PIP<br>Process Industry Practices<br>Refractory<br><br>PIP RFIA1000<br>Refractory Anchor and Accessory<br>Installation Details
PURPOSE AND USE OF PROCESS INDUSTRY PRACTICES

In an effort to minimize the cost of process industry facilities, this Practice has been prepared from the technical requirements in the existing standards of major industrial users, contractors, or standards organizations. By harmonizing these technical requirements into a single set of Practices, administrative, application, and engineering costs to both the purchaser and the manufacturer should be reduced. While this Practice is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this Practice. Determinations concerning fitness for purpose and particular matters or application of the Practice to particular project or engineering situations should not be made solely on information contained in these materials. The use of trade names from time to time should not be viewed as an expression of preference but rather recognized as normal usage in the trade. Other brands having the same specifications are equally correct and may be substituted for those named. All Practices or guidelines are intended to be consistent with applicable laws and regulations including OSHA requirements. To the extent these Practices or guidelines should conflict with OSHA or other applicable laws or regulations, such laws or regulations must be followed. Consult an appropriate professional before applying or acting on any material contained in or suggested by the Practice.

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PIPELINE INDUSTRY PRACTICES

Refractory

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1. **Introduction**

1.1 **Purpose**

This Practice provides installation details for refractory anchors and accessories.

1.2 **Scope**

This Practice provides details for installing metallic and non-metallic anchors and accessories for monolithic, ceramic fiber and brick linings. This Practice provides details for anchor assembly, pattern, spacing, and weld attachments.

2. **References**

Applicable parts of the following Practices and industry codes and standards shall be considered an integral part of this Practice. The edition in effect on the date of contract award shall be used, except as otherwise noted. Short titles are used herein where appropriate.

2.1 **Process Industry Practices (PIP)**

- PIP RFSA1000 – *Refractory Anchor and Accessory Material Specification (under development)*
- PIP RFSM1000 – *Monolithic Refractory Material Specification*
- PIP RFTA1000 – *Refractory Anchor and Accessory Installation Qualification, Inspection, and Testing*
- PIP VESPMI01 – *Positive Material Identification Specification*

2.2 **Industry Codes and Standards**

- American Petroleum Institute (API)
  - API Standard 936 – *Refractory Installation Quality Control – Inspection and Testing Monolithic Refractory Linings and Materials*
- ASTM International
  - ASTM C71 – *Standard Terminology Related to Refractories*
- The Society for Protective Coatings
  - SSPC-SP 3 – *Power Tool Cleaning*
  - SSPC-SP 7/NACE No. 4 – *Brush-Off Blast Cleaning*

3. **Definitions**

With the exception of terms listed in this section, terms used in this Practice are defined in accordance with *PIP RFSA1000, ASTM C71, and API Standard 936*.

**coking**: Service in which coke is deposited in any refractory voids during normal operation

**positive material identification (PMI)**: The procedure used to test and evaluate material to confirm that it is the specified material

**severe abrasion service**: Service in which resistance to abrasion is the main consideration in the selection of the refractory. Included are refractory Types 8, 9 and 10 in accordance with *PIP RFSM1000, Appendix A*. 
thermal cycling: Service in which repetitive variation of the operating temperature at the exposed refractory surface is a design consideration

4. Requirements

4.1 General

4.1.1 Conflicts, Exceptions and Deviations

4.1.1.1 All conflicts between the referenced documents and this Practice shall be submitted in writing to the purchaser for clarification and resolution before proceeding with the anchor installation.

4.1.1.2 All exceptions, deviations and substitutions to the requirements specified herein and in referenced documents shall be approved by the purchaser.

4.1.2 Regulations and Material Safety Data Sheets (MSDS)

4.1.2.1 Anchor and accessory materials and their installation shall be in accordance with all applicable federal, state, and local codes and regulations on surface preparation, welding, storage, handling, safety and environmental requirements.

4.1.2.2 Installation of anchors and accessories including welding shall be in accordance with the manufacturer’s product data sheets, MSDS and installation instructions. These documents shall be available at the installation site.

4.1.3 Documentation

4.1.3.1 Installer shall submit an anchor installation procedure including anchor layout, weld details, material specification, positive material identification (PMI) procedure, etc., for purchaser’s review and approval. Approval shall be received before the start of work.

4.1.3.2 Before installation, welding consumable, metallic anchor and accessory composition shall be confirmed by PMI as follows:

a. Welding consumables: PMI shall be performed in accordance with PIP VESPMI01.

b. Individual anchors: PMI shall be performed on randomly selected samples consisting of 0.5 percent (rounded up to the next whole number) of each component style, component size, metallurgy and manufacturer, with a minimum of one sample per container.

c. Continuous assemblies (e.g., hexmesh and flexmesh): PMI shall be performed at one random location on each continuous assembly.

4.1.3.3 Before welding commences, all welding procedure specifications (WPS) and procedure qualification records (PQR) shall be submitted to and approved by the purchaser.
4.1.4 Notification

4.1.4.1 The Purchaser’s inspectors shall be given adequate notice for inspection and testing of installation of anchors and accessories in accordance with PIP RFTA1000.

4.1.4.2 Inspection hold points shall be in accordance with RFTA1000-F.

4.2 Surface Preparation

4.2.1 Immediately before welding, the surface to which anchors or accessories are to be welded shall be prepared by brush-off grit blast cleaning in accordance with SSPC-SP 7/NACE 4.

4.2.2 If approved by owner, power tool cleaning in accordance with SSPC-SP 3 by grinding of individual spots, repairs, and small areas less than 0.1 square meter (1 square foot) may be permitted.

4.2.3 After cleaning, surfaces shall be vacuumed to remove debris. Surfaces shall be inspected for cleanliness and cleaning shall be repeated if necessary. Washing with water shall not be permitted.

4.3 Welding of Metallic Anchors and Accessories

4.3.1 Welding of anchors and accessories shall be performed by welders code-qualified in accordance with PIP RFTA1000, Section 4.4.

4.3.2 Welding consumables and anchors shall be in accordance with PIP RFSA1000.

4.3.3 Except as specified in Section 4.3.4 below, welding of anchors and accessories shall be performed in accordance with an arc welding process.

4.3.4 If approved by the owner, stud welding may be used for attachment of the following items:
   
a. Stud-pins for ceramic fiber blanket linings.
   
b. Proprietary anchor attachments for ceramic fiber module linings. Welds shall be accessible for inspection.

4.3.5 Welding of anchors and accessories within twice the lining thickness, minimum of 75 mm (3 inches), of pressure boundary welds shall be completed after radiographic or other nondestructive inspection of pressure boundary welds.

4.3.6 Welding of anchors and accessories shall be completed before heat treatment is performed.

4.3.7 Wax crayons, grease markers, or other substances that may interfere with the quality of the attachment welds, base metal, or anchor metallurgy shall not be permitted for marking anchor attachment locations. Chalk, soapstone, or graphite may be used.

4.3.8 Anchor locations shall not be marked with a center punch or other means affecting the base metal.

  Comment: Such a mark may be a stress concentration point, possibly initiating cracking or corrosion.

4.3.9 Individual anchors and accessories shall not be welded on pressure boundary weld seams.
4.3.10 For non-pressure boundary weld seams, surface preparation (e.g., grinding) may be required before welding an anchor to the weld seam.

4.3.11 Anchors shall be welded to clean, dry, surfaces.

4.3.12 For the installation of continuous assemblies (e.g., hexmesh or flexmesh), weld seams shall be ground flush within 0 to plus 1.5 mm (1/16 inch).

4.4 Anchor Replacement

4.4.1 When replacing an anchor, the existing anchor shall be cut above the attachment weld without damaging the shell (e.g., cut off anchor tines). The new anchor shall be attached adjacent to the old anchor in accordance with the requirements of this Practice.

4.4.2 If a new anchor must be located at the same place as an existing anchor, the existing anchor and weld shall be removed by grinding without damaging the shell. After grinding, perform magnetic particle or dye penetrant examination of the surface where the anchor was removed. The new anchor shall be attached in accordance with the requirements of this Practice.

4.5 Anchor Installation Details

Installation of anchors and accessories shall be in accordance with details PIP RFIA1001 through PIP RFIA1032.
A. ANCHOR PATTERN AND TINE ORIENTATION (NOTES 1, 2 AND 3)

(1) 90° SQUARE

(2) 90° STAGGERED

NOTE:
SEE PAGE 5 FOR NOTES
A. Anchor Pattern and Tine Orientation (continued)

(3) 45° Square

45° Staggered

(5) Square Herringbone

30–60° (Note 4)

(6) Staggered Herringbone

30–60° (Note 4)

1/2 S

Curvature of Shell

Dimensions are given in millimeters. Dimensions in parenthesis are in inches, unless noted otherwise.

CAD Filename: RFIA1001_2.dwg

NOTE:

See page 5 for Notes
B. OUTSIDE CORNER DETAIL — LINING THICKNESS (T) ≤ 150 (6)
(NOTES 1, 5 AND 6)

ANCHOR TIMES ORIENTATION
(AS SHOWN ON PAGES 1 & 2)

25 (1)

ANCHOR TIMES ORIENTATION
(AS SHOWN ON PAGES 1 & 2)

25 (1)

25 (1)

S

1/2 S

S

NOTE:
SEE PAGE 5 FOR NOTES

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESIS ARE IN INCHES, UNLESS NOTED OTHERWISE
C. Outside Corner Detail — Lining Thickness (T) > 150 (6) (Notes 2 and 5)

NOTE:
See Page 5 for Notes

Dimensions are given in millimeters. Dimensions in parenthesis are in inches, unless noted otherwise.
D. INSIDE CORNER DETAIL (NOTES 1, 2 AND 5)

NOTES:
1. S = ANCHOR SPACING; SEE RFIA1002 AND RFIA1004.
2. S = ANCHOR SPACING; SEE RFIA1005 AND RFIA1006.
3. ANCHOR PATTERN AND TINE ORIENTATION APPLY ONLY TO LONGHORN, FOOTED WAVY AND DOUBLEHOOK V AND Y, AND TWO-COMPONENT FOOTED ANCHORS.
4. ALL ANCHORS IN HERRINGBONE PATTERNS TO BE AT THE SAME ANGLE FROM THE EQUIPMENT AXIS.
5. CORNER ANCHOR TINES SHALL BE PERPENDICULAR TO EDGE.
6. IF ANGLE 9 is GREATER THAN 270°, CONSIDER PLACING AN ADDITIONAL ANCHOR ON CORNER.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. LINING DETAIL (NOTES 1 AND 2)

B. WELD DETAIL (NOTE 5)

C. ANCHOR SPACING (NOTES 3 AND 4)

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<td>75 63 150</td>
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NOTES:
1. T = LINING THICKNESS.
2. A = ANCHOR HEIGHT.
3. S = ANCHOR SPACING AT THE REFRACTORY HOT FACE.
4. REFER TO RFIA1001 FOR ANCHOR PATTERN AND TINE ORIENTATION.
5. ANCHOR TO BE PERPENDICULAR TO THE SHELL AFTER WELDING.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. LINING DETAIL

B. WELD DETAILS (NOTE 2)

C. STRAND END SPLICE DETAILS

1. REGULAR SPLICE DETAIL
2. ALTERNATE OVERLAP DETAIL

NOTES:
1. ORIENT STRANDS PERPENDICULAR TO FLOW SPACED 150 mm (6 INCHES) ON CENTER.
2. WELD ALL STRAND ENDS TO BACKING MATERIALS.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. LINING DETAILS (NOTES 1 AND 2)

REFRACTORY HOT FACE

(1) WAVY-V

(2) DOUBLEHOOLED-V

B. WELD DETAILS (NOTE 3)

(1) 6 (5/8) DIAMETER ROD

(2) 8 (3/8) DIAMETER ROD

C. ANCHOR SPACING (NOTE 4 AND 5)

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<td>125 5</td>
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NOTES:
1. T = LINING THICKNESS.
2. A = ANCHOR HEIGHT.
3. WELD OUTSIDE ONLY.
4. CENTER TO CENTER SPACING AT REFRACTORY HOT FACE IN OPERATING POSITION.
5. REFER TO RFIA1001 FOR ANCHOR PATTERN AND ORIENTATION.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. LINING DETAILS (NOTES 1 AND 2)

B. WELD DETAILS (NOTE 3)

C. ANCHOR SPACING (NOTE 4 AND 5)

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NOTES:
1. T = LINING THICKNESS.
2. A = ANCHOR HEIGHT.
3. WELD OUTSIDE ONLY.
4. CENTER TO CENTER SPACING AT REFRACTORY HOT FACE IN OPERATING POSITION.
5. REFER TO RFIA1001 FOR ANCHOR PATTERN AND TINE ORIENTATION.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESIS ARE IN INCHES. UNLESS NOTED OTHERWISE.
A. LINING DETAILS (NOTES 1, 2, 3 AND 8)

REFRACTORY HOT FACE

(1) WAVY-V

(2) DOUBLEHOOK-V

STEEL SHELL

B. WELD DETAILS (NOTE 7)

NOTE 6

(1) STRAIGHT STUD

(2) L-SHAPED STUD

C. ANCHOR SPACING (NOTE 4 AND 5)

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NOTES:
1. **T** = HOT FACE LINING THICKNESS.
2. **A** = HOT FACE ANCHOR HEIGHT.
3. **B** = BACKUP LINING THICKNESS.
4. CENTER TO CENTER SPACING AT REFRACTORY HOT FACE IN OPERATING POSITION.
5. REFER TO RFIA1001 FOR ANCHOR PATTERN AND TINE ORIENTATION.
6. ENSURE THE WELD DOES NOT CREATE AN UNVENTED (TRAPPED) VOID.
7. ANCHOR TO BE PERPENDICULAR TO THE SHELL AFTER WELDING.
8. STUD THREADS SHALL BE PROTECTED DURING BACKUP REFRACTORY INSTALLATION.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESIS ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. HEXMESH WELDING PATTERN

(1) WELDING DETAILS (SEE NOTE 3)

B. HEXMESH JOINT WELDING PATTERNS (NOTES 1 AND 2)

(1) EQUAL BUTT JOINT PARALLEL TO SIDES

(2) OFFSET BUTT JOINT PARALLEL TO SIDES

NOTE:
SEE PAGE 2 FOR NOTES

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE
B. HEXMESH JOINT WELDING PATTERNS (CONTINUED)

(3) EQUAL BUTT JOINT PARALLEL TO SIDES

(4) OFFSET BUTT JOINT PARALLEL TO SIDES

(5) JOINT TRANSVERSE TO SIDES (NOTE 5)

(6) JOINT TRANSVERSE TO ENDS (NOTE 5)

NOTES:

1. THE AREA OF IRREGULAR HEXMESH CELL SHALL BE BETWEEN ONE-HALF (0.5) AND ONE AND ONE-HALF (1.5) THE AREA OF THE REGULAR CELL.

2. THE MINIMUM DIMENSION OF IRREGULAR SHAPES SHALL BE 19 (¾).

3. OPTIONAL IS TO WELD EVERY HEX IN EVERY ROW.

4. PROVIDE WELDS IN EACH FULL OR PARTIAL CELL ADJACENT TO THE JOINT.

5. PROVIDE ADDITIONAL WELDS AS REQUIRED TO ENSURE IRREGULAR CELLS (INCLUDING FILLER STRIPS) AT TRANSVERSE JOINTS ARE WELL ATTACHED TO THE BASE METAL.

6. THE MINIMUM DIMENSION IS BETWEEN THE PROJECTING ENDS OF THE PARTIAL HEX CELLS.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESIS ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. HEXMESH WELDING PATTERN (NOTE 1)

1. WELDING DETAILS

- 3 (%) TYP
- 3 (%) TYP

- 100% ON 3 SIDES AS SHOWN (TYP)

- SHELL SIDE
  - 19 (3/4) DEEP HEX-CENTERED HOLES

- SHELL SIDE
  - 25 (1) DEEP HEX-OFFSET HOLES

(2) TAB DETAILS

(3) WELDING DETAIL WITH LANCES

B. HEXMESH JOINT WELDING PATTERNS (NOTES 2 AND 3)

1. EQUAL BUTT JOINT PARALLEL TO SIDES

2. OFFSET BUTT JOINT PARALLEL TO SIDES

NOTE:

SEE PAGE 2 FOR NOTES

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE

CAD FILENAME: RFIA1008_1.dwg
B. HEXMESH JOINT WELDING PATTERNS (CONTINUED)

(3) EQUAL BUTT JOINT PARALLEL TO SIDES

(4) OFFSET BUTT JOINT PARALLEL TO SIDES

(5) JOINT TRANSVERSE TO SIDES (NOTE 4)

(6) JOINT TRANSVERSE TO ENDS (NOTE 4)

NOTES:

1. THE FULL LENGTH OF EACH SIDE OF EACH CELL SHALL BE WELDED WITHIN THE CELL OR WITHIN THE NEIGHBORING CELL TO PREVENT FLOW BENEATH THE HEXMESH.
2. THE AREA OF IRREGULAR HEXMESH CELL SHALL BE BETWEEN ONE-HALF (0.5) AND ONE AND ONE-HALF (1.5) THE AREA OF THE REGULAR CELL.
3. THE MINIMUM DIMENSION OF IRREGULAR SHAPES SHALL BE 19 (¾). 
4. PROVIDE ADDITIONAL WELDS AS REQUIRED TO ENSURE EVERY SIDE OF IRREGULAR CELLS (INCLUDING FILLER STRIPS) AT TRANSVERSE JOINTS IS WELDED TO THE BASE METAL FOR ITS FULL LENGTH WITHIN THE CELL OR WITHIN A NEIGHBORING CELL.
5. THE MINIMUM DIMENSION IS BETWEEN THE PROJECTING ENDS OF THE PARTIAL HEX CELLS.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESIS ARE IN INCHES, UNLESS NOTED OTHERWISE.
WELD DETAIL

NOTES:
1. TIGHTLY ROLLED HEXMESH IS DEFINED AS HAVING AN INSIDE DIAMETER OF:
   a) LESS THAN OR EQUAL TO 300 (12) FOR HEXMESH 19 (¾) HIGH
   b) LESS THAN OR EQUAL TO 450 (18) FOR HEXMESH 25 (1) HIGH
2. COMPLETE THE WELD BEFORE FORMING/ROLLING HEXMESH.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.
LINING TRANSITION WELD DETAILS

1. STRAIGHT LINING TRANSITION

NOTE:
SEE PAGE 2 FOR NOTES

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.
LINING TRANSITION WELD DETAILS (CONTINUED)

ELEVATION

SECTION B-B

(2) TAPERED LINING TRANSITION

NOTE:
1. TYPES REFER TO RFSM1000, APPENDIX A

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESIS ARE IN INCHES, UNLESS NOTED OTHERWISE.

CAD FILENAME: RFIA1000_2.dwg
TYPICAL WELDING PATTERN

VIEW A-A (NOTES 1 AND 2)
(1) EXTERIOR OF CURVED SURFACE

VIEW B-B (NOTES 1 AND 2)
(2) INTERIOR OF CURVED SURFACE

NOTES:
1. WELDS AS SHOWN ARE FOR GENERAL SERVICE.
2. FLEXMESH SHALL NOT BE USED IN COKING, THERMAL CYCLING OR SEVERE ABRASION SERVICE.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.

CAD FILENAME: RFIA1011.dwg
A. CORNER TAB WELD DETAIL (NOTE 1)

B. VARIABLE TAB WELD DETAIL (NOTE 1)

C. U-TAB WELD DETAIL (NOTE 1)

NOTES:

1. TABS SHALL BE PERPENDICULAR TO STEEL SHELL SURFACES AFTER WELDING.
2. SPACE TABS AT:
   (a) 25 (1") MAXIMUM FOR 19 (3/4") TABS
   (b) 38 (11/2") MAXIMUM FOR 25 (1") TABS
   (c) MINIMUM SPACING = 19 (3/4")
3. ANCHOR SPACING IS AT REFRACTORY HOT FACE.
4. ENSURE THE WELD DOES NOT CREATE AN UNVENTED (TRAPPED) VOID.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.
RADIUS TAB WELD DETAIL (NOTE 1 AND 5)

NOTES:
1. TABS SHALL BE PERPENDICULAR TO STEEL SHELL SURFACES AFTER WELDING.
2. S = SPACE TABS AT:
   (a) 25 (1) MAXIMUM FOR 19 (¾) TABS
   (b) 38 (1¾) MAXIMUM FOR 25 (1) TABS
   (c) MINIMUM SPACING = 19 (¾)
3. ANCHOR SPACING IS AT REFRACTORY HOT FACE.
4. ENSURE THE WELD DOES NOT CREATE AN UNVENTED (TRAPPED) VOID.
5. PROVIDE RADIUS TABS IN 180° SEGMENTS.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.

CAD FILENAME: RFIA0103.dwg
MONSTER CORNER TAB WELD DETAILS

NOTES:
1. TABS SHALL BE PERPENDICULAR TO STEEL SHELL SURFACES AFTER WELDING.
2. SPACE TABS AT S=1.5T AT CLOSEST POINT BETWEEN ANCHORS (T=TOTAL LINING THICKNESS).
3. ANCHOR SPACING IS AT REFRACTORY HOT FACE.
4. ENSURE THE WELD DOES NOT CREATE AN UNVENTED (TRAPPED) VOID.
5. INSTALLATION OF V-ANCHORS SHALL BE PER DETAILS IN RFIA1004, RFIA1005 OR RFIA1006.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESIS ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. WELDING AND LINING DETAILS

3 (\%) 3 (\%) NOTE 2 AND 3
13 (\%) (TYP.)

67 (2\%) (REFERENCE)

BACKING

25 (1) (REFERENCE)

B. ANCHOR PATTERN AND SPACING (NOTE 4)

45 (1\%) 45 (1\%) 45 (1\%) 45 (1\%)

75 (\%) 75 (\%) 75 (\%) 75 (\%)

DIRECTION OF FLOW EXCEPT AS NOTED IN NOTE 1

25 (1) MAXIMUM TERMINATION BAR

NOTES:
1. ON PIPE LESS THAN OR EQUAL TO 100 (4) DIAMETER LOCATE ANCHORS AXIALLY TO PIPE.
2. START WELD AT CENTERLINE AND WELD TO THE EDGE.
3. ANCHOR SHALL BE PERPENDICULAR TO THE SHELL AFTER WELDING.
4. CENTER TO CENTER SPACING IS AT THE REFRACTORY HOT FACE.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESIS ARE IN INCHES, UNLESS NOTED OTHERWISE.

CAD FILENAME: RFIA1015.dwg
A. WELDING AND LINING DETAILS

B. ANCHOR PATTERN AND SPACING (NOTES 2, 3, 4 AND 7)

(1) ABRASION SERVICE
(ONE OR TWO-COMPONENT LINING)

(2) OTHER SERVICE
(ONE OR TWO-COMPONENT LINING)

NOTES:
1. ON PIPE LESS THAN OR EQUAL TO 300 (12) DIAMETER, LOCATE ANCHORS AXIALLY TO PIPE.
2. T = TOTAL LINING THICKNESS.
3. S = 50 (2) FOR T LESS THAN OR EQUAL TO 38 (1½).
   S = 75 (3) FOR T GREATER THAN 38 (1½).
4. WHEN USED IN A TWO-COMPONENT LINING, THE HOT FACE LAYER SHALL BE AT LEAST 38 (1½) THICK.
5. START WELD AT CENTERLINE AND WELD TO THE EDGE.
6. ANCHOR SHALL BE PERPENDICULAR TO THE SHELL AFTER WELDING.
7. CENTER TO CENTER SPACING IS AT THE REFRACTORY HOT FACE.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESIS ARE IN INCHES, UNLESS NOTED OTHERWISE.

CAD FILENAME: RFIA1016.dwg
LINING TRANSITION WELD DETAILS

NOTES:

1. TYPE-S ANCHOR HEIGHT TO VARY AS REQUIRED.
2. TYPE-S ANCHORS SHALL BE ORIENTED CIRCUMFERENTIALLY.
3. ANCHORS SHALL BE AT THE SPECIFIED ORIENTATION AFTER WELDING.
4. TYPES REFER TO RFM1001, APPENDIX A.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESIS ARE IN INCHES, UNLESS NOTED OTHERWISE.

CAD FILENAME: RFIA1017.dwg
A. WELDING DETAIL (NOTE 1)

B. ANCHOR PATTERN AND SPACING (NOTE 2)

NOTES:
1. ANCHORS SHALL BE PERPENDICULAR TO THE SHELL AFTER WELDING.
2. CENTER TO CENTER SPACING IS AT THE REFRACTORY HOT FACE.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. WELDING DETAIL (NOTES 1 AND 2)

![Diagram of welding detail](image)

B. ANCHOR PATTERN AND SPACING (NOTE 3)

![Diagram of anchor pattern and spacing](image)

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<td>OVERHEAD</td>
<td>83</td>
<td>3¼</td>
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<tr>
<td>PIPE (INNER)</td>
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<td>PIPE (OUTER)</td>
<td>HORIZONTAL OR VERTICAL</td>
<td>83</td>
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NOTES:
1. PARTIAL TYPE-T SHALL BE AT LEAST ½ OF FULL TYPE-T ANCHOR. WELD EACH END OF THE PARTIAL-T TO THE EDGING BAR.
2. ANCHORS SHALL BE PERPENDICULAR TO SHELL AFTER WELDING.
3. CENTER TO CENTER SPACING IS AT THE REFRACTORY HOT FACE.
4. ORIENTATION IS IN THE OPERATING POSITION.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESIS ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. WELDING DETAIL (NOTE 1)

![Diagram of welding detail]

3 (%)  13 (%)  3 (%)  13 (%)

NOTE 2

B. ANCHOR PATTERN AND SPACING (NOTE 3)

![Diagram of anchor pattern and spacing]

65 (2½)

TERMINATION BAR

38 (1½)

FLOW DIRECTION

32 (1¼)

NOTES:
1. ANCHORS SHALL BE PERPENDICULAR TO SHELL AFTER WELDING.
2. ENSURE THE WELD DOES NOT CREATE AN UNVENTED (TRAPPED) VOID.
3. CENTER TO CENTER SPACING IS AT THE REFRACTORY HOT FACE.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. WELDING DETAIL (NOTE 1)

B. ANCHOR PATTERN AND SPACING (NOTE 3)

NOTES:
1. ANCHORS SHALL BE PERPENDICULAR TO SHELL AFTER WELDING.
2. ENSURE THE WELD DOES NOT CREATE AN UNVENTED (TRAPPED) VOID.
3. CENTER TO CENTER SPACING IS AT THE REFRACTORY HOT FACE.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. WELDING DETAIL (NOTE 2)

(1) HEXCELL

(2) HALF HEXCELL (NOTE 1)

B. ANCHOR PATTERN AND SPACING (NOTE 3)

TERMINATION BAR

FLOW DIRECTION

NOTES:
1. HALF HEXCELLS TO BE LOCATED AT CORNERS AND WHERE NECESSARY TO FILL VOIDS.
2. ANCHORS TO BE PERPENDICULAR TO THE SHELL AFTER WELDING.
3. CENTER TO CENTER SPACING IS AT THE REFRACTORY HOT FACE.
4. IN COKEING SERVICE, WELD ONE SIDE OF EACH FACE.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. WELDING AND LINING THICKNESS DETAILS (NOTE 1)

B. ANCHOR PATTERN AND SPACING (NOTE 3)

NOTES:
1. $T =$ LINING THICKNESS.
2. ANCHOR SHALL BE PERPENDICULAR TO THE SHELL AFTER WELDING.
3. CENTER TO CENTER SPACING IS AT THE REFRACTORY HOT FACE.
4. ENSURE THE WELD DOES NOT CREATE AN UNVENTED (TRAPPED) VOID.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. WELDING DETAIL (NOTE 1)

B. ANCHOR PATTERN AND SPACING (NOTE 2 AND 3)

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</tr>
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<td>18</td>
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</tr>
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<td>13½</td>
<td>24</td>
<td>18</td>
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</tr>
<tr>
<td>18</td>
<td>24</td>
<td>24</td>
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NOTES:
1. T = TOTAL LINING THICKNESS WITH OR WITHOUT BACKUP.
2. X = ANCHOR SPACING, Y = ROW SPACING.
3. CENTER TO CENTER SPACING IS AT THE REFRACTORY HOT FACE.
4. IN THE OPERATING POSITION.
5. NA = NOT APPLICABLE.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. WELDING DETAIL (NOTES 1 AND 2)

B. CERAMIC ANCHOR PATTERN AND SPACING (NOTES 3 AND 4)

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<td>345</td>
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<td>460</td>
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NOTES:
1. T = HOT FACE LINING THICKNESS.
2. L = BACKUP LINING THICKNESS 75 (3) MAXIMUM.
3. X = ANCHOR SPACING, Y = ROW SPACING.
4. CENTER TO CENTER SPACING IS AT REFRACTORY HOT FACE.
5. IN OPERATING POSITION.
6. SHIELD IS TEMPORARY (CARDBOARD) TO COVER OPENING IN CERAMIC ANCHOR DURING INSTALLATION OF PLASTIC REFRACTORY.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.
NOTES:
1. \( T \) = HOT FACE LINING THICKNESS (BRICK OR PLASTIC REFRACTORY),
   \( L \) = BACKUP REFRACTORY THICKNESS.
2. SUPPORT RINGS SPACED AT APPROXIMATELY 1500 (60) APART VERTICALLY.
3. CUT KEYHOLE SLOTS FROM HOT EDGE TO \( \frac{3}{4} \) OF THE WAY TO THE SHELL.
   KEYHOLE SLOT WIDTH AND SPACING TO BE CALCULATED BASED UPON REQUIRED EXPANSION ALLOWANCE.
4. ENSURE THE WELD DOES NOT CREATE AN UNVENTED (TRAPPED) VOID.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. ANCHOR ASSEMBLY PLAN VIEW (NOTE 1)

(1) ANCHOR AND ACCESSORIES

(2) COMPLETE ANCHOR ASSEMBLY

B. WELDING AND LINING DETAIL (NOTE 1)

C. ANCHOR SPACING (NOTE 2)

NOTES:

1. T = HOT FACE LINING THICKNESS
   L = BACKUP LINING THICKNESS
2. CENTER TO CENTER SPACING IS AT THE REFRACTORY HOT FACE
3. ENSURE THE WELD DOES NOT CREATE AN UNVENTED (TRAPPED) VOID.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESIS ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. WELDING DETAIL (NOTE 1)

- **L**
- **T**
- **5 (\(\frac{3}{16}\))**

B. ANCHOR ASSEMBLY ISOMETRIC VIEW

**NOTES:**

1. **T**=HOT FACE THICKNESS
2. **L**=BACKUP LINING THICKNESS
3. DRIVE ANCHORS INTO IFB SURFACE AT APPROXIMATE CENTER OF THE BRICK WIDTH.
4. FIELD DRILL HOLE AND GROOVE FOR 1430°C (2600°F) IFB.
5. ENSURE THE WELD DOES NOT CREATE AN UNVENTED (TRAPPED) VOID.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. WELDING AND ANCHORING DETAILS FOR NORMAL OPERATING TEMPERATURE \( \leq 1095^\circ\text{C} \) (2000°F)

- (1.) PIN STUD AND CLIP WASHER
- (2.) COLLAPSIBLE PIN STUD & CLIP WASHER
- (3.) THREADED STUD AND NUT-WASHER

B. WELDING AND ANCHORING DETAILS FOR NORMAL OPERATING TEMPERATURE \( >1095^\circ\text{C} \) (2000°F)

- REFRACTORILY HOT FACE
- HOT FACE BLANKET LAYER (TYPICAL)
- PIN STUD
- STEEL SHELL
- PIN STUD AND CERAMIC CUPLOCK WASHER

NOTE:

SEE PAGE 2 FOR NOTES

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.

CAD FILENAME: RFIA1029_1.dwg
C. ANCHOR LAYOUT AND SPACING (NOTES 1 AND 2)

NOTES:

1. ANCHOR LAYOUT AND SPACING DIMENSIONS ARE BASED UPON 610 (24) BLANKET.
2. S=300 (12) ON SIDE WALLS.
   S=250 (10) ON ARCH AND OVERHEAD UP TO 980°C (1800°F).
   S=230 (9) ON ARCH AND OVERHEAD ABOVE 980°C (1800°F).
3. ENSURE THE WELD DOES NOT CREATE AN UNVENTED (TRAPPED) VOID.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES, UNLESS NOTED OTHERWISE.
A. WELDING DETAILS

(1) STRAIGHT STUD

(2) L-SHAPED STUD

B. ANCHOR LAYOUT AND SPACING (NOTES 1 AND 2)

NOTES:
1. ANCHOR LAYOUT AND SPACING DIMENSIONS ARE FOR HOT FACE BOARD LAYER AND ARE BASED UPON 610 (24) BOARD WIDTH.
2. S=300 (12) ON SIDE WALLS
   S=250 (10) ON ARCH AND OVERHEAD UP TO 980°C (1800°F)
   S=230 (9) ON ARCH AND OVERHEAD ABOVE 980°C (1800°F)
3. ENSURE THE WELD DOES NOT CREATE AN UNVENTED (TRAPPED) VOID.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESIS ARE IN INCHES, UNLESS NOTED OTHERWISE
A. WELDING DETAIL

B. ANCHOR LAYOUT AND SPACING (NOTES 1 AND 2)

NOTES:
1. ANCHOR LAYOUT AND SPACING DIMENSIONS ARE BASED UPON 610 (24) BLANKET.
2. S=300 (12) ON SIDE WALLS.
   S=230 (9) ON ARCH AND OVERHEAD.
3. ENSURE THE WELD DOES NOT CREATE AN UNVENTED (TRAPPED) VOID.

DIMENSIONS ARE GIVEN IN MILLIMETERS. DIMENSIONS IN PARENTHESIS ARE IN INCHES, UNLESS NOTED OTHERWISE.

CAD FILENAME: RFIA1031.dwg
ANCHOR WELDING DETAILS (NOTES 1 AND 2)

(1) STRAIGHT STUD
(2) L-SHAPED STUD
(3) STUD WITH PLATE

NOTES:

1. THREADED STUD IS FOR USE WITH MANUFACTURER'S PROPRIETARY CERAMIC FIBER MODULE ANCHOR SYSTEM.
2. STUD TO BE SUPPLIED BY MODULE MANUFACTURER.
3. ENSURE THE WELD DOES NOT CREATE AN UNVENTED (TRAPPED) VOID.