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PAKISTAN STANDARD

Gas Water Heater/Geys**er**



**PSQCA Complex, Standardization Wing, 1st Floor, Plot-ST-7/A, Block-3,
Scheme No.36, Gulistan-e-Jauher, Karachi.**

Pakistan Standard Specification
For
Gas Water Heater/Geyser****

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Pakistan Standard Specification

For

Gas Water Heater/Geyser

0. Foreword

- 0.1 This Pakistan Standard has been adopted by the Authority of the Pakistan Standards & Quality Control Authority, (National Standards Body of Islamic Republic of Pakistan), after the draft prepared by the Mechanical Technical Committee (MTC-18) for “Oil & Gas Burning appliances which has been approved and endorsed by the National Standards Committee on Mechanical on 28.02.2017
- 0.2 This Standard was first formulated in 2008, in preparation thereof technical assistance was taken from technical data provided by the Sui Southern Gas Company Limited (SSGCL)/ Sui Northern Gas Pipelines Limited (SNGPL), which are acknowledged with thanks.
- 0.3 Keeping in view the suggestions from the manufacturers, specialists, technologists and utilizing agencies, it has now become imperative to revise the prevailing version.
- 0.4 This revised version of PS: 4858 is adopted after taking into consideration the views and the suggestions of manufacturers, specialists, technologists and utilizing agencies. It is hoped that user will find it well in line with the technical barriers to trade agreement (WTO/TBT).
- 0.5 This Standard is subject to periodical review in order to keep pace with latest development in technology. Any suggestion for improvement will be recorded and placed before the revising committee in due course.

1.

SCOPE:

These requirements apply to automatic storage type water heaters/Geysers having natural gas input rating of 20,000 Btu per hour and over.

2.

CONSTRUCTION REQUIREMENT:

2.1

GENERAL CONSTRUCTION AND ASSEMBLY:

An access opening shall be provided in the vertical heater/Geyser casing of sufficient size to permit ready access for cleaning the burner compartment. If other satisfactory means for cleaning the burner compartment can be demonstrated, with the heater/Geyser installed as it would be in service, this requirement shall be deemed met.

Adequate means shall be provided to prevent products of combustion, or condensation from the products of combustion, from coming in contact with insulating material above the burner port level. The provisions of this requirement shall not be construed to apply to the use of reasonable tolerances for assembly.

Storage vessels shall be equipped with a drain valve to facilitate emptying the tank for cleaning or withdrawing small quantities of water to eliminate foreign deposits.

When it is necessary to remove the flue baffle to clean the flue ways, flue baffles of internal flue type automatic water heaters/Geysers shall be designed for removal within a clearance above the floor of 78 inches, or 24 inches above the flue collar on heater/Geyser taller than 54 inches. Removal by means of bending the baffle shall be considered as complying with this requirement, provided that operation of the heater is not adversely affected after the baffle has been so removed and replaced. The actual capacity of the storage vessel shall be within $\pm 5\%$ of the nominal capacity of the water heater/Geyser.

3.

MATERIALS:

Storage vessels shall be protected against corrosion by dip galvanization or suitable treatment should be given to welded joints followed by galvanizing inside the tank.

The finish of jackets and other exposed parts shall be durable and uniformly applied. After the termination of all tests specified herein, it shall not show undue discoloration or deterioration. Insulation material shall be of inorganic origin. Insulation jackets shall be of same material as storage vessel to avoid corrosion.

4.

PILOT BURNERS AND AUTOMATIC PILOTS:

Water heaters/Geysers shall be equipped with an automatic pilot and pilot burners.

Frames and mounting brackets for pilot burners and flame responsive elements shall be constructed of a metal having a melting temperature of not less than 1450° F (788°C).

The construction of push-button or trigger valves shall be such that they cannot accidentally be blocked in the open position.

5.

GAS AND WATER CONNECTIONS:

Water connections will be sized as follows:-

Upto 30 (gallons) or 135 (litres)	=	1”
31 to 50 (gallons) or 139.5 to 225 (litres)	=	1¼”
51 to 100 (gallons) or 229.5 to 450 (litres)	=	1½”

Hot water connection, cold water connection, or both, shall be clearly and permanently identified & pressure relief valve should be installed.

6.

TEMPERATURE LIMITING DEVICES: Water heaters/Geysers for use at temperature above 160°F (71°C) shall be provided with one of the above temperature limiting devices as an integral part of the heater.

Automatic gas shut off devices, when provided, shall be approved as an integral part of the water heater/Geysers. These devices shall act to shut off the gas supply to the main burner(s).

Immersion type automatic gas shut off devices shall be located so that the temperature sensitive element is immersed in the water within the top 6 inches of the tank.

Surface mounted automatic gas shut off devices shall be securely mounted and located so that the temperature sensitive element senses the water temperature within the top 6 inches of the tank. Such surface mounted temperature sensitive elements shall be adequately insulated or located so as to assure isolation from flue gas heat or other ambient conditions that are not indicative of stored water temperature.

Functional parts of automatic gas shut off devices shall be accessible for servicing and replacement without disconnecting the water lines or removing the heater/Geyser casing. Raising the heater top for the purpose of such accessibility or replacement is acceptable under this requirement.

The listed hourly Btu discharge capacity of the temperature relief valve (or the temperature relief element of a combination valve) shall not be less than the manufacturer’s Btu input rating of the appliance

7.

DRAFT HOODS:

All water heaters/Geysers shall have flues and draft hoods as standard equipment. The outlet of such draft hoods shall accommodate vent connector of integral inch diameter.

Provision shall be made to assure a firm support of :-

- a) The draft hood or vent connector to the flue outlet; and
- b) The vent connector to the draft hood.

All parts of a non-detachable or built-in draft hood, if of sheet metal, shall be constructed of material having a thickness not less than No. 24 U.S. Standard Gauge.

8.

MARKING:

Each appliance shall be indelibly marked with the following;

- i. Manufacturer's name or trade mark (embossed)
- ii. Knob's "on" and "off" position.
- iii. Country of origin.
- iv. Gas input rating
- v. Thermal Efficiency

Brochure with instruction for use shall be provided in national and English language.

It may also be marked with the PS Mark.

NOTE –

The use of PS Mark is governed by the provision of the Pakistan Standards and Quality Control Authority Ordinance Act-VI of 1996, and the rules and regulations made under the ordinance. Products bearing PS Mark are protected with the guarantee that they have been produced to comply with requirements of the relevant standard under a well defined system of inspection, testing and quality control during production. Particular governing conditions under which a license for the use of the PS Mark may be granted to manufacturers, may be obtained from the (PSQCA) Pakistan Standards and Quality Control Authority.

9.

PACKING:

It shall be packed in accordance with the best prevalent trade practice or as agreed between the manufacturer and purchaser taking care of safety requirement during handling, transit and storage.

The supplier shall also supply on instruction card giving the following information:

- i) Brief instructions for installation and regulation which include piping and fitting of terminal, if any.
- ii) Instruction for the correct operation of the appliance.
- iii) Manufacturers name and address.
- iv) Guarantee period, serviced or repair, and replacement of parts.

10. PERFORMANCE REQUIREMENTS:

10.1 GENERAL:

During tests for compliance with these requirements a water heater/Geyser shall not be connected to a vent connector but shall depend solely on the principals of design incorporated in the appliance itself for successful operation. The fact that water heaters/Geysers are tested without flue connections is not to be interpreted as an indication that flue connections are not recommended when heaters/Geysers are installed under actual operation conditions.

The draft hood shall be in place during all performance tests.

Temperature limiting devices shall be in place during all tests. These requirements will apply in addition to all the specifications laid down in gas appliances.

11. COMBUSTION REQUIREMENTS:

The percentage of carbon monoxide in flue gases shall not be in excess of 0.05%

11.1 METHOD OF TEST:

The outlet water temperature, in running water tests, shall be within $\pm 5^{\circ}\text{F}$ (-15°C) of 130°F (55°C).

On storage type heaters/Geysers the tank shall be filled with water at 70°F (21°C), $\pm 2^{\circ}\text{F}$ (-17°C). At the end of 15 minutes of operation at normal test pressure, two samples of the flue gases shall be secured at a point immediately preceding their discharge from the flue outlet of the heater. They shall be taken progressively in the following manner:-

- a) For water heaters/Geysers not equipped with a gas pressure regulators:-

At the increased test pressure after 5 minutes of operation at that pressure and at the reduced test pressure after an additional 5minutes of operation at that pressure. These samples shall be analyzed for carbon dioxide and carbon monoxide. The samples shall be secured before the thermostat begins to reduce the gas rate.

11.2 BURNER AND PILOT OPERATING CHARACTERISTICS:

During operation of the water heater/Geyser, flames shall not extinguish from causes other than normal functioning of the appliance. Water, at a temperature of 70°F (21°C), $\pm 2^{\circ}\text{F}$ (-17°C), shall be supplied to the heater/Geyser through the inlet connection. After the system has been filled, the inlet water valve shall be closed.

The water heater/Geyser shall be operated at the increased test pressure until condensation of the flue gases within the heater/Geyser ceases, or for a period of time sufficient to demonstrate that it would continue to operate in a normal manner.

Burner flames shall not flash back nor become permanently extinguished when subjected to a draft equivalent to a wind velocity of 10 miles per hour striking the heater /Geyser from any side.

The appliance shall be operated for a period of 15 minutes at normal test pressure. A 10 mile per hour wind shall then be directed for a period of 1 minute alternatively against the front sides and back of the water heater/Geyser by means of a fan or blower to determine the stability of burner flames. The burner shall not flash back nor become completely extinguished. This test shall be applied with and without the main burner(s) in operation.

Continuously burning pilot flames shall not be extinguished when the gas to the main burner(s) is ignited in a normal manner even though the pilot gas is burning at the orifice with just sufficient input to maintain the automatic pilot device in the open position.

11.3

AUTOMATIC PILOTS:-

The time required for an automatic pilot, or automatic pilot system, to turn on the gas supply after the pilot has been lighted in accordance with the manufacturer's instructions shall not exceed:-

- a) Not more than ½ minutes for automatic pilots requiring a continually applied manual force to assume the "ON" position, and
- b) Not more than ½ minutes for automatic pilots which operate every time the main burner(s) with which they are used are turned "ON" and "OFF".

Automatic pilot systems shall close the main gas supply within the period of 3 minutes after gas to the appliance is shut off.

The thermostat, if provided, shall be set at the maximum temperature setting if of the adjustable type.

With the water at 70 °F(21°C), ± 2°F(-17°C), at the start of the test, the gas at the main burner(s) shall be lighted and permitted to burn for 1 hour at normal test pressure, or until the thermostat starts to reduce the main gas supply. For instantaneous the outlet water temperature shall be maintained during the test at 130°F(55°C), ± 2°F(-17°C).

The gas supply to the main burner(s) and water to the appliance shall then be shut off. The pilot flame shall then be extinguished but pilot gas flow shall be continued. Under this condition, the time for the system to close the main gas supply shall not be more than 3 minutes.

12.

THERMAL EFFICIENCY:

The thermal efficiency of instantaneous and circulating heaters/Geysers shall not be less than 65%.

The water heater/Geyser to be tested shall be installed and the cold water connection being made at the inlet. The gas input rating shall be adjusted and maintained at normal test pressure.

The temperature of the inlet water shall be maintained at 70°F(21°C), ± 2°F(-17°C).

The water temperature shall be adjusted by varying the rate of flow with the inlet valve until the outlet water temperature is constant at 70°F(21°C), ± 2°F(-17°C), above the inlet water temperature. After the outlet temperature has become constant as indicated by no variation in excess of 1°F over a 3 minute period, the outlet water shall be diverted from the waste line to a weighing container.

The gas meter shall be read at this time. Water shall be allowed to flow into the weighing container for exactly 30 minutes, at this time it shall be diverted back into the waste line, the meter reading noted and the weight of heated water recorded.

Throughout the period of test, the inlet and outlet water temperatures shall be recorded every minute. The temperature and heating value of the gas burned and barometric pressure shall be obtained.

Efficiency shall be computed by use of the following formula:-

$$E_t = \frac{W (\theta_2 - \theta_1)}{CF \times Q \times H} \times 100$$

Where

- E_t = Thermal Efficiency, per cent
- W = Total weight of water heated, lbs
- θ₁ = Average temperature of inlet water, °F
- θ₂ = Average temperature of drained water, °F
- Q = Total gas consumed as metered, cu. ft.
- CF = Correction factor to reduce the observed gas volume to 30 inches of Mercury pressure and 60 °F(16°C).
- H = Total heating value of gas, Btu per cu. ft.

Automatic storage heaters/Geyzers having input ratings above 20,000 Btu per hour shall have a thermal efficiency of not less than 65%. The stand-by loss of heaters in this category shall not exceed 10%.

13.

METHOD OF TEST:

- a) The water heater/Geyser shall be installed in accordance with the manufacturer's instructions. Thermometers shall be installed in the cold water inlet line, the hot water outlet line, and a line from the drain connection shall be arranged to discharge into a container in order to weigh the water. Provision shall be made for shutting off the above lines. The gas rate shall be adjusted and maintained at normal test pressure.

Before starting any tests the setting of the thermostat shall first be obtained by starting the water in the system at 70°F(21°C), ± 2°F(-17°C), and noting the maximum temperature of the water drawn from the hot water outlet immediately after the thermostat

reduces the gas supply to a minimum. The temperature shall be 160°F (71°C), ± 15°F (-10°C).

The meter reading shall be noted and water heater /Geyser shall again be put into operation. When the thermostat reduces the gas supply to a minimum, the inlet water valve and gas valve shall be closed immediately the meter reading taken and the water in the storage vessel drained. The heat content of the water shall be determined by allowing the water flow into a container and reading its temperature at 10 pound intervals, noting the total weight as well. During this test, the temperature and calorific value of the gas and barometric pressure shall be taken and recorded.

Efficiency shall be computed by means of the following formula:-

$$E_t = \frac{W(\theta_2 - \theta_1) \times 100}{(CF \times Q) \times H}$$

Where

- E_t = Thermal Efficiency, per cent
 W = Total weight of water heated, lbs
 θ_1 = Average temperature of inlet water, °F
 θ_2 = Average temperature of drained water, °F
 Q = Total gas consumed as metered, cu. ft.
 CF = Correction factor to reduce the observed gas volume to 30 inches of Mercury pressure and 60 °F(16°C).
 H = Total heating value of gas, Btu per cu. ft.

- b) Stand-by loss shall be determined and shall not exceed 10% per hour of the heat content of the stored water above room temperature.

The water heater/Geyser shall be installed as outlined above under (a). The gas rate shall be adjusted and maintained at normal test pressure. The inlet water temperature for the purpose of this test shall be maintained at 70°F(21°C),± 2°F(-17°C). The thermostat setting shall be the same as that employed during the efficiency test in (a). The pilot or by-pass consumption shall be within the limits specified by the manufacturer.

The gas to the pilot or the by-pass shall then be lighted and the gas to the main burner(s) should turn on. The water heater/Geyser shall be allowed to cycle a sufficient number of times to assure the attainment of thermal equilibrium before beginning the test. In the case of a graduating thermostat, initial meter reading shall then be taken immediately after the thermostat reduces the main gas supply to a minimum and when the water temperature at the top of the storage vessel is constant at 160°F(71 °C), ± 5°F (-15 °C). The duration of the test shall neither be less than 24 hours nor less than 2 cycles.

The final meter reading shall be taken when the water temperature, as recorded by the recording thermometer, corresponds to the initial reading.

In the case of snap or quick-acting thermostats, the burner consumption shall also be taken from the time the thermostat opens until it closes for any cycle. The reason for this is to be able to compute the heat content of the stored water at the time the thermostat turns on.

The room temperature shall not vary more than ± 50°F (10 °C) from the average during the test, temperature readings being taken by means of a recording thermometer and averaged at the end of the test. The calorific value of the gas, barometric pressure and gas temperature shall be taken at such intervals that a fair average may be obtained.

Immediately after the conclusion of the test, the inlet water valve shall be closed and the average temperature of the stored water determined by allowing the water to flow into a container and reading its temperature at 10 pounds intervals, noting the total weight as well.

The average gas consumption, including pilot consumption, in Btu per hour, expressed as a percentage, S, the heat content of the stored water above room temperature shall be determined by the formula:-

$$S = \frac{(CF \times Q) \times H}{W (\theta_2 - \theta_1)} \times 100$$

Where

- S = Stand-by loss, percent per hour, expressed as a percentage of the total heat content of the stored water above room temperature, per cent
- W = Total weight of water heated, lbs
- θ_2 = Average temperature of stored water, °F
- θ_1 = Average room temperature, °F
- Q = Total gas consumed as metered, cu. ft.
- CF = Correction factor to reduce the observed gas volume to 30 inches of Mercury pressure and 60 °F(16 °C).
- H = Total heating value of gas, Btu per cu. ft.

14. WALL AND FLOOR TEMPERATURES:-

During the course of these tests, water flow rate through the water heater/Geyser shall be regulated to deliver outlet water at a constant temperature of 160 °F(71 °C), $\pm 5^\circ\text{F}$ (-15 °C), with the main burner(s) operated at maximum input rating.

The maximum temperature on adjacent walls at points 2 inches from the nearest part of the heater/Geyser jacket or flue for insulated and under fired storage type heaters/Geysers, and at points 6 inches away from such parts of all other types of heaters/Geysers, shall not be more than 90°F(32°C) in excess of room temperature.

15. STORAGE VESSELS OF ASSEMBLY UNITS:-

Storage vessels of assembled units shall withstand a hydrostatic test pressure of 100 pounds per square inch, or their rated hydrostatic test pressure if greater than this amount, without developing leakage or permanent deformation.

16. METHOD OF TEST:

The storage vessel shall be connected to a water supply through a hand pump system incorporating an air chamber, a calibrated bourdon pressure gauge graduated in increments of not more than 5 pounds per square inch., check valve and shut off valves. All tapped openings in the storage vessel shall be closed by use of threaded fittings.

If the storage vessel is equipped with a pressure relief device, the device shall be removed and the opening plugged. The storage vessel and system shall be filled with water at 75°F(24 °C) and at atmospheric pressure, care being exercised to avoid any pocketing of air before starting the test, such measurements of the storage vessel as are necessary to reveal permanent deformation resulting from the hydrostatic pressure test shall be taken.

These observations shall include circumferential measurements at intervals along the vessel of not more than 12 inches by a method permitting readings to be made directly to 0.001 inch. Extensometers reading to 0.001 inch shall be placed with the movable spindles against top and bottom heads.

Hydrostatic pressure in the system shall be gradually raised by means of the hand pump until 150 pounds per square inch, or the rated test pressure of the storage vessel, if greater than that amount, is reached. This pressure shall be maintained for one half hour. At the end of this time, the pressure in the system shall be reduced to atmospheric and the measurements originally taken again repeated. Circumference measurements shall not vary by more than 0.2 percent of the corresponding measurement taken prior to the application of the test pressure. Top or bottom head deflections as shown by the extensometers shall not exceed 0.5% of tank diameter. At no time during the application of the hydrostatic pressure test shall any leakage of water from the storage vessel be evidenced.

Water carrying parts of water heaters/Geysers not containing a storage vessel shall withstand a hydrostatic pressure test of **150** pounds per square inch or their rated hydrostatic test pressure if greater than this amount, without rupture or visible permanent deformation.

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