# PENETRATION SEALS – TERMINOLOGY & FEATURES

## I. Definitions of:

| | |
|---|---|
| Penetration | Guide posts, hangers, thermowells, radiant tubes, inlet and outlet tubes, manifolds, etc. which pass through openings in refractory lined roofs, walls or floors of high temperature enclosures. |
| Penetration Seal | A static or dynamic, internal or external assembly which closes the opening around the penetration to restrict the passage of air, water or heat. |
| Static Seal | The sealing device is stationary relative to the member it is sealing against; relative movement results. |
| Dynamic Seal | The sealing device is clamped to the member it is sealing against, and moves with it. |
| Internal Seal | The sealing device is located inside the steel casing, exposed to the internal operating temperature. |
| External Seal | The sealing device is outside the casing, exposed to external ambient conditions. |
| Individual Seal | Each penetrating member passes through an individual opening in the refractory and/or casing. |
| Ganged Seal | Multiple penetrating members passing through one large opening in the refractory and/or casing. |

## II. A penetration seal provides one or more of the following functions:

- Restrict the influx of ambient air. (negative pressure)
- Restrict the egress of hot gases. (positive pressure)
- Exclude rain water.
- Block the loss of radiant heat through the opening around a penetration.
- Insulate external portions of hot tubes.
- Internal insulation for external steel.
- Allow penetrating member to move freely from cold to hot position.
- Provide for comfort and safety of personnel by reducing heat loss into confined workspaces.
- Allow access for maintenance purposes.

- Increase operating efficiency by creating a tighter heat enclosure.
- Proper operation of low NOx burners by minimizing ingress of ambient air.

## III. Common practice – Static, internal seals

- Rigid materials (castable, brick, RCF board, block insulation, etc.) are typically cut to match the opening in the casing. Problems which often occur include:

  - The resulting gap between the penetrating member and the opening may be filled with more resilient material (RCF rope, blanket, and bulk). If there is much movement these materials are blown or sucked out of the seal.
  - Rigid materials may crack and break up due to stresses caused by movement.
  - Special vacuum formed shapes which fit tightly around penetrations become brittle, crack and fall out in pieces.

- Resilient materials (layered blanket, modules, etc.) may be cut to fit tightly against the penetrating member. Problems which often occur include:

  - Movement enlarges the hole in the seal material.
  - Extreme lateral movement can strip modules off of their supporting hardware.
  - Static internal seals may provide adequate insulation of the casing, but rarely are effective in restricting air flow or heat loss through the opening around the penetration.

## IV. Common Practice – Dynamic, external seals

- High temperature textile fabrics (fiberglass, leached silica, RCF or Nextel) may be specified as roll goods, for field fabrication by installer. Fabrication information is normally too general. Problems which often occur include:

  - Insufficient allowance for movement stretches fabric too tight and it tears.
  - Improper installation and poor fit exposes exterior seal fabric to direct radiant heat which may cause fabric to overheat, shrink and become brittle.
  - Lacking machine stitched and hemmed edges, the cut edges and seams in field fabricated textile seals lack strength; fraying occurs, appearance is poor and sealing is compromised.
  - Field fabricated items require more time and labor cost to install.
  - Insufficient attention to detail on installation instructions requires installer to do a lot of "field engineering" which he may not be capable of doing properly.

- Dynamic external seals provide a more positive air and radiant heat seal but often have poor performance and longevity when supplied in roll goods form for field fabrication.

## V. Thorpe HOTSEAL™ Penetration Seals – Features

- Custom engineered design.
- Designs based on many years of proven performance and experience.
- Composites of various resilient insulating and textile materials are used to provide a positive dynamic seal.
- Shop fabricated from detailed fabrication drawings.
- Machine sewn edges, hems, seams.
- Detailed installation drawing provided.
- Field measurement, design consultation and installation supervision available as required.

## VI. Thorpe HOTSEAL™ Penetration Seals – Benefits

HOTSEAL™ dynamic penetration seals provide more positive air and radiant heat seal.

- Reduced cold air influx when furnace pressure is negative.
    - Flue gas temperature entering convection section is maintained for maximum efficiency.
    - Less load on induced draft fans.
    - Temperature differentials and subsequent thermally induced stresses on welds, hangers, and tubes, near penetrations, are reduced.
    - Reducing secondary air allows better control and more accurate adjustment of combustion equipment for more efficient combustion and lower NOx operation.
- Reduced hot gases escaping around penetrations when furnace pressure is positive.
    - Reduced heat loss/improved operating efficiency.
    - Reduced external ambient temperature around penetrations, improving comfort and safety of personnel.
    - Prevents overheating of external steel, cables, or equipment in close proximity to penetration.
- Reduced radiant heat loss through openings.
    - Reduced heat loss/improved operating efficiency.
    - Reduced ambient temperature around penetrations.

HOTSEAL™ penetration seals are custom engineered.

- Detailed design consideration to determine what type of seal (static, dynamic, internal, external, ganged, or individual, etc.) is best suited to the customer's needs.
- Optimum material selection from a wide variety of high temperature textile fabrics and refractory fiber insulation.
- Full scale mock-ups are used if necessary to determine adequate allowance for movement, and work out installation difficulties in advance.
- Design of the seal is integrated with the existing refractory or a new Z-Blok® module lining.
- Thorough design and engineering reduces installation time and labor expense.
- Detailed installation drawings and instructions provided.
- Eliminates "field engineering" by installer.
- Detailed fabrication drawings are kept on file for expediting maintenance replacements.

HOTSEAL™ penetration seals are shop fabricated.

- Quality of fabrication is controllable.
- All textile fabric edges, hems, seams, etc. are machine sewn to eliminate field cutting and subsequent fraying.
- "Store bought" appearance.
- Reduces field labor time and expense.