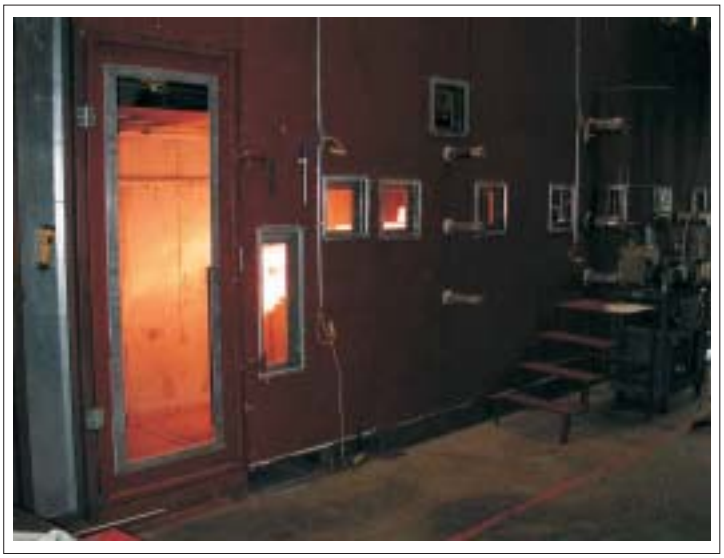
# Flare Test Facility

*CETC's collaborative program on flare testing and development addresses the concern of industry and federal and provincial regulatory bodies to have the most cost effective, safe and environmentally responsible technology to dispose of waste gases.*



*View of Flare Test Facility*

## Background

Flaring is a common method of disposal of flammable waste gases in the upstream oil and gas, downstream refining and chemical processing industries. The flare is an open-air flame usually at the top of a long stack, exposed to the elements, particularly winds. Gases may be flared as a result of an emergency shutdown, as an unwanted by-product of refining or chemical processing, or as part of the production in oil and natural gas fields. A particular problem results from the flaring of solution gas at widely dispersed oil well sites. Solution gas is a mixture of hydrogen, light hydrocarbons, carbon dioxide and nitrogen that come out of solution when oil is brought from high pressure in the well to near atmospheric pressure at the surface. It can entrain significant liquids, both oil and water. In certain areas, the solution gas can contain hydrogen sulphide, and is called 'sour gas'; in other areas it can entrain salt brine.

Gas may be flared in the initial period of production of an oil or gas well, testing the flow rate. Solution gas flares and process flares usually operate at low flow rates relative to the prevailing winds, while emergency flares and well test flares have very high flow rates. The performance of solution gas flares in the Oil Patch of western Canada has recently been a topic of great interest, with tests indicating the potential for release of significant amounts of incomplete combustion products under certain wind conditions. As one of these products can be methane, there is a particular environmental concern because of the high global warming potential of methane (20 times that of carbon dioxide, on a mass basis).

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## Flare Testing

The performance of flares in the field is difficult to quantify. Wind speed and direction are highly variable, so sampling or collecting combustion gases is almost impossible. The composition (and therefore heating value) and flow rate of solution gas vary with time and well site. There is a need, therefore, to have a controlled situation that mimics the actual flaring conditions, particularly as affected by ambient winds, and allows accurate measurement and speciation of combustion products, and the determination of combustion performance.

CETC has constructed the Flare Test Facility (FTF) to achieve this goal. The construction and commissioning of the FTF was completed in 2000. Under contract to the Petroleum Technology Alliance of Canada (PTAC), it is being used to determine the performance of flares with a range of model solution gases, a range of gas and air flow rates, to measure the chemical species produced, and to develop means to enhance flare performance.

*Flare Flame showing wake and tail*

## Features of the FTF

The FTF is a once-through configuration, with the wind driven by a large, variable speed high-capacity fan delivering air to the working section, where the flare is located, perpendicular to the wind flow. The working section is 1.2 metres wide, 8.2 metres long, with a height variable between 1.5 and 2.6 metres. All walls are flame, for a wide variety of ambient and air-cooled to minimise heating of the flare by back radiation. This variable test section allows full development of the flare fueling conditions. Large ceramic windows at strategic locations allow complete viewing of the flame, along with digital recording of same. Complete gas sampling can be performed both in or near the flame in the horizontal test section, and downstream in the vertical stack. All flows are measured by high precision mass flow meters and digitally controlled for stability. Other features include:

- Moveable ceiling, height ranges from 1.5 to 2.6 metres (5 to 8.5 feet);
- Wind speed up to 40 km/h;
- Gaseous fuels such as natural gas and propane, alone or in combination, up to 60 $m^3/h$;
- Inert diluents: $CO_2$, $N_2$;
- Liquid droplet injection (octane/gasoline, diesel, water);
- Flare pipes of 1 inch, 2 inch, and 4 inch internal diameter, with different flare tips;
- Total fuel heat input up to 2.1 GJ/h (2 million BTU/h); and
- Variable grids after the honeycomb air flow straightening sections, upstream of the flare, allow the development of turbulence properties similar to those experienced with real-life conditions.

*Stack gases are analyzed for:*

- Combustion products CO, $CO_2$, $O_2$, $NO_x$, $SO_2$ in real time;
- Unburned fuel ($CH_4$, NMHC) in real time;
- Particulate loading by isokinetic sampling; and
- Specific and total measurements of VOCs and PAHs are also performed by bulk sampling.

The FTF can also test sour gas and brine injection, as well as a wide range of additional waste fuel inputs. With its relatively large scale and lateral wind capability, this unique facility can closely represent a wide range of industrial flares, including those of off-shore oil rigs and of downstream refining and chemical processing facilities.

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