PROVIDING THE BEST COMBUSTION SOLUTIONS AND EQUIPMENT IN THE WORLD

R-V INDUSTRIES INC.

POWER GENERATION EQUIPMENT

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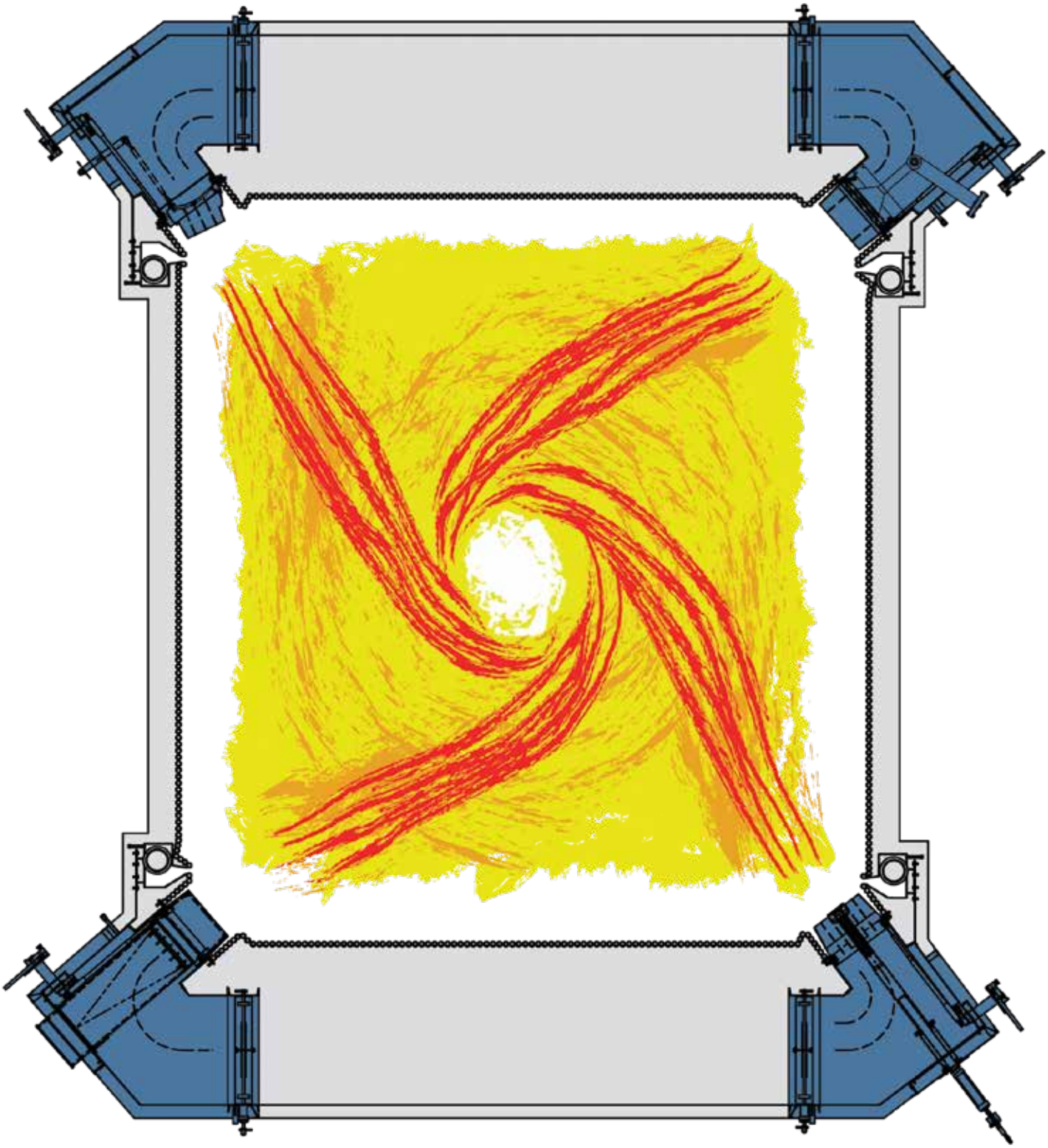

Coal Compartments

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TANGENTIAL EQUIPMENT OFFERING

SOFA Windboxes

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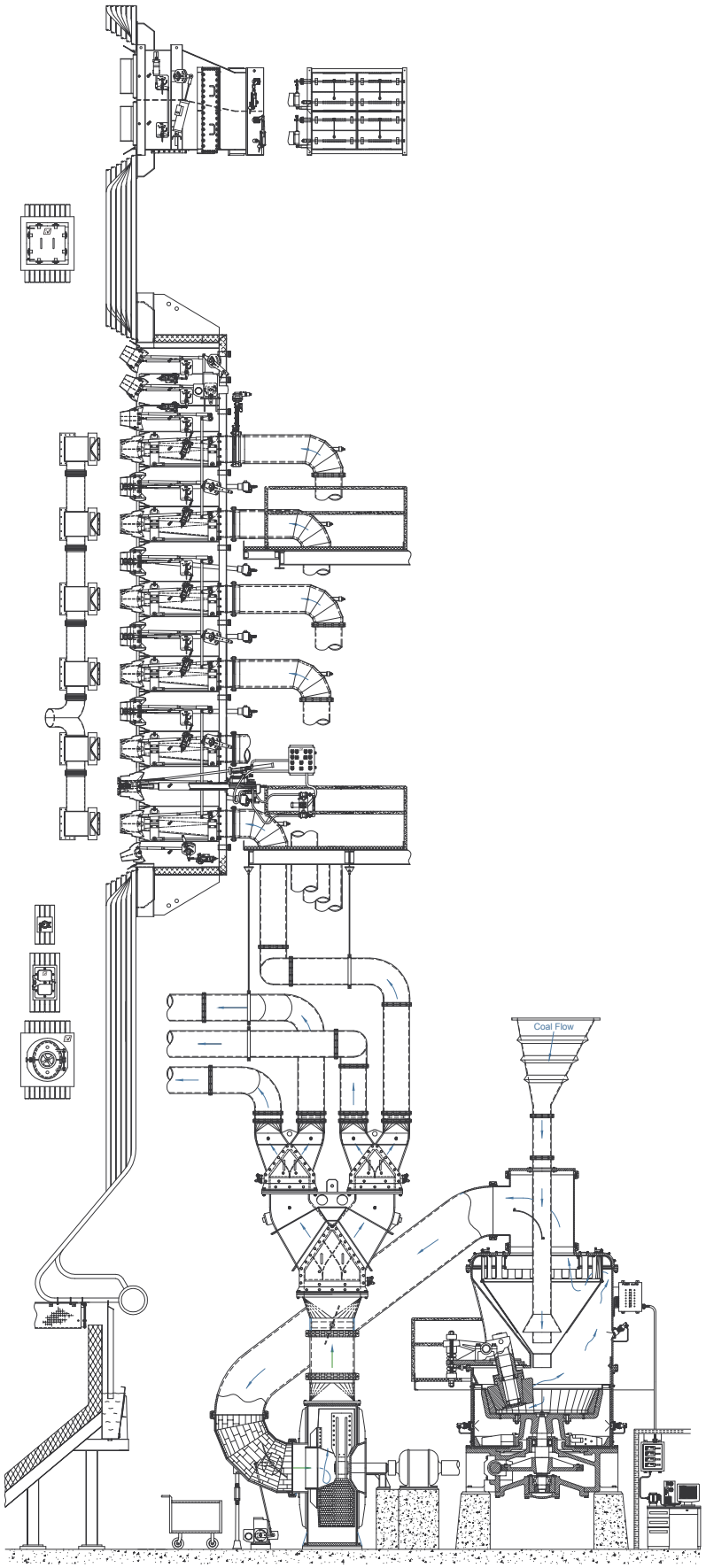
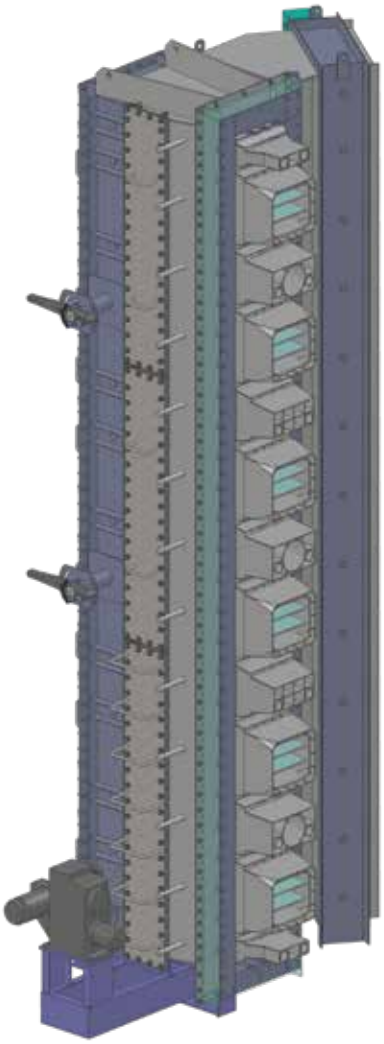




ENGINEERING AND DESIGN

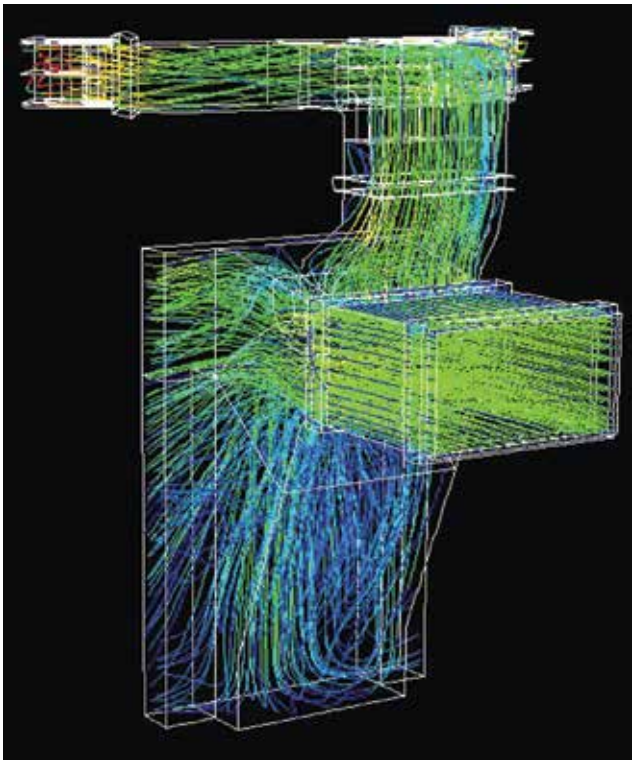
R-V engineers and manufactures our firing system equipment in our company headquarters in southeastern Pennsylvania. All firing systems are designed with the latest materials and components for long-term reliability. Combined with an engineering partner, we offer:

- Power plant design engineers
- Complete boiler house engineering
- Controls engineering
- Metallurgical and manufacturing engineers
- Software capabilities
  - Solidworks
  - AutoCAD
  - Finite element analysis
  - CFD modeling
- Project management
- Combustion engineering and consultation

PERFORMANCE EVALUATIONS AND RECOMMENDATIONS

By utilizing Finite Element Analysis testing and years of firing system experience, R-V can provide customized solutions to

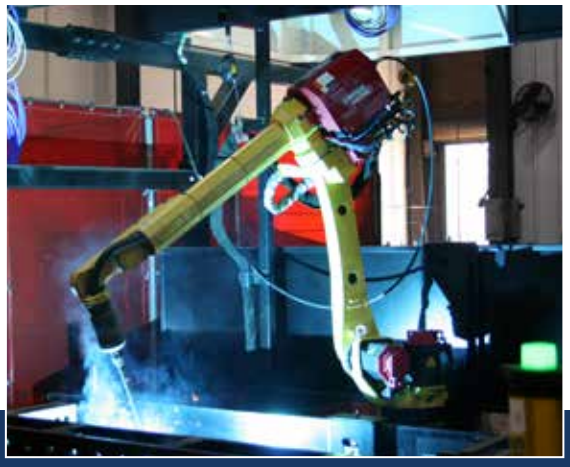
- Coal pipe overloading
- Fuel change effects
- Windbox resizing for air flow issues
- Damper upgrades
- Nozzle tip pluggage and overheating



IN-HOUSE MANUFACTURING

R-V's manufacturing team has decades of experience fabricating power plant equipment. While specializing in customized equipment, our nozzle bay was created to create an efficient and highly skilled group for nozzle tip manufacturing.

All power equipment is manufactured in our corporate headquarters, which allows for efficient teamwork between our sales, engineering, manufacturing, and quality teams. This allows us to create the best combustion systems and equipment in the world.



AUTOMATED MANUFACTURING EXCELLENCE

DEDICATED NOZZLE MANUFACTURING TEAM

CERTIFIED EQUIPMENT AND PROCESSES

Our fleet of weld equipment boasts the latest equipment from Miller, Lincon, and Tip Tig. In addition, our investment into the future of automated and semi-automated welding processes has led us to acquiring our own robotic welding and k-tig equipment.

Welding Processes

- Manual and Semi-Automatic
- Mechanized Welding
- Automated Welding

Material List

- 309 S/S
- 310 S/S
- RA-253MA
- 316 S/S
- AL6XN
- Alloy 20
- Inconel 625

REGISTER MANUFACTURING FOR A WALL-FIRED BURNER PROJECT

ASSEMBLIES FOR MANY FUEL TYPES

R-V designs and manufactures complete windbox assemblies for coal, oil, and gas-fired tangential furnaces. Our expertise includes both mechanical and performance design. New windboxes are fitted with the latest components for emission control and long term reliability.

SEPARATED OVERFIRE AIR WINDBOXES WITH DIRECTIONAL AIR CONTROL ARE AVAILABLE WITH AUTOMATIC REMOTE ADJUSTMENT OF VERTICAL TILT AND HORIZONTAL YAW.

REPLACEMENT WINDBOX FOR A 450-MW OIL-FIRED UNIT

REPLACEMENT
COAL-FIRED WINDBOX

NOZZLE DISTORTION IS A CHRONIC INDUSTRY PROBLEM

R-V's Thermal Guard® nozzle tips have become the dominant design in the industry for service longevity.

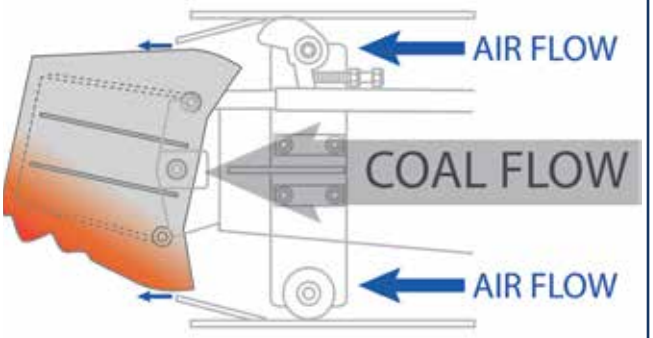
Typical OEM Design: tilting the nozzle tip exposes the outer plate to extreme temperature differential between the inside and outside of the shrouds, causing thermal distortion.

Thermal Guard® Series I: design directs a high velocity stream of air over exposed surfaces, increasing radiation protection as tips are tilted, reducing the temperature gradient across plates.

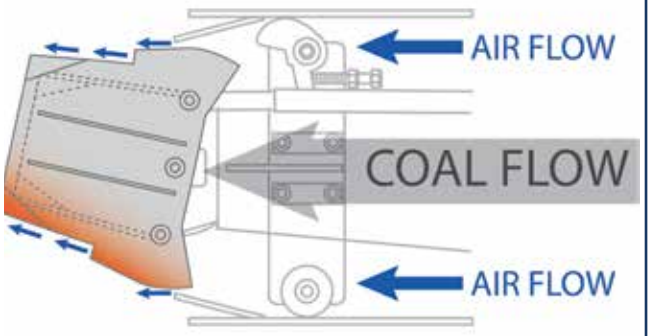
Thermal Guard® Series II: provides additional radiation protection. As tips are tilted, the patented film cooling feature further reduces the temperature gradient across the exposed plate and helps reduce slag deposition. It is particularly suited for the more severe duty of upper burner levels.

Thermal Guard® Series II Plus: Reduces splitter plate distortion.

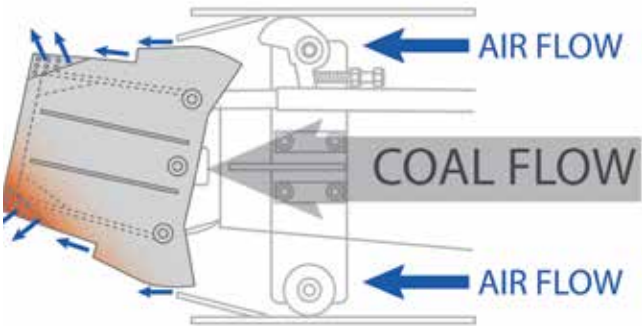
OEM Design



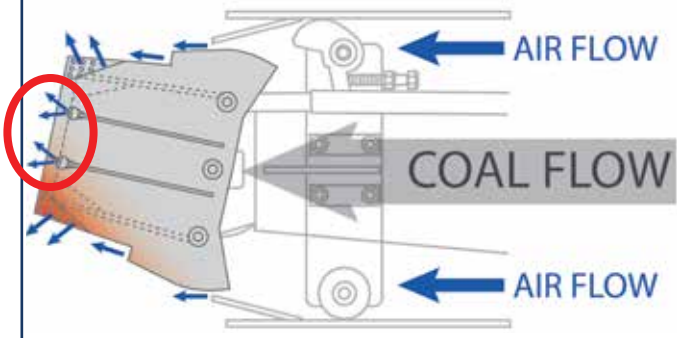
Thermal Guard® Series I



Thermal Guard® Series II



Thermal Guard® Series II Plus

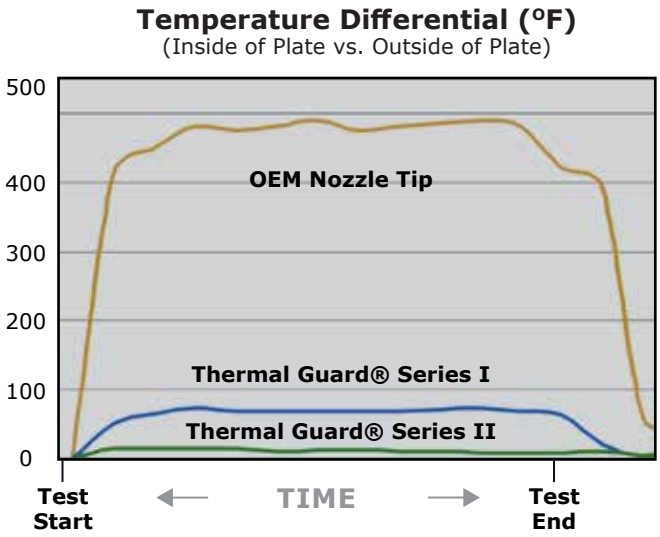


THERMAL GUARD® COMPARISON TESTING

To establish the effectiveness of the Thermal Guard® Series I and II nozzle tip designs compared to other brands, thermocouples were installed on the inside and outside of the top plate to measure the temperature gradients.

The Thermal Guard® Series I and II repeatedly showed lower temperature gradients across the outer plate, reducing thermal distortion.

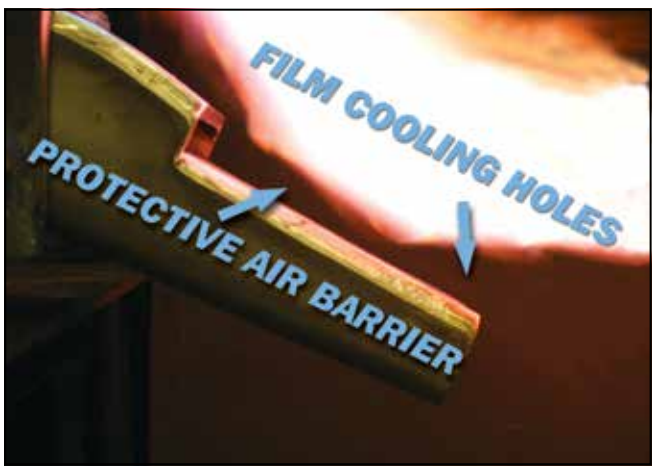
OEM DESIGN - CAUSES A DISTORTION PROBLEM



Test Conditions

Nozzle Tilt: -15 Deg. • Air Temp: 80°F
Windbox Pressure: 2.0 in. wg. • Equal Heat Input

THERMAL GUARD® SERIES I



THERMAL GUARD® SERIES II

SERIES I

The R-V Industries proprietary self-cooling Thermal Guard® Series I design extends performance life of tangential coal and air nozzle tips.

1. Aerodynamic thermal radiation barrier
2. Contoured corners
3. Various erosion protection options
4. Pivot pin design available for furnace side removal
5. Solidly welded inner annulus assures rigidity
6. Shielded corner welds

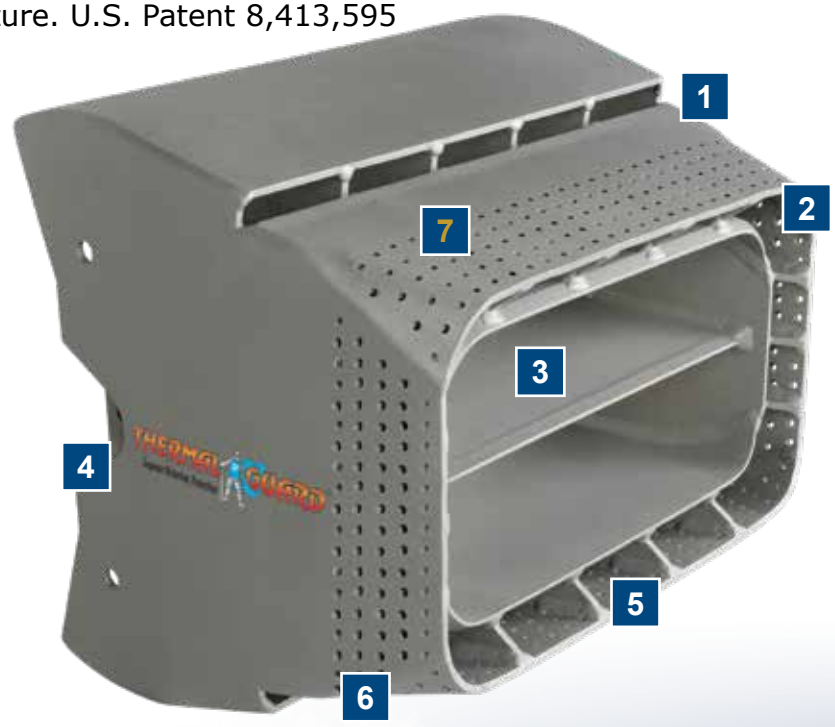
OEM Design after 1 Year

Thermal Guard I After 1 Year

SERIES II

Thermal Guard® Series II was developed for more severe duty applications such as upper elevations which are first out and last in service and hot corners. It has also become our most popular tip series for clients looking to extend the service life of all their coal and air nozzle tips. It features all of the design features of the Series I, while incorporating the additional patented film cooling feature. U.S. Patent 8,413,595

1. Aerodynamic thermal radiation barrier
2. Contoured corners
3. Various erosion protection options
4. Pivot pin design available for furnace side removal
5. Solidly welded inner annulus assures rigidity.
6. Shielded corner welds
7. Additional ported film cooling system



OEM Design after 1 Year

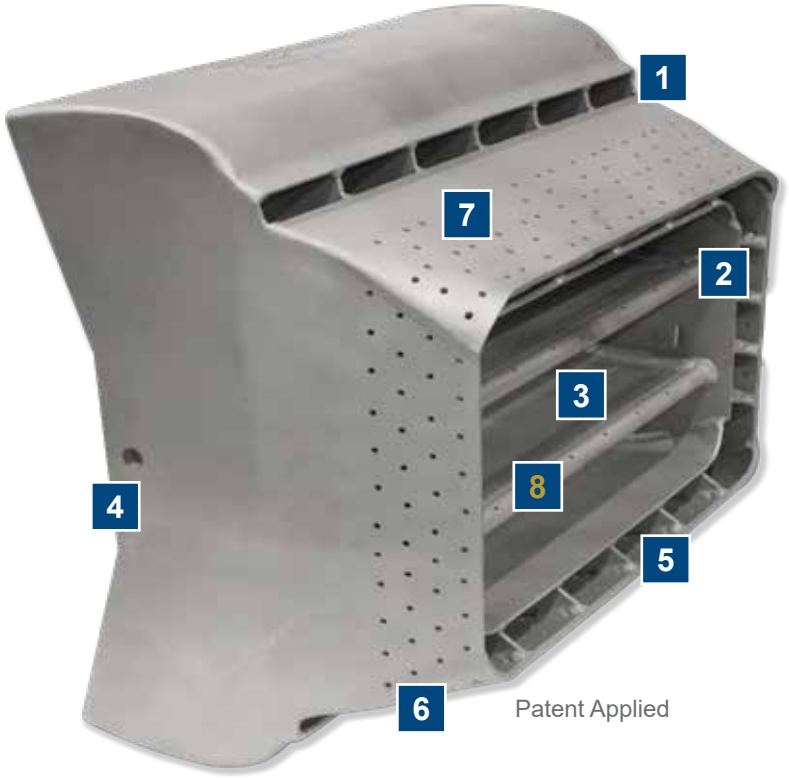
Thermal Guard II After 1 Year

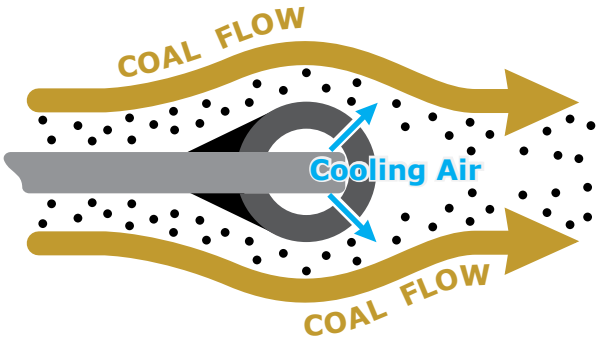
After a one-year side by side comparison test the TGII tips exhibited significantly less distortion and slag deposition than the OEM tips.

SERIES II PLUS

The Thermal Guard® Series II PLUS features an aerodynamically reinforced splitter plate with direct air cooling to reduce splitter plate overheating distortion providing full frontal thermal protection.

1. Aerodynamic thermal radiation barrier
2. Contoured corners
3. Various erosion protection options
4. Pivot pin design available for furnace side removal
5. Solidly welded inner annulus assures rigidity
6. Shielded corner welds
7. Additional ported film cooling system
8. Aerodynamic splitter plate stiffener with direct cooling air.





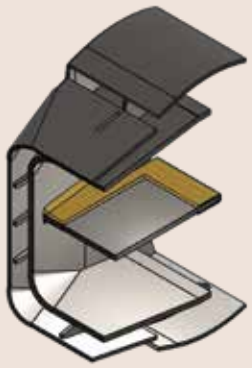
Aerodynamic Splitter Plate Stiffener

Splitter plate distortion is another chronic problem common to coal nozzle tips.

WELD OVERLAY OPTIONS

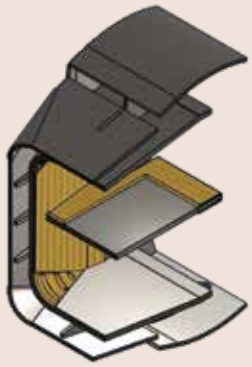
R-V's Thermal Guard® coal nozzle tips are available with optional features to increase nozzle longevity. A variety of high chrome weld overlay options are used to protect the splitter plates and inner annulus. Custom overlay options are also available to provide the best protection based on customer wear experience and firing tilt angle.

BASE



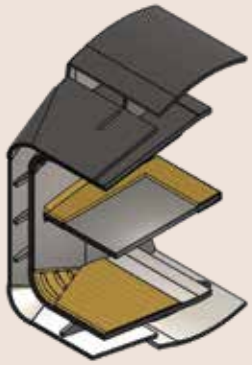
Leading Edge and Partial Sides

OPTION 'A'



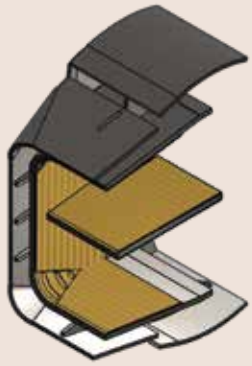
Inner Annulus Sides, Corners and Partial Plate

OPTION 'B'



Inner Annulus Top, Bottom, Corners and Partial Plate

OPTION 'C'



Full Inner Annulus and Splitter Plate

THERMAL GUARD® HEAVY DUTY

Overlay options can be combined with HEAVY DUTY splitter plates and inner annulus to extend nozzle useful service life. For extreme conditions, the Thermal Guard® Heavy Duty Nozzle provides the air barrier and film cooling protection of the Thermal Guard® Series II Nozzle with a more robust plate material.

Typical fillet weld on nozzle tips.

R-V's optional "Full Penetration" weld detail.

INCREASED WELD STRENGTH

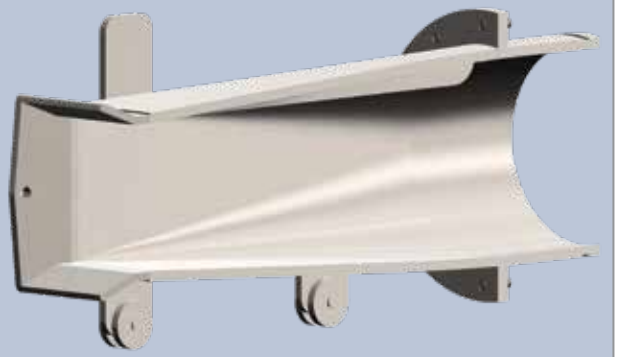
R-V offers the optional 'Full Penetration" weld design for air, gas, oil and coal nozzle tips for increased weld strength under high temperature applications.

STATIONARY COAL NOZZLES

Our stationary coal nozzles are cast or fabricated to the highest quality standards. When compared to cast nozzles, our wear options provide superior long-term protection against coal flow erosion. All coal nozzles are specifically designed or validated to match coal characteristics and pulverizer primary air flow. Complete coal nozzle assemblies with coal nozzle tips and numerous support bracket designs are available and pre-assembled to reduce installation manhours.

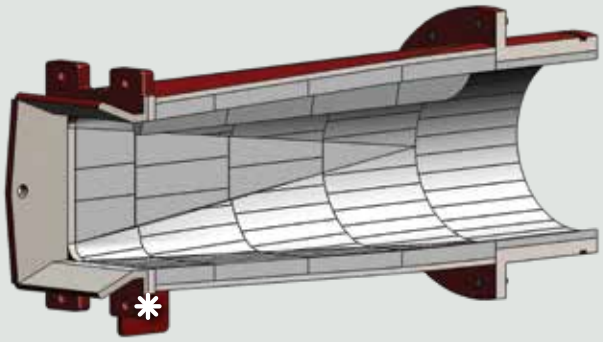
Original Equipment - Cast

Cast from 65-45-12 grade ductile iron.



Ceramic-Lined

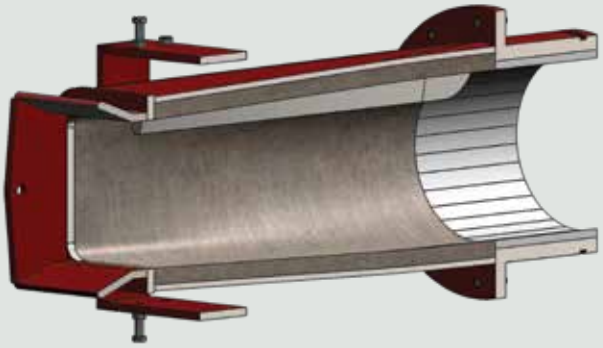
Fabricated steel shell with pre-engineered high alumina ceramic tile lining.



✱ **2-piece design allows choke point replacement**

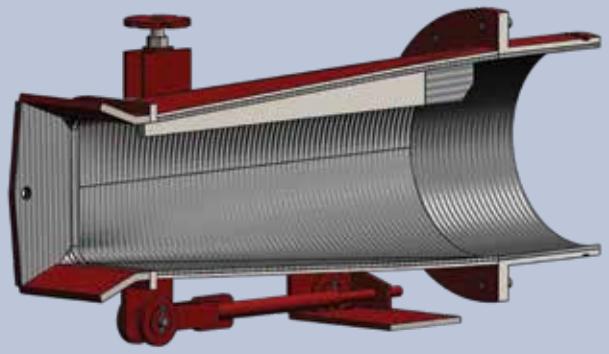
Ceramic and Refractory Lined

Fabricated steel shell with ceramic tile lining in the inlet and high alumina rammable refractory through the transition.



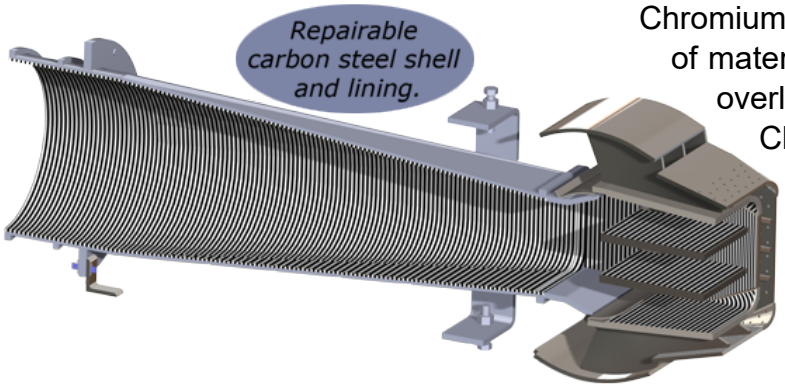
Chromium Carbide Lined

Chromium carbide weld overlay lining on a steel shell throughout the inlet, transition and sides of the discharge throat. Weld overlay is easily repairable.



CHROMIUM CARBIDE WELD OVERLAY LINED COAL NOZZLES

Our most popular design is the chromium carbide weld overlay lined stationary coal nozzle. The coal nozzle is fabricated from chromium carbide weld overlay on carbon steel base plate. When wear does occur, it can be easily repaired by plant personnel by simply laying chromium carbide weld overlay on top of the worn area. Unlike cast stationary coal nozzles, the outer carbon steel shell can also be repaired using 7018 weld rod. Our designs maintain the existing nozzle ID and do not require any modifications to the burner front for installation.



Chromium carbide weld overlay can be applied to a variety of materials including carbon and stainless steel. Typical overlay hardness ranges from 52 to 64 Rockwell C. Chromium carbide lined equipment has a long, successful history of abrasion resistance in the mining and power industries. Based on the abrasive climate and temperature of the nozzle internals, chromium carbide weld overlay is an excellent choice for the lining of a stationary coal nozzle.

CHROMIUM CARBIDE NOZZLE WITH THERMAL GUARD® II TIP (*ABOVE*)
VIEW OF CHROMIUM CARBIDE LINING (*RIGHT*)

Many tangential and wall fired systems, especially older low NO_X retrofits, are oversized. Specifically, the nozzles, registers and dampers are commonly too large. The common symptoms are:

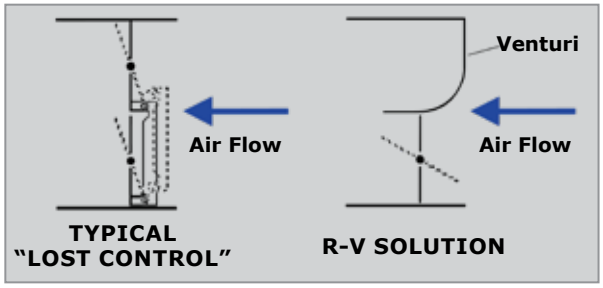
- Low windbox air pressure
- Low nozzle exit velocities resulting in poor fuel air mixing
- Air dampers are closed at all loads to maintain windbox pressure
- Loss of air distribution control between windboxes and burners
- Reduced nozzle tip and register service life
- Localized slagging and nozzle/register pluggage
- High CO levels
- Uneven furnace gas temperature and emission profiles

NOZZLE PLUGGAGE

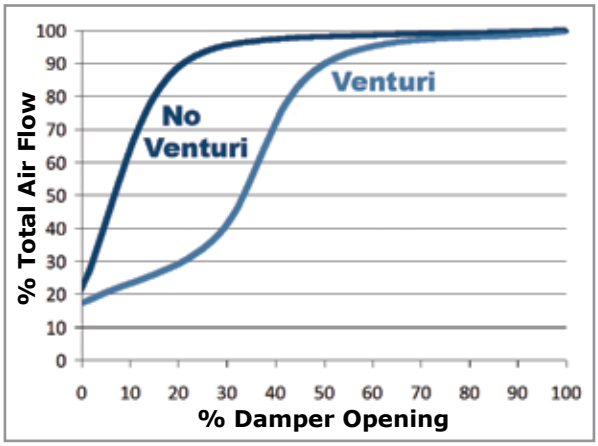
DAMPER VENTURI INSERTS

Installation of damper venturis resize the tangential windbox dampers to:

- Restore windbox and furnace DP control over greater unit load range
- Operate in control range



- Reduce NO_X and CO on overfire air based combustion systems
- Improve nozzle tip cooling and life
- Increase hot air and PA flow to exhauster mills, particularly RPS mills
- Better control of flame stability at low loads

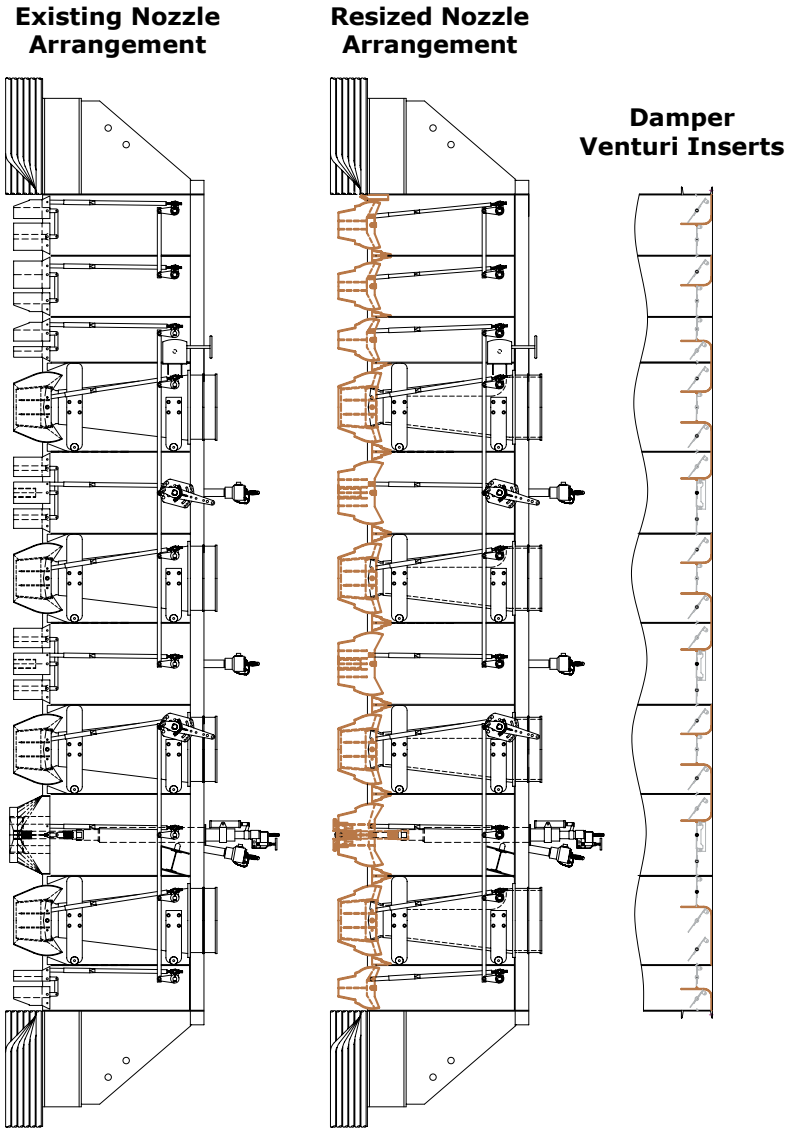


VENTURI INSERTS PROVIDE BETTER AIR FLOW CONTROL ACROSS THE DAMPER OPENING RANGE

NOZZLE TIP RESIZING

R-V's engineers evaluate and determine the appropriate nozzle tip free area requirements to resize the firing system. The ideal time for resizing is with a major nozzle tip replacement. ***Windbox computer modeling is used to resize nozzle tips***. Benefits include:

- Increased air velocity and fuel/air mixing
- Cooler running nozzle tips for longer service life
- Reduced number of tips and styles simplifying tilt linkage and maintenance
- Complements damper venturi inserts
- Improved windbox pressure control across load range
- Improved air flow control and reduced emissions
- Better control of flame stability at low loads

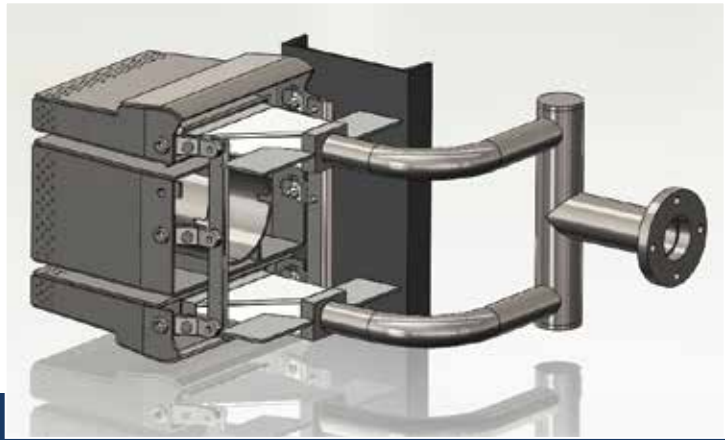


CONVERTING TO NATURAL GAS

While the natural gas supplies increase and clean air restrictions become more stringent, an increasing number of plants are converting or adding natural gas firing. Benefits include:

- Reduced fuel cost
- Emission reduction
- Reduced maintenance cost
- Easily adapted to existing units

R-V will design and manufacture the new natural gas firing system for your unit. In addition, we can package the scanners, side ignitors, valve train and control modifications required for your new gas firing system.



TYPICAL R-V GAS COMPARTMENT ARRANGEMENT WITH FIXED GAS SPUDS AND TILTING NOZZLE TIPS

COAL SWITCHING

Contemplating switching to a different type of coal? Give us a call. Our firing system experts can explain the ramifications of switching coal types and recommend the best system solutions for any type of coal.

HAVE A QUESTION?

WE OFFER FREE CONSULTATIONS
TO REVIEW FUEL SPECIFICATIONS

CALL: 610.273.2457

SOLUTIONS FOR HIGH SULFUR COAL FIRING

Boilers that fire high sulfur coal, regardless of the firing system, are more prone to burner slagging, pluggage and windbox fires. Have you experienced some of the operational problems listed below?

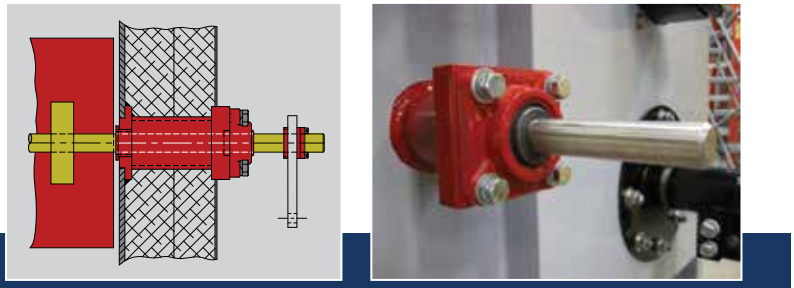
- Burner pluggage, overheating and nozzle distortion
- Coal nozzle and windbox fires
- Tilt linkage problems
- Poor emission control
- High maintenance costs
- Increased LOI

TYPICAL NOZZLE DAMAGE WHEN FIRING HIGH SULFUR COALS

GRAPHITE DAMPER BEARINGS

R-V's self-aligning graphite damper bearing upgrade restores dependable air flow and emission control by replacing the original rigid windbox bearings.

- Self-aligning graphite damper bearings compensate for damper misalignment and any windbox thermal distortion
- Available as a modular retrofit kit to simplify installation
- Allows damper drives to be set further from the hot windbox
- Available for parallel or opposed damper blade arrangements
- New stainless steel shafts are properly extended, when required, to reduce damper positioner overheating



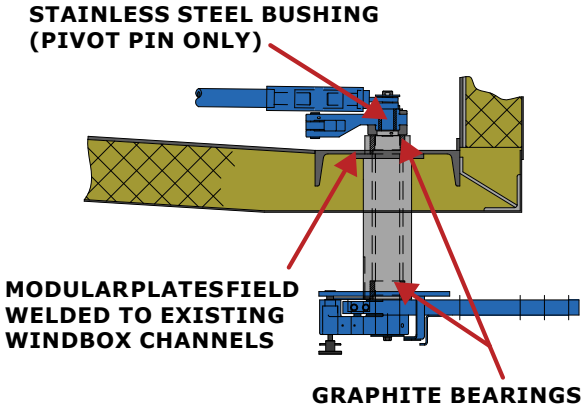
SELF-ALIGNING GRAPHITE BEARINGS

OPPOSED DAMPER BLADE DESIGN

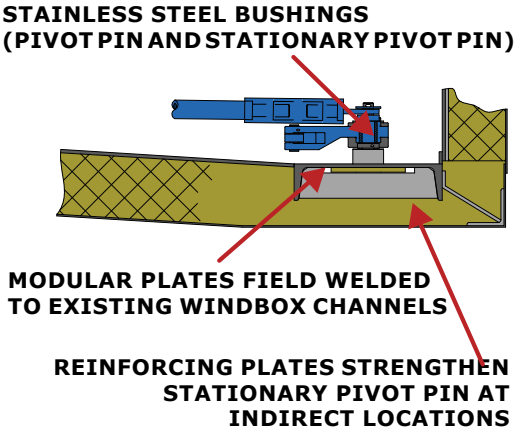
TILT MECHANISM UPGRADE

Reliable nozzle tilts assure long term emission and efficiency control. At the heart of the R-V design are stainless steel bushings and graphite bearings. Each tilt upgrade is available in a modular kit form. Components are shop assembled and aligned assuring a smooth, accurate field installation. Each upgrade includes all necessary components, installation instructions and drawings for a successful system overhaul.

DIRECT DRIVE ASSEMBLY



INDIRECT DRIVE ASSEMBLY



EQUIPMENT AND REPLACEMENT PARTS

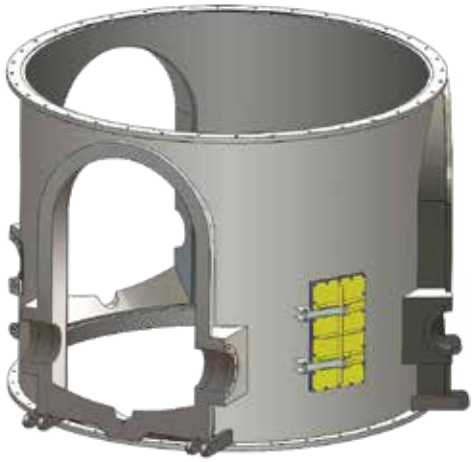
R-V provides a variety of components for the bowl mill design which are listed below:

- Bowl Extension Rings
- Clamping Rings
- Cones and Classifiers
- Convertor Heads, Covers and Vanes
- Journal Shafts
- Main Vertical Shafts
- Mill Bodies and Parts
- Pyrite Access Door
- Upper Mill Body Access Door
- Upper and Lower Journal Housings
- Fan Spiders and Blades

PULVERIZER ACCESS DOORS

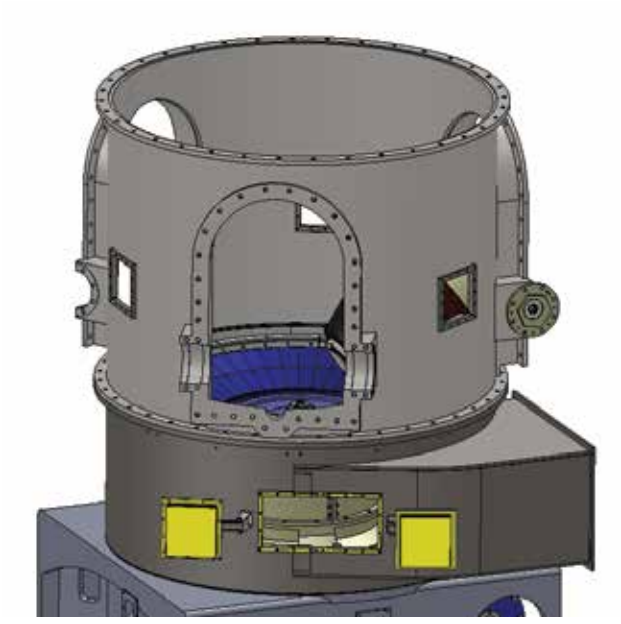
R-V's larger access door is designed to replace smaller existing doors by providing:

- Access to inside of the mill without the need to remove the journal
- Inspect and complete minor repairs on the bowl, journal and vane wheel
- Hinge design meets NFPA pressure requirements
- Custom engineered sizes available



PYRITE ACCESS DOORS

R-V's pyrite access door is a barn-style double-hinged design. It provides access to the pyrite area of the mill for scraper and main shaft seal inspection and repair.

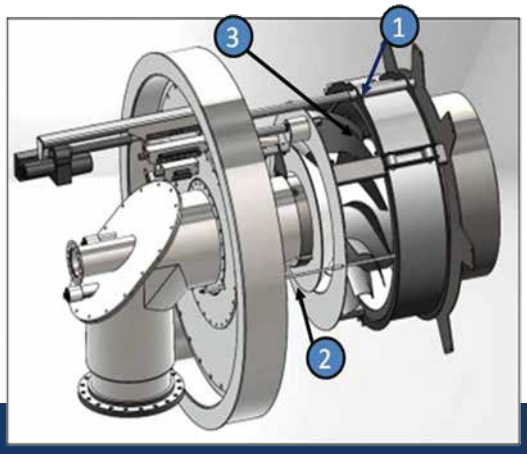


MODULAR REPLACEMENT AIR REGISTERS

Long term component overheating and mechanical binding of wall fired registers is a significant cause of increased emissions and decreased firing system performance. To restore performance and control R-V Industries offers a low NOx air register that will fit over most existing low NOx coal nozzles.

The register's modular design is also very compact to fit into tight boiler houses and/or windboxes, thereby reducing both retrofit time and costs. In addition, this register can be used as a long term repair solution for individual severely damaged burners.

R-V's workhorse air register has only (3) key moving parts and is loaded with many innovative features for long term combustion system performance control and reliability. Its design combined with R-V Industries' manufacturing experience allows for quicker delivery to your site. Based on 40 years of wall-fired burner design and application experience this air register provides an infinite range of air flow, flame shaping and better emission control even with your current coal nozzles.



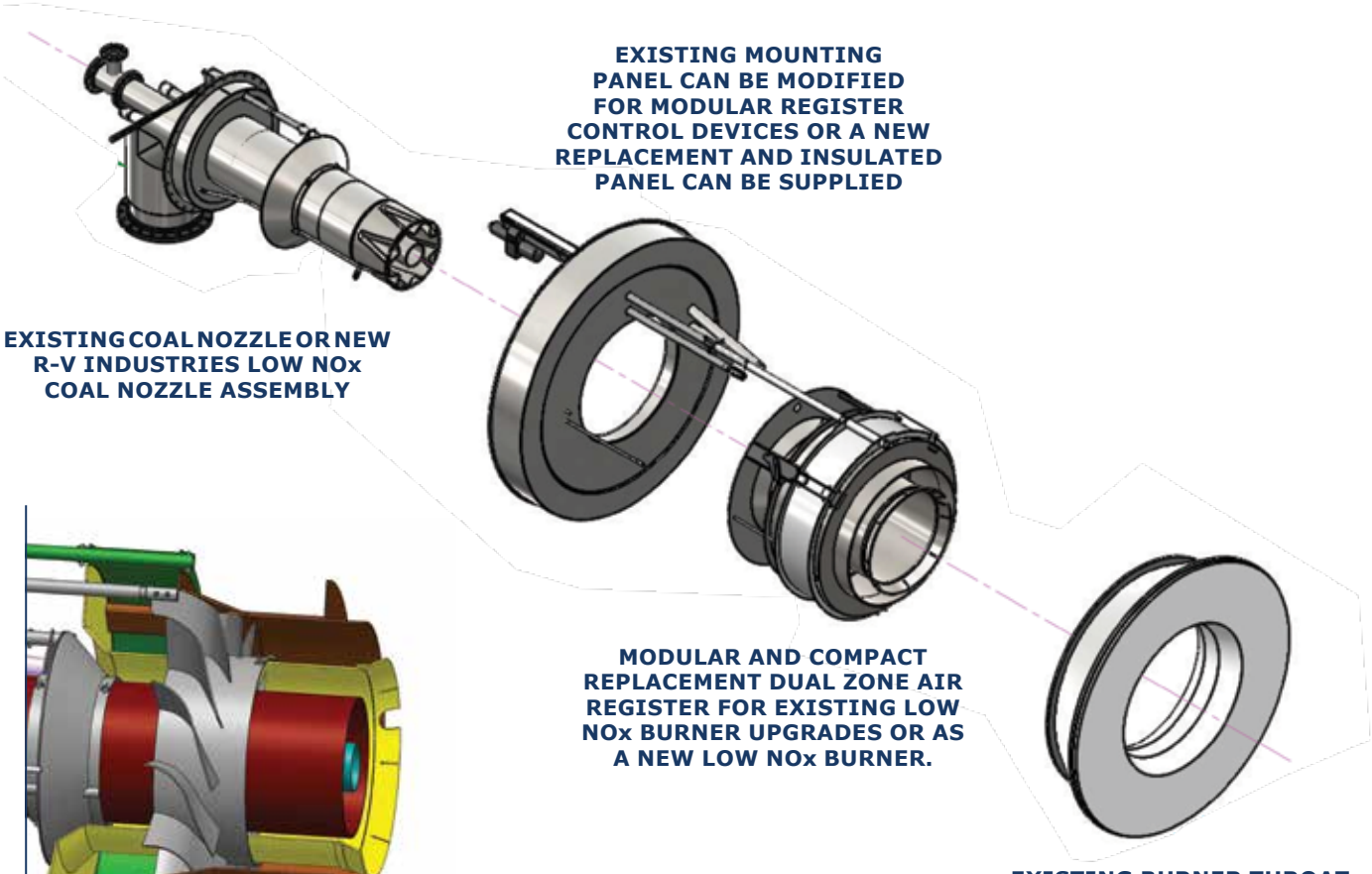
1 OUTER ZONE SLEEVE DAMPER PROVIDES INDIVIDUAL AIR FLOW AND BURNER TO BURNER BIASING CONTROL.

2 INNER ZONE CONICAL AIR DAMPER CONTROLS AIR FLOW AND SWIRL GENERATION CONTROL TO THE INNER ZONE AROUND COAL NOZZLE.

3 AERODYNAMIC AXIAL SWIRLERS PRODUCE THE WIDEST RANGE OF SWIRL CONTROL.

WALL FIRED BURNER PACKED FOR SHIPMENT

MODULAR REPLACEMENT



3D RENDERING DESIGN

THE MOST MODULAR AND COMPACT DESIGN FOR EASE OF INSTALLATION

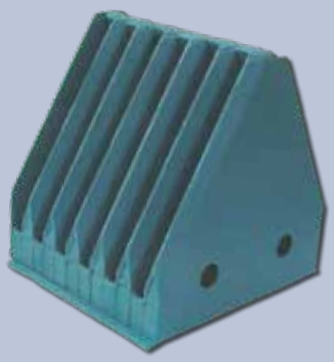
All industry-available low NOx wall-fired burners are large bulky assemblies. They are comprised of coal nozzle, rear mounting panels and air registers, all interconnected with extensive and complex linkage arrangements into one large assembly. This makes them very cumbersome to install and do even regular maintenance. By comparison, the R-V LNx wall fired register and burners are modular. They consist of a separate air register, a separate coal nozzle assembly and a separate rear mounting panel. This allows them to be supplied as complete assemblies or as separate modules.

RIFFLE ELEMENT DESIGNS

With three riffle element design choices, R-V Industries provides the coal flow distribution control and quality you have come to rely on. Choose from the original equipment, mid-cut or coarse cut models. The mid and coarse cut designs are used to minimize system pressure drop and maximize primary air flow. Cast, fabricated and ceramic lined distributor housings are also available.

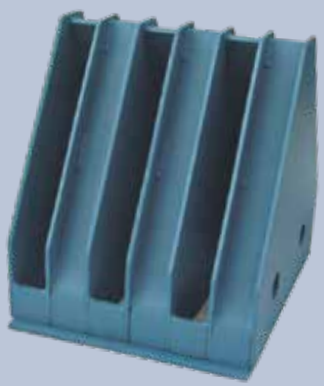
Original Equipment

- Made to original equipment specifications
- Smallest openings of the three designs



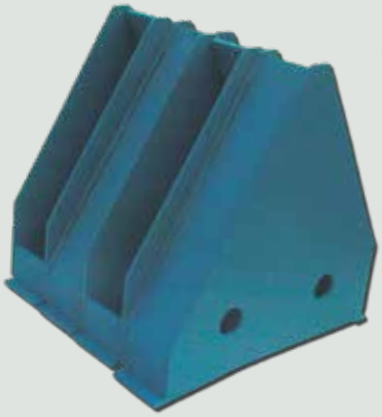
Mid-Cut

- Assembled design with mid-sized openings
- Thicker material but lightest overall weight
- Lowest cost design
- Reduced pressure loss
- Material options include carbon steel, AR400 and AR500



Coarse Cut

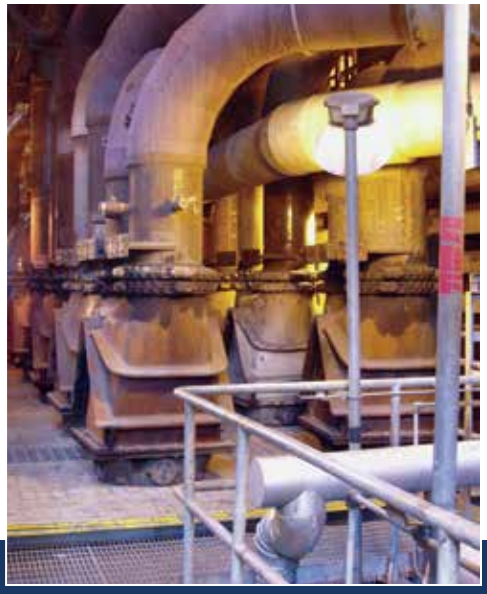
- Sectional design provides easier handling and allows replacement of worn sections
- Widest opening size of the three designs
- Material options include carbon steel, AR400 and AR500



ADJUSTABLE RIFFLE ASSEMBLY

Balanced coal and primary air flow have shown to improve combustion in the furnace and help eliminate numerous related burner problems and emission concerns. R-V's adjustable riffle assemblies allow you to redistribute coal flow online ***without restricting primary air flow***. R-V assemblies offer:

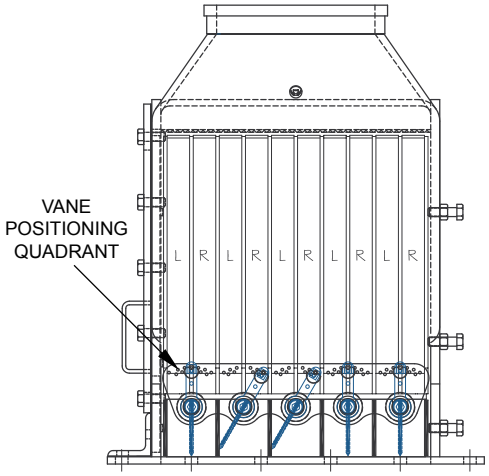
- Complete housing replacement
- Modification kits for existing housings
- 2 or 3 way distribution applications
- The perfect compliment to online coal flow measurement systems



TYPICAL OEM DISTRIBUTOR ARRANGEMENT FOR APPLICATION OF R-V ADJUSTABLE RIFFLE

EPRI ELECTRIC POWER RESEARCH INSTITUTE

EPRI closed loop flow tests evaluated the R-V adjustable riffles' ability to control coal and transport air flow under simulated plant conditions. The results showed that the adjustable riffle can redistribute coal flow from an 80% - 20% imbalance to a 50% - 50% balance without increasing pressure loss. Additionally, primary air distribution can also be controlled.



BIASED POSITION WITH
2 OF 5 VANES ADJUSTED

EPRI RESULTS PROVE THAT R-V'S ADJUSTABLE RIFFLE CAN CONTROL BOTH COAL AND PA FLOW DISTRIBUTION

OBSERVATION AND ACCESS DOORS

DIRECT REPLACEMENTS AND CUSTOM SIZES

R-V offers a full line of furnace, pulverizer, duct and windbox doors including direct replacements for many OEM designs. All furnace doors are available with seal boxes and tube panels as an option. Styles are adaptable to any OEM boiler design.

Observation Doors

- 4" x 10" and 6" x 12"
- 5 1/2" diameter
- 3" and 6" diameter for pressurized furnaces

Access Doors

- 15" x 21" oval
- Water-cooled
- Non-insulated
- Mineral wool or refractory insulated
- Pulverizer and windbox access doors
- Custom doors available

HINGED ACCESS DOOR

15" X 21" OVAL ACCESS DOOR

5-1/2" ROUND OBSERVATION DOOR

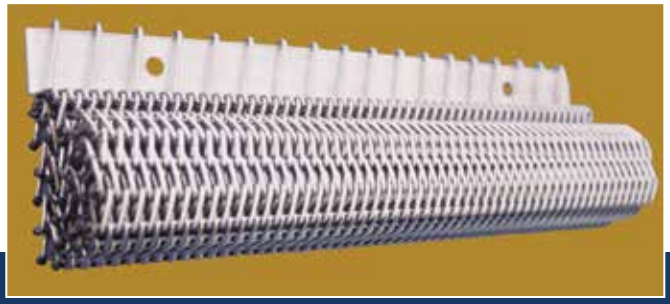
4" X 10" OBSERVATION DOOR
(6" X 12" DOOR NOT SHOWN)

OBSERVATION DOOR FOR
PRESSURIZED FURNACE
3" AND 6" AVAILABLE

DRIP SCREENS

R-V flexible drip screens* last longer than traditional rigid screens which are susceptible to warping. The benefits of a flexible drip screen include:

- Easy Installation: screens ship with attachment bar to easily bolt onto your mounting apparatus
- Reduced Maintenance: flexible design allows screens to be rolled up and secured with S-hooks
- Improved Durability: corrosion and heat resistant screens handle the ash hopper's difficult conditions that cause other rigid screens to warp
- Material Options: 304 S/S, 316L S/S, 317L S/S, 430 S/S and various Inconel grades
- Design Feature: dual layer design is supplied with an open bottom
- Lighter Design: reduces stress on waterwall tubes
- Dual Layer Design: increased durability with open bottom design allows ash to fall out of the bottom to prevent being weighed down.



SCREEN ROLLED FOR HOPPER MAINTENANCE

DUAL LAYER DESIGN

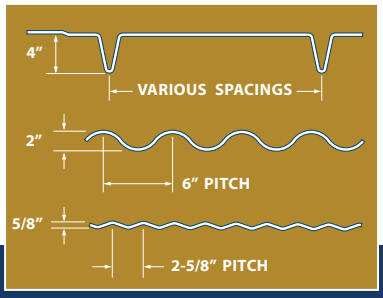
*RIGID DESIGN AVAILABLE UPON REQUEST

SEAL PLATES

All R-V furnace bottom seal plates are manufactured to original equipment specifications and are adaptable to any furnace design. Material options include, but are not limited to:

- 316L Stainless Steel
- Inconel 600
- Inconel 601
- Inconel 625
- AL6XN
- Alloy 20

MANUFACTURED SEAL PLATE



PITCH DESIGN OPTIONS

BEST COMBUSTION SOLUTIONS AND EQUIPMENT IN THE WORLD

R-V Industries, Inc. is a world leader in providing high quality combustion systems from the pulverizer through the burner for nearly 40 years. R-V has designed and manufactured equipment for hundreds of units worldwide. We have completed projects for many types of fuels (coal, oil, natural gas and biomass) and firing system arrangements (tangential and wall-fired), including low NOx retrofits and the addition of or conversion to other fuels.

The R-V team has the technical knowledge and manufacturing capability to support all your combustion system needs. Our mission is to provide our clients with the best combustion system designs, engineered solutions and equipment in the world. A long and growing list of clients define R-V as a preferred supplier for equipment and technical support.

CONSULTATION SERVICES

R-V offers pre-outage and outage diagnostic support, fuel switch analysis, system design, installation support, start-up and optimization. Our consultants are qualified for all types of firing systems.

R-V INDUSTRIES, INC. • 584 POPLAR ROAD • HONEY BROOK, PA • RVII.COM • 610.273.2457