Installation, Operating & Maintenance Manual

HP145 & HP204 Twin Screw Turbine

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Revisions

Revision No.	Change	Released By	Release Date
A	Initial release	I Sommerville	18 May 2021
B	Updates to section 6 clarifying effects of non-compliance with installation requirements	N Alexander	02 Dec 2021
C	Drawing references removed. Steam connections requirements updated. Foundation requirements updated. General revisions throughout.	R Patrick	06 Aug 2022

Contents

Nomenclature and Abbreviation Table

Abbreviation	Description
TST	Twin Screw Turbine
HP	Heliex Packaged
P1	TST Steam Inlet Pressure
P1A	Steam Pressure Between Control Valve and Expander
P2	Expander Steam Outlet Pressure
HMI	Human-Machine Interface
SCADA	Supervisory Control and Data Acquisition
PLC	Programmable Logic Controller

1 Introduction

1.1 Document Scope and Use

This manual is intended to be a reference for the application, installation and use of a Heliex Power Twin Screw Turbine (TST) and contains important information about all life phases of the equipment.

The manual is a component of the product. It describes the TST manufactured and delivered to the customer.

- It should be reviewed thoroughly by the installer before attempting to install the TST.
- Keep the manual in a safe place throughout the life of the TST.
- Please insert any amendment or revision to the manual that may be sent to you.

The content of this manual does not cover all details, nor provide for every possible contingency to be met concerning installation of the TST. Please refer to contract specific documentation for details of operating conditions/limitations/extended scope of supply.

Should further information be required, or should problems arise which are not covered sufficiently for the installer's purposes, please contact:

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1.2 Copyright

1.3 Who We Are

Heliex Power Ltd design and manufacture the TST. This patented technology allows users to gain the benefits of electrical generation from several different applications. Typically, these applications include steam pressure reduction on biomass and fossil fuelled boilers, excess or waste steam from a process, and steam used in waste heat recovery.

1.4 Our Product

The TST is a self-contained base plate mounted unit incorporating G99 protection and is designed to sit on normal factory floors or roadways without special foundations.

They can be lifted by an appropriately rated forklift or lifted by crane using the fabricated pockets in the base frame (Refer to Installation and Interface drawing for lifting details) and are suitable for indoor and outdoor installation to ingress protection standard IP25. The TST is easily installed with several connections. These include steam, electricity and compressed air.

2 Technical Specifications

2.1 Weights and Dimensions

	HP145	HP204
Dimensions	2750 x 1700 x 2000mm (LWH)	3000 x 1850 x 2040 mm (LWH)
Mass	Up to 3,500 kg	Up to 7,500 kg
Lifting	Standard forklift pockets 180 x 80 mm, 1300 mm between centres	Standard forklift pockets 180 x 80 mm, 1300 mm between centres
Site Foundations	Level load bearing surface area of 3000 x 2000mm. See section 7.0	Level load bearing surface area of 3500 x 2500mm. See section 7.0

2.2 Environmental Limits

	HP145	HP204
Storage Temperature	+5 to + 50℃	
Storage Humidity	<95% (non-condensing)	
Operating Temperature	-10 to + 45℃	
Operating Humidity	<95% (non-condensing)	

2.3 Steam Conditions

	HP145	HP204
Max Inlet Pressure	24 bar(g)?	
Max Temperature	Saturation temperature, max 221℃	
Max Inlet Dryness Fraction	Refer to contract documentation	
Max Outlet Pressure	Refer to contract documentation	
Min Outlet Pressure	Refer to contract documentation	
Max Steam Flow	6000 kg/h	15000 kg/h
Max Steam dP	15 bar	20 bar

The feed water in the user's boiler for steam generation shall be to BS EN 12953 –10 2003. Other standards may be acceptable if prior agreement has been provided by Heliex Power.

2.4 Air Supply

The TST requires two air supplies to actuate pneumatic valves and provide the barrier medium for the Expander mechanical seals. Requirements for both are provided in the following sections.

2.4.1 Valve Air Supply

Connection Type	10mm push fit (nylon hose)
Nominal Pressure	5-7 bar(g)
Maximum / Minimum Pressure	16/4 bar(g)

Air Flow	5 L/min
Air Quality	ISO 8573.1, Class 2:3:1

2.4.2 Seal Air Supply

Connection Type	½" BSP
Nominal Pressure	Up to 21 bar(g) (dependent on site process conditions)
Maximum / Minimum Pressure	24 bar(g)/ (dependent on site process conditions)
Air Flow	25 NL/min (dependent on site process conditions)
Air Quality	ISO 8573.1, Class 2:3:1

A local isolation valve should be installed in the line between the compressed air main and the TST.

A booster compressor can be supplied by Heliex Power if seal air supply pressure cannot be met. Please refer to contract specific requirements/scope of supply.

2.5 Oil System

The TST utilises oil to lubricate and cool the expander bearings. When oil is changed during maintenance it should be replaced only with this type.

Oil System	HP145 & HP204
Oil Type	Chesterton 607 Synthetic oil, HTS-220
Oil Change Volume	22 Litres

2.6 Noise Emissions

TST Type	HP145 & HP204
Sound Pressure Level with Standard Canopy	<87 dBA at 1 metre
Sound Pressure Level with Acoustic Enclosure	<60 dBA at 1 metre

2.7 Electrical Power Connection

See section 8 (Electrical Services).

2.8 Fluid Services Drawings

The installer must ensure that the installation complies with all relevant laws and regulations.

Refer to the Installation and Interface Requirements drawing and P&ID for details on the fluid services connections.

3 Safety and Responsibility

3.1 General

The following is general advice on the safe use of Heliex Power equipment and does not take precedence over the user's safe system of working in the place of installation. The user's safety procedures must be adhered to at all times.

A properly installed TST will present no hazards during normal operation. Hazards may only occur when access is required inside the canopy and during maintenance. Maintenance must only be undertaken by persons who have been specifically trained and subsequently judged competent.

DANGER: The TST must never be entered whilst in operation.

If internal maintenance work is required, it is essential that the TST be isolated from all utilities to prevent the possibility of applying power or steam to the TST. When performing internal maintenance, always ensure that manually operated isolating valves on the steam inlet and outlet are locked closed and tagged.

Modification of, incorrect repair of, or use of non Heliex Power repair parts on the TST will invalidate warranty and could result in a serious malfunction that could result in serious injury or death.

If a problem occurs with the TST, it can be shut down using either a soft stop via the control panel or remotely.

If a dangerous situation occurs, the TST can be stopped by pressing the emergency stop on the front of the control panel door or remotely (an "E-Stop").

This will open the generator breaker and close the steam inlet valve. The expander and generator are not braked and will continue to rotate until they come to rest naturally. The emergency stop should only be used as a last resort as consequential damage may be caused to the drive belt. are must be taken when using and working with the TST and the following warnings should be observed where they appear in the manual.

 **Danger! Electricity**	 **Warning! Hot surface**	 **Warning! Hot liquids**
 **Wear protective boots**	 **Wear ear protection**	 **Wear protective gloves**
 **Wear eye protection**	 **Emergency stop**	 **Steam**

3.2 Handling

During the installation, operation, maintenance, and servicing of the TST it will be necessary to move the set or its components. Lifting operations have several dangers associated and the safe practice and use of equipment is essential to prevent injury or damage to the equipment.

The relevant method statements, risk assessments or lifting plans must be in place before carrying out handling operations on the TST.

3.3 Manual Handling

Manual handling operations within the TST should only be carried out by persons who have been appropriately trained. The weight and size of an object should be assessed before it is lifted and mechanical assistance or that of another person should be considered where an object is too heavy, or its situation makes it difficult to move.

3.4 Mechanical

The mechanical system within the TST consists of the expander, drive and generator which rotates to generate electricity. Rotating machinery has dangers associated with its use and guards are in place to prevent contact with that machinery.

The TST starts and stops automatically and without warning. No access or work should be carried out on the mechanical parts of the TST without it first being stopped and isolated both electrically and from the user's steam and condensate system.

The TST should never be operated by bypassing, overriding, or in any way rendering inoperative, guards, protective shutdown equipment, or other safety devices.

3.5 Electrical

The TST uses and generates power at <1000V. While this is regarded as "low voltage", it still has dangers associated with its use. Work on the electrical system should only be carried out by those trained and authorised to do so. Care must be taken when working on or in proximity to a live electrical system.

3.6 Electric Shock

Electricity at any voltage can be dangerous and should always be approached with caution. An electric shock can occur upon contact with any source of voltage capable of causing a current flow through the muscles and nerves.

3.7 Steam and Heat

The TST uses wet steam to generate electricity and this has several dangers associated with its use. Never connect the TST to inlet or outlet sources of unknown pressure or temperature, or to sources whose pressure or temperature exceed the limits specified. For further details see section 2.3 (Steam Conditions).

The expander body and steam pipework will retain heat for a long time after it has stopped rotating and must be allowed to cool sufficiently before being touched or any work is carried out on them. Personnel should always wear gloves and protective clothing. Care must be taken when working on or in proximity to a live steam system.

3.8 Noise

Appropriate ear protection must be worn while accessing a running generator for inspection and maintenance.

3.9 Oils and Lubricants

The TST uses various oils and lubricants in its operation and these have several dangers associated with their use.

Refer to the COSHH data sheet associated with the lubricant for specific hazard information.

3.10 Contact with Oils and Lubricants

To prevent any problems caused by exposure, use barrier cream and wear protective gloves whenever possible. Good standards of care and personal and plant hygiene are advised when handling lubricants.

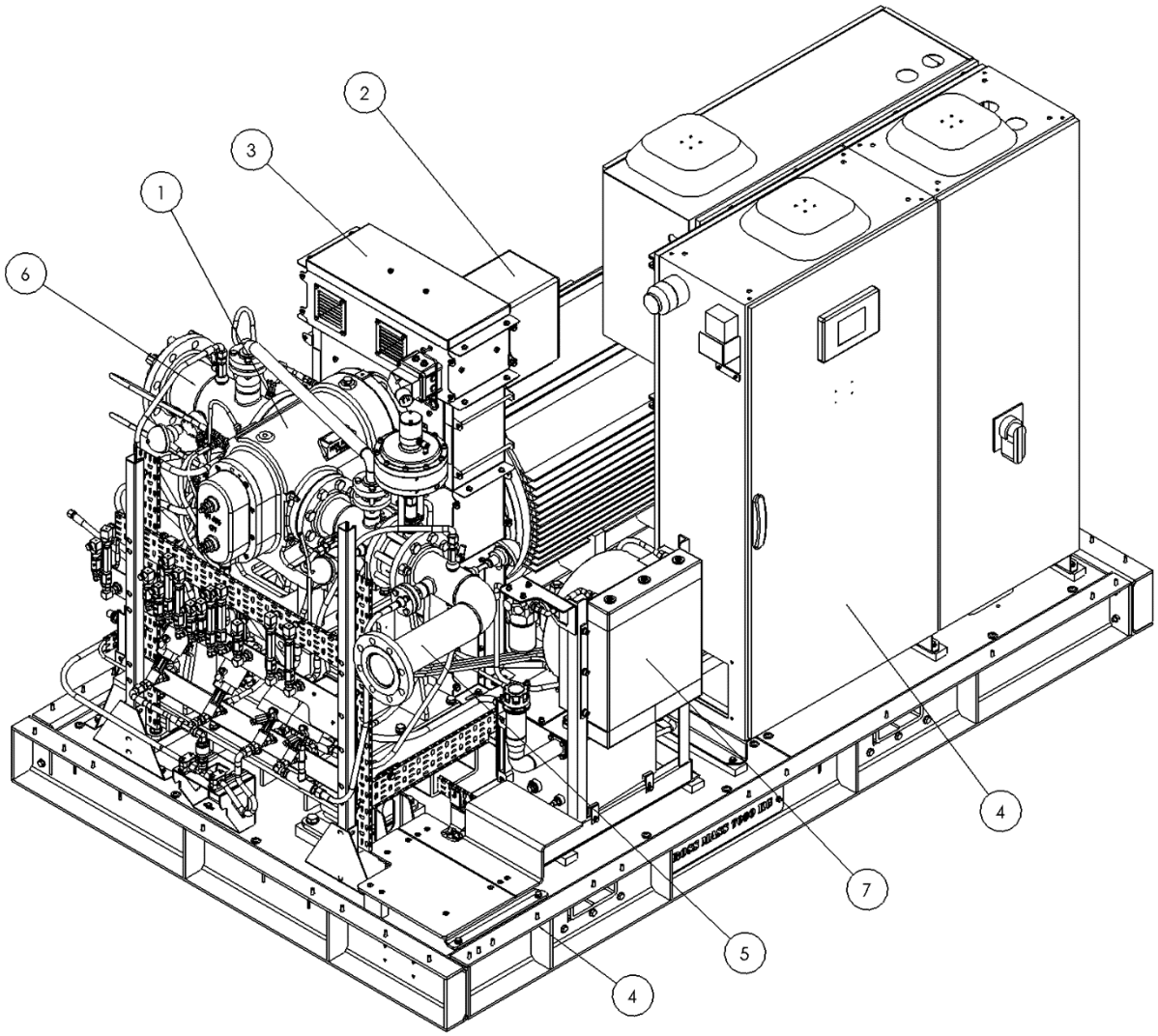
3.11 Disposal

Refer to the COSHH data sheets supplied with any oils or lubricants and dispose of them with care and in accordance with all relevant regulations.

Incorrect installation can result in injury to personnel, damage to the TST, and balance of plant. It remains the responsibility of the installer to ensure that the application and installation design is compliant with all local laws and regulations and that the TST can be operated and maintained in a safe, appropriate and controlled manner.

This manual provides information on the TST. It also provides data and information regarding ancillary equipment and systems which a customer may supply, install, and operate without the involvement of Heliex Power Ltd. This data and information is provided in good faith but Heliex Power Ltd accepts no liability or recourse for its accuracy, interpretation or use.

4 Main Components of The Twin Screw Turbine



Note – above image is for HP204 TST, HP145 is similar.

Item	Description
1	Expander
2	Generator
3	Belt Guard
4	Power and Control Cabinets
5	Inlet Pipework
6	Outlet Pipework
7	Oil Cooler
8	Baseframe.

5 Functional Design Specification

5.1 Applicable Standards

There are several Standards & Specifications which are relevant to the functional design of the equipment mentioned within this document and should be considered where appropriate. A full list of Standards can be referenced in the Heliex Power Technical Construction Files, available on request.

5.2 TST Requirements to Enter Warm-Up (before starting TST)

5.2.1 Steam

Required conditions are based on the required status of the TST.

5.2.2 Electrical Connections

See section 8 (Electrical Services) for further details.

5.2.3 Air Connection

The TST requires compressed air to actuate pneumatic valves and provide the barrier medium for the Expander mechanical seals. Compressed air supply permissives must be met at all stages of TST operation. See section 2.4 (Air Supply) for full details.

5.2.4 Seal Vent Connections

The TST vent lines provide a route for Expander mechanical seals barrier medium to be removed, preventing entering the downstream process. The vent contains a mixture of saturated steam, air, and condensate. Providing these are recovered within an atmospheric condensate recovery system, then the losses to the process in terms of TST performance and condensate top up are negligible. The flowrate from the vent lines is dependent on the operating conditions – contact Heliex Power for estimated flowrates.

5.3 TST Warm-Up Phase

The first phase in the TST cycle is the warm-up phase. This phase brings the required components to the correct temperature to permit start-up.

5.3.1 Permissives to Allow Warm-Up Phase

Controller Mode	Auto
P1 Pressure	>2bar(g)
Seal Differential Pressure	>0.5bar
Valve Air Pressure	>4bar(g)
Canopy Temperature	<70°C
Belt Guard Temperature	<70°C

5.3.2 Overview of Warm-Up Phase

- The warm-up cycle is initiated by putting the controller into 'Auto' mode.
- The warm-up loop valve then opens to provide a bypass around the control valve to allow a small flow of steam to pass through the Expander. This steam flow heats the internal Expander components and body (to achieve thermal expansion equilibrium of the

expander components) until required is recorded at the HP and LP bearings – see section 5.4.1.

- A pressure of <1bar will be registered at P1A.
- During this period, the P1, P1A (HP145 only) and P2 drains are closed.
- The Expander drain remains open to allow condensate to be drained. The volume of condensate from the drain during a warm-up cycle is estimated to be in the region of 25-50L.
- The oil heater is energised to elevate the oil tank temperature to the required temperature for TST start see section 5.4.1.
- During this period, numerous warnings will be present on the HMI including 'Startblocking'. The duration of the TST warm-up phase will be approx. 30 minutes (dependent on inlet pressure and ambient temperature) until all permissives are met indicated by the warnings turning to grey.

Attention should be paid to ensure there are not any of the following leaks present:

- Steam
- Condensate
- Air

5.4 TST Start-Up Phase

5.4.1 Permissives to Allow TST Start-Up Phase

To exit warm-up and enter start-up, the following conditions are required.

Controller Mode	Auto
P1 Pressure	>2 bar(g) (and >2 bar greater than P2)
HP & LP Bearing Temperature	>60°C
Oil Tank Temperature	>35°C
Seal Differential Pressure	>0.5 bar
Valve Air Pressure	>4 bar(g)
Canopy Temperature	<70°C
Belt Guard Temperature	<70°C

5.4.2 Overview of Start-Up Phase

5.4.2.1 Prestart

- P1 drain opens to drain condensate from upstream of control valve.
- Oil pump is energised to pre-lubricate Expander bearings.
- Warning alarm sounds indicating the TST is about to start.

5.4.2.2 Speed Match

- As the generator is asynchronous, a rotational speed of 3000rpm must be achieved before grid connection is established.
- The flow control valve is gradually opened to increase the speed of the Expander and generator.
- The oil pump remains energised to lubricate and cool the Expander bearings.

- The P1 drain is closed.
- The P1A, Expander and P2 drains remain open.
- The belt guard cooling fan is enabled.
- The canopy cooling fans are enabled (if not already operating).

5.4.2.3 Grid Connection

- Once 3000rpm is reached the TST controller will signal the GCB to close and connection to the grid is established.
- An inrush current and small negative power is registered for a short period post grid connection. The scale of this is determined by the generator size and whether a soft start unit is installed. See section 8 (Electrical Services) for more details.
- The speed is now fixed at approximately 3000rpm.
- The oil pump remains energised to lubricate and cool the Expander bearings.
- The control valve is modulated to give the desired control output (inlet, outlet (P2) or power control).

5.5 TST Stop

The TST has two different stop sequences: slow stop and shutdown/emergency-stop.

5.5.1 Slow Stop

A slow stop is the standard sequence for the stopping of the TST. It is initiated through the turning of the local key switch, removal of the 'remote start' signal or fault occurrence.

- The controller will signal the control valve to begin to close, reducing the power output from the generator.
- Once output drops below 5kW, the GCB is opened to disconnect from the grid.
- The control valve is fully closed.
- P1A (HP145 only), Expander and P2 drains are opened.
- The Expander and generator coast to a halt due to drive train friction.
- Oil pump is deenergised once rotation has ceased or bearings are below the required temperature.

5.5.2 Shutdown/Emergency Stop

A shutdown/Emergency stop is used when it is desired for the TST to stop in the quickest way possible. This is initiated by pressing the emergency stop push button or fault occurrence.

- The GCB is opened to disconnect from the grid.
- The control valve is fully closed.
- P1A (HP145 only), Expander and P2 drains are opened.
- The Expander and generator coast to a halt due to drive train friction.
- Oil pump is deenergised once rotation has ceased or bearings are below the required temperature.

5.6 Control Philosophy

The TST has three control philosophies: inlet pressure control, outlet pressure control and power control.

The TST will not generate the inlet or outlet (P2) pressure but modulate the steam flowrate to regulate and react to the process to achieve the targeted output.

The site process should be regulated based on variable signals, not on-off, otherwise the TST will experience sudden changes in pressure/flow/power/temperature which may be harmful.

5.6.1 Inlet Pressure Control (Anext Baseload)

Inlet pressure control is a control method which modulates the flow control valve to maintain a target inlet pressure. The TST will generate the maximum power achievable for the given operating conditions whilst maintaining the inlet steam pressure requested. An external 4-20mA signal modulated by a PID controller is required for this control method.

Logic

If the inlet pressure is below the target setpoint, the control valve will decrease the opening percentage to reduce the flowrate through the TST.

5.6.2 Outlet (P2) Pressure Control (T by Pwr)

Outlet pressure control is a control method which modulates the flow control valve to maintain a target Outlet pressure. The TST will generate the maximum power achievable for the given operating conditions whilst maintaining the inlet steam pressure requested. An external 4-20mA signal is not required.

Logic

If the P2 pressure is below the target setpoint, the control valve will increase the opening percentage to increase the flowrate through the TST.

5.6.3 Power Control (Baseload/Anext Baseload)

Power control is a control method which modulates the flow control valve to maintain a target TST power output. A target power can be entered and providing sufficient steam flow is available the TST will generate the desired output. If insufficient steam flow is not available, the TST will generate the maximum output possible for the given steam conditions. The power target setpoint can be manually adjusted or via an external 4-20mA signal.

The baseload level should always be adjusted (either up or down) in small increments (10kW steps is advised) allowing the TST to reach the new target and settle before applying the next change.

Logic

If the power output is below the target setpoint, the control valve will increase the opening percentage to increase the flowrate through the TST.

5.7 Operator Interface

Interaction with the TST can be achieved via the local HMI or remotely via various connection methods. Interaction such as changing control mode, clearing faults, adjusting control setpoints or viewing TST history is possible. See section 9 (Communications) for full details.

A local key switch, emergency stop push button and isolation switch are present.

6 Pipework Requirements

6.1 Steam Pipe Flange Sizes

Refer to the Installation and Interface Requirement drawing.

6.2 Process Pipework Preparation/Cleaning

Before the TST can be commissioned the site process steam pipework must be blown down to remove scale, weld slag, and any other foreign material. Such material can cause severe damage if it enters the TST. Upstream filters should be inspected, and cleaned if required, prior to commissioning. Failure to comply with this requirement shall void the warranty of the Expander.

6.3 Bypass Pressure Reducing Valve Station

It is a requirement of the installation of a Heliex Power TST that the installer fits a bypass around the TST so that during service and maintenance intervals the user's steam process does not need to be shut down. This protects the TST and customer steam system from sudden pressure changes during start and stop of the TST and provides the ability to continue process operations during maintenance of the TST. This would be in the form of a steam pressure reducing valve station, including modulating valve and interlock with TST/boiler for switchover from TST to bypass.

6.4 Isolation

The installer must install manual double valve isolation on the steam inlet and outlet pipe work, to allow the TST to be serviced and maintained safely without shutting down the user's steam process. Once the isolation valves are closed, they can be locked and tagged, and the pipework allowed to cool prior to work commencing. Heliex Power will not commission or work on the TST unless double valve isolation, in line with the above requirements, is confirmed as being installed.

6.5 Piping Forces, Expansion and Erosion

The steam inlet and outlet connections on the TST are the main terminating points of the equipment, any peripheral piping equipment shall be considered as attachments and require to be supported appropriately with the connected pipework.

The steam inlet and outlet piping, if improperly designed or installed, can exert large forces and moments on the TST. Loads transferred from pipework to the TST can cause or contribute to high levels of equipment vibration and distortion, resulting in mechanical failure of components. The pipework designer/installer must make every effort to ensure that loads transferred to the TST are minimised under all operating conditions.

Maximum allowable steam pipe connection forces and moments:-

HP145						
Pipe Size	**Fx N**	**Fy N**	**Fz N**	**Mx Nm**	**My Nm**	**Mz Nm**
Inlet 80 NB	535	665	445	475	235	360
Outlet 100 NB	710	890	580	665	340	500

HP204						
Pipe Size	**Fx N**	**Fy N**	**Fz N**	**Mx Nm**	**My Nm**	**Mz Nm**
Inlet 100 NB	710	890	580	665	340	500
Outlet 150 NB	1245	1555	1025	1150	590	880

Where X direction is along the expander shaft axis, Z direction is vertical and Y direction is orthogonal to X and Z.

For ease of installation, the connecting steam pipework may include tied bellows providing the bellows are fitted directly to the steam connections on the TST and that every effort is made to ensure that pressure loads and loads due to thermal effects are minimised and not exceed the values in the table above. Untied bellows must never be fitted. Failure to comply with the above will invalidate the warranty of the equipment. To reduce the risk of pipework degradation and to ensure noise is kept to a minimum, it is recommended that the steam pipework be correctly sized to minimise pressure drop and to keep the steam velocity to less than 40 m/s.

6.6 Filtering

Steam strainers must be installed in the inlet pipework to the TST by the installer. This reduces the risk of any foreign object entering and causing damage to the TST. Two Y-type steam strainers should be used to provide two stage filtration, with them being mounted directly before the TST. The second stage of filtration must be within 2 meters of the steam inlet connection to the TST. The bodies of the Y-type strainers fitted in the steam lines should be on their sides and **not** with the strainer basket pointing downwards. Heliex Power will not commission the TST unless filtration, in line with the above requirements, is confirmed as being installed.

Stage	Filter
1st Stage	20 mesh with 0.841 mm holes
2nd Stage	200 mesh with 0.074mm holes

Before the TST is commissioned, the steam piping must be blown down to remove scale, weld slag and any other foreign material. Such material can cause severe damage if it enters the TST. The upstream filtration should be inspected prior to commissioning after the steam pipework has been blown down as detailed in section 6.4 (Process Pipework Preparation/Cleaning). If filtration is not in compliance with the requirements set out above, this shall void the warranty of the Expander.

6.7 Steam Trapping

To ensure that large amounts of condensate do not enter the TST, and that condensate in the steam pipework on the inlet and outlet is correctly removed steam trap sets should be installed at a low point on the steam inlet and outlet of the TST by the installer.

These steam traps sets should be correctly sized for the condensate load on start-up, with the correct type of steam trap used for the duty. To ensure that condensate is effectively removed the steam traps should be connected to the steam pipework via correctly sized drain pockets. Heliex Power will not commission the TST unless steam traps, in line with the above requirements, are confirmed as being installed.

6.8 Safety Valve(s)

6.8.1 Downstream Steam Safety Valve:

It is the user's responsibility to decide whether a safety valve is required on the steam pipework directly downstream of the TST. A downstream safety valve complying with EN ISO 4126-1 or similar acceptable standard must always be used on installations where the maximum allowable working pressure (MAWP) of a downstream system or pressure-containing vessel could be exceeded by the pressure upstream of the TST. This safety valve should be correctly sized for the full flow through the TST and be installed as per the safety valve manufacturer's recommendations.

6.8.2 Upstream Steam Safety Valve:

If the user's upstream steam safety valve has a set pressure of more than 24bar(g) (this safety valve will normally be on the steam boiler itself), then a pressure reducing valve and safety valve will be required on the steam supply serving the TST immediately upstream. This will ensure that the TST is not over pressurised by the upstream steam supply. Heliex Power will not commission the TST unless an upstream safety valve, in line with the above requirements, is confirmed as being installed.

6.9 Seal Vents, and Condensate Drain

Refer to the Installation and Interface Requirements drawing and P&ID for details on the venting and draining connections.

The piping, routing and disposal of vented steam and drained condensate will vary widely depending on the user's process and installation. If in doubt, consult Heliex Power before designing the installation. Some drains isolate high pressure services on the TST and any pipework and isolations must be designed to accommodate the high pressure service should the system become pressurised when the downstream drain pipework is isolated.

6.9.1 Seal Vents

The vents contain a mixture of saturated steam, air, and condensate. The connecting pipework should be designed to induce as little back pressure as possible to prevent blocking of the flow. For information on the usage of the vents see section 5.2.4 (Seal Vent Connections).

For vent piping design specification refer to the following document.

Heliex Power recommends that the seal venting pipework should be routed to a condensate recovery tank (or similar) to minimise loss of heat and demineralised water from the system. Compliance with local environmental requirements (e.g. steam/condensate disposal) is the responsibility of the customer. Seal venting pipework must be completed in line with the above

requirements to ensure optimal seal lifetime. Failure to do so shall void the warranty of the Expander.

6.9.2 Condensate Drain

Whilst the condensate drain discharge is intermittent, it is still advised to recover the condensate if possible, note that during start up and shutdown this can include steam. The condensate drain connection should be piped independently via a gravity drop to a suitable existing condensate return vessel. For information on expected flow rates see section 5.3.2 (Overview of Warm-Up Phase). Incorrect routing of the condensate drain which results in a backpressure being applied to the expander shall void the warranty of the Expander.

7 Installation

7.1 Twin Screw Turbine Foundation Requirements

Surface	Tarmac, concrete, or another sealed surface.	
Maximum Gross Mass	3.5 Tonnes	7.5 Tonnes

The foundation area where the TST is to be mounted must have a mass of at least five times the weight of the equipment and its auxiliaries, be level and flat and of a smooth surface. The TST must be positioned such that it requires no more than 10mm of levelling across the extremes of the base. After levelling, the baseplate must be shimmed to ensure even contact between the base and the concrete floor. Alternatively, a non-shrinking grout can be used. The TST shall then be secured to the concrete with appropriate fixings. See Installation and Interface Requirements drawing.

Metal frames attached to the concrete as a substructure for the TST to be fitted to are not allowed unless specifically agreed by Heliex.

7.2 Installation and Service Access Requirements

Refer to Installation and Interface drawing for minimum laydown and maintenance areas.

7.3 Lifting Methods

Refer to the relevant Lifting Instructions drawing.

The TST is fitted with forklift pockets and can be moved with a counterweight forklift truck which meets the lifting requirements. For the HP145 TST the forklift needs to have 5 tonnes capacity or larger. For the HP204 the forklift needs have 10 tonnes capacity or larger. The holes in the top of the canopy are for lifting the canopy only and will not carry the weight of the TST. If a forklift truck is not feasible then a crane can utilise the forklift pockets to lift the TST using appropriate lifting equipment (e.g. spreader beams) to prevent damage to the equipment.

7.4 Post Shipping Checklist

Once the TST has been unloaded and transit packaging has been removed, a post shipping inspection must be carried out. This is to ensure that the TST has not been damaged during transit and that any parts for site fitting are supplied and inspected for damage.

Visual inspection of the TST to ensure that:

- The canopy is undamaged.
- All connections are free from damage.

Report any damage to Heliex Power.

8 Electrical Services

The installer is responsible for designing and installing the cabling, isolation and protection device(s) between the TST and the point of connection.

It is the responsibility of the installer to ensure that the electrical installation complies with all relevant laws and regulations, the recommendations of Heliex Power, and is carried out in a competent and certified manner.

The TST is an asynchronous device which does not generate its own voltage and frequency reference and cannot therefore be the primary generation source in the distribution network. This means that the TST cannot operate in "voltage/island mode" or perform "black starts". If a voltage/island mode situation develops the TST will automatically shut down.

The TST cannot be programmed to operate at a specified power factor. The motor has a power factor profile similar to a generator. The power factor at which current is generated will be a function of the load factor of the motor. This curve can be obtained from Heliex Power. The TST does not have power factor correction capacitors. When in use the TST reduces a sites electrical power (kW) requirement from the grid but adds to the KVAR (Kilo Volt Ampere Reactive) demand. When it comes to countering the reactive KVARs, the normal method of doing this is to have Power Factor Correction capacitors at the site's incoming mains supply. This is normally a multi-step device that varies depending on the site's Power Factor. If a site already has this and it is not already fully loaded then the full benefit of the TST in terms of kW should be realised, while letting the Power Factor Correction offset the negative impact of inductive KVARs caused by the motor. It remains the installer's responsibility to evaluate what the site requirements are in respect to Power Factor Correction.

At connection, the TST, and the distribution network to which it is connected to will experience an inrush current. This inrush current is proportional to the instantaneous inductive current required to magnetise and excite the motor. The transient peak can be reduced by extending the transient time by the installation of a soft start unit. The soft start is an option on the HP145 and mandatory on the HP204 TST. Note that the Voltage Amp Rating required stay the same.

As the generator is an asynchronous device which is not self-exciting, it cannot be considered to generate a voltage at the generator terminals. If it is disconnected from the grid the internal magnetic field will collapse, so supplementary local earth bonding is not required.

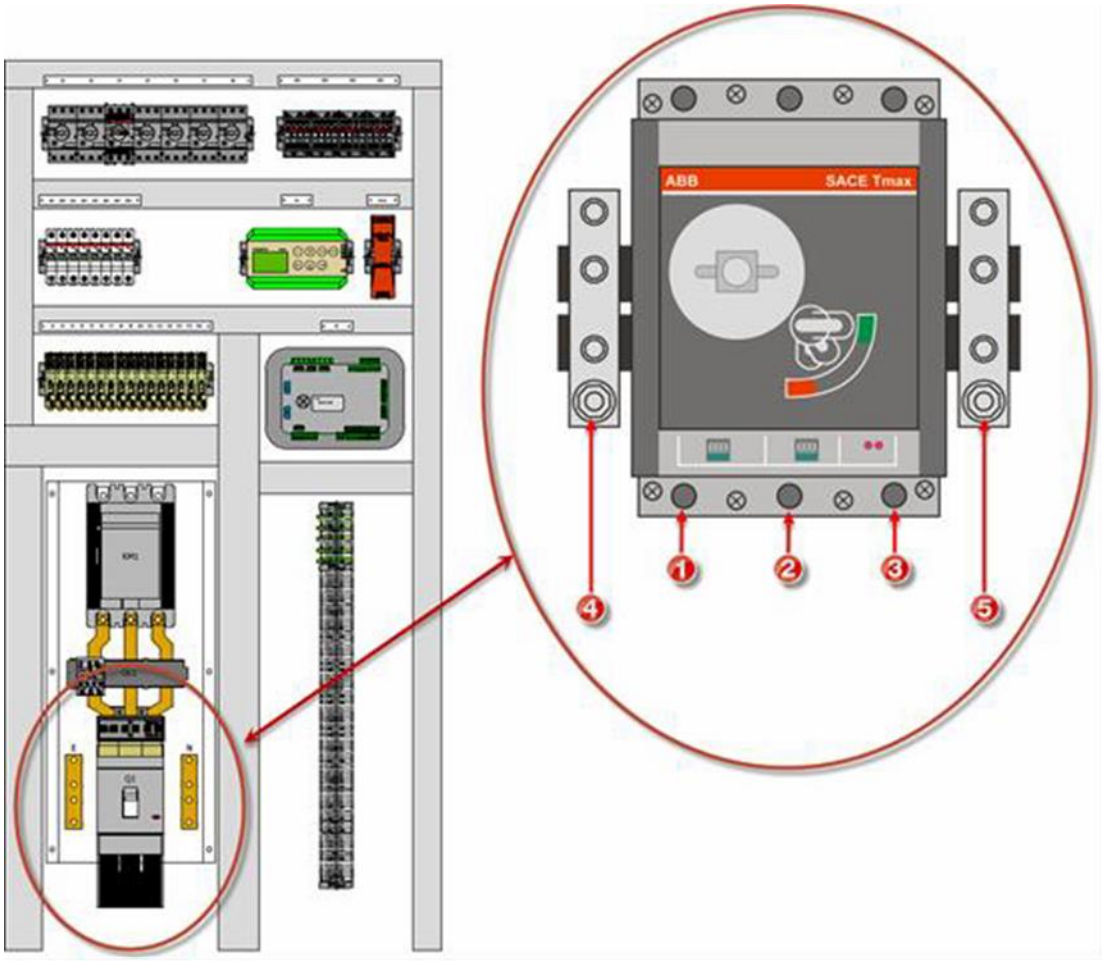
8.1 Cable Entry

The TST is provided with gland plates to allow cable entry.

Refer to the Installation and Interface Requirements drawing for details on the gland plates to allow cable entry.

8.2 Isolator Connection

Diagram showing isolator connection (HP145 illustrated)



Connection	
1	L2
2	L2
3	L3
4	Earth
5	Neutral

8.3 Electrical Power Connection

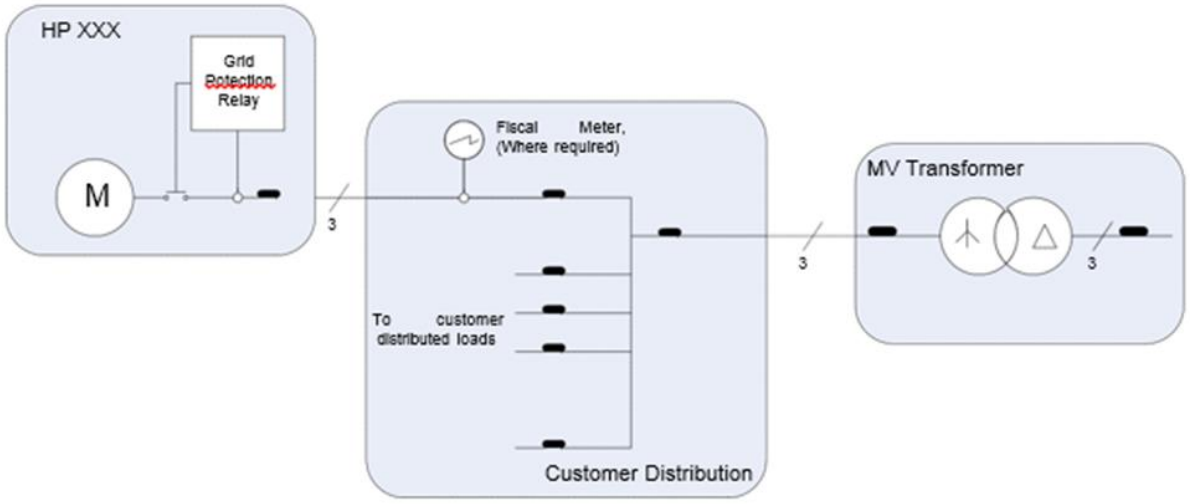
The Heliex Power TST can be provided in the three following variants -

- 415V, 50Hz, 3ph+N
- 415V, 50Hz, 3ph
- 690V, 50Hz, 3ph

Contact Heliex Power to confirm panel type supplied.

The main power connection is the main connection between the TST and the site distribution network. All electrical power to and from the TST is carried by this connection.

Diagram showing main power connection:



Whilst the TST is in standby mode it will maintain its internal control supplies from this connection. During TST start up electrical energy will be drawn through this connection to supply the internal TST loads. During generation electrical energy is exported to the local distribution network via this connection.

The main electrical power connection is made to the bottom terminal set of the main circuit breaker. Mains cables must be installed by a certified electrical installer (installer's responsibility) and can include monitoring CT's at the point of entry/connection to the TST (before the main isolator, on site cables only). No additional modification/connections within any other part of the TST are permitted.

8.4 Generator Data

8.4.1 HP145

	Units	TST Rating	
		110kW	160kW
Pole count	n	2	2
Voltage	V rms	415	415
Frequency	Hz	50	50
FLA	A	185	268
Power factor	n	0.93	0.93
Rotor locked current	A rms	185	268
Sub transient reactance	xd	0.203	0.124
Active/True Power	kW	110	160
Apparent Power	kVA	128.17	185.68
Reactive Power	kVAR	65.79	94.21
Peak Asymmetrical Short Circuit Current @ 10mS	A	2363.77	5684.28
RMS value of initial symmetrical Short Circuit Current	A	787.92	1894.76
RMS value of initial symmetrical Short Circuit Current	A	218.95	466.93
Three phase symmetrical short circuit current	A	*	2613

Three phase asymmetrical short circuit current	A	*	5225
Short circuit withstand current	kA	36	50
TST output protection device	A rms	400	400
Maximum auxiliary power consumption	kW	5	5

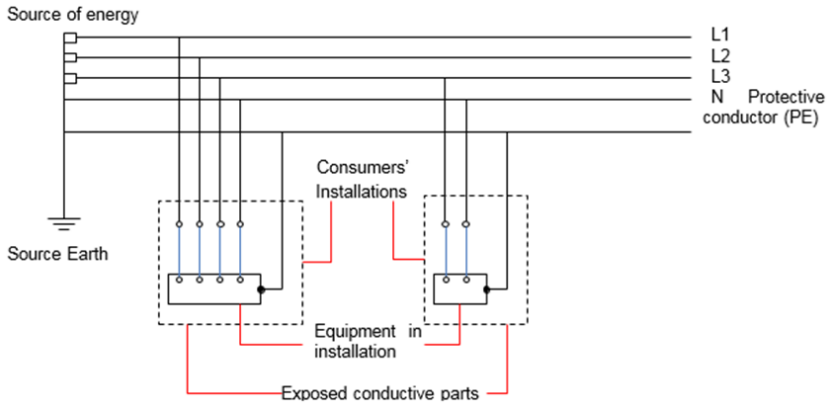
*Contact Heliex Power for values.

8.4.2 HP204

	Units	TST Rating			
		200kW	250kW	315kW	400kW
Pole count	n	2	2	2	2
Voltage	V rms	415	415	415	415
Frequency	Hz	50	50	50	50
FLA	A	331	414	522	662
Power factor	n	0.93	0.91	0.91	0.91
Rotor locked current	A rms	330	413	522	668
Active/True Power	kW	200	250	315	458.65
Apparent Power	kVA	229.32	286.83	361.65	224.4
Reactive Power	kVAR	112.2	140.61	177.67	224.4
Peak Asymmetrical Short Circuit Current @ 10mS	A	7020.51	12913.2	21924	8943.32
RMS value of initial symmetrical Short Circuit Current	A	2340.17	4304.38	7308	2981.11
RMS value of initial symmetrical Short Circuit Current	A	576.69	1374	2219.81	1285.06
Sub transient reactance	xd	0.096	0.068	0.0505	0.0477
Three phase symmetrical short circuit current	A	4114	7342	12495	16928
Three phase asymmetrical short circuit current	A	8229	14693	24990	33856
Short circuit withstand current	kA	50	50	50	50
TST output protection device	A rms	400	630	800	1000
Maximum auxiliary power consumption	kW	5	5	5	5

8.5 Earthing and Grounding

The TST is designed for use with a TN-S grounding scheme –



TN-S System is characterised as having:

- Separate neutral and protective conductors throughout the system.
- The protective conductor can be the metallic covering of the cable supplying the installation or a separate conductor.
- All exposed conductive parts of an installation are connected to this protective conductor via the main earthing terminal of the installation.

Other wiring systems may be used, however advice must be sought from Heliex Power in writing before any other system is employed.

The main TST earth bar is located inside the electrical cabinet on the left hand side of the main circuit breaker. The minimum protective ground conductor size should be the same as that of a single power export conductor.

8.6 Phase Rotation

Power cables to the TST must be tested for correct rotation by the installer before commissioning.

8.7 Testing Requirements

In some regions earth or ground loop impedance testing is required by the site electrical design authority. This should be completed by the installer and the test documentation made available to the commissioning technician.

8.8 Fiscal Meter

A fiscal export meter may be installed by the user if required.

Each region and distribution network operator (DNO) will be able to supply a list of locally approved fiscal meters. It is the responsibility of the installer to install and commission this meter including all correspondence with the DNO.

8.9 Italian Grid Codes

When installed in Italy, to comply with CEI 016 and CEI 021 standard, if required the user must install capacitors before the grid protection relay on the grid side to rectify the power factor to ensure the power is within the range defined by the relevant standard.

8.10 Site Distribution Protective Device

The installer will provide protective and isolating devices located in the local distribution panel sized such that they ensure compliance with all relevant laws and regulations.

The protective and isolating devices will be sized and selected in accordance with the guidance contained in this manual and all relevant regulations. See section 8.4 (Generator Data) for full details.

The protective device will either be in the form of a switched fuse isolator where the fuse elements can be removed once the switch is opened, or a moulded case circuit breaker.

8.11 Cable Sizing

The installer remains responsible for designing and installing the cabling between the TST and the point of connection.

Care should be taken in selecting the correct size and rating of the power cable. Attention should be given to the following to specify the cable correctly:

- Ambient temperature
- Local distribution protective device ratings
- Cable type
- Insulation type
- Armour type
- Installation method
- Voltage drop
- Potential physical damage

8.12 Cable Testing

The electrical installation should be tested to ensure compliance with all relevant laws and regulations. Test documentation must be made available to the commissioning technician.

8.13 Auxiliary Power Connection

There is no auxiliary power connection. All power required during stand by, and start-up is delivered to the TST via the main power connection.

8.14 Grid Protection Relay

Normally the Distribution Network Operator (DNO) will require that a TST connected to the grid be fitted with a grid protection relay to shut down and prevent restart of the TST in the event of the voltage or frequency moving outside a pre-set tolerance or becoming unstable.

As standard the TST is provided with a ComAp MainsPro grid protection relay to perform this function. Where required for local markets other units can be specified.

8.15 Binary Input Signals

Binary Input signals allow remote input signals from the user's SCADA/PLC to start and stop the TST.

Signal Name	Description	Circuit Type	Connection Type
Emergency Stop	Remote emergency stop signal	Closed	24V Volt free contact
Remote Start	Remote signal to initiate TST start	Open	

8.16 Binary Output Signals

Binary Output signals provide information on the status of the TST which can be fed into the user's SCADA/PLC to provide full process integration. Each TST has three signals which are configured as standard shown in the table below. Each signal is configurable to the requirements of the process requirements. For full list of available signals see ComAp GenConfig Reference Manual.

Signal Name	Description	Circuit Type	Connection Type
Auto & Ready	Controller in Auto mode and warm-up cycle has been completed	Open	24V Volt free contact
Slow Stop	Slow stop initiated	Closed	
Shutdown/ Emergency Stop	Shutdown/Emergency stop initiated	Closed	

Final terminations of these signals in the control cabinet should be completed by the commissioning technician.

9 Communications

Remote monitoring of the TST is possible via the following sources:

- Internet bridge (via internet cable or built in Wireless GPRS/UMTS Modem)
- BMS or SCADA systems, RS232, RS485, MODBUS via RS485, UBS Port

Refer to the ComAP InteliGen communications guide for further information.

10 Commissioning

10.1 Pre-Commissioning

The following drawings and certification must be made available to the commissioning technician before commissioning:

- As-installed pipework drawing
- Electrical one line back to MV transformer showing isolation and distribution capacity.
- Electrical cable test certificates
- Pipework pressure test certificates
- Pressure relief valve certificates (where required)

Evidence that the following have been carried out must be made available to the commissioning technician before commissioning:

- If new - Written scheme of examination (WSE)
- If retrofit - Changes to WSE
- Pipework pressure test
- Earth loop test
- PRV test and certification

Refer to Heliex Power document HP-IMS-CUST-GEN-007 for the full pre-commissioning checklist.

10.2 Twin Screw Turbine Commissioning

Commissioning of the TST will be carried out by Heliex Power technicians.

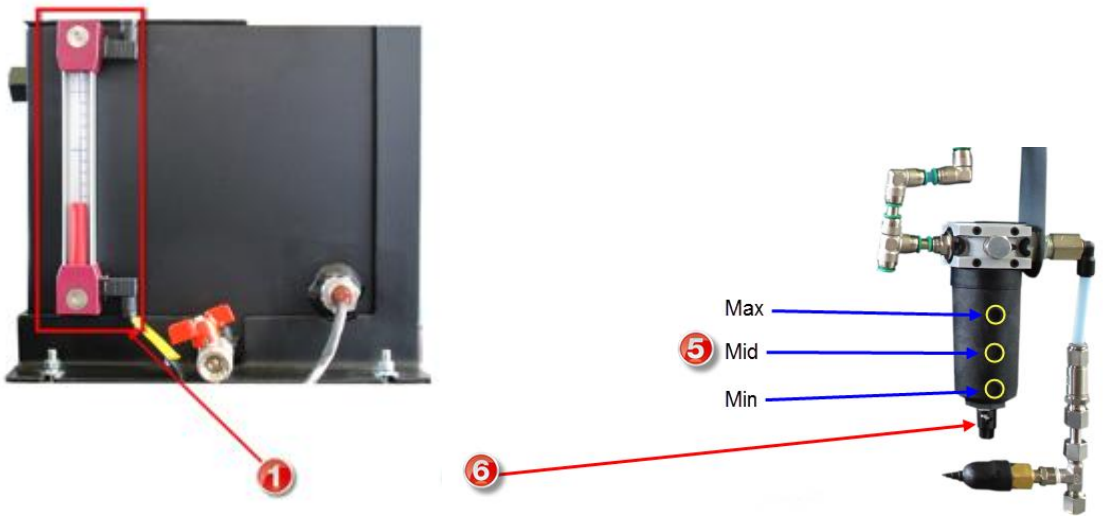
For the full TST commissioning checklist, refer to Heliex Power document HP Form 11 for a comprehensive list of tasks to be completed.

11 Operation

11.1 Pre-Start Inspection

Prior to starting the TST or on a daily basis the following inspection should be carried out.

Note - The operator should never enter the canopy whilst it is running.



- **Check oil level**

The oil level sight glass (1) is located on the side of the oil tank. If the level is found to be low top up as required. If the TST continually requires to be topped up report the issue to the person responsible for maintenance.

- **Check the air filter for water**

If water is visible at the middle indicator (5) of the air filter pot drain the water by pressing the drain button (6) located on the base of the filter pot.

- **Check for leaks**

Ensure that the equipment is free from oil, steam, condensate, or air leaks. Any issues found should be rectified prior to the equipment being started.

11.2 Power Up

Once the pre-start checks are complete the TST can be powered up by switching on the main isolator on the control panel door. The user interface will display the start-up screen. Once complete the Alarm Screen will be displayed providing details of any current alarms.

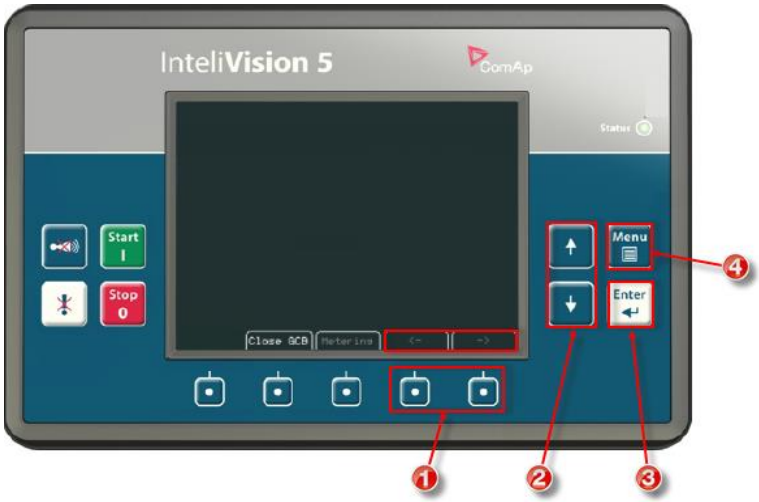
11.3 Operation Using Local HMI Screen

11.3.1 Icons & Controls

Access to view information or update settings is achieved through a set of user screens found on the HMI. These screens use several icons to display information to the user, these are listed below.

11.3.1.1 Navigation Controls

To navigate through the screen menus or to input settings the following navigation buttons are used.



1. Left, Right
2. Up, Down
3. Enter
4. Back

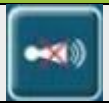
11.3.1.2 Context Controls

Context sensitive buttons are used to access commonly used functions.

1. GCB Control
2. Alarm List
3. History
4. Mode

11.3.1.3 Control Buttons

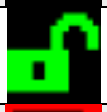
The following control buttons are mounted on the left hand side of the user display.

Icon	Description
	Horn reset (Unused)

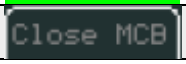
	Fault reset/clearing (active only in Alarm screen)
	Starts the TST whilst in manual mode. To be used by service personnel only.
	Stops the TST whilst in manual mode. To be used by service personnel only.

11.3.1.4 Icons

11.3.1.4.1 Icons at the Top of HMI Screen

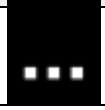
Icon	Description
	Controller is locked; no user is logged in
	Controller is NOT locked; user is logged in
	Access lock is active; display is locked for security reasons
	Remote communication; visible when any remote connection to controller is active

11.3.1.4.2 Icons at the Bottom of HMI Screen

Icon	Description
	Mains voltage, frequency are/are not within the set limits
	Load voltage, frequency are in the limits/no available power source
	Voltage, frequency are in the limits/out of the limits or not started
	A new alarm is active
	Breaker failure MCB/GCB fail
	Closed breaker
	Opened breaker

11.3.1.4.3 Screen Icon Description

Icon	Description
	Menu screen

		Measurement screens
		Setpoints screen
		Alarm list screen
		History screen
		Help/Others screen

11.3.1.4.4 View TST Status

The controller status is displayed in the left bottom part of the screen. Status depends on the external conditions and is updated immediately when any condition is changed.

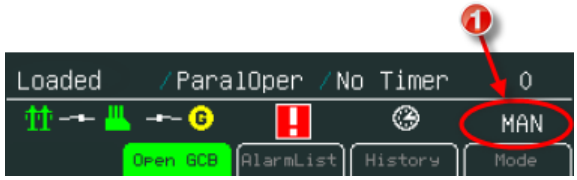
1. TST status

The TST can operate in the various states as detailed in the table below.

Status	Definition
Not ready	TST is not ready to start
Init	After controller power supply switch on
Stopped	No Running indication
Starting	Waiting for ReadyToLoad signal
Running	Waiting for GCB connection or start synchronizing
Soft load	TST power is ramping up
Loaded	TST is loaded
Soft unld	TST power is ramping down
Stopping	Stopping procedure before the BI ReadyToLoad is opened.
Stopped	Stopped - initial state – waiting for engine start

11.3.1.4.5 View TST Operating Mode

The TST status is displayed in the bottom left of the metering screen.



1. TST operating mode

TST Operating Mode	Description
OFF	TST inactive
MAN	Default position if red alarms reset. TST will not grid connect in this mode.
SEMI	Unused
AUTO	Warm-up or operating mode

11.3.1.4.6 Metering Screens

Access for the user to view the TST parameters, such as steam pressures, temperatures etc, is provided through various pages on the local HMI screen.

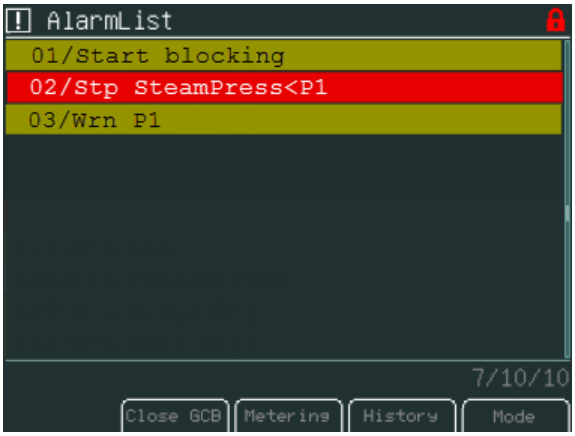
The screens can be accessed using the Down button if the main screen is displayed (i.e. not the alarm list). If the main screen is not displayed then press the Menu button to display a list of the available menus, then select Metering.

11.3.1.4.7 Setpoints

The Setpoints menu allows the user to change the parameters of the TST. With the exception of Base Load, Load Ctrl PtM, TempByPwr Treq and Time and Date setpoints values must not updated by the user unless instructed by Heliex Power.

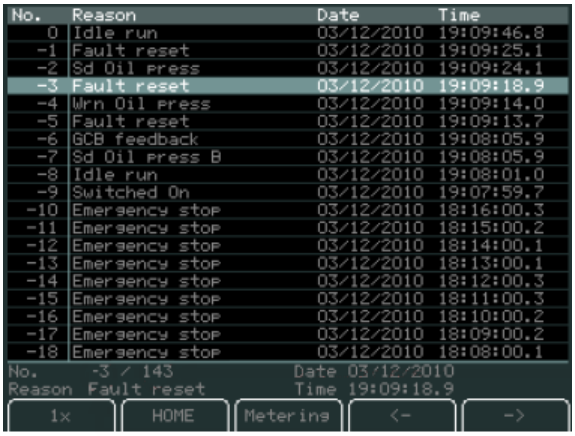
11.3.1.4.8 Alarm List

On selecting the Alarm List menu option from the Main Menu screen a list of currently active alarms will be displayed.



11.3.1.4.9 History

On selecting the History menu option from the main menu, a list of the last 1,000 'events' will be displayed. A snapshot of the TST's current performance values is captured automatically (time between snapshots is configurable), in addition any status change, setpoint change or alarm status change is also recorded. Once 1,000 records have been recorded the system will automatically overwrite the oldest history records.



11.3.1.4.10 Help/Others

The Help/Others menu provides access to a set of sub menus that allow the user to display or update basic controller information. These sub-menus are accessed using standard navigation controls.

11.3.1.4.10.1 Languages

The Languages sub-menu allows the user to select from a pre-loaded set of languages.

11.3.2 Starting and Stopping the TST

The TST is fitted with a local key switch mounted on the TST control panel door or by a remote key switch installed in a suitable location such as a control room.

1. Location of control panel mounted key switch.

11.3.2.1 Unlocking the Control Module

1. Open the Metering screen by pressing the Metering button.
2. Press the Menu button, the Menu screen will open.
3. Select the Help/Other option using the Up/Down arrow keys.
4. Press Enter to confirm.
5. Select the User/Password option using the Up/Down arrow keys.
6. Press Enter to confirm.
7. Use the Up, Down, Left and Right arrow buttons to move the cursor and increment. values. Press the enter key to confirm.
8. Select the Enter Password option.
9. Input the password value and press Enter to confirm.

10. When unlocked green icon will be visible.

11.3.2.2 Starting

1. Review alarm list and ensure no red alarms are present.
2. Clear any redundant alarms by pressing the Fault Reset button.
3. Press the Mode button, the mode menu will be displayed.
4. Use the Up and Down arrow buttons so highlight the Auto mode.
5. Press Enter to confirm. The warm-up phase is now initiated.

Note – If a red alarm is present whilst in Auto mode, the warm-up phase will not be active.

6. Once the warm-up phase has been completed both the remote start signal and the key switch must be switched on for the TST to start.

Note – if both signals were already switched on, the TST will go into the prestart and then start phase automatically.

7. Once both are switched on, the TST will go into the prestart phase for a short period during which a warning alarm will sound. A countdown is shown on the screen during this phase.
8. The control valve will then open to initiate rotation in the system.

11.3.2.3 Stopping

1. To stop the TST turn the local key switch to the OFF position or remove the remote start signal. This will initiate a slow stop. Once stopped, the TST will remain in Auto mode and cycle in and out of the warm-up phase until a start signal is reinitiated or removed from Auto mode.

If the TST is to be switched off for a prolonged period of time, the controller mode should be switched to OFF.

11.3.2.4 Restarting the TST Following an Alarm

1. Turn the key switch to Off.
2. If not already shown, press Alarm List to open the alarm list window.
3. Alarms that are no longer active will now be grey and can be cleared.

Note – active alarms will be displayed in red, the cause of all active alarms must be rectified before they can be cleared.

4. Press the Fault Reset button to clear all inactive alarms from the alarm list.

Note – the TST mode will change to manual.

5. Press the Mode button to open the mode list.
6. Select Auto.
7. Press Enter to confirm.
8. Press the Metering button to return to the main screen.
9. Turn the key switch to On.

Note – the TST will only start once all permissives are met.

11.3.2.5 Control Methods

The TST has three control philosophies: inlet pressure control, outlet pressure control and power control. See section 5.6 (Control Philosophy) for full details.

11.3.2.5.1 Control by Outlet (P2) Pressure

11.3.2.5.1.1 Change Outlet (P2) Target

1. Press the Menu button, the Menu screen will open.
2. Select the Setpoints option using the Up/Down arrow keys.
3. Press Enter to confirm.
4. From the Setpoints menu select ProcessControl.
5. Press Enter to confirm.
6. From the Process Control menus select TempByPwr Treq.
7. Press Enter to confirm.

8. The TempByPwr Treq window will be displayed.
9. Use the Up, Down, Left and Right arrow buttons to move the cursor and increment values.
10. Press the enter key to confirm desired outlet (P2) pressure.

11.3.2.5.2 Power Control (Baseload)

11.3.2.5.2.1 Change Power Output (Baseload) Target

The baseload level should always be adjusted (either up or down) in small increments (10kW steps is advised) allowing the TST to reach the new target and settle before applying the next change.

1. Press the Menu button, the Menu screen will open.
2. Select the Setpoints option using the Up/Down arrow keys.
3. Press Enter to confirm.
4. From the Process Control menu select Base Load.
5. Press Enter to confirm.

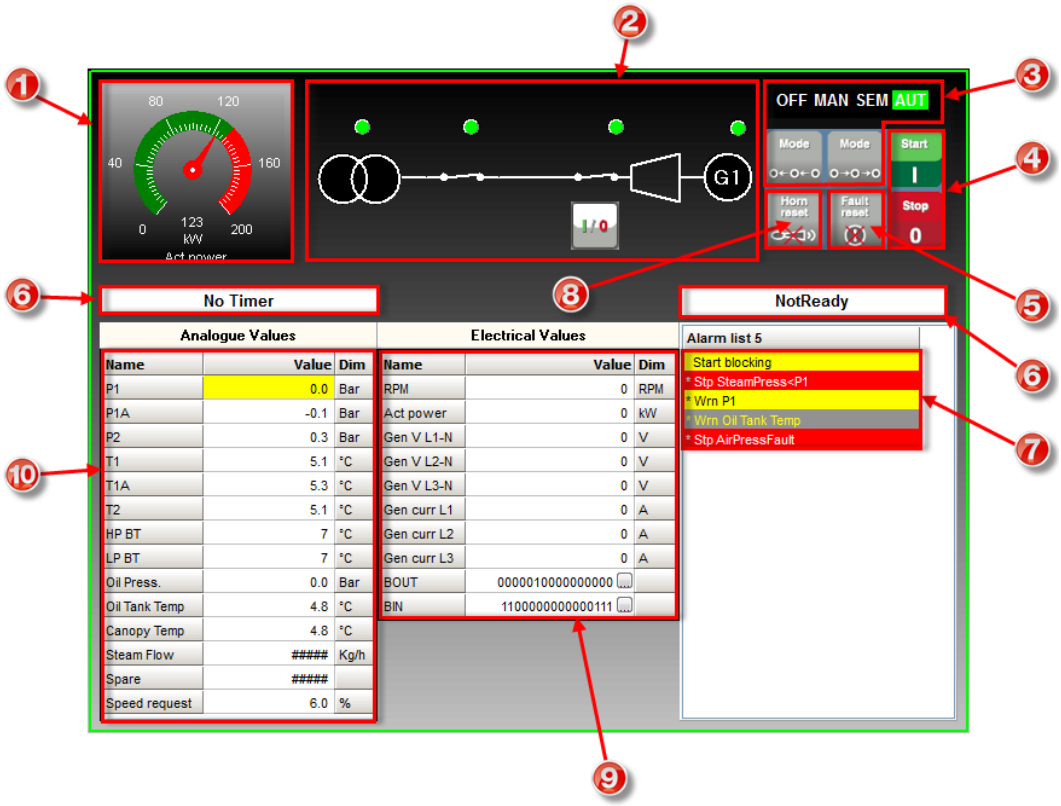
6. Use the Up, Down, Left and Right arrow buttons to move the cursor and increment values.
7. Press the enter key to confirm desired power output.

11.4 Remote Operation Using Intelimonitor

11.4.1 Icons and Controls

11.4.1.1 The Main Screen

The main screen displays the information most required by the user. This screen can be configured to meet the user's requirements, the layout below shows the default TST configuration.

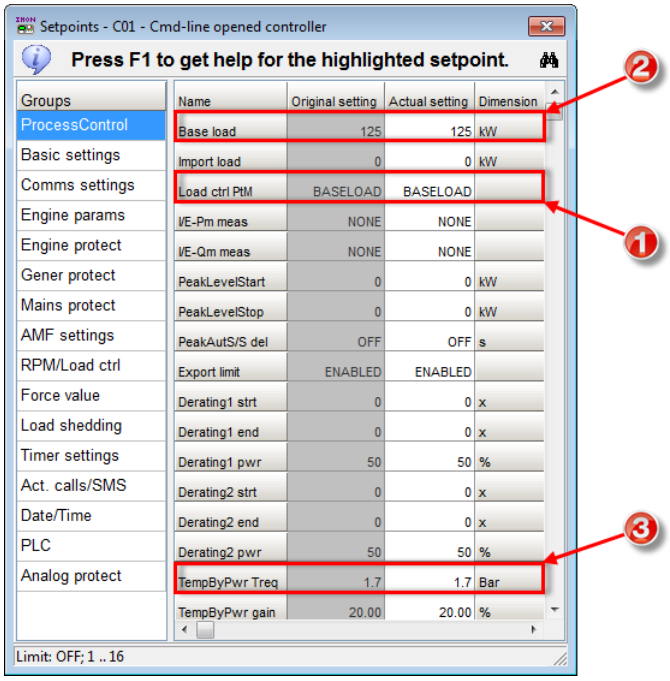


1. Actual Power Generated
2. System Status & GCB manual open/close control
3. TST Mode display and controls
4. Start/Stop TST in manual mode. To be used by service personnel only.

5. Fault Reset
6. TST Status Display
7. Active Faults & Alarms
8. Horn Reset (Unused)
9. Power Quality Statistics
10. TST Operating Conditions

11.4.1.2 The Setpoint Window

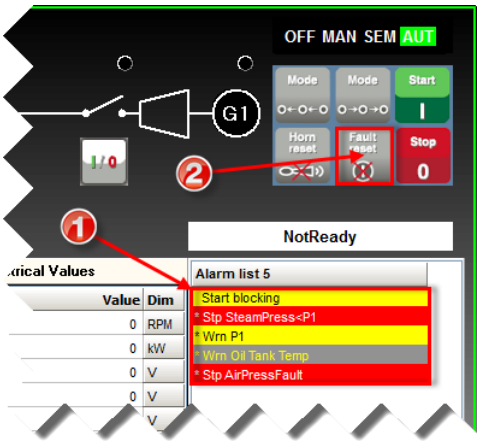
The Setpoints menu allows the user to change the parameters of the TST. With the exception of Base Load, Load Ctrl PtM, TempByPwr Treq and Time and Date setpoints values must not updated by the user unless instructed by Heliex Power.



1. Control Method
2. Power Target
3. Output Pressure Target

11.4.1.3 Viewing and Clearing Alarms

A list of all current alarms and warnings is displayed on the main screen. To acknowledge a warning or to clear any alarm that is no longer active (shown in grey) press the Fault Reset button.



1. List of current Alarms & Warnings.
2. Press Fault Reset to acknowledge warnings or clear alarms that are no longer current.

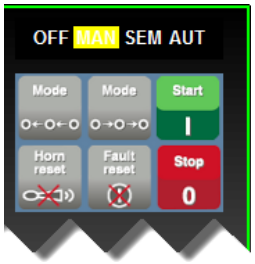
Note – clearing an inactive red alarm whilst in Auto mode will divert control into Man mode. If a red alarm is present whilst in Auto mode, the warm-up phase will not be active.

11.4.1.4 Setting the TST mode

The TST operating mode can be changed directly from the Main Screen.

TST Operating Mode	Description
OFF	TST inactive
MAN	Default position if red alarms reset. TST will not grid connect in this mode.
SEMI	Unused
AUTO	Warm-up or operating mode

1. Hover the mouse over the desired mode, when this highlights press the left mouse button to accept the change.



2. The active mode will be highlighted in yellow.

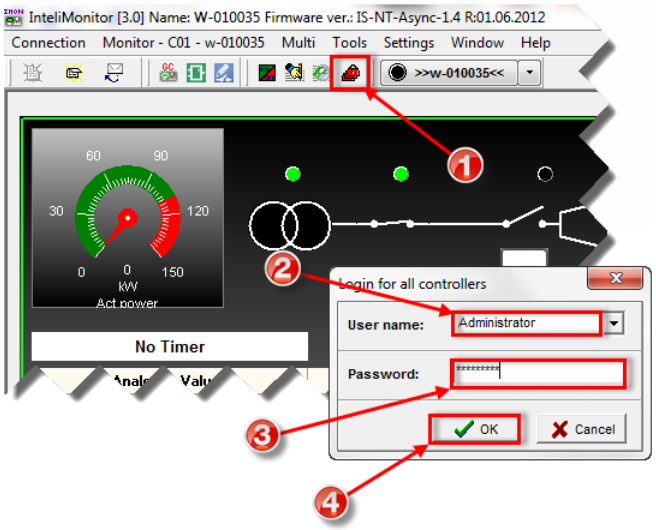
11.4.2 Starting & Stopping the TST

The TST is fitted with a local key switch mounted on the TST control panel door or by a remote key switch installed in a suitable location such as a control room.

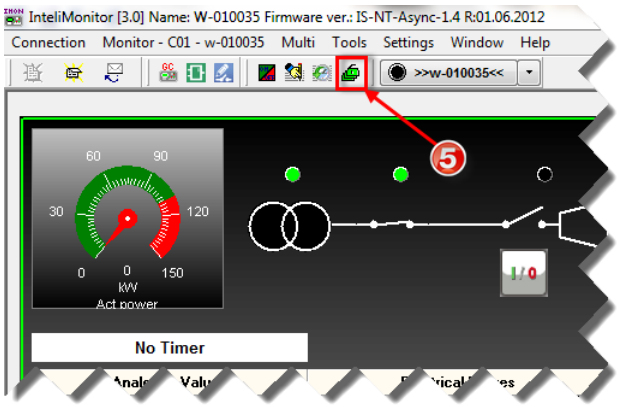
1. Location of control panel mounted key switch.

11.4.2.1 Unlocking the TST

To make changes to the TST configuration, setpoints or operating mode access to the unlocked. The user must have a valid username and password to unlock access to the TST.



1. Press Lock/Unlock, the Login window will open.
2. Enter username.
3. Enter password.
4. Press OK.



5. When unlocked the Lock/Unlock icon will display in green.

11.4.2.2 Starting

1. Review alarm list and ensure no red alarms are present.
2. Clear any redundant alarms by pressing the Fault Reset button.
3. Press Auto to enter Auto mode and initiate the warm-up sequence.

Note – If a red alarm is present whilst in Auto mode, the warm-up phase will not be active.

4. Once the warm-up phase has been completed both the remote start signal and the local key switch must be switched on for the TST to start.

Note – if both signals were already switched on, the TST will go into the prestart and then start phase automatically.

5. Once both are switched on, the TST will go into the prestart phase for a short period during which a warning alarm will sound. A countdown is shown on the screen during this phase.
6. The control valve will then open to initiate rotation in the system.

11.4.2.3 Stopping

1. To stop the TST turn the local key switch to the OFF position or remove the remote start signal. This will initiate a slow stop. Once stopped, the TST will remain in Auto mode and cycle in and out of the warm-up phase until a start signal is reinitiated or removed from Auto mode.

If the TST is to be switched off for a prolonged period of time, the controller mode should be switched to OFF.

11.4.2.4 Restarting the TST Following an Alarm

1. Turn the key switch to Off.
2. Review alarm(s) which are present in the alarm list window.
3. Alarms that are no longer active will now be grey and can be cleared.

Note – active alarms will be displayed in red, the cause of all active alarms must be rectified before they can be cleared.

4. Press the Fault Reset button to clear all inactive alarms from the alarm list.

Note – the TST mode will change to manual.

5. Select Auto to change mode.
6. Turn the key switch to On.

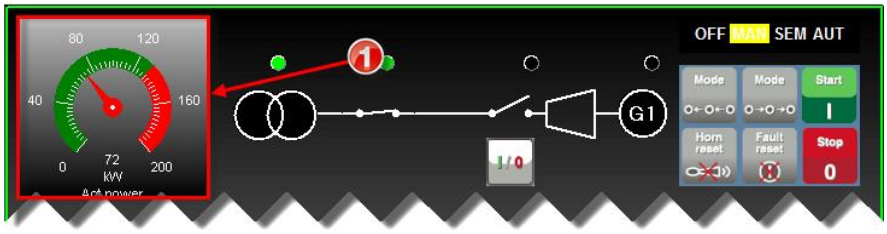
Note – the TST will only start once all permissives are met.

11.4.2.5 Control Methods

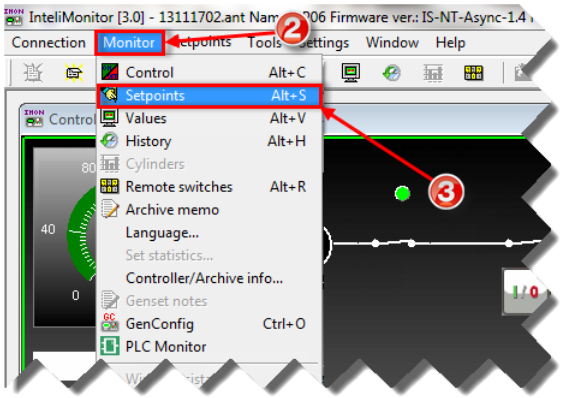
The TST has three control philosophies: inlet pressure control, outlet pressure control and power control. See section 5.6 (Control Philosophy) for full details.

11.4.2.5.1 Control by Outlet Pressure

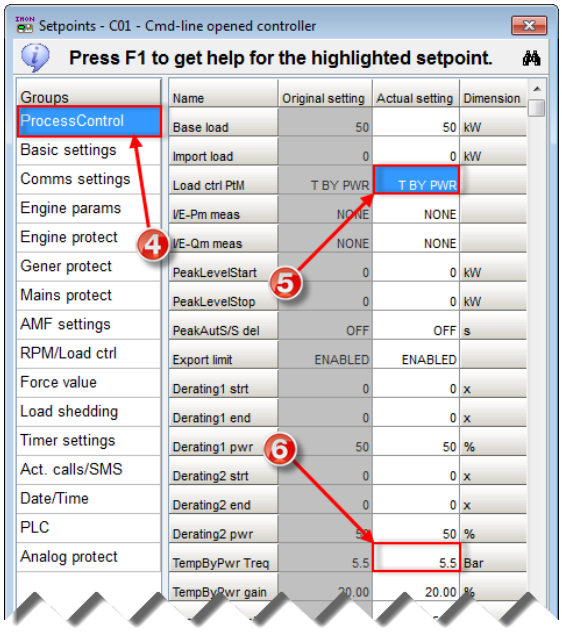
11.4.2.5.1.1 Change Outlet (P2) Target



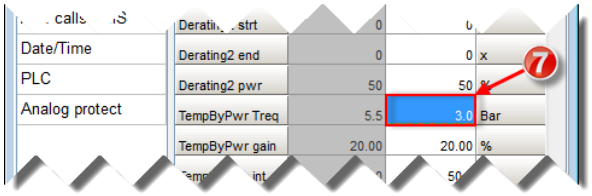
1. The InteliMonitor main screen will display the current power being generated.



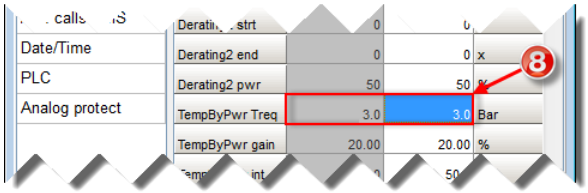
2. Press Monitor.
3. Select Setpoints to open the Setpoint menu.



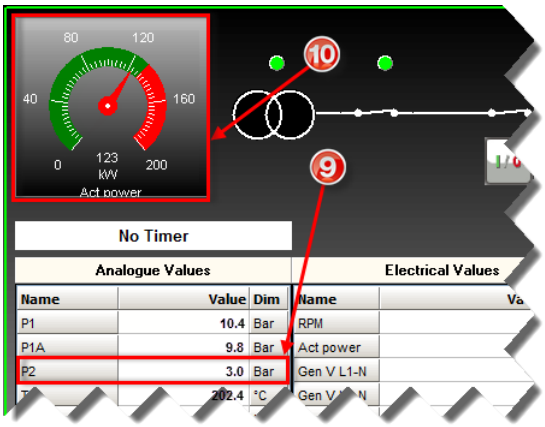
4. Select the Process Control tab.
5. Confirm that the Load ctrl PtM is set to T BY PWR.
   Note – the operating mode can only be changed when the TST is idle.
6. The outlet pressure target is displayed.



7. Enter the new outlet pressure target and press Enter.



8. The outlet pressure setpoint will be updated.



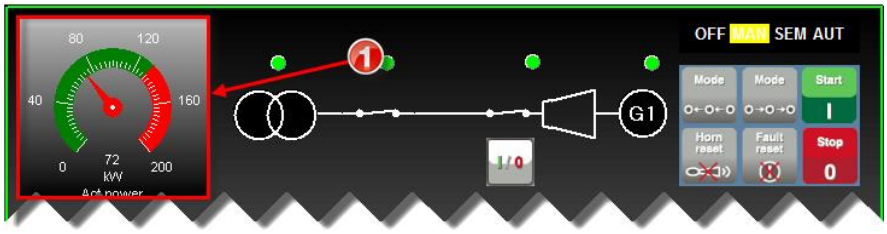
9. The actual outlet pressure value is displayed on the main screen.

10. The TST will modulate the control valve generate the maximum amount of power whilst attempting to achieve the setpoint pressure target.

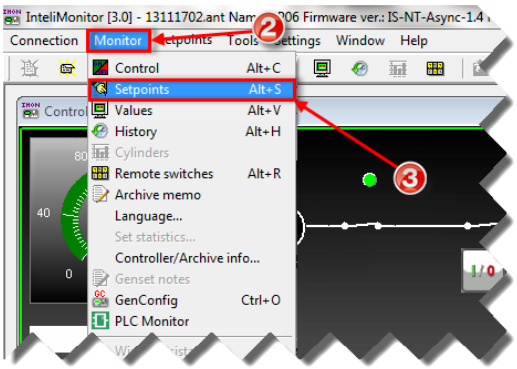
11.4.2.5.2 Control by Baseload

11.4.2.5.2.1 Change Power Output (Baseload) Target

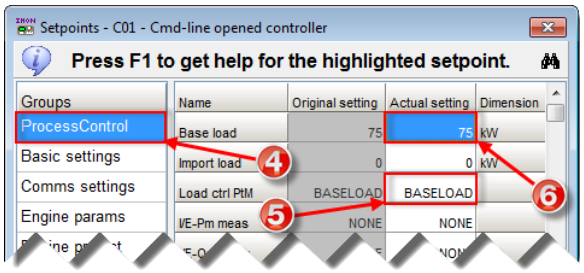
The baseload level should always be adjusted (either up or down) in small increments (10kW steps is advised) allowing the TST to reach the new target and settle before applying the next change.



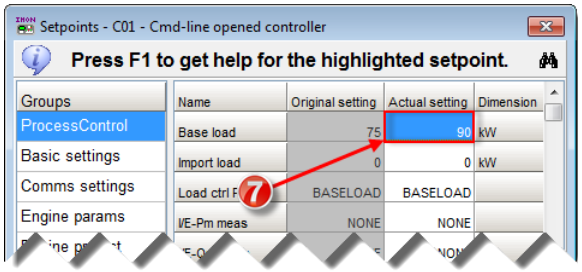
1. The InteliMonitor main screen will display the current power being generated.



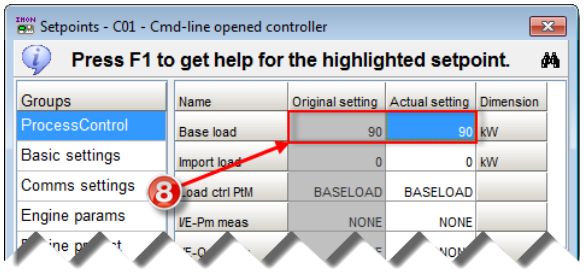
2. Press Monitor.
3. Select Setpoints to open the Setpoints menu.



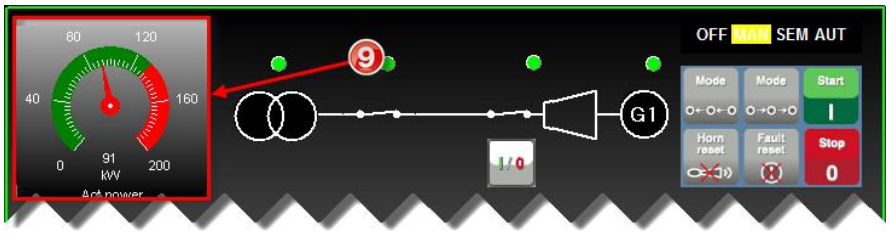
4. Select the Process Control tab.
5. Confirm that the Load ctrl PtM is set to Baseload.
6. The current power target is displayed.



7. Enter the new power target and press Enter.



8. The target power setpoint will be updated.



9. The TST will modulate the control valve to attempt to achieve the new setpoint power target.

11.5 Fault Recognition and Rectification

11.5.1 Alarm List

Message	Protection Type	Description
Canopy Temp	Warning/Slow Stop	Internal ambient temperature of TST high
Fan Fault	Warning	Belt guard fans trip
Canopy Fan O/L	Slow Stop	Canopy fans trip
HP BrgT	Warning/Slow stop	Expander high pressure bearing temperature high
LP BrgT	Warning/Slow stop	Expander low pressure bearing temperature high
Oil Press. <	Warning/Shutdown	Oil supply pressure low
Oil Press. >	Shutdown	Oil supply pressure high
Oil Heat Fail	Warning	Oil tank heater trip
Oiltank Lvl	Shutdown	Oil tank level high/low
Oil Tank Temp <	Warning	Oil tank temperature low
Oil Tank Temp >	Warning	Oil tank temperature high
ExpOilTemp	Warning	Oil supply temperature high
Oil Sys Fault	Slow Stop	Oil system operation trip
P1 <	Warning/Slow stop	Inlet steam pressure low
P1 >	Warning/Slow stop	Inlet steam pressure high
P1A <	Warning/Slow stop	Inlet steam pressure (after control valve) low
P1A >	Warning/Slow stop	Inlet steam pressure (after control valve) high
P2 >	Warning/Slow stop	Outlet steam pressure high
PressDiff>	Warning/Slow stop/Shutdown	Differential pressure across Expander (P1A-P2) high
Seal Diff Low	Warning/Shutdown	Expander seal pressure low
Comp P <	Warning	Seal compressed air supply pressure low
Oil Recirc	Shutdown	Expander oil recirculation line pressure high
Wrn SpdRegLim	Warning	Indication that main control valve is fully open
RPM Overspeed / GAC Overspeed	Shutdown	Rotational overspeed detected
Rotation Fail	Shutdown	No rotation detected
Batt volt	Warning	Controller basebox battery voltage issue
Startblocking	Warning	Permissives not met to allow TST to start
OflStartblocking	Warning	Incoming voltage fault
Emergency Stop	Shutdown	Emergency stop button pressed
Air Pressure Fault	Slow Stop	Auxiliary compressed air supply pressure low
WindingTempHi	Slow Stop	Generator windings temperature high
BOC Reverse Pwr	Shutdown	Reverse power measured
Main Motor Trip	Shutdown	Main motor circuit breaker trip
G99 Trip	Shutdown	G99 circuit breaker trip

MotorDE BrgT	Warning/Slow stop	Generator drive end bearing temperature high
Gen I unbal	Shutdown	Generator current unbalanced
Gen V unbal	Shutdown	Generator voltage unbalanced
Mains V unbal	Shutdown	Mains voltage unbalanced
WrnServiceTime	Warning	Service timer reached zero hours

11.6 Rectification

Message	Protection Type	User Remedial Actions
Canopy Temp	Warning/Slow Stop	Check high temperature is real.
		Check filters are clean.
		Contact Heliex Power Service department.
HP BT	Warning/Slow Stop	Check oil level and top up if required.
		Contact Heliex Power Service department.
LP BT	Warning/Slow Stop	Check oil level and top up if required.
		Contact Heliex Power Service department.
Oil Press	Warning/Slow Stop	Check oil level and top up if required.
		Contact Heliex Power Service department.
Oiltank Lvl	Shutdown	Check level and top up if required.
		Contact Heliex Power Service department.
Oil Tank Temp <	Warning	Ensure warm-up phase is active.
		Contact Heliex Power Service department.
Oil Tank Temp >	Warning/Slow stop	Check oil level and top up if required.
		Check oil cooler filter is clean.
		Contact Heliex Power Service department.
Comp P <		Check power is supplied to seal air supply source.
		Ensure all valves on seal air supply line are open.
		Contact Heliex Power Service department.
Air Pressure Fault	Slow Stop	Check air supply to TST.
		Check air filter.
Emergency Stop	Shutdown	Investigate if pressed.
All other alarm signals		Contact Heliex Power Service department.

12 Maintenance

12.1 Planned Preventive Maintenance (PPM)

Heliex Power provides maintenance both directly and through other approved organisations. PPM activities can be broken down into two categories, user checks and technician maintenance.

12.1.1 Planned Maintenance by Heliex Power Approved Technicians

Heliex Power recommends that the TST should be inspected and maintained quarterly and annually. These maintenance activities should only be carried out by Heliex Power or personnel who are trained and considered competent by Heliex Power to complete the work. Instructions on how to complete quarterly and annual maintenance will be given during technician training and a register of competent personnel maintained by Heliex Power.

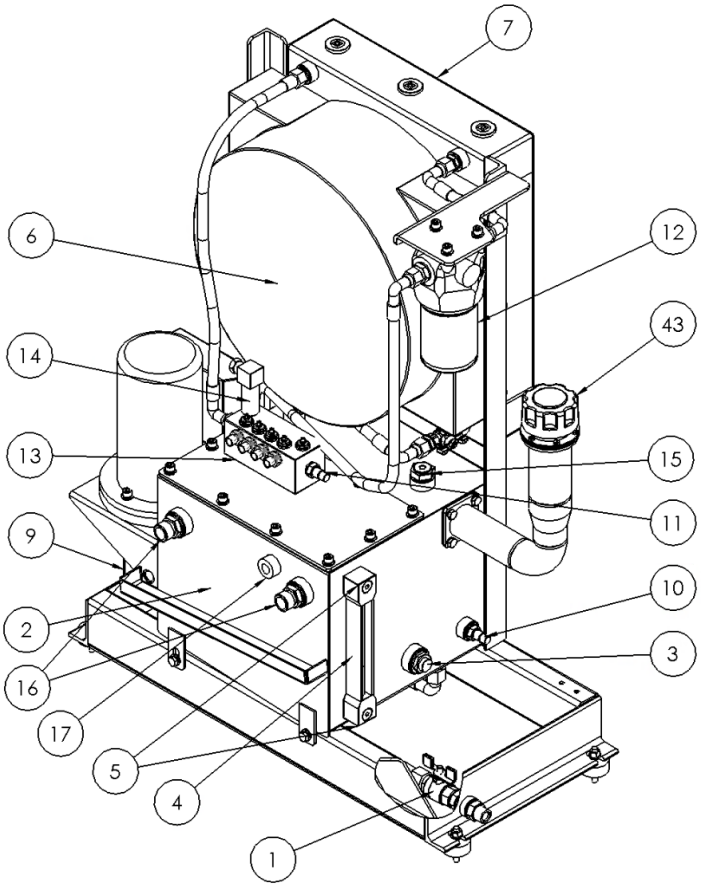
A trained technician should complete quarterly and annual maintenance visits within two to three standard working days, excluding travel, provided no abnormal conditions are found.

Heliex Power will carry out planned maintenance visits on a chargeable basis or can offer a package that includes all planned quarterly visits which would be in line with our PPM document HP-CUST-GEN-009 for a fixed annual fee.

12.1.2 User Regular Checks

Heliex Power recommends that user checks be carried out regularly. These are mainly visual checks and should take no more than fifteen minutes to complete. The user will be instructed on how to carry out these checks during user operator training and are detailed overleaf.

12.1.3 Oil Cooler

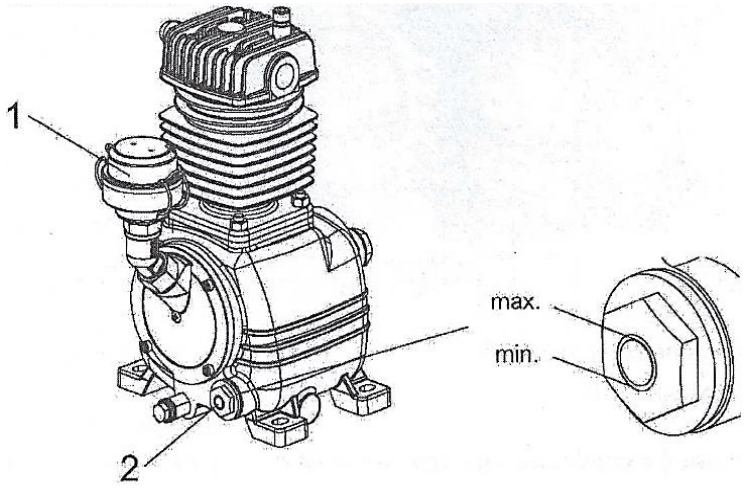


No.	Description
1	Oil Tank Drain Valve
2	Oil Tank
3	Oil Heater
4	Oil Level Sight Glass
5	Oil Level Sensors
6	Cooling Fan
7	Cooler
8	Oil Pump Motor
9	Oil Pump
10	Oil Tank Temperature Sensor
11	Oil Manifold Temperature Sensor
12	Oil Filter
13	Oil Manifold
14	Oil Pressure Sensor
15	Oil Tank Level Sensor
16	Oil Return Ports
17	Oil Recirculation Line Port
18	Oil Filler Cap

1. Check oil level of the tank and top up with Chesterton 607 Synthetic oil, HTS-220 as required.
2. Visual check for cleanliness of the cooler.
3. Visual check of the filter indicator.
4. Ensure cooling fan, external fins are clear of dust and dirt.

12.1.4 Air Booster Compressor

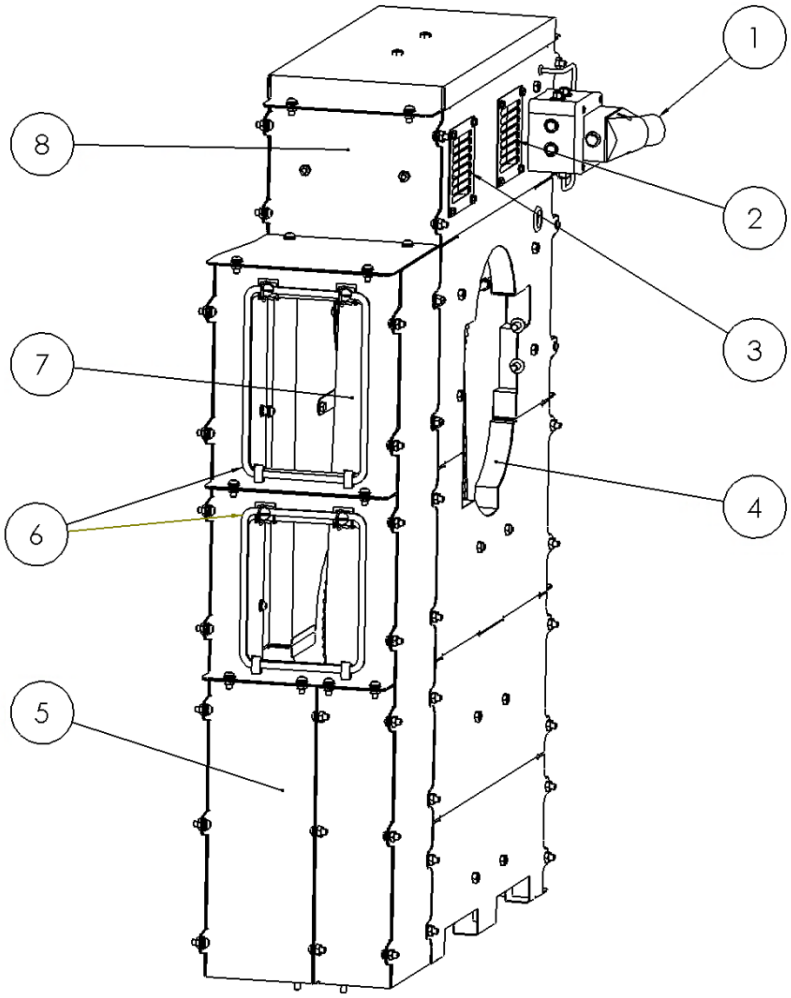
Checks can be performed while the compressor is running however if any maintenance work (including oil top up) is required, both the TST and compressor should be stopped. Under normal operation the booster compressor should run for less than three minutes and then stop for twenty minutes or more.



No.	Description
1	Oil Filler and Crankcase Vent
2	Oil Level Sight glass

1. Check the oil level and top up as necessary with VDL 150 Synthetic oil only.

12.1.5 Drive System



No.	Description
1	Fan Electrical Plug
2	Cooling Fans
3	Fan Louvres
4	Sound Attenuation
5	Belt Guard Panels
6	Perspex Panels
7	Drive Belt
8	Cooling Fan Assembly

1. Visually check belt for signs of belt wear and/or chipping. The belt can be inspected through the Perspex covers. Inspection should only be carried out when the TST is shutdown.

12.1.6 General PPM

1. Visual inspection of hoses for rubbing / wear and leaks.
2. Keep the TST clean i.e. canopy surfaces, canopy fans, baseplate during shutdowns.

12.2 Extended Shutdown Period (incl. Prior to Commissioning)

If the TST is to be shut down for more than 2 weeks, then the following actions should be carried out by the user to ensure it is kept in optimal condition.

Turn the expander shaft in the direction shown on the expander casing by 2 ¼ turns. This ensures, for both the expander and the generator, that:

- Bearings (generator and expander) do not develop flat spots.
- Bearings remain lubricated.
- Rotors are prevented from sagging or bending.

As the expander contains mechanical gas lift seals, it is critical that the expander seals are provided with an air supply during this process. If the site air connection is not available, then a workshop air compressor can be connected to the seal air connection on the TST.

The process for performing the above work should be:

1. Ensure an air supply of >1bar is connected to the expander seals. The connection is found on the manifold below the outlet pipe. The supply hose from the booster will currently be connected so this should be removed, and a temp supply should be connected to the ½" NRV on the manifold.
2. Remove the top section of the belt guard to reveal the expander shaft.
3. Check the direction of rotation arrow on the expander casing.
4. Using a torque wrench or spanner (HP145 – 17mm / HP204 - 24mm) turn the expander 2 and ¼ turns.
5. Replace belt guard.
6. Disconnect air supply.

The above process should be repeated every two weeks until the TST is recommissioned.

13 Recommended Spare Parts

For all spare parts contact Heliex Power for recommended replacements and quotation.

Tel: +44 (0)1355 233127
Email: info@heliexpower.com