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# Steel Erection

- *§1926 Subpart R*



# Objectives

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In this course, we will discuss the following:

- Conception of the Steel Erection Rule
- Scope of the standard
- The key provisions of 1926 Subpart R
- A review of each of the key provisions
- Safe working practices





# Subpart R - Final Rule

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- Steel Erection Rule was published on January 18, 2001
- OPN 121





# Scope

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1926.750(a)

- Sets forth requirements to protect employees from the hazards associated with steel erection activities involved in:
  - Construction, alteration, and/or repair of:
    - » Single and multi-story buildings
    - » Bridges
    - » Other structures where steel erection occurs





# Scope

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1926.750(a)

- Does **not** include:
  - Electrical transmission towers
  - Communication and broadcast towers
  - Tanks





# Scope

1926.750(b)

- Covers all employers engaged in steel erection activities
- Contains two lists of activities:
  - **Primary list**
    - » All are covered (connecting, bracing, guying...)
  - **Ancillary list**
    - » Covered only “when they occur during and are a part of steel erection activities” (sealing, caulking, etc...)





# Scope

13 NCAC 07F .0205(b)(1)

- Steel erection activities include:
  - Hoisting, laying out, placing, connecting, welding, burning, guying, bracing, bolting, plumbing and rigging structural steel, steel joists, bridge steel girders and metal buildings; installing metal decking and moving point-to-point while performing these activities.





# Scope

13 NCAC 07F .0205(b)(2)

- Employer has the burden of establishing and determining when to implement employee fall protection measures.

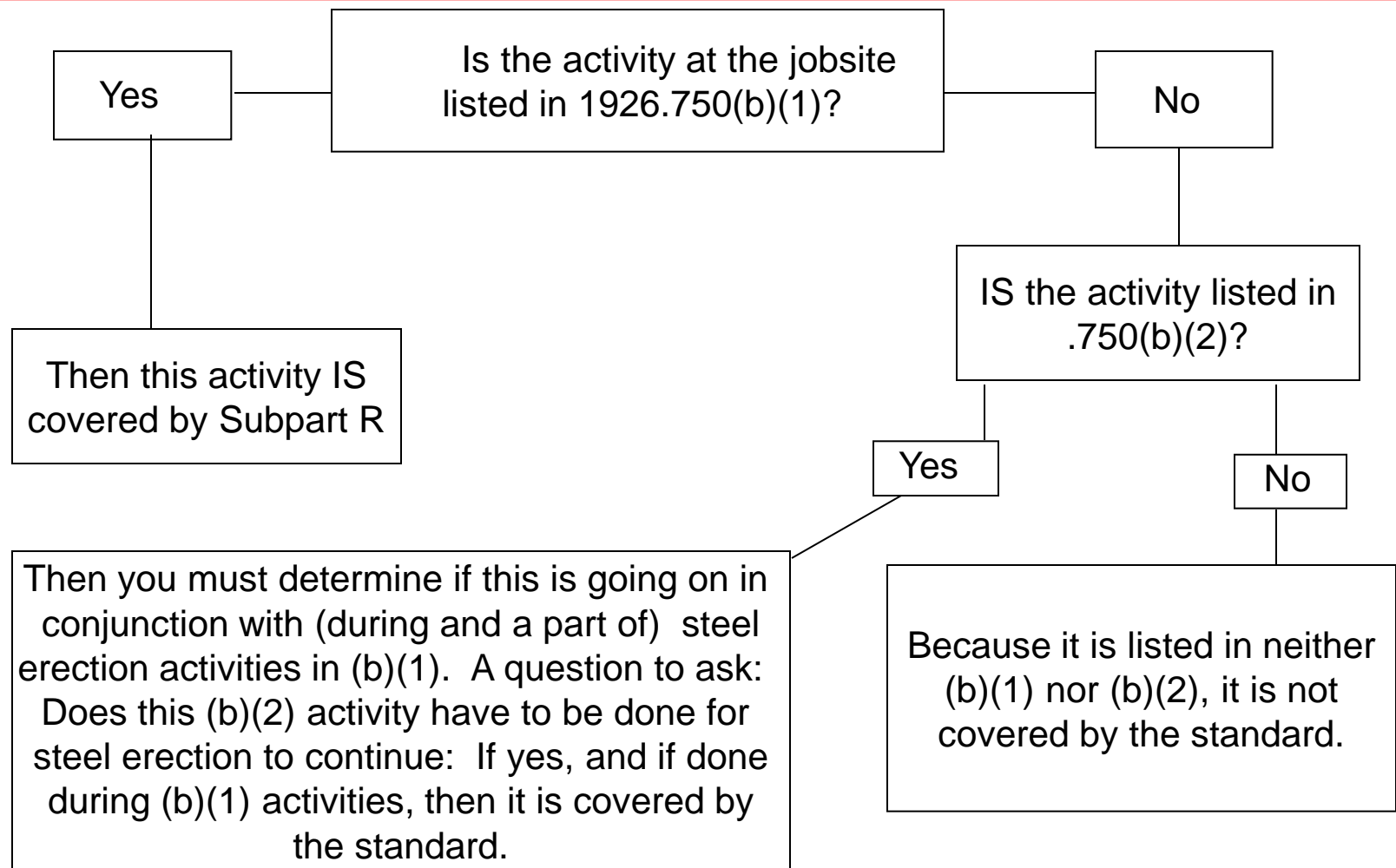






# Steel Erection Decision Tree

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# Key Provisions of 1926 Subpart R

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- Site layout, site-specific erection plan and construction sequence
- Hoisting and rigging
- Structural steel stability requirements
  - Structural steel assembly
  - Column anchorage
  - Beams and columns
  - Open web steel joists





# Key Provisions of 1926 Subpart R

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- Systems-engineered metal buildings
- Falling object protection
- Fall protection
- Worker training





# Site Layout, Site-Specific Erection Plan and Construction Sequence

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1926.752(a)-(b)

- Controlling contractor ensures the steel erector is provided with written notification.
  - Concrete being used has reached sufficient strength to support the intended load
  - Repair, replacements and modification of steel bolts were conducted in accordance with §1926.755(b)
- Steel erection contractor shall not proceed without ensuring that concrete has reached sufficient strength to support intended load.





# Site Layout, Site-Specific Erection Plan and Construction Sequence

1926.752(c)

- Site layout
  - Adequate access roads
    - » Safe delivery of supplies
    - » Movement of equipment
  - Firm, properly graded, and drained area
    - » Allows for work with adequate space
    - » Allows for safe operation of equipment





# Site Layout, Site-Specific Erection Plan and Construction Sequence

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1926.752(e)

- Site-specific erection plan
  - See 1926 Subpart R, Appendix A
    - » Provides guidelines for a non-mandatory site specific erection plan







# Hoisting and Rigging

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1926.753(c)-(d)

- Provides additional crane safety for steel erection by requiring a pre-shift crane inspection
- Minimizes employee exposure to overhead loads through pre-planning and work practice requirements





# Hoisting and Rigging

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1926.753(e)

- Provides multiple lift rigging procedures (Christmas-treeing)







# Structural Steel Assembly

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1926.754

- Structural stability
- Walking/working surface
- Plumbing up
- Metal decking





# Structural Stability

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1926.754(a)

- Shall be maintained at all times during construction



# Structural Stability

1926.754(b)

- Multi-story structures
  - Permanent floors installed as erection progresses
    - » Eight stories maximum between erection floor and upper-most permanent floor
  - Four floors maximum (or 48 feet) of unfinished bolting or welding above foundation or uppermost permanently secured floor
  - Fully planked floor or nets maintained within two stories (or 30 feet) directly under erection work





# Walking/Working Surfaces

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1926.754(c)

- Shear connectors and other similar devices
  - Field-installed rather than shop installed
  - Installed after the metal decking
  - Not attached until after walking/working surface has been installed



**Shear Connectors**



# Walking/Working Surfaces 13 NCAC 07F .0205(c)(1)

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- Tripping hazards
  - Employees protected from falls due to tripping hazards
    - » Employees protected from falling hazards greater than 6 feet by suitable fall protection systems
    - » Shear connectors not welded or applied until working/walking surface is installed
    - » Shear connectors covered by temporary decking, metal, or wood box until walking/working surface is installed







# Plumbing-Up Equipment

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1926.754(d)

- Installed in conjunction with steel erection process to ensure stability of structure
- In place and properly installed before structure is loaded with construction material
- Be removed only with approval of competent person





# Metal Decking

1926.754(e)(1)

- Bundle packaging and strapping cannot be used for hoisting
- Any loose items placed on top of metal decking bundles must be secured
- Support provided so bundles will not be dislodged when bands are removed
- Metal decking secured at end of shift





# Metal Decking

1926.754(e)(2)

- Structural member turned down to allow continuous deck installation
- Roof and floor holes and openings shall be decked over
- Holes and openings shall not be cut prior to its intended use







# Metal Decking

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1926.754(e)(3)

- Covers for roof and floor openings should support twice the weight of their intended load
- Covers shall be marked with the word “**HOLE**” or “**COVER**”





# Metal Decking

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1926.754(e)(5)

- Installation of metal decking
  - Laid tightly and immediately secured to prevent accidental movement or displacement
  - Metal decking panels placed to ensure full support by structural members



# Column Anchorage

1926.755(a)

- Minimum 4 anchor bolts per column
- Set on level finished floor, pre-grouted leveling plates, leveling nuts, or **shim packs**
- Competent person determines whether guying or bracing is needed





# Column Anchorage

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1926.752(b) and 1926.755(b)

- Written notification of proper curing of concrete in footings, piers, walls for steel columns
- Written notification of adequacy of anchor bolts modified, replaced or repaired in the field





# Beams and Columns

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1926.756

- Placing and bolting solid web structural members
- Diagonal bracing
- Double connections and seats
- Column splices
- Perimeter columns

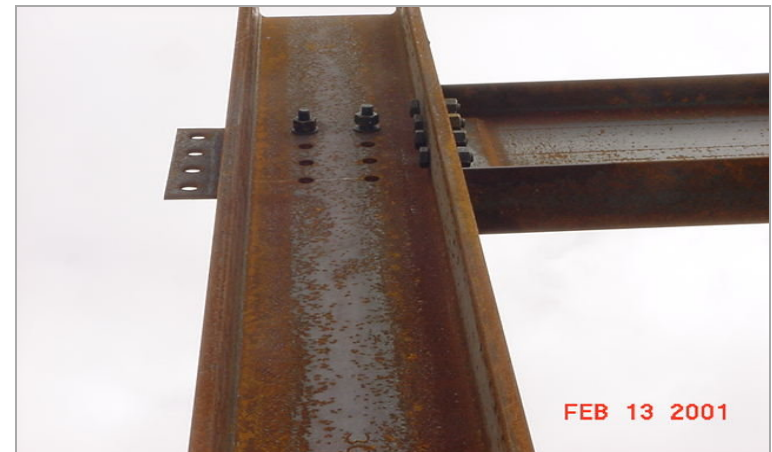




# Beams and Columns

1926.756(a)

- Two bolts per connection installed before releasing the hoisting line
  - Competent person shall determine if more are needed to ensure the stability of cantilevered members







# Diagonal Bracing

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1926.756(b)

- Solid web structural members used as diagonal bracing secured by at least one bolt drawn up wrench tight



# Double Connections

1926.756(c)(1)

- When connecting two structural members, at least one bolt shall remain connected to the first member.
  - Unless a seat is supplied to prevent the column from being displaced





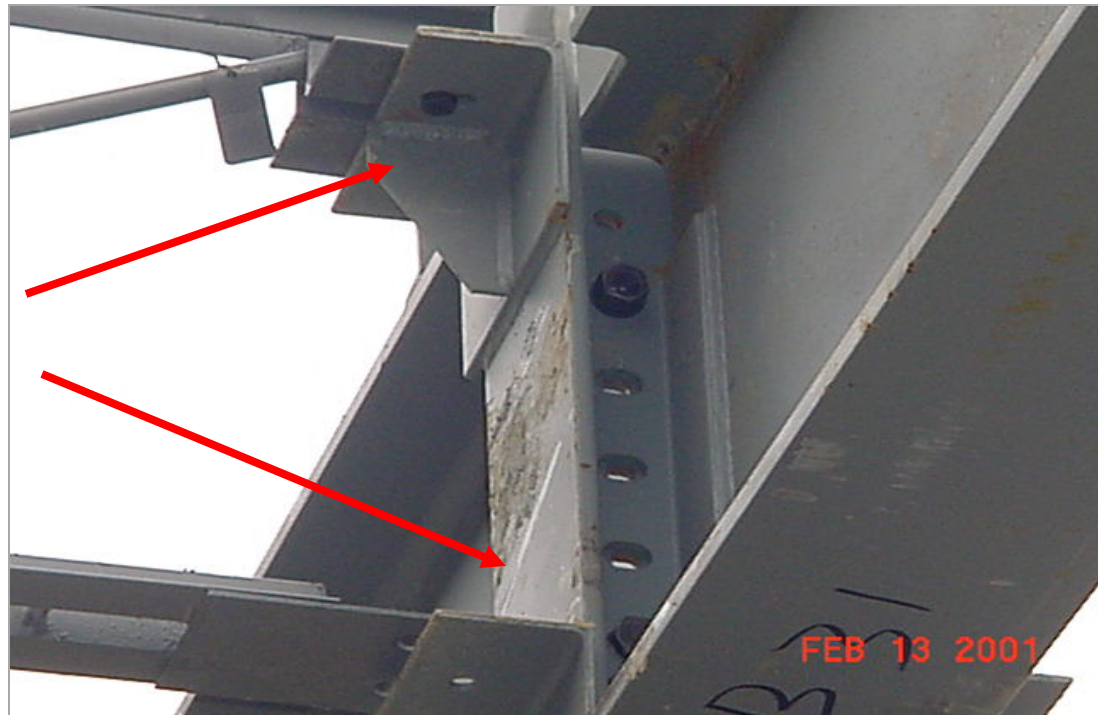


# Seat Design

1926.756(c)(2)

- Seats designed to support the load during the double connection process

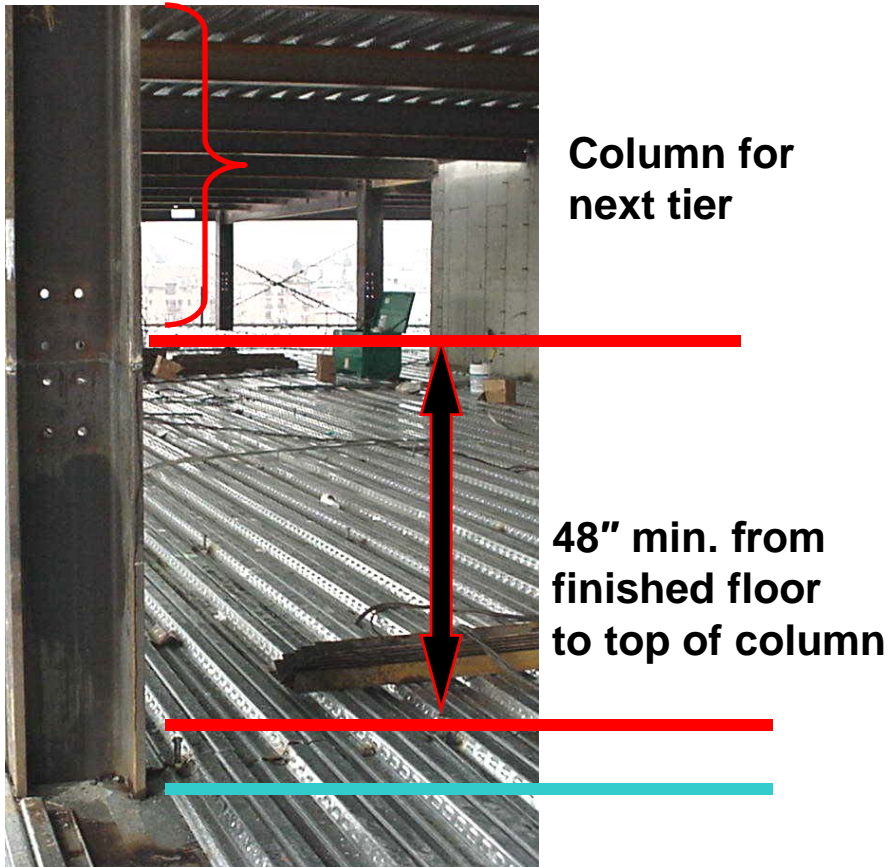
Seats





# Perimeter Columns

1926.756(e)(1)



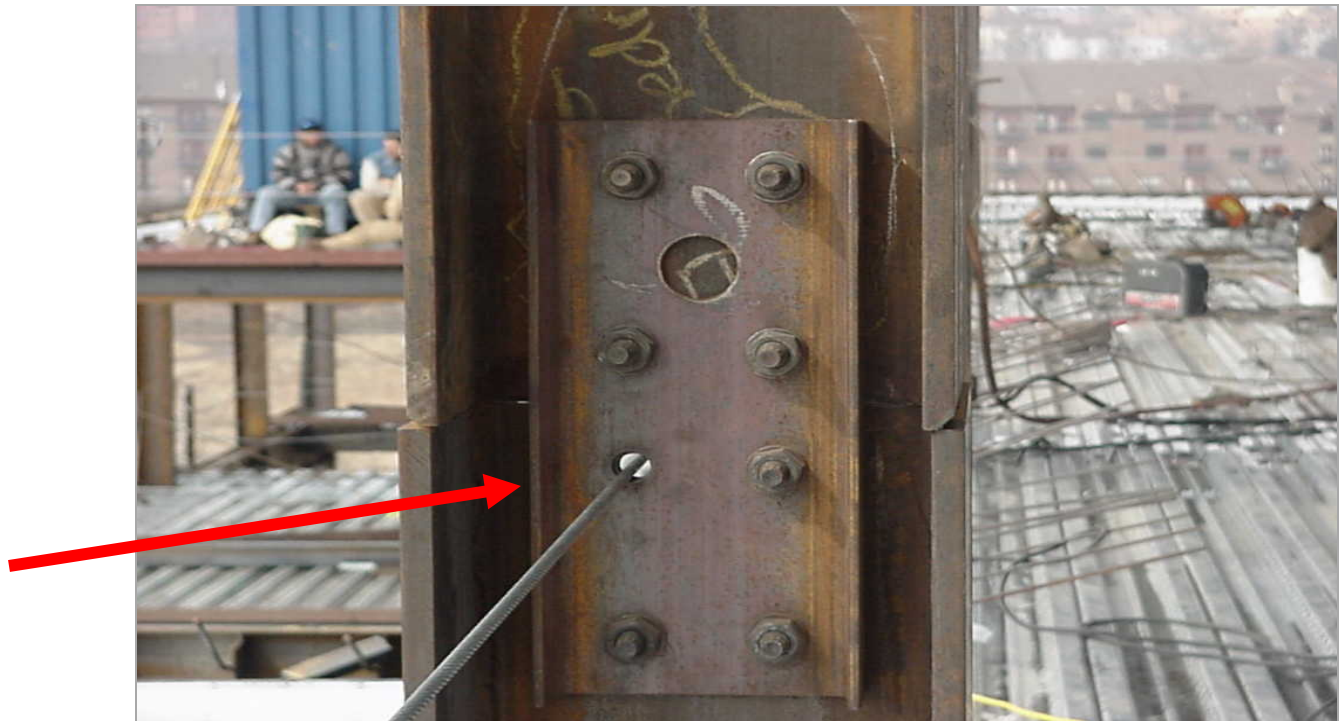
- Perimeter columns must extend a minimum of 48 inches (1.2 m) above the finished floor to permit installation of perimeter safety cables prior to erection of next tier



# Perimeter Columns

1926.756(e)(2)

- Perimeter columns must have holes in/attached to perimeter columns at 42-45 inches above finished floor and midpoint between finished floor and top cable





# Open Web Steel Joists

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1926.757

- Attachment of steel joists and joist girders
- Erection of steel joists
- Erection bridging
- Landing and placing loads





# Open Web Steel Joists

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1926.757(a)

- Steel joist shall be field-bolted at column to provide lateral stability during erection
- Where constructability does not allow it, an alternate means shall be installed
  - Designed by qualified person
  - Shop installed
  - Included in erection drawings





# Field-Bolted Joists

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1926.757(a)

- Connections of individual steel joists to steel structures in bays of 40 feet or more shall be fabricated to allow field bolting during erection
- Steel joists and girders shall not be used as anchorage points for fall arrest systems





# Attachment of Steel Joists and Girders 1926.757(b)

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- Attachment of “K”, “LH”, and “DLH” series steel joists and girders
- Each steel joist must be attached to support structure
  - Immediately upon placement in the final erection position, *and*
  - Before additional joists are placed
- Pre-assembled panels attached with bridging to structure at each corner before hoisting cables are released



# Erection of Steel Joists

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1926.757(c)(1)-(3)

- Attach both sides of the seat of one end of each steel joist to the support structure before hoisting cables are released
- For joists over 60 feet
  - Both ends of the joist must be attached, *and*
  - Meet provisions of paragraph (d) before releasing hoisting cables
- **Only** one employee is allowed on steel joists that do not require erection bridging under **Tables A and B** until all bridging is installed and anchored





# Erection of Steel Joists

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1926.757(c)(4)-(5)

- Employees not allowed on steel joists where span of joist is equal to or greater than span shown in Tables A and B
- When permanent bridging terminus points cannot be used during erection, temporary bridging required





# Erection Bridging

1926.757(d)

- Specific procedures related to span of steel joists
  - Bolted diagonal bridging and installation
  - Releasing of hoisting cables
  - Number of employees allowed on these spans during bridging





# Landing and Placing Loads

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1926.757(e)

- Loads not to exceed carrying capacity of steel joists
- Attention paid to weight and placement of load within the structure
- No bundle of decking placed on joists until bridging is installed



# Systems-Engineered Buildings

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# Systems-Engineered Metal Buildings

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1926.758(a)-(c)

- Structural columns anchored by a minimum of four anchor bolts
- Rigid frames
  - Shall have 50% of their bolts or number specified by manufacturer installed before releasing hoisting equipment

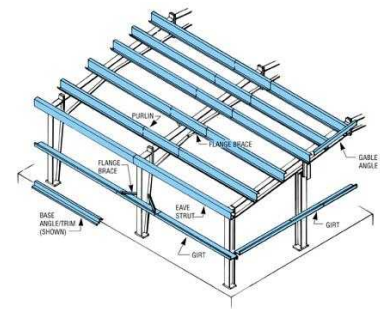




# Systems-Engineered Metal Buildings 1926.758(d)-(e)

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- Construction loads not placed on structural steel framework unless secured
- When girts or eave struts share common connection holes:
  - At least one bolt must remain connected to the first member
  - Field-attached seat supplied by the manufacturer may be used in lieu of the bolt





# Systems-Engineered Metal Buildings 1926.758(f)-(g)

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- Both ends of steel or cold-formed joists fully bolted or welded before:
  - Releasing cables
  - Allowing employees on the joists
  - Allowing construction loads on the joists
- Purlins and girts not used as anchorage points for a fall arrest system

**Girts**







# Systems-Engineered Metal Buildings 1926.758(h)-(i)

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- Purlins may be used as a walking/working surface when installing safety systems
  - After installation of permanent bridging, *and*
  - Fall protection provided
- Construction loads placed within a zone that is within 8 feet of the center-line of the primary support member





# Falling Object Protection

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1926.759(a)-(b)

- Secure loose items aloft
- Protection from falling objects other than materials being hoisted





# Fall Protection

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1926.760

- Fall protection requirements
- Connectors
- Controlled decking zone (CDZ)
- Criteria for fall protection equipment
- Custody of fall protection





# Fall Protection

1926.760(a)

- Employees must be protected by conventional fall protection
  - When on walking/working surface with unprotected edge more than 15 feet above lower level
- Perimeter cables required
  - Must be installed “*as soon as the metal decking has been installed*”
- Connectors and employees working in CDZ shall be protected from fall hazards





# Connectors

1926.760(b)

- Connectors between 15 and 30 feet/2 stories
  - Provided all equipment necessary to be tied off or provided other fall protection
  - Completed connector training
  - Not required to tie off





# Controlled Decking Zone

1926.760(c)

- Deckers between 15 and 30 feet/2 stories can use a CDZ instead of fall protection
- Be no more than 90 feet wide and 90 feet deep from leading edge
- Limited access to CDZ
- Boundaries designated and clearly marked
- Employees must complete CDZ training





# Fall Protection Equipment

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1926.760(d)

- Fall protection equipment must conform to 1926.502
- Fall arrest system components shall be used in fall restraint systems
- Body belts or body harnesses shall be used in fall restraint systems
- Perimeter safety cables shall meet criteria for guardrail systems







# Custody of Fall Protection

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1926.760(e)

- Steel erector may leave fall protection in place so it may be used by other trades if the controlling contractor:
  - Has directed the steel erector to leave the fall protection in place, *and*
  - Has inspected and accepted control and responsibility of the fall protection before authorizing other trades to work in the area





# Training

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1926.761(a)

- Training provided by a qualified person





# Fall Hazard Training

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1926.761(b)

- Training shall include the following:
  - Recognition and identification of fall hazards
  - Use and operation of guardrail systems
  - Correct procedures for erecting, maintaining, disassembling, and inspecting fall protection systems
  - Procedures to prevent falls
  - Fall protection requirements





# Special Training

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1926.761(c)(1)

- Multiple lift rigging
  - Hazards associated with multiple lifts
  - Procedures and equipment to perform multiple lifts





# Special Training

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1926.761(c)(2)

- Connector procedures
  - Hazards associated with connecting
  - Establishment, access, proper connecting techniques and work practices





# Special Training

1926.761(c)(3)

- Controlled decking zone procedures
  - Hazards associated with work within a controlled decking zone
  - Establishment, access, proper connecting techniques and work practices





# Summary

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In this course, we discussed the following:

- Conception of the Steel Erection Rule
- Scope of the standard
- The key provisions of 1926 Subpart R
- A review of each of the key provisions
- Safe working practices







# Thank You For Attending!

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# Final Questions?

# Handouts

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Place all handouts at the end of this presentation.