

Passive Fire Protection Design and Application on Onshore Facilities

Procedure

This Standard replaces and cancels its previous revision.

The CONTEC - Authoring Subcommittee provides guidance on the interpretation of this Standard when questions arise regarding its contents. The Department of PETROBRAS that uses this Standard is responsible for adopting and applying the sections, subsections and enumerates thereof.

Technical Requirement: A provision established as the most adequate and which shall be used strictly in accordance with this Standard. If a decision is taken not to follow the requirement ("non-conformity" to this Standard) it shall be based on well-founded economic and management reasons, and be approved and registered by the Department of PETROBRAS that uses this Standard. It is characterized by imperative nature.

Recommended Practice: A provision that may be adopted under the conditions of this Standard, but which admits (and draws attention to) the possibility of there being a more adequate alternative (not written in this Standard) to the particular application. The alternative adopted shall be approved and registered by the Department of PETROBRAS that uses this Standard. It is characterized by verbs of a non mandatory nature. It is indicated by the expression: **[Recommended Practice]**.

Copies of the registered "non-conformities" to this Standard that may contribute to the improvement thereof shall be submitted to the CONTEC - Authoring Subcommittee.

Proposed revisions to this Standard shall be submitted to the CONTEC - Authoring Subcommittee, indicating the alphanumeric identification and revision of the Standard, the section, subsection and enumerate to be revised, the proposed text, and technical/economic justification for revision. The proposals are evaluated during the work for alteration of this Standard.

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CONTEC

Comissão de Normalização
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SC - 09

Thermal Insulation and
Refractories

Introduction

PETROBRAS Technical Standards are prepared by Working Groups - WG (consisting specialized of Technical Collaborators from Company and its Subsidiaries), are commented by Company Units and its Subsidiaries, are approved by the Authoring Subcommittees - SCs (consisting of technicians from the same specialty, representing the various Company Units and its Subsidiaries), and ratified by the Executive Nucleus (consisting of representatives of the Company Units and its Subsidiaries). A PETROBRAS Technical Standard is subject to revision at any time by its Authoring Subcommittee and shall be reviewed every 5 years to be revalidated, revised or cancelled. PETROBRAS Technical Standards are prepared in accordance with PETROBRAS Technical Standard [N-1](#). For complete information about PETROBRAS Technical Standards see PETROBRAS Technical Standards Catalog.

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Foreword

This Standard is the English version (issued in 12/2012) of PETROBRAS [N-1756](#) REV. D 07/2012. In case of doubt, the Portuguese version, which is the valid document for all intents and purposes, shall be used.

1 Scope

1.1 This Standard sets required conditions for passive fire protection design and application of steel structural elements, inside areas subject to fire on onshore industrial facilities.

NOTE This Standard does not apply to protection of electrical components and instrumentation.

1.2 This Standard defines structural elements that shall be protected against fire, the extent of protective coating, materials used and coating qualification requirements.

1.3 This Standard applies to projects started as of the date it is published and also to already existing equipment, at the time of its maintenance or renovation.

1.4 This Standard contains Technical Requirements and Recommended Practices.

2 Normative Reference

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced documents applies.

Norma Regulamentadora nº 13 ([NR-13](#)) - Caldeiras e Vasos de Pressão;

PETROBRAS [N-133](#) - Welding;

PETROBRAS [N-1617](#) - Application of Refractory Castable;

PETROBRAS [N-1618](#) - Thermal Insulation Material;

PETROBRAS [N-1728](#) - Castable Refractory;

PETROBRAS [N-1997](#) - Electrical Networks in Cable Tray Systems - Design, Installation, and Inspection;

PETROBRAS [N-2677](#) - Polyurethane Acrylic Paint;

PETROBRAS [N-2913](#) - Anticorrosive Coating for Tank, Sphere and Storage Cylinder;

ISO [22899-1](#) - Determination of the Resistance to Jet Fires of Passive Fire Protection Materials - Part 1: General Requirements;

ABNT [NBR 5732](#) - Cimento Portland Comum;

ABNT [NBR 7211](#) - Agregado para Concreto;

ANSI/UL [1709](#) - Rapid Rise Tests of Protection Materials for Structural Steel;

API [PUBL 2218: 2010](#) - Fireproofing Practices in Petroleum and Petrochemical Processing Plants;

API [STD 521](#) - Pressure-relieving and Depressuring Systems;

ASME [BPVC - Section IX](#) - Boiler and Pressure Vessel Code - Section IX - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators Welding and Brazing Qualifications;

NFPA [290](#) - Standard for Fire Testing of Passive Protection Materials for Use on LP-Gas Containers Effective.

NOTE For documents referred in this Standard and for which only the Portuguese version is available, the PETROBRAS department that uses this Standard should be consulted for any information required for the specific application.

3 Terms and Definitions

For the purposes of this document, the terms and definitions contained in PETROBRAS standard [N-1617](#), and the following apply.

3.1

fire protection coating or lining

the purpose of this protection is, during a fire, to prevent collapsing of structural elements which are deemed vital to operation and safety of onshore industrial facilities, during fire protection time.

3.2

fire protection time

period of time during which coating submitted to the ANSI/[UL 1709](#) fire-resistant standard test is capable of keeping surface temperature of the structure below 538°C

3.3

fire-potential equipment

those with potential for generating fire, according to 5.2 from API [PUBL 2218:2010](#), from which areas subjected to fire are determined

3.4

fire-scenario area

It is obtained by increasing radially in 6 m in process units, or in 3 m outside process units, the projection of the equipment with a potential to generate fire, on the ground level or the highest continuous floor, covering height of 8 m from the reference ground, as shown in Figure A.1 in Annex A

3.5

unwetted wall vessel

it is one in which the walls are exposed to gas, vapor or are internally refracted, regardless of the type of fluid contained

4 General Conditions

4.1 To determine the fire-potential equipment, an analysis shall be performed, according to 5.2 of API [PUBL 2218:2010](#).

NOTE 1 Areas subject to fire shall be represented in a "Plant of Areas Subjected to Fire," containing and listing the equipment and structures that shall have passive protection and fire-potential equipment.

NOTE 2 Documents listed in 4.1 shall be submitted for prior approval of PETROBRAS.

4.2 Fire protection time shall meet requirements defined in Table 2 of API STD [PUBL 2218: 2010](#) and ANSI/[UL 1709](#).

4.3 Fire protection coating shall not be deemed a replacement for firefighting equipment and techniques.

4.4 Concrete structures are deemed sufficiently fire-resistant.

4.5 If there is the need for applying fire protection coating on most of the steel structure, an economic assessment of its cost compared to equivalent reinforced concrete structure is recommended. **[Recommended Practice]**

4.6 Dimensions indicated in item 3.4 may be smaller, provided there is a structure which is deemed limiting to fire-scenario areas such as:

- a) fireproof walls and construction ceilings;
- b) brickwork or reinforced concrete walls.

4.7 The following structural elements do not require fire insulation:

- a) elements designed for wind loads only;
- b) traveling crane beams;
- c) staircases and platforms;
- d) heat exchanger and horizontal vessel cradle;
- e) the upper face of fire protected beams, which purpose is to support piping, equipment or platforms.

4.8 Structural drawings of fire-coated elements shall be marked with the letters "PCF", indicating Fire Protection.

4.9 Studs and anchor bolts which constitute the basis of equipment and of the fire-protected structures shall also be protected.

4.10 Applicable paint schemes

4.10.1 For structures and equipment protected with concrete and mortar.

- a) metallic structures: PETROBRAS N-1550;
- b) industrial equipment: PETROBRAS [N-2](#);
- c) support columns of spheres: PETROBRAS [N-2913](#). To receive the paint on the coating, it shall be sufficiently dry and the surface properly prepared in order to avoid defects in the dry film coating.

NOTE For a) and b), it is recommended to apply fungicidal paint on the concrete or mortar, in regions of high humidity and proliferation of fungi. **[Recommended Practice]**

4.10.2 For structures and equipment protected with other coatings, the manufacturer's instructions for setting the paint scheme shall be followed.

5 Extension of Fire Coating for Typical Structures and Equipment

5.1 Raised Piping Support (Pipe Rack and Others)

Fire protection (see Figure A.2 of Annex A) shall be counted from ground level, or from the nearest continuous floor and meet criteria described in Table 1.

NOTE It is recommended that all pipe-racks within process units are fire protected. For pipe-racks located outside the process units (off-site), it shall be followed the criteria of 6.2.1 of API [PUBL 2218:2010](#). [Recommended Practice]

Table 1 - Extent of Fire Coating on Raised Piping Support

Structure height (h)	Coating extent
$h < 8\,000\text{ mm}$	Entire support extent
$h \geq 8\,000\text{ mm}$	8 000 mm maximum

5.2 Metallic Structure for Supporting of Air Coolers

Fire protection shall extend up to 200 mm above the last horizontal beam of the cooler supporting structure, limited to an 8 000 mm height (see Figure A.3 of Annex A), counted from ground level or from the nearest continuous floor.

5.3 Steel Structure for Equipment Support

Fire protection shall extend up to 200 mm above the last horizontal beam of the equipment supporting structure, limited to an 8 000 mm height (see Figure A.4 of Annex A), counted from ground level or from the nearest continuous floor.

5.4 Metallic Structure for Supporting of Furnace and Boiler

Fire protection shall extend up to a 300 mm level below the first horizontal beam, limited to an 8 000 mm height (see Figure A.5 of Annex A), counted from ground level or from the nearest continuous floor.

5.5 Vertical Vessel Skirt

5.5.1 Fire protection shall be applied externally and internally on the vertical vessel skirt. The vessel skirt with an inner diameter lower than 1 500 mm does not need internal protection, except when there are flanges or valves in it or unsealed openings which are greater than 24" (600 mm).

5.5.2 The fire protection of vessel skirt shall extend from the base ring to the top of the skirt, limited to 8 000 mm high (see Figures A.6, A.7 and A.8 of Annex A).

5.6 Unwetted Wall Vessel

5.6.1 The fire protection of unwetted wall vessels contained in a fire-scenario area, when required according to API [STD 521](#), shall be only made with intumescent coating.

NOTE The reaction temperature of the intumescent coating shall be greater than the temperature of the plating.

5.6.2 For vertical unwetted vessel walls, the skirt shall be protected as well, according to extension from 5.5. The protection of the skirt shall be done with castable refractory or intumescent coating.

5.7 Stack and Ducts

5.7.1 The fire protection of chimneys and freestanding ducts contained in area subject to fire shall be in intumescent coating.

NOTE The reaction temperature of the intumescent coating shall be greater than the temperature of the plating.

5.7.2 For chimneys, the skirt shall be protected as well, according to extension from 5.5. The protection of the skirt shall be done with castable refractory or intumescent coating.

5.8 Support Columns of Spheres

Fire protection shall extend up to 200 mm below the leg weld with side reinforcement plate (see Figure A.9 of Annex A).

6 Material

6.1 Grout

6.1.1 Applicable in steel structural elements of equipment and piping, with the following exceptions:

- a) support columns of spheres;
- b) chimney skirts;
- c) tower skirts, vessels and reactors defined as category I of [NR-13](#).

6.1.2 The following ratios shall be maintained for preparation of the grout:

- a) sand x cement - 3:1 (in volume);
- b) cement x water - 10:7.35 (in weight).

6.1.3 Sand shall be classified as a Small Aggregate in accordance with ABNT [NBR 7211](#), with maximum 4.8 mm particle sizing, in which there may not be noxious substances such as: clay, organic matter, dusty materials and others. Quartz natural sand shall be used.

6.1.4 Cement shall be common Portland type, class 250 or 320, in accordance with ABNT [NBR 5732](#), and cement with hydration and stoning start may not be used.

6.1.5 Grout shall have a minimum compression strength of 5.0 MPa (51 kgf/cm²), right after 7 days.

6.2 Castable Refractory

6.2.1 Applicable on steel structural elements of equipment and piping.

6.2.2 Refractory contained in PETROBRAS [N-1728](#), shall be used, except for insulators.

6.2.3 Refractory shall have a minimum 5.0 MPa (51 kgf/cm²) compression strength, right after curing and 24 hours of air-drying.

6.3 Other Materials

6.3.1 The use of other fire protection materials is allowed, such as intumescent coats and special mortars mentioned in 7.3 of API [PUBL 2218:2010](#), provided they meet the established in 6.3.2 of this Standard.

6.3.2 At least the following documents are required for use of other materials:

- a) test certificate for fire protection [ANSI/UL 1709](#), considering minimum guard time of 1.5 h, tested in a profile of section "I" W10x49;
- b) calculation memory of the thickness of the coating, based on test [ANSI/UL 1709](#) or recognized credibility certificate, for each metal profile and equipment to be protected;
- c) procedure for applying the coating, containing schematic drawing for each type of structure, defining:
 - coating thickness;
 - anchoring (or strengthening) system;
 - protection against ingress of rain water (if applicable);
 - surface finishing (fire protection coating);
 - preparation conditions of the metal surface;
 - specification of the coating exterior painting (if applicable).
- d) certificate of technical capacity of the installation team (on behalf of the applicator company), issued by the material manufacturer or manufacturer's technical supervision during installation;

NOTE The technical capacity certificate shall have the maximum validity of five years and its last installation shall have been executed no more than two years ago.

- e) certificate of resistance to water spray, according to [NFPA 290](#), issued by an internationally recognized laboratory or with accreditation recognized by INMETRO, if applicable to the fire-scenario area;
- f) certificate of resistance to fire spray, according to [ISO 22899-1](#), issued by an internationally recognized laboratory or with accreditation recognized by INMETRO, if applicable to the fire-scenario area.

6.4 Anchoring Devices (Refractory Mortar and Concrete)

6.4.1 A carbon steel wire mesh shall be used (carbon content not exceeding 0.3 %), BWG diameter 14 (2.1 mm), 50 mm x 50 mm square mesh, the screen can be fence-type or welded screen-type in all knots. Both alternatives can be whether or not galvanized.

6.4.2 Wire mesh and clamp layout, which involve the structural elements to be protected, shall be performed according to Figure A.10 of Annex A.

6.4.3 Wire mesh anchors (clamp/hook) shall be made of SAE 1020 carbon steel, as shown in Figures A.11 and A.12 of Annex A.

6.4.4 Anchoring screen fastening and clamps/hook spacing shall be according to Figure A.13 of Annex A. Clamps/hook shall be welded by stud welding or conventional processes according to PETROBRAS [N-133](#) and ASME code [BPVC Section IX](#).

7 Fire Protection Sizing

7.1 Fire coating thickness, by using grout (6.1) or refractory concrete (6.2), shall be 50 mm.

7.2 Fire coating thickness, by using other materials (6.3), shall be sized according to calculation memory (6.3.2 b).

8 Application

8.1 Grout and Refractory Concrete

Application of fire coatings shall be in accordance with PETROBRAS [N-1617](#), with the exceptions described in items from 8.1.1 to 8.1.6.

8.1.1 Disregard hot-drying as indicated in PETROBRAS [N-1617](#).

8.1.2 Disregard anchoring devices as indicated in PETROBRAS [N-1617](#).

8.1.3 All fire coating edges shall be cut back or rounded and top ends shall be sloped so as to prevent water build-up, and junctions between the isolated surface and coating, prone to water penetration, shall be waterproofed with a non-dryable sealant according to PETROBRAS [N-1618](#) or sealed with metallic protection plate (as the examples of Figures A.8 and A.9).

8.1.4 Grout preparation shall be performed with concrete mixers. For refractory concrete, a paddle mixer shall be used.

8.1.5 It is recommended that shakeout be performed only after the hydraulic cure period (24 hours for refractory concrete or 72 hours for grout),.At first remove only one mold and examine coating for hardening and other molds may be removed only if coating is sufficiently hardened. **[Recommended Practice]**

8.1.6 In application, tests shall be performed on 3 test specimens with 50 mm x 50 mm x 50 mm dimension, per application front.

NOTE In application by pneumatic projection, fill a 300 mm x 300 mm panel, placed on the place of application. Samples shall be removed from this panel.

8.1.6.1 Additional removal by journey and by material supply source is recommended. **[Recommended Practice]**

8.1.6.2 Upon completing application on test panels or molds, hydraulic cure shall be performed during 24 hours for refractory concrete and 72 hours for grout.

8.1.6.3 Compression strength tests shall be performed and results shall meet in 6.1.5 and 6.2.3.

8.1.7 Upon completing application, coating shall meet the following criteria:

- a) not present empty spaces and lack of material;
- b) not present cracks larger than 1mm;
- c) finishing shall be uniform;
- d) an out-of-flat is allowed between contiguous surfaces up to 3mm.

8.2 Other Materials

Application of other fire coatings shall be in accordance with API [PUBL 2218: 2010](#) and manufacturer's specific application instructions.

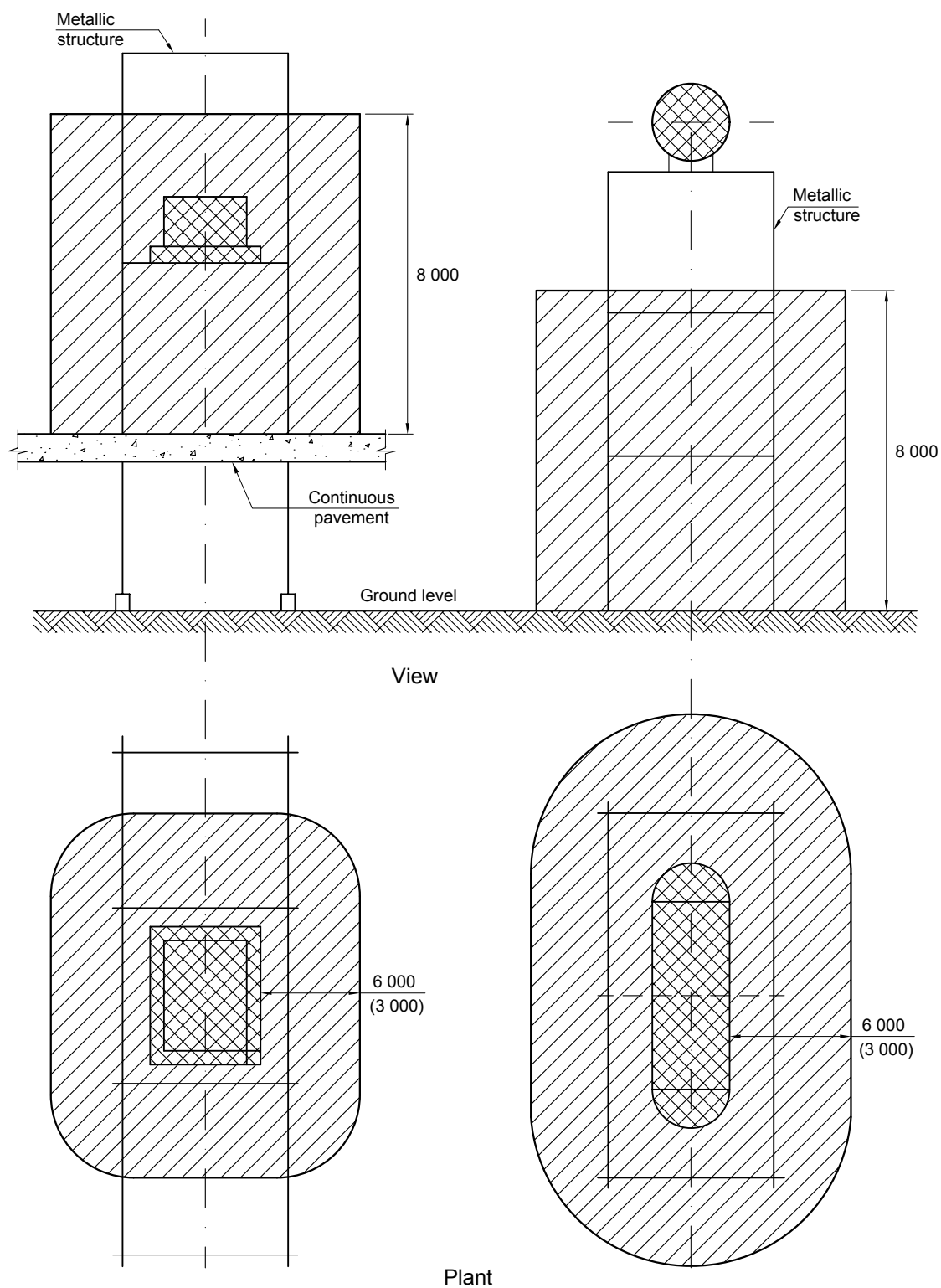
9 Fire Protection Lining Inspection of Equipment Submitted to Operation

9.1 Annually perform outside visual inspection of coating, checking the presence of cracks, empty spaces, falling of material or traces of water seepage.



9.2 In the event of the need for checking the corrosive aspect of protected steel components, it is recommended to open windows (300mm x 300mm) on coating for inspection. **[Recommended Practice]**

9.3 Coatings presenting seepage areas or regions with coating detachment with protected surface, compromising integrity of protected steel component are not accepted.

Annex A - Figures



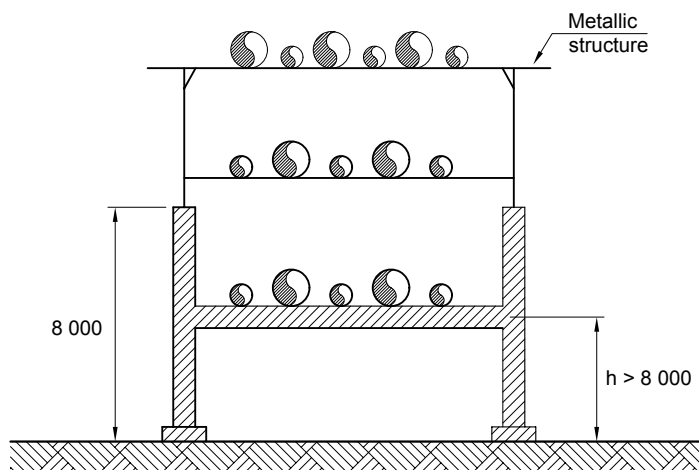
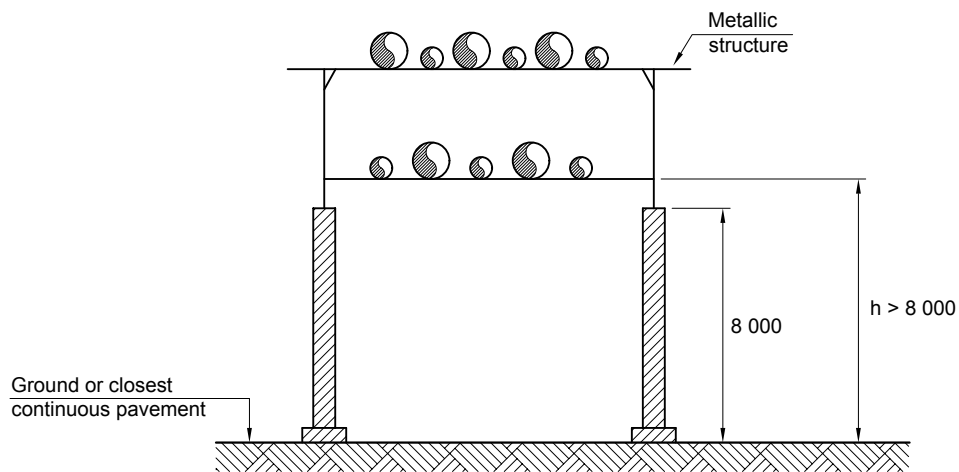
Legends :

-  Fire - potential equipment
-  Fire - scenario areas

NOTE 1 Heights in parenthesis refer to equipment located outside process units.

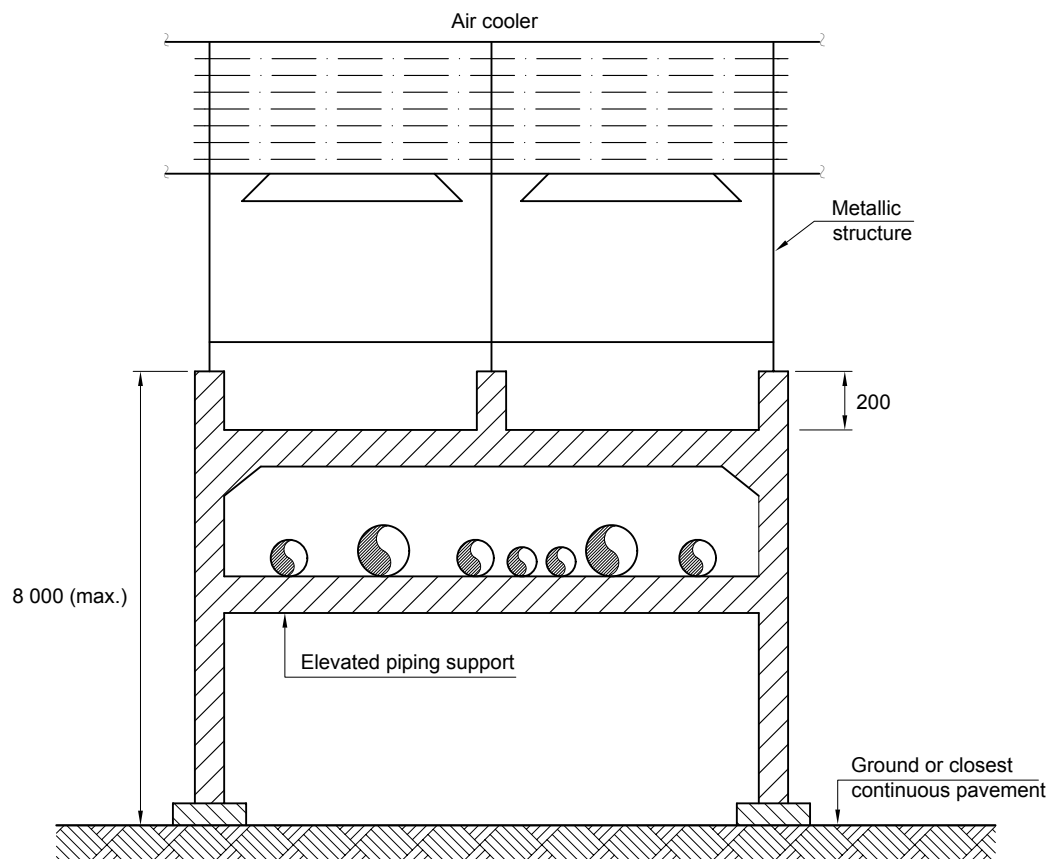
NOTE 2 Dimensions in millimeters, unless otherwise indicated.

Figure A.1 - Fire - Scenario Areas



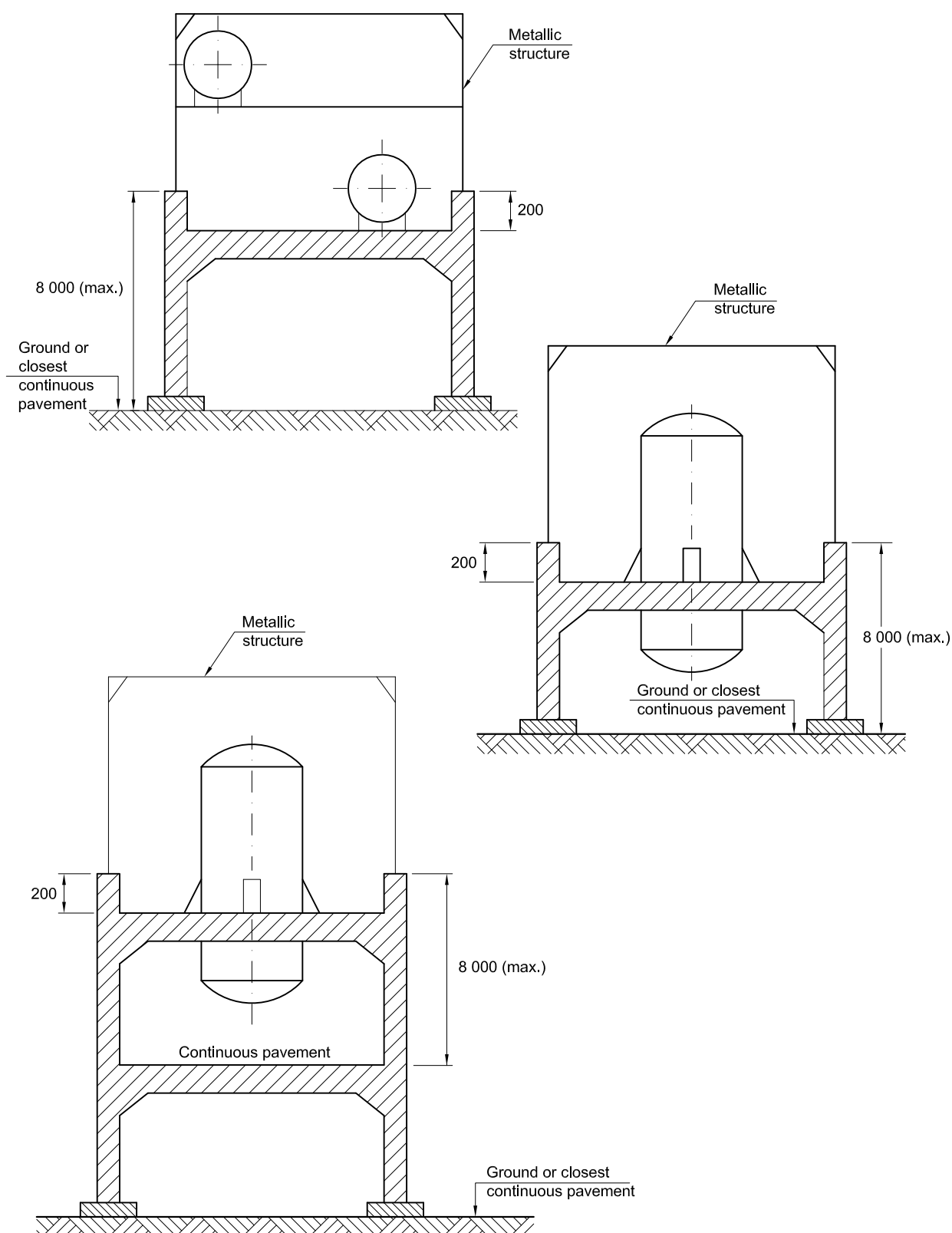
NOTE Dimensions in millimeters, unless otherwise indicated.

Figure A.2 - Fire Protection for Elevated Piping Supports



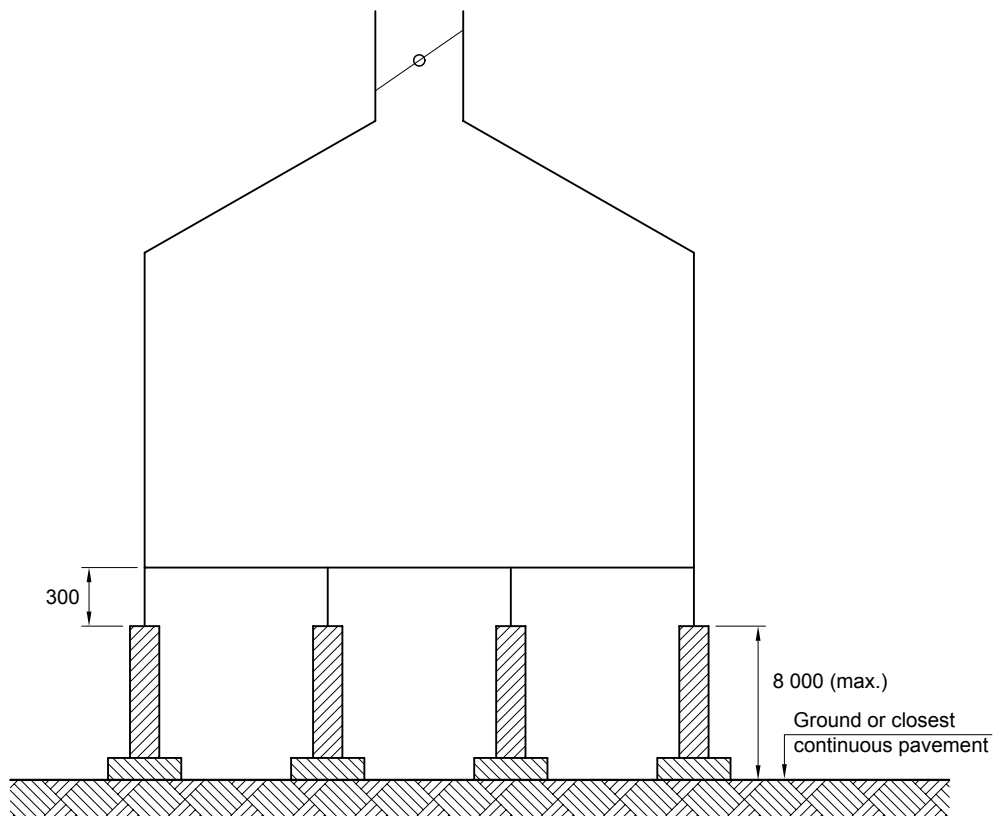
NOTE Dimensions in millimeters, unless otherwise indicated.

Figure A.3 - Fire Protection for Elevated Piping and Air Cooler Supports



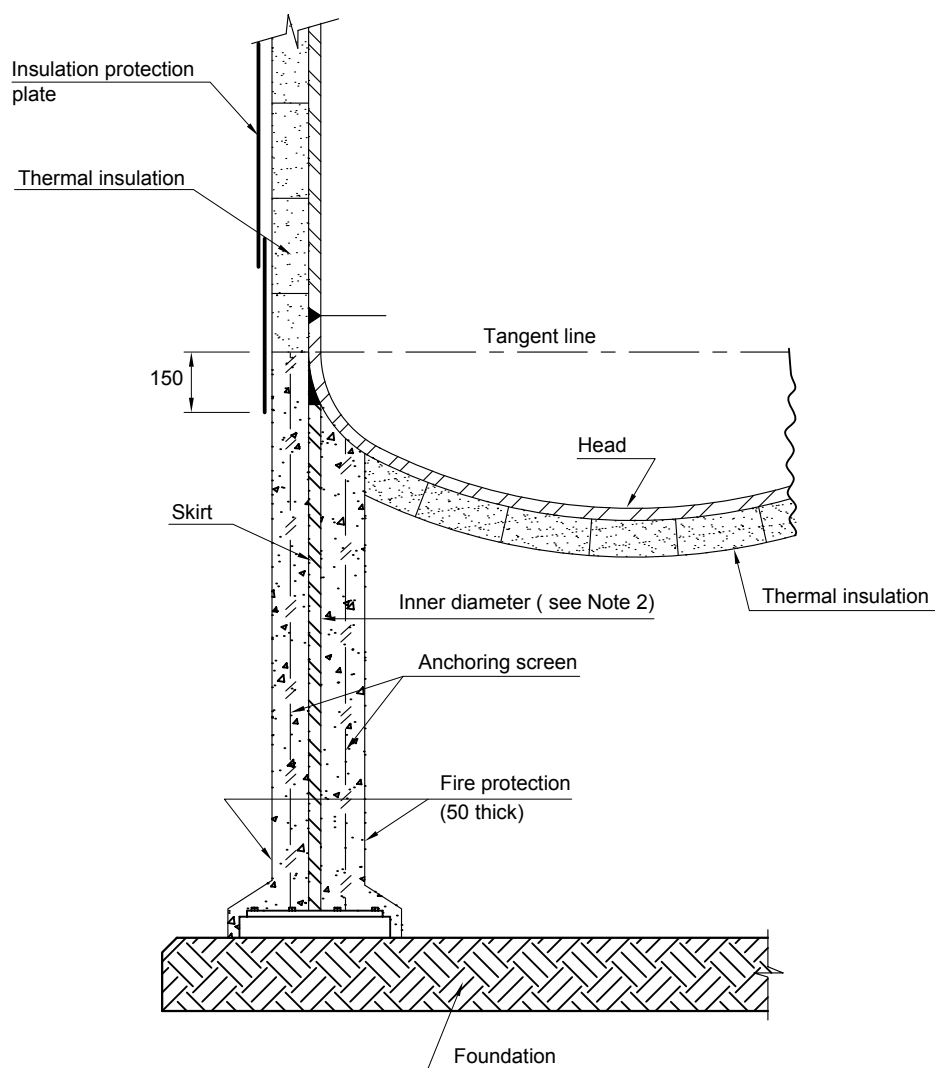
NOTE Dimensions in millimeters, unless otherwise indicated.

Figure A.4 - Fire Protection for Vessel and Equipment Structures



NOTE Dimensions in millimeters, unless otherwise indicated.

Figure A.5 - Fire Protection of Fired Heaters and Boilers Structures



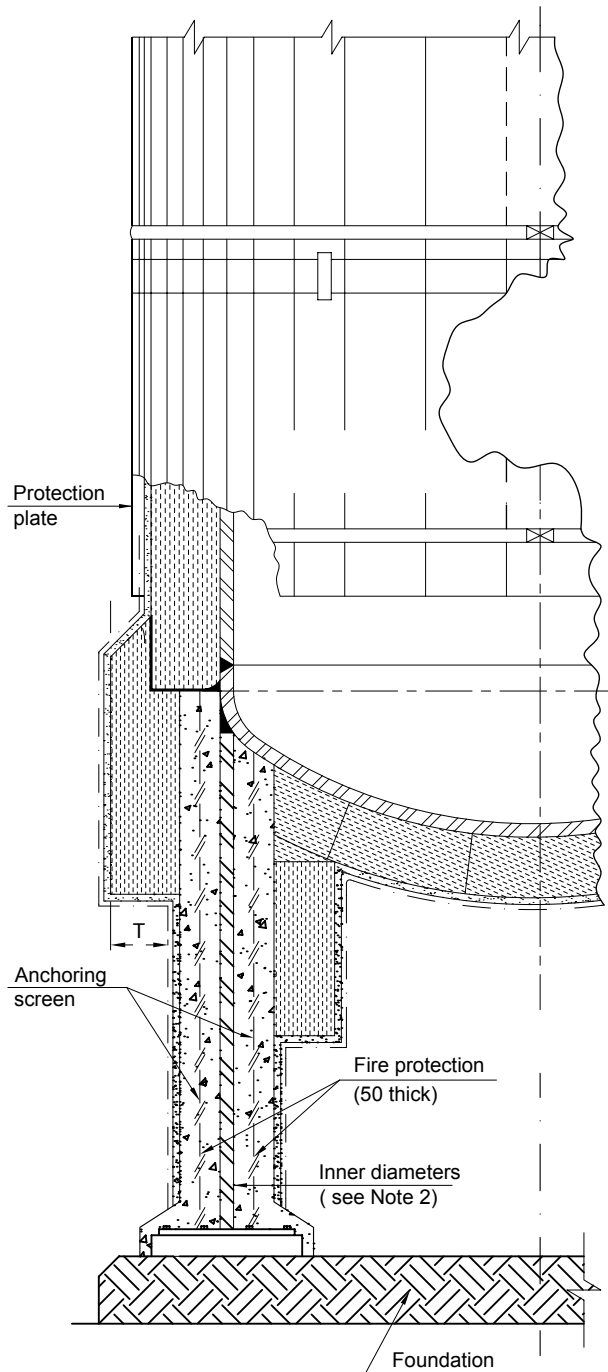
NOTE 1 For fire protection using castable refractory.

NOTE 2 Skirts of vessels with inner diameters smaller than 1 500 do not require inner fire protection.

NOTE 3 Dimensions in millimeters, unless otherwise indicated.

NOTE 4 Not applicable to unwetted vessels.

Figure A.6 - Fire Protection of the Vertical Vessel Skirt with Thermal Insulation for High Temperatures



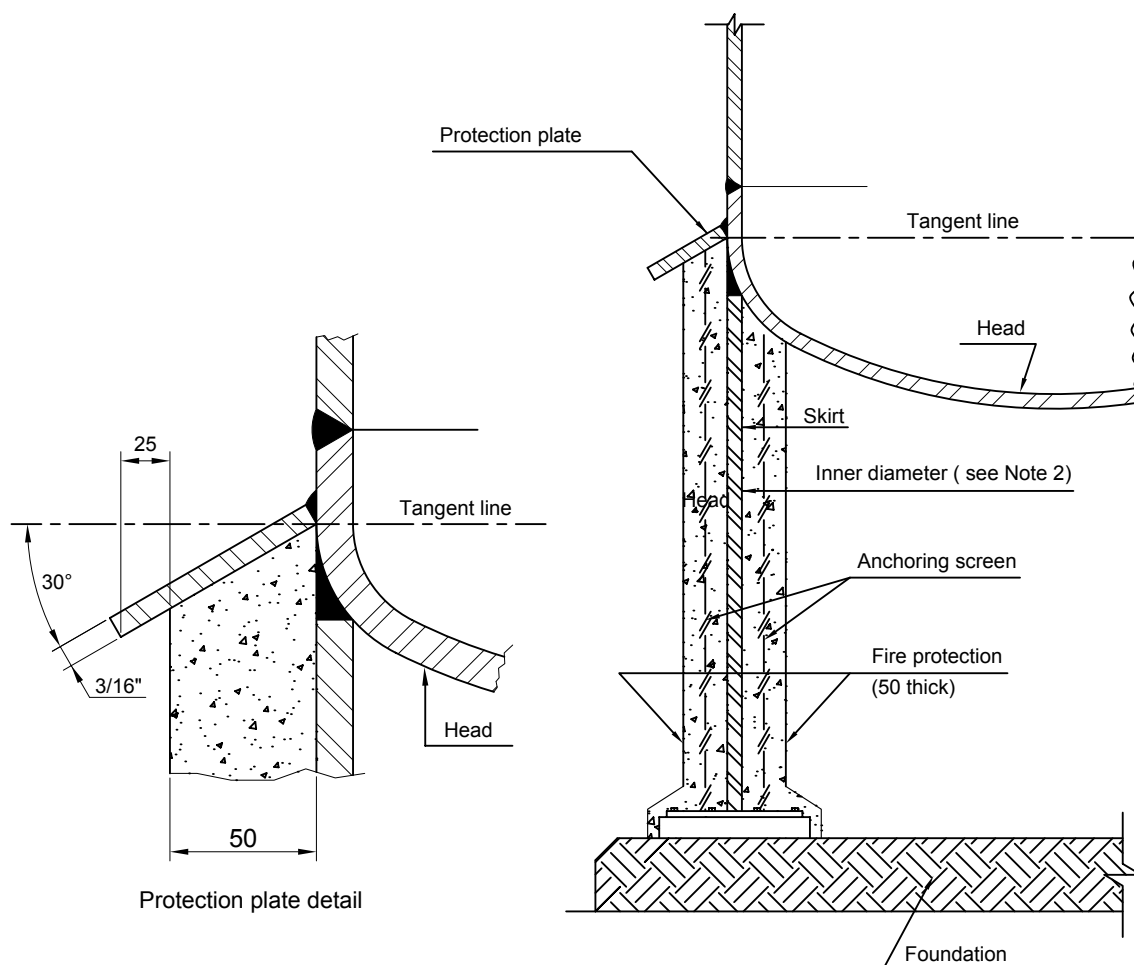
NOTE 1 For fire protection using castable refractory.

NOTE 2 Skirts of vessels with inner diameters smaller than 1 500 do not require inner fire protection.

NOTE 3 Dimensions in millimeters, unless otherwise indicated.

NOTE 4 Not applicable to unwetted vessels.

Figure A.7 - Fire Protection of the Vertical Vessel Skirt with Thermal Insulation for Low Temperatures



NOTE 1 For fire protection using castable refractory.

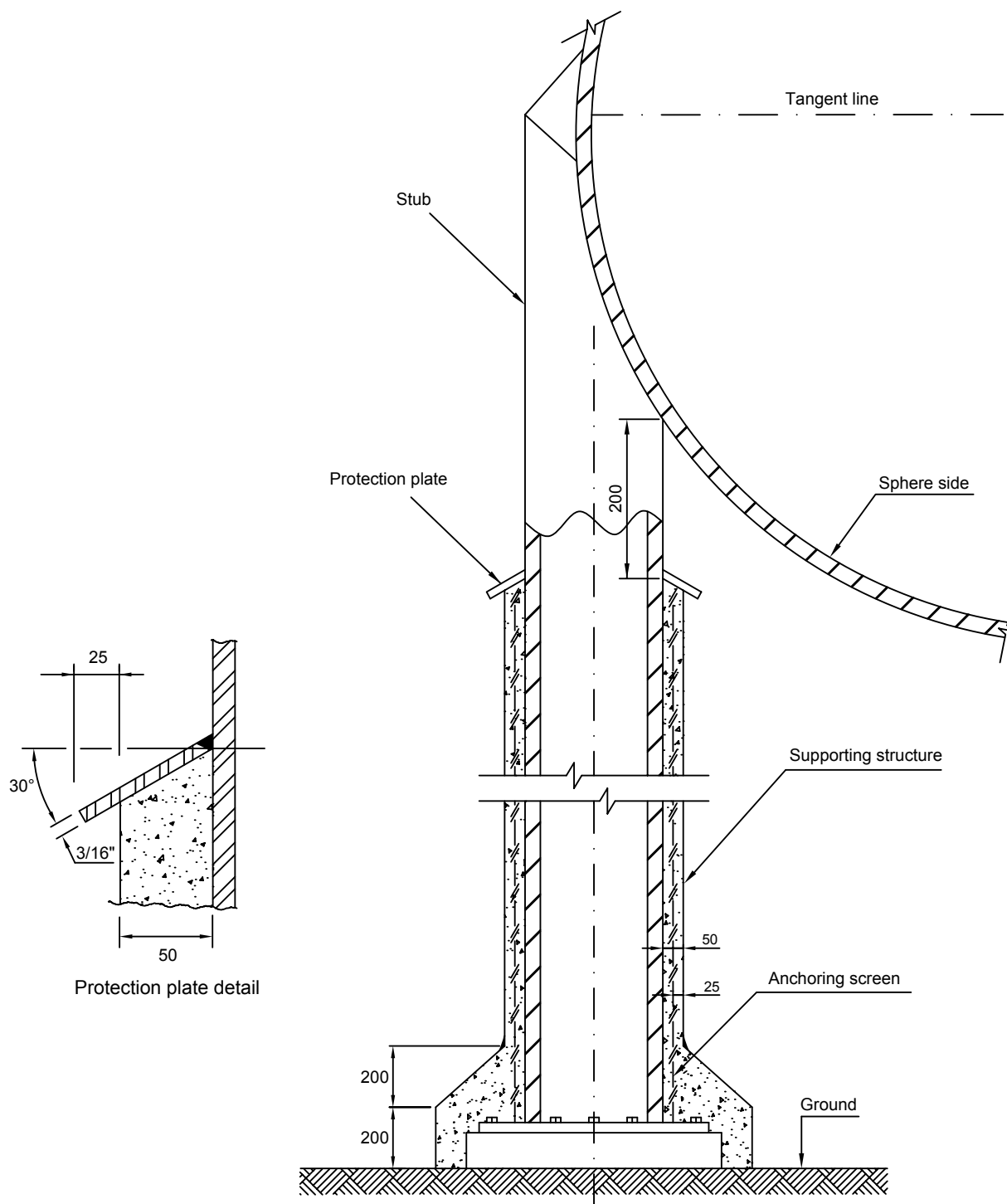
NOTE 2 Skirts of vessels with inner diameters smaller than 1 500 do not require inner fire protection.

NOTE 3 Dimensions in millimeters, unless otherwise indicated.

NOTE 4 Protection plate shall be of the same material as the head.

NOTE 5 Not applicable to unwetted vessels.

Figure A.8 - Fire Protection of Vertical Vessel Skirt Without Thermal Insulation

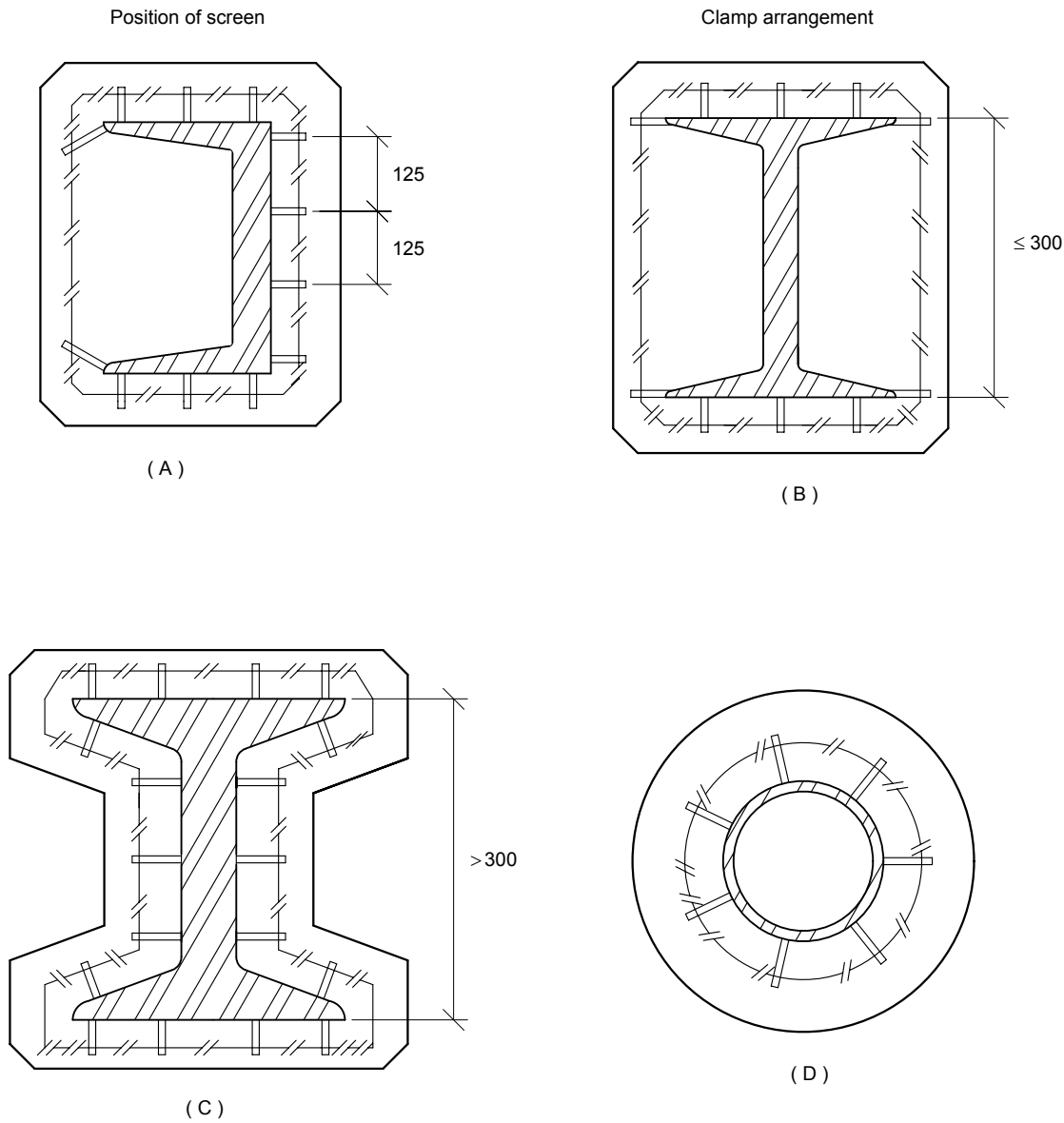


NOTE 1 For fire protection using castable refractory.

NOTE 2 Dimensions in millimeters, unless otherwise indicated.

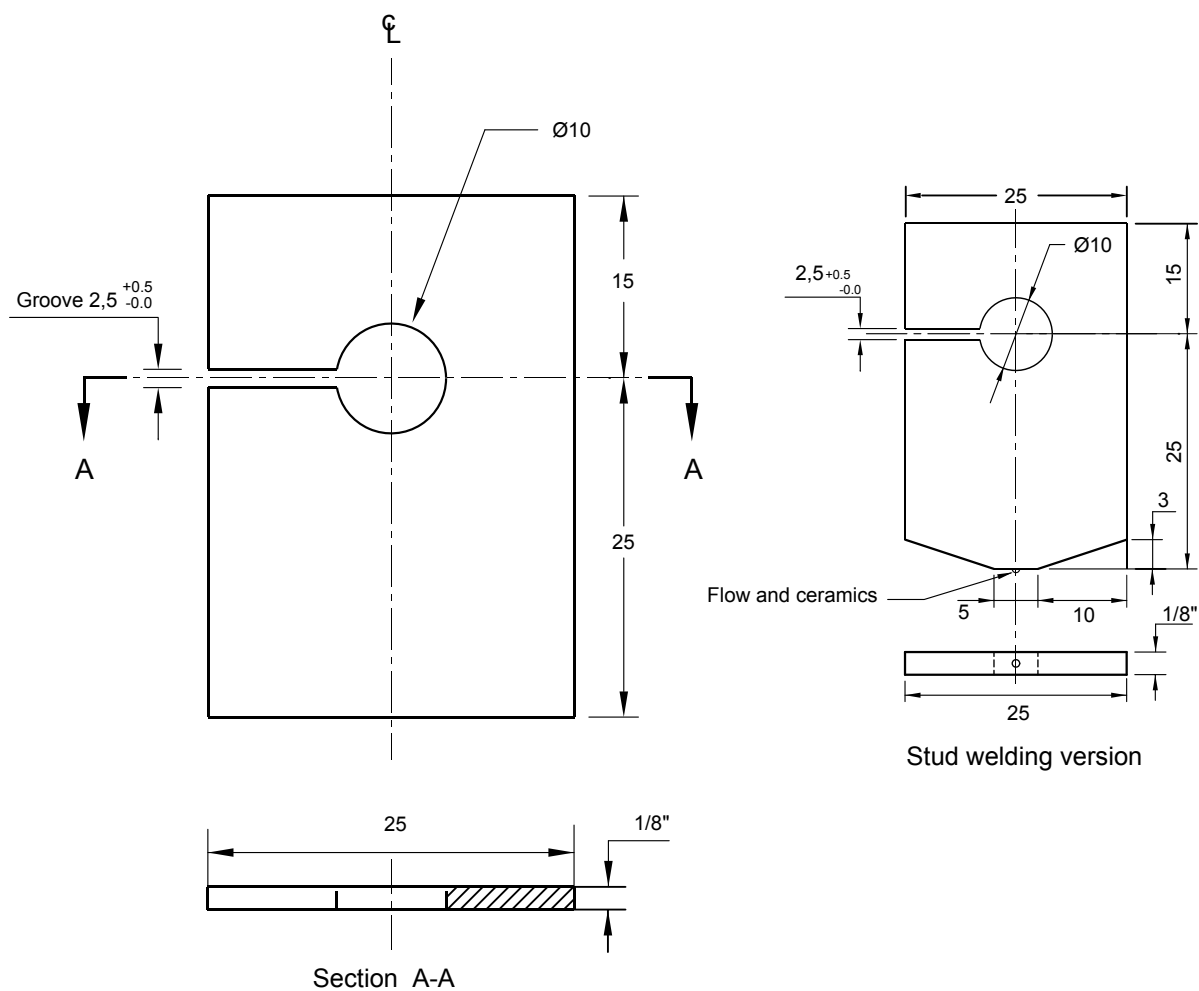
NOTE 3 Protection plate shall be of the same material as the sphere support.

Figure A.9 - Fire Insulation of Sphere Support



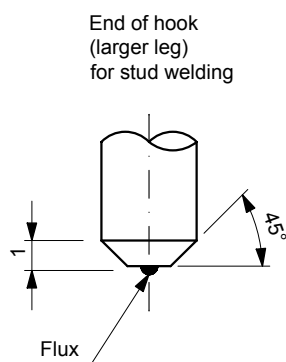
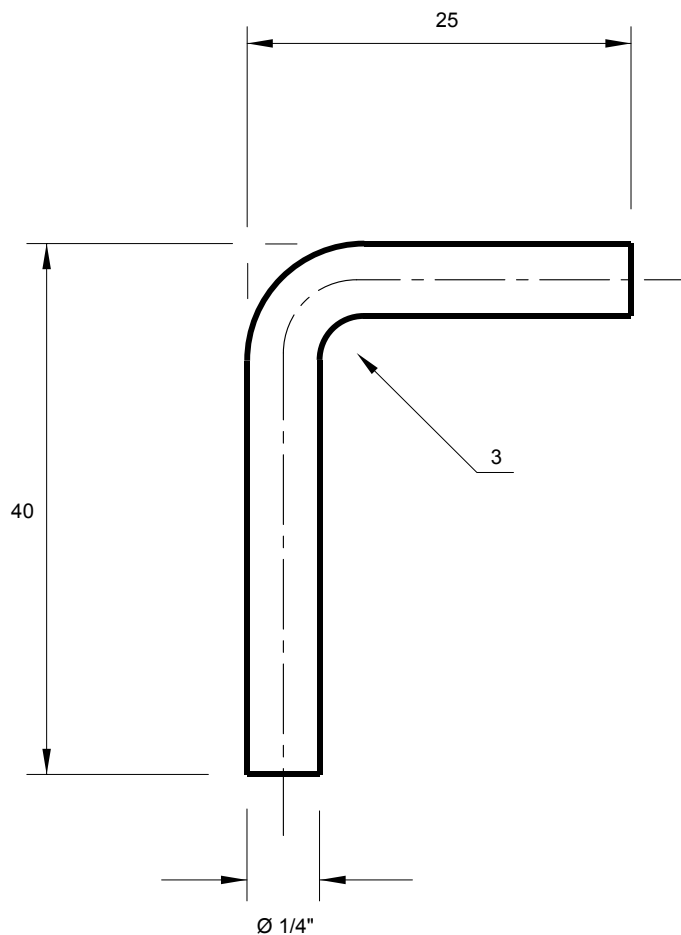
NOTE 1 For fire protection using grout or castable refractory.
NOTE 2 Dimensions in millimeters, unless otherwise indicated.

Figure A.10 - Fire Protection Anchoring Device Details



- NOTE 1 Dimensions in millimeters, unless otherwise indicated.
 NOTE 2 General tolerance: $\pm 5\%$ (excepted when indicated).
 NOTE 3 Anchors for the stud welding process shall be provided with the ceramics.

Figure A.11 - Plate Anchor

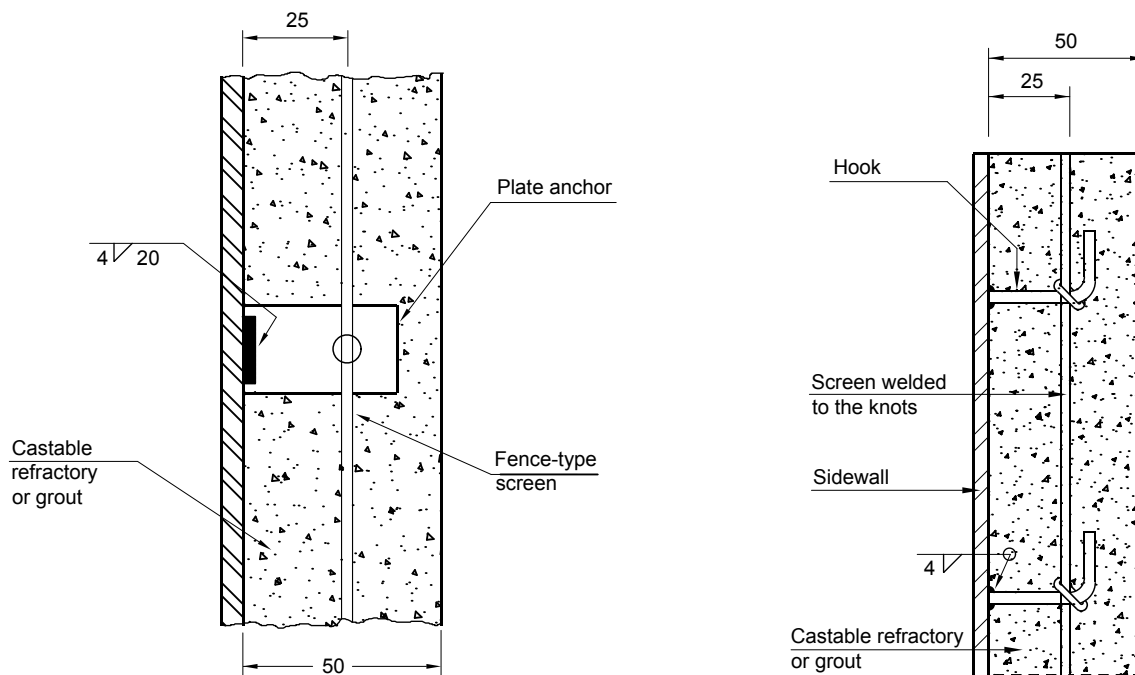


NOTE 1 Stud welding process studs shall be provided with the ceramics.

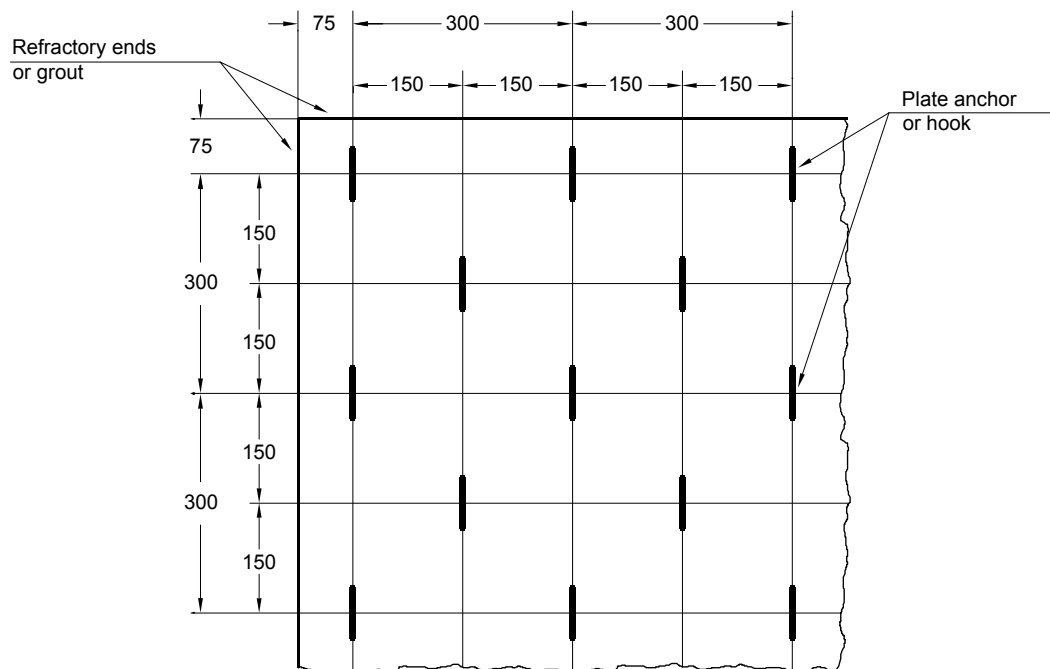
NOTE 2 Dimensions in millimeters, unless otherwise indicated.

NOTE 3 General tolerance: $\pm 5\%$ unless otherwise indicated.

Figure A.12 - Hook



Position of screen / anchors fixation / hooks



Anchors arrangement / hooks

NOTE Dimensions in millimeters, unless otherwise indicated.

Figure A.13 - Installation of Plate Anchors or Hooks and Screen

REV. A and B

There is no index of revisions.

REV. C

Affected Parts	Description of Alteration
All	Revised

REV. D

[illegible]