



5.0 GUARDS: MECHANICAL, HOT SURFACE, AND CHEMICAL SPRAY

5.1 SECTION CONTENTS

This section provides guidance for the design, and use of machinery guards. Designs for both steel and wood construction are included in this section. Steel construction is preferred and should be considered first. Use of wood should be minimized. See Section 1.5 for additional guidelines.

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NOTE: An asterisk (*) after a section of text indicates that the information in that section is new or revised as of September 1996.

Fed-OSHA 1910.219

5.2 GENERAL AND DESIGN REQUIREMENTS FOR MACHINERY GUARDS

A. CONDITIONS WHICH REQUIRE GUARDING OF EXPOSED PARTS

1. Flywheels:

Flywheels located so that any part is 7 feet or less above the floor or platform shall be guarded as follows:

- With an enclosure of sheet, perforated, or expanded metal, or woven wire.
- With guard rails placed between 15 - 20 inches from the rim.
 - When the flywheel extends into a pit or is within 12 inches of the floor, a standard toeboard shall also be provided.
 - When the upper rim of a flywheel protrudes through a working floor, it shall be entirely enclosed or surrounded by a guardrail and toeboard.

Note: For flywheels with smooth rims 5 feet or less in diameter, see 1910.219 (b) (iv).

2. Whenever flywheels are located above working areas, guards shall be installed having sufficient strength to hold the weight of the flywheel in the event of a shaft or wheel mounting failure.

3. Cranks and Connecting Rod:

When exposed to contact, cranks and connecting rods shall be meet the general requirements for "Standard Guards".

Note: See Section 5.2 B.

4. Horizontal Shafting:

- All exposed parts of horizontal shafting 7 feet or less from floor or working platform shall be protected by a stationary casing enclosing shafting completely or by a trough enclosing sides and top or sides and bottom of shafting as location requires.

Note: See Chevron Interpretation below.

- Shafting under bench machines shall be enclosed by a stationary casing, or by a trough at sides and bottom as location requires. The sides of the trough shall come within 6 inches of the underside of the table, or if the shafting is near the floor, within 6 feet of the floor. In every case the sides of the trough shall extend at least 2 inches beyond the shafting or protuberance.

✚ Chevron Interpretation

The sides of the trough protecting horizontal shafting shall come within 6 inches of the floor or foundation. In every case the sides of the trough shall extend at least 2 inches beyond the shafting or protuberance.

(continued next page)

Chevron Guidelines

1. All moving parts of machinery that could cause injury if inadvertently contacted by personnel and that are not guarded by equipment or by location shall be guarded if located within 7 feet 0 inches vertical height of floors, stairways or platforms and within 15 inches horizontal distance of floors, platforms, walkways, stairs, or ladders.
2. Some moving parts may require guarding even though located greater than 7 feet 0 inches vertical height or greater than 15 inches horizontal distance because of hazards when failure occurs - such as a broken drive chain or belt which may fall onto platform or walkway.
3. Typical hazardous moving parts are:
 - rotating equipment such as shafts, pulleys, gears, couplings, and flywheels
 - reciprocating equipment such as pistons and connecting rods
 - conveyor belts and drive chains
 - in-running rolls and screws



Fed-OSHA 1910.219

5. Shaft Ends:

Projecting shaft ends shall present a smooth edge and end and shall not project more than 1/2 the diameter of the shaft unless guarded by non-rotating caps or safety sleeves.

6. Pulleys:

Note: Any parts of pulleys which are 7 feet or less from the floor or working platform shall be guarded in accordance with 1910.219 (d).

7. Horizontal belts, ropes and chain drives:

- Overhead horizontal belts with lower parts 7 feet or less from the floor or platform shall be guarded on the sides and bottom per 1910.219 (o)(3). Under certain conditions, overhead belts must be guarded for their entire length.

Note: See 1910.218(e)(2).

- Where both runs of horizontal belts are 7 feet or less from the floor level, the guard must extend at least 15 inches above the belt, except where both runs of belt are 42 inches or less from the floor, the belt shall be fully enclosed.

8. Gears, sprockets, and chains, unless they are more than 7 feet above the floor or work platform, shall be guarded in accordance with one of the following:

- By a complete enclosure
- By a standard guard
- By a band guard

Note: See 1910.219 (f)(1).

9. Keys, setscrews, and other projections:

- Such projections in revolving parts shall be removed or made flush or be guarded by metal covers.

Note: See exceptions in 1910.219 (h)(1).

10. Collars and Couplings:

All revolving collars, including split collars, shall be cylindrical, and screws or bolts used in collars shall not project beyond the largest periphery of the collar.

Shaft couplings shall be constructed so as to present no hazard from bolts, nuts, setscrews or revolving surfaces. Bolts, nuts, setscrews are permitted where they are covered with safety sleeves or where they are used in parallel with the shafting and are countersunk or else do not extend beyond the flange or the coupling.

11. Openings for oiling of gears, sprockets and chains:

Note: See 1910.219 (f)(4) for requirements for guard openings for the purpose of oiling moving parts.

Fed-OSHA 1910.219

1. Materials for guards shall be expanded metal, perforated or solid sheet metal, wire mesh on a frame of angle iron, or iron pipe securely fastened to the floor or frame of machine. All metal should be free from burrs.
2. Expanded metal, perforated or solid sheet metal and wire mesh shall be securely fastened to frame.

Cal-OSHA 3944

1. Where a guard or enclosure is within 2 - 4 inches of moving parts, openings through the guard shall be of such size as will preclude the passage of any object 1/2 inch in diameter.
2. Where a guard or enclosure is within 4 - 15 inches of moving parts, the maximum opening shall be of such size as will preclude the passage of any object greater than 2 inches in diameter. Where slatted guard is used, the width of the opening shall be not greater than 1 inch.

Cal-OSHA 3945

1. Where lubrication must be performed while the machine is operating, openings with hinged or sliding covers shall be provided.
2. Where machines or machine parts must be lubricated while in motion the lubricant fittings shall be located at least 12 inches from the dangerous moving parts unless such parts are guarded and the fittings are piped outside the guard.

1. Metal Guards.

All guards shall be rigidly braced every 36 inches or fractional part of their height to some fixed part of machinery or building structure.

Note: Guards for overhead belts must comply with the requirements of 1910.12219 (o)(3).

B. DESIGN REQUIREMENTS FOR STANDARD GUARDS

Chevron Guidelines

1. Design requirements for guards are as follows. Guards:
 - shall be built according to recognized standards of construction and performance
 - shall not create a hazard of their own (free of sharp edges and burrs and not a bumping or tripping hazard)
 - shall be securely fastened and sturdy enough to support impact load of personnel falling against guard,
 - should contain hazard resulting from failure of any moving part
 - shall not interfere with the operation of equipment or machinery
 - should minimize need for removal of guard for routine inspection and lubrication or should be supplied with removable, sliding, or hinged sections for routine maintenance or inspection
2. Where machinery or equipment is lubricated while in motion, lubrication fittings shall be stationary and extended a minimum of 12 inches from the moving parts or extended outside of the guard.

5.3 APPROVED MATERIALS FOR GUARDS

A. METAL GUARDS

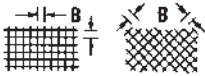
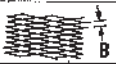


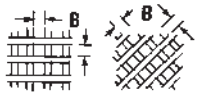
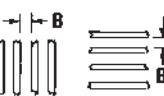

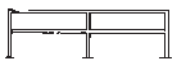

Chevron Guidelines

1. Acceptable guard materials are specified in *Figure 5.1*.
2. Acceptable fastening methods are specified in *Figure 5.2*.
3. Materials for framework of guards shall be metal angle 1 x 1 x 1/8 inch, 3/8 inch solid metal rod, or metal construction of equivalent strength. Guards of woven wire or expanded metal in a frame with a total area of more than 6 square feet shall have additional reinforcement.
4. Guards shall have rigid braces every 36 inches maximum spacing to a fixed part of the machinery or building structure. Where the guard may contact moving equipment, additional strength or reinforcement may be required.



5. The framework of guards fastened only to the floor or working platform shall consist of 1-1/2 x 1-1/2 x 1/8 inch metal angle, 1-1/2 inch outside diameter metal pipe or metal construction of equivalent strength. The framework shall be rigid for all probable loading conditions.
6. Rectangular guards shall have minimum 4 upright frame members which shall be securely fastened to fixed equipment or floor. Cylindrical guards shall have a minimum 3 supporting members which shall be securely fastened to fixed equipment or floor.

Guard Material Specification

SIZE OF FILLER MATERIALS					
MATERIAL		CLEARANCE FROM GUARDED PART AT ALL POINTS	LARGEST MESH OR OPENING ALLOWABLE B	MINIMUM GAUGE (U.S. STANDARD) OR THICKNESS	MIN. HEIGHT OF GUARD FROM FLOOR OR PLATFORM LEVEL
WOVEN WIRE		UNDER 2" 2" - 4" 4" - 15"	3/8" 1/2" 2"	NO. 16 NO. 16 NO. 12	7'-0" 7'-0" 7'-0"
EXPANDED METAL		UNDER 4" 4" - 15"	1/2" 2"	NO. 18 NO. 13	7'-0" 7'-0"
PERFORATED METAL		UNDER 4" 4" - 15"	1/2" 2"	NO. 20 NO. 14	7'-0" 7'-0"
SHEET METAL		UNDER 4" 4" - 15"	—	NO. 22 NO. 22	7'-0" 7'-0"
WOOD OR METAL STRIPS CROSSED		UNDER 4" 4" - 15"	3/8" 2"	WOOD 3/4" OR METAL NO. 16	7'-0" 7'-0"
WOOD OR METAL STRIPS NOT CROSSED		UNDER 4" 4" - 15"	1/2 WIDTH 1 WIDTH		7'-0" 7'-0"
PLYWOOD OR EQUIVALENT		—	—	5/16"	7'-0"
STANDARD RAILING		MIN. 15" MAX. 20"	—	—	3'-6"
PLASTIC		UNDER 4" 4" - 15"	1/2" 2"	* *	7'-0" 7'-0"
SOLID WOOD		—	—	1"	7'-0"

* TENSILE STRENGTH OF 10,000 LB/IN²

Figure 5.1 Guard Filler Material

Other material may be used if equivalent strength and protection are provided. Stronger and heavier gauge material may be required for vibration, chemical attack, or other exceptional stress. Wood guards shall not be used except where the presence of fumes or other manufacturing conditions would cause rapid deterioration of metal guards or where extreme heat or cold would make metal guards undesirable.

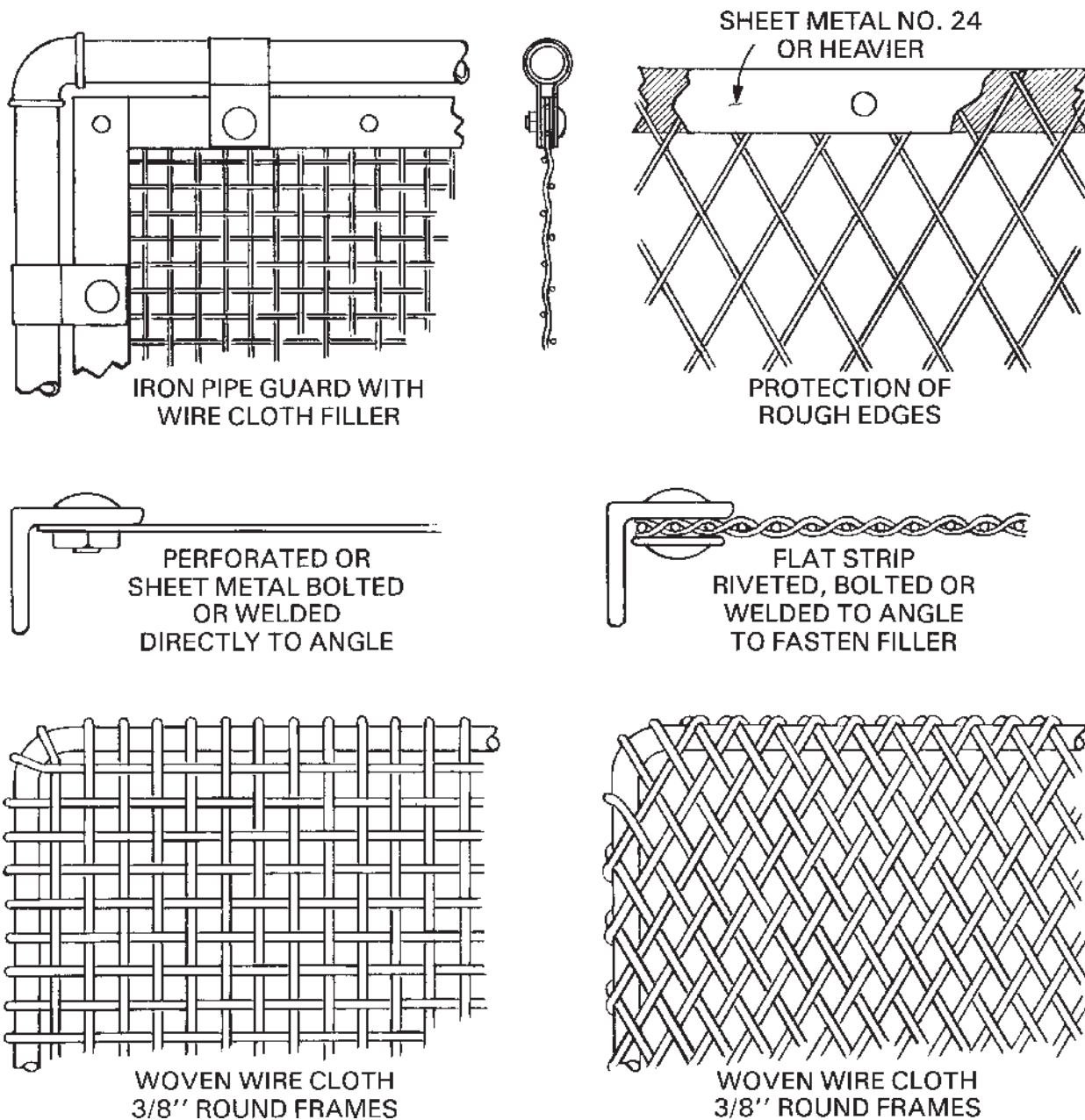


Figure 5.2 Methods of Fastening Filler to Frame

The filler may be fastened to framework by:

- rivets or bolts spaced not more than 5 inches center to center;
- welding spaced not more than 4 inches center to center;
- weaving through angle frame or pipe; or
- bending entirely around rod frames (if filler material is 14 gauge or heavier).



B. WOOD GUARDS

Chevron Guidelines

1. Wood guards may be used where manufacturing conditions would cause the rapid deterioration of metal guards and where temporary guards may be needed during construction work.*

1. Wood guards may be used in the woodworking and chemical industries, in industries where the presence of fumes or where manufacturing conditions would cause the rapid deterioration of metal guards; also in construction work and in locations outdoors where extreme cold or extreme heat make metal guards and railings undesirable. In all other industries, wood guards shall not be used.

5.4 GUARDING FOR CONVEYORS AND RELATED EQUIPMENT

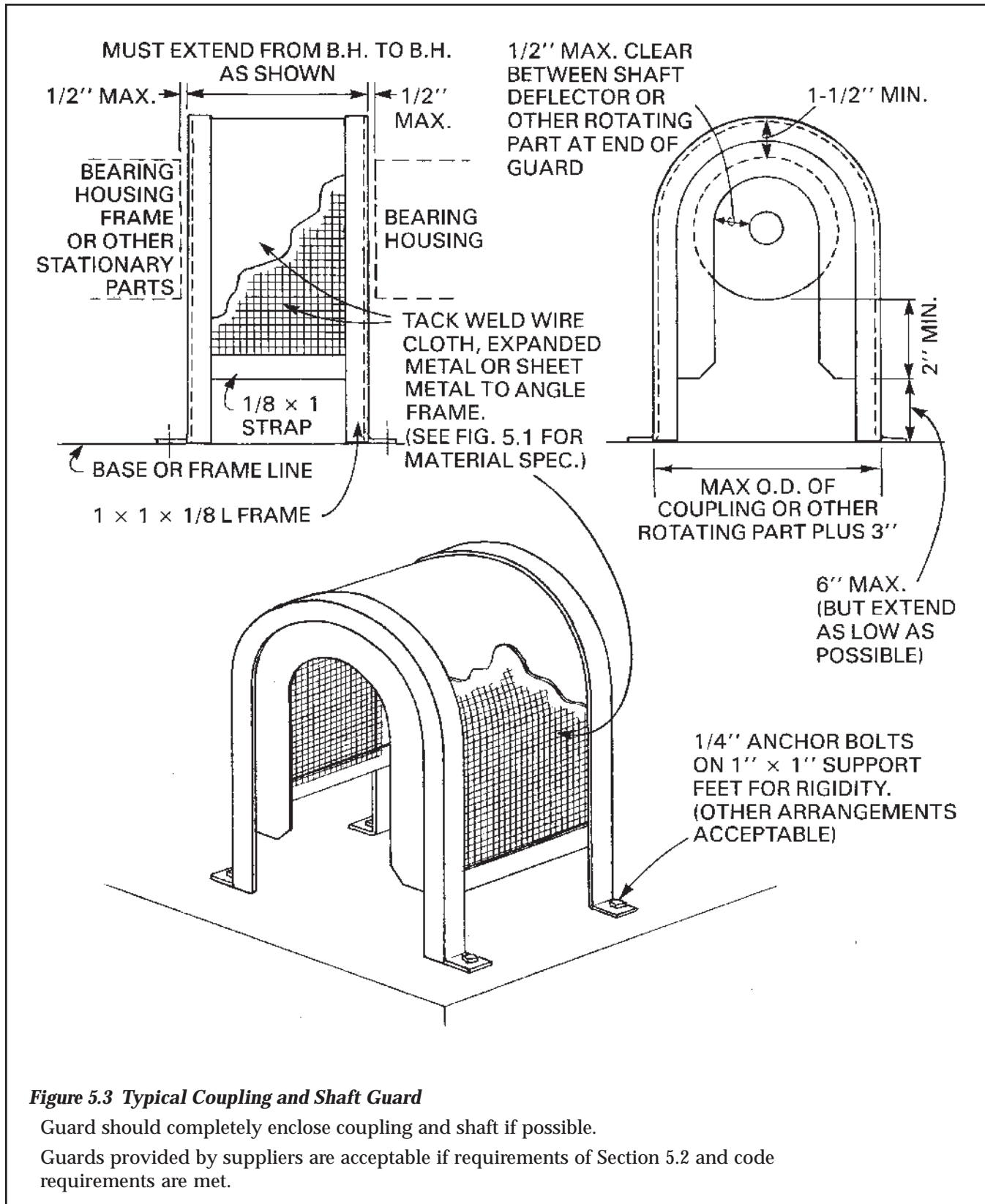
Chevron Guidelines

1. Guards for conveyors and related equipment should be in accordance with ANSI B 20.1.

5.5 TYPICAL FABRICATION ARRANGEMENTS FOR GUARDS

Suggested Fabrication Details (see following pages)

- Figure 5.3 Typical Coupling and Shaft Guard*
- Figure 5.4 Typical V-Belt Guard*
- Figure 5.5 Typical Service Station Air Compressor Guard*
- Figure 5.6 Typical Belt and Pulley Guard*
- Figure 5.7 Counterweight Guards*
- Figure 5.8 Easily Replaced Guards*
- Figure 5.9 Engine Fan Guards*
- Figure 5.10 Guardrail for Flywheel Guard*



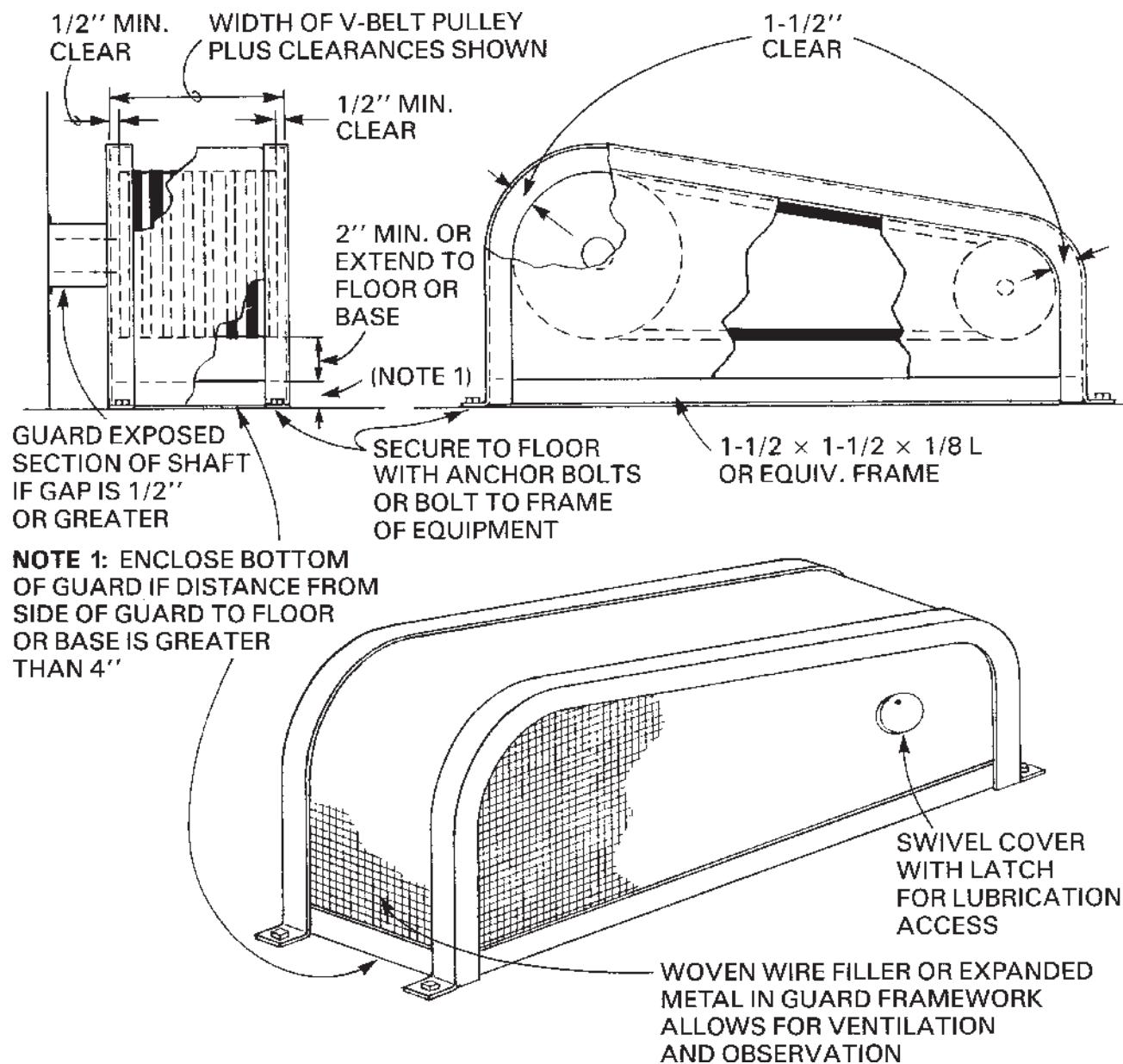
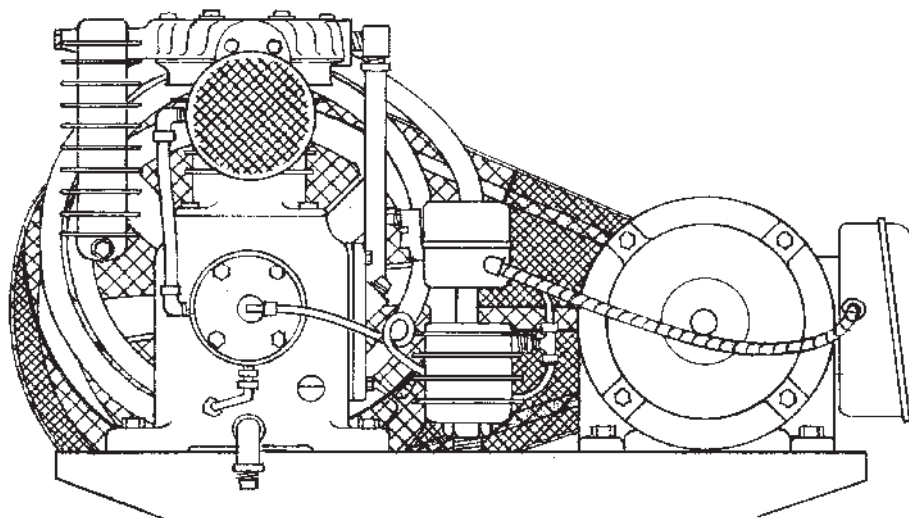
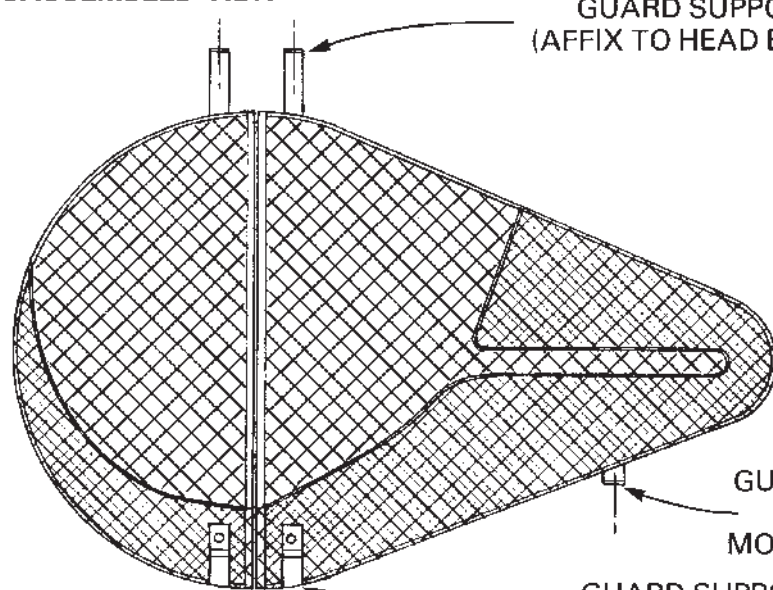
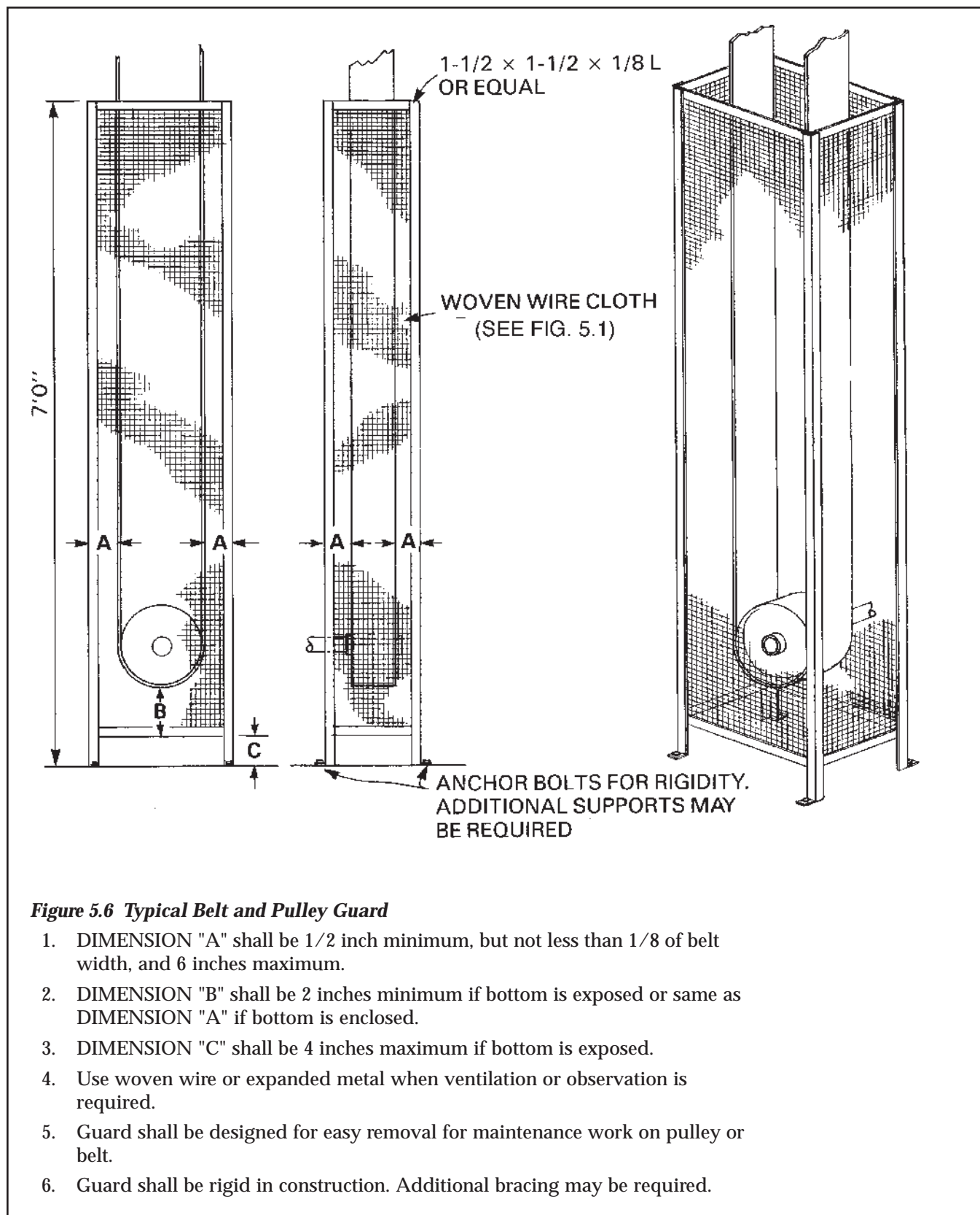


Figure 5.4 Typical V-Belt Guard

Guard should completely enclose belts, pulleys, and shafts, if possible.

ASSEMBLED VIEW**DISASSEMBLED VIEW**GUARD SUPPORT
(AFFIX TO HEAD BOLTS)**END VIEW**SHEET
METALSCREEN
FACINGGUARD SUPPORT
(AFFIX TO
MOTOR SUPPORT)GUARD SUPPORT
(AFFIX TO UNIT SUPPORT)**Figure 5.5 Typical Service Station Air Compressor Guard**

Where the compressor is located such that the entire compressor unit is screened off from any contact even during routine servicing or lubrication while running, complete enclosure guarding is not required.



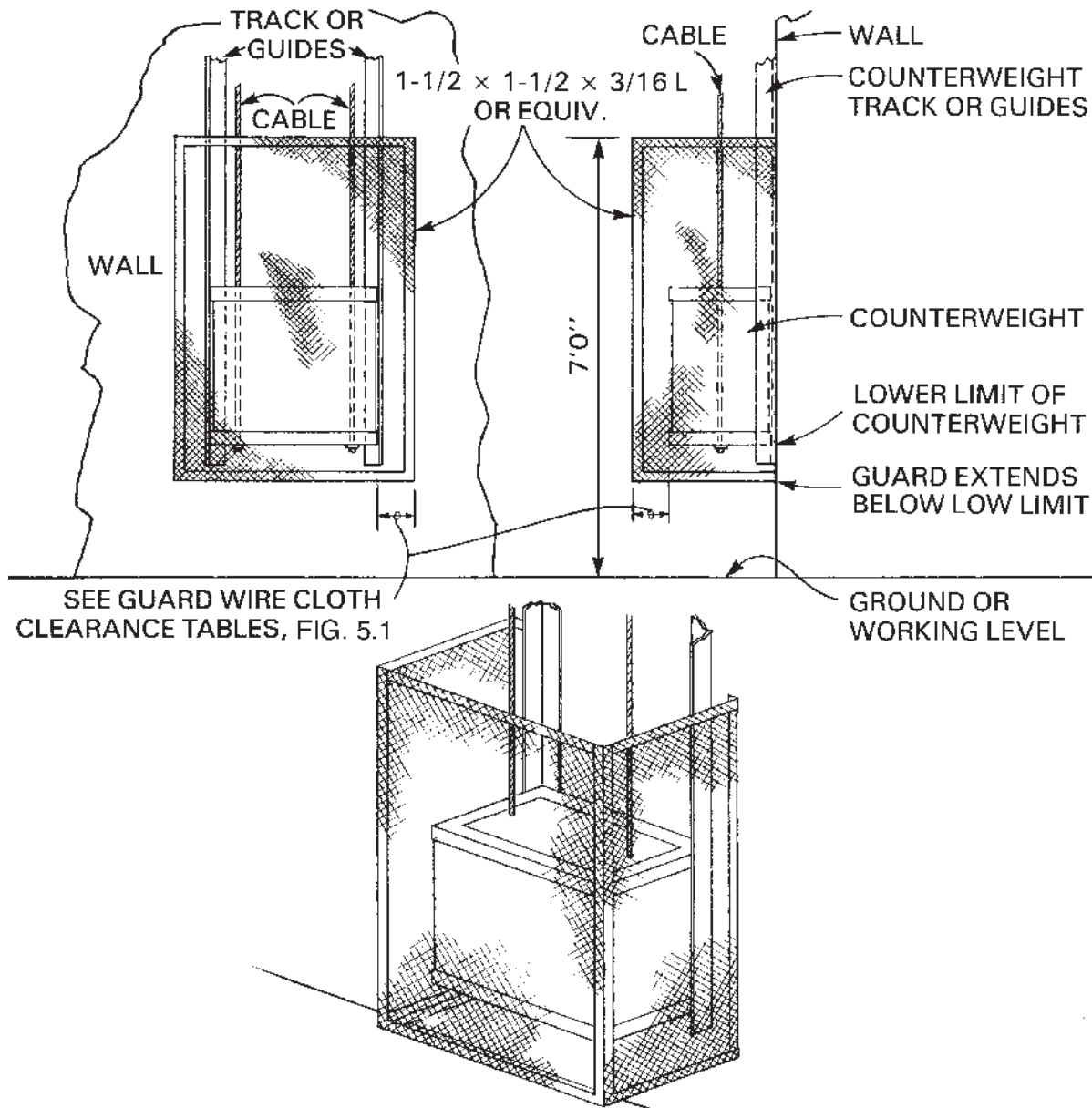
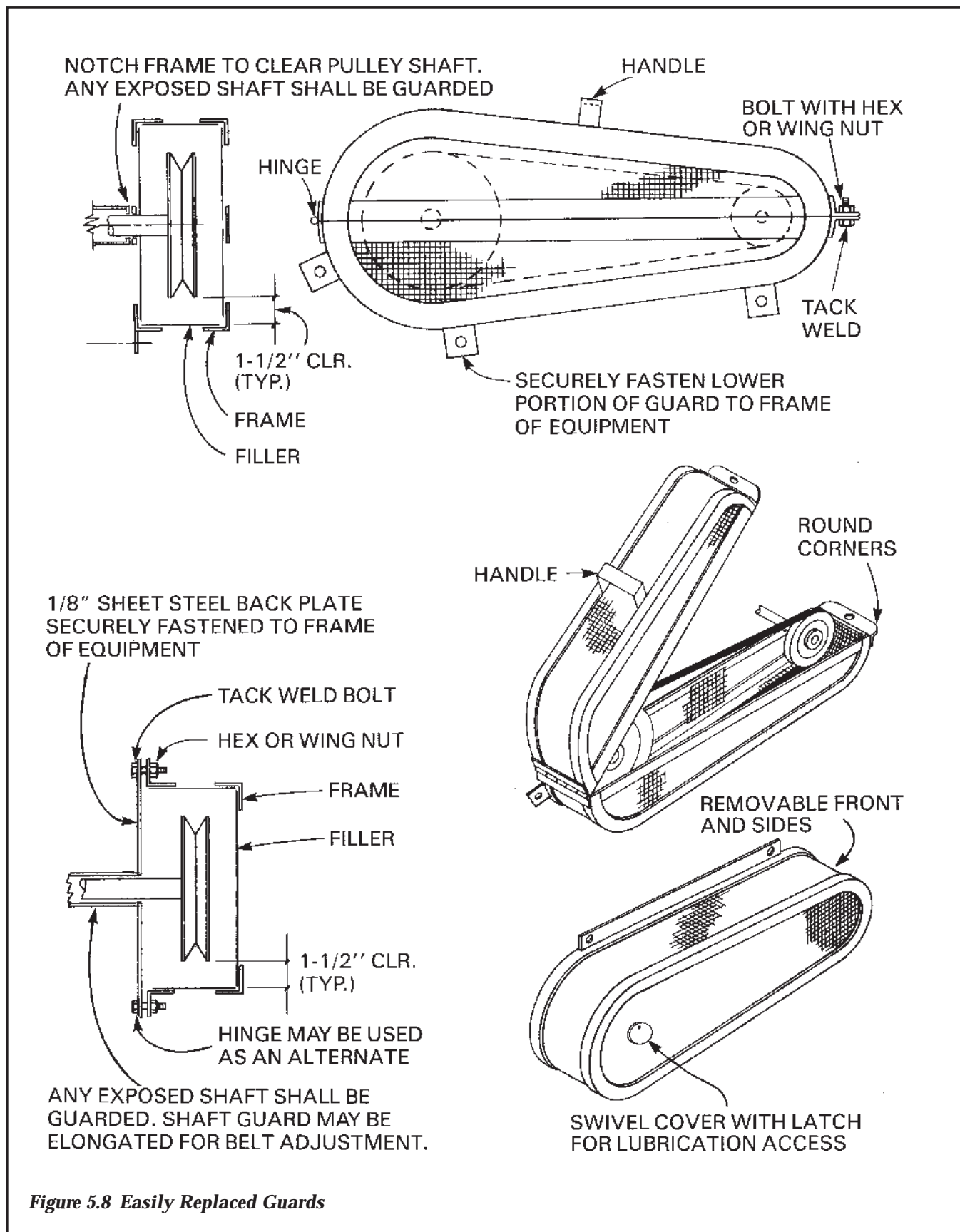


Figure 5.7 Counterweight Guards

1. Contact with or access under counterweights shall be prevented by an enclosure guard as shown above or a standard handrail barricade.
2. Overhead counterweights shall be equipped with safety chains or cables or shall be barricaded so that their falling would not be a hazard.



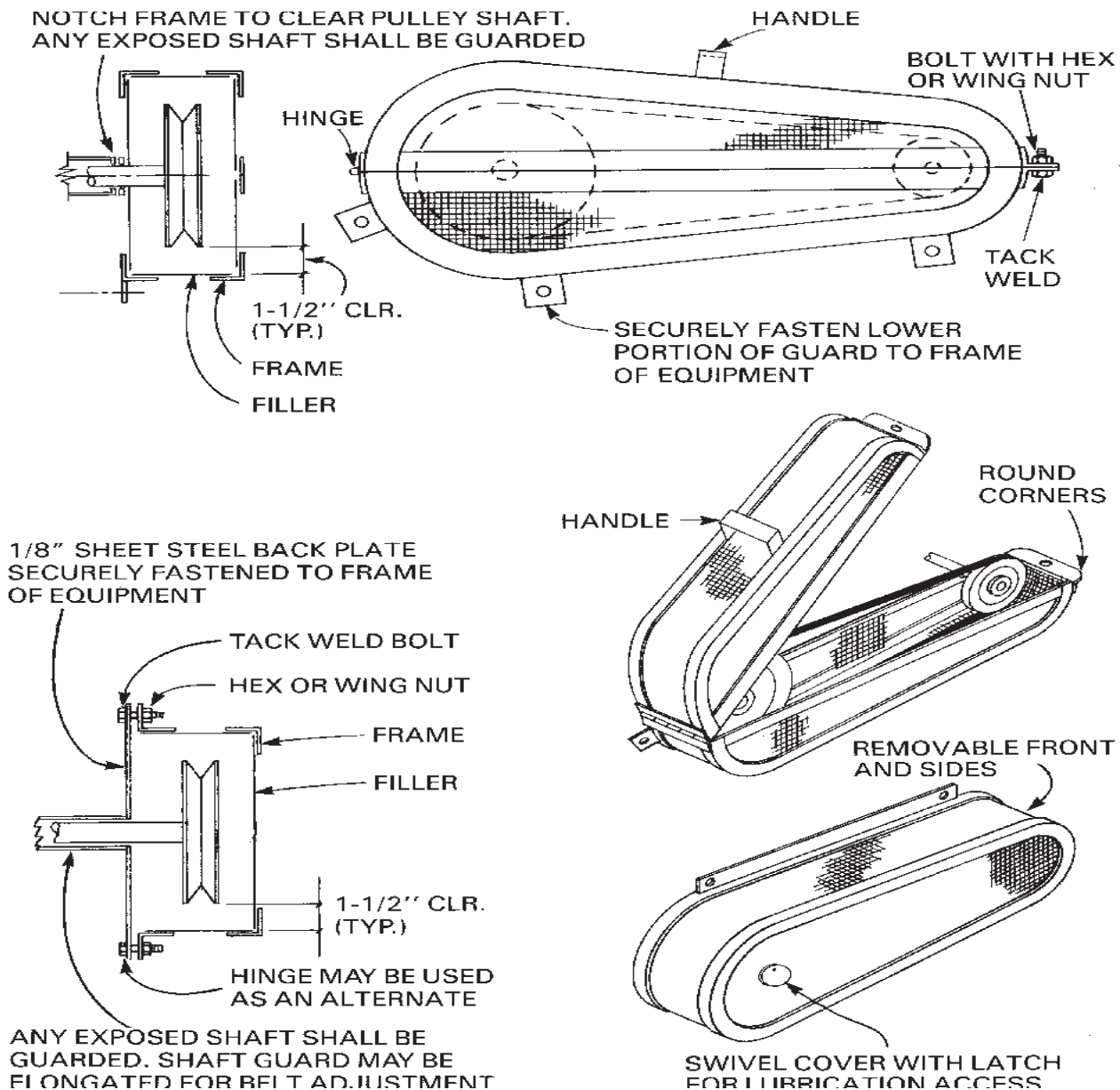


Figure 5.9 Engine Fan Guards

1. The fan and fan belt guards should extend to the shoulder of the engine block as shown.
2. Exposed shafting on such units as water pumps, fuel pumps, and magnetos should also be guarded.
3. Other styles of guards are acceptable if requirements of Section 5.2 and code requirements are met.

FLYWHEEL GUARD

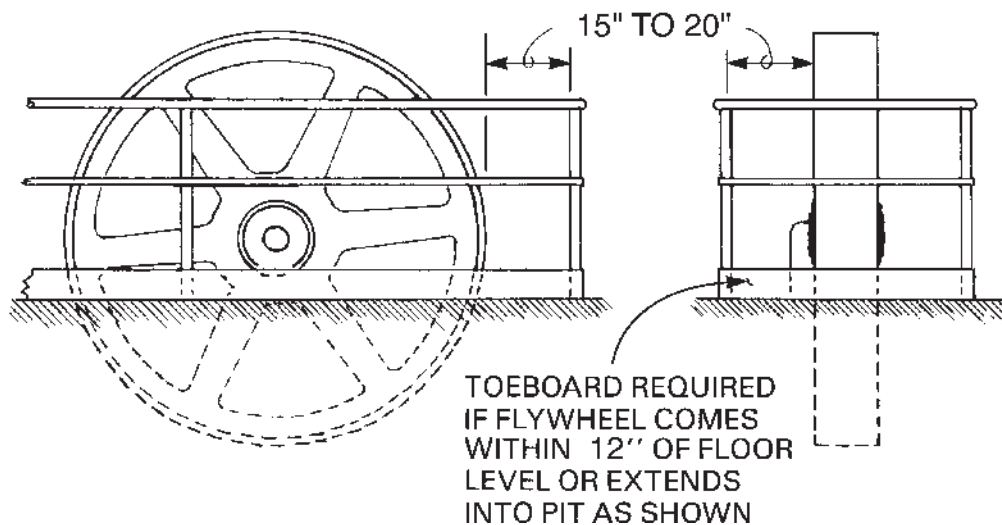


Figure 5.10 Guardrail for Flywheel Guard

Use of Railing for Guarding Moving Parts

1. Railings shall meet requirements of Section 2.3 and shall be placed not less than 15 inches and not more than 20 inches from moving parts of machinery.
2. The use of railings for guard protection should be minimized. Railings do not provide adequate guard protection where moving parts may be thrown out or otherwise moved from the guarded location.

5.6 PUMPING UNIT GUARDS

A. REQUIREMENTS FOR PUMPING UNIT GUARDS

Cal-OSHA 6631

Note: Power transmission, prime movers, and machinery parts shall be guarded in accordance with guard standards set forth in 8 C.C.R. 3940-4086 except as otherwise provided below.

1. If the lowest point of travel of the beam horsehead is less than 6 feet 6 inches above the floor or working level, it shall be guarded by a substantially constructed and securely fastened single or standard railing placed at least 42 inches but not more than 45 inches above the floor or working level, and between 15 - 20 inches in the clear of a vertical plane with the outmost point of travel of the horsehead.
2. If the guard railing is continued and attached to the sansome post, it will be considered to be in compliance with this order.

Note: Other methods of guarding that will provide equivalent protection to employees may be used if they comply with 8 C.C.R. 3940-4086.

Chevron Guidelines

1. Guards are required at pumping wells to: protect personnel from mechanical motion of power transmission equipment, prevent livestock from approaching the pumping unit, and prevent attractive nuisance in populated areas. Guards are also required for exposed hot surfaces (see Section 5.8).

2. **Personnel Protection**

- For personnel protection from slow moving parts such as pitman and counterweights, a standard railing may be used if:
 - design requirements as detailed in Section 2.3 are met, and
 - top of railing is at 42 inches elevation with midrail halfway between top and grade, and
 - railing is placed 15 - 20 inches horizontally from moving part.

This standard railing may be covered with wire mesh to serve as a livestock barrier.

- Alternatively, a 7 foot 0 inch or higher wire mesh fence with 2 x 2 inches maximum mesh size placed 4 - 15 inches horizontally from moving part may be used.
- For personnel protection from hazardous parts such as belts, pulleys, and shafts, enclosure type mechanical guards (See *Figures 5.3, 5.4, and 5.8*) shall be used.
- Routine maintenance and operation work shall not be permitted within the guarded area if the equipment is energized.
 - Lubrication fittings shall be extended to grade outside of the guarded area.
 - Control switches, disconnects, and break control shall be located outside of the guarded enclosure.

3. **Livestock Barrier**

- For livestock barrier, a 42 inch or higher wire mesh fence may be used. This fence may also serve as personnel protection from slow moving parts if the:
 - fence is designed for 200 lbs.
 - fence is placed 15 to 20 inches horizontally from moving part.

4. **Attractive Nuisance Prevention**

- For attractive nuisance prevention in urban areas, an 8 foot 0 inch or higher locked fence may be used around the entire pumping unit or group of units. Guard material specified in *Figure 5.1* can be used. Local codes may have more stringent requirements.



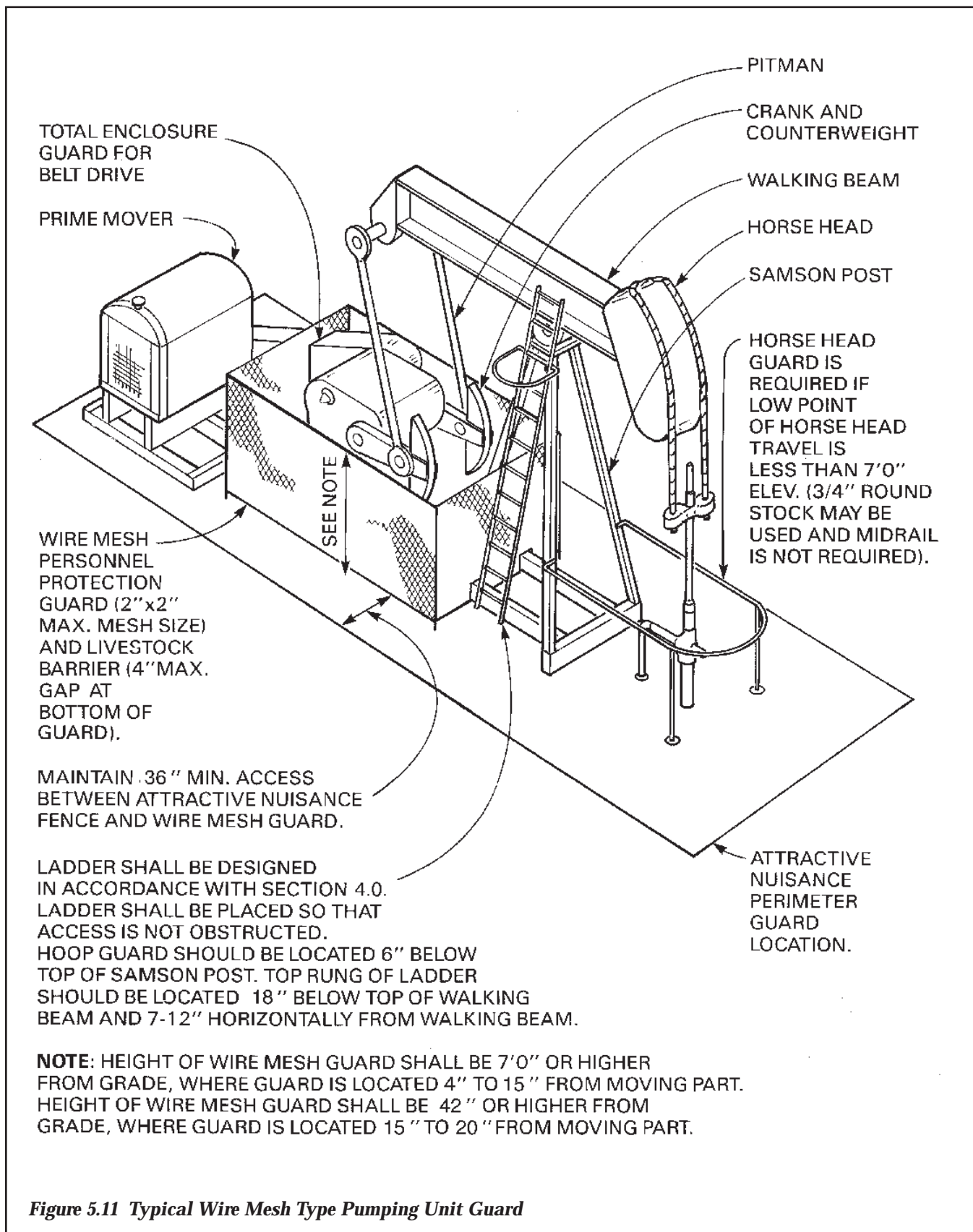
- Design should be sturdy enough to support impact load of persons falling against fence and should not have gaps which may allow unauthorized entry. A secondary exit may be required if main door or gate can be blocked.
- In addition, guarding shall be required for personnel protection from moving parts.

B. TYPICAL PUMPING UNIT GUARDS

Suggested Fabrication Details

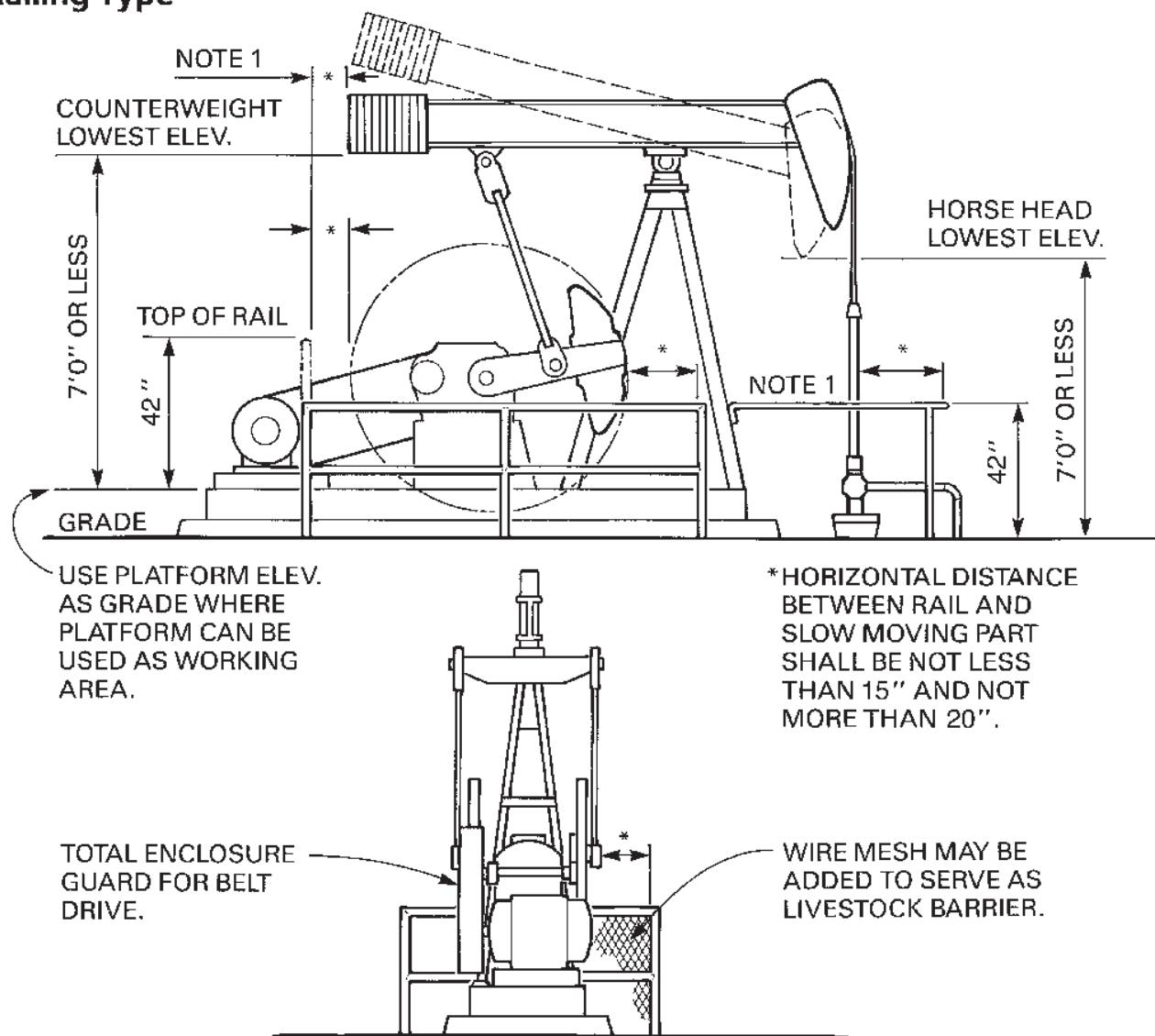
Figure 5.11 Typical Wire Mesh Type Pumping Unit Guard

Figure 5.12 Typical Rail Type Pumping Unit Guard





Pumping Unit Guard Detail Railing Type



NOTE 1: WHERE LOWEST ELEV. OF COUNTERWEIGHT OR HORSE HEAD IS 7'0" OR LESS, RAIL SHALL BE PROVIDED TO MAINTAIN HORIZONTAL CLEARANCE OF 15" TO 20".

Figure 5.12 Typical Rail Type Pumping Unit Guard

Fed-OSHA 1910.215

Note: Guards for abrasive wheel machinery must comply with the requirements contained in 1910.215.

Cal-OSHA 3577

Note: Guards for abrasive wheel machinery must comply with the requirements contained in 8 C.C.R. 3577.

5.7 REQUIREMENTS FOR ABRASIVE WHEEL GUARDS

Chevron Guidelines

1. Work rests shall be kept adjusted to the wheel with a maximum gap of 1/8 inch.
2. Tongue guards shall be kept adjusted closely to the wheel with a maximum opening of 1/4 inch.
3. The maximum angular exposure of the grinding wheel periphery should not exceed 90°. This exposure shall begin at a point not more than 65° above the horizontal plane.
4. Whenever the nature of the work requires contact with the wheel below the horizontal plane, the exposure shall not exceed 125°.
5. Refer to *Figure 5.13* for the above-referenced dimensions.

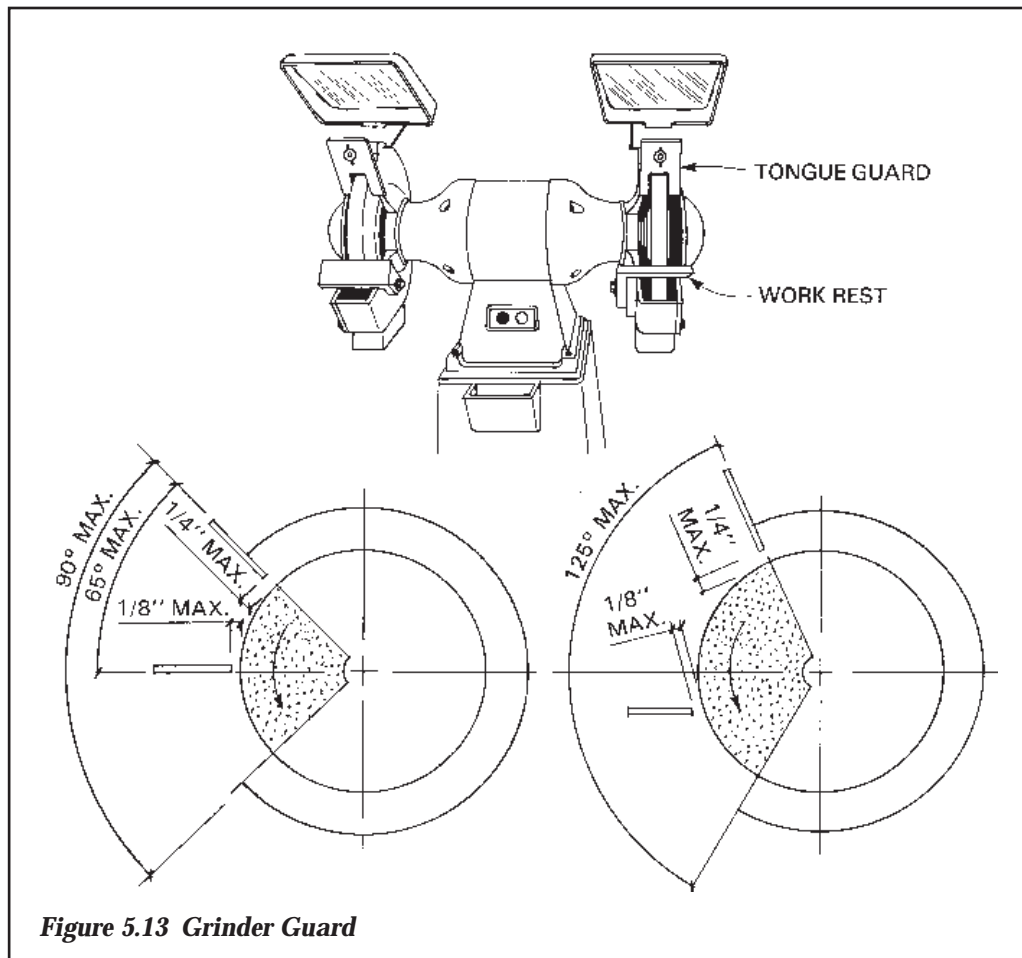


Figure 5.13 Grinder Guard



5.8 PROTECTING PERSONNEL FROM HOT OR COLD SURFACES

Chevron Guidelines

1. Hot surfaces having an external surface temperature sufficient to burn animal tissue on momentary contact and located within 7 feet 0 inches vertically from floor or working level or 15 inches horizontally from floor, working level, stairs, ramps or fixed ladders shall be insulated or otherwise guarded against accidental contact.
2. Generally, metal surfaces with a surface temperature of 140°F or more should be insulated or guarded.
3. Insulation is the preferred means of protection from hot surfaces, unless heat retention is undesirable. It should be of sufficient thickness to reduce the surface temperature to a maximum of 140°F. Generally, thin commercial insulation (e.g. 1 inch thick) materials such as mineral wool or calcium silicate will reduce surface temperatures of 400°F equipment or piping to below 140°F. A source of information on thickness of insulation required above 400°F is CRTC *Insulation and Refractory Manual*, Section 100.
4. Guarding is another way to provide protection from hot surfaces. Typical examples are as follows:
 - Guard railing placed not more than 20 inches nor less than 15 inches away from the vertical plane of the hot surfaces.
 - Woven wire, expanded metal, or perforated sheet metal mounted on Nelson studs or equal. The surface temperature of the guard should not exceed 140°F and the openings shall be such that the hot surface cannot be inadvertently touched.
5. Cold equipment should be evaluated to prevent “cold” burns. Normally, however, a layer of ice will form on surfaces and act as an insulator.*
6. When guarding (or insulating) is planned to be used on new vessels, lengthen ladder brackets, stair supports, treads, etc. to provide minimum clearances, stair widths, etc.

Suggested Fabrication Details

7. Refer to *Figure 5.14* for hot surface guards.

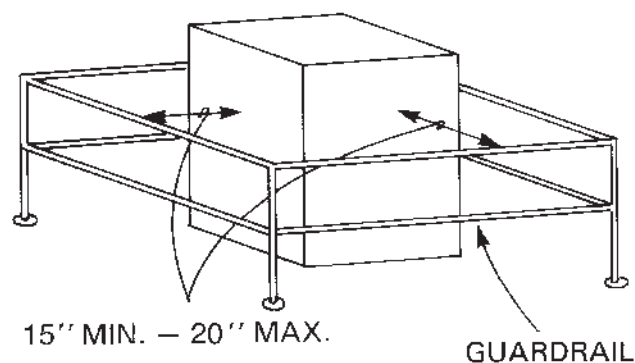
Cal-OSHA 3308

1. Pipes or other exposed surfaces having an external surface temperature sufficient to burn human tissue on momentary contact and located within 7 feet measured vertically from floor or working level or within 15 inches measured horizontally from stairways, ramps or fixed ladders shall be covered with a thermal insulating material or otherwise guarded against contact. This does not apply to operations where the nature of the work or the size of the parts makes guarding or insulating impracticable.

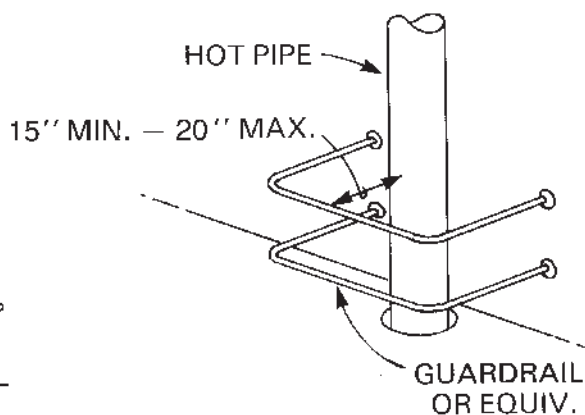
■ Chevron Interpretation

140° F is deemed to be a sufficient temperature to burn human tissue on momentary contact.

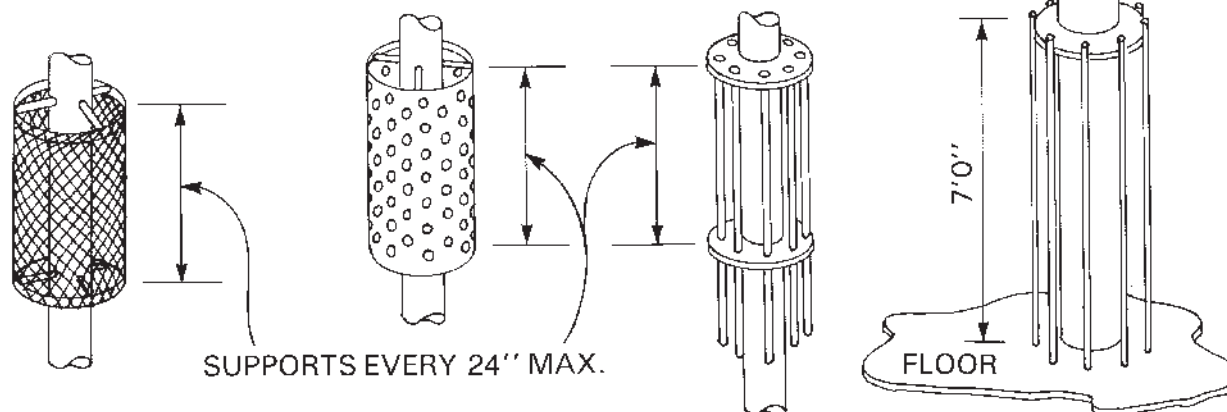
HOT VESSELS AND OTHER LARGE OBJECTS



HOT PIPE LINES AND OTHER SMALL OBJECTS



HOT PIPE LINES AND EXHAUST STACKS AT OPERATING POINTS



AT OPERATING POINTS AROUND BASES OF HOT UNINSULATED EQUIPMENT AND ALONGSIDE STAIRS, LADDERS, OR WALKWAYS

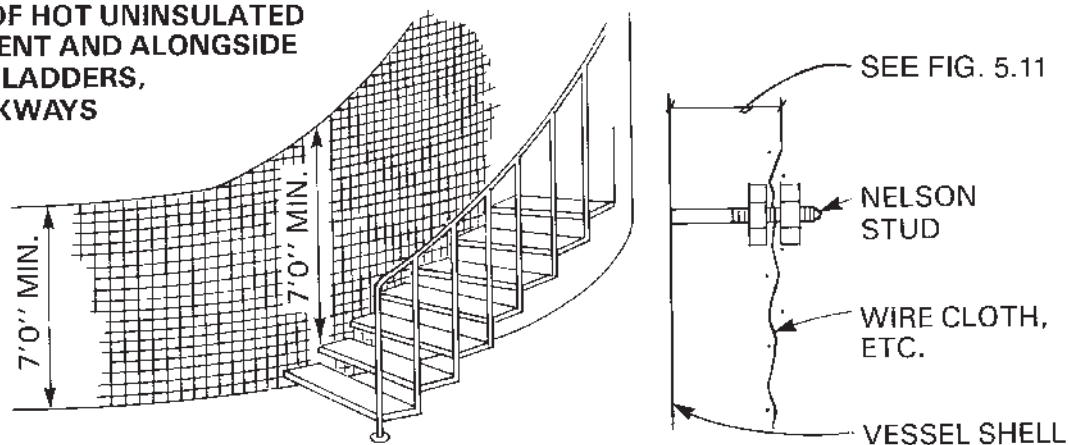


Figure 5.14 Hot Surface Guard—Alternative to Insulation



5.9 PROTECTING PERSONNEL FROM CHEMICAL SPRAYS

Chevron Guidelines

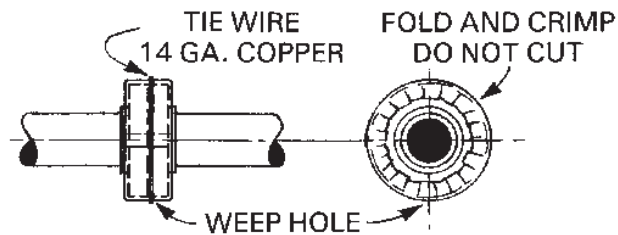
1. Personnel shall be protected from potential leaks and sprays of corrosive or toxic chemicals.
2. Methods and types of protection include, but are not limited to the following:
 - Spiral wound gaskets with compression centering ring should be used with raised face flange connections.
 - Screwed connections should be sealwelded.
 - Easily removable solid shield guard may be installed around pump seals to contain chemical sprays due to a seal failure and channel corrosive or toxic chemical to a safe location.
 - Drip pans may be installed under pipeway flanges and valves over walkways, platforms, roadways, etc. to contain drips and leaks and channel to a safe location.
 - Chemical spray covers may be installed around valves, flanges, stuffing boxes to contain potential leaks and sprays (weep hole in cover for leak detection is required; piping or channeling of any leakage to a safe location may be required).
3. Other safeguards to consider:
 - Minimize flanged and screwed connections to reduce potential leak sources.
 - Inspect for leakage routinely to detect leakage at an early stage.

Suggested Fabrication Details

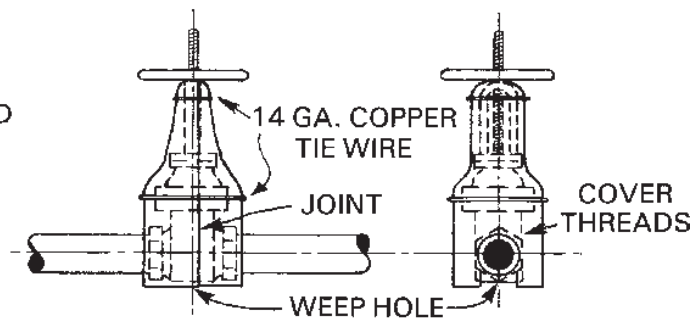
4. Refer to *Figure 5.15* for typical chemical spray guards.

GUARD STYLE 1

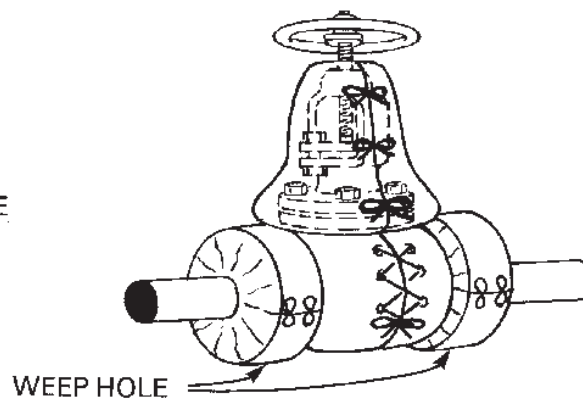
LEAD GUARD USED ON SCREWED OR WELDED FLANGES. PERMACEL-GLASS FIBER TAPE NUMBER 621 OR EQUIVALENT CAN BE USED IF SURFACE IS PROPERLY CLEANED

**GUARD STYLE 2**

LEAD BONNET USED ON SCREWED VALVES. USE SAME BONNET GUARD ON LARGE FLANGED VALVES, WITH STYLE 1 FLANGE GUARDS

**GUARD STYLE 3**

GUARDS FABRICATED FROM DACRON CLOTH, TEFLON, FIBERGLASS, GLASS CLOTH, ETC., WHICH ARE EASILY AND QUICKLY INSTALLED OR REMOVED ARE COMMERCIALY AVAILABLE



GUARD STYLE	SIZE OF SHEET REQUIRED (INCHES)										
	UP TO 1"	1-1/2"	2"	3"	PIPE SIZE						
					4"	6"	8"	10"	12"	14"	16"
1	9x10	10x12	10x13	11x15	12x18	12x22	15x26	16x30	17x39	18x44	
2*	7x22	8x27	8x28	10x35							
2*&3*	33x18	38x21	43x25	49x34	51x24	44x41	52x50	40x48	46x50	51x51	54x60

*GUARD STYLE 2 FOR SCREWED VALVES

*GUARD STYLES 2 AND 3 FOR FLANGED VALVES

Figure 5.15 Chemical Spray Guards

Guard material rated for the highest operating temperature and for adequate resistance to chemical attack and corrosion is required.

Materials which may be considered are:

- sheet metal of galvanized steel, lead, stainless steel, etc.
- synthetic sheet of dacron, teflon, fiberglass, glass cloth
- Permacel-Glass Fiber tape Number 621 or equivalent



5.10 NOTES AND REFERENCES

OTHER GUIDES

ANSI/ASME B15.1-1992

“Safety Standard for Mechanical Power Transmission Apparatus”

ANSI/ASME B20.1-1993

“Safety Standard for Conveyors and Related Equipment”

API Standard RP 11ER

“Recommended Practice for Guarding of Pumping Units”

ADDITIONAL REFERENCES

CRTC Insulation and Refractory Manual

“Section 100”

CRTC Standard Drawing GC-K-99519

“Standard Guard for Flexible Coupling”