MIDWEST	EAST	CENTRAL	WEST	MOUNTAIN
24400 Sperry Drive	350 Green Oaks Pkwy	1976 Innerbelt Business Center Drive	28258 Avenue Stanford	875 S 600 W
Westlake, OH 44145	Holly Springs, NC 27540	Overland, MO 63114	Valencia, CA 91355	Heber City, UT 84032
(800) 504-4016	(866) 387-9965	(314) 942-8786		

Web: https://www.fallprotect.com/

SECTION 11 81 29.16 - TRIANGULAR TRUSS FALL ARREST SYSTEM

VERSION NO.	DATE	"RELEASED FOR…."	DESCRIPTION OF ADDITIONS / DELETIONS / CHANGES / UPDATES / & CLARIFICATIONS
1	10-30-2023	1ST REVIEW	NEW SECTION
2			
3			

TIPS:

To view/hide non-printing Editor's Notes that provide guidance for editing:
Word 365 and recent versions: Select Home/Font and check/uncheck Hidden in the Effects group.
Word legacy versions: Select Tools/Options and check/uncheck Hidden Text in the Formatting Marks group.

WHAT MANNER OF FALL PROTECTION SHOULD BE PROVIDED? Step one is to determine, for the structure or area in question, whether fall protection will be provided via a "Travel Restraint System" or a "Fall Arrest System." The main difference between "travel restraint" and "fall arrest" is that travel restraint stops people from accessing or approaching a fall hazard through a tie off system, while fall arrest allows a fall to occur but arrests and minimizes injury in the event of a fall. Additionally, exterior Building Maintenance (EBM) anchorage systems are required when façade access such as window washing, caulking, or other maintenance activities are to be accomplished using suspended access via powered platform and/or RDS (Rope Descent System)

WHO IS RESPONSIBLE FOR FALL PROTECTION: Building owners, employers, workers, architects and engineers all have their respective duties and responsibilities.

✍ **Building Owners** are responsible for fall protection if they hire someone to work at height. This happens more often than you'd think. The frequency of cleaning, maintenance and repair work at height is often underestimated. As the owner of a building, you are responsible for the work that is done on your building. Therefore, building owners are advised to ensure that the appropriate safety measures are taken, and that workers observe the applicable regulations for the use of triangular truss system.

Per 29 CFR § 1910.27(b)(1)(i) - Before any rope descent system is used, the building owner must inform the employer, in writing that the building owner has identified, tested, certified, and maintained each anchorage so it is capable of supporting at least 5,000 pounds (2,268 kg), in any direction, for each employee attached. The information must be based on an annual inspection by a qualified person and certification of each anchorage by a qualified person, as necessary, and at least every 10 years.

Per 29 CFR § 1910.27(b)(1)(i) - The employer shall assess the workplace to determine if hazards are present, or are likely to be present, which necessitate the use of personal protective equipment (PPE).

✍ **Employers** are responsible for the safety of their employees. They are also expected to make sure that all employees possess the skills and knowledge needed to use the equipment the correct way. This also applies to interns, temporary workers or third-party workers under the supervision of an employer. See 29 CFR § 1926.501 - Duty to have fall protection

✍ Qualified Person is responsible for supervising the design, selection, installation, use and inspection of certified anchorages and horizontal lifelines.

✍ Competent Person is responsible for the immediate supervision, implementation and monitoring of the fall protection program.

Authorized person means a person approved or assigned by the employer to perform a specific type of duty or duties or to be at a specific location or locations at the jobsite

✍ **Employees** - It is mandatory for employees to make use of triangular truss system. They are also expected to assess their own safety in a particular situation. Among other things, this means they have to inspect the equipment before using it. If something is not in good condition, they must cease to use the equipment. When in doubt, they are required to report the situation to their supervisor, to rule out the possibility of work at height being executed in an unsafe manner.

✍ **Architects** should develop, in coordination with the Owner and structural and specialty fall protection engineers, a preliminary design layout that is in compliance with applicable Building Codes, OSHA Regulations, and industry standards for suspended facade access and fall protections systems that will best suit the building facade access and/or fall protection requirements and that are safe, functional and compliant. One of the most important aspects of personal triangular truss systems is fully planning the system "before" it is put into use. Probably the most overlooked component is planning for suitable anchorage points. Such planning should ideally be done before the structure or building is constructed so that anchorage points can be incorporated during construction for use later for window cleaning or other building maintenance. If properly planned, these anchorage points may be used "during" construction, as well as afterwards.

✍ **Structural Engineer of Record**: Building structural engineer should design roof and wall structures to accommodate added loads imposed by triangular truss system that is integrated into the building structure. Specialty fall protection engineers are best equipped to perform final design of triangular truss system in a

design/build capacity. Depending on the scope of the project and the qualifications of the engineer, this party may act as the Fall Protection Engineer (see below).

✍ **Fall Protection Engineer**: Qualified by OSHA and ANSI z359.6 to supervise the design, selection, installation, use and inspection of triangular truss systems.

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes horizontal overhead triangular truss triangular truss systems.

B. Related Requirements:

Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.

Coordinate related work required to make a complete installation. Delete sections that do not apply to Project; add other sections as required. Be sure that structural design includes live and dead loads and safety factors for this equipment. Also consider suspension point locations, architectural obstructions, maintenance access to roof areas, hot and cold water supply for window washing, power supply, and method of hoisting and installation of equipment.

If including Section Numbers with or instead of Titles, below is MasterFormat Section Number 03 30 00.

1. Div. 03 Section "CAST-IN-PLACE CONCRETE" for embedment of anchorage devices in concrete foundations.

1.03 REFERENCES

A. Abbreviations and Acronyms:
1. HLL: Horizontal lifeline.
2. ISA: Intermittent stabilization anchorage.
3. PFPE: Personal triangular truss system.
4. SAE: Suspended access equipment.
5. SRL: Self retracting lifeline.
6. SWPS: Suspended work platform system.

B. Definitions: Definitions in OSHA 29 CFR 1910 and 1926 including their subparts apply to this Section.

Below are some definitions in OSHA 29 CFR 1910 and 1926 that are pertinent to this Section but need not be repeated herein.

Anchorage means a secure point of attachment for lifelines, lanyards or deceleration devices devices, and which is independent of the means of supporting or suspending the employee. - APPENDIX C TO § 1910.66

Personal fall arrest system means a system used to arrest an employee in a fall from a working level. It consists of an anchorage, connectors, a body belt or body harness and may include a lanyard, deceleration device, lifeline, or suitable combinations of these. As of January 1, 1998, the use of a body belt for fall arrest is prohibited. - APPENDIX C TO § 1910.66

Personal triangular truss system means a system (including all components) an employer uses to provide protection from falling or to safely arrest an employee's fall if one occurs. Examples of personal triangular truss systems include personal fall arrest systems, positioning systems, and travel restraint systems.

Positioning system (work-positioning system) means a system of equipment and connectors that, when used with a body harness or body belt, allows an employee to be supported on an elevated vertical surface, such as a wall or window sill, and work with both hands free. Positioning systems also are called "positioning system devices" and "work-positioning equipment."

Positioning device system means a body belt or body harness system rigged to allow an employee to be supported on an elevated vertical surface, such as a wall, and work with both hands free while leaning. - § 1926.500

Guardrail system means a barrier erected to prevent employees from falling to lower levels. - § 1926.500

Lifeline means a component consisting of a flexible line for connection to an anchorage at one end to hang vertically (vertical lifeline), or for connection to anchorages at both ends to stretch horizontally (horizontal lifeline), and which serves as a means for connecting other components of a personal triangular truss system to the anchorage. - APPENDIX C TO § 1910.66

Travel restraint (tether) line means a rope or wire rope used to transfer forces from a body support to an anchorage or anchorage connector in a travel restraint system.

Travel restraint system means a combination of an anchorage, anchorage connector, lanyard (or other means of connection), and body support that an employer uses to eliminate the possibility of an employee going over the edge of a walking-working surface.

Warning line system means a barrier erected on a roof to warn employees that they are approaching an unprotected roof side or edge, and which designates an area in which roofing work may take place without the use of guardrail, body belt, or safety net systems to protect employees in the area.

Safety factor means the ratio of the design load and the ultimate strength of the material.

Note: Travel restraint systems allow users to approach fall hazards without falling over a dropoff. If a travel restraint system is used, there is no need to provide for prompt rescue under §1926.502(d)(20), since there would not be an arrested fall. ANSI Z359.2 prohibits travel restraint systems on sloped roofs with slope over 4:12.

1. **[Travel Restraint System]**: A system, consisting of a combination of an anchorage, anchorage connector, lanyard (or other means of connection), and body support that an employer uses to eliminate the possibility of an employee going over the edge of a walking-working surface. A Travel Restraint System is arranged so that a worker is allowed to approach fall hazards yet is prevented from falling over a dropoff.

Note: When use of a travel restraint system is not feasible, a fall arrest system must be used and engineered so if a user falls, the system will promptly arrest or stop the fall. A fall arrest system further requires provision for prompt rescue under §1926.502(d)(20).

2. **[Fall Arrest System]**: A system used to arrest an employee in a fall from a working level. A fall arrest system exposes a worker to a fall, but arrests or stops the fall within specified parameters.
3. Anchorage, as used in this Section, means a secure point of attachment for lifelines, lanyards, or deceleration devices, which is independent of the means of supporting or suspending an employee or worker.
4. Anchor, as used in this Section, means a fastener or fastening device used to secure an anchorage or other component of the triangular truss system to the structure.
5. Competent Person:
   a. As defined in 29 CFR 1910.140(b) as "a person who is capable of identifying existing and predictable hazards in any personal triangular truss system or any component of it, as well as in their application and uses with related equipment, and who has authorization to take prompt, corrective action to eliminate the identified hazards."
6. Qualified Person:
   a. As defined in 29 CFR 1910.140(b) as "a person who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience has successfully demonstrated the ability to solve or resolve problems relating to the subject matter, the work, or the project."

C. Reference Standards: Perform Work per standards specified and as follows unless modified by requirements in the Contract Documents.

Include the following Paragraph only when cost of acquiring specified standards is justified. Retain first option for paid or free subscription access. Retain second option when a physical copy on site is required.

1. American National Standards Institute (ANSI)/The American Society of Safety Professionals (ASSP):
   a. ANSI/ASSP Z359.16 "Safety Requirements for Climbing Ladder Fall Arrest Systems."
   b. ANSI/ASSP Z359.6 - Specifications and Design Requirements for Active Triangular truss systems."

In 1988, the ANSI Z359 Fall Protection Committee was chartered to develop the first consensus standard. In 1992, ANSI Z359.1 - Safety Requirements for Personal Fall Arrest Systems, Systems and Components was published. It was developed to provide standard safety requirements for personal fall arrest systems, subsystems, and components. The purpose of these ANSI safety standards was to provide guidance in regards to the design of triangular truss systems and the variety of equipment used in the industry. The standard was revised in 2007 in conjunction with American Society of Safety Engineers (ASSE). ANSI and ASSP have continued to work together with other industry leaders and government agencies to keep the standard of fall protection updated. The standard is constantly evolving and has added separate sections to address different parts of the Fall Protection Code. The following are a list of the current sections::
ANSI/ASSP Z359.0-2012 - Definitions and Nomenclature Used for Fall Protection and Fall Arrest
ANSI/ASSP Z359.1-2016 - The Fall Protection Code - Digital Only
ANSI/ASSP Z359.2-2017 - Minimum Requirements for a Comprehensive Managed Fall Protection Program

ANSI/ASSP Z359.3-2017 - Safety Requirements for Lanyards and Positioning Lanyards
ANSI/ASSP Z359.4-2013 - Safety Requirements for Assisted-Rescue and Self-Rescue Systems, Subsystems and Components
ANSI/ASSP Z359.6-2016 - Specifications and Design Requirements for Active Triangular truss systems
ANSI/ASSP Z359.7-2011 - Safety Requirements for Assisted Rescue and Self Rescue Systems, Subsystems, and Components
ANSI/ASSP Z359.11-2014 - Safety Requirements for Full Body Harnesses
ANSI/ASSP Z359.12-2009 - Connecting Components for Personal Fall Arrest Systems
ANSI/ASSP Z359.13-2013 - Personal Energy Absorbers and Energy Absorbing Lanyards
ANSI/ASSP Z359.14-2014 - Safety Requirements for Self-Retracting Devices for Personal Fall Arrest and Rescue Systems
ANSI/ASSP Z359.15-2014 - Safety Requirements for Single Anchor Lifelines and Fall Arresters for Personal Fall Arrest Systems
ANSI/ASSP Z359.16-2016 - Safety Requirements for Climbing Ladder Fall Arrest Systems
ANSI/ASSP Z359.18-2017 - Safety Requirements for Anchorage Connectors for Active Triangular truss systems

2. Occupational Safety and Health Administration (OSHA):
   a. OSHA 29 CFR 1910, "Occupational Safety and Health Standards."
      1) OSHA 29 CFR 1910, Subpart D "Walking and Working Surfaces."

Below covers powered platform installations permanently dedicated to interior or exterior building maintenance such as window cleaning, caulking, metal polishing and reglazing. Building owners have a duty to inform the employer before each use in writing that the installation meets the requirements.

      2) **[OSHA 29 CFR 1910, Subpart F "Powered Platforms, Manlifts, and Vehicle-Mounted Work Platforms."]**
   b. OSHA 29 CFR 1926, "Safety and Health Regulations for Construction."
      1) OSHA 29 CFR 1926, Subpart M "Fall Protection."

Delete the following paragraph and subparagraphs below if NOT in California.

3. **[State of California Regulations: Code of Regulations, Appendix C to Article 6 (Personal Fall Arrest System).]**

Retain below for Sustainable Design projects.

4. U.S. Green Building Council (USGBC) - Leadership in Energy and Environmental Design (LEED) (http://www.usgbc.org/):
   a. USGBC-LEED **[v4]** for **[Building Design and Construction (BD+C)] [Interior Design and Construction (ID+C)] [Building Operations and Maintenance (O+M)] [Neighborhood Development (ND)] [Building Design and Construction: Homes and Midrise (BD+C)]** Reference Guide.

1.04 ADMINISTRATIVE REQUIREMENTS

Insert agenda items below not listed in Div. 01 Section "Project Meetings."

A. Coordination:
   1. Coordinate layout and installation of work of this Section with interfacing and adjoining work and other Sections affecting or affected by work of this Section for proper sequencing of each installation.

2. Furnish setting drawings, diagrams, templates and installation instructions to other Sections.
3. Furnish inserts and anchoring devices which need to be preset and built into structure to appropriate trade. Supply on timely basis to avoid delay in Work.
4. Instruct other trades of proper location and position.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities; operating weights; furnished specialties; and accessories.

B. Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication and assembly of triangular truss system, as well as procedures and diagrams.
1. Show complete layout and configuration of triangular truss system including all components and accessories.
2. Clearly indicate design and fabrication details and installation details.
3. Include plans, elevations, sections, details, and attachments to other Work
4. Include installation and rigging instructions and all necessary Restrictive and Non-Restrictive Working Usage Notes and General Safety Notes.
5. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

Retain "data" below unless project engineers specifically request "calculations."

C. Delegated-Design Submittal: Include design **[data] [calculations]**for triangular truss system for which design is assigned to Contractor.
1. Indicate working and ultimate loads for each item of triangular truss system.
2. Indicate design loads imposed on foundations and other structurs at points of support.

ICC 2015 IBC 107.3.4.1 reads:

"Deferral of any submittal items shall have the prior approval of the building official. The registered design professional in responsible charge shall list the deferred submittals on the construction documents for review by the building official."

DEFERRED SUBMITTAL (def): Those portions of the design that are not submitted at the time of the application and that are to be submitted to the building official within a specified period.

Deferred Submittals shall be submitted to the registered design professional in responsible charge who shall review them and forward them to the building official with a notation indicating that the deferred submittal documents have been reviewed and found to be in general conformance to the design of the building. The deferred submittal items shall not be installed until the deferred submittal documents have been approved by the building official.

1.06 INFORMATIONAL SUBMITTALS

A. Manufacturers’ instructions for each product.

Field quality control test and inspection reports.Retain below for Sustainable Design projects.

B. Sustainable Design **[LEED]** Submittals:
   1. **[<insert requirements or reference to Division 01 Sections as required>]**

Only retain last option below if Contractor or manufacturer selects testing agency or if Contractor is required to provide services of a qualified testing agency in "Field Quality Control" Article.

C. Qualification Statements for**[manufacturer,] [installer,] [welders,] [design professional,] [**
   1. Include manufacturer's approval for installer.
   2. Include list of past Projects and contacts evidencing compliance with specified qualifications.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For triangular truss systems, subsystems, and equipment to include in operation and maintenance manuals.
   1. Requirements for personal fall protection including complete instructions for users and building maintenance personnel for the safe and proper use, operation, and maintenance of the equipment specified.
   2. Provisions for pre-operational, operation, and maintenance inspections. Include a Log Book outlining mandatory annual inspection requirements that are in accordance with ANSI and OSHA Regulations and Industry Standards.
   3. Plan view drawing of the building's roof, including the building name and address.
      a. Show triangular truss system layout and details.
      b. Identify anchorage points for personal fall arrest systems.
      c. Identify load ratings of each item of triangular truss system including special use conditions.

The following paragraph applies only to California. Delete if not required.

   4. **[An Operating Procedures Outline System (OPOS) for all procedures not covered by the California Labor Code orders. Indicate date the OPOS was prepared on isometric or plan view drawing.]**

Retain below if required by authorities having jurisdiction.

B. **[Regulatory agency approvals for use of triangular truss system.]**

1.08 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer Qualifications: Minimum **[10]** years experience
      a. Company: One specializing in the design, fabrication and installation of triangular truss system specified in this Section and whose products have a record of successful in-service performance.

Verify manufacturer insurance requirements with Owner.

b. Manufacturer shall maintain specific liability insurance (products and completed operations) in the amount of **[$2,000,000.00]** to protect against product/system failure.

2. Installer Qualifications: Minimum **[5]** years experience
   a. Company: A firm or individual certified, licensed, or otherwise qualified or employed by triangular truss system manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements. A manufacturer's willingness to sell its materials to Contractor or to an installer engaged by Contractor does not in itself confer qualification on the buyer.
   b. Project Experience: Minimum **[5]** years experience on at least **[5]** projects of similar nature in past **[5]** years.
   c. Staff: Employ a competent foreman who is a Competent Person as defined in 29 CFR § 1926.32(m) and who is a certified installer to supervise Work of this Section. Foreman shall be present whenever Work is in progress.
3. Welder Qualifications: Welders must be qualified to applicable AWS Standards for each type of weld required.

Retain "Testing Agency Qualifications" Paragraph below if Contractor or manufacturer selects testing agency or if Contractor is required to provide services of a qualified testing agency in "Field Quality Control" Article.

4. Design Professional Qualifications:
   a. Professional engineer **[employed by the triangular truss system manufacturer and]** experienced in design and engineering of triangular truss system, its application and safety requirements, **[licensed] [or] [registered]** in jurisdiction in which Project is located, and who assumes responsibility for the following:
      1) Preparation of comprehensive engineering analysis data.
      2) Preparation of engineering calculations.
      3) Preparation of shop drawings and other submittals.

Below may include lab or field testing for compliance.

      4) Testing program development.
      5) Review and corroborate comments from Architect and other reviewers on delegated-design submittals and address required changes in their design.

B. Certifications:

1910.27(b)(1)(i) now requires that before “employers use a rope descent system, the building owner must inform the employer in writing that the building owner has identified, tested, certified, and maintained each anchorage so it is capable of supporting 5,000 pounds (2268 kg) in any direction, for each worker attached”.

Building owners had until fall of 2017 to ensure all of your anchorage is capable of supporting 5,000 pounds (2268 kg) in any direction for each attached worker. The only way to definitively make this determination is to pull test each anchorage.

1. Inspection certificates**[and use permits]** for triangular truss system.

Normally retain first option below if manufacturer or supplier will perform preconstruction testing. Retain second option if Owner will perform testing.

1.09 DELIVERY, STORAGE, AND HANDLING

Retain this article only if providing detailed requirements that apply to Work of this Section and that supplement general provisions in Section 016000 "Product Requirements."

A. Delivery Requirements: Deliver materials in manufacturer’s undamaged packaging, complete with installation instructions.

1.10 WARRANTY

A. Manufacturer's Standard Warranty: Manufacturer will warrant the products specified below, to operate properly, if the triangular truss system is inspected annually by the manufacturer or a certified representative.
   1. Warranty Periods from date of Substantial Completion:

Edit below to retain only those components intended for installation on this Project.

      a. Triangular Truss System: 10 years.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

Retain "Manufacturers" Paragraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

A. Manufacturers: Subject to compliance with requirements, **[provide products as furnished by the following]**

On June 23, 2015, 3M www.3m.com announced a deal to acquire Capital Safety for $1.8 billion. The Capital Safety brands—including DBI-SALA® and Protecta®—products, and people are now a part of 3M Fall Protection.

   1. Diversified Fall Protection.
   2. Substitutions **[will] [will not]** be considered. Comply with provisions of Div. 01 Section "SUBSTITUTION PROCEDURES."

B. Project Source Limitations: Obtain triangular truss system, whether specified in this Section or in other Sections, through one source from a single manufacturer who is capable of showing prior successful production of units similar to those required for entire Project

2.02 DESCRIPTION

Suspended Access Fall Arrest Systems, are designed to provide two independent tie-off points required to support a suspended worker - one for the boatswain's chair or other worker support device and the other as the workers safety line. Suspended access fall arrest systems are typically used by window cleaners and other maintenance trades that need to access exterior building façades. Suspended access systems include anchorage points and may include davits, rigging sleeves, monorails, and outrigger beams.

Rooftop Access: Travel restraint and fall arrest systems allow workers to traverse rooftops or similar elevated areas while maintaining 100 percent tie-off to an OSHA and ANSI compliant system.

Rooftop access systems are typically needed by trades who perform routine maintenance of roof-based equipment such as HVAC equipment, communication equipment, security cameras, gutters, solar panels, skylights, and lighting, or use by trades performing window cleaning or façade maintenance, allowing them to be safely tied to an anchorage point while rigging, prior to performing their descents.

A. Triangular truss systems consist of permanently installed triangular truss system with required attachment devices and accessories:

Retain anchorages and systems used below. Delete items not planned for use.

1. Anchorages secured to building structure for securing worker safety lines**[, suspended scaffolds,][and rope descent systems].**

Consider anchorage at mezzanines or similar removable railing/gate openings for hoist area material handling.

2. **[Intermittent stabilization anchorage secured to building facade** for powered platform stabilization.
3. **[Horizontal lifelines]** for attachment of personal fall arrest systems.
4. **[Vertical lifelines]** for attachment of personal fall arrest systems.
5. **[Rigid trolley rails]** for attachment of personal fall arrest systems.
6. **[Overhead monorails]** for attachment of **[rope descent systems] [and powered platforms]**.
7. **[Davit assembly]** for support of **[rope descent systems,] [powered platforms,] [single worker cages,] [or] [boatswain's chairs]**.
8. **[Outrigger beams]** for support of **[rope descent systems,] [powered platforms,] [single worker cages,] [or] [boatswain's chairs]**.
9. **[Rigging sleeves]** intended to directly or indirectly support or change the force direction of loads.

Fall protection guards may also include barriers across truck dock edges, dock doorways, roof hatches, ladder/stair access points, mezzanines, and other raised platforms.

Protection is required per 1910.28(b)(3)(i) at holes including skylights, stairway floor holes, ladderway floor holes, hatchway and chute-floor holes, and other holes on roofs

10. **[Ballasted** guard rails
11. **[Skylight screens.]**
12. **[Permanent powered platforms.]**
13. **[Warning lines]** to warn workers they are approaching an unprotected side or edge, and which designate areas in which work may take place without using other means of fall protection.

B. Product Options: Drawings **[may]** indicate suggested locations**[, profiles, and dimensional requirements]** of triangular truss system and are based on the specific system indicated. Final locations shall be determined according to triangular truss system manufacturer's design requirements.
1. If modifications are proposed, submit, with Shop Drawings, comprehensive explanatory data to Architect for review.

Retain applicable standards below.

C. Regulatory Requirements: Provide triangular truss system, supports, and anchorage designed and constructed to suit building configuration and in accordance with the Contract Documents and applicable regulations and codes.
   1. Comply with the following ANSI/ASSP regulations:
      a. **[ANSI/ASSP Z359.16 "Safety Requirements for Climbing Ladder Fall Arrest Systems."]**
      b. ANSI/ASSP Z359.18 "Safety Requirements for Anchorage Connectors for Active Triangular truss systems "Part of The Fall Protection Code."

ANSI/IWCA I-14.1 Window Cleaning Safety Standard requires fall protection whenever a worker must travel within 6 feet of a vertical drop. Fall protection may be in the form of a code-compliant guardrail or parapet. When such code-compliant perimeter guarding does not exist and cannot be installed, a horizontal Travel Restraint cable system may be the best option for providing fall protection.

      c. ANSI/IWCA I-14.1 "Window Cleaning Safety Standard."

Coordinate the code citations below with State and local requirements. The first set is U.S. OSHA regulations for all States except New York and California, which have more stringent regulations.

   2. Comply with the following OSHA regulations:
      a. OSHA 29 CFR 1910, Subpart D "Walking and Working Surfaces."

Below covers powered platform installations permanently dedicated to interior or exterior building maintenance such as window cleaning, caulking, metal polishing and reglazing. Building owners have a duty to inform the employer before each use in writing that the installation meets the requirements.

      b. **[OSHA 29 CFR 1910, Subpart F "Powered Platforms, Manlifts, and Vehicle-Mounted Work Platforms."]**
      c. OSHA 29 CFR 1926, Subpart M "Fall Protection."

Delete the following paragraph and subparagraphs below if NOT in California.

   3. **[Comply with State of California regulations: Code of Regulations, Appendix C to Article 6 (Personal Fall Arrest System).]**

2.03 PERFORMANCE / DESIGN CRITERIA

A. Delegated Design: Professional design services are specifically required of Contractor. Engage a qualified design professional to design the triangular truss system, using performance requirements and design criteria specified herein.
   1. Design Criteria:
      a. Triangular truss system shall comply with current applicable federal, OSHA, ANSI, and state regulations and standards.
      b. Design anchorage components, using proper engineering principles, to provide adequate attachment to foundations; ensure compatibility with industry standard equipment.
      c. Design triangular truss system to accommodate structural movement, movement within system, movement between system and support components, dynamic loading and release of loads, and deflection of structural support, without detriment to durability or performance, without damage to support structure.
      d. Design triangular truss system and provide clearances that will allow for installation tolerances.
   2. Structural Performance Criteria: Provide triangular truss system, including anchorages, complying with specific performance and design criteria indicated, capable of

withstanding, without failure, the effects of gravity loads and in-use loads and stresses under conditions indicated or reasonably anticipated. Include necessary modifications to meet required criteria.

a. Contract Documents may indicate certain performance requirements, features, and primary components required, but do not cover details of design and construction, and do not purport to identify nor solve problems of thermal or structural movement, anchorage, or moisture disposal. Requirements shown by details are intended to establish basic locations and dimension of triangular truss systems.
b. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
c. Compliance with requirements of authorities having jurisdiction is the responsibility of Contractor.

2.04 HORIZONTAL TRIANGULAR TRUSS SYSTEMS

Designer/Specifier must decide if system is for "travel restraint" (to eliminate a fall possibility) or "fall arrest" (which allows a fall but arrests the fall to minimize injury). See discussion in TIP at beginning of this Section.

A. Design Criteria: Design as part of a complete **[travel restraint] [fall arrest]** system as follows:

Insert maximum number of simultaneous users below as required to suit Project.

1. Design to allow for **[one] [two]** simultaneous users maximum.
2. Maximum allowable force per truss span: 1,350 lbf (6 kN) per worker, 2,700 lbf (12 kN) maximum.

B. Horizontal Rigid Triangular Truss System: Fixed overhead horizontal truss mounted by **[single-sided (one truss) inverted L] [double sided (two trusses) T]** type support columns. Design system for **[travel restraint] [fall arrest]** purposes and install to allow users to walk uninterrupted the entire length of the system. System consists of a fixed steel angles or rods welded into a triangular cross-section truss with S-shape profile bottom rail with attached travelers to which persons attach to enable freedom of movement along the length of the rail.
1. Basis of Design System: Triangular Truss System by Diversified Fall Protection.
2. Rail Joints: Welded and ground smooth.
3. Curve Transitions: Factory fabricated units forming degree of curve as required.
4. Carriage Stops: Manufacturer’s standard stops which prevent rolling carriages from unintentionally separating from bottom rail. **[Included rubber buffers/stops are secured to rail ends.]**
5. Attachment Carriages: Manufacturer’s standard aluminum units with aluminum, nylon coated wheels. Equip with stainless steel shackle with carabiner hook which pivots for any angle connection.

2.05 STEEL MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A 36M.

Round steel tubing and pipe are sized differently. Pipe is designated by the terms "nominal pipe size (NPS)" in inches and by "weight" or "schedule number." The NPS is approximately equal to the ID for Schedule 40 or Standard Weight pipe. For other weights, the size is neither OD nor ID because the OD is kept the same for all weights (to allow use of the same pipe fittings) and the ID is varied to provide

the required wall thickness. Round tube is designated by OD and wall thickness. Although the size designations are different, only the round tube sizes that match pipe sizes are generally available.

B. Steel Pipe: ASTM A53/A 53M, Standard Weight (Schedule as indicated) unless otherwise indicated.

In 2013, a new standard for HSS, ASTM A1085 Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS), was developed to enhance the performance of HSS and make designing with HSS easier and more efficient for structural engineers. ASTM A1085 has increased the lower bound bend radius to address corner cracking during galvanizing so it is much less frequent and the need for heat treatment is less common. Although the specification of A500 is still very abundant, the design and material improvements within A1085 are leading to increased availability and use in seismic, bridge, and transportation structure applications.

• ASTM A500/A500M-20 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
• ASTM A1085/A1085M-15 Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS), 2015
• ASTM A1065/A1065M-18 Standard Specification for Cold-Formed Electric-Fusion (Arc) Welded High-Strength Low–Alloy Structural Tubing in Shapes, with 50 ksi (345 MPa) Minimum Yield Point

C. Steel Tubing: ASTM **[A1085] [or] [A500] [or] [A1065]**, cold-formed **[Hollow Structural Sections (HSS)] [steel tubing]**.

D. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

2.06 STAINLESS STEEL MATERIALS

Retain next two paragraphs below if any of the following was retained above and specified to be made of stainless steel:
Alternating tread ladders
Ships' ladders
Grating

Usually retain Type 304 in first two paragraphs below; Type 316 is better for corrosive environments. The difference between 316 and 316L stainless steel is that 316L has a 0.03 max carbon and is good for welding whereas 316 has a mid range level of carbon. Both 316 alloys contain molybdenum, which also makes them more corrosion resistant. Even greater corrosion resistance is delivered by 317L, in which molybdenum content increases to 3 to 4% from the 2 to 3% found in 316 and 316L.

A. Stainless Steel Sheet, Strip, and Plate: ASTM A240/A 240M or ASTM A666, **[Type 304] [Type 316] [Type 316L]**.

B. Stainless Steel Bars and Shapes: ASTM A276, **[Type 304] [Type 316] [Type 316L]** with minimum yield strength of 35 ksi.

C. Stainless Steel Anchor Rods: **[Type 304] [Type 316] [Type 316L]** with minimum tensile strength of 100 ksi and minimum yield strength of 65 ksi.

D. Stainless Steel Tubing: ASTM A554, **[Grade MT 304] [Grade MT 316L]**.

E. Stainless Steel Pipe: ASTM A312/A312M, **[Grade TP 304] [Grade TP 316L]**.

F. Cast Stainless Steel: ASTM A747/A747M precipitation hardened casting.

2.07 FASTENERS

A. General: Select fasteners and anchors for type, grade, and class required. Unless otherwise indicated, provide fasteners as follows:

The three options below are listed best, better, good for exterior use.

Usually retain Type 304 stainless; retain Type 316 if required for corrosive environments.

ASTM F2329 specifies avg hot-dip zinc thickness of 0.0020" (50 microns).

ASTM B633 electro-deposited zinc coating classes (Service Condition = SC) - ASTM F1941 uses same designations but doesn't mention Service Conditions:
Fe/Zn 5 = SC 1 (mild) at 5 micron thickness
Fe/Zn 8 = SC 2 (moderate) at 8 micron thickness
Fe/Zn 12 = SC 3 (severe) at 12 micron thickness
Fe/Zn 25 = SC 4 (very severe) at 25 micron thickness

1. Material for exterior **[and interior]**locations in contact with stainless steel: Type **[304] [316]** stainless-steel fasteners.
2. Material for exterior locations exposed to weather: **[Type [304] [316]** stainless steel fasteners] **[hot-dip galvanized fasteners per ASTM F2329]** service condition].
3. Material for interior locations or where built into exterior walls or below roof flash point: [Hot-dip galvanized fasteners per ASTM F2329] [Zinc-plated fasteners with coating per ASTM B 633, Class Fe/Zn]

Retain Group 1 option in first paragraph below for use with Type 304; retain Group 2 option for use with Type 316.

B. Stainless Steel Bolts and Nuts: ASTM F593 **[regular] [heavy]** hexagon-head annealed stainless steel bolts; with ASTM F594 hex nuts; and, where indicated, flat washers; Alloy **[Group 1] [Group 2]**.

C. Stainless Steel Washers: ASTM A240/A 240M, **[Type 304] [Type 316]** and ANSI B18.22.1, Type A Plain.

D. High-Strength Steel Bolts and Nuts: ASTM A325, Type 3 regular hexagon-head bolts; with ASTM A563, Grade C3 hex nuts; and, where indicated, flat washers.

E. Steel Bolts and Nuts: ASTM A307, Grade A regular hexagon-head bolts; with ASTM A563 hex nuts; and, where indicated, flat washers.

F. Post-Installed Anchors: Torque-controlled expansion anchors **or chemical anchors** designed for and recommended by anchorage manufacturer for conditions encountered.

2.08 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

2.09 STEEL AND IRON FINISHES

Hot-Dip Galvanization (HDG) has been the standard for corrosion protection in manufacturing but cannot be done in-house, is labor intensive, has a high energy requirement, represents a large carbon footprint which is hard on the environment, and it requires shipping products from manufacturer to galvanizer and back.

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

Retain subparagraph below if galvanized items are painted.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Pigmented Organic Finish: Manufacturer's standard **[powder coat]** comparable in performance to AAMA 621 coatings.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color: **[High visibility yellow] [As selected from manufacturer's full range]**.

PART 3 - EXECUTION

3.01 INSTALLERS

Under most standard forms of contract, any installer who can perform the work as specified is acceptable. The two primary reasons to list names of installers are (1) to contractually limit the Contractor's options and (2) to give the Contractor the information necessary to find an installer who can do the work specified. Examples of work that might require limiting the Contractor's options are historical restoration work, testing and balancing of mechanical systems, and special finishes where an unusually high level of workmanship is required. When using this Article, coordinate its use with Part 1 Article "Qualifications." If installer names are listed, use the Article "Substitution Limitations" to define the purpose of the installer list. The term "Installers" may be replaced by "Applicators," "Erectors," or "Constructors," as appropriate to the operation to be performed.

Retain "Installers" Paragraph below if a list of preapproved firms is used as a quality-control procedure. Retain first or second option if additional firms will not be considered; retain third option if they will. If retaining third option, include procedure for approving other firms in the Instructions to Bidders.

The term "Installers" may be replaced by "Applicators," "Erectors," or "Constructors," as appropriate to the operation to be performed.

A. Installer List: Installation contractor shall be trained or qualified by the manufacturer.

See association member lists for names of potential firms.

3.02 EXAMINATION

A. Verification of Conditions:**[<insert as required>]**

1. Examine mounting surfaces for suitable conditions where triangular truss system will be installed for compliance with requirements for, installation tolerances, operational clearances, and other conditions affecting performance of work.
2. Verify that structural members to which anchorage is to be attached have adequate bearing surface required to ensure proper attachment per manufacturer's requirements.

Delete subparagraph below if not required.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 PREPARATION

A. Coordinate location of triangular truss system indicated to be attached to permanent structure elements and provide appropriate anchoring devices with installation templates, diagrams, and manufacturer's instructions.

3.04 INSTALLATION, GENERAL

A. Comply with manufacturer's written installation instructions and recommendations, referenced standards, requirements of authorities having jurisdiction, and approved submittals.

B. Securely and rigidly install products in place to obtain the required working loads without exceeding allowable loads for each item of triangular truss system.

C. Field Welding: Welding methods shall comply with AWS D1.1. After installation, clean and paint as necessary any field welds with cold galvanizing compound to prevent corrosion.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where fall protection devices are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

1. Install fasteners in accordance with fastener manufacturer's recommendations to obtain the allowable working loads published in their product literature.

Retain first option below to allow for future intentional removal of bolts.

2. **[Apply thread-locking fluid or deform threads of tail end of anchor studs after nuts have been tightened** to prevent accidental removal or vandalism at pedestrian accessible equipment

3.05 REPAIR

Div. 01 Section "Execution" covers general requirements for repairing, replacing, or restoring defective and damaged new and existing work other than operating products, systems and equipment.

Describe how existing work is to be repaired and/or restored.

A. Repairing Damaged Finishes: Immediately after installation, clean **field welds and/or** abraded and other areas where coatings are damaged.
   1. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.
   2. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish per manufacturer's written instructions.

3.06 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

Delete the option in the following paragraph if the manufacturer is also the installer.

   1. Require product manufacturers to provide field surveillance of the installation of their products and to **[observe installation of equipment and]**assist in Owner's demonstration and training.

Delete subparagraph below if the manufacturer is also the installer.

   2. Monitor and report installation procedures, and unacceptable conditions.
   3. Engage manufacturer's Qualified Person to perform field tests and inspections and to prepare test reports.

Retain below for long, multiple-span runs of truss. Delete for single-span systems.

B. Testing Services: Testing and inspecting of completed applications of triangular truss system work shall take place in successive stages as triangular truss system is installed. Do not proceed with work for the next area until test results for previously completed applications of work show compliance with requirements.
   1. Prepare a written report to Contractor with copy to Architect and Owner including the date and results of the inspection, the signature of the person who performed the inspection, and the number, or other identifier, of the building support structure and equipment which was inspected.

C. Do not load or stress system until materials and fasteners are properly installed and ready for service.

D. Field Tests: Test using load cell test apparatus in accordance with applicable OSHA and ANSI requirements, supervising engineer, and manufacturer’s recommendations.
   1. Test 100 percent of anchorage that rely on chemical adhesive fastening.

Serviceability load testing is not required for Type A anchorage by ANSI Z359.

   2. Test anchorage by applying the greater of twice the working load or 2,500 pounds (1134 kg), applied at up to 900 pounds (408 kg) per minute and maintained for at least 3 minutes.

E. Field Inspections:
   1. Inspect each anchorage attachment to foundation structure for proper installation.
   2. **[Inspect operating equipment as recommend by equipment manufacturer.]**

F. Remove and replace work where test results indicate that it does not comply with specified requirements.

G. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

H. Do not allow use of triangular truss system until users have been trained in the use of the systems.

3.07 ADJUSTING

A. Verify that products have been installed in accordance with manufacturer's instructions.

B. Adjust fall protection components to function smoothly and safely and as necessary to ensure compliance with reference standards.

C. Correct component deficiencies to assure compliance prior to Substantial Completion

3.08 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate function, operation, maintenance, and safety procedures for each fall protection component.

State requirements for demonstrating, instructing, and training Owner on sequence of operations, general facility operation, and facility maintenance procedures.

State requirements of the installer or manufacturer to demonstrate the proper operation of equipment.

State requirements of the installer or manufacturer to train the Owner's personnel in the operation and maintenance of equipment for ongoing facility management and maintenance.

B. Training: Train Owner's personnel in proper use and maintenance of triangular truss system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

3.09 PROTECTION

A. Protect roof surfaces from damage during installation.

3.10 RECERTIFICATION AGREEMENT

A. Agreement: Furnish a proposal to Owner for an annual recertification program per the manufacturers recommendations.
   1. Furnish proposal in the form of a standard yearly agreement.
   2. State services, obligations, conditions, and terms for agreement period and for future renewal options.

END OF SECTION 11 81 29.16