# Thermax Pressure Reducing Station

User Manual

## 1 Important Safety Instructions to the Users

- This manual presents information that will help to install, operate and maintain the equipment properly. It is expected that the contents be carefully read before handling the equipment.
- All safety instructions and warnings given in these mounting and operating instructions, particularly those concerning installation, start-up and maintenance, must be strictly observed.
- To ensure appropriate use, only use the TPRS in applications where the operating pressure and temperatures do not exceed the specifications used for sizing at the ordering stage.
- The manufacturer does not assume any responsibility for damage caused by external forces or any other external factors.
- Any hazards that could be caused in the TPRS by the process medium, operating pressure or by moving parts are to be prevented by taking appropriate precautions.
- A good installation is a permanent asset while a bad one can be a constant source of trouble. It can cost much more to correct a bad installation than to put a new one.
- The TPRS is a product of many years of knowledge, field experience & engineering effort, to provide long life & excellent service to the users. This unit will provide continued trouble-free service, if instructions on installation, operation and maintenance are properly followed.
- It is expected that the personal involved in Installation, Operation & Maintenance possess necessary qualification, competence, license & authority (if applicable) only should handle the product. It is solely the responsibility of the equipment owner & user to ensure that all applicable statutory (if applicable) norms are adhered to during Installation, Operation & Maintenance of this equipment.
- The mechanical devices supplied as a part of the unit are chosen because of their known ability to perform, with proper operating techniques and maintenance procedures.

Tampering with the safeties & controls or bypassing any of these is not permissible at any time.

- Any "Automatic" features included in the design do not relieve the attendant of any responsibility. Such features may free him of certain repetitive chores and give him more time to devote to the proper upkeep of the equipment.
- No amount of written communication can replace intelligent thinking & reasoning.

**The following symbols/terms have been used in this manual at the end of some chapters for the attention of the users:**

This is a symbol of **"warning"** to the equipment user & provides information about practices or circumstances that should never be allowed as can lead to personal injury or death, property damage, or economic loss.

This symbol is for hot surface areas where there is chance of temperatures above ambient temperatures which causes injuries.

This symbol is to avoid hand/fingers getting crushed with the flange joints/pipes.

Avoid the injuries while working in steam leaking areas.

This is a symbol of **"Caution"** to the equipment user & provides information about the care to be taken on the actions or procedures which if not performed correctly may lead to personal injury or incorrect function of the instrument or connected equipment.

Recommended action

## 2 Abstract

Thank you for choosing sustainable solutions in energy and environment which helps in conserving resources and preserving the future. This manual describes the principle of operation, instructions for installation, operation & maintenance of self-actuating (Diaphragm) type Thermax Pressure Reducing Station (TPRS) supplied by Thermax Ltd. The General Instructions which are not detailed out in this document to be performed in accordance with standard and safe acceptable practices. Further please contact Thermax for detailed clarification. The instructions contained within this manual must be read before undertaking any work on the equipment supplied. For any queries please contact Thermax Limited.

## 3 Product Identification

**The product specifications and details are mentioned in the name plate details, please refer the figure 3.1A for template.**

For all maintenance, service & spares requests, it is important to mention the serial identification number as mentioned in the name plate details of your product to Thermax Ltd.

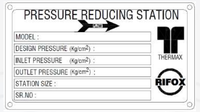



figure 3.1A

## 4 General Guidelines for Steam Usage

When water is heated, its temperature rises (region A – B) as shown in figure 4.1A. As its temperature reaches the boiling point, its phase changes to steam (region B – C), with no rise in temperature, and it boils at its saturation temperature. Note that a large amount of heat is added with no rise in temperature, but a change in phase. This steam is called **saturated steam.**

The Bell Curve as per figure 4.1A shows this, with each line representing a constant pressure. The total energy in saturated steam is the sum of the enthalpy of water and the enthalpy of evaporation.

**hg = hf +hfg**

Where:
**hg** = Total enthalpy or Total heat of saturated steam (kJ/kg)

**hf** = Enthalpy of Water (Sensible heat) (kJ/kg)

**hfg** = Enthalpy of Evaporation (Latent heat) (kJ/kg)

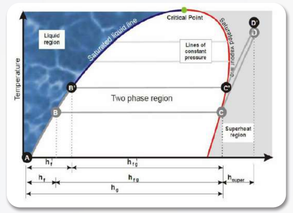
### 4.1 The Physics of Pressure Reduction

Steam imparts heat to the process by condensing into water, thus giving off its latent heat. Thus, the work done by steam in a process is primarily done by latent heat (hfg).

In the figure 4.1A, follow the higher-pressure line A'-B'-C'-D' on the curve. The total energy in saturated steam at the higher pressure still remains hg, but the hf' increase and the hfg decreases. Hence, lower the pressure of steam, the higher the latent heat content (hfg) or the Enthalpy of Evaporation. This is why use steam at lower pressures.

So, to conserve fuel, if the process demands a certain Delta Temperature (DT/Temperature difference) for efficient heat transfer, then we have to find out the lowest pressure that satisfies the temperature demand.

**Figure 4.1A**




### 4.2 What Is Superheated Steam?

When more heat is added to saturated steam in the region B-C, its temperature rises further to reflect the amount of heat added (refer figure 4.1A).

Steam in the region C – D is called superheated steam. Thus, superheated steam is steam that is at a temperature higher than its boiling point (or saturation temperature) at the given pressure (refer figure 4.1A).

For example, saturated steam at a pressure of 32 bar g has a temperature of 238.5°C. If further heat is added to this, its temperature could be 300°C at a pressure of 32 bar g.

### 4.3 The Need for A PRS

- Thermax Pressure Reducing Stations are an integral part of any steam system used for process heating. They are used to reduce the pressure to increase the latent heat and correspondingly reduce the temperature of steam.
- Usually, high pressure (HP) steam is generated at a central location & gets distributed. At the usage points the pressure gets reduced through TPRS according to the requirement of each process. Along with this the TPRS also helps to maintain the stable pressure required to the process in varying flow conditions, until there is no major fluctuation in pressure and flow at the inlet of TPRS.

### 4.4 Why Can't Steam Be Generated at Low Pressure?

- Most modern boilers operate at relatively high pressure. A typical process boiler operates at 10.5 to 17.5 kg/cm2(g). The operating pressure of a boiler determines various parameters like water holding capacity, steam space, water level etc and importantly the dryness fraction of the saturated steam.
- Steam at high pressure (HP) has a relatively higher density, or low volume than at atmospheric pressure. This means that the higher the pressure, the smaller the bore of pipe work required for distribution of a given mass of steam.
- The advantage is the boiler size stays small as HP steam has low volume. Also, HP boilers rarely have problems like reduced output and 'carryover' of boiler water.
- Wet steam is most likely to be produced at lower pressures which correspond to lower temperatures. Therefore, it is energy efficient to produce and distribute HP steam and reduce pressure upstream of any items of plant designed to operate at a lower pressure.

### 4.5 What Are the Economic Benefits of Pressure Reduction?

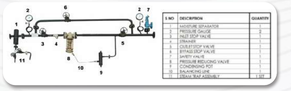
- Low pressure steam has a higher latent heat and can tend to reduce the amount of steam produced by the boiler.
- Another reason is that all steam equipment whether process or utilities have a MAWP – Maximum Allowable Working Pressure. The boiler as we have learnt supplies steam at a high pressure for its advantages. A PRS is used so that safe working pressures are not exceeded downstream of the PRV and the process /utilities can be designed for lower steam pressure applications thus avoiding the higher thickness pipes/metal plates/reactor vessels. These heavy utilities would otherwise consume a large portion of heat from steam, resulting into higher steam consumption.
- Less flash steam is lost if the plant is operated on LP steam. Reduced pressure will lower the temperature of the downstream pipe work and reduce radiation losses.
- The temperature of saturated steam varies with the pressure, so this also provides a simple method of controlling temperature of steam going to a process. You can see this in the paper industry on driers and also in heat exchangers, sterilizers and autoclaves, in various industries.
- For the same output, LP steam equipment may be larger, but is still cheaper as it follows a lower design specification.
- Plants are normally built in stages. Starting with the HP stage, we flash HP condensate and use the LP flash steam in the LP stage. This saves energy. At times the flash steam being generated is not enough and a PRS is used to maintain continuity of supply in the LP system.

## 5 Working Principle and System Configuration

### 5.1 Self Acting (Diaphragm type) TPRS

The figure 5.1A shows the general arrangement of a typical TPRS with Self-acting PRV - diaphragm type

**Figure 5.1A:**




The Moisture Separator at the inlet ensures that any water carryover traveling with the steam does not cause damage to the rest of the TPRS, and provides dry steam to the process.

The inlet valve can be used to shut-off steam supply to the PRV. The strainer removes dirt, welding slag and other particles that could damage the seat and plug of the PRV.

Inlet and outlet pressure gauges are used to check generation pressure, configure the set pressure and check PRV operation. These need to be provided with pig tail siphons to cool the steam, and isolating valves for removal / isolation of the gauge.

As PRV sizing depends on the flow capacity required, it may not be of the same size as the inlet line. In fact, often the PRV size will be one size smaller than the inlet line. Also, as the pressure drops, the specific volume of steam increases, so the outlet size will be a size or two more than the inlet.

Eccentric reducers and expanders are recommended to decrease and increase line sizes within the TPRS.

A sensing line from the outlet is connected to the PRV actuator, to act as a feedback to balance pressure to the set pressure.

For best results, this sensing line should be taken from a point 0.7 – 1m downstream of the PRV to ensure that the turbulence caused by the pressure reduction is overcome.

A condensing pot is used in the sensing line to cool the steam so that the life of the diaphragm in the PRV is enhanced, as it does not come in direct contact with high temperature steam. The outlet valve shuts off supply to the process, while the bypass line and valve provide an alternative flow path in case the PRV needs to be repaired or maintenance work is required.

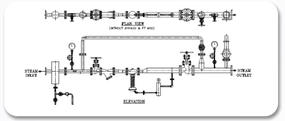
A suitably sized safety valve is required to ensure that the outlet steam pressure does not exceed the setpoint, even if the PRV fails. This would normally be set to blow at 10% above the PRV set pressure, and should have the capacity to discharge the maximum flow of the TPRS.

Safety valve exhaust line to be connected and routed to a safer location.

The entire TPRS station to be insulated as per the specifcation provided in the P&I drawing.

Technically The condensate pot to the PRV impulse line not to be insulated. Hence there will be chance of above ambient temperature

**Figure 5.2A**




## 6 Unloading Receiving and Inspection

The TPRS components are supplied in semi assembled condition, duly packed in polythene sheets & wooden cases/ boxes for assembly & installation at site.

Ensure that the wooden cases should not be dropped or turned to any other position other than marked on the cases.

At the time of receipt at site, a thorough visual inspection of the product should be made for evidence of damage during shipment. Packaging slip should be referred for checking the items supplied for the system.

On receipt of the consignment at site, check that all the cases have been received per delivery documents & packing slip.

By careful inspection, determine whether any damage/loss has occurred in transit, in spite of proper Checking and loading of each component/equipment, at our factory before dispatch.

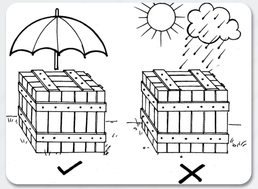
In the event of any damage is noted, the company should be notified at once so they can start claims procedure for repairs or replacements as per applicable clauses of contract.

# 7 Storage

**The place of storage of these equipment's should be**

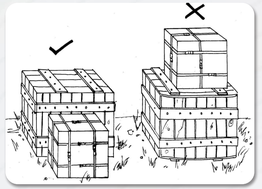
- Dust free, Clean, Dry and well ventilated
- All the material should be stored under roof and should be protected from rain, water or direct sunlight.

**Figure No 7.1A:** Material should be stored under roof.



- Do not pile up cases.

**Figure No 7.1B:** Do not pile up cases.



- Do not store heavy material on soft soil.
- Parts should not be stored under corrosive atmosphere.
- Periodically the unit should be inspected to make sure no damage, such as corrosion, is taking place.

# 8 Installation Guidelines

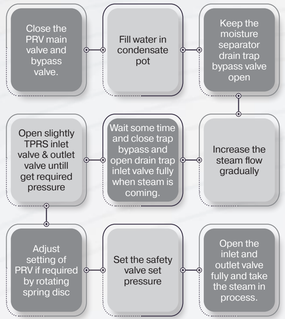
The TPRS assembly should be installed at the elevation of 1 to 1.2 meters from the floor level for the ease of operation & maintenance (O&M). Where this is to be installed at higher elevation then provide platform with railing & stair case for the safety during O&M. The following guidelines are to be followed during installation of TPRS:

- Assemble the entire TPRS on ground, start assembling with bypass line first without Pressure reducing valve (PRV), condensate pot assembly, pressure gauge assemblies with siphon and gauge cock. And then followed by strainers, isolation valves & PRV.
- Flush the assembled components with compressed air.
- Install the assembled TPRS in the steam pipe line.
- Ensure that the condensate pot is installed as per drawing and arrangement is made for filling water in it.
- Note that PRV is fitted with EPDM diaphragm having temperature limitation. Hence it should not come in contact with heat. Therefore, it is necessary to fill clean water in the condensate pot and the sensing line.
- Self-acting PRV is to be installed with actuator/diaphragm pointing downwards as per the GA diagram.
- Ensure that the TD trap drain module is connected to the moisture separator.
- Ensure that all the valves /strainers are fitted as per the flow direction and arrow indicated on them.

## WARNING

- The statutory IBR regulations to be followed strictly during the installation of the TPRS.
- The IBR certificates copies are to be preserved and used for cross checking the components with IBR certificates.
- Hydro test at the pressure of 1.5 times of design pressure is mandatory before charging the TPRS. Safety valve to be made dummied during the Hydro test.
- Specifications of Gaskets and fasteners to be used as recommended/supplied by Thermax. (Note: As per design calculations, HT Bolts and metallic spiral wound gaskets are not required until specified by Thermax).
- The orientation of the TPRS station should be ensured as per the figure 5.2A (refer the GA drawing in detail). Any changes in the orientation requires proper Thermax approval.
- The TPRS to be supported properly as per figure 5.2A (refer the GA drawing in detail)

# 9 Commissioning Sequence




System needs to be flushed thoroughly before starting of the unit.

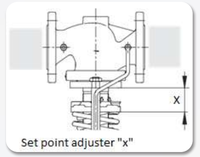
- The required downstream pressure is set by turning the set point adjuster using an open-end wrench.
- Turn clockwise to increase the downstream pressure and turn counter clockwise to reduce it.
- The pressure gauge located on the downstream pressure side allows the adjusted se point to be monitored.

**Disclaimer:** This manual represents standard offering of our TPRS, please refer separate manual for non-standard TPRS applications.

**9.1 Set point adjustment – Dimension x**

An adjustment of the set point can also be made by turning the set point adjuster until the distance "X" (see Figure 9.1A ) is reached

**Figure: 9.1A**




Below Table lists the set points and their assigned distance x for the regulators and their various set point ranges –

| Set point range | Nominal size DN | | |
|---|---|---|---|
| 8 to 16 bar | 15 to 25 | 32 to 50 | 65 to 100 |
| 10 bar | x = 89 mm | x = 106 mm | x = 133 mm |
| 12 bar | x = 97 mm | x = 117 mm | x = 150 mm |
| 14 bar | x = 104 mm | x = 128 mm | x = 168 mm |
| **4.5 to 10 bar** | | | |
| 5.9 bar | x = 85 mm | x = 100 mm | x = 131 mm |
| 7.3 bar | x = 93 mm | x = 112 mm | x = 152 mm |
| 8.6 bar | x = 101 mm | x = 123 mm | x = 172 mm |
| **2 to 5 bar** | | | |
| 2.8 bar | x = 83 mm | x = 97 mm | x = 126 mm |
| 3.5 bar | x = 92 mm | x = 110 mm | x = 170 mm |
| 4.3 bar | x = 100 mm | x = 122 mm | x = 184 mm |
| **0.8 to 2.5 bar** | | | |
| 1.2 bar | x = 79 mm | x = 92 mm | x = 117 mm |
| 1.7 bar | x = 89 mm | x = 106 mm | x = 142 mm |
| 2.1 bar | x = 99 mm | x = 121 mm | x = 167 mm |
| **0.2 to 1.2 bar** | | | |
| 0.45 bar | x = 71 mm | x = 81 mm | x = 98 mm |
| 0.70 bar | x = 83 mm | x = 98 mm | x = 127 mm |
| 1.0 bar | x = 95 mm | x = 117 mm | x = 157 mm |
| **0.1 to 0.6 bar** | | | |
| 0.23 bar | x = 71 mm | x = 81 mm | x = 98 mm |
| 0.35 bar | x = 83 mm | x = 98 mm | x = 127 mm |
| 0.48 bar | x = 95 mm | x = 115 mm | x = 157 mm |
| **0.05 to 0.25 bar** | | | |
| 0.10 bar | x = 70 mm | x = 80 mm | x = 92 mm |
| 0.15 bar | x = 81 mm | x = 95 mm | x = 116 mm |
| 0.20 bar | x = 91 mm | x = 110 mm | x = 139 mm |

Note that only a rough set point adjustment is performed by turning the set point adjustment until the distance x is reached. The special properties of the process medium and plant are not considered in this case. Check the pressure at the pressure gauge downstream of the regulator for a precise set point adjustment.

# 10 Troubleshooting

| Malfunction | Possible reasons | Recommended action |
|---|---|---|
| **Pressure exceeds the adjusted set point.** | Insufficient pressure pulses on the operating diaphragm. | Clean the balancing line and the screw joint with restriction. |
| | Seat and plug worn down by deposits or foreign particles. | Disassemble the regulator and replace damaged parts. |
| | Pressure tapped at the wrong place. | Reconnect balancing lines at a different place. Do not tap pressure at pipe bends or necks. |
| | Control response too slow. | Install larger screw joint at the diaphragm actuator. |
| | Foreign particles blocking the plug | Disassemble the regulator and replace damaged parts. |
| **Pressure drops below the adjusted set point.** | Valve installed against the flow; see arrow on body. | Check direction of flow. Install valve correctly. |
| | Pressure tapped at the wrong place. | Reconnect balancing line at a different place. |
| | Valve or KVS coefficient too small | Check valve sizing. Install larger valve, if necessary. |
| | Control response too slow. | Install larger screw joint at the diaphragm actuator. |
| | Foreign particles blocking the plug. | Disassemble the regulator and replace damaged parts. |
| **Jerky control response** | Increased friction, e.g. due to foreign particles between seat and plug. | Remove foreign particles. Replace damaged parts. |
| **Slow control response** | Restriction in the screw joint of the actuator dirty or small. | Clean screw joint or install larger screw joint. |
| | Dirt in the balancing line. | Clean the balancing line. |
| **Downstream pressure hunts** | Valve too large | Check valve sizing. Select smaller KVS coefficient, if necessary. |
| | Restriction in the screw joint of the actuator too large. | Install smaller screw joint. |
| | Pressure tapped at the wrong place. | Select better place for pressure tapping. |
| **Loud noises** | High flow velocity, cavitation. | Check sizing. Install flow divider with gases and steam. |

# 11 Maintenance


- Up to 5000 hours of operation, strainer needs to be checked for every 200 hours of operation.
- After 5000 hours of operation, the strainers need to be checked for every 5000 hours.
- If any additional or new welding work carried out at the upstream of the pipeline and if TPRS shifted to other location, then, again for up to 5000 hours of operation, strainer needs to be checked for every 200 hours of operation

# 12 Warranty

Only trained or instructed personnel may be assigned to operation or servicing.

All our equipment is thoroughly inspected before dispatch and therefore can be depended upon for long and trouble-free services. We undertake to make good by replacement or repair, defects arising out of faulty design, materials or workmanship within 12 (Twelve) months of the date of commissioning or 18 (Eighteen) months from the date of dispatch whichever is earlier subjected to mentioned in your purchase order warranty terms. The parts, in respect of which a claim is made, must be sent to our works at buyer's expenses. If the claim is found to be legitimate, we shall refund such expenses.

## Warranty Excludes

- Normal Wear & Tear
- Damages/defects due to wrong operation at the purchaser's end, and/or arising out of forced major.
- Bought out components are guaranteed by us only to the extent of guarantees given to us by our suppliers.
- Electrical components such as heaters, motors, contactors etc. Rubber components and instruments such as pressure gauges, thermometers, Controllers, etc. are however, not covered under this warranty.

**This warranty is valid subject to the following conditions: -**

- Installation completed within three months from the date of dispatch of the equipment and as per our installation instructions.
- The supply/ installation formally accepted as per the handing over clause.
- Use of specified utilities in technical quotation.
- The equipment being operated and maintained as per our Operation and maintenance Manual.
- The equipment or part thereof not being subject to accident, alteration, abuse or misuse.
- Any replacements/repairs required under provisions of the above warranty will be carried out at our's option either at site or at works. In the latter case, Buyer will send the defective parts to our works at Buyer's cost & liability.
- Warranty period for the entire equipment including replaced or repaired parts will be limited to the unexpired portion of the total warranty period.
- Accessories and fittings not manufactured by us, form an integral part of the equipment supplied, the warranty for such accessories & fitting will be in line with main equipment.
- If the purchaser delays to lift the equipment up its readiness, the warranty will be limited to 18 months from the date of readiness at our works.
- Any repair / replacement on our equipment during the warranty period shall be carried out by authorized representatives in writing from us.
- The warranty obligations will be honoured by us provided Buyer has fulfilled obligations under the order relating to release of due payments, etc.
- After repairs/replacement, warranty period for the entire equipment including replaced or repaired parts will be limited to the unexpired portion of the total warranty period.
- Any short supply or damages to the equipment to be intimated to Thermax within 15 days of receipt of material at site. Any late report will void the warranty.
- If the transit insurance is in client scope, damages and missing items during transit to be claimed by clients directly.
- Any improper use, intervention in the design and deviation from the design data will automatically lead to termination of the warranty.

Diaphragm will get damaged if steam directly comes in contact with the Diaphragm, such a failure is not cover under warranty.

# 13 Recommended Spares

| Actuator | Diaphragm | TD Trap | Pressure Gauges | Safety Valve spring |
|---|---|---|---|---|
| 01 | 02 | 03 | 04 | 05 |


THERMAX

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