TECHNICAL MANUAL

SIMPLEX MODEL: QUANTUM 500B

4A27482

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I. Description

The Simplex Quantum 500 Portable Generator Load Bank is a self contained package; designed to provide electrical load testing of generator sets at unity power factor, as well as, the base unit for unlimited expansion for increased kilowatt and lower power factor testing. The standard load bank can not only test conventional 50/60 hertz, single, and three phase generator sets; but also 400 hertz units, substantially increasing load testing capabilities.

To provide maximum versatility, the Quantum 500 incorporates a unique two source test capability. The Quantum 500 contains two isolated load sections, either of which can be operated at rated KW at either 480, 416, 240, or 208V.A.C. Voltage, frequency, and current of each section can be monitored through use of the metering range selector switch. Load section A is rated at 275KW with 5KW resolution and load section B is rated at 225KW with 25KW resolution. These two load sections can be connected in parallel to give a single load test capability of 500KW with 5KW resolution.

With the addition of auxiliary load banks, which have been designed for maximum compatibility with the Quantum 500, the load bank system can be expanded at any time. The auxiliary load banks can be controlled from the Quantum 500 by means of a plug in control cable, to give the operator total system control from one location; or the versatility to use the units independently by means of its own load controls, standardly installed on each auxiliary unit.

The metering section of the Quantum 500 is of a modularized construction; that is, it consists of a separate panel which can be replaced without affecting the other components. It is possible to add optional features to a load bank which was purchased years before. Only a few connections to a terminal block have to be made to install any metering option. This prevents obsolescence of older load bank and makes repairs simple. The standard metering section consists of plus or minus 2% accuracy; 50-60 hertz voltmeter and frequency meter, 50-400 hertz multi-range ammeter, and running timer meter. Along with the standard metering, there is available an extensive selection of optional metering 400 hertz voltmeter and frequency meter, kilowatt meters, total load ammeter and kilowatt meters (used with auxiliary load banks), plus or minus 1% accuracy meters, digital meters, and chart recording instruments.

The removable load programming/control panel allows the load bank to be operated from a remote location. Supplied with 10 feet of cable, with the availability of 25 feet extension cables, permits it to be hand carried to the engine generator or any other location for load bank control. The standard Quantum 500 control panel is equipped with eleven (11) load control switches and two (2) master loading switches. When auxiliary load banks are added; a new control panel, containing the additional load control switches, can be installed by simply disconnecting the circular connector and connecting the new control panel.

The five operational programming switches allow quick and easy set-up for the specific testing requirements. The load bank voltage switch automatically programs for the appropriate application voltage. The load bank mode selector switch programs for the input frequency, either 50-60 hertz, or 400 hertz. For testing of sources other than 208-240 V.A.C. or 416-480 V.A.C., 60 hertz, 3 phase; fan and control power must be supplied from an external source. The fan/control power source selector switch and the fan/control power voltage selector switch provides the means for quick selection of the voltage range and source location. If the fan rotation is incorrect, it is reversed by rotating the fan reversal switch.

The load bank protective system utilizes a "self-checking" circuit, which will not permit operation unless the components of the system are functioning. The system monitors for: fan failure, over temperature, load section over voltage, improper fan/control voltage, and element ground fault. On any failure; a light is illuminated, the horn sounds, and all load steps are de-energized and locked-out until manually reset.

The cooling for the load resistors is provided by a quiet system consisting of a cast aluminum fan blade driven by a three phase, low speed, permanently lubricated motor. The motor is protected by a circuit breaker and overload coils which must be manually reset after tripping.

The load bank cabinet is of heavy gauge steel construction which is phosphatized, primed, and painted. The control section is protected by "clam shell" doors, which when opened, provide a writing surface. There is provided, on each cabinet, cable storage area for load cables, which are provided standardly. There is also provided a recessed hand rail to assist in movement, lifting eyes, and tiedown provisions.

II. Specification

A. Quantum 500

Kilowatt Ratings	500KW @ 240 or 480 V.A.C., 3 Phase 500KW @ 208 or 416 V.A.C., 3 Phase 333KW @ 240 or 480 V.A.C., 1 Phase
Voltage Range	0-480 V.A.C., 3 Phase or 1 Phase
Frequency Range	25-400 Hertz
Load Steps	Load Section One - 5KW/10KW/20KW 40KW/40KW/80KW/80KW Load Section Two - 25KW/40KW/80KW/80KW Rated at 208, 240, 416 or 480 V.A.C. 3 Phase
Load Step Accuracy	Plus or minus 5%
Mechanical	Height - 183 CM / 72 IN. Width - 84 CM / 33 IN.

	Depth - 142 CM / 56 IN. Weight - 682 KG / 1500 LBS
Maximum Ambient	50 Degrees C / 122 Degrees F
Cooling	Forced Air; 13,000 CFM
Standard Metering	50-60 Hertz Voltmeter - 3½", 0-600V Scale Plus or minus 2% accuracy Voltmeter Switch - 4 position Off/V1-V2/V2-V3/V3-1 50-400 Hz Ammeter - 3½", Dual Scale 0-250/1000 Scale, plus or minus 2% accuracy Ammeter Switch - 4 position Off/L1/L2/L3 Metering Range Switch - Rotary Switch for manual range selection Frequency Meter - 3½", dial type, 45 to 65 hertz scale, plus or minus 2% of reading accuracy Running Time Meter - 0 to 99,999.9 hours

III. Controls Description and Application

A. Programming Switches

1. Load Section Voltage Selector Switches - Two four position rotary switches which program for the desired load bank operating voltage. These switches automatically program load contactors for the proper load resistor configuration. Load section A voltage selector switch and load section B voltage selector switch operate independently so as to allow the two load sections to be loaded by sources operating at different voltages. When the Quantum 500 is operated from a single load source, both load section voltage selector switches must be positioned to correspond to the voltage of the load source. If a smaller load with more resolution is needed, this can be accomplished by setting the load section voltage selector switch(es) to a setting higher than the voltage applied and de-rating the load steps as explained in section VIII, C.

2.) Load Bank Mode Selector Switch - A three position rotary switch used to program for the proper input frequency, either 50-60 hertz, off, or 400 hertz. This switch automatically selects the proper metering required as well as assuring that 400 hertz is not applied to the control/fan circuit, if the control/fan power source selector switch is inadvertantly placed in the "internal" position.

3.) Fan/Control Power Source Switch - A two position rotary switch which selects the voltage source for the cooling fan and control circuit from either internal voltage (voltage from the source being tested) or external voltage (external voltage source connected by a 15 feet, 3 phase power cord supplied with the load bank). A 208-240 V.A.C. or 416-480 V.A.C., 3 phase, 60 hertz or 190/200 - 380/400 VAC, 50 Hertz, 3 phase external power source must be available when the internal voltage is different than that just listed. One exception is when internal power is 380-400 V.A.C., 3 phase, 50 hertz; fan/control power can be from the internal source. Caution: this also allows the external power source to be 380-400 V.A.C., 3 phase, 50 hertz; only if the internal voltage is less than 200 V.A.C. (Load bank voltage selector switch in the 240 Volt position) or 400 V.A.C. (load bank voltage selector switch in the 480V position). The internal voltage must be reduced (which reduces heat produced) for this application due to the reduced fan speed (which reduces cooling capabilities) because of the 50hertz fan/control power. While operating the Quantum 500 as a dual test source in internal mode the fan/control power is taken from load source A.

4.) Fan/Control Power Voltage Selector Switch - A two position rotary switch which programs for the desired cooling fan and control circuit voltage. In the "low voltage" position; a voltage range between 208-240 V.A.C., 60 hertz, 3 phase can be applied. In the "high voltage" position; a voltage range between 416-480 V.A.C., 60 Hertz, 3 phase can be applied. When the special 380-400 V.A.C., 50 Hertz, 3 phase application described in item 3 of this section is used, the switch should be in the "high voltage" position. This switch automatically connects the fan motor and control power transformers for the proper operating configuration.

5.) Fan Reversal Switch - A four position rotary switch which allows easy selection of the cooling fan direction, irregardless of the fan/control power source phase sequence.

B. Operating Switches

1.) Cooling Fan Motor Control Switch - A toggle switch which controls the cooling fan. When in the "off" position, the fan is off and no load can be applied. All metering is still functional; so that the voltage and frequency, of the source being tested, can be adjusted. Although all the load controls are locked-out, the over voltage failure circuit still monitors for a system over voltage. When placed in the "on" position, the fan is started and all failure systems enabled.

2.) Load Control Switches - The load control switches consist of load step toggles and two master loading switches. The load step switches allow the desired amount of load to be selected and the master loading switches allow the pre-selected load steps to be simultaneously energized. If the master loading switch remains in the "on" position; as each load control switch is operated, its representative load will be applied.

3.) 50-60 Hertz Voltmeter Switch - A four position rotary switch which selects the desired line-to-line voltage to be monitored by the voltmeter or, in the "off" position, disconnects the voltmeter.

4.) 50-400 Hertz Ammeter Switch - A four position rotary switch which selects the desired line current to be monitored by the ammeter or, in the "off" position, disconnects the ammeter.

5.) Metering Range Selector Switch - A six position rotary switch which selects the range for the ammeter and the source for the voltmeter, frequency meter, and ammeter when operating from dual test sources. While operating from dual test sources the voltmeter, frequency meter, and ammeter will display readings from load source A when the metering range selector switch (MRSS) is in either of the two positions indicated as load A and will display readings from load source B when in either of the two ranges designated load B. When operating from a single load source, the MRSS should be positioned to one of the ranges designated total load. However, it should be noted that the 400A range in the section designated total load will only indicate current into the load of load section A.

C. Failure Indicators and Controls

Five failure lamps annunciate any load bank failure. The failure system monitors for fan failure, system over voltage, over temperature, improper fan/control voltage, and ground fault breaker "tripped". The failure controls consist of the ground fault circuit breaker and failure reset pushbutton. The fan failure lamp indicates an insufficient cooling air flow or improper fan rotation. The over voltage lamp indicates a harmful mis-programming of the load bank voltage selector switch (high voltage application with the switch in the "low" voltage positions). The over temperature lamp indicates excessive cooling chamber temperature. The improper fan/control voltage lamp indicates a harmful mis-programming of the fan/control power voltage selector switch, either over voltage or under voltage. The ground fault circuit breaker monitors the ground current flowing, and if it exceeds a safe level, the breaker will trip. The source of the ground must be located and corrected before the breaker can be reset. With the illumination of any indicating lamp, all load steps are locked out and a horn sounds. The fan failure and over temperature remain energized until the problem is corrected and is reset by depressing the failure reset pushbutton. The over voltage and improper fan/control voltage lamps automatically reset when the programming error is corrected.

C. Optional Equipment Controls

1.) Total Load Ammeter Switch - A four position rotary switch used like the 50-600 hertz ammeter switch, to select the desired phase to be monitored, except in the total load capacity.

2.) Total Load Ammeter Range Switch - A two position toggle switch used to select the desired range for the total load ammeter.

3.) Total Load Kilowatt Meter Range Switch - A two position toggle switch used to select the desired range for the total kilowatt meter.

4.) Vernier Step Switch - Five position rotary switch, located on the removable load programing/control panel, used to select the desired amount of the optional 4-1 kilowatt steps to be applied.

IV. Metering Description and Application

A. Standard Quantum 500

1.) 50-60 Hertz Voltmeter - A 3½", plus or minus 2% accuracy, 0-600 scale voltmeter used to monitor line-to-line voltage of the tested source, when the frequency range is 50-60 hertz position.

2.) 50-400 Hertz Ammeter - 1 3½", plus or minus 2% accuracy, dual range (0-250/1000 amps) ammeter used to monitor the line currents of the tested source for A.C. applications between 25 to 400 hertz.

3.) 50-60 Hertz Frequency Meter - A 3½", plus or minus 2% accuracy, 45 to 65 hertz scale frequency meter used to monitor the frequency of the tested source. The meter is disconnected automatically by the load bank mode selector switch when in other than the "50-60 hertz" position.

4.) Running Time Meter - A 0-99,999.9 hour meter used to indicate the total number of operating hours for maintenance schedules and equipment logs.

B. Optional Metering

1.) Total Load Ammeter - A 3½", plus or minus 2% accuracy, dual range ammeter used to monitor the total system current when auxiliary load banks are used. The meter option is supplied with a total load current transformer tray which connects to the Quantum 500 by means of an interconnect cable and circular connector. The cables from all of the load banks being used are run through the appropriate current transformers, all phase "A" cables through phase "A" current transformers and so on. The total load ammeter option is also provided with an ammeter switch and range selector switches, which are described previously in part III, section D, item #1 and #2.

2.) Total Load Kilowatt Meter - A 3½" plus or minus 2% accuracy, single or dual range kilowatt meter. The meter is used like the total load ammeter, except to monitor the system's total kilowatts. The system is dual voltage, with automatic voltage selection, for a frequency range of 50-60 hertz. The meter is automatically disconnected by the load bank mode selector switch when in other than the "50-60 hertz" position. When the meter is dual scaled, a range selector switch is provided as described in part III, section D, item #3.

3.) 400 Hertz Voltmeter - A 3½", plus or minus 2% accuracy, 0-600 scale voltmeter used to monitor the line-to-line voltage of the tested source when the frequency range is 380 to 420 hertz. The meter is automatically connected by the load bank mode selector switch when in the "400 hertz" position. This option is also supplied with a voltmeter switch which operates the same as the 50-60 hertz switch as described in part III, section B, item #3.

4.) 400 Hertz Frequency Meter - A 3½", plus or minus 2% accuracy, 380 to 420 hertz frequency meter used to monitor of the tested source. The meter is automatically connected by The load bank mode selector switch when in the "400 hertz" position.

V. Operation

A. Normal Operation (Initial Operation See Section "D")

1.) Locate the load bank in the desired area of operation, assuring there is no intake or exhaust restrictions. Adequate ventilation must be provided so the ambient air temperature does not exceed the specified maximum of 50 degrees C.

2.) Make the appropriate load bank generator connection as shown on the applicable diagram of the generator connection drawing #7B26060.

Warning: For operator safety, make sure this equipment is properly grounded when in use.

3.) Place the load bank voltage selector switches, the load bank mode selector switch, the fan/control power source selector switch in the proper positions for the source that is to be tested (see part III, Section A, items #1 through 4 for switch description and application).

Caution: Do not switch the load bank mode selector switch, or fan/control power source selector switch when fan is running or serious damage to load bank may occur.

4.) Place the load bank control location switch in the appropriate position. See part II, Section A, Item #6 for switch description and application.

5.) Place the fan reversal switch in either of the two "on" positions.

6.) The cooling fan control switch and all load control switches should be in the "off" position.

7.) If the fan and control power is to be supplied by an external source, connect the external power cord to an appropriate 3 phase voltage source.

8.) Apply the source to be tested.

9.) Adjust the voltage and frequency of the test source.

10.) Turn the cooling fan switch to the "on" position.

11.) Check for the proper fan rotation (air should exhaust the top). If the fan rotation is incorrect; turn the cooling fan switch off. After the fan has completely stopped, place the cooling fan switch back to the other "on" position.

12.) Ten seconds after the cooling fan switch is turned on, the fan failure circuit and the load controls are enabled. At this time, the required amount of load can be energized.

B. Normal Shutdown

1.) Remove all load by placing all the load control switches in the off position.

2.) Allow the cooling fan to run for approximately five minutes after removal of all load, to provide thorough cool-down of the complete system.

3.) The tested source can be turned off at this time, if the fan/control power is from an external source, and load cables disconnected and stored in the cable compartment.

4.) After the required cool-down is provided, turn the cooling fan switch to the "off" position.

C. Failure Shutdown

1.) While operating, any failure of the load bank will: illuminate the appropriate failure lamp, sound a horn, and lock-out all load steps. The failure condition must be corrected and system reset before any load steps can be energized. For description of failure controls, see part III, Section C.

D. Initial Operation and Failure Circuit Check - After the load bank is uncrated, several areas must be checked for possible problems which are caused by rough handling and vibrations incurred in shipment.

1.) Mechanical Check

A.) Meters should be checked for damaged case or broken movement

B.) All switches should be operated to check for mechanical damage

C.) Fan blade should be checked for tip to shroud clearance

D.) Cabinet should be checked for structural damage that will lessen any electrical clearances or in any way impair the safe operation of the load bank.

E.) The electrical connections, that are accessible through the hinged door, should be checked for tightness. If loose connections are found, a complete load bank tightness check of all electrical connections is required.

2.) Electrical Check (Failure and Control Circuit Operation)

A.) Follow steps #1 through #11 of the normal operating instructions, Part V, Section "A".

B.) To check the operation of the fan failure circuit, turn the fan reversal switch to either of the "off" positions. As the fan slows, a fan failure should be signaled by a light and horn. Place the fan reversal switch back to the original "on" position; the fan should restart, but the failure should still be indicated. Attempt to energize a load step. All load steps should be locked-out until the failure is reset by depressing the reset pushbutton.

C.) To check the over voltage circuit, the test source must be a high voltage source of 416 to 480 V.A.C. with the load bank programmed for high voltage and operating from a high voltage source, switch the load bank voltage switch to the 208V or 240V position. The over voltage lamp should energize a load step, all load steps should be locked-out until the failure condition is corrected by placing the load bank voltage switch back to the "high voltage" position.

D.) Field testing of over temperature failure is not feasible, due to the extreme temperature required to actuate the temperature probe. The temperature probe is factory calibrated to pick-up at 300 degrees C / 575 degrees F. (Caution: Improper heating of the temperature probe by means of a propane or similar type torch can cause probe damage).

E.) The improper fan/control voltage failure monitors for two system problems: under voltage and over voltage. To check the under voltage portion of the circuit, program and operate the fan from a low voltage (208 to 240 V.A.C., 3 Phase, 60 Hertz) source. With the fan running, change the fan/control power voltage selector switch to the "high voltage" position. The fan should be de-energized, the improper fan/control voltage lamp should be locked-out until the failure is cleared. A fan failure will also be indicated because the fan has been de-energized. Place the fan/control power voltage selector switch back to the "low voltage" position. The cooling fan should restart and the improper fan/control voltage lamp should reset. After the fan has returned to full speed, reset the fan failure lamp and horn by depressing the failure reset pushbutton. To check the over voltage portion of the circuit, turn the cooling fan switch to the "off" position. Program and apply a high voltage (416 to 480 V.A.C., 3 Phase, 60 Hertz) source to the fan/control/control power circuit. With the cooling fan switch still in the "off" position, change the fan/control voltage switch to the "low voltage" position. The improper fan/control voltage lamp should illuminate and the horn sound. Attempt to energize the cooling fan and load steps, the cooling fan and all load steps should be locked-out until the failure is reset. Place the fan/control voltage switch back to the "high voltage" position, the failure lamp and horn should be reset and the cooling fan and load steps enabled.

F.) To check the operation of the ground fault circuit breaker "tripped" circuit, place the breaker in the "tripped" position. The ground fault circuit breaker "tripped" lamp should illuminate and horn sound. Attempt to energize a load step, all load steps should be locked-out until the failure is reset. Placing the breaker back to the "normal" position will reset the failure indicators.

G.) The failure circuits must operate exactly as indicated in the previous description. If any failure circuit problems(s) exist; it must be corrected before the load bank is operated, to prevent possible damage to the load bank. See the trouble shooting guide, Part VII.

VI. Maintenance

The load bank has been designed to require minimum maintenance. All components have been chosen for a long reliable life. Three basic intervals of maintenance are required: Each operation, 6 months or 50 hours, and 12 months or 100 hours.

A.) Each Operation

1.) 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 miscellaneous items can be readily drawn into the air intakes.

2.) The load steps should be checked for blown fuses or burned out load resistors. To check for defective fuse or load resistor, 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 sizable difference is noted. one or more load fuses or load resistors have possibly failed. See the trouble shooting guide, Part VII, if unbalance s noted.

B.) Every 50 Hours or 6 Months (Whichever Comes First)

1.) Due to the critical need for the failure circuit to always be operational, it incorporates a "self checking" concept. This system does not allow load bank operation if a common cause of component failure occurs. In rare cases, a more unlikely cause of component failure could occur; which will not be detected by the "self checking" system. This is why the necessity for a periodic check of the failure circuit as outlined in the failure operation check, Part V.

C.) Every 100 Hours or 1 Year (Whichever Comes First)

1.) As a precautionary measure, the tightness of the electrical connection must be checked. Due to the expansion and contraction of the electrical connections caused by the cycling of the load step, and the vibration caused by movement and cooling fan; the wiring may be susceptible to loosening. When the load bank is subjected to "over the road" transportation, or extreme movement or vibration; the electrical connections should be checked for tightness at a shorter time interval than normal.

D.) Motor Lubrication - The following is taken from the motor manufacturer's lubricating instructions.

Frequency of Relubrication

A two year relubrication interval is suggested for motors on normal, steady running, light duty indoor load in relatively clean atmosphere at 40 degrees C/104 degrees F ambient.

Type of Grease

Use Westinghouse 53701RY grease unless a special grease is specified on the nameplate. Some equivalent greases are:

Chevron SR1-2	Standard Oil of California
Premium RB	Texaco, Inc.
Unirex N2	Exxon
Dolium R	Shell Oil Company
Rykon Premium	American Oil

Procedure for Relubrication

When regreasin , s motor remove out et p ug, and add amount of grea e pe reference table wi h hand lever gun only. Discon nue t once if grease appears at outlet plug, this may cc r befo e speci ied amount of used. Run for about ten minu es before rep acing outlet plug.

Volume - Reference Table

Shaft Diameter At Face of Bracket	Amount of Grease to Add
3/4" to 1 1/4"	1/8 Cu. In. or 0.1 Oz.
1 1/4" to 1 7/8"	1/4 Cu. In. or 0.2 Oz.
1 7/8" to 2 3/8"	3/4 Cu. In. or 0.6 Oz.
2 3/8" to 3 3/8"	2 Cu. In. or 1.6 Oz.

Caution: Overgreasing is a major cause of bearing and motor failure. Make sure dirt and contaminants are not introduced when adding grease.

VII. Trouble Shooting

Problem	Check For:
Voltmeter does not operate properly	1.) Blown metering fuse(s) 2.) Defective voltmeter 3.) Defective Metering Range Selector Switch 4.) Defective voltmeter switch 5.) Defective load bank mode selector switch
Ammeter does not operate properly	1.) Defective ammeter 2.) Defective ammeter switch 3.) Defective ammeter range switch 4.) Defective load bank mode selector switch 5.) Defective load bank voltage selector switch
Cooling fan motor will not operate	1.) Fan motor switch in the "on" position 2.) Correct programming of fan/control power source selector switch 3.) External power cord is connected to an appropriate 3 phase source, when the fan/control power source selector switch is in the "external" position 4.) Tripped fan overload relay(s) 5.) Tripped fan circuit breaker(s) 6.) Blown control power fuse(s)

	7.) Defective "FCVR" relay 8.) Defective fan motor 9.) Defective failure circuit control power transformer 10.) Defective fan motor switch 11.) Defective fan motor 12.) Defective fan/control power source selector switch 13.) Defective fan/control power voltage selector switch 14.) Defective fan reversal switch 15.) Defective load bank mode selector switch
Fan failure indicated with fan running	1.) Incorrect fan direction 2.) Restrictions of air intake and exhaust 3.) Defective fan pressure switch (P.S.) 4.) Defective "FFR" relay 5.) Defective "RR" relay
False over temperature failure	1.) Defective "OTR" relay 2.) Defective "RR" relay 3.) Defective temperature switch (T.S.)
False over voltage failure	1.) Shorted or partially shorted over voltage resistor 2.) Defective "OVR" relay
False improper fan/control voltage failure	1.) Defective "FCVR" relay
False ground fault breaker "tripped" failure	1.) Defective "GBTR" relay 2.) Defective ground fault circuit breaker (EGB)
Fan failure does not operate	1.) Defective fan pressure switch (PS) 2.) Defective "TDR" relay
Over voltage failure does not operate	1.) Blown fuse metering fuse or internal voltage monitor fuse 2.) Defective over voltage resistor (R4, R5) 3.) Defective over voltage rectifier bridge (D1, D2) 4.) Defective "OVR" relay 5.) Defective over voltage capacitor (CP1, CP2)

Improper fan/control voltage failure does not operate	1.) Defective "FCVR" relay
Ground fault circuit breaker "tripped" failure does not operate	1.) Defective "FCVR" relay 2.) Defective ground fault circuit breaker (EGB)
Fan failure and over temperature operate but do not lock-in	1.) Defective "RR" relay 2.) Defective failure reset pushbutton (S16)
No load steps can be energized (with no failures indicated and and fan running for a minimum of 15 seconds)	1.) Master load switch in "off" position 2.) Programming/control panel not plugged in 3.) Defective "TDR" relay 4.) Defective "CPC" contactor 5.) Defective "CLR" relay 6.) Defective failure relay ("FFR", "OTR", "FCVR", UVR 1 and 2", "GBTR") 7.) Defective "T2 transformer 8.) Defective master load control switch
One or a few load steps cannot be energized	1.) Programming/control panel 2.) Programming/control panel circular connector contacts damaged 3.) Programming/control panel damaged 4.) Defective load step switch(es) 5.) Defective contactors of the corresponding load step 6.) All fuses of load step blown 7.) All load resistors of load step burned out
Unbalanced load step(s)	1.) Unbalanced voltage from test source 2.) Blown fuse (see fuse reference chart) 3.) Burned-out load resistor(s) (see load resistor reference chart)

Element/fuse reference chart - Lists which element/fuse to check on affected load step.

Load Section One

Step Rating Affected	Fuses to Check	Elements to Check
5	F7 - F12	LR25 - LR48
10	F13 - F18	LR49 - LR60
20	F19 - F24	LR61 - LR72
40	F25 - F30	LR73 - LR84
40	F31 - F36	LR85 - LR96
80	F37 - F48	LR97 - LR120
80	F49 - F60	LR121 - LR144

Load Section Two

Step Rating Affected	Fuses To Check	Elements to Check
25	F61 - F66	LR145 - LR156
40	F67 - F72	LR157 - LR168
80	F73 - F84	LR169 - LR192
80	F85 - F96	LR192 - LR216

VIII. Calculations

A.) Determining kilowatts of load when current and voltage is known. The following explains how to determine the actual kilowatt load being applied by the load bank, when line voltages and currents are known at 1 P.F. (Unity)

<u>3 Phase</u>

1.) Read all three line currents and find the average reading
2.) Read all three line-to-line voltages and find the average reading
3.) Multiply the average current times the average voltage

4.) Multiply the answer of step #3 times the square root of three (1.732)
5.) Divide the answer of step #4 by 1000
6.) The answer of step #5 is the actual kilowatts of load being applied by the load bank

EXAMPLE

Current Readings: L1=249A, L2=250A, L3=254A

Voltage Readings: L1-L2-481V, L2-L3=479V, L3-L1=483V

$$\text{Average Current} = \frac{\text{L1 Amps} + \text{L2 Amps} + \text{L3 Amps}}{3}$$

$$= \frac{249 + 250 + 254}{3} = 251\text{A}$$

$$\text{Average Voltage} = \frac{\text{L1-L2 Volts} + \text{L2-L3 Volts} + \text{L3-L1 Volts}}{3}$$

$$= \frac{481 + 479 + 483}{} = 481$$

$$\text{KW} = \frac{\text{Volts} \times \text{Amps} \times 1.732}{1000}$$

$$= \frac{481 \times 251 \times 1.732}{1000} = 209.1\text{KW}$$

1 Phase

1.) Determine the line current
2.) Determine the line-to-line voltage
3.) Multiply the line current times the line-to-line voltage
4.) Divide the answer of step #3 by 1000
5.) The answer of step #4 is the acutal kilowatts of the load being applied by the load bank

Example:

Current Reading: 150A   Voltage Reading: 240 Volt

$$\text{KW} = \frac{\text{Volts} \times \text{Amps}}{1000} = \frac{150\text{ A} \times 240}{1000} = 36\text{KW}$$

B.) Determining amperage when kilowatts and voltage is known. The following will explain how to determine what the current will be when desired amount of kilowatts is applied at 1 P.F. (Unity)

3 Phase

1.) Multiply the desired amount of kilowatts, to be applied, by 1000
2.) Multiply the operating voltage times the square root of 3 (1.732)
3.) Divide the answer of step #1 by the answer of step #2
4.) The answer of step #3 is what the average line current will be when the desired amount of kilowatts are applied at 1 P.F. (Unity)

Example:

Find the amperage of 50KW operating voltage of 480 Volt

$$\frac{\text{KW x 1000}}{\text{Volts x 1.732}} = \frac{50 \text{ X } 1000}{480 \text{ x } 1.732} = \frac{50{,}000}{831.36} = 60.1 \text{ Amps}$$

1 Phase

1.) Multiply the desired amount of kilowatts, to be applied, by 1000
2.) Divide the answer of step #1 by the operating voltage
3.) The answer of step #2 is what the average line current will be when the desired amount of kilowatts are applied at 1 P.F. (Unity)

Example:

Find the amperage of 25KW operating voltage of 240 Volt

$$\text{Amps} = \frac{\text{KW x 1000}}{\text{Volts}} = \frac{25 \text{ x } 1000}{240} = \frac{2500}{240} = 104.2 \text{ Amps}$$

C.) Determining the kilowatt rating of a load step at voltages other than the rated voltages. The following explain how to determine a step kilowatt rating at other than a rated voltage. This is accomplished by referencing the load step to a KW value at a known voltage.

1.) Determine the new unrated operating voltage
2.) Divide the new operating voltage by the reference voltage
3.) Square the answer of step #2
4.) Multiply the answer of step #3 times the reference kilowatt value of the load step which the new kilowatt rating is desired
5.) The answer of step #4 is the kilowatt rating of the load step at the new voltage

Example:

Find the value of a load step operating at 450 V.A.C. with load step value of 80KW at 480 Volt

$$\text{New KW Value} = \frac{(\text{New Volts})^2}{(\text{Reference Volts})^2} \times \text{Reference KW}$$

$$= \frac{(450)^2}{(480)^2} \times 80 = (.9375)^2 \times 80 = 70.3\text{KW}$$

D.) Formulas

ALTERNATING CURRENT

UNKNOWN	SINGLE PHASE	THREE PHASE
Kilowatts	$\frac{\text{VoltsxAmpsxP.F.}}{1000}$	$\frac{\text{1.732xVoltsxAmpsxP.F.}}{1000}$
Amperes (When known	$\frac{\text{KW x 1000}}{\text{Volts x P.F.}}$	$\frac{\text{KW x 1000}}{\text{1.732 X Volts X P.F.}}$
KW	$\frac{\text{Volts x Amps}}{1000}$	$\frac{\text{1.732 X Volts x Amps}}{1000}$
Amperes (When KVA is known)	$\frac{\text{KVA x 1000}}{\text{Volts}}$	$\frac{\text{KVA x 1000}}{\text{1.732 x Volts}}$
KVAR	$\frac{\text{Volts x Amps x }\sqrt{1-PF^2}}{1000}$	$\frac{\text{1.732xVoltsxAmpsx }\sqrt{1-PF^2}}{1000}$

Power factor (P.F.) is expressed as a decimal - such as 0.85