SEATECH
ENGINEERING & MAINTENANCE SDN BHD
(388925-D)

# 700KW 1.0PF POWER FACTOR LOAD BANK SPECIFICATION

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# 1. GENERAL DESCRIPTION

## 1.1 Load Bank Capacity

Maximum capacity of 700KW, 1pf, 700kVA is available at 400V, 50/60Hz. The load

consists of several resistor banks with a total of :

Resistance 700kW, resistor elements
The rated capacities can be achieved continuously in ambient temperatures up to 50ºC.

## 1.2 Enclosure

The load bank is packaged in an ISO type container of the following dimensions:

Length : 2000mm
Width : 1300mm
Height : 1300mm
Weight : 1000kgs

The container is metal clad giving IP44 environmental protection to switchgear and controls and is of robust construction capable of enclosing and transporting the equipment without distortion or damage.

Forklift pockets are provided and the top and corner fittings can be used for lifting and securing.

## 1.3 General Arrangement

Housed within the enclosure formed by the container is all the equipment necessary for the operation of the load bank as follows:

- Resistive elements
- Cooling fans
- Load switching contactors
- Load circuit protection
- Copper work
- Control circuit protection
- Switching control

The interior of the enclosure is divided into separate sections by bulkheads, forming an element chamber which houses the cooling fans and resistor elements, a contactor section and a control section.

Resistive Elements

Resistive load is provided by fused groups of tubular resistor elements switched in various values by contactors.

Each totally enclosed element consists of 80/20 nickel chrome resistance wire connected to terminal pins, centred in a stainless steel tube which is filled with compressed magnesium oxide to ensure rapid heat transfer. The terminal pins form a non-heated section of the element and are insulated from the stainless steel tube by ceramic bushes. The outside of the tube has a helically formed stainless steel cooling fin which progresses the full length of the element.

The elements are cooled so as to operate in the black heat sector of the radiation spectrum and are fitted into element chambers with compression type bulkhead glands enabling a watertight transition of the terminal pins through internal bulkhead to the interior of the container. The element construction and method of installation ensures that the current carrying portion of the equipment is totally shielded from both the operator and the environment.

## 1.4 Cooling Fans

The resistor elements are cooled by one TEFC fan which can be fed from an external auxiliary source either being selected by manual selection of a changeover switch.

Fans are suitable for use on 400V, 50/60Hz supply only.

Cooling air is drawn into the element chamber through louvres located at low level in the side of the enclosure, passed over the element cooling fins and exhausted horizontally through grilles in the top. Cooling fans is fitted with air flow detector switches to provide protection against loss or reduction of airflow.

The reactor/contactor section of the is fitted with a blower fan directing cooling air through ducts to the base of the reactors and a fan drawing heated air out of the enclosure at high level.

Fan controls are electrically interlocked with load switching controls to prevent load being applied unless fans are running.

Load Switching

Each load step of resistance and reactance is switched by 3 pole contactors mounted inside the enclosure. Control

System

The heart of the loadbank control system is the 'Solar' control panel with various switches to switch the load as well as a power meter PM 8 with logging capabilities .
The main features of this PM810 are:

- Powerful CISC CPU
- A mix of memory technologies for storage of program and loadbank calibration data
- Battery-backed real-time clock
- Serial ports configurable for RS-232 or RS-485 operation
- Sixteen analogue inputs with 12-bit ADC conversion for data acquisition  Digital I/O lines for load control

The PM810r board is sited within the loadbank and is responsible for running the loadbank supervisory system.

## 1.5 Control Terminals and Operation:

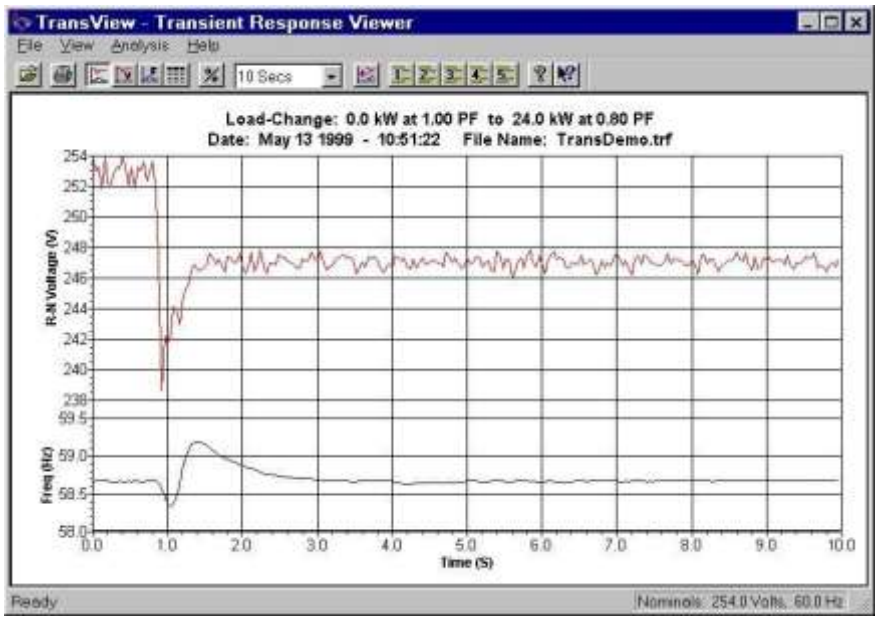
The control termainl panel is retty simple to use : Switch of various loads in several steps, smallest step being 1kw. The Operator programs the load he wants and switch the main load butto on to apply the charge. IN the meantime the logger capture the voltage, current, and frequency response from the power source.

Transient Response

In addition to the data logging capabilities described above, during a load-change the loadbank samples voltage and frequency data at a far higher rate. This information can then be transferred to the PC hard disk for analysis.

During a load-change the frequency transducer and a user-selected voltage transducer are each sampled every forty milliseconds giving twenty-five data points every second for each parameter. This sampling can continue for up to ten seconds after the load-change. Once the load-change is completed the transient information can be downloaded to the PC at the touch of a single key. Once received by the PC it is stored as a text file in comma-separated variable (CSV) format. This information can then be read into most commercially available spreadsheets for viewing and analysis.

A typical screen dump from the TransView program is shown below.



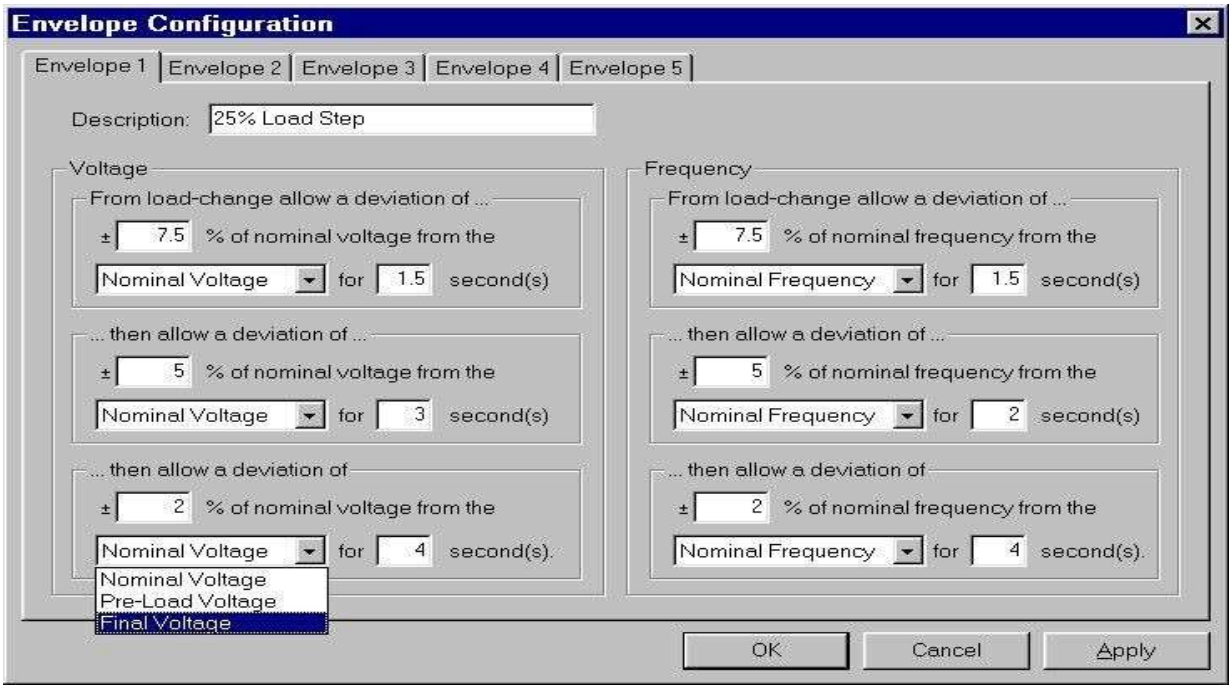

## 1.6 Transient Analysis

In addition to the viewing and printing of transient response waveforms, the TransView program can also analyse the performance of the generator during step changes of load. This can be accomplished in two ways.

Firstly the right-hand axes of the chart and the chart grid can be scaled in terms of the percentage deviation of the waveform from the nominal values of voltage and frequency. This enables the at-a-glance determination of whether a parameter has exceeded a percentage limit.

The second analysis-method available in TransView is the definition and display of a response "envelope" which the voltage or frequency must remain within during a load-change. Up to five of these envelopes may be defined to suit different types of load-change and each envelope can have up to three steps of variable duration.

Each step in an envelope is defined as a percentage deviation of the nominal value (voltage or frequency) from one of three reference points (the nominal voltage/frequency, the pre-load voltage/frequency or the final voltage/frequency) for a period of time. The response envelope configuration screen is reproduced below.




Envelopes can be defined to match the excursion limits and recovery times given in the generator test specification.

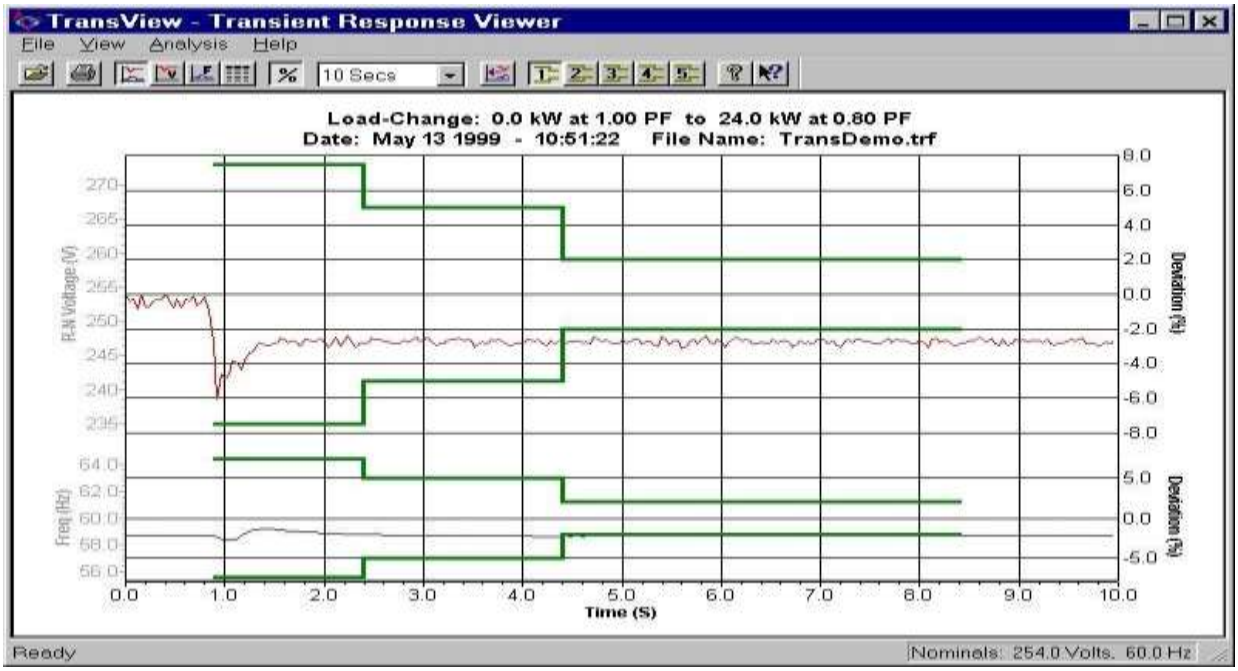
For example, if the generator specification states that, after a load-change, "the peak frequency attained must not exceed 2.5% of nominal frequency and should recover to within 1% of final frequency within two seconds, and additional must reach 0.5% of final frequency within four seconds", then the frequency envelope for this specification would be set as follows:

Step 1 ± 2.5% of Nominal Frequency for 2 seconds

Step 2 ± 1% of Final Frequency for 2 seconds (i.e. at the end of this step four seconds will have passed since load-change)

Step 3 ± 0.5% of nominal frequency for 10 seconds (to take the envelope to the end of the chart)

If the frequency waveform at any point deviates outside this envelope then the generator is not performing to specification. Once the envelopes have been configured they can easily be applied to the waveform being displayed to immediately show if the generators response to a load change is within the limits being tested. An example of the TransView display showing the voltage and frequency response within their response analysis envelopes is given below.




## 1.7 Protection

Load bank is fitted with thermal detector devices and airflow switches which will remove all load in the event of an over temperature occurring.

An emergency stayput switch mounted on the exterior of the container removes all load and stops cooling fans.

Cooling fans are protected by circuit breakers, thermal overload relays. Single phasing protection is provided together with phase sequence sensing and automatic correction of fan rotation.

Load switching contactor circuits are interlocked with cooling fans to prevent operation unless fans are running.

Each group of resistor elements, each reactor and control circuits are protected with either a HRC fuse or an MCB.

Over/under Voltage and frequency protection is provided in control software.

## 1.8 Grounding Protection

Two grounding points are available at opposite load bank corners for grounding cable connection, M10.

Grounding monitoring is done via the PM810 and alarm is generated if a grounding leakage is detected.

## 1.9 Cable entry

Provision for entry of customers flexible load cables is through a canvas sleeve with bolted terminations onto busbars, through gland plates to avoid water splash inside the load bank connection point.

## 1.10 Testing

The load bank will be subjected to standard Crestchic works test prior to despatch from our factory. Test sheets will be produced

### 1.11 Handbook

The load bank will be provided with one CD copy and one paper copy of a standard Crestchic handbook (English language), the handbook will contain the following sections:

- Warnings
- Introductions
- Technical Description
- Operating Instructions
- Parts List
- Circuit Diagrams
- General Arrangement Drawings

### 1.12 Warranty

The load bank will be subject to 12 months warranty from the date of initial use or 15 months from date of delivery whichever is the first to expire.

## 2. LOAD BANK TECHNICAL MANUAL OPERATION

### 2.1 DESCRIPTION

Load Banks are precision test instruments specifically designed to apply a discrete, selectable resistive electrical load to a power source while measuring the response of the genera-tor to the applied load. They also pro-vide a means for routine maintenance exercise to assure long term reliability and readiness of the standby generator. Exercise Load Banks eliminate the detrimental effects of unloaded operation of diesel engine generators.
This fully self-contained Load Bank includes test instrumentation, cooling system, rugged load elements, load-application control devices and automatic system protection devices. Operating controls are located on a Local Control Panel.

The resistive load elements in this Load Bank are cooled by a horizontal forced air system. The load system is connected to the test source via the load cables.
This Load Bank is equipped with the following automatic safety systems which de-energize all load steps when any condition is present which could damage the Load Bank or present a safety hazard to the operator:

1. The Cooling Failure Subsystem de-energizes any load applied when cooling of the load elements becomes inadequate due to fan failure, high intake air temperature, or high exhaust temperature.

2. The Load Power Over Voltage Failure System removes all load from the test source in the event the Load voltage selector switch is in the low voltage position (less than 240V), and a high test source voltage (greater than 480V) is applied.

## 2.2 PRIMARY INSPECTION

Preventative visual inspections of the shipping crate and Load Bank is advised. Physical or electrical problems due to handling and vibration may occur. Never apply power to a Load Bank before performing this procedure. The following Nine Point/30 Minute Inspection is recommended before installation, as part of the 50 hour / 6 month maintenance schedule and whenever a Load Bank is relocated:

1. If crate shows any signs of damage examine the Load Bank in the corresponding areas for signs of initial problems.

2. Check the entire outside of the cabinet for any visual damage which could cause internal electrical or mechanical problems due to reduced clearance.

3. Operate all hinged panels and doors for smooth and safe operation, try all latches and knobs.

4. Rotate and push all switches through all positions to ensure smooth operation.

5. Check cooling system by inspecting fan motor and blade. Slowly rotate blade by hand and note clearance of blade tip through its rotation near the housing. Observe free rotation of motor shaft.

6. Inspect all relays, timers, and control modules by opening all accessible panels. Make sure all components are secure in their bases and safety bails are in place. Spot check electrical connections for tightness. If any loose connections are found inspect and tighten all remaining connections.

7. Examine all accessible internal electrical components such as fuses, contactors and transformers. Check lugged wires at these components.

8. Inspect bottom of crate/enclosure for any components that may have jarred loose during shipment such as indicator light lenses, switch knobs, etc.
9. Visually inspect element chamber for foreign objects, broken ceramic insulators, mechanical damage.

## 2.3 OPERATION

1. Confirm the test source is properly grounded and ground the Load Bank to its own independent ground.

2. Confirm the “Control Power” circuit breaker (MCB) is in the “Off” position.

3. Using the cables provided, connect the load source to the Load Bank as shown.

If external control power is desired, place the External Fan Control Power Plug into a 400V, 3ø, 50Hz, 32A receptacle.

4. Place the “Control Power Selector” switch and “Volt-age Selector” switch in the appropriate positions.

5. Start-up generator set or bring other test source on line. If External Control Power is being used, place the “Control Power” circuit breaker to energize the cooling fan before starting the generator to assure proper fan operation (Step 7).

6. Adjust power source voltage and frequency.

7. Place the “Control Power” circuit breaker (MCB) in the “On” position to energize the cooling fan. A false “Cooling Failure” lamp indication will be present until the cooling fan creates sufficient airflow to close the Fan Pressure Switch (PS) and the “Alarm Reset” pushbutton is pressed (Step 9).

8. Visually observe correct fan operation and investigate any unusual fan related noises.

9. Check air intake for obstructions and confirm positive air flow.

10. Press the “Alarm Reset” pushbutton.

11. Verify the “Cooling Failure” lamp is extinguished before proceeding. When the “Cooling Failure” lamp extinguishes, control power is supplied to the “Master Load” switch.

12. Select the desired load steps by placing them in the “On” position.

13. Place the “Master Load” switch in the “On” position. This simultaneously applies all of the load steps which are in the “On” position. Trim is achieved by flipping the load steps “On” and “Off” while the “Master Load” is in the “On” position.

14. Adjust source voltage and load. Monitor as needed.

## 2.4 EACH OPERATION

The air intake screens and louvers, fan and cooling chamber, and exhaust openings must be checked for any obstructions or foreign objects. Due to the high volume of air circulated, paper and other items can be drawn into the air intakes. During Load Bank operation insure that air is exiting from the exhaust vent.The load branches should be checked for blown fuses or opened load resistors. To check the fuses or load resistors, operate the Load Bank from a balanced 3-phase source and check the three line currents. The three current readings should be essentially the same. If a sizeable difference is noted one or more load fuses or load resistors may have malfunctioned.

## 2.5 SHUTDOWN

1. De-energize the load.
2. Run the cooling fan for 5 minutes to assure a thorough cool down of all load elements (optional).

3. Place the “Control Power” circuit breaker (MCB) in the “Off” position.

## 2.6 MAINTENANCE

The Load Bank has been designed to require minimum maintenance. All components have been chosen for a long, reliable life. Two basic intervals of maintenance are required: each operation and every 50 hours or 6 months (whichever comes first).
Regular maintenance is basically each month of operation:

- Remove dust from bus bars
- Tighten and check connection - Verify megger and insulation