

NGV-CYL-SP14

BONFIRE TESTING MACHINE

ISO 11439 Statement

A.15 Bonfire test

A.15.1 General

The bonfire test is designed to demonstrate that finished cylinders, complete with the fire protection system (cylinder valve, pressure relief devices and/or integral thermal insulation) specified in the design, will prevent the rupture of the cylinder when tested under the specified fire conditions.

Precautions shall be taken during fire testing in the event that cylinder rupture occurs.

A.15.2 Cylinder set-up

The cylinder shall be placed horizontally with the cylinder bottom approximately 100 mm above the fire source.

Metallic shielding shall be used to prevent direct flame impingement on cylinder valves, fittings, and/or pressure relief devices. The metallic shielding shall not be in direct contact with the specified fire protection system (pressure relief devices or cylinder valve).

Any failure during the test of a valve, fitting or tubing that is not part of the intended protection system for the design shall invalidate the result.

A.15.3 Fire source

A uniform fire source of 1,65 m length shall provide direct flame impingement on the cylinder surface across its entire diameter.

Any fuel may be used for the fire source provided it supplies uniform heat sufficient to maintain the specified test temperatures until the cylinder is vented. The selection of a fuel should take into consideration air pollution concerns. The arrangement of the fire shall be recorded in sufficient detail to ensure that the rate of heat input to the cylinder is reproducible.

Any failure or inconsistency of the fire source during a test shall invalidate the result.

A.15.4 Temperature and pressure measurements

Surface temperatures shall be monitored by at least three thermocouples located along the bottom of the cylinder and spaced not more than 0,75 m apart.

Metallic shielding shall be used to prevent direct flame impingement on the thermocouples. Alternatively, thermocouples may be inserted into blocks of metal measuring less than 25 mm square.

Thermocouple temperatures and the cylinder pressure shall be recorded at intervals of every 30 s or less during the test.

A.15.5 General test requirements

The cylinder shall be pressurized to working pressure with natural gas or compressed air and tested in the horizontal position at working pressure and at 25 % of working pressure if a thermally activated PRD is not used.

Immediately following ignition, the fire shall produce flame impingement on the surface of the cylinder along the 1,65 m length of the fire source and across the cylinder diameter.

Within 5 min of ignition the temperature at least one thermocouple shall indicate a temperature ≥ 590 °C. This minimum temperature shall be maintained for the remainder of the test.

For cylinders of length 1,65 m or less, the centre of the cylinder shall be positioned over the centre of the fire source.

For cylinders of length greater than 1,65 m, the cylinder shall be positioned as follows:

- a) if the cylinder is fitted with a pressure relief device at one end, the fire source shall commence at the opposite end of the cylinder;

- b) if the cylinder is fitted with pressure relief devices at both ends, or at more than one location along the length of the cylinder, the centre of the fire source shall be centred midway between the pressure relief devices that are separated by the greatest horizontal distance;
- c) if the cylinder is additionally protected using thermal insulation, then two fire tests at service pressure shall be performed, one with the fire centred midway along the cylinder length, and the other with the fire commencing at one of the ends of a second cylinder.

A.15.6 Acceptable results

The cylinder shall vent through a pressure relief device.

DESCRIPTION OF MACHINE

1. Bonfire chamber

The bonfire chamber has been designed for full safety. The drawing of the chamber is as attached. The 4 walls and the roof chamber are made of steel reinforced concrete (RC). Although there is an opening at both sides of front wall, the front barrier wall is made big enough to prevent any flying out object from the blast of the CNG cylinder to escape.

On the front wall, there is a viewing window for the video camera.

2. Design Calculation

1. The inter size of the chamber is 8 m length x 7.5 m width x 5 m height. This big chamber design prevent the concrete wall damaged by blast pressure wave.

The blast wave energy of a CNG cylinder of 80 liter capacity = 11.7 MJ.

2. The walls and roof are designed to withstand for impact of flying pieces from the cylinder blast.

The maximum velocity of projectile at blast = 33.6 m/s (121 km/h)

The maximum impact energy on the wall = 28224 J

3. Hence, the RC wall and roof thickness to withstand above factors is 40 cm and walls are standing on the strong foundation. (The foundation design depends on the soil bearing capacity)

(All detail calculations will be available at the time of contract.)

The following figures show the similar design without front barrier wall.



3. Fire source

The fire source uses the LPG fuel as shown. The length of fire source is 1.65 m.

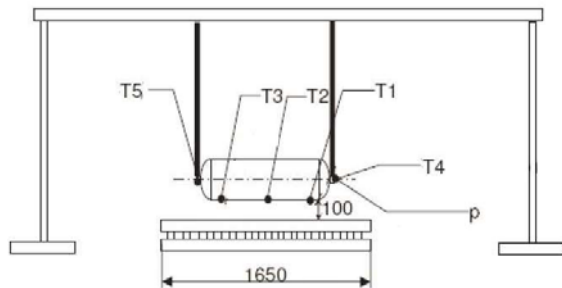


The burner has been designed to have even heating along the cylinder length.

The fire source is able to be ignited remotely.

4. Instrumentations

Three thermocouples (T) are installed on the bottom surface of the cylinder. Two thermocouples are installed at both ends. Metallic shielding is used to prevent direct flame impingement on the thermocouples. The water cooled pressure transducer (P) is installed at inlet pipe.



The machine can record time, temperature, and pressure readings at 30 second intervals or less, beginning when the fire is ignited and continuing until the pressure release device releases.

SPECIFICATIONS

1. The machine can be used to test the CNG cylinders according to ISO11439 Annex A (normative) Test methods and criteria A.15. Bonfire test.
2. The machine can be used to test the CNG cylinder of size: diameter 406.4 mm and length 1,400 mm or bigger.
3. Bonfire chamber:
 - a. steel reinforced forced concrete (RC) walls and roof with sable foundation,
 - b. internal dimensions 8 m Length x 7 m Width x 5 m Height,
 - c. thickness of walls and roof 40 cm
 - d. The chamber geometry prevents any flying object from the cylinder blast to escape outside chamber
 - e. Test station is able to control the temperature and pressure during bonfire test
4. Fire source:
 - a. fuel LPG
 - b. length 1.65 m
 - c. material steel
 - d. distance between the fire source and cylinder is 100 mm ± 3 .
 - e. The fire source is able to get the cylinder bottom surface temperature of 590°C or more within 5 minutes of ignition
5. Instruments:
 - a. Surface temperature is monitored by 3 thermocouples located along the bottom of the cylinder and spaced less than 0.75 m apart. Thermocouples are inserted into blocks of metal measuring less than 25 mm square.
 - b. Thermocouple type K 0 to 1000 °C 5 pcs
 - c. Pressure Transducer (water cooled) 1000 bar 1 pc for pressure measurement of cylinder gas pressure during test.
 - d. The PRD (pressure relief device) 1 pc (made of stainless steel.)
 - e. PC data acquisition system
 - f. Temperature and pressure data are recorded at 30 second interval or less.
6. The bonfire test is monitored by the software program running on Windows XP Professional. Data are recorded and stored in the data collection. The recorded data can be analysed and the graph can be plotted. The test result is reported as number or graph and printed out on the printer. The report format can be selected by user.
7. Video camera (see attached)
8. PC (see attached)