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PAKISTAN STANDARD

Storage Gas Water Heater / Geyser



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

Pakistan Standard Specification For Storage Gas Water Heater/Geysers

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Pakistan Standard Specification

For

Storage 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

0.2 This Standard was first formulated in 2008 which was revised in 2017. 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 academia, manufacturers, specialists, technologists and utilizing agencies, it has now become imperative to revise the prevailing version.

0.4 In preparation of this standard the Technical Committee has derived assistance from the following foreign publication:

ANSI Z21.10.1:19

BS EN 89:2015

0.5 This revised version of PS: 4858 is adopted after taking into consideration the views and the suggestions of manufacturers, specialists, technologists and utilizing agencies and working committee constituted under the chairmanship of Senator, Nauman Wazir, It is hoped that user will find it well in line with the technical barriers to trade agreement (WTO/TBT).

0.6 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:

- 1.1 These requirements apply to automatic storage type water heaters/Geysers having Natural Gas input rating of 20,000 Btu per hours and over.
- 1.2 In this Standard, “shall” is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the standard; “should” is used to express a recommendation or that which is advised but not required; and “may” is used to express an option or that which is permissible within the limits of the Standard.

2. CONSTRUCTION REQUIREMENT:

2.1 GENERAL CONSTRUCTION AND ASSEMBLY:

- 2.1.1 The construction of a water heater, whether specifically covered in this standard or not, shall be in accordance with reasonable concepts of safety, substantiality and durability.
- 2.1.2 The general construction and assembly of the water heater shall be of a neat and quality manufacturer with parts well fitted and bolts or other fasteners drawn up tightly to give rigidity. Any exposed edges that might reasonably be brought in contact with the hand during servicing and usage shall be smooth.
- 2.1.3 An access opening shall be provided in the vertical water heater/Geysers 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/Geysers installed as it would be in service, this requirement shall be deemed met.
- 2.1.4 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.
- 2.1.5 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.
- 2.1.6 The actual capacity of the storage vessel shall be within + 5% of the nominal capacity of the water heater/Geysers.
- 2.1.7 An appropriate designed conical flue baffle shall be placed in the flue ways to improve the thermal efficiency of the water heater/Geysers. To clean the flue ways by removing the flue baffles of internal flue type automatic water heaters/Geysers shall be installed at suitable place.

Note: *Preferably a conical flue baffle having 55mm diameter with a length of 1120 mm for 25 gallon to 55 gallon should be used. Additional size of conical baffle should be based on the capacity of water heater.*

- 2.1.8 A sacrificial anode rod (anti-corrosion rod) shall be introduced in the tank of the water heater/Geysers to delay the corrosion of the inner side of the tank.

2.2 MATERIALS:

- 2.2.1 The manufacturer shall supply evidence that materials in contact with potable water are suitable for food contact surfaces.

- 2.2.2 All parts, except flue baffles, with surfaces in contact with flue gases shall have rigidity, and heat and corrosion resistant

Note: *Heat and corrosion resistant of said parts should not less than that of 0.772 mm (0.0304 inch) thick AISI C1010 steel.*

- 2.2.3 The storage vessel shall be constructed of metal sheet having a thickness not less than No. 14 U.S. Standard Gauge AISI steel (t= 2.0mm/0.08 in.).

Note: *Storage vessels should be protected against corrosion by hot dip galvanization or suitable treatment should be given to welded joints followed by galvanizing inside the tank. As an alternative the inside of the storage vessel should be protected by the application of suitable ceramic coating on un-galvanized metal sheet*

- 2.2.4 The positioning and placement of the hot water pipe, cold water pipe and sacrificial anode rod shall be maintained as per standard practice.

- 2.2.5 The finish of jackets and other exposed parts shall be durable and uniformly applied.

- 2.2.6 Insulation jackets shall be of same material as storage vessel to avoid corrosion.

- 2.2.7 Thermal Insulation should cover uniformly all sides and top except bottom. Thermal Insulation material shall be of inorganic origin with thickness not less than 25 mm and conductivity not exceeding 0.043 K cal/m²/ h °C/mm.

Note: *Preferably it should be either high density glass wool or extruded polystyrene.*

- 2.2.8 Parts and fittings shall not sag, distort, melt, or show leakage of gas when used as a gas conduit during any of the tests specified herein.

2.3 BURNERS AND PILOTS:

- 2.3.1 Main burners and mixer tubes shall be properly placed and securely positioned so the burners will not twist, slide, or drop out of position while in service.

- 2.3.2 Burners shall be constructed of a corrosion-resistant material or have a corrosion-resistant finish to resist corrosion by condensate. Steels with coatings, such as paint suitable to the temperature to which exposed, and cast iron are considered corrosion resistant.

- 2.3.3 Main burner orifice spuds shall be constructed of metal having a melting point of not less than 788 °C (1450 °F).
- 2.3.4 The diameter of main burner shall not be less than 127mm.
- 2.3.5 Provision shall be made to permit satisfactory visual observation (a glass window) of main burner flames and pilot(s) during adjustment and under operating conditions with the combustion chamber door in place.
- 2.3.6 Water heaters shall be equipped with an automatic pilot and pilot burners.
- 2.3.7 Pilot burner tips shall be made of material having heat and corrosion-resistant properties equal or superior to AISI Type No. 416 steel. Nickel alloys of greater than 1.0 percent nickel, because of catalytic cracking effect, are not acceptable.
- 2.3.8 Frames and mounting brackets for automatic ignition devices and flame responsive elements shall be constructed of a metal having a melting temperature of not less than 788°C (1450 °F). Pilot burner bodies and orifice spuds shall be constructed of a material having a melting point above 538°C (1000°F).
- 2.3.9 Orifice fittings, except those used with multiple injection tube burners, shall be adjustable and replacement. In all cases, orifice fittings shall be securely positioned to prevent misalignment with the burner mixer.
- 2.3.10 direct ignition system

2.4 AUTOMATIC GAS IGNITION SYSTEMS

- 2.4.1 Every water heater should be equipped with an automatic gas ignition system(s).
- 2.4.2 When a piezo-electric spark device is provided, it shall be used to ignite only pilot burner gas.

2.5 GAS AND WATER CONNECTIONS:

2.5.1 Water connections will be sized as follows:-

Rated Storage Capacity	Gas Connection	Water Connection
Upto 30 Gallons (or 135 Litres)	½ " or ¾"	1 "
31 to 50 Gallons (or 139.5 to 225 Litres)	½" or ¾"	1¼"
51 to 100 Gallons (or 229.5 to 450 Litres)	¾" or 1 "	1½ "

- 2.5.2 Hot water connection, cold water connection, or both, shall be clearly and permanently identified.
- 2.5.3 A pressure relief valve should be installed.

2.6 THERMOSTATS

- 2.6.1 Automatic storage type water heaters shall be equipped with a thermostatic control mounted on the tank.
- 2.6.2 A thermostat shall have no setting higher than 75 °C (167 °F).
- 2.6.3 The construction of push-button or trigger valves shall be such that they cannot accidentally be blocked in the open position.

2.7 TEMPERATURE LIMITING DEVICES:

- 2.7.1 The following devices are considered as being temperature limiting devices:
 - a. Automatic gas shut off system
 - b. Temperature relief valves or combination temperature and pressure relief valves.
- 2.7.2 Water heaters shall be provided with one of the above temperature limiting devices as an integral part of the heater.
- 2.7.3 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).
- 2.7.4 Immersion type automatic gas shut off devices shall be located so that the temperature sensitive element is immersed as close to the top of the tank as possible.
- 2.7.5 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.
- 2.7.6 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.

2.8 DRAFT HOODS:

- 2.8.1 All water heaters/Geysers shall have flues and draft hoods as standard equipment. The outlet of such draft hoods shall accommodate vent connector.
- 2.8.2 Provision shall be made to assure a firm support of:
 - The draft hood or vent connector to the flue outlet; and
 - The vent connector to the draft hood.
- 2.8.3 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 (t= 0.024 in/ 0.628mm).

3. MARKING;

- 3.1.1 Each appliance shall be indelibly marked with the following;

- i. Manufacturer's name or trade mark (embossed)
- ii. Knob's indicating "OFF" with Red Color Coding, "Pilot" position with Yellow and Burner position "ON" with Green color coding.
- iii. Country of origin.
- iv. Gas input rating
- v. Thermal Efficiency
- vi. Standby Heat Loss

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

3.1.3 It shall 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.

4. PACKING

4.1.1 Water Heaters of all types 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.

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

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

5. PERFORMANCE REQUIREMENTS

5.1 GENERAL

5.1.1 The following requirements will apply in addition to all the specifications and requirements laid down in other governing Pakistan (PS) gas appliances.

5.1.2 The water heater shall be installed and operated in accordance with the manufacturer's instructions unless specifically required otherwise by the Method of Test.

- 5.1.3 During tests for compliance with these requirements a water heater/Geyser shall depend solely on the principals of design incorporated in the appliance itself for successful operation.
- 5.1.4 The appliance is installed in a well-ventilated, draught-free room (air speed less than 0.5 m/s), which has an ambient temperature of 20(+7to -3°) C, unless otherwise specified. The appliance is protected from direct solar radiation.
- 5.1.5 The draft hood shall be in place during all performance tests.
- 5.1.6 Temperature limiting devices shall be in place during all tests.

5.2 COMBUSTION REQUIREMENTS

- 5.2.1 Flue gases shall contain no more than the following than the following percentage values:

	Maximum allowable value
Carbon Monoxide	0.04%
Oxygen	2-4%

5.2.2 Method of Test: Combustion Efficiency:

- 5.2.3 The tank shall be filled with water at $21 \pm 1^{\circ}\text{C}$ ($70 \pm 2^{\circ}\text{F}$). The thermostat shall be set to the high stop. When necessary for continuous burner operation, a water flow rate shall be established to maintain an outlet water temperature of $54.4 \pm 3^{\circ}\text{C}$ ($130 \pm 5^{\circ}\text{F}$). This flow shall be established when the water in the tank reached 54.4°C (130°F).
- 5.2.4 At the end of 15 minutes of operation at normal inlet test pressure, two samples of the flue gases shall be secured at a point immediately preceding their discharge from the flue outlet of the appliance. The two samples shall be taken progressively:
- 5.2.5 One with the appliance adjusted to have an input rate of 106.25 percent of the manufacturer’s specified input rate. This condition shall be obtained by changing the outlet pressure of the regulator.
- 5.2.6 The sample of flue gases shall be secured after 5 minutes at this input rate.
- 5.2.7 The outlet pressure of the appliance regulator shall then be returned to it’s normal setting to provide the manufacturer’s specified input rate.
- 5.2.8 The gas supply pressure to the appliance shall be adjusted to the reduced inlet pressure of 0.87 kPa at 3.5 inches water column.
- 5.2.9 After 5 minutes of operation at this pressure, a second sample of flue gases shall be secured at a point immediately preceding their discharge from the flue outlet of the appliance.

5.2.10 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.

5.2.11 The average of the two samples shall be used as the measure of compliance with the maximum allowable values.

5.3 BURNER AND PILOT OPERATING CHARACTERISTICS

5.3.1 During operation of all types of water heaters flames shall not extinguish from causes other than normal functioning of the appliance.

5.3.2 Burner flames shall not flash back nor become permanently extinguished when subjected to an external draft.

5.3.3 Method of Test: Maintenance of Flame and Flashback

5.3.4 For Storage Water Heaters, water at a temperature of 21°C, $\pm 1^\circ\text{C}$, shall be supplied 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.

5.3.5 A 3 mph (1.34 m/s) wind shall then be directed for a period of 1 minute alternatively against the front sides and back of the water heater by means of a fan or blower to determine the stability of burner flames. Wind speed to be measured immediately next to the outer water heater casing of the water heater directly in line with the flow of air.

This test shall be applied with and without the main burner(s) in operation.

5.3.6 The burner shall not flash back nor become completely extinguished.

5.3.7 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.

5.4 AUTOMATIC PILOTS

5.4.1 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) 30 seconds for automatic pilots requiring a continually applied manual force to assume the "ON" position, and

(b) 30 seconds for automatic pilots which operate every time the main burner(s) with which they are used are turned "ON" and "OFF".

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

5.4.3 For storage water heaters, the thermostat, if provided, shall be set at the maximum temperature setting if of the adjustable type.

5.4.4 With the water at 21.0°C, ±1.0°C, at the start of the test, the gas at the main burner(s) shall be lit and permitted to burn for 1 hour at normal test pressure, or until the thermostat start turns off the gas supply.

5.4.5 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.

5.5 THERMAL EFFICIENCY, STANDBY HEAT LOSS AND PILOT LIGHT ENERGY CONSUMPTION

5.5.1 Water heaters shall have the following minimum thermal efficiency:

	Minimum Thermal Efficiency
Storage Water Heaters	65-84%

5.5.2 NEECA Star Rating Classification based on Thermal Efficiency Threshold Levels shall be complied as Annex-A.

5.5.3 Water heaters shall have the following maximum Standby Heat Loss Rate:

Rated Storage Capacity	Maximum Standby Heat Loss Rate per Hour
Storage Water Heaters	Not great than 10%

5.5.4 Where fitted, water heater pilot lights shall consume no more that the following maximum hourly energy value:

Maximum hourly pilot light energy consumption	0.045 cu m/hr or 1.5826 MJ/hr or (1500 Btu/hr)
------------------------------------------------------	------------------------------------------------------

5.5.5 Method of test: Thermal Efficiency

5.5.6 The water heater 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.

5.5.7 Before starting any tests the setting of the thermostat shall first be obtained by starting the water in the system at 21.0°C, ±1.0°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 61.0°C, ± 8.0°C.

5.5.8 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.

5.5.9 Thermal Efficiency shall be computed by means of the following formula:

$$E_t = \frac{m \times C_p (T_2 - T_1) \times 100}{(V) \times H}$$

Where

- E_t = Thermal Efficiency, per cent
- m = Total mass of water heated, kg (lbs)
- C_p = Specific heat capacity of water, 4.186×10^{-3} MJ/kg °K (1.0 Btu/lb °F)
- T_1 = Average temperature of inlet water, °C (°F)
- T_2 = Average temperature of drained water, °C (°F)
- V = Total gas consumed as metered, cu. m (ft³)
- H = Total heating value of gas, MJ / cu. m (Btu/ ft³)

5.5.10 Method of test: Standby Heat Loss Rate

- 5.5.11 The storage water heater shall be installed as detailed in Clause 5.5.3
- 5.5.12 The inlet water temperature for the purpose of this test shall be maintained at 21.0°C, ±1.0°C. The thermostat setting shall be the same as that employed during the thermal efficiency test in Clause 5.5.5 The pilot or by-pass consumption shall be within the limits specified by the manufacturer.
- 5.5.13 The gas to the pilot or the by-pass shall then be lit and the gas to the main burner(s) should turn on. The water heater 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 be 61.0°C, ± 3°C.
- 5.5.14 When thermal equilibrium is achieved, a gas meter reading should be taken.
- 5.5.15 The water heater should then be left to operate normally for at least 24 hours, or two reheat 2 cycles, whichever is the longer.
- 5.5.16 A final gas reading shall be taken when the water temperature, as recorded by the recording thermometer, corresponds to the initial reading.

- 5.5.17 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.
- 5.5.18 The room temperature shall not vary more than $\pm 3.0^{\circ}\text{C}$ 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.
- 5.5.19 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.
- 5.5.20 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:

$$S = \frac{(V) \times H \times 100}{m \times C_p \times (T_s - T_r)}$$

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
- m = Total mass of water heated, kg (lbs)
- T_s = Average temperature of stored water, $^{\circ}\text{C}$ ($^{\circ}\text{F}$)
- T_r = Average room temperature, $^{\circ}\text{C}$ ($^{\circ}\text{F}$)
- V = Total gas consumed as metered, cu. m (ft^3)
- C_p = Specific heat capacity of water, 4.186×10^{-3} MJ/kg $^{\circ}\text{K}$ (1.0 Btu/lb $^{\circ}\text{F}$)
- H = Total heating value of gas, MJ / cu. m (Btu/ ft^3)

5.5.21 Method of Test: Pilot light energy consumption

- 5.5.22 For storage water heaters with a pilot light, the water heater shall be installed in line with the manufactures instructions.
- 5.5.23 The pilot light shall be lit and left to reach thermal equilibrium, typically 15 minutes.
- 5.5.24 A gas meter reading will be made, with a further reading taken after 1 hour.
- 5.5.25 The energy consumed by the pilot during the period is determined from the following formula:

$$E_p = (V) \times H$$

Where

- Ep = Energy consumed by the pilot (MJ/hr) (Btu/ hr)
 V = Total gas consumed as metered, cu. m (ft³)
 H = Total heating value of gas, MJ / cu. m (Btu/ ft³).

5.6 FLUE GAS TEMPERATURE

- 5.6.1 The average temperature of the flue gases shall not exceed 266.5°C (480°F) above room temperature. This provision does not apply to water heaters for outdoor installation only.

5.6.2 Method of Test

- 5.6.3 This test shall be conducted at normal inlet test pressure. The flow of water through the appliance shall be regulated to deliver outlet water at the maximum setting of the thermostat. A sample of the flue gases shall be secured ahead of the draft hood and analyzed for carbon dioxide.
- 5.6.4 The draft hood relief opening shall then be blocked. A 610 mm (2 ft) long vertical vent pipe shall be attached to the outlet of a vertically discharging draft hood. If the draft hood discharges horizontally an elbow and a 610 mm (2 ft) section of vertical vent pipe shall be used. The draft hood, elbow, if used, and the vent pipe shall be insulated with a layer of 25.4 mm (1inch) glass fiber insulation. A horizontal plane of measurement shall be established within the insulated vent pipe, 305 mm (1 ft) below the vent pipe outlet, by establishing two lines, intersecting at 1.57 rad (90 degrees), and oriented so they will divide the internal cross section into four equal areas.
- 5.6.5 The vent pipe outlet shall be gradually restricted until the carbon dioxide concentration in a sample of flue gases secured in the plane of measurement noted above is the same as determined under the conditions specified in the first paragraph under the Method of Test.
- 5.6.6 The flue gas temperature shall then be determined using a bead type, iron-constantan thermocouple not larger than 0.20 mm² No. (24 AWG). One temperature reading shall be taken at the intersection of the two lines in the plane of measurement, and eight readings taken in two sets of four along each line at points respectively 1/3 and 2/3 of the distance from the intersection of the lines to the periphery of the test vent. The flue gas temperature shall be the average of the individual readings. At the discretion of the testing agency, these readings may be obtained using bead-type, iron constantan thermocouples not larger than 0.20 mm² No. (24 AWG) secured in the positions described above by a frame inserted in the vent and presenting no appreciable restriction to the passage of the flue gasses.

5.7 WALL AND FLOOR TEMPERATURES

- 5.7.1 The temperature of walls, ceiling, and floor adjacent to or in contact with the water heater shall not exceed room temperature by more than 65 °C (117 °F). The temperatures on the floor under the water heater shall not exceed 50 °C (90 °F) above room temperature.

5.8 HYDROSTATIC TEST

5.8.1 Storage vessels of assembled units shall withstand a **hydrostatic test** pressure of 1.04 MPa (10.36 bar/150psi), or their two times manufacturer's rated hydrostatic test pressure if greater than this amount, without developing leakage or permanent deformation.

5.8.2 Method of Test: Hydrostatic Pressure

5.8.3 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 34.5 kPa (0.35 bar/5psi), check valve and shut off valves. All tapped openings in the storage vessel shall be closed by use of threaded fittings.

5.8.4 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 21.0°C, ±1.0°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.

5.8.5 These observations shall include circumferential measurements at intervals along the vessel of not more than 30 cm (12 in.) by a method permitting readings to be made directly to 0.025 mm (0.001 in.). Extensometers reading to 0.025 mm (0.001 in.) shall be placed with the movable spindles against top and bottom heads.

5.8.6 Hydrostatic pressure in the system shall be gradually raised by means of the hand pump until 1034 kilo newton per square meter, 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.

6. SAFETY

6.1 WATER OVERHEAT SAFETY DEVICE

6.1.1 Requirements

6.1.2 The overheat safety device shall result in non-volatile lockout before the water temperature can exceed 100 °C(212°F).

6.1.3 The overheat safety device shall not be actuated by prolonged operation of the ignition burner or of the reduced rate of the modulating thermostat or the high/low thermostat.

6.1.4 Method of Test

6.1.5 The appliance is started up at its nominal heat input with one of the reference gases corresponding to its category.

6.1.6 The control thermostat is put out of operation.

6.1.7 The water temperature in the tank is measured by drawing off immediately at the moment of shutdown by the overheat safety device.

6.1.8 In addition, for appliances with a permanent or alternating ignition burner, and/or with a modulating or multi-rate ignition burner the following test is carried out:

- the control thermostat is adjusted to its maximum position;
- the ignition burner preset device, if fitted, is adjusted to its maximum position.

6.1.9 The main burner rate is reduced or stopped by the control thermostat and the ignition burner supplied at the maximum gas pressure.

6.1.10 After 16 h, it is verified that, solely under the action of the ignition burner or reduced rate, the water temperature in the tank has not risen to the above value.

6.2 ENAMELLING - PHYSIOLOGICAL SAFETY

6.2.1 The release of lead and cadmium ions or compounds into the water shall not exceed the following limit values:

Lead:

- cold water test: 0.3 mg/(m²,d);
- hot water test: 0.3 mg/(m²,h).

Cadmium:

- cold water test: 0.03 mg/(m²,d);
- hot water test: 0.03 mg/(m²,h).

6.2.2 Method of Test

6.2.3 A double parallel test with special specimen plates is carried out in cold and hot water. The cut edges of the specimen are covered with a coating of a material that does not contain lead or cadmium.

6.2.4 The cold water test shall be carried out using water at a temperature of 18 °C ± 5°C and the hot water test using water at a temperature of 90 °C ± 5°C. Two parallel tests are carried out with special specimen plates.

6.2.5 The cold water test is performed in 3 succeeding extractions of 72 h, the hot water test in 4 succeeding tests of 24 h.

- 6.2.6 It is checked that the results obtained from the final extractions (cold and hot) satisfy the requirements of the given limits for lead and cadmium. The concentration is measured at each extraction. Concentrations of the successive extractions shall be not greater than that obtained at the preceding extractions

6.3 REQUIREMENTS OF PLASTIC MATERIALS

- 6.3.1 In the manufacture of water heaters and their components, only those plastic materials that meet mechanical, chemical and thermal demands as well as physiological and hygiene requirements throughout the life of the equipment shall be used in contact with water intended for human consumption. This means they shall be suitable for coming into direct contact with food and not pose any health threat. Special attention shall be paid to microbiological properties of the plastic materials used and to the prevention of substances from leaching out

6.3.2 *Preferable selection of the plastic materials is given in Table as;*

Material Area of application	Abbreviation	Area of application
Unplasticized polyvinylchloride High and medium-density polyethylene	PVC-U PE-HD, PE-MD	Cold water systems
Cross-linked polyethylene Polybutylene Propylene copolymer (Polypropylene) Chlorinated polyvinylchloride	PE-X PB PP-H, PP-R PVC-C	Cold and hot water systems
Composite pipes (plastic-metal-plastic)	Various	Cold and hot water systems
Polyamides	PA, PPA	Cold and hot water systems

7. SOUNDNESS OF THE GAS CIRCUIT

7.1. Requirements

7.1.1 The gas circuit shall be sound.

Soundness is ensured if the leakage of air does not exceed:

- test n° 1: 0.06 dm³/h;
- test n° 2: 0.06 dm³/h, per shut-off device;
- test n° 3: 0.14 dm³/h.

7.1.2 Tests of Test

7.1.3 The appliance gas inlet is connected to an air supply delivering an appropriate and constant pressure.

7.1.4 The appliance is at room temperature which shall remain constant throughout the tests.

7.1.5 The tests are carried out, firstly on delivery of the appliances, before any other test, and then on completion of the tests in this standard and after parts of the gas circuit comprising gas-tight joints which are specified as being removable in the technical instructions are removed and refitted 5 times.

Annex-A

Rated Storage Capacity	1 Star*	2 Stars	3 Stars	4 Stars	5 Stars
Upto 30 Gallons (or 135 Litres)					
31 to 50 Gallons (or 139.5 to 225 Litres)	65%-67	68%-71%	72%-75%	76%-80%	>81%
51 to 100 Gallons (or 229.5 to 450 Litres)					

Note: The product should comply with all the parameters specified in 5.5.1, 5.5.2 and 5.5.3.