Installation, Operation & Maintenance of Temperature Gauges

Recommendations on the selection and installation of Temperature Gauges, regarding (ATEX) 2014/34/EU Equipment Group II for Zones 1, 2, 21, 22.

STEWARTS

FOREWORD

This manual is an integral part of the supply, please read carefully before using this product.
Keep it in a safe place for reference as may be required.
The user should make it available to local I.O.M. trained personnel.

1 – GENERAL

1.1 The sudden and uncontrolled release of pressure to atmosphere (particularly of gas and steam) represents a potential danger.
1.2 Fire, explosion, fatigue, corrosion etc. within a pressure system can lead, in some instances, to complete disintegration or melting of the instrument with violent effects.
1.3 It is the responsibility of both the manufacturer of pressure containing components and the user to protect operators from this danger by ensuring the system is properly designed, constructed from suitable materials and is correctly installed, maintained and operated by technically competent persons.
1.4 In the UK, these responsibilities are covered by Government legislation, in the European Union the PED and ATEX Directives are applicable, (EU-OSHA is the European Union information agency for occupational safety and health).
(i) **Health and Safety at Work Act**, 1974.
(ii) **Pressure Systems Safety Regulations 2000** (SI 2000 No.128), L122 second Edition 2014.
(iii) **Pressure Equipment (Safety) Regulations 2016** (SI 2016 No.1105), or the **Pressure Equipment Directive** (**PED**) **2014/68/EU**.
(iv) **The Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 2016** (SI 2016 No. 1107) or (**ATEX**) **Directive 2014/34/EU**.
(v) **The Dangerous Substances and Explosive Atmospheres Regulations 2002** (**DSEAR**), L138 second Edition 2013, or (**ATEX Workplace Directive**) (**ATEX 137**) **Directive 99/92/EC**.
You are advised to be familiar with this legislation and any that apply in countries out with the UK where these products may be used.
1.5 Temperature Gauges whose failure or being out of calibration could lead to danger must be maintained in good working order and calibration. They must not be isolated from the system (except for repair, replacement or re- calibration).
1.6 In view of the wide variety of operating conditions where these components may be installed, it is impossible to stipulate an exact period for calibration checks. Depending upon these operating conditions the user will have to determine, in the light of experience, what constitutes a reasonable period between calibration checks. This may vary from daily to several months, but we would recommend a maximum period of three months between checks and immediate action taken to replace or remedy any instrument that is damaged or does not meet the accuracy requirements.
1.7 The accuracy of Temperature Gauges should be checked against a Test Thermometer or a Master Thermometer of known and certified accuracy traceable to National Standards.
1.8 These notes have been prepared to assist in the selection and installation of Temperature Gauges, to ensure, as far as possible, they give safe and satisfactory service in the purpose for which they are intended. They are based largely on European Standard ***EN 13190*** for Temperature Gauges. Reference to this Standard should be made for further information.
1.9 It is essential the manufacturer be advised of any arduous or non-standard conditions under which these instruments may operate so that the correct product can be offered. In the absence of any information to the contrary, instruments of standard ATEX materials of construction will be supplied.
If any doubt exists, it is imperative the Manufacturer is consulted.

2 – TEMPERATURE GAUGES

2.1 MATERIALS
2.1.1 Wetted parts used in the construction of HVAC gauges are made from bronze or brass and similar non-ferrous materials. Such gauges are suitable for use on Air, Oil & Water and other non-corrosive fluids.
2.1.2 For corrosive fluids, alternative materials, e.g. stainless steel, should be specified.
2.1.3 For special applications, e.g. when the process medium may be corrosive, at high pressure or have high flow rate or velocity in piping, a Thermowell should be used to protect the instrument sensing element and stem from damage due to external factors. (See also **2.6**)
2.1.4 Environmental conditions should be taken into account when considering suitable material for cases, capillary etc. Stainless Steel weatherproof cases and capillary (plain or armoured or PVC covered) are available for corrosive atmospheres and outside installations.
2.1.5 Do not use Glycerine filled gauges in any application which has present any strong oxidizing agents including (but not limited to) Chlorine, Nitric Acid and Hydrogen Peroxide.
2.2 GAS FILLED (GF) MEASURING ELEMENT MODELS
2.2.1 Care must be taken to ensure the temperature sensing element (bulb) is not damaged during installation. Do not attempt to bend the bulb.
2.2.2 The temperature sensing element (bulb) should be totally immersed in the medium which is being measured. If a Thermowell is being used, the heat transfer delay can be improved by filling the Thermowell with a heat transfer substance (i.e. graphite).
2.2.3 When fitting the temperature sensing element (bulb) into a Thermowell it is essential the bulb is not forced against the bottom of the Thermowell when tightening the nut. This can lead to increased pressure within the bulb and cause incorrect readings. The bulb should be inserted into the Thermowell until it bottoms and then withdrawn approximately 5mm before tightening the compression nut to hand tight plus one quarter turn.
2.2.4 Check capillary is correct length by laying along proposed route. Never attempt to stretch capillary as this will lead to fracture of pressurised system.
2.2.5 The capillary should be securely supported and clipped to a wall or other solid surface and must be free from buckling and twists and have a minimum bending radius of 60mm. Particular care should be taken at the points where the capillary enters the case and the bulb. Excess capillary should be coiled and arranged in free swinging loops between the last fixing point and the sensing element (bulb).
2.3 BI-METALIC (BM) MEASURING ELEMENT MODELS
2.3.1 Care must be taken to ensure the temperature sensing element (Bi-metal Spring) is not damaged during installation. Do not attempt to bend the stem.
2.3.2 The temperature sensing element (Bi-metal Spring) should be totally immersed in the medium which is being measured. If a Thermowell is being used, the heat transfer delay can be improved by filling the Thermowell with a heat transfer substance (i.e. graphite).
2.3.3 When fitting the sensing element (Bi-metal Spring) into a Thermowell it is essential the stem is not forced against the bottom of the Thermowell when tightening the nut. This can damage the element and cause incorrect readings. The stem should be inserted into the Thermowell until it bottoms and then withdrawn approximately 5mm before tightening compression nut to hand tight plus one quarter turn.
2.4 MAXIMUM WORKING TEMPERATURE
2.4.1 Whilst Temperature gauges will withstand a full-scale temperature, it is recommended that the maximum working temperature does not exceed 60% of the dial full-scale value.
2.4.2 Under no circumstances should Temperature Gauges be subject to a constant temperature greater than the dial full-scale value.
2.5 OPERATING TEMPERATURE
2.5.1 Ambient temperature acting upon the gauge. (See also **3.3**).
2.5.2 The maximum surface temperature of an instrument assembly, **not due to mechanical working**, can be equal to the dial full-scale value or process temperature, at the point of the process connection.
2.6 VIBRATION, PRESSURE SURGES, PRESSURE PULSES, OVERPRESSURE, HIGH PROCESS MEDIA FLOW RATE
2.6.1 All these factors can create stress in the temperature responsive element and can lead to rupture, loss of accuracy and premature failure. The manufacturer should be consulted where these conditions are present. A Thermowell is recommended in all applications.
2.6.2 It should be appreciated that the temperature responsive element in a temperature gauge is subjected to external stresses and if any of the above conditions are present, failure is liable to occur. Installing the instrument within a Thermowell will provide protection.
2.6.3 The instrument may exhibit excessive wear on the bearing surfaces of the movement if vibration is present. Gas Filled models are available with a Vibragauge movement to reduce wear effects.
2.6.4 If an installed gauge fails and exhibits the symptoms described in para.2.6.3. it is almost certain the wrong type of gauge has been used for that application and it is essential the Manufacturer be consulted.
2.7 THREADS AND JOINTING (INSTALLATION)
2.7.1 All pressure connections should be leak tight and should be tested when first applying pressure in the system.
2.7.2 Recommended maximum pressure for each size of thread and type of material must not be exceeded.
2.7.3 Carefully install to ensure mismatch of threads does not occur.
2.7.4 Mating female connections must have a pressure rating that is compatible with the maximum design pressure of the system.
2.7.5 Gauges with parallel threads must have the seal made on the flat seating using a washer of material compatible with the medium.
2.7.6 Gauges with tapered threads have the joint made by mating of the threads. It is common practice to apply jointing material to the male thread. This must be compatible with the medium and applied in the correct quantity to ensure non-interference with mating of the threads.
2.7.7 The joint must be made by tightening the gauge by means of a spanner on the hexagon or square provided on the screwed fitting.
Do not tighten by grasping the case of the instrument as this can lead to pointer shift and loss of calibration accuracy.
2.7.8 NPT and other tapered thread forms when manufactured to the standard specification may not be adequate to offer sufficient thread engagement for safe use under pressure.
Our tighter tolerance NPT threads ensure sufficient thread engagement.
Please consult our Datasheet Ref.QA125.20B for further information.
2.7.9 The instrument connecting thread, correctly installed, will form an Ohmic contact with the mating process connection, ensuring electrical continuity. (Also, for clamp or bolting of a flange connection).
2.8 MOUNTING
2.8.1 Instrument heads should be mounted in the vertical position unless otherwise agreed with the manufacturer.
2.9 STORAGE
2.9.1 Gauges should be stored in dry, clean conditions within the temperature range of -40°C to +70°C. Because of a possible build-up of internal pressure, liquid filled cases must be stored in the upright position and at temperatures not exceeding +50°C.
The housing can be ventilated after installation. See affixed label.
2.9.2 Gauges must be protected against any impact damage. This could affect the calibration or correct operation of the instrument without visible damage. Temperature Gauge calibration should always be confirmed prior to installation.
2.10 TRANSPORT
2.10.1 Although care is taken in packing these instruments for shipment, it is possible they can sustain transit damage.
2.10.2 Gauges should be checked for damage before use. (See also **2.9.2**).
2.11 MAINTENANCE
2.11.1 The function of the gauge does not require any special maintenance procedures, but frequent checks must be made to ensure the instrument is still working correctly and accurately. Check any blowout device has not been accidentally obstructed. Check for visual signs of damage to the instrument.
(Broken Window, Missing Blow-out Plug reduce the ***IP*** rating of gauge).
The instrument should be replaced if found not to be functional as specified. A good maintenance program will ensure safe operation.
2.11.2 Any shift in temperature readings greater than twice the tolerance of the instrument must be investigated and the immediate replacement of the gauge if it is faulty.
2.12 REPAIRS AND SPARE PARTS
2.12.1 The repair and recalibration of gauges should be undertaken only by competent personnel with the necessary facilities available.
2.12.2 We do not recommend the carrying of spare parts but advise the carrying of complete instruments which will allow quick replacement and ensure the system continues to operate within the requirements of the law.
2.12.3 Where the cost is justified, gauges should be returned to the manufacturer for any remedial work. Certified clean for safe handling.

3 – CONSTRUCTION

3.1 STANDARDS
3.1.1 Temperature Gauges are designed and constructed to comply with the requirements of international standards and legislative safety requirements. Full understanding of all obligations and compliance to these, are necessary for correctly specifying, installing, commissioning, operating and maintenance.
3.1.2 Temperature gauges are manufactured in accordance with international standards such as, ***EN13190*** (or ***ASME B40.200***), and also to corporate global standards, which reference these, to facilitate ease of selection and use.
3.1.3 Temperature Gauges must comply with legislation and directives in force in the UK, in Europe and elsewhere, as indicated in section **1.4**.
3.2. OPERATION PRINCIPLE
3.2.1 An elastic measuring element, Gas Filled Bourdon Tube & Bulb or Bi-metallic Spring, is subjected to a temperature and deflects. The linear deflection is proportional to the applied temperature and is transmitted, directly to the pointer for Bi-metal gauges, or via link, to a rotary geared movement for Gas Filled gauges. The movement carries the pointer which indicates the pressure on a circular dial scale ≤270°, printed with graduations of appropriate pressure units.
3.2.2 A Temperature Gauge has "**no own source of ignition**" when not in use or when under normal operating conditions, but when operating normally can have hot surfaces heated by the process.
In adverse conditions gauges may "**during foreseeable malfunction**" develop an ignition hazard. Additional accessories or features can be specified to prevent these potential hazards.
3.3 AMBIENT TEMPERATURE
3.3.1 Ambient temperature acting upon the gauge housing should be within the range -20°C to +60°C, as specified in ***EN13190***.
The instrument head and capillary (if fitted) should be protected from localised heat or cold sources as this can lead to indicating errors. Compensation for ambient temperature variation acting on the gauge housing is provided by a bi-metal link attached to the movement in Gas Filled models.
3.3.2 In regions with high solar radiation or high external heat source, Gauges should be installed with protection to prevent high surface temperature at the gauge housing.
3.3.3 In regions with low ambient temperature, liquid filling the gauge housing is recommended to safeguard instrument from effects of frost on internal mechanism or window. Gauges may also be installed within an insulated, heated, (***IP6x***) enclosure.
3.4 FEATURES
3.4.1 Temperature Gauges for **ATEX Directive 2014/34/EU** have housings manufactured from Stainless Steel Case & Bezel (***IP6x***) or Aluminium Case & Brass Bezel (***IP5x***). Sealing gaskets and filler plug are Nitrile on ***IP6x*** models. The window is Laminated Safety Glass.
ATEX hazard assessment based on ***EN ISO 80079-36*** and ***80079-37***.
3.4.2 Materials of construction in accordance with **PED 2014/68/EU**.

STEWART-BUCHANAN GAUGES LTD
Sales Office & Manufacturing Facility - 7 Garrell Road, Burnside Industrial Estate, Kilsyth, Glasgow G65 9JX, SCOTLAND
Tel: +44 (0)1236 821533 | Fax: +44 (0)1236 824090 | E-mail: sales@stewarts-group.com | Web: stewarts-group.com

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4 – OPERATING PARAMETERS

4.1 SPECIFICATION

4.1.1 Wetted materials must be compatible with process medium conditions.

4.1.2 Pressure and temperature also have direct bearing on the correct material to be used and must be considered when specifying.

4.1.3 Gauge housing to be compatible with local ambient conditions.

4.1.4 Correct temperature units must be represented on the dial scale.

4.1.5 If in any doubt, consult the manufacturer.

4.2 TEMPERATURE LIMITS

4.2.1 See Temperature Gauges sections **2.4** & **2.5**, for limitations on use.

4.3 THREADS AND JOINTING

4.3.1 See Temperature Gauges section **2.7**, for limitations on use.

4.4 ADDITIONAL FEATURES

4.4.1 Gauges are available with enhanced features or accessories to minimise hazards from known adverse process operating conditions.

4.4.2 Pressure Surges & Pulses; Thermowell protects gauge stem and temperature sensing element by providing a stronger barrier to process system pressure fluctuations.

4.4.3 System Vibration; Vibragauge® movement or Liquid Filled housing dampens pointer fluctuation. Remote mounting the instrument via capillary will avoid mechanical stresses.

4.4.4 High Process Media Flow Rate; Thermowell protects gauge stem and temperature sensing element by providing a stronger barrier to process flow induced stresses.

4.4.5 Corrosive Media; Thermowell protects gauge stem and temperature sensing element by providing a chemically compatible barrier to process mediums.

4.4.6 Overpressure; Thermowell protects gauge stem and temperature sensing element by providing a stronger barrier to process system pressure.

5 – GAUGES WITH ELECTRIC CONTACTS

5.1 Recommendations and instructions contained in sections **2** and **3** apply also to these instruments, except window is Perspex and dial size is Ø100mm.
We recommend these are built-in housing type (***IP6x***) with Liquid Filled housing.

5.1.1 Instructions regarding setting of contacts and wiring which accompany the instruments must be adhered to strictly.

5.1.2 Ensure the correct voltage and current are supplied.

5.1.3 All wiring should be either clipped to a solid surface or run in conduit piping. Avoid running close to a heat source or naked flame.

5.1.4 Different types of contacts are available to meet ATEX requirements, intrinsically safe or pneumatic contacts.
If in doubt, contact the manufacturer.

5.1.5 Where there is danger of explosion, intrinsically safe contacts, relay and cabling must be used. (Refer to Wiebrock and Pepperl+Fuchs datasheets).

5.1.6 Inductive contact switches to ***IEC 60947-5-6*** (NAMUR) with slot type proximity sensors certified to **2014/34/EU** (ATEX) and **2014/30/EU** (EMC).

5.1.7 We recommend a relay should be used in all applications, as this will give a more efficient and safer installation.
Switch amplifier WE 77/Ex. types, which are certified to **2014/34/EU** (ATEX), **2014/30/EU** (EMC) and **2014/35/EU** (LV).

5.1.8 Instruments supplied with electric contacts must not be used as "Safety Accessories" as described in the **Pressure Equipment (Safety) Regulations 2016** (SI 2016 No.1105), or the **Pressure Equipment Directive** (**PED**) **2014/68/EU**, unless the design has been subject to third party approval.
For further information contact the manufacturer.

5.2 MAINTENANCE

5.2.1 Always disconnect power supply before carrying out maintenance work.

5.2.2 Drain housing fill fluid prior to and re-fill after maintenance.

5.2.3 Check all electrical wiring and joints for any wear or damage.

5.2.4 Refer to contacts' label or diagram attached to the instrument.

6 – POTENTIAL MALFUNCTIONS

6.1 FAILURE MODES

6.1.1 Overpressure Failure.

6.1.1.1 Caused by the application of pressure greater than the rated limit of the stem or temperature sensing element. More critical in compressed gas than liquid-filled systems.

6.1.1.2 Installing the Stem/Element in a Thermowell provides the most protection by reducing possibility of damage during this failure mode.

6.1.1.3 Short duration pressure pulses can occur in systems when valves open or close and their magnitude may be many times the normal operating pressure causing immediate stem damage or elastic element failure or incorrect indication of temperature on the dial scale.

6.1.2 Corrosion Failure.

6.1.2.1 Caused when corrosive chemicals in the media attack and weaken the stem or temperature sensing element.

6.1.2.2 Installing the Stem/Element in a Thermowell provides the best protection by reducing possibility of corrosion during this failure mode.

6.1.3 Vibration Failure.

6.1.3.1 The most common mode of vibration failure is wear of movement parts or bearing surfaces due to high cyclic loading caused by vibration, which results in gradual loss of accuracy and ultimately failure of the pointer to indicate any pressure change.

6.1.3.2 Vibration can be subdued by Vibragauge® feature or Liquid Filled housing option.

6.1.4 Vibration-Induced Fatigue Failure.

6.1.4.1 The most common mode of fatigue failure is stress of stem parts due to high cyclic loading caused by media flow, which results in frequency induced oscillations and ultimately failure of the stem.

6.1.4.2 Fatigue can be eliminated by installing in a Thermowell, which can also be designed to overcome wake frequency failure mode.

6.2 OPERATING FAULTS

6.2.1 Temperature Indication error. (Pointer outwith accuracy class)

6.2.1.1 Calibration has been affected by an unidentified malfunction.

Operator; close isolate valve and remove gauge for calibration check.

6.2.2 Safety Device Activated.

6.2.2.1 Blow-out Plug (Filler Plug) is dislodged from the case.
(Missing Blow-out Plug reduces ***IP*** rating of gauge).

6.2.1.2 Can be caused by, leaking element or a build-up of internal pressure within the case due to ambient or process temperature rise.

Operator; check for pressure leaks, close isolate valve and remove gauge for further inspection or re-fitting of Blow-out Plug.

6.3.1 Over-Temperature Indicated. (Pointer outside graduated scale).

6.3.1.1 Can be caused by permanent excess temperature or temporary higher-temperature causing pointer-shift.

Operator; close isolate valve and remove gauge for calibration check.

6.4.1 Rapid Pointer Oscillation.

6.4.1.1 Instrument is being subjected to harmful system vibration. Possible incorrect gauge specification, requires features to subdue oscillation. Liquid Filled housing or Vibragauge®, (See sections **2.6** and **4.4**).

7 – INSTALLATION

7.1 Temperature Gauges should be installed in accordance with European Standard ***EN13190*** (or ***ASME B40.200***) recommendations.

7.1.1 Mounting must not create mechanical stress at the process connection, remote flange mount the gauge via flexible capillary where necessary.

7.1.2 Do not hold the gauge housing to install, use spanners on flats provided on the gauge process connection and system connection.

7.1.3 Install the gauge in a Thermowell to facilitate maintenance.

7.1.4 System features should be employed to reduce the effects of Gaseous media, Adiabatic Compression can cause rapid pressure or temperature changes affecting calibration and surface temperatures.

7.1.5 Protect the gauge from high process media flow or pressures. Install the gauge in a Thermowell to reduce stress induced effects, use an enclosure or sunshade to reduce ambient temperature effect.

8 – MAINTENANCE

8.1 A planned maintenance program should be in place and operated by trained personnel. Scheduled maintenance should be conducted to ensure no damage has occurred during operation and that the window, gaskets and safety blow-out plug (Filler Plug) are intact.

8.1.1 Do not allow dust to deposit on the gauge thicker than 5mm, the gauge should be cleaned using a cloth with water and soap solution.

9 – CE MARKED EQUIPMENT

9.1 Materials of construction in accordance with **PED 2014/68/EU**.

9.1.1 Pressure Equipment Directive (**PED**) **2014/68/EU** specifies categories for essential safety requirements based on Medium, Pressure and Volume. (PED is applicable to Gas Filled models only). Gas Filled models are **Category S.E.P**. (Gas Group 2, PV<1000 Bar). It is illegal to CE mark these instruments for PED.

9.1.2 PED 2014/68/EU; Gas Filled gauges have an internal volume below the lower limit (0.1 litre) shown in the **PED 2014/68/EU** charts.

9.1.3 PED 2014/68/EU; A vessel with a volume ≤ 0.1 litre, refer to PED Guideline A-05. Article 4.3 applies, Sound Engineering Practice (SEP)

9.2 Temperature Gauges supplied with a CE mark in accordance with essential Health & Safety requirements of (**ATEX**) **Directive 2014/34/EU** for Equipment Group II, Categories 2G, 3G, 2D & 3D, suitable for use in Zones 1, 2, 21 & 22. *Not suitable for Zone 0 or 20.*
ATEX hazard assessment based on ***EN ISO 80079-36*** and ***80079-37***.

9.2.1 The maximum surface temperature of an instrument assembly, **not due to mechanical working**, can be equal to the dial full-scale value or process temperature, at the point of the process connection. **The actual maximum surface temperature depends not on the equipment itself, but mainly due to the operating conditions.** The table below shows limitations on the gauge housing operating conditions. The gauges are suitable for all ATEX temperature classes, dependant on limitations and applied features.

Gauge housing, **ATEX** Temperature Gauge to be within limits below.

Class	T max [°C]	(***EN IEC 60529***) Instrument Case [°C]		
		(***IP5x***) Dry	(***IP6x***) Dry	(***IP6x***) Filled
T6	85	85	85	90 Glycerine *200 Silicone
T5	100	100	100	
T4	135	135	*135	
T3	200	200	*200	
T2	300			
T1	450			
Marking to **ATEX**		CE Ex II 2G	CE Ex II 2GD	
Marking to IECEx (Gas)		Ex h IIC T6…T1 Gb X	Ex h IIC T6…T1 Gb X	
Marking to IECEx (Dust)		-----	Ex h IIIC T85°C…T450°C Db X	

Refer to ATEX individual model series datasheet for (*) restrictions.

9.3 Temperature Gauges (Gas Filled) may be CE marked for (**ATEX**) **Directive 2014/34/EU** only, but may also come under category **S.E.P** (Sound Engineering Practice) as described within Part 1 Paragraph 8 of the **Pressure Equipment (Safety) Regulations 2016** (SI 2016 No.1105) or the **Pressure Equipment Directive** (**PED**) **2014/68/EU.** Refer to labelling affixed to each Instrument.

WARNING: Misuse or misapplication of these products is potentially dangerous and could lead to personal injury. Do not use without first reading and understanding the Installation and Operation Instructions contained within. If in any doubt consult the manufacturer.

STEWART-BUCHANAN GAUGES LTD
Sales Office & Manufacturing Facility - 7 Garrell Road, Burnside Industrial Estate, Kilsyth, Glasgow G65 9JX, SCOTLAND
Tel: +44 (0)1236 821533 | Fax: +44 (0)1236 824090 | E-mail: sales@stewarts-group.com | Web: stewarts-group.com