

Workplace Health and Safety Bulletin



Safe Operation of Fired Equipment in Hazardous Locations

Alberta Employment and Immigration investigated a flash fire in which a treater fire box ignited a cloud of accidentally released natural gas. The ignition occurred because the burner access port on the fire box front cover had been left open. Since it is physically impossible to prevent ignition when an explosive atmosphere meets with a source of ignition, the primary safety objective is to stop the flame from propagating (by containing an explosion) and igniting an explosive atmosphere outside the equipment

A firebox can never be completely isolated from the outside atmosphere. Operational openings such as inspection ports, combustion air intakes and flue stacks are needed to operate a piece of fired equipment. The main factors contributing to failure of flame arrestors are:

- inadequate design
- improper maintenance

Protection in hazardous locations

Hazardous locations (H.L.'s) are defined and classified according to the Canadian Electrical Code. In oil and gas installations, Class 1 H.L.'s are defined as "those in which flammable gas or vapour are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures".



In field battery applications, areas inside unventilated process buildings (e.g. treater buildings, pump houses etc.) as well as dikes and sumps below grade are classified as Class 1 Division I H.L.'s. Areas outside buildings (normally within an area extending 8 m, (25 feet)) from the walls in all directions are classified as Class 1 Division II H.L.'s.

Unrestricted use of open flames in areas where flammable substances are handled, stored, or processed should be prohibited for obvious reasons. The first measure of protection is to avoid locating fired equipment inside Class 1 Division I H.L.'s. Firebox air intakes are located outside the building's walls. Once outside, but within the boundaries of Division II H.L's, a properly designed (sealed to prevent flame propagation) fire box and an adequate flame arrestor affixed to the air intake opening are a further means of protection.

Section 168(4) and (5) of the Occupational Health and Safety (OHS) Code pursuant to Alberta's *Occupational Health & Safety Act* states the requirements of employers:

“168(4) An employer must ensure that intakes, exhausts and the fire box of a furnace or fired heater are not located or operated in a Division 1, Zone 0 or Zone 1 hazardous location of any Class under the Canadian Electrical Code.

168(5) An employer must ensure that a furnace or fire heater is not located or operated in a Division 2 or Zone 2 hazardous location of any Class under the Canadian Electrical Code, unless

- (a) it is totally enclosed,*
- (b) all surfaces exposed to the atmosphere operate below the temperature that would ignite a flammable substance present in the hazardous location, and*
- (c) the combustion air intake and exhaust discharge are equipped with a flame arresting device or are located outside the hazardous location.”*

Prevention of ignition

In a flame arrestor, quenching of flames, is possible due to the cooling effect of narrow passages. Heat from the flames, passing through narrow-aperture channels of the flame arrestor element, is absorbed by the element's mass and flames are quenched. In order for quenching to take place, however, the size of a single channel must be adequately small. Each flammable gas (vapour) has its own quenching diameter. Table 1 gives burning velocities and quenching diameters for typical oil and gas industry applications

Table 1

Flammable Gas/Vapour	Standard Burning Velocity cm/sec (ft/sec)	Quenching Diameter mm (in)
1. Methane (Natural Gas)	36.6 (1.2)	3.2 (0.13)
2. Butane (LPG)	39.6 (1.3)	2.8 (0.11)
3. Pentane (Condensate Vapours)	44.4 (1.46)	4.18 (0.16)

Because flame speeds normally exceed standard burning velocities; channels in flame arrestor elements should not be greater than 50% of the quenching diameter. This means that a typical flame arrestor for field battery applications will have a single channel aperture approximately 1.4 mm (0.055 in) in diameter.

Consequently, any opening larger than the size of a single channel in the flame arrestor element would render a firebox incapable of containing an internal explosion. Field inspections and accident investigations have identified several potentially dangerous situations:

- flame cell centercore, rod missing, unplugged
- flame cell disfigured due to inappropriate maintenance i.e. “rodding”
- improper seal of the flame arrestor element in its housing
- poor seal around front cover circumference due to warped or disfigured cover
- missing bolt, leaving a bolt hole open to inside (old design with internal flange, still in use)
- open burner access port (the most dangerous situation because of the size of this opening; ignition a 100 percent certainty!).

Reminder

Under Alberta's *Occupational Health and Safety Regulation* employers have an obligation to ensure that equipment is of adequate design and is properly maintained (§12).

Under the OHS Code, employers have an obligation to ensure that where a work site is classified as hazardous, that procedures and precautionary measures are developed and that the boundaries of the hazardous location are clearly marked or fenced off (§165).

It is suggested that owners/operators of field batteries:

- (1) inspect existing facilities for potential fire and explosion hazards;
- (2) introduce adequate and effective maintenance programs to ensure the integrity of flame arrestors;
- (3) develop and implement procedures for safe start-up, lighting/re-lighting and operation of fired equipment including the burner's pilot;
- (4) consider the following:
 - each burner should have its own intake air firebox flame arrestor and smoke stack
 - all vent lines should be vented to the smoke stack
 - gas detection system to control emergency shut down valve should be installed
 - provide automatic shut down of fuel gas supply to the burner upon failure detection of burner's pilot
 - ensure enclosed buildings are ventilated to prevent the accumulation of flammable gases
 - maintain an air tight seal between the treater and the flame arrestor, as well as the sight glass, in accordance with the recommendations of the manufacturer
 - replace all damaged flame arrestor elements in consultation with the manufacturer of the equipment
 - train all workers adequately.

Employers have an obligation to ensure that equipment is of adequate design and is properly maintained (§ 165).

Employers have an obligation to ensure that where a work site is classified as hazardous, that procedures, and precautionary measures are developed and the boundaries of the hazardous locations are clearly marked or fenced off (§ 165).

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Workplace Health and Safety



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