

Prevention through Design Toolkit for the Construction Industry



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Prevention through Design Toolkit

Prevention through Design (PtD) is the process of designing out a hazard, and it is the most reliable and effective way to protect workers. The ultimate goal of PtD is to reduce occupational injuries, illnesses, and fatalities. This toolkit is intended to promote the use of PtD practices by construction companies and contractors to address and eliminate some of the most significant hazards seen by construction workers. This toolkit includes:

1. **Preventing falls in construction.** Falls from elevation is the leading cause of construction worker fatalities.
2. Reducing or eliminating **struck-by incidents in highway workzones.** Struck-by incidents are the second leading cause of construction worker fatalities and the leading cause of nonfatal injuries.
3. Preventing **building construction struck-by incidents.** Struck-by incidents are the second leading cause of construction worker fatalities. Many of the struck-by incidents during building construction involve dropped objects or falling or flying objects.
4. Prevention through design in **residential construction.** Small residential construction contractors are at increased risk of injuries and fatalities on the job. By planning how the work is done and eliminating hazards early in the design process, many injuries can be prevented.



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Fall Prevention Toolkit for Architects and Design Engineers

Use this table to minimize common fall exposures during the construction and maintenance of buildings.

PtD recognizes that architects and design engineers can “design out” potential hazards to eliminate or minimize the risk and improve workers’ safety and health. This table, used during the planning and design phase, will help/ guide architects and design engineers to identify and eliminate potential hazards that are found in building construction and later maintenance of the building or site. To increase PtD application and certainty in the scope of work, PtD controls should be part of bids and contracts associated with the construction and maintenance and included in plans and drawings.

Design Engineer Codes: CE = Civil, ME = Mechanical, SE = Structural, PE = Project

Component	Design Risk	PtD Controls	Architect	Engineer
Roof Openings (skylights, solar tubes, exhaust fans, etc.)	Falling through roof openings during installation, maintenance, or emergency operations due to no or inadequate fall protection systems	• Design permanent guardrails or protective netting around openings	X	CE, SE
		• Specify skylights to have guardrails, load bearing mesh, or certified protective covers that can support the weight of a person	X	SE
		• Design/group roof openings together to create one larger opening with guardrails rather than many smaller openings	X	CE, SE
		• Locate roof access away from roof edges	X	SE
		• Implement clear signage and marking around roof openings to enhance visibility and awareness of potential hazards	—	PE
Roof Access	Falling from unsafe roof access points (Unprotected ladders, unsafe roof hatch openings)	• Design safe access to all roof levels or from level to level (stairs, protected ladder, ships ladder)	X	CE, SE
		• Install a permanent stairway with handrails for safer and easier access to the roof, especially if frequent access is required	X	SE
		• Provide adequate space around roof hatch to allow for safe personnel movement and equipment handling during access and maintenance operations	X	SE
		• Design/provide safety grab bar for hatch access or handrail that extends above the roof level	X	CE, PE
Roof Edges (elevated levels/ changes in elevations)	Falling off exposed edges during construction and maintenance if they are not adequately guarded or protected	• Design minimum 42” height parapets or railings at all roof edges	X	CE, SE
		• Design/specify embedded anchor points: - Locate to enable the end user to safely perform regular maintenance - Involve a fall protection supplier/designer in the plan review	X	CE, PE, SE

Component	Design Risk	PtD Controls	Architect	Engineer
Windows, Balconies, Elevated Patios	Prior to installing windows, low sill heights increase the likelihood of falling through window openings or fall from elevated balconies/patios	• Design window sills to be 42" minimum above the floor level (i.e., act as guard rails during construction)	X	SE
		• Include fall protection anchorage points (roof davits or horizontal lifelines) for workers constructing balconies/elevated patios	X	CE, SE
		• Include mounting brackets for temporary guardrail posts or sections during construction	X	SE
Window Washing Systems	Poorly designed or absent window washing systems increase the risk of falls during window washing operations	• Include window washing equipment safety anchorage points in design, and engineered in structural drawings	X	CE, SE
		• Use a window washing consultant to evaluate building exterior shape and safe window/building washing post construction maintenance	—	CE, PE
		• Allow the permanent window washing system (davits and tiebacks) to be used for construction activities (exterior skin installations, painting, final cleaning, etc.)	*	CE, PE
Mechanical/ HVAC (equipment location)	Unsafe location of mechanical and HVAC systems (e.g., near openings or edges) can create fall and other worker safety hazards	• Locate rooftop mechanical/HVAC equipment away from the structure's edge and skylights—locate within parapet walls	X	SE, ME
		• Include slip-resistant walk pads to access serviceable equipment	X	PE
		• Ensure safe transitions between mechanical penthouses and roof surfaces with no steps greater than 8" and steps should have slip resistance surface	X	SE
Mechanical/ HVAC (equipment supports)	Mechanical and HVAC systems and their supports that are not well designed for construction loads could collapse and create fall hazards	• Design overhead equipment and their supports to hold the weight of several construction workers - Consult with the manufacturers	X	SE, ME
		• Install conduit and mechanical, electrical, and plumbing lines to prevent workers having to walk or climb over them. Build stairs over these lines to make it easier for workers to access equipment and other areas of roof.	X	SE, ME
		• Install HVAC equipment after the floor is complete, and permanent guard rails and anchor points have been installed	X	SE, PE

Component	Design Risk	PtD Controls	Architect	Engineer
Stairs, Ladders, Ramps (usage and materials)	Frequent use of ladders, stairs, or ramps by construction and maintenance workers to move material and equipment increases falls. Inadequate stair, ladder and ramp materials can also increase risk of slips and falls	• Build permanent stairways as soon as possible in the construction phase (for use by construction personnel). Add all ramps during construction and provide a permanent non-slip surface.	—	CE
		• Consider stairs rather than a ladder where workers frequently move materials and equipment or when equipment requires frequent service i.e. filter changes	*	CE
		• Use prefabricated or ground-assembled stairways installed as one assembly	X	CE
		• Choose stairway materials based on the anticipated construction activities and environmental factors to minimize deterioration of the stairways and fall potential. Exterior stairway should allow rain and snow to pass through.	X	CE, SE
		• Include warning strips at the top and bottom to each flight in a contrasting color to interior stairs to alert users to the change in elevation	X	PE
		• Pour with a brushed finish or install a slip-resistant surface for each stair tread	X	PE
		• Install inserts in each tread and temporary guardrails on steel pan until concrete is poured and permanent handrails installed	X	PE
Structural Steel Framing (steel erection)	Falling from steel beams, purlins, girts, or utility bridges during steel erection related to inadequate fall protection systems	• Provide holes in the webs of beams above piping for attachment of supports and lifelines	X	SE
		• Contract drawings should show clear locations of attachment and how many lifelines each beam can support	X	SE, PE
		• Provide columns with holes at 21" and 42" above the floor level to provide support locations for lifelines and guardrails	X	SE
		• Attach retractable lanyards to columns before erection. All beams should have stanchions and safety lines already installed	*	SE, PE
		• Assemble multiple sections of steel when practical to eliminate connecting pieces at height	*	SE, PE
Outdoor Platforms/ Walkways	Slips, trips and falls on/from unguarded or unsafe outdoor platforms and walkways	• All platforms, loading docks, and walkways located above ground level should include appropriate guardrails	X	CE
		• Provide non-slip surfaces on walkways and platforms exposed to the weather. In cold climates, consider ice melting, cabling, or grating so snow will not accumulate.	X	PE
		• Locate exterior stairs and ramps on the sheltered side of the structure to protect them from rain, snow, and ice	X	CE, SE

Component	Design Risk	PtD Controls	Architect	Engineer
Concrete Slab on Grade	Falls from elevated concrete slab-on-grade and related obstructions	• Design and schedule slabs-on-grade, sidewalks, roadways, and other flatwork construction near elevated structures as early as possible for use by construction workers	X	CE, PE
		• Design concrete floor finishes, stairway, and ladder landings with brushed surfaces to prevent falls and obstructions	X	CE
		• All stairways and landings located above ground level should include appropriate guardrails	X	CE
General Arrangement/ Project Layout	Inadequate floor plan can lead to fall hazards if the floor levels vary in size/shape or height	• Group floor openings together to create one larger opening rather than many smaller openings - Provide permanent guardrails around floor openings located above ground level	X	SE
		• Design floor plans with limited offsets of varying sizes/shapes and minimized changes in floor level to be flush with walking surfaces	X	SE

* not applicable (n/a)

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Struck-by Toolkit for Design Engineers and Resident Engineers - Roadway Work Zones

Use this table to prevent through design many common struck-by exposures during the construction and maintenance of roadways.

Prevention through Design (PtD) recognizes that design/resident engineers are able to “design out” potential hazards to eliminate or minimize risk and improve workers’ safety and health. This table, when used during the planning and design phase, should help design/resident engineers identify and eliminate hazards when used in roadway construction and maintenance. To increase PtD application and certainty in the scope of work, PtD controls should be part of bids and contracts associated with the construction and maintenance and included in plans and drawings.

Design Engineer Codes: CE = Civil, TE = Traffic, SE = Structural, PE = Project

Component	Design Risk	PtD Controls	Resident Engineer	Design Engineer
Pedestrian worker	Walking adjacent to motor vehicle traffic and construction equipment and vehicles increases the risk of workers being struck by passing vehicles and equipment.	<ul style="list-style-type: none"> Develop and use an Internal Traffic Control Plan (ITCP). Specify physical barriers to separate and protect workers from motorist traffic <ul style="list-style-type: none"> Ensure positive protection is used to isolate workers from passing motorists 	✓	PE, TE
		<ul style="list-style-type: none"> Schedule work activities at different times to reduce work crew exposure to passing construction vehicles and equipment 	✓	PE
		<ul style="list-style-type: none"> Design separate work zone entry and exit points for pedestrian workers and vehicles 	✓	PE, TE
		<ul style="list-style-type: none"> Design pedestrian worker crossing points so that drivers and pedestrians can see each other <ul style="list-style-type: none"> Specify signs and lighting at the crossing points regardless of the time 	✓	PE, TE
		<ul style="list-style-type: none"> Determine safe movements for workers to/from and within each operation and specify them on site drawings <ul style="list-style-type: none"> Design safe access for traffic within the general work zone 	✓	PE
		<ul style="list-style-type: none"> Identify “pedestrian-free zones” on the site plan in high construction traffic areas such as access/egress points 	✓	PE, TE
		<ul style="list-style-type: none"> Ensure all heavy equipment used on site has back-up cameras and alarms 	✓	-
Vehicle and heavy equipment	Construction vehicle movement and activities can lead to struck-by hazards for workers.	<ul style="list-style-type: none"> Design access/egress to minimize construction and motorist traffic conflicts. Design workflow to eliminate the need for spotters 	✓	PE, TE
		<ul style="list-style-type: none"> Design the order of work to minimize vehicle backing 	✓	PE, TE
		<ul style="list-style-type: none"> Design the order of work to minimize pedestrian worker and equipment conflicts 	✓	PE, TE

Component	Design Risk	PtD Controls	Resident Engineer	Design Engineer
Motorist traffic	Highway and roadway motorist traffic can enter construction zones and strike construction workers.	<ul style="list-style-type: none"> Reference and follow the FHWA, MUTCD. Specify physical barriers to protect workers in construction zones from passing motor vehicle traffic 	✓	TE, PE
		<ul style="list-style-type: none"> Design lateral buffers to increase space between pedestrian workers and passing vehicles where positive protective barriers are not feasible 	✓	PE, TE
		<ul style="list-style-type: none"> Specify truck-mounted attenuators into traffic control plans to increase protection for motorists and workers 	✓	PE, TE
		<ul style="list-style-type: none"> Specify adequate lighting during night operations <ul style="list-style-type: none"> - Install lighting in a manner that minimizes glare and potential blinding of oncoming motorists 	✓	PE, TE
Vehicles striking objects	Low overhead objects such as bridges and powerlines can lead to struck-by hazards for vehicles and workers.	<ul style="list-style-type: none"> Specify protective measures and warning signs where there is potential of people being struck by vehicles 	✓	CE, PE, SE, TE
		<ul style="list-style-type: none"> Specify overhead powerlines on site plans <ul style="list-style-type: none"> - Design appropriate powerline height if vehicles must pass beneath. Post clear ground level warnings. 	✓	CE, PE, TE
		<ul style="list-style-type: none"> Design traffic flow around any potential overhead obstructions 	✓	CE, PE, TE
		<ul style="list-style-type: none"> Install height restriction bars before overhead hazards to physically prevent over-height vehicles from proceeding 	✓	CE, PE, TE
		<ul style="list-style-type: none"> Specify warning signs and messaging on approach to bridges and overpasses 	✓	CE, PE, TE
		<ul style="list-style-type: none"> Specify bridge treatment using retro-reflective paint or striping 	✓	CE, PE, TE
Vehicle tip over (grading and roads)	Grading and roads should be designed to prevent overturns.	<ul style="list-style-type: none"> Design temporary roads with adequate drainage and good access to for the mobility of all vehicle and equipment types 	—	CE, PE
		<ul style="list-style-type: none"> Design dump locations with flat and solid surfaces for dumping. Protect the edge using a berm of at least mid-axle height. 	—	CE, PE

Component	Design Risk	PtD Controls	Resident Engineer	Design Engineer
Project planning	Creating conditions that decrease preventable general hazards/built-in risks.	• Schedule multiple tasks in a manner that prevents conflicts between separate operations	✓	CE, TE, PE
		• Plan construction under closed road conditions when feasible	—	PE
		• Plan for emergency vehicle access, signage and locate emergency access points on project plans	✓	PE, TE
		• Plan to develop Internal Traffic Control Plans with “pedestrian-free zones” and equipment paths throughout the construction process	✓	PE, TE

FHWA, MUTCD is the Federal Highway Administration, Manual of Uniform Traffic Control Devices

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Struck-by Toolkit for Architects and Design Engineers - Building Construction

Use this table to prevent through design many common struck by exposures during the construction and maintenance of buildings.

Prevention through Design (PtD) recognizes that architects and design engineers working with construction teams can “design out” potential hazards to eliminate or minimize the risk and improve workers’ safety and health. This table, during the planning and design phase, should assist architects and design engineers to identify and eliminate hazards in building construction and maintenance. To increase PtD application and certainty in the scope of work, PtD controls should be part of bids and contracts associated with the construction and maintenance and included in plans and drawings.

Design Engineer Codes: CE = Civil, ME = Mechanical, SE = Structural, PE = Project

Component	Design Risk	PtD Controls	Architect	Design Engineer
Pipes/beams overhead objects, underground hazards	Striking of existing/ uncharted/ abandoned/ underground/ overhead utilities or structures.	<ul style="list-style-type: none"> Route piping or overhead objects to avoid “head knockers” (6’-6” min. above grade) 	✓	CE, ME
		<ul style="list-style-type: none"> Design and install protective barriers or guards around critical overhead utilities to prevent accidental strikes 	✓	ME, PE
		<ul style="list-style-type: none"> Specify markings or warning signs on low-clearance overhead objects 	✓	ME, SE
		<ul style="list-style-type: none"> Always contact 811 and obtain utility maps from service providers and complete trenching or ground penetrating radar surveys before starting work 	✓	ME, SE
Piping and ductwork (erection)	Large pipe or ductwork sections, which lack adequate connection points for lifting and lack restraint from rolling, creating struck-by hazards.	<ul style="list-style-type: none"> Design large pipe or ductwork sections to be oval or have one flattened portion to prevent rolling Weld a temporary strut to the side of casings to prevent rolling if tipped during handling. Consider off-site modular construction of pipe racks and/ or on ground assembly. Require dedicated connection points for any round materials like drill casings. Design sections with integrated lifting points or lugs to facilitate safe handling and reduce the risk of slippage or rolling. Use specialized lifting equipment, such as spreader bars or lifting beams, to distribute the load evenly and reduce the risk of instability. 	✓	ME, SE

Component	Design Risk	PtD Controls	Architect	Design Engineer
Vehicles striking objects	Temporary structures, liquified petroleum gas (LPG) storage areas, areas of limited headroom, electric cables, pipelines, etc. can lead to struck-by hazards while operating vehicles and machinery.	<ul style="list-style-type: none"> Specify solid physical protection and warning signs in areas that have high potential for struck by vehicles 	—	CE, PE, SE
		<ul style="list-style-type: none"> Specify solid safety barriers to protect LPG storage areas and goalposts, bunting and barriers where there is a risk of striking overhead services 	✓	ME, PE
		<ul style="list-style-type: none"> Specify reflective hazard markings on hard-to-see objects and structures 	—	PE
		<ul style="list-style-type: none"> Designate vehicle traffic lanes for deliveries using Internal Traffic Control Plans and for equipment used on site <ul style="list-style-type: none"> Mark travel lanes for both day and night operations Designate and light areas for pedestrian crossings. 	✓	PE
Vehicle and heavy equipment traffic	Pedestrians can be struck by heavy equipment, construction vehicles and their loads.	<ul style="list-style-type: none"> Establish well-lit primary pedestrian routes that provide safe access to work areas away from main vehicle routes 	✓	CE, PE
		<ul style="list-style-type: none"> Specify physical protection like temporary concrete barriers where pedestrians may be struck by vehicles or their loads 	✓	PE
		<ul style="list-style-type: none"> Establish public pedestrian crossing points and pedestrian control measures where necessary 	✓	PE
		<ul style="list-style-type: none"> Establish an ITCP to route construction traffic away from pedestrians that include safe entry and exit points 	✓	PE
		<ul style="list-style-type: none"> Design temporary traffic control devices to slow vehicle traffic Complete a vehicle swept path analysis to assess constructability and safety and ensure that vehicle movements do not encroach on pedestrian paths 	—	PE
Powered industrial trucks (PIT)	Pedestrians or workers can be struck by PITs (forklifts), or objects falling from a forklift.	<ul style="list-style-type: none"> Specify steel bollards/guardrails at potential pedestrian/forklift conflict areas 	✓	CE, PE

Component	Design Risk	PtD Controls	Architect	Design Engineer
Precast and Prefabrication Elements; Steel Beams and other structural elements	Large and heavy precast structures need a wide lifting radius and pose struck-by hazards.	<ul style="list-style-type: none"> Specify U-shaped precast beams with cast-in-situ infill concrete to reduce the crane load 	✓	PE
		<ul style="list-style-type: none"> Design precast shell columns with cast-in-situ infill concrete to reduce the crane load Consider the risk, location, and access to items with stored energy such as prestressed beams, post-tensioned concrete, springs/dampers, and other stored energy systems. Consider labeling as such. 	✓	CE, SE
Concrete Masonry Units (Concrete Blocks)	Crowded and confined areas below elevated masonry work increase the risk of workers being struck by dropped objects.	<ul style="list-style-type: none"> Specify large, limited access zones below elevated masonry work to minimize dropped objects striking workers Install physical barriers or debris nets below elevated work areas to catch any falling objects and prevent them from reaching workers below. Implement phased work plans to ensure that only necessary personnel are present during high-risk operations. Use tool lanyards and tethering systems to prevent tools from being accidentally dropped. 	✓	CE, PE
Hoists	Workers can be struck by the platform, the load, or other moving parts of the hoist.	<ul style="list-style-type: none"> Design an enclosed hoist way in areas where the worker could be struck (e.g., working platforms or window openings) 	✓	CE, PE
		<ul style="list-style-type: none"> Design adequate lighting and access to the hoist area 	✓	PE
		<ul style="list-style-type: none"> Design gates at all landings and at ground level 	✓	PE
		<ul style="list-style-type: none"> Design hoist controls where they will prevent being struck by a falling load, broken cable or chain due to mechanical failure 	✓	PE
		<ul style="list-style-type: none"> Specify a hoist rated for appropriate loads, and prevent using non-conforming components 	—	ME, PE
		<ul style="list-style-type: none"> Design hoists in areas that will minimize nearby foot traffic, or install guardrails to prevent walking beneath elevated loads 	✓	PE
		<ul style="list-style-type: none"> Specify misalignment detection to prevent lifting an unbalanced load that could cause uncontrolled swinging 	—	PE

Component	Design Risk	PtD Controls	Architect	Design Engineer
Building exterior	Loose materials and equipment can lead to struck-by and other safety hazards for workers.	<ul style="list-style-type: none"> Specify impact resistant windows, doors and shields at occupied spaces in high wind areas Ensure secure material inside or solid anchoring in open outdoor areas 	✓	CE, PE
General (overhead)	Overhead construction can lead to struck-by or other safety hazards for workers.	<ul style="list-style-type: none"> Design components for prefabrication on the ground and erecting complete assemblies 	✓	CE, PE
		<ul style="list-style-type: none"> Design adequate exclusion zones to prevent entry where overhead work is underway. 	✓	PE
Exits and doorways	Blind exit passageways, vehicular exit ways, or blind door swings can lead to struck-by or safety hazards for workers.	<ul style="list-style-type: none"> Specify mirrors, warning bells or other warning devices 	✓	CE, PE
		<ul style="list-style-type: none"> Specify steel bollards or physical barriers to protect workers on foot exiting blind passageways 	✓	PE
		<ul style="list-style-type: none"> Design one-way paths where swinging doors are used 	✓	PE
		<ul style="list-style-type: none"> Specify non-slip surfaces at all entries and ensure adequate lighting exists. 	✓	PE

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Toolkit for Design Engineers and Architects – Residential Construction

Use this table to prevent through design common safety and health hazards during the construction and maintenance of residential buildings.

Prevention through Design (PtD) recognizes that design engineers and architects can “design out” potential hazards to eliminate or minimize the risk and improve worker safety and health. This table, used during the planning and design phase, may assist design engineers and architects working with construction teams to identify and eliminate potential hazards present during residential construction and maintenance. To increase PtD application and certainty in the scope of work, PtD controls should be part of bids and contracts associated with the construction and maintenance, and included in plans and drawings. Include additional materials, lumber, anchor points, fasteners, plywood, etc., to build temporary guardrails, stairs, hole coverings and other fall prevention items. Identify anchor point locations on truss layout. Identify location of vent pipes for easy access from a ladder without having to enter an attic. These PtD controls are recommended for consideration in residential building construction when practical and feasible.

Design Engineer Codes: CE = Civil, EE = Electrical, ME = Mechanical, SE = Structural, PE = Project

Component	Design Risk	PtD Controls	Architect	Engineer
Framing, Painting, and Trim	Working from ladders or stilts presents a risk of injury from falls. Minimizing their use can reduce falls.	• Design roofs with easy access or access from upper interior levels when practical (no ladder required)	✓	SE
		• Locate exterior flatwork such as siding and eaves adjacent to areas that may require work at height to provide stable surfaces	✓	SE
		• Design interior and exterior spaces to accommodate the use of Perry-type work platforms instead of ladders or stilts	✓	SE
		• Schedule exterior flatwork early in the the construction process to provide stable surfaces for ladder placement	—	PE, SE

Component	Design Risk	PtD Controls	Architect	Engineer
Roofing	Working on roofs presents a fall risk, often from a substantial height. Sloped roofs also present a risk of struck-by incidents when tools and materials fall onto workers below.	<ul style="list-style-type: none"> Specify locations, types, and dimensions of guardrail systems on plans 	✓	PE
		<ul style="list-style-type: none"> Install anchors (temporary or permanent) into structural elements for attaching fall restraint systems 	✓	SE
		<ul style="list-style-type: none"> Add parapets to roof design to provide a barrier to falls for workers on the roof when appropriate to house design. Also, consider use of guardrails when appropriate. 	✓	PE, SE
		<ul style="list-style-type: none"> Design roof pitches with lower slopes that improve traction and stability of workers 	✓	SE
		<ul style="list-style-type: none"> Specify roofing materials with increased traction such as asphalt shingles, to avoid slips (instead of metal or tile roofs). 	✓	PE
		<ul style="list-style-type: none"> Locate rooftop features (e.g., vents, skylights, drains) to prevent tripping and allow safe movement on the roof 	✓	SE
		<ul style="list-style-type: none"> Design a flat area on the roof when feasible for loading roofing and solar components during installation and for future roof maintenance 	✓	SE
		<ul style="list-style-type: none"> Plan for roof work during dry and cooler seasons when feasible to minimize slip risks 	—	PE
		<ul style="list-style-type: none"> Perform roof inspections with a drone or other remote devices to eliminate the need for a person on the roof 	—	ME, SE
Electrical	Working with electrical wiring and equipment can present a risk of electrocution.	<ul style="list-style-type: none"> Design centrally-accessible, grounded, temporary power sources during construction that are ground fault circuit interrupted (GFCI) 	✓	PE
		<ul style="list-style-type: none"> Incorporate emergency shutoff switches and circuit breakers that are easily accessible in case of an electrical fault 	✓	EE
		<ul style="list-style-type: none"> Specify underground service lines rather than overhead wiring to prevent accidental contact and electrocution. Mark underground lines on the surface (flags, stakes, paint etc.) so they are not disturbed by other work. 	✓	CE, PE
		<ul style="list-style-type: none"> Mount lighting, electrical equipment, and wiring at lower levels, and easily accessible locations where feasible to reduce fall risks during installation and maintenance 	✓	EE, ME

Component	Design Risk	PtD Controls	Architect	Engineer
Solar	Installing and maintaining solar systems can present a risk of electrical hazards and falls from roofs.	• Minimize roof penetrations to prevent tripping hazards and simplify array installations	✓	ME, SE
		• Specify pre-wiring for solar and installation of conduit and raceways to reduce work on the roof after construction has ended	✓	ME, EE
		• Specify anchor points (temporary or permanent) for attachment of fall restraint systems	✓	SE
		• Design a simple roof shape for simpler installation of solar systems	✓	SE
		• Avoid placing overhead electrical service lines over solar zones	✓	ME, PE
		• Provide roof access when feasible for maintenance and emergency operations	✓	ME, PE, SE
		• Specify modular solar systems built on the ground and lifted to the roof in one piece	—	ME
Floor and Roof Openings, Windows, Leading Edges, Stairs, and Skylights	Unprotected openings, leading edges, stairs, windows and skylights can lead to a risk of falls from heights.	• Specify the locations of guardrail systems (temporary or permanent) on construction plans to protect against falls	✓	PE
		• Design stairwell openings that allow for ease of guardrail installation	✓	SE
		• Specify reinforced/shatterproof skylights designed to hold the weight of a person or design skylight guardrails or mesh covers to prevent workers falling through the opening	✓	PE
		• Specify modularization or pre-fabrication of components on the ground and lifting into place, including roof sections, trusses, floor framing, upper-level walls, and modular rooms	✓	ME, PE, SE
		• Place temporary stairwell/ladder openings in areas with less foot traffic when feasible to decrease the risk of falling through stairwell openings	✓	SE
		• Eliminate tripping hazards (e.g., changes in elevation, curbs, etc.) around floor openings	✓	ME, SE
		• Specify gutters, soffit, and trim materials that do not require painting to decrease ladder use or specify painting prior to installation	✓	PE
		• Design upper story window sill heights such that they act as guardrails for fall protection (at least 42" from floor)	✓	PE
		• Perform upper-level progress and final inspections with a drone or other remote visualization device to eliminate the need for a person at elevation	—	PE, SE

Component	Design Risk	PtD Controls	Architect	Engineer
Trenching and Excavation	Unsupported trenches and excavations can lead to a risk of injury or death from cave-ins. Striking underground utilities during excavation can result in fire, serious injury, and service interruptions.	<ul style="list-style-type: none"> Design or purchase engineered shoring systems (e.g., sheet piling and soldier piles), trench boxes or trench shields to prevent foundation excavations and cave-ins 	✓	CE
		<ul style="list-style-type: none"> Specify sloped or benched excavation where feasible to minimize cave-ins and reduce the need for shoring Work from outside, prefab or precast materials/structures rather than do the task in the excavation. Cut any piping or similar activities outside of the excavation. Prior to disturbing the ground, ensure all utilities have been located and properly marked. Use safe digging methods, such as hand digging or vacuum trucks, to expose utilities instead of heavy equipment. Use remotely controlled tampers to reduce worker exposures to open excavations. Ensure that ladders, ramps, or stairs are included in the design to provide safe access and egress for workers in excavations. 	—	CE
Concrete and Masonry	Flatwork set-up and finishes can lead to unsafe walking surfaces. Masonry and complex concrete walls can increase fall and struck-by hazards.	<ul style="list-style-type: none"> Specify 4" × 4" mat mesh or welded wire fabric on top of widely spaced rebar to provide a safer walking surface during concrete pours. Plywood may be used on top as a walkway. Cover exposed vertical rebar with reinforced caps to minimize impalement hazards. 	✓	CE, SE
		<ul style="list-style-type: none"> Eliminate offsets and other complicated shapes which increase cave-in hazards 	✓	—
		<ul style="list-style-type: none"> Design the covers over sumps, outlet boxes, drains, etc., to be flush with the finished floor 	✓	ME, SE
		<ul style="list-style-type: none"> Keep steps, curbs, slab depressions, and other similar floor features away from window openings, exterior edges, and floor openings 	✓	ME, PE, SE
		<ul style="list-style-type: none"> Specify a non-slip surface on walkways and platforms that are adjacent to open water like a pool or exposed to any weather 	✓	—
		<ul style="list-style-type: none"> Restrict masonry finishes to ground-level areas where feasible to reduce masonry work on scaffolding which can lead to falls and struck-by hazards 	✓	PE

Component	Design Risk	PtD Controls	Architect	Engineer
Mechanical	Improper mechanical room design can make access challenging and lead to struck-by hazards.	• Provide adequate headroom for access to equipment, control panels, and storage areas	✓	ME, PE
		• Design mechanical rooms with clear, unobstructed access paths to all equipment to prevent tripping and struck-by hazards	✓	ME, PE
		• For easier servicing and maintenance locate mechanical equipment on the ground rather than on the roof or within an attic space	✓	ME, PE
		• Design utility lines with exterior color codes or markings to easily identify the contents and reduce the amount of work time in the mechanical room	✓	ME, PE
Miscellaneous	Additional unclassified hazards can cause injury from struck-by incidents, traumatic injuries and noise.	• Design overhangs (e.g., porches or balconies) that don't need temporary support to prevent unstable structures collapses	✓	SE
		• Specify standard sizes or pre-cut materials to reduce cutting or shaping in the field and decrease cuts, lacerations and noise exposures	✓	ME, PE, SE
		• Use saws with braking technology that eliminate the potential for amputations	✓	—
		• Utilize battery powered tools to eliminate cord hazards and inspections. Charge batteries outside of the structure.	✓	—

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