

Plant <b>1.0 MTPA ALUMINA REFINERY STREAM-5</b>	Client <b>NALCO</b>	Contract Code <b>NAL</b>	Document ID <b>6695-ELT-G00-EC-0035</b>	Contract No. <b>66-6695</b>	
	<b>TECHNICAL SPECIFICATIONS – LOW VOLTAGE POWER FACTOR IMPROVEMENT CAPACITOR PANEL</b>			 <b>नेशनल एल्युमिनियम कम्पनी लिमिटेड</b> <b>National Aluminium Company Ltd.</b>	
	Rev	<b>00</b>	Page	<b>1</b>	of

<p><b>TKIS - India / Vendor</b></p> <p><b>Category Codes (Submission Purpose)</b></p> <table style="width: 100%;"> <tr><td><input type="checkbox"/></td><td>1</td><td>For Approval</td></tr> <tr><td><input type="checkbox"/></td><td>2</td><td>For Review / Comments</td></tr> <tr><td><input type="checkbox"/></td><td>3</td><td>For Information</td></tr> <tr><td><input type="checkbox"/></td><td>4</td><td>For Engineering</td></tr> <tr><td><input type="checkbox"/></td><td>5</td><td>For Enquiry</td></tr> <tr><td><input type="checkbox"/></td><td>6</td><td>For Order Placement</td></tr> <tr><td><input type="checkbox"/></td><td>7</td><td>Final &amp; Approved</td></tr> <tr><td><input type="checkbox"/></td><td>8</td><td>Released for Construction</td></tr> </table> <hr/> <p><b>Acceptance Codes (Approval Codes)</b></p> <table style="width: 100%;"> <tr><td><input type="checkbox"/></td><td>1</td><td>Approved</td></tr> <tr><td><input type="checkbox"/></td><td>2</td><td>Approved for Manufacturing / Fabrication with Comments as marked</td></tr> <tr><td><input type="checkbox"/></td><td>3</td><td>Not Approved / Resubmit</td></tr> <tr><td><input type="checkbox"/></td><td>4</td><td>Retained for Information / Records</td></tr> <tr><td><input type="checkbox"/></td><td>5</td><td>Reviewed</td></tr> <tr><td><input type="checkbox"/></td><td>6</td><td>Reviewed as Noted / Resubmit</td></tr> </table> <p><b>Remarks for AC2 :</b> This marked-up drawings is hereby approved for fabrication / manufacturing and shall be re-submitted after revision. This drawing should be revised only to the extent of TKIS - India / Owner / Client comments. Any other changes made by you will not be considered unless clearly highlighted in covering letter asking for approval.</p> <p><b>This approval / review does not absolve the supplier from the full responsibility for design and fabrication.</b></p> <p>Date : ___/___/___      Name : _____</p>	<input type="checkbox"/>	1	For Approval	<input type="checkbox"/>	2	For Review / Comments	<input type="checkbox"/>	3	For Information	<input type="checkbox"/>	4	For Engineering	<input type="checkbox"/>	5	For Enquiry	<input type="checkbox"/>	6	For Order Placement	<input type="checkbox"/>	7	Final & Approved	<input type="checkbox"/>	8	Released for Construction	<input type="checkbox"/>	1	Approved	<input type="checkbox"/>	2	Approved for Manufacturing / Fabrication with Comments as marked	<input type="checkbox"/>	3	Not Approved / Resubmit	<input type="checkbox"/>	4	Retained for Information / Records	<input type="checkbox"/>	5	Reviewed	<input type="checkbox"/>	6	Reviewed as Noted / Resubmit	<p><b>TKIS - India / Owner / Client</b></p> <p><b>Category Codes (Submission Purpose)</b></p> <table style="width: 100%;"> <tr><td><input type="checkbox"/></td><td>1</td><td>For Approval</td></tr> <tr><td><input type="checkbox"/></td><td>2</td><td>For Review / Comments</td></tr> <tr><td><input type="checkbox"/></td><td>3</td><td>For Information</td></tr> <tr><td><input checked="" type="checkbox"/></td><td>4</td><td>For Engineering</td></tr> <tr><td><input type="checkbox"/></td><td>5</td><td>For Enquiry</td></tr> <tr><td><input type="checkbox"/></td><td>6</td><td>For Order Placement</td></tr> <tr><td><input type="checkbox"/></td><td>7</td><td>Final &amp; Approved</td></tr> <tr><td><input type="checkbox"/></td><td>8</td><td>Released for Construction</td></tr> </table> <hr/> <p><b>Acceptance Codes (Approval Codes)</b></p> <table style="width: 100%;"> <tr><td><input type="checkbox"/></td><td>1</td><td>Approved</td></tr> <tr><td><input type="checkbox"/></td><td>2</td><td>Approved for Manufacturing / Fabrication with Comments as marked</td></tr> <tr><td><input type="checkbox"/></td><td>3</td><td>Not Approved / Resubmit</td></tr> <tr><td><input type="checkbox"/></td><td>4</td><td>Retained for Information / Records</td></tr> <tr><td><input type="checkbox"/></td><td>5</td><td>Reviewed</td></tr> <tr><td><input type="checkbox"/></td><td>6</td><td>Reviewed as Noted / Resubmit</td></tr> </table> <p>Date : ___/___/___      Name : _____</p>	<input type="checkbox"/>	1	For Approval	<input type="checkbox"/>	2	For Review / Comments	<input type="checkbox"/>	3	For Information	<input checked="" type="checkbox"/>	4	For Engineering	<input type="checkbox"/>	5	For Enquiry	<input type="checkbox"/>	6	For Order Placement	<input type="checkbox"/>	7	Final & Approved	<input type="checkbox"/>	8	Released for Construction	<input type="checkbox"/>	1	Approved	<input type="checkbox"/>	2	Approved for Manufacturing / Fabrication with Comments as marked	<input type="checkbox"/>	3	Not Approved / Resubmit	<input type="checkbox"/>	4	Retained for Information / Records	<input type="checkbox"/>	5	Reviewed	<input type="checkbox"/>	6	Reviewed as Noted / Resubmit
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Plant <b>1.0 MTPA ALUMINA REFINERY STREAM-5</b>	Client <b>NALCO</b>	Contract Code <b>NAL</b>	Document ID <b>6695-ELT-G00-EC-0035</b>	Contract No. <b>66-6695</b>
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				Rev <b>00</b> Page <b>2</b> of <b>2</b>

### INDEX SHEET

The document Cover Sheet indicates revisions made in this document along with the purpose of issue of the revised document. The details of revisions made in the enclosures of this document are listed in the table of *Contents* below and the enclosures listed therein are an integral part of this document.

### CONTENTS

Part	Docu Size	Description	No. Of Pages	Rev. No.	Revised Clauses
	A4	Index sheet and status of revision	2	0	-
Part-I	A4	General specifications	7	0	-
Part-IIA	A4	Design Data Sheet (General)	10	0	-
Part-IIB	A4	Design Data Sheet (Specific wise)	2	0	-
Part-III	A4	Inspection Test Plan	3	0	-
Annexure-I	A4	Summation CT's Wiring Scheme For APFC Panel	3	0	-

Plant <b>1.0 MTPA ALUMINA REFINERY STREAM-5</b>	Client <b>NALCO</b>	Contract Code <b>NAL</b>	Document ID <b>6695-ELT-G00-EC-0035</b>	Contract No. <b>66-6695</b>
	<b>LOW VOLTAGE POWER FACTOR IMPROVEMENT CAPACITOR PANEL</b> <b>Part-I - General Specifications</b>			 <b>नेशनल एल्युमिनियम कम्पनी लिमिटेड</b> <b>National Aluminium Company Ltd.</b>
				Rev <b>00</b> Page <b>1</b> of <b>7</b>

## 1.0 INTRODUCTION

This specification covers the design, manufacturing, inspection and testing of **Low Voltage Power Factor Improvement Capacitor Panel**. Equipment to be supplied shall comply with latest revision of applicable IS & IEC and specific codes and standards mentioned in clause 'Codes and standards' of Part-II of this specification.

Standard and descriptive requirement is covered in Part-I while specific requirement is covered in Part-II. Requirements for testing at vendor's work are covered in Part-III.

## 2.0 GENERAL REQUIREMENTS

### 2.1 Construction

- a. The low voltage power factor improvement capacitor panels shall be metal clad, totally enclosed CRCA sheet steel cubicles, compartmentalized and as specified in Part-II.
- b. Each vertical section of panel shall be divided into horizontal and vertical bus bar chamber, cable compartments for accommodating incoming cables and equipment compartment in modular design for accommodating all components of each outgoing feeder.
- c. The incomer feeder shall be with Air Circuit Breakers / MCCBs/ SFUs as specified in Part-II.  
Each Capacitor feeder shall be provided with SFU/FSU/MCCB, capacitor duty contactor etc. as specified in Part-II.
- d. Each feeder compartment shall be provided with front access hinged door of adequate strength and padlocking facility with main power switch / MCCB handle.
- e. Compartment door shall be interlocked mechanically with the switch such that the door cannot be opened unless the switch is in OFF position, also means shall be provided for defeating the interlock at any time.
- f. If louvers are provided, they shall be backed up by fine wire mesh.
- g. Each vertical section of panel and feeder compartment shall be constructed, such that failure of one equipment does not affect the adjacent units. Between bus compartment and breaker compartment & breaker compartment and cable compartment, non perforated flame retardant partitions shall be provided.
- h. The design and construction of each panel shall be such as to allow extension at either end.
- i. Relays, meters and control switches shall be located at height which shall be convenient for monitoring and operating.
- j. Bolted doors to cover front and back of busbar alley shall also be provided. Busbar alley shall be covered with screwed perforated sheet to avoid direct access to the vertical busbars on opening of the busbar alley door. Doors of busbar alley shall be fitted to board frame with special screw / bolts such that same can be opened with special key only. Vertical cable alley covering the entire height with hinged door shall be provided.
- k. Power and Control terminals in cable alley for incomer feeder shall be covered with bolted type, sloped hylam sheet or FRP sheet which shall be fixed after termination of power cable. Adequate number of slotted cable support arms shall be provided for cleating the cables.

Plant <b>1.0 MTPA ALUMINA REFINERY STREAM-5</b>	Client <b>NALCO</b>	Contract Code <b>NAL</b>	Document ID <b>6695-ELT-G00-EC-0035</b>	Contract No. <b>66-6695</b>
	<b>LOW VOLTAGE POWER FACTOR IMPROVEMENT CAPACITOR PANEL</b> <b>Part-I - General Specifications</b>			 <b>नेशनल एल्युमिनियम कम्पनी लिमिटेड</b> <b>National Aluminium Company Ltd.</b>
				Rev <b>00</b> Page <b>2</b> of <b>7</b>

The size of cable alley for incomer shall be sufficient to accommodate the terminals and the cables. Sufficient space shall be provided to accommodate the bends in the cores of the cables.

- m. Location of Incomer will be decided by LSTK Contractor during approval of drawing. Also location of breaker control switches, indicating lamps, relays, selector switches and meters shall be decided during approval of drawing and these shall be located on respective panels.
- n. All openings, covers and doors shall be provided with neoprene gaskets.
- o. Lifting Lugs shall be provided on the top of all shipping sections.
- p. Continuous current rating of various switchgear components/ busbars is in panel rating at full load condition for design ambient temperature and site conditions. Vendor shall suitably derate the nominal rating to suit above condition.
- q. All hardware shall be Stainless steel.
- r. Provision shall be made in capacitor panel so that capacitor panel door cannot be opened unless capacitors are fully discharged or alternatively caution plate shall be provided on the back door clearly indicating " Open the door only after all the capacitors are disconnected and discharged".
- s. Individual capacitor feeder shall have provision to Switch ON/OFF the unit manually through A/M switch and ON-OFF PB.
- t. The switching and protective devices and the connections shall be designed to carry continuously a current of 1.15X1.3 times the current that would be obtained with a sinusoidal voltage of an r.m.s. value equal to rated voltage (i.e. rated capacitor voltage - 525 V) at the rated frequency.

## 2.2 Bus Bars and Bus Taps

- a. Busbars shall be of uniform cross section throughout the length rated for continuous and short time currents and Bus bar material shall be as indicated in Part II. Bus bars shall be supported on insulators made of non-hygroscopic, non inflammable, track resistant material.

Wherever joints between dissimilar materials are envisaged, silver paste or bi-metallic strips shall be provided on the surface.

All busbars and busbar joints shall be easily accessible for periodic inspection without requirement of dismantling any components like CTs etc.

- b. Separate vertical droppers shall be provided for each vertical panel.
- c. Connecting plates with required hardware for joining busbars at the shipping sections shall be supplied.
- d. Vertical bus bars shall be sized for fault current as well as continuous rated current.

Plant <b>1.0 MTPA ALUMINA REFINERY STREAM-5</b>	Client <b>NALCO</b>	Contract Code <b>NAL</b>	Document ID <b>6695-ELT-G00-EC-0035</b>	Contract No. <b>66-6695</b>
	<b>LOW VOLTAGE POWER FACTOR IMPROVEMENT CAPACITOR PANEL</b> <b>Part-I - General Specifications</b>			 <b>नेशनल एल्युमिनियम कम्पनी लिमिटेड</b> <b>National Aluminium Company Ltd.</b>
				Rev <b>00</b> Page <b>3</b> of <b>7</b>

- e. Only zinc passivated or cadmium plated high tensile strength steel bolts, nuts and washers shall be used for all bus bar joints and supports.

## 2.3 Earth Bus

Separate earth bus rated to carry maximum fault current for the specified time shall be provided along the full length of each board. Each feeder, base plate, breaker unit etc. shall be earthed directly to this earth bus. Provision shall be made to terminate ground system cable at each end of the switchgear assembly.

Hinged doors shall be earthed through flexible earthing braids. All non-current carrying metal parts shall be effectively bonded to the earth bus.

## 2.4 Switchgear Components

Make of Switchgear Components shall be as specified in Part II. Technical particulars of switchgear component shall be as per various parts of this specifications and enclosed relevant documents.

### 2.4.1 Air Circuit Breakers

Circuit breakers shall be of proven design.

Each breaker shall be provided with emergency manual trip device, mechanical 'ON-OFF' indicators, operation counter, spring 'CHARGED-DISCHARGED' indicators, manual spring charging facility with manual 'close' push button. Manual 'Close' push button shall be accessible after opening the front door.

Each breaker shall have three (3) positions - SERVICE, TEST and DISCONNECTED with mechanical indication. The design of breaker shall be such that it will be possible to close the front access door even when the breaker is pulled out to DISCONNECTED position.

After failure of power supply to the spring charging motor, at least one CLOSE-OPEN operation of the circuit breaker shall be possible.

For safe operation, maintenance and testing of circuit breaker, interlocks shall be provided for the following :

- i. To prevent a closed circuit breaker from being isolated or inserted into the service position.
- ii. To prevent operation of circuit breaker in any intermediate position.
- iii. Earthing of circuit breaker carriage before the main circuit breaker contacts are plugged into the stationary contacts. Positive earthing of the circuit breaker truck shall be maintained in the connected position.
- iv. To prevent compartment door from being opened if the breaker is in closed position. Interlock defeat to be provided.

Circuit breaker cubicles shall be provided with safety shutters, operated automatically by the movement of draw-out carriage to cover stationary isolated contacts when the carriage is withdrawn.

Plant <b>1.0 MTPA ALUMINA REFINERY STREAM-5</b>	Client <b>NALCO</b>	Contract Code <b>NAL</b>	Document ID <b>6695-ELT-G00-EC-0035</b>	Contract No. <b>66-6695</b>	
	<b>LOW VOLTAGE POWER FACTOR IMPROVEMENT CAPACITOR PANEL</b> <b>Part-I - General Specifications</b>			 नेशनल एल्युमिनियम कम्पनी लिमिटेड National Aluminium Company Ltd.	
				Rev	<b>00</b>

#### 2.4.2 Moulded Case Circuit Breaker (MCCB)

MCCBs shall be provided with spring assisted quick make / break, manually operated with trip free mechanism.

MCCBs shall have magnetic trip, thermal trip or thermal magnetic trip as per requirement specified in Part II.

MCCBs shall be of Current limiting type and type tested for type-2 coordination as per IS:13947.

MCCBs shall be provided with shunt trip, auxiliary contacts and contact for trip indication / alarm as per requirement specified in Part II.

#### 2.4.3 Current Transformer & Potential Transformer

Accuracy class, VA burden, ratio shall be as specified in relevant single line diagram. VA burden of current and Potential Transformer shall suit the connected load with minimum 20% margin in case same is not specified.

Earthing of CT secondary shall be done through separate earth link on terminal block.

CTs polarity shall be indelibly marked on each transformer & at the associated ferrules on terminal block.

#### 2.4.4 Relays & Meters

Protection relays and meters, make and type shall be as per Part II ~~and enclosed SLD~~. All relays shall be flush/semi flush mounted on the front of respective cubicle.

Numerical / Microprocessor based relays & digital meters shall have facility for communication with SCADA if specified in Part-II.

#### 2.4.5 Control Wiring

Control wiring shall be carried out with flexible heat resistant switchboard wires of minimum size 1.5 mm<sup>2</sup> for control circuits and 2.5 mm<sup>2</sup> for CT circuits. Wires connected to earth shall be of green colour only. For potential tappings from busbar for PT, Voltmeter etc. HRPVC wires shall be used.

Each wire shall be identified at both ends with wire designation in accordance with the wiring diagram developed from approved control schematics. Inter-locking type plastic ferrules of yellow colour shall be used for identification. Colour of lettering of ferrule shall be black.

All wire termination except for Elmex type terminal blocks shall be made with ring/fork tongue compression type connectors. Wires shall not be tapped in between terminal points. Type of lug shall suit relevant application.

The wiring inside the panel shall be properly laid and fixed in wiring ducts with removable covers. The wiring ducts shall be properly insulated. Wires shall be accessible from the front without removing the component mounting plate. Routing of wires behind the component mounting plate is not acceptable.

Plant <b>1.0 MTPA ALUMINA REFINERY STREAM-5</b>	Client <b>NALCO</b>	Contract Code <b>NAL</b>	Document ID <b>6695-ELT-G00-EC-0035</b>	Contract No. <b>66-6695</b>	
	<b>LOW VOLTAGE POWER FACTOR IMPROVEMENT CAPACITOR PANEL</b> <b>Part-I - General Specifications</b>			 नेशनल एल्युमिनियम कम्पनी लिमिटेड National Aluminium Company Ltd.	
				Rev	<b>00</b>

Wires forming part of tripping circuit of circuit breaker shall be provided with additional red ferrule marked `T` or some other acceptable identification mark shall be provided as per manufacturers standard.

Wiring between different shipping section shall be carried out through separate set of terminal block. Sufficient length of jumper wires shall be provided with ferrule nos. at both ends. One end of such wires shall be connected to the terminal block. Full details of such wiring shall be furnished by the vendor.

All spare contacts of relays, switches and other components shall be wired upto terminal blocks.

All openings in sheet steel partitions for carrying out inter-panel wiring shall be provided with rubber/PVC grommets.

Wiring between fixed portion of cubicle and door mounted equipment shall be routed through flexible PVC conduits.

Two wires shall not be terminated in one terminal. Additional terminations if required shall be done on adjacent terminals by suitable shorting.

#### **2.4.6 Control Terminal Block**

The terminal block shall be grouped and segregated according to circuit functions and different voltage levels, and shall have 20% spare terminals. Individual terminals in each blocks in each group shall be serially numbered in accordance with the drawings. Such numbering shall be legible, permanent and indelible. Terminal block for CTs shall be provided with drop out facility for testing purposes for shorting and shall be segregated from other terminals.

Sufficient clear space shall be provided between gland plate and terminal blocks.

## **2.5 GENERAL REQUIREMENT FOR CAPACITORS, REACTORS AND APFC CONTROLLER**

### **2.5.1 Capacitor Unit**

Capacitor Unit shall consist of one or more capacitor elements stacked together to form a column. Type of dielectric (APP/MPP), number and thickness of layers i.e. dielectric and Al foil (in case of APP) shall be as specified in part-II of this specification. The capacitor assembly shall be impregnated with non-toxic, non-PCB (Poly-Chlorinated-bi-phenyl) liquid under high degree of Vacuum.

Fuses shall be provided internally for each capacitor element or externally across each capacitor unit as required. All capacitors shall be hermetically sealed. Each capacitor unit shall have proper name plate (contents of which shall be as per IEC).

As per the requirement, the capacitors units shall be used for "Feeder Compensation" or "Bus compensation".

### **2.5.2 Capacitor Bank**

Capacitor bank shall consist of individual capacitor units with supporting insulators, steel rack assembly, busbars, connectors, mounting channels, frame etc.

Capacitor bank and associated accessories shall be metal enclosed with adequate ventilation provided with louvers covered by brass mesh.

Plant <b>1.0 MTPA ALUMINA REFINERY STREAM-5</b>	Client <b>NALCO</b>	Contract Code <b>NAL</b>	Document ID <b>6695-ELT-G00-EC-0035</b>	Contract No. <b>66-6695</b>
	<b>LOW VOLTAGE POWER FACTOR IMPROVEMENT CAPACITOR PANEL</b> <b>Part-I - General Specifications</b>			 <b>नेशनल एल्युमिनियम कम्पनी लिमिटेड</b> <b>National Aluminium Company Ltd.</b>
				Rev <b>00</b> Page <b>6</b> of <b>7</b>

The temperature rise above specified ambient of any part of capacitor and associated equipment shall not exceed maximum permissible temperature as specified in relevant IS.

### 2.5.3 Discharge Resistance

Discharge resistance shall be provided for each capacitor unit to allow capacitors to discharge gradually from terminal voltage or residual voltage to 50V in 5 minutes for voltage greater than 1000V and 1minute for voltage less than equal to 1000V as specified in standards.

### 2.5.4 Series Reactor

If specified in part-II, series reactors shall be used with capacitor banks to dampen the effect of transients during capacitor switching and to control the natural frequency of the capacitor bank and system impedance to avoid resonance or to mitigate harmonic current. Special care shall be taken while designing of capacitors & Reactors.

Indoor type Iron core / Air core reactors can be used. If iron core reactor is used, then the reactor shall be designed such that it shall not saturate when the harmonic flux and fundamental flux are additive, i.e.- co-incidence factor of 1.0. The reactor shall be designed for peak harmonic current, i.e. sum of the individual harmonic currents. The Harmonic current spectrum shall account for voltage variation, manufacturing tolerance and harmonic load growth.

Reactor shall be properly constructed to release less audible sound. The noise level shall not exceed 70 dB (A) at 1 meter. Insulation class of winding and temp rise of core/ winding shall be as specified in Part II. Reactor shall be vacuum pressure impregnated and moisture proof. Laminated Iron core shall be of low Hysteresis loss.

The detuned series reactor shall be provided such that at all times resonance is avoided.

Thermistors shall be provided in all three phases of reactor such that, tripping shall be initiated if the winding temperature crossing the specified temperature limits.

### 2.5.5 Automatic Power Factor Controller

APFC system shall consist of intelligent controller which continuously monitors various electrical parameters & controls the power factor and Harmonics using signals received from CT's provided in all three phases. Capacitor Duty rated contactors or thyristor modules shall be used for switching capacitor banks.

It shall be possible for user to set different switching steps for different targeted power factor values. The number of switching steps shall be provided such that the PF shall not exceed unity, (normally lagging, not leading at any point of operation). Necessary interlocks shall be provided to ensure that the switch operation taken place only on logical predetermined sequence.

With the help of computed load kVAr, controller automatically switches "ON" and "OFF" the desired capacitors (to maintain the load power factor at desired value). In case of contactor switching, hunting shall be prevented by suitable design of controller. In addition, suitable control setting shall be selected to minimize the number of contactor operations.

Plant <b>1.0 MTPA ALUMINA REFINERY STREAM-5</b>	Client <b>NALCO</b>	Contract Code <b>NAL</b>	Document ID <b>6695-ELT-G00-EC-0035</b>	Contract No. <b>66-6695</b>
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				Rev <b>00</b> Page <b>7</b> of <b>7</b>

For power systems with multiple incomers and buses, summation CT shall be provided to receive the CT inputs from incomer connected to corresponding bus and associated buscoupler. The controller shall operate the capacitor bank to compensate power factor for loads connected only to respective bus.

Controller shall consist of sensing and display unit displaying various electrical parameters as mentioned in Part II.

## 2.6 Name Plate

Main name plate on top of the board, on front and back shall be provided. Panel number shall also be indicated on a separate label both in front and rear.

Name plates of approved design shall be provided at the front of each cubicle. Rating plates for each instrument, relay and auxiliary switch, mounted on the face shall also be provided. All internally mounted components shall be identified with painting marks as per approved scheme drawings.

Material for name plates shall be as specified in Part – IIA or approved equivalent. Inscription details on name plate shall be as per Owner/LSTK Contractor's requirements and details of name plate will be issued after approval of vendor's GA drawing.

## 2.7 Painting

Vendor / LSTK Contractor to furnish complete details of painting procedure and painting facilities available along with the offer and final paint shade shall be as indicated in Part II.

## 3 FACTORY ACCEPTANCE TEST

Owner / Consultant / LSTK Contractor shall have the option to carry out the stage inspection.

Tests as specified in Part III shall be carried out during final inspection. Fifteen days advance notice shall be given for carrying out final inspection.

Vendor / LSTK Contractor shall ensure that all meters associated with testing of the equipment shall be calibrated by competent authority and this calibration certificate shall be valid at the time of carrying the testing of equipment.

## 4 GUARANTEED PERFORMANCE

The performance figures quoted in the Technical Particulars sheets shall be guaranteed within the tolerance permitted by relevant standards. In case of failure of the equipment to meet the guarantee, the Owner/LSTK Contractor reserves the right to reject the equipment. However, Owner/LSTK Contractor reserves the right to use the rejected equipment until the new equipment meeting the guarantee requirement is supplied by the vendor. However the vendor will be given an opportunity to rectify his equipment at his own cost. Also Owner/LSTK Contractor reserves the right to use rejected equipment till it is rectified. The period of guarantee of the equipment shall be as indicated elsewhere in the tender.

 नालको NALCO नेपाल एल्युमिनियम कम्पनी लिमिटेड National Aluminium Company Ltd.		<b>LOW VOLTAGE POWERFACTOR IMPROVEMENT CAPACITOR PANEL</b>		Code	NAL		
				Contract no.	66-6695		
 thyssenkrupp		<b>PART - II A DESIGN DATA SHEET (GENERAL)</b>		Doc.	6695-ELT-G00-EC-0035		
				Rev.	0	Page	1 OF 10
<b>GENERAL</b>	001	Make	: As per Vendor List- Electrical				
	002	Nominal system voltage	: 415 V				
	003	Voltage Variation	: +/- 10 %				
	004	Highest system voltage	: 460 V				
	005	System frequency	: 50 Hz				
	006	Frequency Variation	: + 3% / - 5%				
	007	Power System	: 3 Phase, 4 Wires				
	008	Neutral Grounding	: Solidly grounded				
	009	Individual Panel details	: As per Part-II B				
<b>CODES</b>	010	IEC 61439/IS 8623 (All parts) - Specification for low voltage switchgear & control gear assemblies					
	011	IS : 11353 - Marking of Insulated Conductors.					
	012	IS : 5578 - Marking of Terminals & insulated Conductors.					
	013	IS : 13703 - Low Voltage Fuses					
	014	IS : 1248 - Indicating Meters					
	015	IS : 3156 - Potential Transformers					
	016	IS : 2705 - Current Transformers					
	017	IS 191 - Copper Busbars					
	018	IS 5082 - Material data for Aluminium Busbars					
	019	IS13947/IEC : 60947 - Low voltage switchgear and control gear					
	020	IS 13925 : Shunt Capacitors for A.C. power system.					
	021	IS 5553 : Reactor.					
	022	IS 13340/ IEC60831 : Power Capacitors of Self-healing type for AC power systems having rated voltage up to 1000V.					
	023	IS 13585/ IEC60931 : Power Capacitors of Non-self healing type for AC power systems having rated voltage up to 1000V.					
	024	IS 12672 : Internal fuses & internal overpressure disconnectors for shunt capacitor.					
	025	IEEE 1036 : Application of Shunt Power Capacitor.					
	026	IEEE 18 : Standards for Shunt Power Capacitor.					
	027	CEA Regulations					
<b>RATING</b>	028	Rated Operational Voltage ( $U_e$ )	: 415 V				
	029	Rated insulation Voltage ( $U_i$ )	: 1100 V				
	030	Rated Impulse withstand voltage ( $U_{imp}$ )					
		a) Main Circuit	:	kV	*		
		b) Auxiliary Circuit	:	kV	*		
	031	One minute Power frequency withstand voltage	:	2.5 kV			
032							
<b>CONSTRUCTION</b>	033	Degree of Ingress Protection	: IP 42 for PFIC panels, IP 4X for ACB panels				
	034	Module Construction	: ACB Drawout, other wise fixed type				
	035	Front	: Single Front				
	036	Access	: Front & rear both				
	037	Cable Entry	: Bottom				
	038	Material of Construction	: CRCA, Sheet Steel				
	039	<b>Thickness of sheet steel</b>					
		a) Frame / Door / Covers	:	_____ (Min 2 mm)	*		
		b) Gland plates	:	_____ (Min 3 mm)	*		
	040	<b>Material for Gland plate</b>					
		a) Multicore cables	:	3 mm thick sheet steel			
		b) Single core cables	:	4 mm thick aluminium			
	041	Gasket	:	Neoprene Rubber			

 नैलको एल्युमिनियम कम्पनी लिमिटेड National Aluminium Company Ltd.		<b>LOW VOLTAGE POWERFACTOR IMPROVEMENT CAPACITOR PANEL</b>  <b>PART - II A</b>  <b>DESIGN DATA SHEET (GENERAL)</b>		Code	NAL		
				Contract no.	66-6695		
				Doc.	6695-ELT-G00-EC-0035		
				Rev.	0	Page	2 OF 10
<b>PAINTING</b>	042	Type of painting process	: 7 tanks process for surface preparation				
	043	Primer	: 2 coats of epoxy based primer , powder coating				
	044	Final paint	: 2 coats of epoxy based finish paint, powder coating				
	045	Final paint shade	: RAL-7032				
	046	Minimum thickness of paint	: 60 Micron				
<b>NAME PLATE</b>	047	<b>Name plate</b>	:				
		a) Material	: CRCA sheet steel				
		b) Thickness	: 2 mm (Minimum)				
<b>BUS BAR</b>	048	Bus bar material	: Aluminium				
	049	Grade	: Electrolytic grade				
	050	<b>Clearance for busbars &amp; connectors</b>					
		a) Phase to phase (min. 25 mm)	: _____ mm			*	
		b) Phase to ground (min. 19 mm)	: _____ mm			*	
	051	<b>Maximum allowable temperature at rated current</b>					
		<b>a) Contacts/ Terminals</b>					
		i) Bare copper	: 100		Deg C		
		ii) Bare Brass	: 105		Deg C		
		iii) Tin coated copper/ brass	: 105		Deg C		
		iv) Silver/ nickle coated copper/ brass	: 110		Deg C		
		v) Other metals (eg. aluminium)	: 105		Deg C		
		<b>b) Manual operating means</b>					
		i) Metallic	: 55		Deg C		
		ii) Non-Metallic	: 65		Deg C		
		<b>c) Parts intended to be touched but not hand held</b>					
		i) Metallic	: 70		Deg C		
		ii) Non-Metallic	: 80		Deg C		
		<b>d) Terminals for connections to external conductors</b>	: 110		Deg C		
		<b>e) Parts accessible but need not be touched during normal operation/ Exterior of Enclosures near cable entry</b>					
		i) Metallic	: 80		Deg C		
		ii) Non-Metallic	: 90		Deg C		
	052	<b>Busbars/ terminals/ joints/ contacts during short circuit conditions</b>	: 200		Deg C		
	053	(a) Bus bar to be sleeved	: Yes, Colour coded, Heat shrinkable sleeves.				
		(b) Rated withstand temperature of sleeves	: _____ Deg C			*	
054	Shrouding of Bus bar joints	Yes					
055	Material of Shrouds	: SMC/ DMC/ FRP/ Epoxy					
056	<b>Support Insulators</b>						
	a) Voltage class	: 1.1		kV			
	b) Material of insulator	: Epoxy / SMC / DMC					
	c) Maximum distance between busbar supports	: _____ mm			*		
	d) Rated cantilever breaking load	: _____ kN			*		
057	<b>Earth Bus</b>						
	a) Short circuit withstand capacity	: Same as upstream feeding switchgear					
	b) Material	: Copper					
	c) Size	: _____ mm minimum			*		
<b>CONTROL AND AUX. SUPPLY</b>	058	Protection Relays	: 110V DC +10%, -15%				
	059	ACB control and spring charging	: 110V DC +10%, -15%				
	060	Aux. supply for Panel space heaters	: 240V AC +/- 10%				
	061	Aux. supply for digital meters	: 110V DC +10%, -15%				
	062	Aux. supply for Contactor controlled capacitor feeder	: 240V AC +/- 10% through Control transformer				
	063	Aux. supply for Thyristor	: 240V AC +/- 10% through Control transformer				

 नालको NALCO नेपाल एल्युमिनियम कम्पनी लिमिटेड National Aluminium Company Ltd.		<b>LOW VOLTAGE POWERFACTOR IMPROVEMENT CAPACITOR PANEL</b>		Code	NAL		
				Contract no.	66-6695		
<b>PART - II A</b>  <b>DESIGN DATA SHEET (GENERAL)</b>		Doc.	6695-ELT-G00-EC-0035				
		Rev.	0	Page	3 OF 10		
<b>AIR CIRCUIT BREAKER</b>	064	Type	: Drawout Air Circuit Breaker				
	065	Make/ Model No.	: *				
	066	<b>Short circuit rating</b>	:				
		a) Rated Short time withstand current (Icw)	: Same as upstream feeding switchgear				
		b) Rated ultimate short circuit current (Icu)	: kA *				
		c) Rated service short circuit current (Ics)	: 100 %Icu				
		d) Rated short circuit making current (Icm)	: *				
	067	<b>Interrupting time of breakers at rated current</b>	:				
		a) Opening time	: msec. *				
		b) Closing time	: msec. *				
	068	Operating duty	: 0 - 3 min.- CO - 3 min. - CO				
	069	<b>Permissible no. of operation without inspection of contact at</b>	:				
		a) Rated current	: Nos. *				
		b) 50% rated breaking current	: Nos. *				
		c) 100% rated breaking current	: Nos. *				
	070	<b>Operating mechanism type</b>	: Stored energy spring charged				
	071	<b>Spring charging motor</b>	:				
		a) Type	: *				
		b) Rating	: watts *				
	072	Spring charging time	: Seconds *				
	073	<b>Allowable range of control voltage variation</b>	:				
		a) Closing	: + % to - % *				
		b) Tripping	: + % to - % *				
	074	<b>Power required by</b>	:				
		a) Closing coil	: Watts *				
		b) Tripping coil	: Watts *				
	075	Auxiliary contacts	: 4NO +4NC *				
	076	<b>Make &amp; continuous rating of auxiliary contacts at</b>	:				
		a) 240V AC	: Amps *				
	b) 220 V DC (Inductive breaking)	: Amps *					
	c) 110 V DC (Inductive breaking)	: Amps *					
077	Integral releases to be provided for ACBs	: No					
078	Type and model no. of Integral Release (if provided)	: *					
079	<b>Inpanel breaker rating at design ambient temperature and site operating conditions :</b>	:					
	630 A/ 1250A/ 1600A	:	/	/	Amps	*	
	2000 A/ 2500A/ 3150A	:	/	/	Amps	*	
<b>MCCB</b>	080	Make	:				
	081	Rated ultimate short circuit current (Icu)	: Same as upstream feeding switchgear **				
	082	Rated service short circuit current (Ics)	: 100 % Icu for all applications				
	083	Rated short circuit making current (Icm)	: kA *				
	084	<b>Type of Release/ Protections to be covered by releases</b>	:				
		a) For Incomers	: As per SLD encl. in Part-IV *				
	b) For Capacitor Feeders	: As per SLD encl. in Part-IV *					

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 नालको NALCO नेशनल एल्युमिनियम कंपनी लिमिटेड National Aluminium Company Ltd.		<b>LOW VOLTAGE POWERFACTOR IMPROVEMENT CAPACITOR PANEL</b>		Code	NAL		
 thyssenkrupp		<b>PART - II A DESIGN DATA SHEET (GENERAL)</b>		Contract no.	66-6695		
				Doc.	6695-ELT-G00-EC-0035		
				Rev.	0	Page	4 OF 10
<b>MCCB</b>	085	<b>Model no. of MCCB and Release</b>					
		a) For Incomers	:				*
		b) For Capacitor Feeders	:				*
	086	Shunt trip required	:	Yes /			**
	087	Aux. contacts	:	NO - I NC			**
	088	Trip/ Alarm contacts	:	Yes			
	089	Rotary operating mechanism with defeat interlock	:	Yes			
	090	<b>Inpanel MCCB rating at design ambient temperature and site operating conditions :</b>					
		63A/ 100A/ 125A	:	/	/	Amps	*
		160 A/ 200A/ 250A	:	/	/	Amps	*
	400A/ 630A	:	/	/	Amps	*	
<b>SWITCH</b>	091	<b>Category of duty &amp; type</b>					
		<b>Incomer feeder</b>					
		a) Rated current	:	As per Part IIB			
		<b>Outgoing Capacitor bank feeder</b>					
		a) Duty	:	AC6b			
		b) Rated current	:	Min. 1.15X1.3 times rated Capacitor bank current at rated Capacitor voltage i.e. 525 V			
	092	Derating for installation inside Panel / feeder module at design ambient temp. & site operating conditions : % *					
<b>POWER FUSES</b>	093	Make/ Model No.	:				*
	094	Type	:	High rupturing			
	095	Rupturing capacity	:	80 kA			
	096	Derating for installation inside Panel / feeder module at design ambient temp. & site operating conditions : % *					
	097	I <sup>2</sup> t of HRC fuse	:	I <sup>2</sup> t of HRC fuses shall not exceed 70% of I <sup>2</sup> t of switching element. The fuses shall not blow during repeated switching operations irrespective of the control through electromagnetic contactors			
<b>CONTACTORS</b>	098	<b>Power contactor</b>					
		a) Make/ Model No.	:				*
		b) Coil Voltage	:	240V			
		b) Range of operating voltage	:	85 to 110 % of rated Volatge			
		c) Minimum drop out voltage	:	75 % rated voltage			
		d) Category of duty					
		i) For capacitor feeders	:	AC6b			
		e) Rating	:	Min. 1.15X1.3 times rated Capacitor bank current at rated Capacitor voltage i.e. 525 V			
	099	<b>Auxiliary contactor</b>					
		a) Make/ Model No.	:				*
	b) Range of operating voltage	:	85 to 110 % of rated Volatge				
	c) Minimum drop out voltage	:	75 % rated voltage				
<b>CT / PT</b>	100	CT Construction	:	Cast resin wound / bar primary			
	101	PT Construction	:	Cast resin			
	102	Ratio, accuracy class and VA burden of CT/PT shall as per SLD.					

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 <b>LOW VOLTAGE POWER FACTOR IMPROVEMENT CAPACITOR PANEL</b>		Code	NAL		
		Contract no.	66-6695		
<b>PART - II A</b> <b>DESIGN DATA SHEET (GENERAL)</b>		Doc.	6695-ELT-G00-EC-0035		
		Rev.	0	Page	5 OF 10
<b>RELAYS</b>	103	<b>Auxiliary relays</b>			
		a) Type	: Electromechanical		
		b) Make/ Model No.	: *		
	104	<b>Tripping Relays</b>			
		a) Type	: Electromechanical		
		b) Make/ Model No.	: *		
		c) Tripping Relays shall be high-speed lock-out type with hand reset contact.			
	105	<b>Timers</b>			
		a) Type	: Electromechanical		
		b) Make/ Model No.	: *		
106	<b>Protection relays</b>				
	a) Type	: Numerical			
	b) Make/ Model No.	: *			
	107	Metering to be included in Numerical Relays	: Yes		
	108	Requirement of Numerical Relay Connectivity to SCADA	: No		
	109	Min. no. of binary inputs and outputs (for numerical relays)	: To meet control logic requirement		
	110	Loading of software and configuration of relay	: By vendor at factory		
<b>INDICATING METERS</b>	111	Metering Parameters for Incomers/ Outgoing feeders			
			: *		
	112	Accuracy Class of Meters	: *		
	113	<b>Type of Meters</b>			
		a) Incomers/ Buscoupler	: Digital		
		b) Outgoing feeders	: Digital		
		c) kWh/ kVARh/ KVAh meter (if applicable)	: Digital		
	114	<b>Analog Meters</b>			
		Type, Scale	: Taut Band, 240 degree		
	115	<b>Size of Analogue meters</b>			
	a) Incomers	: min. 96 x 96 mm			
	b) Outgoing feeders	: min. 72 x 72 mm			
116	<b>Make</b>				
	a) kWh/ kVARh/ KVAh meter (if applicable)	: *			
	b) Composite Meter (if applicable)	: *			
	117	Requirement for Connectivity to SCADA	: NO		
<b>REMOTE COMMUNICATION</b>	118	Communication protocol	: IEC 61850(For Relay's) / MODBUS RTU (For Meters)		
	119	Communication Port	: RJ 45(For Relay's) / RS 485(For Meters) *		
	120	Real Time clock	: *		
	121	Time stamping resolution	: 1 msec		
	122	Parameters to be transmitted to SCADA	: NA		
	123	Dual redundant ports	: Dual Redundant (For relay's) / Single (For Meters)		

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 नालको NALCO नेपाल एलुमिनियम कार्पोरेशन लिमिटेड National Aluminum Company Ltd.		<b>LOW VOLTAGE POWER FACTOR IMPROVEMENT CAPACITOR PANEL</b>		Code	NAL		
				Contract no.	66-6695		
 thyssenkrupp		<b>PART - II A</b> <b>DESIGN DATA SHEET (GENERAL)</b>		Doc.	6695-ELT-G00-EC-0035		
				Rev.	0	Page	6 OF 10
<b>METERING, PROTECTION &amp; CONTROL</b>	124	<b>Control of each Capacitor feeder</b>					
		a) Type of control	: Auto / Manual				
		b) Provision of timers in Auto & Manual mode to ensure repeated switching of capacitors only after proper discharge	: Yes				
		c) Push buttons for ON/OFF in manual mode	: Yes				
	125	Switching of individual capacitors	: Contactor / Thyristor *				
	126	Parallel operation of capacitors	: Yes				
	127	<b>Metering &amp; Indication</b>					
		a) Incomer Feeder					
		Metering & Indication	: As per SLD, 6695-ELT-G00-FA-0003				
		b) Outgoing Capacitor bank feeders					
		i) Bank is ON & healthy	: Yes				
		ii) Bank is faulty & switched OFF	: Yes				
		iii) Bank is OFF	: Yes				
	128	<b>Protection with Annunciation for capacitor bank feeder</b>					
		a) Capacitor Overload	: Yes				
		b) Overtemperature protection for Reactor ( thermistor 150°C )	: Yes				
	c) Overvoltage (provided in upstream switchgear)	: No					
	d) Under voltage	: Not applicable since the contactor control supply is from PFIC bus					
<b>AUTO PF CONTROLLER</b>	129	Type of Controller	: Numerical, microprocessor based				
	130	Make & Model	: *				
	131	Control voltage	: ____ *				
	132	VA burden	: ____ *				
	133	No. of steps	: As per no. of step required for PFIC mentioned in Part IIB+1 spare				
	134	Minimum time required between two consecutive operations of capacitor switching	: ____ m Sec. *				
	135	Switching Logic	: FIFO/ LIFO				
	136	Parameters to sense, calculate & display	: kVAR				
	137	Parameters to display	: 1) Line voltage, Line current, Line Power factor				
			: 2) Line Active power, Line Reactive power, Line Apparent power				
			: 3) Injected capacitive kVAR to reach targetted P.F.				
			: 4) Line CT ratio selected				
	138	Indication	: LED indication for number of capacitor banks switched ON				
	139	Measurement system	: 3 Phase				
	140	Operating temperature range	: ____ *				
	141	Auto synchronisation facility	: Yes				
142	HMI & Display	: Yes					
143	Facility shall be provided for connectivity with Laptop/computer/scada system.	: Yes					
144	Protocol	: Serial Communication with Modbus protocol					

 नालको NALCO नेपाल एल्युमिनियम कम्पनी लिमिटेड National Aluminium Company Ltd.		<b>LOW VOLTAGE POWER FACTOR IMPROVEMENT CAPACITORS PANEL</b>  <b>PART - II A</b>  <b>DESIGN DATA SHEET (GENERAL)</b>		Code	NAL		
				Contract no.	66-6695		
 thyssenkrupp				Doc.	6695-ELT-G00-EC-0035		
				Rev.	0	Page	7 OF 10
<b>CAPACITOR BANKS</b>	145	Make & Model	: As per Vendor List- Electrical				
	146	Location of Capacitor bank	: Inside APFC panel				
	147	Mounting of Capacitors	: *				
	148	Bank Connection	: As per Part-II B				
	149	Terminals for grounding of capacitor required	: Yes				
	150	Dielectric for capacitors	: APP				
	151	No. of Layers	: *				
	152	Thickness of Layer	: _____ microns *				
	153	Total Loss at rated voltage & frequency	: _____ Watts / kVAR without resistor *				
	154	Temperature rise	: As per IS				
	155	Continuous Overvoltage withstand value	: As per IS/IEC *				
	156	Overload Capacity	: 135% of Rated KVAR at 525V				
	157	Maximum operating current of capacitor during switching ON/OFF operation	: Rated current *				
	<b>SERIES REACTOR</b>	158	Series Reactor Required	: Yes			
159		Make & Model	: As per Vendor List- Electrical *				
160		Material of winding	: Copper				
161		Voltage Class	: 1.1 KV				
162		Type of Shielding	: Magnetic / Non- magnetic *				
163		Cooling	: Air / Oil *				
164		Rating	: As per step mentioned in Part -II B				
165		Linearity	: Up to 150 % of rated current				
166		Rated Current	: As per step mentioned in Part -II B				
167		Continuous Overcurrent handling capacity	: 1.5 times Capacitor bank rated current at rated Capacitor voltage i.e. 525 V				
168		% Voltage drop (Reactor Voltage) under full load condition	: 7				
169		Basic insulation level	: 3 kV ( Min. )				
170		Short circuit withstand capacity	: Same as upstream feeding switchgear				
171		Class of insulation	: Class H with temp. rise restricted to Class F				
172		Thermistor to be provided	: Yes ( in all three phases )				
173		Insulation Resistance	: > 100 MΩ				
174		Temperature Rise					
	a) Core	: < 85 K					
	b) Coil	: < 95 K					
175	Catalogues indicating complete technical particulars, enclosed	: Yes					

 नालको NALCO नेशनल एल्युमिनियम कम्पनी लिमिटेड National Aluminium Company Ltd.		<b>LOW VOLTAGE POWER FACTOR IMPROVEMENT CAPACITOR PANEL</b>		Code	NAL			
				Contract no.	66-6695			
		<b>PART - II A</b> <b>DESIGN DATA SHEET (GENERAL)</b>		Doc.	6695-ELT-G00-EC-0035			
				Rev.	0	Page	8 OF 10	
<b>DISCHARGE RESISTANCE</b>	176	Make & Model	:				*	
	177	Type / Material used	:				*	
	178	Rated resistance	:	___	Ohm			*
	179	Wattage rating	:	___	W			*
	180	Discharge Time	:	___	sec.			*
	181	Mounting	:	Internal / External			*	
	182	Catalogues indicating complete technical particulars, enclosed	:	Yes				
<b>THYRISTORS</b>	183	<b>Thyristor</b>						
		a) Make & Model	:				*	
		b) Operating Voltage Range	:	415 V AC				
		c) Rated Current	:	Min. 1.15X1.3 times rated Capacitor bank current at rated			*	
				Capacitor voltage i.e. 525 V				
	184	PIV (peak Inverse Voltage)	:	2200 V				
	185	On state voltage drop	:				*	
	186	Off state leakage current	:	10 mA at 25 degree celsius				
	187	Thyristor Firing method	:	Zero Differential crossing				
	188	Type of Cooling	:	Heat Sink with Cooling Fan				
	189	Off state dv/dt	:	Max. 1000 V/μs				
	190	Heat sink temp. rise allowed	:	70 Deg C (max.)				
	191	Zero differential voltage switching	:	Yes				
	192	Response / correction time	:	3 cycles to 250 cycles				
	193	Protection against supply transients	:	Yes				
	194	Thyristor over current protection fuse	:	Yes				
	195	Capability to handle high dv/dt to prevent	:	_____	Volts / micro sec.			*
		spurious turn on due to transients	:					
	196	Fuse monitoring	:	Yes				
	197	Protections to be provided in Thyristor Switch Modules	:	1 ) Spike current protection				
			2 ) Over Current Protection					
			3 ) Short Circuit Monitoring					
			4 ) Over temp. cut-off					
			5 ) Over Transients and Higher Harmonics					
			6 ) Earth Fault Trip					

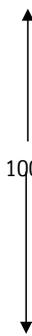
 नालको NALCO नेपाल एलुमिनियम कम्पनी लिमिटेड National Aluminium Company Ltd.		<b>LOW VOLTAGE POWER FACTOR IMPROVEMENT CAPACITOR PANEL</b>		Code		NAL		
				Contract no.		66-6695		
 thyssenkrupp		<b>PART - II A</b> <b>DESIGN DATA SHEET (GENERAL)</b>		Doc.		6695-ELT-G00-EC-0035		
				Rev.		0		Page
CONTROL TRANSFORMER	198	Make & Model	:	*				
	199	Type	:	Dry type, Air cooled, vacuum impregnated				
	200	Rating	:	based on load, minimum 100 VA				
	201	Margin in VA capacity on connected load	:	50%				
	202	Secondary voltage	:	240 V AC				
	203	Off Load Tap changer	:	+/- 5% in steps of 2.5 %				
	204	Control Supply for Capacitor feeder modules :	:	One number Control Transformer, fed from bus				
INDICATING LAMPS	205	Type	:	Clustered LED with min. 8 mm dia.				
	206	ON/ OFF/ Trip	:	Red/ Green/ Amber				
	207	Trip circuit supervision	:	White				
	208	Spring Charged	:	Blue				
	209	DC control supply fail (for each bus-section)	:	Blue				
CONTROL/ SEL. SWITCH	210	<b>Type</b>						
		a) For control power supply	:	Rotary, stayput				
		b) For breaker control	:	Pistol grip, T-N-C Switch, spring return to neutral				
		c) Auto-Manual switch	:	Rotary, stayput				
PUSH BUTTONS	211	<b>Type</b>						
		a) ON	:	spring return				
		b) OFF	:	Stay put type, Mushroom head, turn to release				
SPACE HEATER	212	Type of control	:	Thermostat with MCB				
	213	Location	:	Cable chamber				
	214	Rating	:	As per space heating requirement *				
MAKE OF COMPONENTS	215	Electro mechanical relays	:	Alstom/ ABB/ Siemens *				
	216	Numerical/ Microprocessor based relays	:	ABB/ Alstom/ Siemens *				
	217	Auxiliary relays	:	Schneider/ ABB/ Easun Reyrolle *				
	218	Timer Relays	:	Alstom/ ABB/ Easun Reyrolle *				
	219	Power fuses	:	Siemens / L&T / ABB / Schneider / Mersen (Ferraz) *				
	220	Instrument transformers	:	AE/Indcoil/Precise/Kappa/ ABB/Pragati/Siemens *				
	221	Bus bar support insulator	:	Dolf/Fibrochem/Glassfibro/Baroda Insulators/Vinayak *				
	222	kWh meter	:	Areva / SIMCO *				
	223	Digital / Composite / Multi function meter	:	Conserv/ Secure/ Siemens/ HPL/ L&T/ Satec *				
	224	Analog meters	:	AE/ SIMCO/ IMP/ Rishabh/ MECO *				
	225	Air circuit breaker	:	L&T/ Siemens / ABB / Schneider *				
	226	Moulded case circuit breaker	:	ABB / L&T / Schneider / Siemens *				
	227	Miniature circuit breaker	:	L&T/ Siemens/ ABB/ Schneider / Havells/ MDS *				
	228	Switch	:	Kaycee / Siemens / L&T / Areva / Schneider / ABB *				
	229	Contactora	:	Siemens / L&T / ABB / Schneider *				
230	APFC controller	:	ABB/ Beluk/ EPCOS *					

 <b>LOW VOLTAGE POWER FACTOR IMPROVEMENT CAPACITOR PANEL</b>		Code	NAL						
		Contract no.	66-6695						
		Doc.	6695-ELT-G00-EC-0035						
<b>PART - II A</b> <b>DESIGN DATA SHEET (GENERAL)</b>		Rev.	0	Page	10 OF 10				
<b>MAKE OF COMPONENTS</b>	231	Breaker control switch	: Kaycee/ Areva / Recom / Vaishno / Gem Telergon *						
	232	Control selector switch	: Kaycee/Siemens/L&T/Recom/Vaishno/Gem Telergon *						
	233	Terminal block	: Elmex/ Connectwell/ Allen Bradley / Fuji *						
	234	Internal wiring	: BIS comliant *						
	235	Lugs	: Dowell/ Jainson *						
	236	Push Buttons	: Siemens/ L&T/Teknik/ Hensel / Vaishno *						
	237	Indication lamps	: Tecknik/ L&T/ Siemens /Schneider/Altos *						
	238	Capacitor Banks	: Universal / Shreem/ ABB/ EPCOS *						
	239	Reactor	: Quality power / Shrihans / EPCOS *						
	240	Thyristor	: Semikron/ Hirect/ West code/ UPEC *						
<b>MISC.</b>	241	a) Relay and metering compartment shall be provided with Panel Illumination Lamp.							
	242	b) 1 ph 240 V AC, 5 Amps socket shall be provided for Relay and metering compartment.							
<b>DRAWINGS &amp; DOCUMENTS</b>		<b>Description</b>	<b>For review &amp; Approval</b>	<b>Final, As-built Documents</b>					
	243	<b>GA &amp; Foundation drawings indicating</b>	For No. of copies of drawing/documents to be issued by LSTK Contractor for Approval/Review/Information during Detail Engineering and as a part of final, As built documentation - LSTK Contractor to refer requirement indicated elsewhere in the tender						
		a) Static & Dynamic loading details, outline of panel & space required in front & rear of panel.							
		b) Cross section view of the panel.							
		c) List of parts & complete bill of material.							
	244	Detailed SLD of APFC panel showing protection, metering, etc.							
	245	Control schematic diagram of all feeder types showing all interlocks, annunciations, etc.							
	246	Control logic diagram for all feeder types							
	247	Wiring diagram with terminal block disposition, ferrule nos., etc.							
	248	Descriptive literature of major components							
	249	Installation,operation & maintenance manual for all eqpt.							
	250	Certificates for type tests on similar equipment (as per Part-V)							
	251	Test certificates for bought out equipment							
	252	Routine Test Certificates							
	253	List of recommended spares apart from items mentioned in Part-III B.							
	254	Manufacturing bar chart.							
	255	Quality Assurance and Inspection Test procedure							
	256	Calculation of Heat losses							
	257	Nameplate drawings							
	258	Note:							
		1) Data marked as '**' thus to be furnished / confirmed by LSTK Contractor during detail Engineering.							

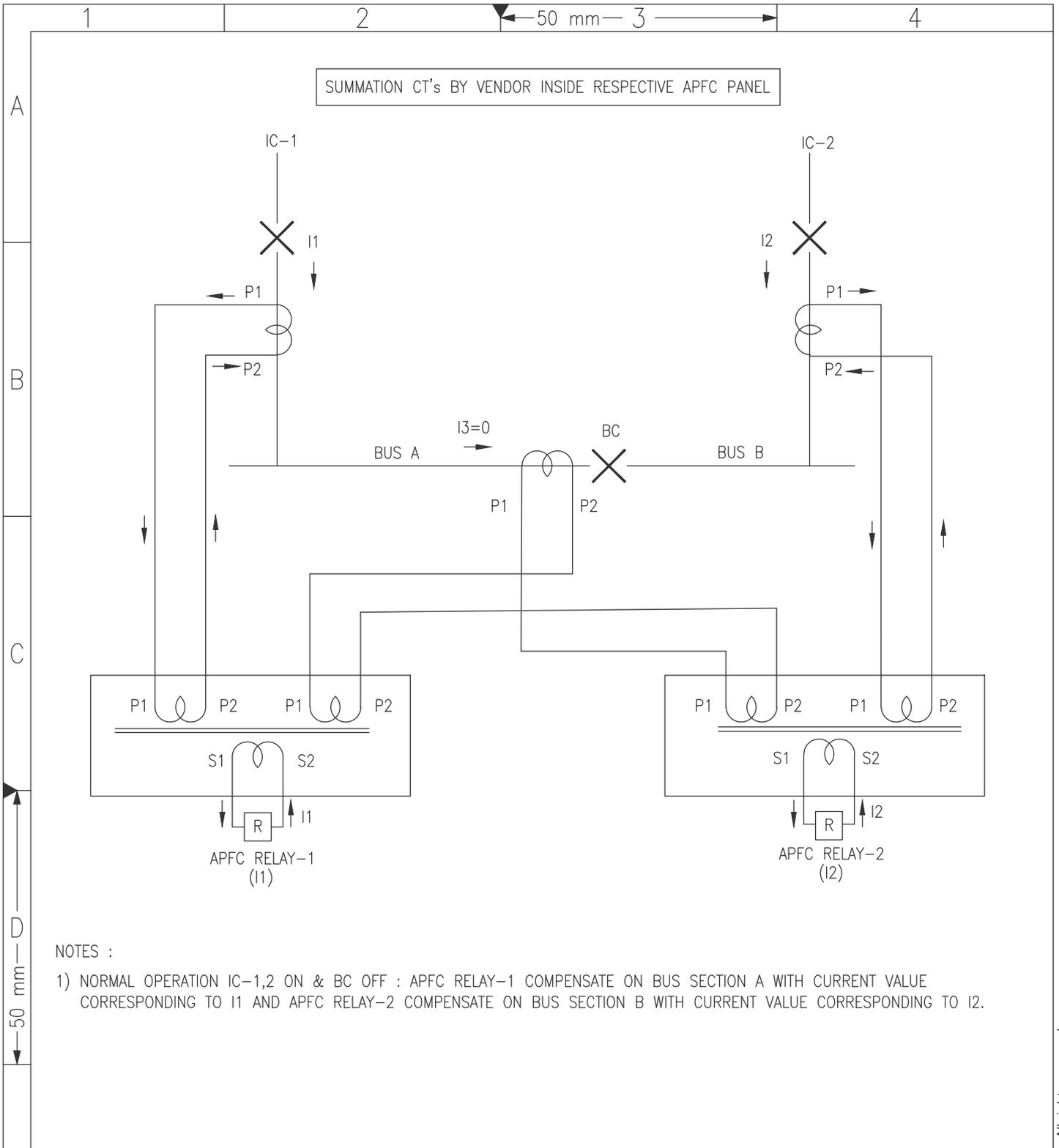
 नालको NALCO नेशनल एल्युमिनियम कंपनी लिमिटेड National Aluminium Company Ltd.		<b>LOW VOLTAGE POWERFACTOR IMPROVEMENT CAPACITOR PANEL</b>  <b>PART - II B</b>  <b>DESIGN DATA SHEET</b>		Code	NAL		
				Contract no.	66-6695		
				Doc.	6695-ELT-G00-EC-0035		
				Rev.	0	Page	1 OF 2
<b>GENERAL</b>	001	Panel designation (Tag number)	:	*			
	002	System Voltage	:	415 V ± 10 %			
	003	Capacitor rated voltage	:	525 V			
	004	PFIC panel rating in KVAR at 415 V	:	*			
	005	Capacitor Bank connection	:	Delta			
	006	Incoming terminal suitable for termination of Incoming cable	:	*			
	007	Protection and Metering	:	As per GES & SLD			
	008	CT and PT Specification	:	As per GES & SLD			
	009	Reference SLD no.	:	6695-ELT-G00-FA-0003			
	010	Heat Load	:	watts. *			
	011	Location	:	Indoor			
<b>APFC CONTROLLER</b>	012	Make & type of APFC controller	:	*			
	013	Details of switching steps	:				
		a) Required numbers of step for power factor correction	:	*			
		b) Details of each steps with kVAR rating	:	*			
		c) Provision of number of steps in APFC controller (Min. required number of steps + 1)	:	*			
	014	Range of targetted PF selection	:	*			
<b>BUS BAR</b>	015	Continuous current rating (In panel rating at design ambient temperature and site conditions)	:	_____ A *			
	016	Size and nos. for	:				
		a) Per phase	:	*			
		b) Neutral	:	*			
	017	Rated short time current withstand capacity	:	same as upstream feeding switchgear			
	018	Rated peak current withstand capacity	:	kA(peak) *			
<b>DIMENSIONS</b>	019	Overall Dimensions (L x B x H mm)	:	*			
	020	<b>Recommend clearances for maintenance</b>	:				
		a) Front	:	*			
		b) Rear side	:	*			
		c) Sides	:	*			
	021	Weight of PFIC panel	:				
		Static Weight of PFIC panel (Kgs)	:	*			
	Dynamic Weight of PFIC panel (Kgs)	:	*				
		<b>Notes:</b>					
		1) Data marked as '**' thus to be furnished / confirmed by LSTK Contractor during detail Engineering.					



 <b>LOW VOLTAGE POWERFACTOR IMPROVEMENT CAPACITOR PANEL</b>		Code		NAL		
		Contract no.		66-6695		
 <b>PART - III</b> <b>INSPECTION TEST PLAN</b>		Doc.		6695-ELT-G00-EC-0035		
		Rev.		0	Page	1 OF 3
Tests	Reference Documents	Sample size	Scope of Inspection			
			Vendor	Owner / Consultant / LSTK Contractor	Remarks	
<b>1.0 Tests for Complete LV PFIC Panel</b>						
<b>A</b>	<b>Type Test</b>					
i	Verification of IP protection	IS 8623, IEC 61439	P <sub>PROTO</sub>	R		
<b>B</b>	<b>Routine Tests</b>					
i	Visual check including layout, tag plates, paint shade, bus marking & sleeving, joint shrouding, identification of location of components etc.	GA drawings	100%	P	W	
ii	Dimensional check including operational height, bus size, Clearances, creepage distances, bus duct flange dimensions etc.	GA drawings		P	W	
iii	Verification of busbar support arrangement with respect to type tested panel drawings	GA Drawings.		P	W	
iv	Bill of material / Make of component Check	-		P	W	
v	Mechanical operation of circuit breakers, outgoing feeder modules, auxiliary switches, manual devices, etc.	-		P	W	
vi	Operation checks for all control functions and safety interlocks.	Approved vendor drgs.		P	W	
vii	Operation of circuit breaker for minimum allowable control voltage.	-		P	R	
viii	Closing & opening time of circuit breaker at rated and min. control voltage	-		P	R	
ix	Relay operation check through secondary injection	Approved vendor drgs.		P	W	
x	Checking of meters through secondary injection	Approved vendor drgs.		Min. 10% and one of each type	P	W
xi	CT Polarity tests	-	P		R	
xii	Checking protection circuit & electrical continuity of protection circuit	IS 8623	100%		P	W
xiii	Functional tests	IS 8623, IS/IEC 60947			P	W
xiv	High Voltage Test (Dielectric test)	-do-			P	W
xv	Insulation resistance of Main, auxiliary & control circuits before & after HV test.	-do-		P	W	
<b>C</b>	<b>Test Certificates</b>					
i	Test Certificates for bought out items like breakers, MCCB, CT, PT, meters, relays, switches, contactors, capacitors, APFC controller, reactors, discharge register etc.	GA drawings	P	R		
Notes:						
W = Witness, R = Review, P = Perform on project equipment, P <sub>PROTO</sub> = Perform on prototype.						

 <b>LOW VOLTAGE POWERFACTOR IMPROVEMENT CAPACITOR PANEL</b>		Code		NAL		
		Contract no.		66-6695		
		Doc.		6695-ELT-G00-EC-0035		
		Rev.		0	Page	2 OF 3
 <b>PART - V</b> <b>INSPECTION TEST PLAN</b>		Scope of Inspection				
		Tests	Reference Documents	Sample size	Vendor	Owner / Consultant / LSTK Contractor
<b>2.0 Tests for Capacitor units &amp; Capacitor banks</b>						
<b>A Routine Tests</b>						
i	Visual examination	GA drawings	100% 	P	W	
ii	Sealing test	IEC 60831 / IEC 60931		P	W	
iii	Measurement of capacitance and Output	IEC 60831 / IEC 60931		P	W	
iv	Capacitor loss tangent (tan δ) measurement	IEC 60831 / IEC 60931		P	W	
v	Voltage test between terminals	IEC 60831 / IEC 60931		P	W	
vi	AC Voltage test between terminals & container	IEC 60831 / IEC 60931		P	W	
vii	Test of discharge devices	IEC 60831 / IEC 60931		P	W	
viii	Insulation resistance test between terminals & container	IEC 60831 / IEC 60931		P	W	
ix	Fuse capability test for internally fused capacitors	IEEE 18		P	W	
<b>B Type Tests</b>						
i	Voltage test between terminals	IEC 60831 / IEC 60931	100% 	P <sub>PROTO</sub>	R	
ii	AC Voltage test between terminals & Container	IEC 60831 / IEC 60931		P <sub>PROTO</sub>	R	
iii	Thermal Stability test	IEC 60831/ IEC 60931, IEEE 18		P <sub>PROTO</sub>	R	
iv	Lightning Impulse voltage test between terminals & Container	IEC 60831/ IEC 60931, IEEE 18		P <sub>PROTO</sub>	R	
v	Short circuit discharge test	IEC 60831/ IEC 60931, IEEE 18		P <sub>PROTO</sub>	R	
vi	Bushing tests	IEEE 18		P <sub>PROTO</sub>	R	
vii	Radio influence voltage test	IEEE 18		P <sub>PROTO</sub>	R	
viii	Voltage decay test	IEEE 18		P <sub>PROTO</sub>	R	
ix	Ageing Test	IEC 60831 / IEC 60931		P <sub>PROTO</sub>	R	
x	Self healing test	IEC 60831		P <sub>PROTO</sub>	R	Not applicable for APP Capacitor
xi	Destruction test	IEC 60831 / IEC 60931		P <sub>PROTO</sub>	R	
<b>C Acceptance tests</b>						
i	Visual examination	IEC 60831 / IEC 60931	100% 	P	W	
ii	Test for output & capacitance	IEC 60831 / IEC 60931		P	W	
iii	Capacitor loss tangent (tan δ) measurement	IEC 60831 / IEC 60931		P	W	
iv	Insulation resistance test	IEC 60831 / IEC 60931		P	W	
v	Voltage test between terminals	IEC 60831 / IEC 60931		P	W	
vi	AC Voltage test between terminals & container	IEC 60831 / IEC 60931		P	W	
vii	Test of discharge devices	IEC 60831 / IEC 60931		P	W	
viii	Sealing test	IEC 60831 / IEC 60931		P	W	

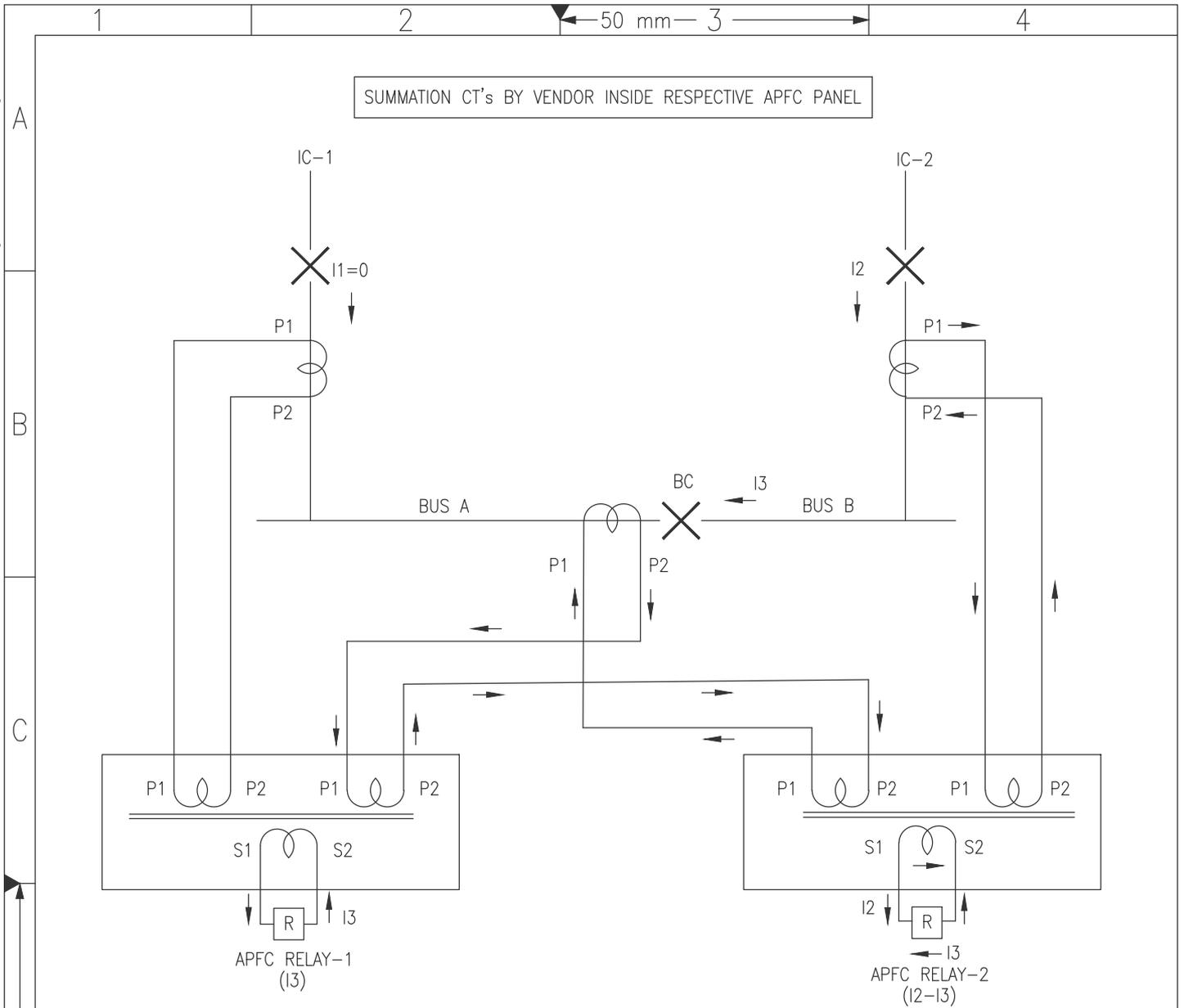
	<b>LOW VOLTAGE POWERFACTOR IMPROVEMENT CAPACITOR PANEL</b>  <b>PART - V</b>  <b>INSPECTION TEST PLAN</b>		Code	NAL		
			Contract no.	66-6695		
			Doc.	6695-ELT-G00-EC-0035		
			Rev.	0	Page	3 OF 3
				Scope of Inspection		
	Tests	Reference Documents	Sample size	Vendor	Owner / Consultant / LSTK Contractor	Remarks
<b>3.0</b>	<b>Tests for Reactor</b>					
<b>A</b>	<b>Routine Tests</b>					
i	Visual check including layout, Tag plates, Paint shade etc., Dimensional check	GA drawings	↑ 100% ↓	P	W	
ii	Measurement of winding resistance	IEC 60076-6		P	W	
iii	Measurement of insulation resistance	-do-		P	W	
iv	Measurement of impedance at continuous current	-do-		P	W	
v	Measurement of loss	-do-		P	W	
vi	Separate source voltage withstand test	-do-		P	W	
vii	Induced over voltage withstand test	-do-		P	W	
<b>B</b>	<b>Type Tests</b>					
i	Temperature rise test at rated continuous current	IEC 60076-6	1 of each rating /type	P	W	
ii	Lightning impulse test	-do-		P <sub>PROTO</sub>	R	
<b>C</b>	<b>Special tests</b>					
i	Short-time current test & measurement of impedance at short-time current	IEC 60076-6	-	P <sub>PROTO</sub>	R	



NOTES :

- 1) NORMAL OPERATION IC-1,2 ON & BC OFF : APFC RELAY-1 COMPENSATE ON BUS SECTION A WITH CURRENT VALUE CORRESPONDING TO I1 AND APFC RELAY-2 COMPENSATE ON BUS SECTION B WITH CURRENT VALUE CORRESPONDING TO I2.

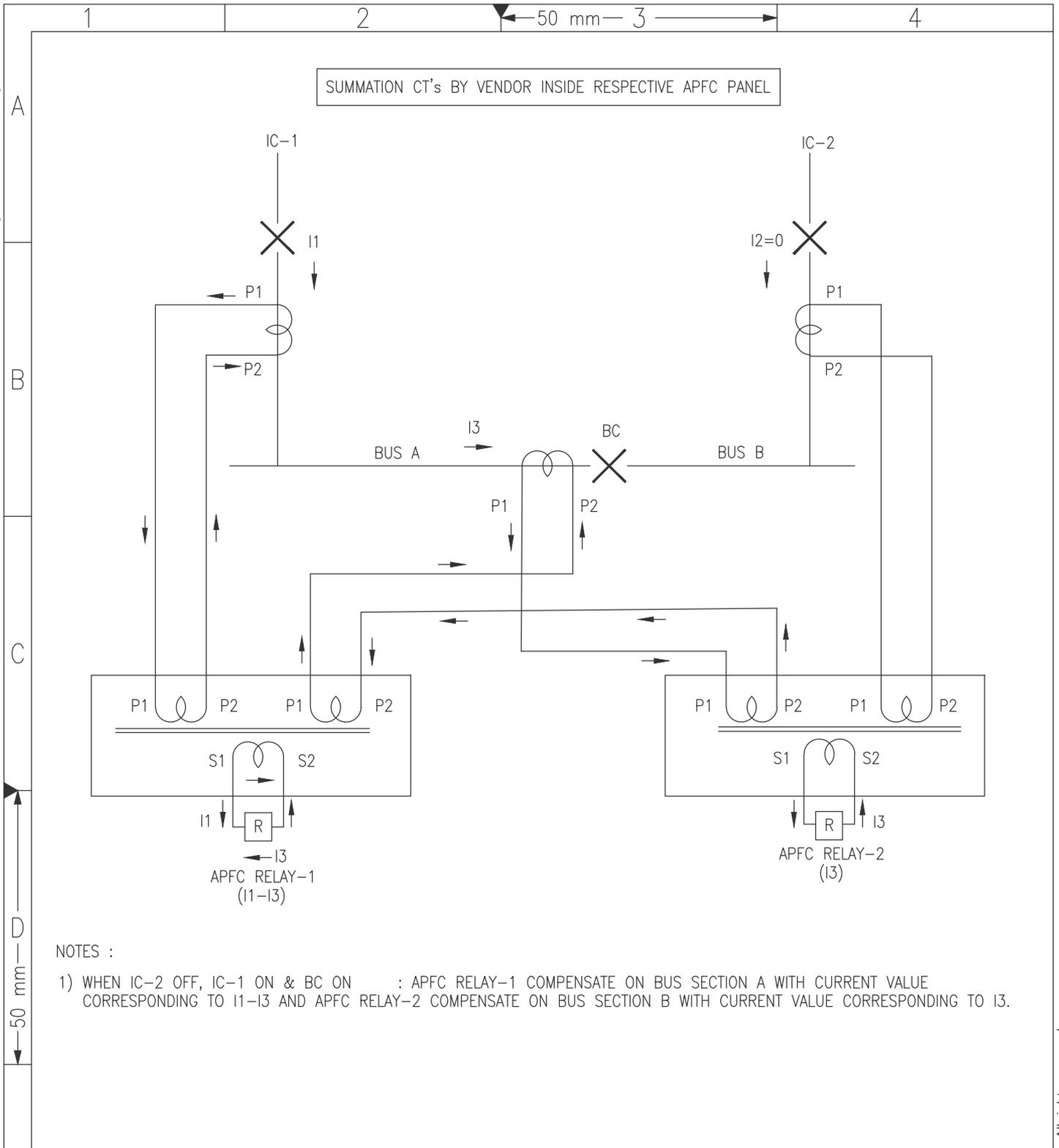
Code	NAL	Contract No.	66-6695	Document ID	Annexure-I	Part	Rev.					
00	31.10.17	APE	APE	31.10.17	PDW	31.10.17	MSD	ISSUED AS STANDARD	--	Cat. Code	Acc. Code	Status
Rev.	Date	Name	Date	Name	Date	Name	Description	Acc. Code	--	--	--	--
BAR-Code								Store Location: Server/Share				
								Store Location: Folder				
								Store Name				
Pro. Unit		TON		Group		Type of Document		Sheet		1 / 3		
Con. Unit		Scale		Order No.								
--		NTS				<b>thyssenkrupp</b>						
ISO A4	Date	Name		Description								
Drawn	31.10.17	APE		SUMMATION CT'S WIRING SCHEME FOR APFC PANEL								
Prepared	31.10.17	APE										
Checked	31.10.17	PDW										
Approved	31.10.17	MSD										



NOTES :

- 1) WHEN IC-1 OFF, IC-2 ON & BC ON : APFC RELAY-1 COMPENSATE ON BUS SECTION A WITH CURRENT VALUE CORRESPONDING TO I3 AND APFC RELAY-2 COMPENSATE ON BUS SECTION B WITH CURRENT VALUE CORRESPONDING TO I2-I3.

	Code	Contract No.	Document ID	Part	Rev.
	NAL	66-6695	Annexure-I		00
Rev.	Date	Name	Date	Name	Date
00	31.10.17	APE	31.10.17	PDW	31.10.17
		Drawn/Prepared		Checked	Approved
BAR-Code			Store Location: Server/Share		
			Store Location: Folder		
			Store Name		
Pro. Unit		TON	Group	Type of Document	Sheet
					2 / 3
Con. Unit		Scale	Order No.		<b>thyssenkrupp</b>
		NTS			
ISO A4	Date	Name	Description		
	31.10.17	APE	SUMMATION CT'S WIRING SCHEME FOR APFC PANEL		
	31.10.17	APE			
	31.10.17	PDW			
	31.10.17	MSD			



NOTES :

- 1) WHEN IC-2 OFF, IC-1 ON & BC ON : APFC RELAY-1 COMPENSATE ON BUS SECTION A WITH CURRENT VALUE CORRESPONDING TO I1-I3 AND APFC RELAY-2 COMPENSATE ON BUS SECTION B WITH CURRENT VALUE CORRESPONDING TO I3.

Code		Contract No.		Document ID		Part		Rev.				
NAL		66-6695		Annexure-I				00				
00	31.10.17	APE	APE	31.10.17	PDW	31.10.17	MSD	ISSUED AS STANDARD	--	Cat. Code	Acc. Code	Status
Rev.	Date	Name		Date	Name	Date	Name	Description	Acc. Code	--	--	--
		Drawn/Prepared		Checked		Approved						
BAR-Code								Store Location: Server/Share				
								Store Location: Folder				
								Store Name				
Pro. Unit		TON		Group		Type of Document		Sheet / 3				
Con. Unit		Scale		Order No.								
--		NTS										
ISO A4	Date		Name		Description SUMMATION CT'S WIRING SCHEME FOR APFC PANEL							
	Drawn		31.10.17 APE									
	Prepared		31.10.17 APE									
	Checked		31.10.17 PDW									
Approved		31.10.17 MSD										