# Naval Facilities Engineering Command
# Fall Protection Awareness Training
# For
# Architects and Engineers

ESAMS COURSE # 1900
July 2012
Basil Tominna, P.E.

## Training Objectives

- Acquire knowledge and understanding:
  - Best practices and considerations for management of fall hazards
  - FP regulations, standards, instructions and requirements
  - Fall protection systems and equipment



## Training Outline

- Introduction – Fall mishap statistics
- Applicability of Program Requirements to A/E
- Examples of fall hazards
- Design considerations
- Regulations, standards and instructions
- FP requirements, systems and equipment
- Selection of safe anchorages
- Application and use issues
- Case study



## Introduction

- Falls are the leading cause of work related injuries and fatalities
- Two to three fall fatalities occur every work day in the US
- Over 300,000 injuries annually
- Fall Mishaps can be prevented

## CONUS Fatal Occupational Injuries (BLS)

| Type of exposure | 2009 | 2010 |
|---|---|---|
| 1. Highway | 985 | 968 |
| 2. Falls to lower level | 538 | 515 |
| – Same level falls | 93 | 93 |
| 3. Homicides | 542 | 506 |
| 4. Struck by object/equipment | 420 | 402 |
| 6. Fires and explosion | 113 | 187 |
| 7. Contact w/electric current | 170 | 163 |



## All Types of fall mishaps within the Navy for FY02, 03 and first 6 months of 04

| | |
|---|---|
| – Same level falls or falls thru walkways and other surfaces ---------- | 3,529 |
| – Falls to lower level ---------- | 831 |
| – Falls down stairs ---------- | 462 |
| – Falls from/onto equipment Structures or objects ---------- | 419 |
| – Walking without incident but injured- | 207 |
| – Falls from ladders ---------- | 197 |
| – Falls from moving and non moving vehicles ---------- | 144 |
| – Falls on/from ship or boat ---------- | 47 |
| Total | 5,836 |

*** Note: Data source is the Naval Safety Center**



## Navy Slips, Trips and Falls Mishaps 2005-2008

| Mishap | Class of 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|
| A | 4 | 3 | 2 | 0 |
| B | 6 | 7 | 4 | 1 |
| C | 616 | 693 | 808 | 760 |
| D | 1100 | 1292 | 1105 | 1126 |
| Total | 1728 | 1995 | 1733 | 1887 |



## FP Program Requirements

- Every Command which has personnel exposed to fall hazards shall establish a managed Fall Protection Program as per:
  - OPNAVINST 5100.23G
    - ✓Navy FP Guide for Ashore Facilities
  - USACE EM 385-1-1, Section 21
  - ANSI Z359.2: Minimum Requirements for a Comprehensive Managed FP Program

## Applicability of FP Requirements to A/Es (Designers)

- **OPNAVINST 5100.23G, Chapter 13**
  - **Anchorages requirement for new buildings, facilities and structures**
    - ✓ **During design, fall hazards should be considered and eliminated whenever possible. If not possible, include certified and labeled anchorages (Design and identification of hard points)**
  - **A/Es shall be trained IAW 5100.23G, Chapter 13, Appendix 13-A**
- **ANSI Z359.2:**
  - **Design Requirements for Fall Protection Systems in New Facilities**



## Reasons for incorporating Fall Prevention during Design Phase

- **Any part or location of a building, facility, structure or equipment will one day require maintenance work**
- **Personnel will be required to work at heights to perform maintenance work**
- **Prevention and control measures should be incorporated in the design to eliminate and prevent the need to work at heights with its subsequent exposure to fall hazards**



## Reasons for incorporating Fall Prevention during Design Phase (Continued)

- **Ethical Reasons**
- **Cost feasibility (More economical)**
- **Assist contractors protect their workers from fall hazards during construction phase**
- **Practical and substantial benefits during construction**



## Reasons for incorporating Fall Prevention during Design Phase (Continued)

- **<u>Ethical Reasons</u>**
  - **NSPE Code of Ethics**
    - ✓ **Engineers shall hold paramount the safety, health and welfare of the <u>public</u>**
  - **ASCE Code of Ethics**
    - ✓ **Engineers shall recognize that the lives, safety, health and welfare of the <u>general public</u> are dependent upon engineering decisions**

## Reasons for incorporating Fall Prevention during Design Phase (Continued)

**Cost Feasibility**

**Example: Replacing light bulbs in a Hangar**

**Fall Prevention Cost Profile**

- During Conceptual design $1
- Final drawing stage $10
- Construction modification $100
- Startup & testing $1,000
- Maintenance $10,000

## Responsibility of A/Es

- **Providing safe design to prevent fall mishaps and protect personnel exposed to fall hazards during:**
  - **Construction phase**
  - **Occupancy and normal operations**
  - **Maintenance phase**
- **Major role for creating safe work environment**
- **Knowledge and awareness of fall hazards encountered at workplaces**



## Responsibility of A/Es (Continued)

- **Designers should consider all factors that will affect the building or facility and design out the fall hazards**
- **Type of selected solution**
  - **Look for a solution that prevents a fall and requires little or no user expertise or supervision**



## Responsibility of A/Es (Continued)

- **A change at the design phase may:**
  - **Make enormous differences during construction and maintenance phases**
  - **Will lead to a safer solution**
  - **More economical in the long run**
- **Always look for a long term solution**

# Design for Construction Site Safety



## Role of Design Professionals in Influencing Construction Site Safety

- **Traditional Role: Designing a building conforming w/accepted practices, building codes and safety of the public**
- **Construction workers safety is left to the prime contractor**
- **However, designers can make better choices during planning and design phase to help contractors protect their workers during construction**

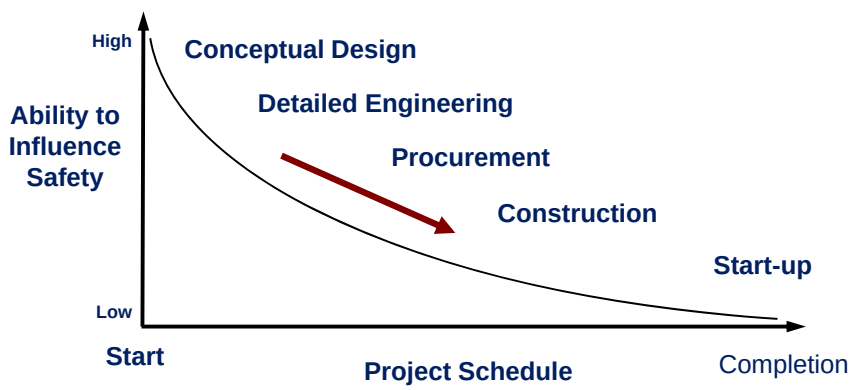


## Role of Design Professionals in Influencing Construction Site Safety

- **The earlier safety is incorporated into the schedule, the more influence it will have on the total project**
- **More effective to design safety into a process than it is to try to manage safety within a process that is inherently unsafe**



## Considering Safety During Design Offers the Most Payoff



## Design for Construction Safety Definitions

- **Constructability: Incorporating construction expertise into the design process to ensure the design is cost effective and buildable**
- **Design for Construction Safety: Incorporating design decisions based on how construction worker safety may be affected**
  - **Do not focus on how to use FP systems**
  - **Focus on how often FP will be needed**



## Design for Construction Safety (Continued)

- **Why should designers take responsibility for construction site safety issues? Although,**
  - **ASCE thru Engineers Joint Contract Document Committee clearly states "Designers have no responsibility for means and methods affecting construction workers"**
- **This also impacts the safety of workers during maintenance phase**



## Design for Construction Safety (Continued)

- **OSHA Standards support this position by ascribing the primary safety responsibility for construction workers to their employer**
- **CI, OSHA and other entities formed an alliance to:**
  - **Improve construction worker safety**
  - **Encourage and enable designers to design for construction safety**



## Design for Construction Safety Statistics

- **50% of general contractors interviewed identified poor design features (1996 paper)**
- **60% of accidents studied in Europe could have been eliminated or reduced with more thought during design (European Foundation)**
- **Changes during design would have reduced the likelihood of 47% of the 100 construction mishaps studied in UK**
- **American researcher finding in Oregon, WA and CA, design was linked to:**
  - **22% of 226 injury accidents**
  - **42% of 224 fatalities**

## Results: Impact on Projects

**Changes as a result of implementing prevention thru design in UK**

**(% of respondents)**

| Item | Decrease | No Change | Increase |
|---|---|---|---|
| Design cost (n=35) | 6% | 46% | 49% |
| Construction cost (n=38) | 34% | 24% | 42% |
| Design duration (n=37) | 8% | 57% | 35% |
| Construction duration (n=39) | 38% | 44% | 18% |
| Construction quality (n=39) | 8% | 28% | 64% |
| Construction worker productivity (n=30) | 13% | 33% | 53% |
| Construction worker health & safety (n=45) | 4% | 9% | 87% |
| End-user health and safety (n=42) | 5% | 10% | 86% |



## Design for Construction Safety Reason for A/Es involvement

- **Designers are an integral part of the construction process**
- **Not a separate industry divorced from the realities of site environment**
- **Designers dictate the configuration and components of the building or facility, thereby control to a large extent, how the project will be constructed**



## Design for Construction Safety Reasons for A/Es involvement

- **Projects designed for safety can often be completed faster:**
  - **Safety-related delays are reduced or eliminated**
- **Designers may understandably fear that any effort to consider the safety of construction workers may face a lawsuit by injured workers**
- **Not suggesting that designers should be held partially responsible for construction mishaps**



## Design for Construction Safety Considerations

- **Consider how the project will be built or constructed**
- **Seek the views of other interested parties in the construction process (i.e. other designers, contractors, etc.)**
- **Do not rely on the use of fall arrest systems without having considered other alternative design solutions**

## Design for Construction Safety Considerations (Continued)

- **Reduce the risk when working at heights (e.g. installation of guardrails to the perimeter structural members prior to erection)**
- **Reduce the need to work at heights as much as possible (e.g. construct modules on the ground before lifting them up into position)**



## Design for Construction Safety Considerations (Continued)

**Tilt-up Wall Construction)**



## Design for Construction Safety Considerations (Continued)

**Specify prefabricated building components**

**Steel Stairs**

**Concrete Wall Panels**

**Concrete Segmented Bridge**



## Design for Construction Safety Considerations (Continued)

**Specify prefabricated building components (Continued)**

**Steel work**

**Pre-Fabricated Service Risers**

## Design for Construction Safety Considerations (Continued)

- **Placement and condition of access roads leading to a building, facility or structure**
  - **Easy access would enable a crane to place roofing material or equipment at the most appropriate and accessible location**
  - **Ensure every part of the building is within the lifting capacity of the crane**



## Design for Construction Safety Considerations (Continued)

- **Prepare grounds or floors and clear debris to support equipment**
  - **Using scissors lift safely**
  - **Maintaining good housekeeping**
- **Make the specification more stringent**



## Design for Construction Safety Considerations (Continued)

- **Placement of <u>roof and floor</u> openings**
  - **Locate skylight openings away from access areas on the construction site**
- **Maintain consistent floor layout throughout the building:**
  - **Promotes efficient production and**
  - **Provides workers with thorough knowledge of the hazards present at each floor**

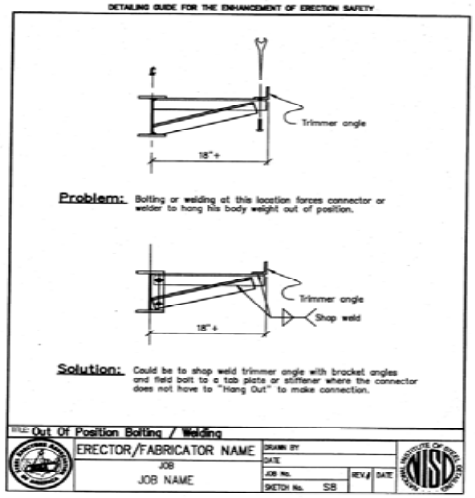


## Design for Construction Safety Considerations (Continued)

- **Design window sills 42 inches high (Will act as railing during construction)**
- **Column erection: Specify holes for tie lines 21 and 42 inches above each floor slab to string a cable as railing**
- **Specify how many sheets of plywood can be stacked on each other**

## Design for Construction Safety Considerations (Continued)

**Specify shop welding instead of field welding**

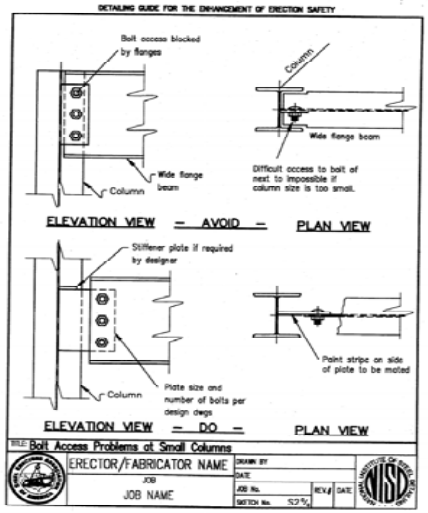





## Design for Construction Safety Considerations (Continued)

**Difficulty accessing for tying the bolt**

**Solution: Change plate size**






## Design for Construction Safety Considerations (Continued)

- **Consider horizontal and vertical space needs for safe crane operation when making site layout decisions:**
  - **Bearing capacities**
  - **Sufficient proximity to the building, to prevent excessively long load radii**
  - **Vertical space that is clear of power lines and other obstructions**



## Design for Construction Safety Considerations (Continued)

- **Procure for Safety**
  - **Require bidders to have FP/Safety programs in place and submit documentation**
  - **Consider bidders safety records**
    - ✓**Workers Compensation Experience Modification Rating (EMR),**
    - ✓**OSHA 300 logs for the last 3 years**
- **Review submittals for safety**
- **Inspect for safety**

# Design Considerations During Maintenance Phase



## Design Considerations during Maintenance Phase

- **Safe access or egress from or to work areas**
  - **If possible specify Stairs or fixed ladders with Ladder Climbing Devices**



## Design Considerations during Maintenance phase (Continued)

- **Provisions of permanent guardrails or edge protection**
  - **IBC requires a parapet wall to be at least 30 inches high**
  - **OSHA requires 39-45 inch high guardrails or use other fall protection system**
  - **If the specified parapet is 39-45 inches high, other FP system is not required**

**Note: Increasing the height of parapet will increase wind exposure, since the parapet will act as a cantilever. The stresses at the base of parapet are proportional to the square of the height**



## Design Considerations during Maintenance Phase (Continued)

- **Locate equipment (i.e. HVAC) at least 15 ft way from the edge**

## Design Considerations during Maintenance Phase (Continued)

- **Identification and provision of suitably located anchorages**



## Design Considerations during Maintenance phase (Continued)

- **Use of temporary work platforms**



## Design Considerations during Maintenance Phase (Continued)

- **Selection of proper and safe material and equipment on roofs that can withstand harsh environment (i.e. specify plywood)**
- **Location of amenities (e.g. plants, flag poles, security cameras, etc.)**
- **Can service runs be designed for access from the floor above?**
- **Availability and location of first aid facilities**



## Fall Hazard Identification

- **Consultation, communication and coordination w/safety and health professionals**
- **Communication w/various A/E firms and contractors**
- **Knowledge of fall injuries occurred at similar work places**
- **Review fall accidents or near miss incidents**
- **Review relevant FP standards**

## Fall Hazard Identification (Continued)

- Communication w/employees of similar facilities
- Conduct a walk through inspection of the facility or similar facilities
- Compile statistical records of unsafe work practices
- Question: Who will review design drawings to identify fall hazards?



## Risk Assessment

- Steps in the risk assessment process
  - Identify the specific hazardous situation that might occur in the work place
  - Identify who has responsibility of the decisions to be made about the hazard
  - Define and decide how much info needs to be presented to the decision maker



## Risk Assessment (Continued)

- Required information
  - Size, height and layout of a workplace
  - Material handling methods
  - Access to equipment or material
  - Location and condition of all equipment or material used
  - Number, type of work and movement of all employees



## Examples of Fall Related Hazards

# Fall Hazards
## Working/Walking On, Close or Near

**Unprotected sides or edges**



# Fall Hazards (Continued)

**Working around Floor Openings or Holes**



# Fall hazards (Continued)

**Working on Roofs or Near Roof Edges**



# Fall hazards (Continued)

**Servicing equipment located near roof edges**

# Fall hazards (Continued)

**Servicing water valves, meters, instrumentation and equipment at high locations**



# Fall Hazards (Continued)

**Working Around Skylights**



# Fall hazards (Continued)

**Climbing and Maintaining Communication or Water Towers**



# Fall Hazards (Continued)

**Window Washing Hazards**

# Fall Hazards (Continued)

**Solar Panels**



# Fall hazards (Continued)

**Crane rail maintenance**

**Equipment Maintenance**



# Fall hazards (Continued)

**Confined space entry**



# Fall Hazards (Continued)

**Maintenance personnel spray the weeds near the roof edge of the facility**

**Maintenance Work at Weapon Storage Facilities**

## Fall Hazards (Continued)

- Aircraft maintenance
- Climbing fixed ladders
- Maintenance of projectors, cameras, flag poles on roofs or high places
- Delivery of material, equipment and furniture to high locations
- Lighting fixtures replacement hazard



## Fall Hazards (Continued)

**Other hazards (Continued):**

- Designing parapets or railings with wide caps
- Maintenance work performed on top of elevator shafts and mechanical rooms
- Working over water or machinery



## How long does it take to Fall?

If you fall due to gravity alone, how fast will you be going when you hit the ground?

| *Height* (feet) | *Time* (seconds) | *Velocity* (miles/hour) |
|---|---|---|
| 4 | 0.5 | 11 |
| 16 | 1.0 | 22 |
| 64 | 2.0 | 44 |
| 145 | 3.0 | 88 |



## Applicable Instructions

**Navy Personnel:**

- OPNAVINST 5100.23G (2005)-Safety and Occupational Health Manual

**Federal Employees:**

- Executive Order #12196 (1980)Occupational Safety and Health Programs for Federal Employees

## Applicable OSHA Standards and Regulations

- 29 CFR 1910 (1970) -- Occupational Safety and Health Standards (General Industry)
  - Notices of Proposed Rulemaking, 29 CFR 1910 (24 May 2010) - Walking and Working Surfaces and Personal Protective Equipment (FP Systems) for General Industry
- 29 CFR 1960 (1980) – Basic Program Elements for Federal Employees OSH Programs



## Applicable Standards and Regulations (Continued)

Contractors Performing Construction and Demolition Work shall comply with:

- USACE EM 385-1-1: Safety and Health Requirements Manual
- 29 CFR 1926.500 – (Subpart M) FP in Construction
- FAR Clause:
  - 52.236-13 -- Accident Prevention



## Applicable (ANSI) Fall Protection Standards

General Industry

- ANSI Z359: Fall Protection Code
- ANSI A1264.1 (R2007): Safety Requirements for Workplace Walking/Working Surfaces and Their Access, Workplace Floor and Wall Openings, Stairs and Guardrail Systems

Construction Industry

- ANSI A10.32 (2004): Personal Fall Protection used in Construction and Demolition
- ANSI A14.3 (R2008): Safety Requirements for Fixed Ladders



## ANSI/ASSE Z359 Fall Protection Code/Standards

- In 2007, ANSI approved and published 5 Standards as part of the Fall Protection Code
  - National in scope
  - Best industry practices and applications of FP systems and equipment
  - Improved performance of the equipment, and
  - Manufactured new equipment

## Published ANSI Z359 FP Code/Standards

- ANSI Z359.0 Definitions and Nomenclature Used for FP and FA for PFAS
- ANSI Z359.1 Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components
- ANSI Z359.2 Minimum Requirements for a Comprehensive Managed Fall Protection Program
- ANSI Z359.3 Safety Requirements for Positioning and Travel Restraint Systems
- ANSI Z359.4 Safety Requirements for Assisted-Rescue and Self Rescue Systems, Subsystems and Components



## Published ANSI Z359 Fall Protection Code/Standards (Continued)

- ANSI Z359.6 Specifications and Design Requirements for Active FP Systems
- ANSI Z359.7 Certification Testing of fall Protection products
- ANSI Z359.12 Connecting Components for Personal Fall Arrest Systems
- ANSI Z359.13 Personal Energy Absorbers and Energy Absorbing Lanyards
- ANSI Z359.14 Safety Requirements for Self Retracting Devices for PFA and Rescue Systems



## ANSI Z359 Standards Under Development

ANSI Z359.5 Safety Requirements for PFAS

ANSI Z359.8 Requirements for Rope Access

ANSI Z359.9 Safety Requirements for Descent Control Devices

ANSI Z359.10 Not selected

ANSI Z359.11 Requirements for Full Body Harnesses



## ANSI Z359 Standards Under Development

ANSI Z359.15 Requirements for Vertical Lifelines for PFAS

ANSI Z359.16 Safety requirements for Fall Arresters for PFAS

ANSI Z359.17 Safety Requirements for Horizontal Lifelines for PFAS

ANSI Z359.18 Requirements for Anchorage Connectors for PFAS

## International Building Code Health and Safety Requirements

**IBC is based primarily on:**

- **Protection of occupants in a building from failure of life safety provisions**
- **Preventing structural collapse**
- **Property protection**

**Contains minimum criteria for H&S**
**No reference to OSHA or ANSI Fall Protection Standards**



## International Building Code FP Requirements

**Guards are required:**

- **Along open-sided walking surfaces, mezzanines, industrial platforms, stairways, ramps, landings, hatches and mechanical equipment**
- **When located 30 inches or more above the floor or grade below**
- **When equipment or hatches are located within 10 feet from the edge**
- **Guards shall be 42 inches high**
- **Top rail strength – 200 lbs**



## Fall Prevention Verbiage in Unified Facilities Guide Specifications

- **UFGS Section 01 35 26.05 20: Safety and Occupational Health Requirements for Design-Build**
- **UFGS Section 01 33 10.05 20: Design Submittal Procedures – Basis of Design**
  - **Paragraph 1.9.5 – Fall Protection Analysis**
- **Design Criteria Documents**



## FP Requirements

**Workers exposed to fall hazards shall be protected from falling to lower level by guardrail, temporary floors, work platforms, safety net, personal fall arrest system or the equivalent**

- **Trigger heights for providing fall protection**
  - **Navy Ashore Facilities ---------- 4 ft**
  - **EM 385-1-1 for USACE Owned Facilities-- 4 ft**
  - **29 CFR 1910 General Industry ---------- 4 ft**
  - **29 CFR 1926 Construction ---------- 6 ft**

**Or falling from any height onto dangerous equipment, hazardous environment or onto an impalement hazard**

## Navy FP Program Requirements

- Activity Policy
- Duties and Responsibly
- Workplace Surveys and Assessment of Fall Hazards
- Fall Hazard Prevention and Control
- Training, Inspection, Storage, Care and Maintenance of FP Equipment
- Rescue Procedures
- Mishap Reporting
- Audits and Evaluations



## Personnel assigned to FP Program

**Competent person for FP**

- A person designated by the employer
- Responsible for the immediate supervision, implementation and monitoring of FP Program
- Has the knowledge, training and experience in the application and use of fall protection, rescue systems and equipment
- Has the authority to take prompt corrective measures to eliminate or control fall hazards



## Personnel assigned to FP Program (Continued)

**Qualified Person for FP**

- A person w/recognized engineering degree or professional certificate and/or
- Has extensive knowledge, training and experience in FP and rescue field
- Capable of performing design, analysis and evaluation of FP and rescue systems



## Personnel assigned to FP Program (Continued)

**End user/authorized person**

- A person who is trained and authorized to use FP equipment in a typical fall hazard situation
- Shall be trained by a competent person

## Personnel Assigned to FP Program (Continued)

**FP Program Manager**

- **A person who manages the FP program**
- **Ensures all personnel involved in the FP program receive adequate training**



## Training Requirements

- **All personnel working at heights, exposed to fall hazards and using FP equipment shall be trained to recognize the hazards of falling**
- **End users shall be trained before using fall protection equipment**
- **Documentation of the training is important and required**



## Available Training Courses

- **End User Training:**
  - **Manufacturers of the equipment**
  - **Designated CP for the Command**
- **Competent Person Training:**
  - **Nationally accredited training firms approved by ECHELON II**



## Available FP Web Based Training

- **ESAMS Course #2018: End user training and Supervisors of end users**
- **ESAMS Course #3024: Outline for end users Hands-On Training and Practical Demonstrations**
  - **Complementary to course #2018**
  - **Shall be delivered by CP, qualified to deliver end user training**

## Available FP Web Based Training (Continued)

- ESAMS Course #1259: Slips Trips and Falls
- ESAMS Course #3639: A/Es and other inspectors conducting roof inspection, investigation and assessment work
- ESAMS Course #XXX for FPPM training
  - Part 1: Program Management
  - Part 2: FP Systems and Equipment



## Additional Training (Continued)

- NAVFAC 40 Hours Construction Safety Training for Construction Management Personnel
- ESAMS Course #1900: For NAVFAC A/Es involved in planning and design of new buildings, facilities and structures (Classroom)



## Personnel Training and Continued Education Requirements

- Refresher/update training: Required for the following personnel to stay current with the FP educational requirements
  - Competent Person (every 2 years)
  - End User (every 2 years)
    - ✓ Receive ESAMS Course #2018 again
    - ✓ Hands-on training and practical demonstrations is detailed in ESAMS Course #3024. May be delivered to the end user again per discretion of the CP



## Personnel Training and Continued Education Requirements (Continued)

- Refresher/update training is recommended for the following personnel to stay current with the FP educational requirements
  - Program Manager (0.8 units/year)
  - Qualified Person (0.8 units/year)
  - Competent Person Trainer (1.6 units/year)
  - Qualified Person Trainer (1.6 units/year)
  - Competent Rescue Trainer (1.6 units/year)

❖ Units/year: Are the recommended annual continued education units
  - ✓ One unit = 10 hours (per International Association for Continued Education and Training)

## Fall-hazard Prevention and Control, Order of Control Measures or Hierarchy of Controls

- **Elimination**
- **Prevention**
- **Engineering Controls**
- **Administrative Controls**
- **Personal Protective Systems and Equipment**



## Fall Protection Systems



## Guardrails, Work Platforms and Covers

## Prevention Systems

## (Passive Fall Protection Systems)



## Guardrail System

- **Guardrail system is installed at all open sided floors, openings and platforms where a person is required or permitted to work or pass**
- **Guardrail system consists of:**
  - **Top rail --- 39-45 inches high**
  - **Mid rail --- 21 inches high**
  - **Posts --- Spaced no more than 8 feet apart**
  - **Toeboards --- 3 1/2 inches high**

## Guardrail System (Continued)

**Minimum Material of Construction:**

- **Wood**
  - Top rail and posts (2X4), Mid rail (1X6), toeboard (1X4)
- **Structural steel**
  - Top rail, mid rail and posts (2 in X 2 in X 3/8 in) angels
- **Pipe railing**
  - Top rail, mid rail and posts (1 ½ in nominal diameter, schedule 40 pipe)
- **Steel cable**
  - Toprail & midrail (1/4 in steel cable) flagged every 6 ft w/highly visible material

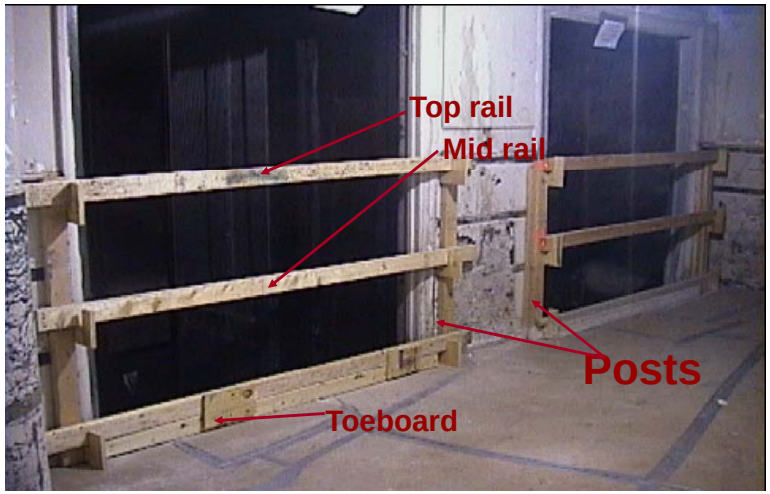


## Guardrail System (Continued)

- **Strength requirement:**
  - **Top rail:** Shall withstand a force of 200 lbs applied 2 inches from the top in any outward or downward direction
  - **Mid rail:** 150 lbs
  - **Toeboard:** 50 lbs
  - **Screens/mesh/intermediate vertical members, solid panels:** 150 lbs
  - – Top rails shall not deflect more than 3 inches when a 200 lbs force is applied



## Guardrail System (Continued)




**Temporary Guardrails**



## Guardrail System (Continued)

**Collapsible Railing**

## Guardrail System (continued)

**Removable Guardrails**



## Stair Rails and Hand Rails

- **Permanent Hand Rails: 34-38 inches high**
- **Permanent Stair Rails: 42 inches high**



## Parapets

- **Usually designed for 30 inches high (less than OSHA guardrail height requirement of 42 inches)**
  - **Parapet height of 30 inches is permitted, if the sum of width and height is over 48 inches (width is more than 18 inches)**
- **Existing Parapets**
  - **Increasing height of parapet will require involvement of a structural engineer**
    - **Adding one foot to 2 ft high parapet, will double the wind stresses at the base**



## Covers

- **Install covers on any hole 2 inches or more in its least dimension in walking working surfaces such as floors, roofs or other openings**
- **Covers shall be capable of supporting without failure at least twice, the weight of the employee, equipment and material combined**

## Skylights FP Solutions

Railing

Screen



## Hatches

- Shall always be protected when opened

- If ladder is used to access thru a hatch, it shall extend 3 – 3 ½ feet above the walking working surface

## Hatch/Opening Protection

Hatch Cover solution

Pour in place netting system



## Work Platforms

When working from elevated work platform, it shall be equipped with standard guardrail or other FP system

## Work Platforms (Continued)

Work Stand Used for Aircraft Maintenance



## Walkways

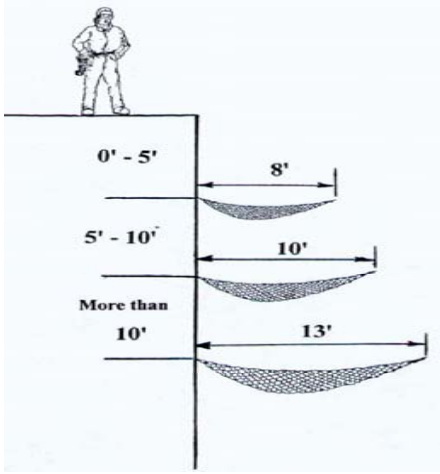
# Safety Nets



## Safety Nets

- Installed as close as practicable under the walking working surfaces
- Border rope or webbing - minimum breaking strength of 5,000 lbs
- Tested in suspension and certified by a QP immediately after installation and at six months intervals w/400 lbs weight dropped from the same elevation a person might fall
- Maximum size of mesh opening shall not exceed 36 square inches and shall be no longer than 6 inches on any side

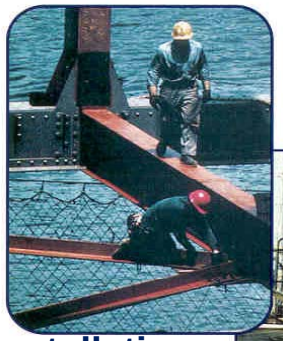
## Safety Nets Outward Extension




- Safety Nets Standard – ANSI A10.11



## Safety Nets (Continued)



- Shall not be installed lower than 25 ft from the working surface

**Inspection**

- Immediately After installation
- At least weekly thereafter
- Following any repair or alteration
- Inspection has to be documented



# Personal Fall Arrest Systems

# (Active FP Systems)



## Fall Arrest System

- Assembly of components and subsystems used to arrest a fall
- System Requirements
  - Limit maximum arresting force on the body to 1,800 lbs, when using full body harness
  - Max free fall distance of 6 ft
  - Shall stop the fall with a deceleration distance of not more than 42 inches
  - Prevent fallen worker from contacting lower level or object

## Basic Fall Arrest System Components

1. Anchorage System
2. Connecting Means
3. Body Support (full body harness)
4. Rescue



## Basic Fall Arrest System Components

# Anchorage System



## Anchorage System

**Anchorage system is a combination of anchorage and anchorage connector**

- **<u>Anchorage:</u>**
  - **Can be a beam, column, floor or any rigid part of structure or equipment**
  - **Shall withstand a minimum force of <u>5,000 lbs per person</u> or designed by a QP for twice the maximum arrest force**
  - **Unquestionably strong element of the building, structure or equipment**
-

## Certified Vs Non Certified Anchorages



## Definitions

- **Certification:** Act of attesting in writing the established criteria has been met
- **Certified:** An act or process resulting in documentation attesting the criteria of ANSI Z359 standards has been met



## Types of Anchorages

- **Certified Anchorage**: An anchorage capable of supporting the potential fall forces, which is designed and certified by or under the supervision of QP
  - If the average arrest force on the body is 900 lbs the anchorage can be designed for twice the arresting force = 1,800 lbs
  - CP can supervise the installation, use and inspection of certified anchorages under the direction of the QP



## Types of Fall Protection Anchorages

- **Certified Anchorages depends on:**
  - Availability of QP
  - In-house staff lack of FP experience to act as QP
  - On the job training as QP
- **Re-Certification** of anchorages – Once every 5 years

## Types of Anchorages (Continued)

- **Non Certified Anchorages: Are anchorages selected by CP**
  - **An anchorage that a CP can judge to be capable of supporting the fall forces prescribed by ANSI Z359 Standards**



## Types of Anchorages (Continued)

- **Non Certified Anchorage depends on:**
  - **CP judgment**
  - **Potential violation of building code**
  - **Some structural members may not be adequate for higher loads**
  - **Decision can only be defended by testing or calculations by PE**
  - **Has negative connotation**



## Question?

**Certified anchorage means an anchorage guaranteed to be adequate**

**True _____ or False _____**



## Building Loads

- **Existing structural members are:**
  - **Designed and constructed to support existing loads**
- **Types of Loading:**
  - **Permanent loads: Dead weight**
    - ✓ **Roofing, piping, mechanical equipment, etc.**
  - **Transient loads --- Live or temporary**
    - ✓ **Occupancy, wind, snow, seismic**
    - ✓ **Conditional loads**

## Building Loads (Continued)

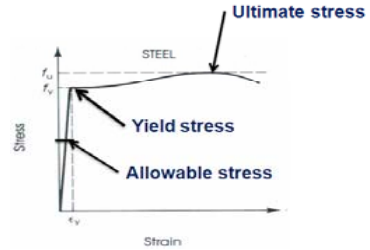
- **Per IBC and Design Criteria Documents, structural members are designed to withstand the intended loading:**
  - **Structural members are designed for a Factor of Safety of 1.5 - 5**
- **Fall arrest forces are characterized:**
  - **Low static loading, and**
  - **High infrequent dynamic loads**

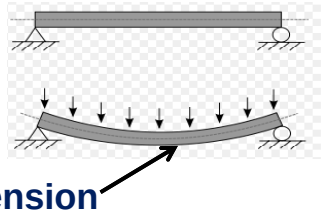


## Structural Members Steel

**Strongest material known that is used in construction**

- **Allowable tensile stress varies from 50% - 60% of the yield stress**
- **Yield stress varies from 36-50 KSI**
- **Ultimate stress varies from 58- 65 KSI**



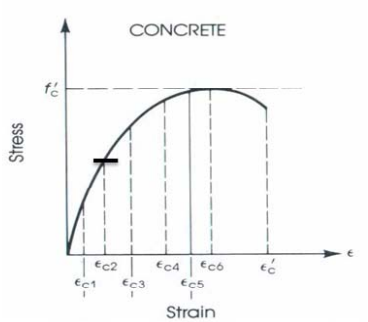






## Structural Members (Continued)

**Concrete is:**

- **Weak under tension**
- **Very strong under compression**

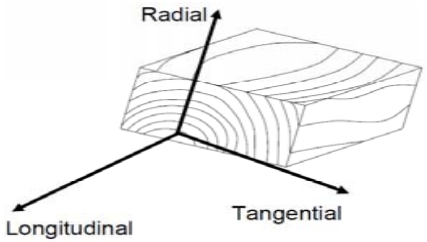


## Structural Members (Continued) Wood

**Height of structures 1-3 stories**

**Attach to beams/rafters or posts**

- **Parallel to Grain**
  - **Tension =1,575 psi**
  - **Compression = 1,875 psi**
- **Perpendicular to grain**
  - **Tension = 180-350 psi**
  - **Compression = 625 psi**
- **Laminate Beams**



# Anchorage System (Continued)

- **Anchorage connector:**
  - **A component intended for attaching PFAS to the anchorage**
  - **Shall withstand a force of 5,000 lbs**



# Anchorage Connectors

**Adjustable energy Absorbing Lanyard used as anchorage Connector**

**Tie-off Adaptor (Anchor Strap)**



# Anchorage Connectors (Continued)

**Permanent Anchor**

**Concrete Anchor**

**Tie back Anchor**



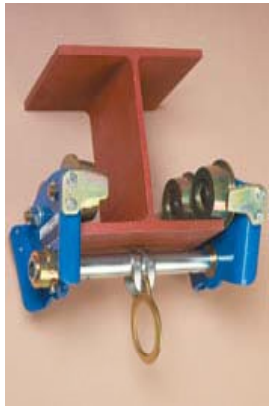
# Anchorage Connectors (Continued)

**Roof Anchor**

**Swivel Roof Anchor**

## Anchorage Connectors (Continued)

**Flanged Beam Clamp**

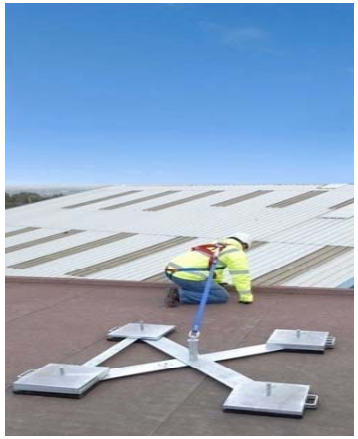


**Trolley**

**Plate Anchor**



## Anchorage Connectors (Continued)

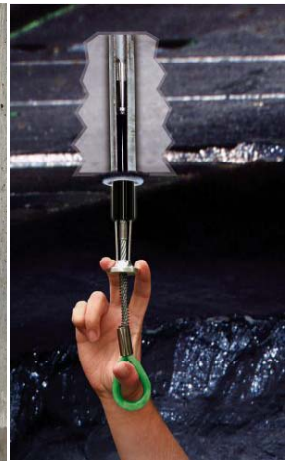


**Free Standing Anchors or Ballasted Anchors**



## Anchorage Connectors (Continued)

**Roof Anchor**



**Builders Grip**



## Anchorage Connectors (Continued)

**Miller Fusion Roof Anchor Post adapts to a variety of roof structures**

# Anchorage Connectors (Continued)

Non penetrating anchor

Stanchions used for steel erection



# Anchorage Connectors (Continued)

Safe Ridge Anchor



# Anchorage Connectors (Continued)

Concrete anchor strap

Concrete D-ring anchor



# Anchorage Connectors (Continued)

HLL Rail system

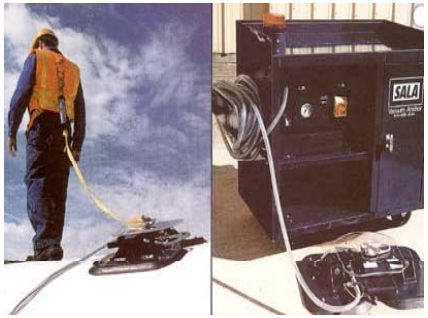
Roof anchor

## Anchorage Connectors (Continued)

**Dual Harness Beam** **Single Harness beam**



## Anchorage Connectors (Continued)



**Vacuum anchor**



## Connecting Means

**Method or subsystem used to connect body support to the anchorage**

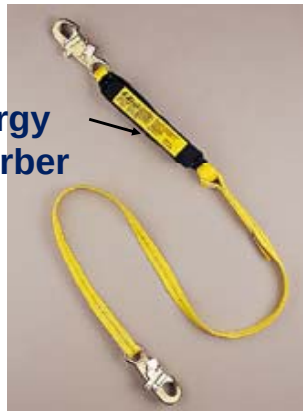
**<u>Subsystem may include</u>:**

- **Energy absorber (EA) or Shock Absorbing Lanyard) made of strap, webbing or rope**
- **Self retracting Device**
- **Fall arrestor (rope/cable grab) connected to a lifeline or rope lanyard**



## Connecting Means (Continued) Energy Absorbing Lanyards

**Energy Absorber**



**<u>OSHA requirements</u>: Deceleration/deployment distance <u>3.5 ft</u> and minimum breaking strength of the lanyard – <u>5,000 lbs</u>**

**Lanyards used in FA vary in length from <u>2 - 6 ft</u>**

## Connecting Means (Continued)
## Energy Absorbing Lanyards

**Two types of energy absorbers:**

**1. Six Ft Free Fall Personal Energy Absorbers:**

- **Average arrest force**
  - ✓ **Ambient Dry -- 900 pounds**
  - ✓ **Ambient Wet – 1,125 pounds**
- **Deployment Distance – Max 4 ft**



## Connecting Means (Continued)
## Single Lanyards with Energy Absorbers

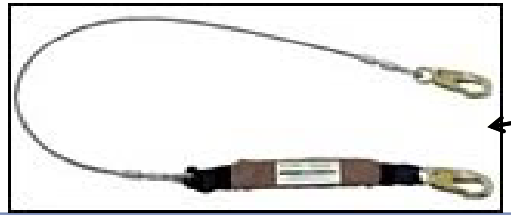
**2. Twelve Ft FF Personal Energy Absorbers:**

- **Average arrest force**
  - **Ambient Dry -- 1,350 pounds**
  - **Ambient Wet -- 1,575 pounds**
- **Deployment Distance - Max 5 ft**



## Connecting Means (Continued)
## Single Lanyards w/Energy Absorbers

**Used for 6 ft free fall**



**Used for 12 ft free fall**



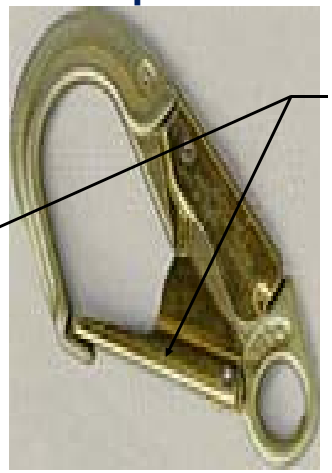
## Connecting Means (Continued)
## Twin leg (Y) lanyard

- **Joint between the legs shall withstand a force of 5,000 lbs**
- **Maximum length of the 6 Ft FF and 12 Ft FF "Y" lanyards shall not exceed 6 ft**

# Connecting Means

**Carabiner**

**Snaphook**

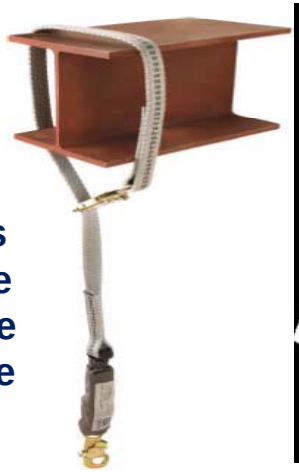


**New 3,600 lbs gates**

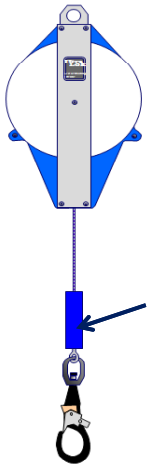


# Connecting Means (Continued)

- **Snaphook with 5,000 lbs gate strength**
- **The 5,000 lbs gate allows the snaphook to be tied back to the lanyard**



# Connecting Means (Continued) Self Retracting Devices



**Energy Absorber**

# Connecting Means (Continued) Self Retracting Devices Classifications

- **Drum wound line that automatically locks at the onset of a fall**
- **Pays out and automatically retracts onto the drum during normal movement**

**SRDs are classified in accordance w/dynamic performance:**

- **Class A: Max Arrest Distance – 2 feet**
- **Class B: Maximum Arrest Distance – 4.5 feet**

## Types of Self Retracting Devices (Continued)

**Types of SRDs**

1. **Self Retracting Lanyard (SRL)**
2. **Self Retracting Lanyard w/Leading Edge Capability (SRL-LE)**
3. **Self Retracting Lanyard with Rescue Capability (SRL-R)**
4. **Hybrid Combination of the above**



## Types of Self Retracting Devices (Continued)

**1. Self Retracting Lanyard**

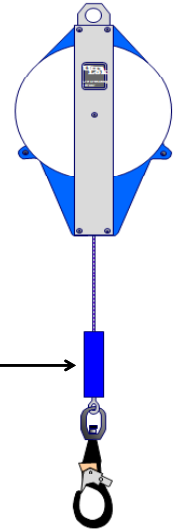
**Requirements**

- **Maximum Arrest Distance – 2 ft**
- **Average arrest force- 1,350 pounds**
- **Maximum Peak Force of 1,800 pounds**
- **Used only in vertical applications**

## Types of Self Retracting Devices (Continued)

2. **SRL with Leading Edge Capability (SRL-LE)**
3. **Requirements**

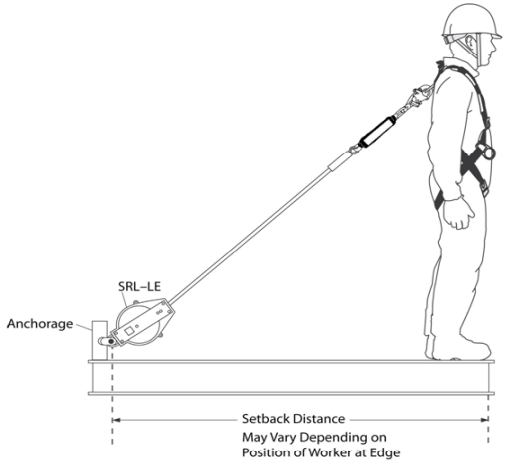
- **Maximum Arrest Distance 4.5 ft**
- **5 feet Free Fall**
- **Average arrest force – 900 pounds**
- **Equipped w/Energy Absorber**
- **Max peak force – 1,800 lbs**
- **Used in horizontal and vertical applications**





## Types of Self Retracting Devices (Continued)

**SRL-LE**



## Types of Self Retracting Devices (Continued)

**3. SRL with Rescue Capability (SRL-R)**

- **Minimum static strength – 3,000 pounds**
- **Minimum Mechanical Advantage shall be 3:1**

**4. Hybrid Device: Combination of any 2 Types of SRDs in one**



## Connecting Means (continued)

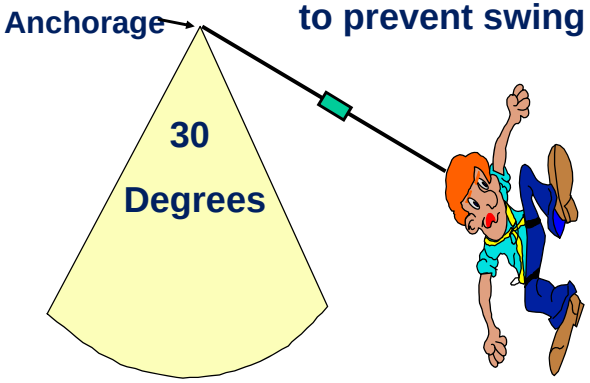
**SRL for 100% tie-off**

**Used like a "Y" lanyard**



## Connecting Means (continued)

**STAY WITHIN A 30° CONE to prevent swing fall**






## Connecting Means (continued)

**Method for lowering the snaphook to the person's level for tying off to the D-ring**

**Tag Management Plan**

## Connecting Means (Continued)
## Fall Arrestor

**A device that travels on a lifeline that will automatically engage and is designed to lock off by inertia to arrest a fall**

- **Use only Type -1 FA**
- **Minimum Ultimate Strength – 3,600 lbs**

**Cable Grab**

**Rope Grab**



## Body Support
## Full Body Harness

**Straps connected together to contain the torso and distribute the arresting forces over the upper thighs, waist, shoulders, chest and pelvis with a Dorsal D-ring integrally attached at the upper back between the shoulder blades for attaching a lanyard to other components of the system**



## Full Body Harness
## (Two styles)

**1. Cross-over Style**

**2. Vest Style – Chest Strap**

**Harness w/Dorsal D-ring**



## Full body harness (Continued)

**(Utility harness) Arc Flash Harness**
**(There is no metal above the waist)**

## Full Body Harness (Continued)

- **Breaking strength of all straps – min 5,000 lbs**
- **Capacity Range:**
  **130 - 310 lbs**
- **All straps must be connected together properly**



## Fall Body Harness
## Ring Location on the Harness

| Location | Used for |
|---|---|
| • Dorsal---------- | FA, Restraint, Rescue |
| • Sternal ---------- | FA, Ladder Climbing, Work Positioning, Rope Access |
| • Frontal ---------- | Ladder Climbing |
| • Waist, Rear -------- | Restraint |
| • Hip (Pairs) --------- | Positioning |
| • Shoulder (Pairs) - | Rescue, Entry and Retrieval |
| • Saddle (Pairs) ----- | Positioning |



## Fall Body Harness
## Location of Rings on the Harness

# Inspection, Storage, Care and Maintenance of FP Equipment

## Inspection Criteria of Fall Protection Equipment

- **Establish inspection procedures IAW manufactures instructions and recommendations**

- **Equipment shall be inspected by:**
  - **End user - prior to each use, and**
  - **Competent Person – at least once a year w/documentation**



## Fall Arrest System Considerations

- **Prior to selecting a fall arrest system, the following information should be verified and considered:**
  - **Movement of the worker**
  - **Existing obstructions in the worker's path**
  - **Location and availability of safe anchorages**
  - **Total fall distance, free fall distance and available clearance**

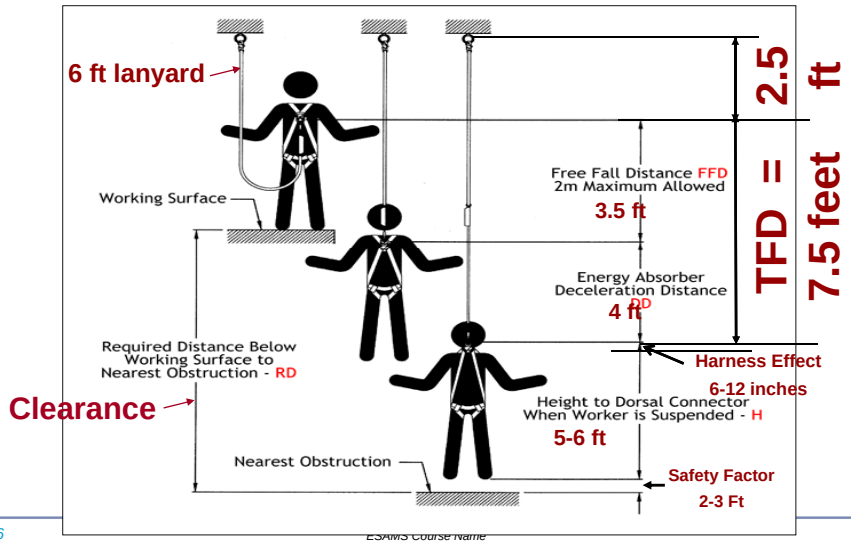


## Fall Arrest System Considerations (Continued)

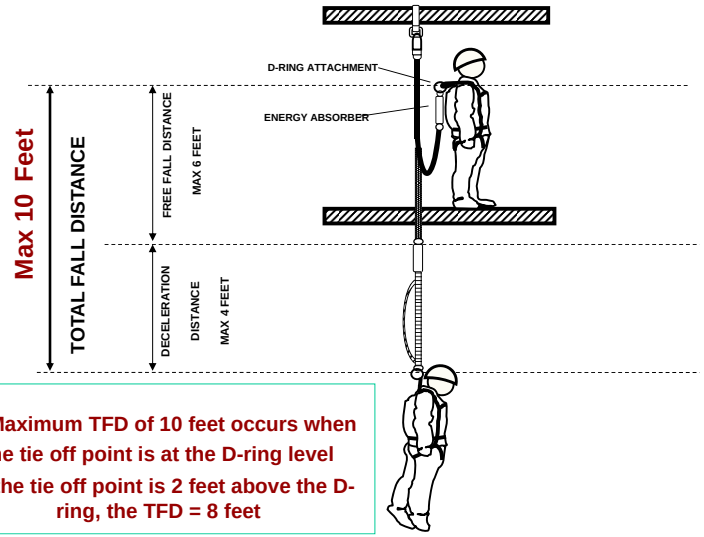
- **Swing fall hazards**
- **<u>Compatibility</u> of all components of the system**
- **Impact forces**
- **Availability of rescue/self rescue**



## Total Fall Distance Considerations
## TFD = Free Fall Distance + Deceleration Distance



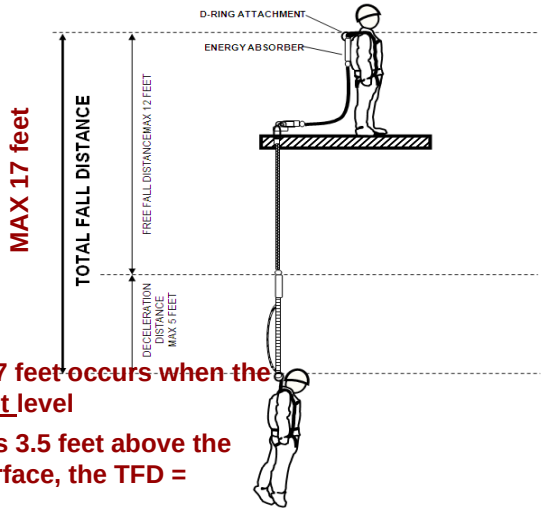
# 6 Ft Free Fall, EA Single Lanyard




- Maximum TFD of 10 feet occurs when the tie off point is at the D-ring level
- If the tie off point is 2 feet above the D-ring, the TFD = 8 feet



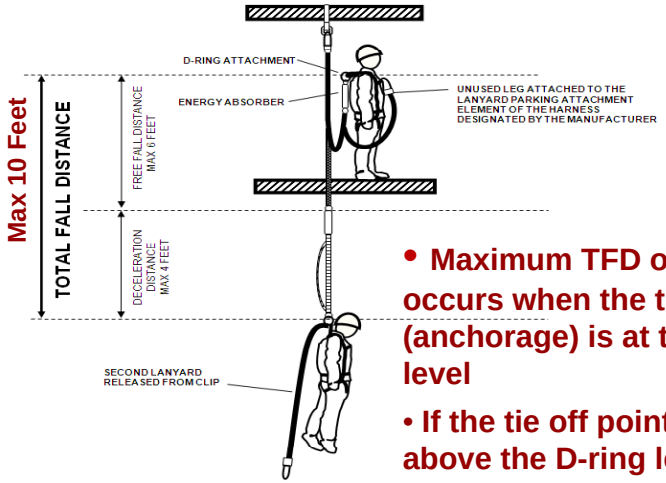
# 12 Ft Free Fall, EA Single Lanyard




- Maximum TFD of 17 feet occurs when the tie off point is at foot level
- If the tie off point is 3.5 feet above the walking/working surface, the TFD = 13.5 feet



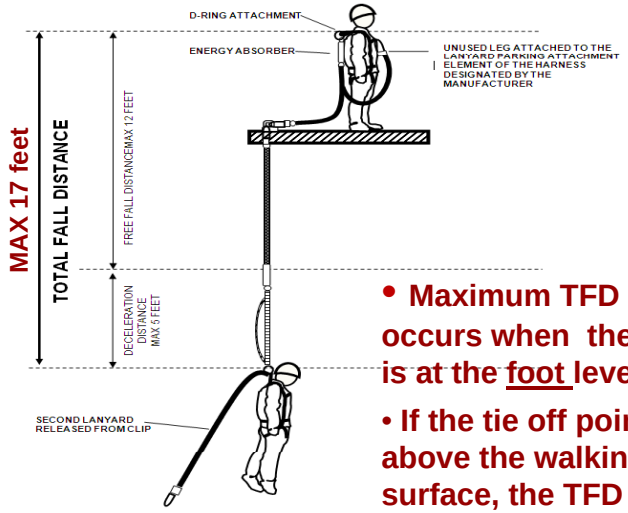
# TFD for 6 Ft Free Fall, EA "Y" Lanyard




- Maximum TFD of 10 feet occurs when the tie off point (anchorage) is at the D-ring level
- If the tie off point is 2 feet above the D-ring level, the TFD = 8 feet



# TFD for 12 Ft FF, EA "Y" Lanyard




- Maximum TFD of 17 feet occurs when the tie off point is at the foot level
- If the tie off point is 3.5 feet above the walking/working surface, the TFD = 13.5 feet

# Lifelines



## Horizontal lifeline

- A fall arrest system that uses flexible wire, rope or synthetic cable, spanned horizontally between two end anchorages, may include in-line energy absorber or lifeline tensioner, turnbuckles and intermediate anchorages
- HLL shall be designed installed and used under the supervision of a qualified person as part of a complete fall arrest system, which maintains a safety factor of at least two



## Horizontal Lifeline (Continued)

- HLL design shall include:
  - Drawings
  - Required clearance
  - Instructions for installation, use and inspection requirements
  - All HLL anchorages shall be designed by registered Professional Engineer, qualified in designing HLL systems

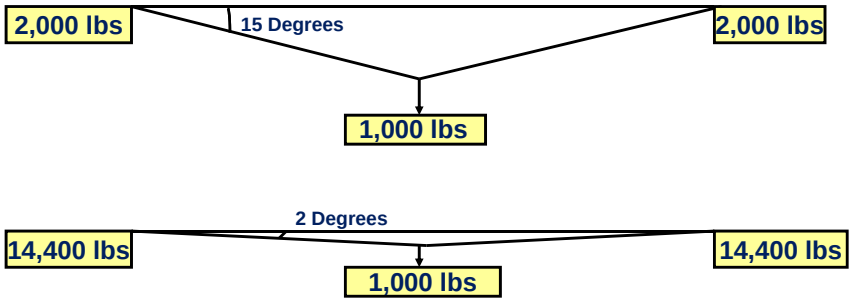


## Horizontal lifeline (Continued)

- If cables are used as guardrails and also used for tying off, they shall be designed as HLL
- Depending on the angle of sag and the line's elasticity, the forces generated by a fall are greatly amplified at the anchorages

# Horizontal Lifeline (Continued)

## Angle of Sag




**Decreasing angle of sag increases the impact of fall forces at the anchorages**



# Horizontal Lifeline (Continued)

# Horizontal Lifeline (Continued)

# Horizontal Lifeline (Continued) Components

**Shock Absorber**

**Personal Shuttle**

**Tensioner**

## Horizontal Lifeline (continued)

**The correct way to attach to the HLL: Connect the snaphook to the ring instead of attaching it directly to the line/cable**

## Horizontal Lifeline (Continued)

**HLL used in Restraint System**



## Horizontal Lifeline (Continued)

**Temporary HLL System**

**HLL installed on a roof, used as a restraint system**



## Vertical Lifeline

- **A vertically suspended flexible line with a connector at the upper end for tying it to 5,000 lbs overhead anchorage, along which a fall arrestor (rope grab) travels**
- **VLL shall have a min tensile strength of <u>5,000</u> lbs**
- **Each employee shall be attached to a separate lifeline system**

## Positioning System

- A combination of FP equipment that permits the user to have both hands free while supported on an elevated vertical work surface (e.g. rebar assembly, towers or poles)
- System Requirements
  - Limits FF distance to 2 ft
  - Secured to an anchorage capable of supporting at least twice the potential impact load of an employee's fall or 3,000 lbs, whichever is greater



## Positioning System (Continued)

According to OSHA, When working or moving on a re-bar assembly, above 24 ft, Fall Arrest Equipment is required

## Positioning System (Continued)

Additional Requirements

- Positioning system shall not be used as a primary FP system
- Positioning system (if used alone) does not constitute a FP system
- While in positioning system a person is exposed to fall hazard and requires backup (Additional FP system is required)



## Positioning System (Continued)

## Restraint System

**A system that prevents a worker from reaching unprotected side or edge**

- **Anchorage strength requirement per OSHA is 3,000 lbs**
- **Per ANSI Z359.2 is 1,000 lbs**
- **Used on roofs or minimum slopped surfaces between 0-18.4 degrees (4:12)**

# Selection of Safe Anchorages



## Anchorages Strength Requirements for Various Fall Protection Systems

| Anchorages | Non-Certified | Certified |
|---|---|---|
| Fall arrest | 5,000 lb | 2 x Max Arrest Force |
| Positioning | 3,000 lb | 2 x Foreseeable Force |
| Restraint | 1,000 lb | 2 x Foreseeable Force |
| Rescue | 3,000 lb | 5 x Foreseeable Force |
| HLL | N/A | 2 x Maximum Tension in the line |

- **CP shall not select HLL anchorages**
- **OSHA requirement for restraint anchorage is 3,000 lbs**
- **Temporary restraint anchorages – can be designed for 400 lbs static loading by the QP (ANSI)**



## Selection of Safe Anchorages Hard points

- **Anchorage location should be as high as possible to minimize the free fall distance**
- **Do not tie off to a hole in a beam. Unless it is designed to withstand the fall forces**
- **Consider the impact forces and bending moment at the supports**
- **When selecting anchorage location consider the hazard of swing fall effect**

## Selection of Safe Anchorages (Continued)

- The closer the tie off point is to the support of a beam, the impact force on that support is greater
- Consider the exposure of anchorage connectors to sharp edges, abrasive surfaces and physical hazards such as heat, electrical and chemical sources
- Consider the free fall distance, total fall distance and available clearance



## Selection of Safe Anchorages (Continued)

- When selecting anchorages, accessibility, location and ease of tying off should be taken into consideration
- If assisted rescue is required, additional anchorage for rescue should be selected
- Always specify the number of personnel attached to the anchorage
- Anchorage and anchorage connector shall be compatible



## Selection of Safe Anchorages (Continued)

- Welding the anchorage connector to the anchorage shall be performed by a certified welder
- Anchorages embedded in concrete
  - NYC Building Department - New Protocol



## Post installed Anchors in Concrete, Masonry and Natural Stone Structures

**Types and load transfer mechanism**

- Friction (Micro-keying)
- Keying (Undercut)
- Adhesion (Bonding): Concrete adhesive anchors
- Combination

## Rope Access System

- Method of access used for inspecting dams, bridges or flood control structures. Also used for window washing

Working Line

Safety line



## Rescue Plans and Procedures

- Fallen employee suspended in FBH shall be promptly rescued or can rescue themselves
- A written rescue plan shall be prepared and maintained when personnel are working at heights and using FP equipment
- The plan shall contain provisions for self-rescue or assisted-rescue, including rescue equipment



## Rescue Plans and Procedures (Continued)

- Personnel conducting rescue shall be trained
- If other method of rescue is planned, it shall be indicated in the rescue plan (i.e. Fire Dept.)
  - Pre-Incident Plan shall be prepared
- If required, anchorages for rescue shall also be identified and selected



## Rescue Equipment

Rescue Lanyard/w Anchorage Connector for Rescue

Synthetic Rope Tackle Block

## Rescue Equipment (Continued)

Motorized

Manual

**Self Retracting Lanyards w/Rescue Capability**



## Rescue Equipment (Continued)

**Self Retracting Lanyard w/Winches for Rescue**



## Rescue Equipment (Continued)

**Rescue Y lanyard**

**Rescue Davit System**



## Rescue Equipment (Continued)

**Strap to prevent suspension trauma (Use two straps, one for each leg)**

## Raising/lowering Devices
## Free Standing Tripod

- Tripod shall withstand a force of 5,000 lbs
- Used for confined space entry and retrieval



# Scaffolds

# Aerial Lift Equipment, Movable Work Platforms

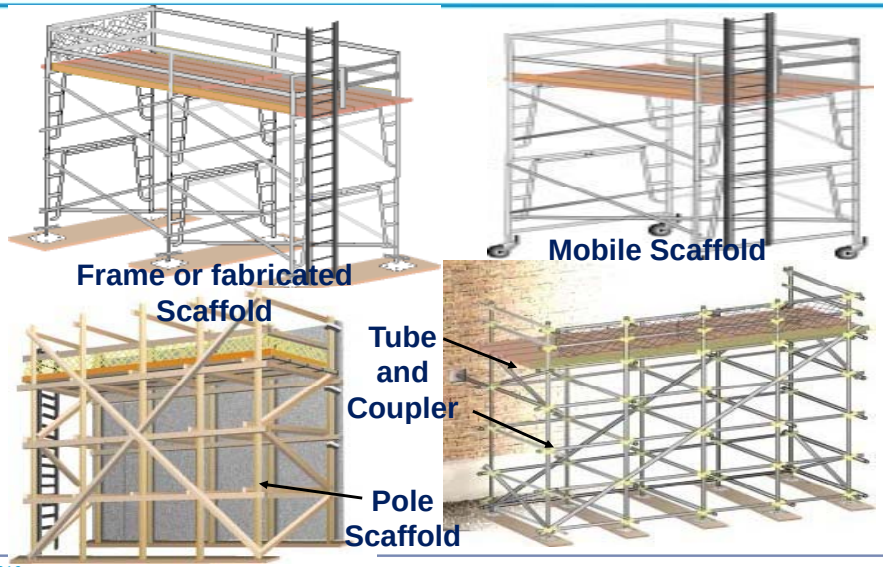


## Scaffolds

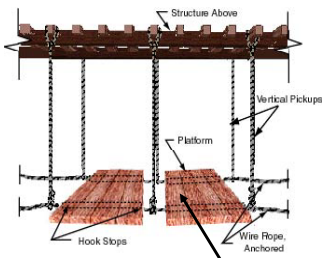
- **Scaffolds** shall be equipped with a standard guardrail or other fall protection system
- Scaffold erection and dismantling/staging
  - OSHA recognizes the difficulty of providing fall protection
  - Competent person shall conduct and evaluation to determine the feasibility and safety of providing fall protection for
  - When erecting supported scaffolds do not tie off to the scaffold



## Self Supporting and Free Standing Scaffolds



## Suspended Scaffolds

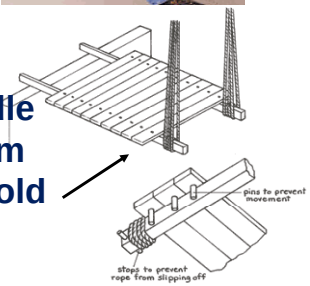



**Vertical lifeline is required for all suspended scaffolds**

**Boatswain Chair**

**Catenary Scaffold**

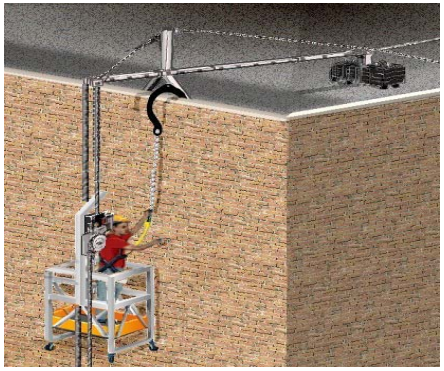
**Needle Beam Float Scaffold**




**Scaffold**



## Suspended Scaffolds (Continued)



**Single Point Scaffold**

**Two Point Scaffold**

- **When working in single or two point suspended scaffolds, in addition to railings, workers shall also be tied off to an independent vertical lifeline using full body harness**



## Scaffold (Continued) Scissors Lift

- **Scissors lift shall be equipped with standard guardrail and anchorage for using restraint system**



## Aerial lift equipment

- **When using aerial lift equipment, workers shall be tied off to the boom or basket**
  - **When tying off to the basket, use short lanyard**
  - **Tying off to an adjacent pole or structure when inside the aerial lift is not permitted unless a safe device for 100% tie off is used for the transfer**

## Aerial lift equipment (continued)

In aerial lifts, tying off using PFAS is required



# Ladder Climbing Devices and Portable ladder systems

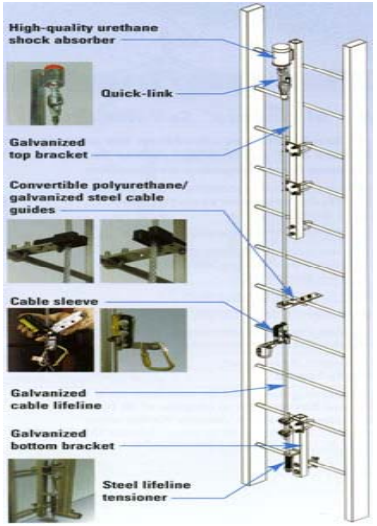


## Ladder Climbing Device

- Made of rigid rail, cable or rope, attached to a fixed ladder over 20 ft in length
- Anchorage strength requirement is 3,000 lbs
- Free fall distance - 2 feet
- The connector between front D-ring and the ladder cable is <u>9 inches</u> long
- Requires 100% transition at the top

## Fixed Ladders
## Ladder climbing system

- Standard fixed industrial ladders (off the shelf) are designed to absorb 500 lbs for 2 persons with ¾ inch rungs (OSHA)
- Make sure off-the-shelf ladders are adequate for attaching Ladder climbing devices to them
  - This is more critical for rope or cable



## Portable Ladder Systems

**Pneumatic Wheels Ladder Extension**

**Adjustable free standing Ladder Access System**



## Cages Installed on Fixed ladders

- **Cages allowed by OSHA, protect no one (Not a good FP method)**
- **Care should be exercised when climbing a ladder with a cage**



# Warning Systems



## Warning Line System Used during Construction Work

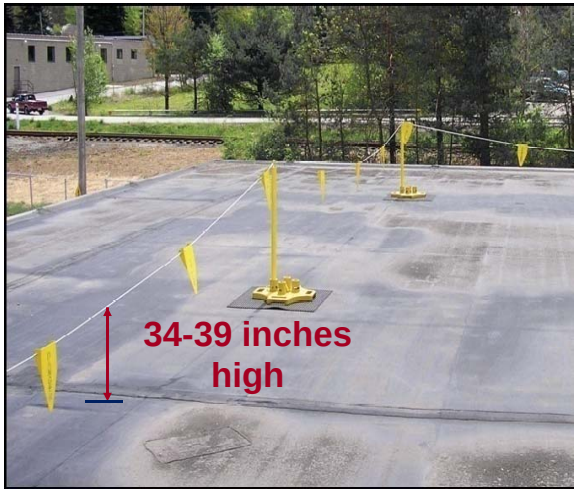
- **A barrier erected on a roof to warn workers they are approaching unprotected side or edge**
- **Erected near the edge of flat or slopped roofs up to 4:12 or up to 18.4 degrees**
- **Working within the line does not require fall protection. FP is required when working outside the line**
- **Located around all sides of the work area**

## Warning Line System Requirements

- Consists of rope, wires or chains, 34-39 inches high, flagged every 6 feet, with supporting stanchions
- Wire, rope or chain shall have a minimum tensile strength of 500 lbs
- Stanchions shall be capable of resisting a force of 16 lbs
- On flat roofs, line is located 6-10 ft away from the edge. For other trades the line shall be located 15 ft away
- On low slopped roofs (For all work or when using mechanical equipment), line shall be located 15 ft away from the unprotected edge



## Warning Line System (Continued)

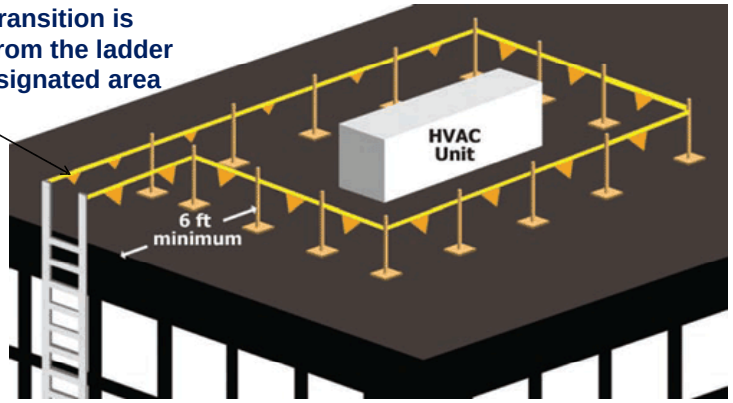


Base of Stanchion



## Designated Area Method (DAM) (For General Industry Work)

100% transition is required from the ladder to the designated area



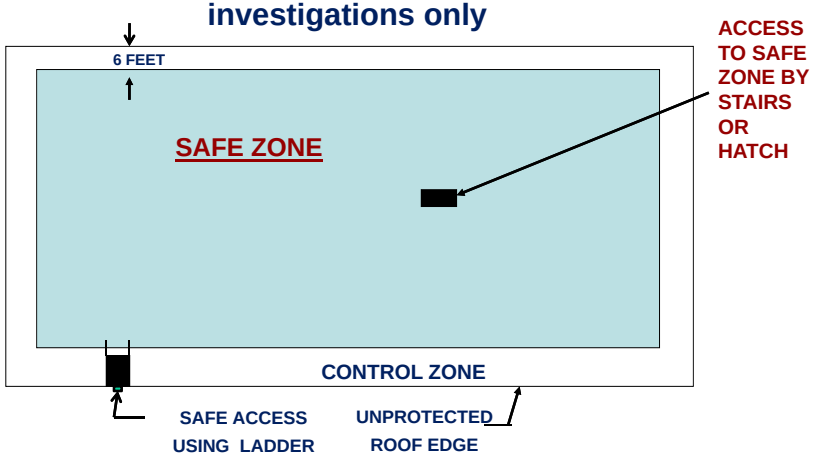

- Designated area is also used for inspecting mechanical equipment (Other than roof inspections)
- Requirements of DAM are similar to WLS



# Requirements for Roof Inspection and Investigation Work

## Control Zone

**Used for roof inspections and investigations only**






## Safe Work Practices for Conducting Roof Inspections and Investigation Work

- **Establish Control Zone**
- **Do not work alone, work in pairs**
- **Require safe access**
- **Access to roof only permitted by safety office**
- **Receive newly developed ESAMS training**
- **If inspection work is performed within 6 feet from unprotected roof the edge FP is required**
- **Other hazards**
- **Complete inspection and investigation checklist**



## Working Over or Near Water (Piers, Wharves/Quay Walls/Machinery/Barges)

- **PFD is required for all work over or near water except when:**
  - **FP is used without exception (This means the drowning hazard is effectively removed)**
  - **Distance to the water is more than 25 ft deep**
  - **Distance to the water is less than 25 ft deep and water depth is under 10 ft, or**
  - **Presence of other hazards (i.e. currents, machinery, barges, intakes, etc.)**



# Fall Protection Application and Use Issues

## Fall Protection Application and Use Issues

- **<u>Shallow pits</u> for steam or electric lines shall be protected w/guardrails, fenced or covered**
- **Portable and extension ladders do not require fall protection- only light work for a short duration shall be performed on portable and extension ladders**
- **During any phase of work, if FP is not feasible this should not be the norm during other phases of work**



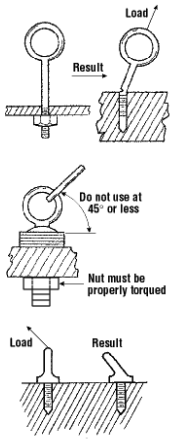
## Fall Protection Issues (Continued)

- **<u>Guardrail height</u> when working above the walking/working surfaces- (e.g. maintaining equipment/light fixture at high locations or using stilts)- increase the guard rail height**



## Improper Usage of Connectors (Continued)

**Large Snaphook Misuse**




**Eye Bolt Misuse**



## Selected FP Solutions

**Solution to service equipment at high locations**

## Selected FP Solutions (Continued)
## Confined Space Entry Solution

**Before**

**After**



## Selected FP Solutions (Continued)
## Installation or removable guardrails

**Before**

**After**



## Cranes Modification

**Before**

**After**



## Cost Comparison between Selected Solutions

| Cost | FAS HLL | Rigid Rail | Fixed Platform |
|---|---|---|---|
| Initial | $29,000 | $32,000 | $52,000 |
| Annual Costs | $4,100 | $4,100 | $1,000 |
| Capitalized Cost @ 5% Over 10 Yrs | $111,000 | $114,000 | $72,000 |

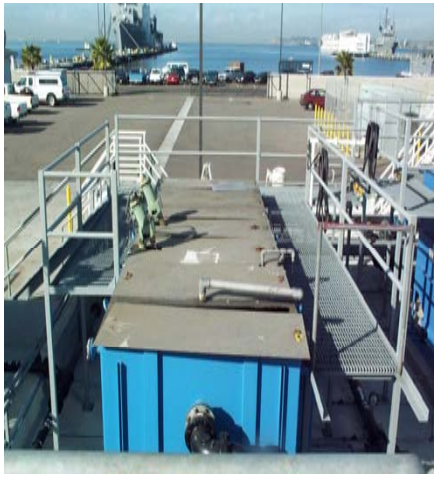
# Fall Protection and Prevention Design Issues

## "Case Studies"



**Design deficiency:** No access to top of tank, FP was not provided for servicing equipment on top

Before



After



**Design deficiency:** Operators had to enter from either end of the process area & walk over 300 feet to reach an area only 15 feet from the roadway

Before

New ladder and platform was installed



## Solution

After

## Design Deficiency: no platform was installed for the port to observe interior of tank

## Design Deficiency: No fall protection provided for personnel servicing instrumentation located on top of tank

## Design Deficiency: No fall protection provided for personnel servicing instrumentation on top of cylindrical tanks

## Conflict between HLL and Crane Rail

Crane Rail

HLL

## Conflict between HLL and Crane Rail (Continued)

## Cranes: Maintenance Personnel Exposed to Unprotected Edges
## SOLUTION: Designed Trolley Top Platform Grating

Before

After



## Summary

- **Incorporating Fall prevention early in the design phase is:**
  - **The right thing to do, and**
  - **The smart thing to do.**
- **Your participation and involvement in this effort is needed!**



## How to Acquire FP Information

- **Navy Fall Protection Guide for Ashore Facilities:**
- **https://portal.navfac.navy.mil/portal/page/portal/navfac/navfac_ww_pp/navfac_hq_pp/navfac_sf_pp/navfac_sf_fall/tab109972/fall%20protection%20guide-8%20september%202009.pdf**
- **OSHA Web Site: http://www.osha.gov/**
- **ANSI Web Page: http://www.ansi.org**
- **Fall Protection Handbook: by Dr. Nigel Ellis**
  - **Call ASSE, Phone: (847) 699-2929**
- **For Fall Protection Videos: http://www.msanorthamerica.com/fallProtectionVideos.html**

## Personal Information

**Basil Tominna, PE**

**NAVFAC Fall Protection Subject Matter Expert**

**Naval Facilities Engineering Command, SW**

**Address: 1220 Pacific Hwy, San Diego CA 92132-5190**

**Email: basil.tominna@navy.mil**

**Phone: Commercial (619) 532-3041,**

**DSN: 522-3041**



## Questions?

## Comments?



## Thanks for your participation