, shall be provided at each chute opening.

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1926.856 Removal of walls, floors, and material with equipment.
1926.856(b)

Floor openings shall have curbs or stop-logs to prevent equipment from running over the edge.

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7.0 APPLICABLE CONSENSUS STANDARDS

7.1 ANSI/ASSE A10.6 – 2006

The American National Standards Institute (ANSI) and American Society of Safety Engineers (ASSE) address the demolition of buildings and other structures in the ANSI/ASSE A10.6 standard, Safety & Health Program Requirements for Demolition Operations. The 2006 edition of this standard addresses the disposal of material into chutes and through floor openings in sections 10.1 and 10.2. ANSI/ASSE 10.6 is not incorporated by reference in Title 8 regulations or federal OSHA regulations.

Protection to prevent equipment from running over the edge of or into the floor opening of a building or structure while depositing material into chutes is addressed in section 10.1.7 of ANSI/ASSE A10.6 – 2006. Pursuant to this standard, bumpers or toeboards must be provided at chute openings. Unlike Title 8 regulations, ANSI/ASSE A10.6 – 2006 requires chutes to be

provided when materials will be deposited through floor openings. Additionally, section 10.2 requires that floor openings be protected by guardrails or barricades when not covered or sealed off.

ANSI/ASSE A10.6-2006 Safety and Health Program Requirements for Demolition Operations – American National Standard for Construction and Demolition Operations

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10.1 Chutes

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10.1.7 When the material is dumped into a chute, a securely attached toeboard shall be provided.

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10.2 Removal of Materials Through Floor Holes.

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10.2.3 Openings in floors as well as the demolition floor shall be protected by solid planking, barricades or guardrails conforming to ANSI/ASSE A10.18, unless the floor is sealed off.

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7.2 ANSI/ASSE A10.18 – 2007

The requirements for guarding floor openings are addressed in ANSI/ASSE A10.18, Safety Requirements for Temporary Floor Holes, Wall Openings, Stairways & Other Unprotected Edges in Construction and Demolition Operations, incorporated by reference in ANSI/ASSE A10.6. Pursuant to ANSI/ASSE A10.18, guardrails must withstand a 200-pound force outward or downward at any point without deflecting more than three inches. This strength requirement is intended to serve as fall protection for employees not to prevent mechanical equipment from running over the edge of buildings or floor openings. Strength requirements for barricades are not established within ANSI/ASSE 10.18.

ANSI/ASSE A10.18-2007 Safety Requirements for Temporary Roof and Floor Holes, Wall Openings, Stairways, and Other Unprotected Edges in Construction and Demolition Operations– American National Standard for Construction and Demolition Operations

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7. GUARDING HOLES, OPENINGS, LADDERWAYS, ELEVATOR SHAFTS AND HOISTWAYS

7.1 Holes. All roof and floor holes, as well as skylights both completed and under construction, shall be protected or attended. Protection shall be provided by a hole cover or guardrail system. A standby person may be used to warn other people until permanent protection is installed. A personal fall arrest system shall be used by the standby person when the hole is large enough for a person to fall through unless the standby

person can be positioned away from the hole so as not to be exposed to a fall hazard, and yet is still able to complete the job duties.

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8.0 BACKGROUND ON PETITIONER AND DESCRIPTION OF THE PROPOSED CABLE PROTECTIVE SYSTEM

8.1 Petitioner's Background

The petitioner is the safety director of Kroeker, Incorporated, a private, full-service demolition and recycling company operating in the western United States. Kroeker, Inc. has been in business since the mid-1970s and is one of the largest demolition and recycling companies in central California. The petitioner has worked in the construction industry since 1978 and began his career in the demolition industry in 2001, when hired at Kroeker, Inc. After three years as a project manager with the company, the petitioner was promoted in 2004 to his current position as safety director.

In addition to his position at Kroeker, Inc., the petitioner is also the current Safety Chair Person for the National Demolition Association (NDA). The NDA is a North American association that represents over 800 demolition companies in the United States and Canada. Activities of the NDA include providing educational programs and tools to keep its members abreast of new advances in equipment and regulatory requirements. The NDA also provides information to regulatory agencies and the general public on current issues in the demolition industry.

The proposal for a cable system in lieu of curbs or stop-logs to prevent vehicles from falling into floor openings on demolition projects was first conceptualized in 2010 by members of the NDA. After the petitioner became the Safety Chair Person of NDA in 2012, NDA members requested that the petitioner develop the cable system and present a proposal to the demolition industry and Cal/OSHA.

8.2 Proposed Cable Protective System

A conceptual protective cable system designed by Conn Engineering (Attachment 1) was included with the petition application. The system consists of two 6 x 19 fiber core[2] steel wire rope cables, 1 3/8 inches diameter each, erected at heights of approximately four and six feet from the floor level around a floor opening or at the unprotected edge of a building undergoing demolition. According to the petitioner, the height of the lower cable was chosen to allow for the front shovel of the skid steer or loader to pass under it and allow material to be dumped into a floor opening. The upper cable height was chosen so that it would be approximately at the eye level of a skid steer operator. Based on the design, both cables are to have high visibility markings on them. Each rope has a maximum breaking strength of 85 tons and assigned a working load of 16 tons in the design. The petitioner stated that the submitted design has not been employed on any demolition projects.

[2] A wire rope cable composed of 6 strands each consisting of 19 steel wires which are laid around a synthetic fiber core.

The design requires both upper and lower cables to terminate at structural members of the building or structure undergoing demolition. Two terminal connection options are described in the design.

The first option requires the ends of the upper and lower wire ropes to be inserted through drilled holes in concrete walls or columns. The wire ropes are then formed into a loop by connecting the ends of the upper and lower wire ropes with FF-C-450 type 1 class 1[3] wire rope clips. A minimum of eight wire rope clips are required by the design at each cable termination.

In the second option, the wire ropes are secured to exposed I-beams of the structure with beam clamps. The engineering design submitted by the applicant specifies the Crosby model IPTK clamps (Figure 1). These clamps comprise hooked jaws that are tightened around the flanges of an I-beam. A strength specification of 25 tons is required by the design for clamps used at I-beam terminations. The strength and dimensions of the concrete and steel members are not specified in the design and must be evaluated for each individual installation.

Figure 1. Crosby IPTK Beam Clamp

The design analysis of the Conn Engineering system provided by the applicant was based on the forces created by a fully loaded Caterpillar 246 skid steer with a weight of 10,792 pounds traveling at a coasting speed of three miles per hour. It is unclear if a safety factor was included in this force calculation. It was assumed in the design that only one cable would provide the stopping force for the equipment and that it would impact perpendicularly to the cable. A maximum deflection in the cable of one foot is required by the design equating to a one foot stopping distance utilized in the engineering analysis. The following limitations were also included in the design:

1. A maximum span of 20 feet between column/wall cable terminations.
2. Cable spans installed in line with the floor opening or roof edge being protected.
3. Termination wall or column member must be capable of resisting the design forces.
4. No substitution of materials unless of equivalent strength and higher grade.
5. No deviation in the design unless evaluated by a professional engineer licensed within the jurisdiction of the project.

9.0 PETITIONER'S BASIS FOR NEW REGULATION

9.1 Adoption of Section 1735(v) from ANSI 10.6 – 1969

The petitioner contends that the current requirements of Title section 1735(v) for curbs or stop-logs around floor openings is antiquated and not applicable to modern demolition operations. In supporting this assertion, the petitioner alludes to similar requirements to that of section 1735(v)

[3] U.S. federal classification for wire rope clips. Class 1 clip u-bolts, nuts and saddles must be made of forged carbon steel.

in previous versions of ANSI A10.6 which were subsequently removed from the standard. Section 1735(v), the petitioner argues, uses old language that has not been included in the ANSI A10.6 standard since the 1969 edition. Section 6.8 of ANSI 10.6-1969, referenced by the petitioner, contains very similar language to that found in Title 8 section 1736(i)(1) and the exact language of CFR section 1926.852(f) listed in sections 4.0 and 6.0 of this evaluation respectively. These standards require openings around waste chutes to be protected by a toeboard or bumper when material is dumped into the chute by a wheel barrow or mechanical equipment.

9.2 Disadvantages of Curbs and Stop-Logs

The petitioner asserts that curbs and stop-logs provide inferior safety due to several disadvantages compared to that of a protective cable system. With the introduction of larger and more powerful skid steers to the demolition industry, the petitioner argues that curbs and stop-logs are no longer an effective means to prevent the equipment from running over the edge. No functional testing or other data was provided by the petitioner in support of this assertion.

An additional disadvantage of curbs and stop-logs, the petitioner contends, is the effect they have on the operation of the loading equipment. In order to deposit material into a floor opening protected by curbs or stop-logs, the operator of the skid steer must raise the bucket above the floor in order to clear the curb or stop-log. This action, the petitioner argues, causes the center of gravity of the skid steer to move forward at varying levels depending on the size of the load, thereby increasing the likelihood that the equipment will fall into the opening. The petitioner also asserts that having to raise the bucket of the skid steer over a curb or stop-log may require barriers or guardrails to be removed, presenting a potential fall hazard.

9.3 Advantages of a Protective Cable System

Utilizing a protective cable system around floor openings, the petitioner argues, eliminates the above-mentioned hazards by allowing the skid steer operator to keep the bucket of the equipment on the floor. This situation, he contends, prevents changing the center of gravity of the equipment, which can be substantial depending on the size of the load. The use of a cable system, he asserts, also eliminates the need to remove barriers or guardrails, because the protective cable system itself serves as fall protection for the floor opening.

9.4 Federal OSHA Interpretation Letter

In support of the potential effectiveness of the proposed protective cable system, the petitioner submitted a letter of interpretation for CFR 1926.856(b) from federal OSHA Director of the Directorate of Construction, Dean McKenzie. Section 1926.856(b) contains identical requirements to that of Title 8 section 1735(v) and is included in section 6.0 of this evaluation. In his letter, Director McKenzie states that a protective cable system such as the conceptual design from Conn Engineering dated March 4, 2016, has the potential to prevent mechanical equipment such as a skid steer from running over the edge of a floor opening. McKenzie states, however, that the effective utilization of such a device would depend on individual site conditions due to the limitations and variables of the design such as the weight and speed of the equipment, span and specified sag of the cables as well as the strength of the cables, columns, walls and attachment points. Therefore, McKenzie concluded in the letter that each location of such a system would require a design from a registered structural engineer.

The petitioner asserts that this letter indicates an affirmation from federal OSHA that a cable protective system may be utilized in lieu of the curbs and stop-logs required by section 1926.856(b).

10.0 ANALYSIS

10.1 Adoption of Section 1735(v) from ANSI 10.6 – 1969

Title 8 section 1735(v) was likely adopted in the early 1970s, based on a review of the amendment history of that section. The Initial Statement of Reasons (ISOR) was requested from the Occupational Safety and Health Standards Board, but the adoption of section 1735(v) was found to predate the Board's rulemaking records. It is possible that section 1735(v) was adopted using guidance from ANSI A10.6 based on the similar requirement found in section 6.8 of the 1969 addition. Although the exact language of this section is no longer present in A10.6, very similar language still exists in section 10.1.7 of the current (2006) edition of the ANSI standard. This language is included within section 7.1 of this evaluation.

However, Cal/OSHA disagrees that the age of section 1735(v) affects its applicability. Curbs, stops and similar devices have been widely employed since the 18th century and are still used today in industry as well as on public roads and in parking lots as an effective means to prevent vehicles and mechanical equipment from traveling into unwanted areas. Although the size, power and technological advancements of modern demolition equipment may have changed since the 1970's, the basic vehicle design has not changed. This type of equipment still rides on wheels with rubber tires and may be by successfully brought to a stop with the use of sufficient curbs or stop-logs.

10.2 Disadvantages of Curbs and Stop-Logs

Cal/OSHA agrees that the size of loading equipment such as skid steers can affect the ability of a curb or stop-log to prevent the vehicle from running over the edge of a floor opening. With the increased size and capacity of loading equipment comes an increase in mass as well as a potential increase in wheel and/or tire size. These two characteristics have a two-pronged effect on the ability of curbs or stop-logs to stop the equipment. Due to the increased mass of a vehicle, the force required to stop it is greater at any particular speed. In addition, an increase in the diameter of the tires of the equipment results in the curb contacting the tire at a proportionately lower height than it would with a smaller tire. This situation decreases the stopping force applied by the curb thereby allowing the tires to roll over the curb more easily. At the same velocity, heavier vehicles with larger diameter tires are more likely to go over curbs than a lighter vehicle with smaller diameter tires without taking into account the difference in engine power.

Cal/OSHA also agrees that the power output of skid steers and other loading equipment can also affect the effectiveness of curbs and stop-logs. An increase in engine power allows a vehicle to more easily roll over or dislodge a curb or stop-log. The same can occur, however, with a protective cable system. A piece of equipment with greater power will also require greater stopping force by the cable system.

Although Cal/OSHA agrees that the size and power of loading equipment can affect the use of curbs and stop-logs, it disagrees with the conclusion that such loading equipment

characteristics render the curbs and stop-logs ineffective. Section 1735(v) is a performance-based standard and does not dictate the physical characteristics of the curb or stop-log to be utilized. Pursuant to the standard, a curb or stop log must be used that will effectively prevent mechanical equipment from running over the edge of a floor opening. In the event that a particular design is not effective, the dimensions, material, attachment points etc. must be changed to meet the stopping force requirements of the weight, speed and power of the equipment to be utilized.

10.3 Advantages of a Protective Cable System

Cal/OSHA agrees that raising a loaded bucket of a skid steer or other equipment above the floor changes the center of gravity. The laws of physics dictate that if the weight of an object is changed unevenly, the center of gravity will also change. However, Cal/OSHA does not agree that changing the center of gravity will necessarily cause the equipment to fall into a floor opening. Mechanical equipment equipped with buckets is designed so that a load may be raised safely to different heights for deposition. Pursuant to sections 1509, 1510 and 3328 of Title 8 regulations, the operators of loading equipment must be trained, qualified and are prohibited from operating the equipment under loads and/or speeds in excess of the manufacturer's recommendations or that can create a hazard. If a piece of equipment with a loaded bucket is operated within its capacity and limitations, it will not fall into a floor opening despite the fact that the center of gravity of the equipment has changed.

Cal/OSHA also does not agree that providing a protective cable system such as that proposed by the petitioner eliminates the need for guardrails or barriers. Pursuant to Title 8 section 1620(a), guardrails must be constructed with a top rail from 42 to 45 inches with a mid-rail half way between. The upper and lower cable heights (48 and 72 inches respectively) of the proposed cable system do not meet this requirements of 1620(a) and would, therefore, not be considered an adequate means of fall protection.

10.4 Federal Interpretation of Section 1926.856(b)

Cal/OSHA agrees that the federal interpretation letter from Director McKenzie indicates that a protective cable system such as that proposed by the petitioner would be acceptable in lieu of curbs or stop-logs provided that all of the conditions set forth in the letter are met. Pursuant to section 18(c) of the OSH Act of 1970, state OSHA programs are required to adopt regulations that are at least as effective as those of the federal OSHA program. Interpretations of a regulation provided by federal OSHA, however, do not constitute a change to the standard itself and need not be considered in the adoption or amendment of Title 8 regulations.

10.5 Challenges of a Protective Cable System

Although Cal/OSHA agrees that a protective cable system such as that proposed by the petitioner does have the potential to prevent mechanical equipment used in demolition operations from running over the edge of floor openings, the nature of such systems could make them challenging to implement successfully. Provided that a protective cable system has been designed by a competent and licensed engineer, the system must still be properly installed taking into account multiple variables, assumptions and limitations.

10.5.1 Cable Deflection

One of the most crucial of these variables is the amount of deflection allowed in the cable. As per the engineering analysis from Conn Engineering (Attachment 1), the tension produced in the 20-foot cable with one foot of deflection is 32,631 pounds. If this identical system were installed to allow for a smaller amount of deflection, the amount of resultant tension in the cable would be substantially greater. Decreasing the cable deflection by only one inch, for example, increases the tension in the cable to 38,771 pounds. Based on the manufacturer's rated working load of 20% of the maximum breaking strength, this tension exceeds the recommended rated load for the cable by over 4,000 pounds. A cable deflection of six inches would generate a tension of 156,250 pounds which is over 475% of the recommended rated load.

10.5.2 Structural Supports for Cables

Another variable that can affect the viability of a protective cable system is the termination points of the cables. The proposed system relies on the attachment of the cables to structural members of a building or structure that is being demolished. The structural members may be damaged or partially removed during dismantling operations which would likely result in their inability to sustain the required forces in excess of 32,000 pounds.

10.5.3 Cable Terminations

Proper securing of the cables is also a crucial variable that can affect the strength of the proposed system. This is particularly the case for the option that employs the use of wire rope clips as securing means. Although many wire rope clips may appear similar, they can vary widely in capacity. Although the Conn Engineering design calls for forged steel wire rope clips meeting the federal FF-C-450 type 1 class 1 classification, less costly clips of inferior materials are often used in place of them. Cal/OSHA inspections commonly find that cast malleable wire rope clips are used in lieu of forged steel clips. These cast malleable clips often have no data provided from the manufacturer as to their maximum working load.

Variables in the use of wire rope clips may also be present even if the proper forged and rated wire rope clips are utilized. In order to retain a certain percentage of working load, wire rope clip manufacturers publish requirements specifying the number and spacing of the clips as well as the torque specification for the u-bolt nuts. It is commonly observed during Cal/OSHA inspections, however, that these requirements are not properly followed. The Conn Engineering design does not appear to take a reduction of working load into account, as the calculated tension forces in the cable are nearly 100% of the cables recommended working load.

10.5.4 Assumptions and Limitations of Cable System Design

Any design of a system such as the proposed conceptual protective cable system must rely on assumptions and are subject to limitations. The Conn Engineer design assumes an equipment of 10,792 pounds traveling at a maximum speed of 3 miles per hour. Additionally, the design assumes a path of travel that is perpendicular to cable and that the equipment will impact at the center of the cable span. These variables are difficult to control in real-world work conditions on a demolition project making it challenging to meet the limitations of the design.

The Conn Engineering design also assumes that the equipment frame, cab and/or other components that utilize the system will have sufficient strength to withstand the required stopping forces. This would have to be considered for each type of equipment to be used at the

site. An effective hazard analysis would have to be done for each new piece of equipment before it is introduced. The same may be said for equipment of varying configurations. In order to prevent a skid or other equipment from running over the edge of a floor opening, the cable must be placed far enough back so that the wheels are not allowed to pass over the edge. This distance may vary depending on the type, design, configuration and wheel base of the equipment and may make it impractical to use for certain types or designs of equipment.

11.0 Conclusion

Cal/OSHA reviewed the petition requesting the addition of new requirements for the use of a cable system within Title 8 subsection 1735(v) to prevent mechanical equipment from running over the edge of floor openings in demolition operations. These new requirements would allow for the use of a protective cable system composed of two wire rope cables designed by a professional engineer as an alternative to curbs or stop logs.

Information provided by the petitioner was reviewed as to the purpose of the petition and how the new regulation would enhance worker safety. The conceptual design from Conn Engineering Consultants, Inc. of the proposed cable system was reviewed, along with materials specifications, termination connections, and securing devices. Additionally, the International Union of Operating Engineers (IUEO Local 12), the American Society of Safety Engineers, and the Laborer's Health and Safety Fund of North America (LHSFNA) were contacted to provide their opinions on the proposed petition. Neither ASSE nor LHSFNA could provide an official position on the proposal, and no response was received from IUEO Local 12.

Although the proposed cable protective systems have the potential to prevent mechanical equipment from running over the edge of floor openings, the many variables and limitations inherent in such designs carry with them many challenges. Small changes in the installation or materials could render the systems ineffective. In addition, effectively controlling the work environment to conform to the many limitations of these systems would be problematic. Cal/OSHA believes the petition should be denied.