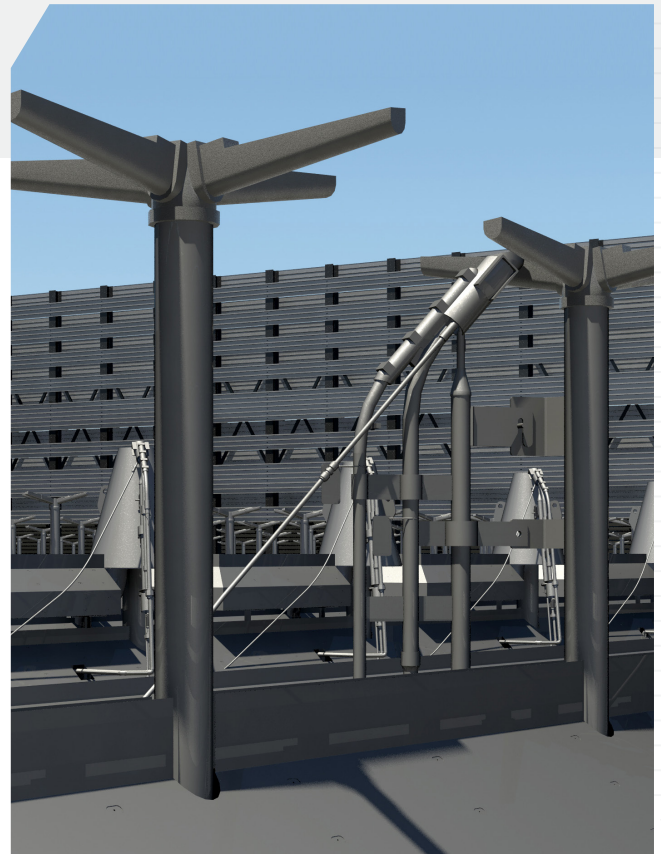


LRGO™ MULTI-POINT GROUND FLARES

Low Radiation and Maximum Smokeless Performance

The LRGO multi-point ground flare (MPGF) design has been refined through many years of technical development at the John Zink Research and Development Center. It has become the design of choice for operators who desire a flare system that can provide high smokeless capacities and combustion efficiency in a flare design that minimizes visual impact to the surrounding community.

FEATURES	BENEFITS
Hidden flame	Safe and efficient flare operation with minimal visual impact and ground level radiation
Short flame length burner design	Minimal fence height required to ensure hidden flames
High smokeless capacity	Provides 100% smokeless operation of large-capacity flare systems
Little or no assist medium (steam or air) for smoke control	High smokeless capacity with minimal utility costs
High hydrocarbon destruction efficiency (> 99.5% DRE)	Significant reduction in emissions versus elevated flares (typically 98% DRE)
No steam or air controls required to maintain high DRE	Reduces cost and complexity of smoke control and eliminates risk of oversteaming which can produce low DRE



The LRGO flare is designed with staging and ignition systems to ensure safe, short, smokeless flames are maintained over the full operating range of the flare.

BURNER TECHNOLOGIES

The LRGO flare system features a unique range of burner designs that provide optimum flame stability, high hydrocarbon destruction efficiency (normally > 99.5% DRE) and many additional benefits.

The LRGO-HC burner design is ideal for demanding applications when short flame length with reliable cross-lighting is required. Compared to conventional burners, the LRGO-HC burner allows for:

- Much shorter flame lengths
 - Reliable cross-lighting at greater burner spacing
 - Better cross-lighting of low heating-value gases
- Improved smokeless performance and turndown
 - Efficient air entrainment
 - Better mixing
- Shorter radiation fence
 - Reduced installation and maintenance costs
 - Less expensive foundation design



LRGO — HC Burners

FIRST-STAGE BURNERS

The first stage of most MPGF systems requires a burner design that can produce smokeless flaring at turndown from purge rate to maximum rate. This typically requires utilizing steam-assisted or air-assisted burners on the first stage, which adds complexity to the design and controls. It also requires continuous utility usage (steam or blower power). This increases the likelihood of over-steaming or over-aerating the

burners, which produces decreased hydrocarbon destruction efficiency. The JZ Indair first-stage burner design utilizes a variable-slot mechanism to produce 100% smokeless flaring from purge through maximum flow rate without the use of any outside utilities. This provides a low-maintenance, simple operation design that is guaranteed to produce high DRE without operator interface.



JZ Indair First Stage Burners

DESIGN VERIFICATION

There are many variables that can affect the flame length and maximum cross-light distance on MPGF burners, including burner type, burner size, burner orifice sizing, gas composition, gas pressure, burner spacing along rows, spacing between rows, wind speed and direction, etc. Since flame-length control and cross-lighting are critical parameters in the safe design and operation of an MPGF, it is critical that the flare designer be able to accurately predict these performance parameters over the range of operation required for a particular application. At John Zink, we have invested heavily in the development of engineering tools required to accurately

predict our burner performance over this wide range of variables. Our full-scale LRGO burner test facility allows our researchers to study these variables.

Our state-of-the-art design capabilities are backed by actual field verification gained through more than 40 years of experience designing some of the largest MPGF systems in the world. We have provided LRGO flare systems in numerous applications, including olefins and polyolefins, aromatics, LNG production, oil and gas production, refineries, pipeline operations, and more.



Our unique multi-burner test facility can achieve multiple burner configurations via a rail-system that enables multi-dimensional movement of full-scale burners.

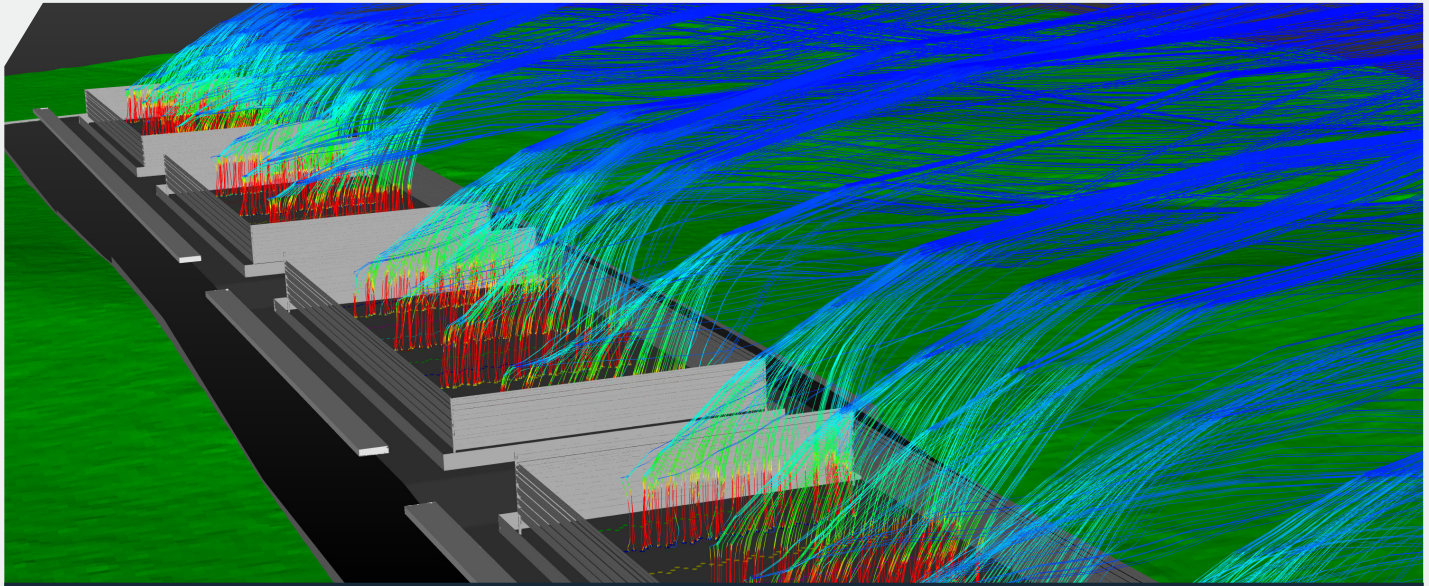


Full-Scale LRGO Burner Test Facility

Computer Simulation in Flare Technologies

Computational Fluid Dynamics (CFD) is an integral part of the research and development of our industry leading flare technologies. CFD modeling is a simulation methodology that can provide a prediction of flow, mixing, and combustion in flare flames, including the airflow and combustion gas-flow characteristics within the LRGO flare field.

Our engineers routinely perform CFD analysis on innovative flare technologies to optimize performance and streamline the development cycle of those new technologies. Those CFD simulation results are then validated by experimental data from our test facility. Our engineers also utilize CFD to assess flare performance and environmental impact at customer sites.



Multi-Point Ground Flare CFD Modeling

Our engineers routinely perform CFD analysis to model operational characteristics of ground flares.

FLARE EMISSIONS TESTING CAPABILITIES

Predicting and measuring emissions produced by flares has become increasingly important. As a result, we've developed the industry's leading capability for accurate measurement of flare emissions. At our research and development test center, we conduct emissions testing for EPA permitting of our customer's flare systems. Recognizing our advanced capabilities, the Texas Commission on Environmental Quality conducted their 2010 Flare Efficiency Study at our facilities.



Industry-Leading Flare Emission Testing Expertise

Global Headquarters // Tulsa, OK, USA // +1-918-234-1800 // To locate an office in your region, visit johnzink.com/contact.