

BUILDING SERVICES BRANCH
TESTING AND COMMISSIONING
PROCEDURE NO. 2
FOR
ELECTRICAL INSTALLATION
IN
GOVERNMENT BUILDINGS
HONG KONG

ã HONG KONG SPECIAL ADMINISTRATIVE REGION GOVERNMENT

Building Services Branch
Architectural Services Department
(2002 Edition)

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B.S.B. Testing and Commissioning Procedure No. 2

Electrical Installation

1. Introduction

- 1.1 This procedure is intended to lay down the minimum testing and commissioning requirements to be carried out by the Contractor on a new Electrical Installation upon completion or on an existing Electrical Installation after a major alteration. Additional testing and commissioning (T & C) requirements may be proposed by the Contractor as appropriate and agreed by the Project Building Services Engineer (PBSE), e.g. for special equipment supplied and/or installed by the Contractor.
- 1.2 This procedure is also written to facilitate the PBSE and Project Building Services Inspector (PBSI) in carrying out the following aspects of work with respect to T & C.
 - (i) To vet and approve the T & C procedures proposed and submitted by the Contractor.
 - (ii) To witness those T & C procedures as specified.
 - (iii) To receive the T & C certificate and other supporting data.
- 1.3 “Major Alteration” of an existing electrical installation means alteration involving work on any distribution board or electrical equipment having an electrical current rating exceeding 100A single phase or 60A three phases in an existing electrical installation.
- 1.4 This procedure is also intended to lay down the minimum testing and commissioning requirements to be carried out by the Contractor on a new Low Voltage Cubicle Switchboard Installation upon completion or on an existing Low Voltage Cubicle Switchboard Installation after a major alteration involving modification of the main busbar such as upgrading, reposition and extension.

2. General Requirements

- 2.1 The Contractor shall submit his T & C procedures together with the Testing and Commissioning progress chart in Appendices A-2 and B-2 to the PBSE for approval. The submission shall be made at least one month before the commencement of T & C.
- 2.2 Where tests are required to be witnessed by the PBSE/PBSI, the Contractor shall give due advance notice (usually not less than three days) of his intention and provide details of date, time and type of tests to be performed.

- 2.3 Upon completion of such T & C procedure, the Contractor's project engineer shall complete and sign a testing and commissioning certificate as Appendices A-1 and B-1, to the effect that agreed T & C procedures have been duly carried out.
- 2.4 Before carrying out any test, the Contractor shall ensure that the installations comply with the statutory requirements and regulations.
- 2.5 For Low Voltage Cubicle Switchboard Installation, in addition to the above requirements, the Contractor shall:
- (i) carry out visual inspection in accordance with the checklists as shown in Part 3 of Appendix B-1 and abnormalities shall be rectified before despatch of the cubicle switchboard to site,
 - (ii) deliver the cubicle switchboard to site either in its entirety or in transportation sections (in the latter case, the section shall be reassembled on site), and
 - (iii) carry out the visual inspection again on those items which may be affected during the transportation e.g. the tightness of bolt and nuts, the alignments of the various sections of the switchboard, etc.

3. Testing and Inspection

- 3.1 The requirements are in general as specified in the latest General Specification for Electrical Installation (EEGS) issued by the Architectural Services Department, the Government of the HKSAR. If there is any discrepancy between this procedure and the General Specification, the General Specification shall take precedence.
- 3.2 The Contractor shall carry out the tests and inspections as shown in Part 3 and record the test results on Part 4 of Appendices A-1 and B-1 and as agreed between the Project BSE and the Contractor.
- 3.3 The Contractor shall provide all the necessary staff, labour, materials and equipment for a thorough test and examination of the installation.

4. Statutory Inspection/Commissioning

- 4.1 After the proper testing and commissioning of the electrical installation, the Contractor shall notify the appropriate Authority, through the PBSE, on the completion of the installation and its readiness for inspection and testing.

4.2 With all the test results being satisfied in all respects to the requirements laid down in the Code of Practice for the Electricity (Wiring) Regulations (COP) issued by the Electrical & Mechanical Services Department, the Government of the HKSAR and EEGS, the electrical installation shall be energized in accordance with the followings: -

4.2.1 Before Energization

Check :-

- (i) Busbar chambers, main and sub-main switch connections i.e. bolts and nuts tightness.
- (ii) Earthing connections at compartments, all switches and earth electrodes.
- (iii) Clearance of live parts from direct contact with or any likelihood of contact with tools, spurious bare conductors remaining in switches, air circuit breakers (ACB) and switch cubicles.
- (iv) Polarity, phase sequence of all switches and relevant fuse ratings.
- (v) Stand-by battery supply and the operation of shunt trip mechanism.
- (vi) Settings of overcurrent, earth fault relays and current transformer (C.T.) polarity.
- (vii) Vacuum cleaning of switches and ACBs.
- (viii) Provision of danger and warning signs.

4.2.2 Switch on Process

Whenever there is any break of time e.g. the next day, in carrying out the switch on process, re-test of insulation resistance is required.

- (i) Switch on the main switch/ACB with all other sub-main switches off.
- (ii) If normal, switch on other sub-main switches one by one with all other outgoing switches off.
- (iii) If normal, then switch on all other out-going switches one by one.
- (iv) Observe the disc of the overcurrent (o/c) and earth fault protection relays for any movement for IDMT relays or for digital protection relays check whether there are any fault indications.
- (v) Keep vigilance for about 30 minutes to see if any smell or abnormal noise being generated.

4.2.3 Lightning Protection System if Provided

Check :-

- (i) All connections at terminations, tee off points and earth electrodes for tightness.
- (ii) Continuity of all down conductors.

Remarks: Locations of all earth electrodes and down tape routing should be clear of any dangerous goods store, diesel tanks and inflammable stores, etc.

5. Calibrated Equipment

- 5.1 The Contractor shall supply calibrated equipment as stipulated in the Specification of the Contract for the inspection, measuring and testing of the installation.

Testing and Commissioning Certificate on Electrical Installation

Part 1 : Detail of Project

- 1.1 Project title (with location) :
- 1.2 * P.W.P. / Project No. :
- 1.3 * Contract/Sub-contract/Quotation No. :
- 1.4 * Contractor/Sub-contractor :
- 1.5 PBSE :
- 1.6 PBSI :

Part 2 : Declaration

- 2.1 I certify that the Electrical Installation as specified in the *Contract/Sub-contract/Quotation at the above location has been inspected, tested and commissioned in accordance with this procedure and/or any other procedures agreed between the PBSE and the Contractor. The results are satisfactory in the aspects as mentioned in Part 3 and/or as recorded in Part 4 of this Certificate, except as indicated in the COMMENTS items.
- 2.2 I also certify that site tests have been performed in accordance with the requirements set out in Appendix A-1 of this procedure and that the results are satisfactory. A record of the tests has been prepared and submitted to the project BSE.
- * 2.3 I also certify that the lightning protection system has been inspected and tested, in accordance with the requirements of British Standard 6651.

Signature of Contractor's Representative _____

Full Name of Contractor's Representative _____

Designation of Contractor's Representative _____

Name and Stamp of Contractor _____

Date _____

Note : This certificate must be signed by a person authorized by the Firm/Company.

* Delete if not applicable

Items tested /
checked by
Contractor

Items witnessed
by
PBSE/PBSI

Part 3. Items Inspected and Tested

3.1	<u>Visual Inspection (COP Code 21A)</u>		
3.1.1	All conductors are correctly and securely connected and identified.	*Yes/No	*Yes/No
3.1.2	Fire barriers and other measures for protection against thermal effects are properly installed.	*Yes/No	*Yes/No
3.1.3	Methods of protection against direct contact with live parts are properly and correctly installed.	*Yes/No	*Yes/No
3.1.4	Isolation and switching devices are properly and correctly installed.	*Yes/No	*Yes/No
3.1.5	Protective devices and monitoring devices are properly and correctly installed and set.	*Yes/No	*Yes/No
3.1.6	Circuits, fuses, switches, terminals, etc. are properly and correctly labelled.	*Yes/No	*Yes/No
3.1.7	Danger notices, warning notices, schematic diagrams, instructions and similar information are correctly and adequately provided.	*Yes/No	*Yes/No
3.1.8	Methods of protection against indirect contact are properly and correctly applied.	*Yes/No	*Yes/No
3.1.9	Protective measures against adverse environmental conditions are properly provided.	*Yes/No/N.A.	*Yes/No/N.A.
3.1.10	Mutual detrimental influence is properly prevented.	*Yes/No	*Yes/No
3.2	<u>Type of Protective Devices</u>		
3.2.1	Overcurrent protective device provided.	*Yes/No	*Yes/No
3.2.2	Residual current device provided.	*Yes/No	*Yes/No
3.2.3	Undervoltage protective devices provided.	*Yes/No/N.A.	*Yes/No/N.A.

Tested / Checked by _____
(Name of Contractor's Representative)

Signature _____

Witnessed by _____
(Name(s) of *PBSE/PBSI)

Signature(s) _____

		Items tested / checked by <u>Contractor</u>	Items witnessed by <u>PBSE/PBSI</u>
3.3	<u>Conductor Continuity (COP Code 21B(3) and (4))</u>		
3.3.1	All final ring circuit conductors including the protective conductors have been tested for continuity.	*Yes/No	*Yes/No
3.3.2	All protective conductors including all conductors and any extraneous conductive parts used for equipotential bonding have been tested for continuity and are electrically and mechanically sound and correctly connected.	*Yes/No	*Yes/No
3.4	<u>Earth Electrode Resistance (results recorded in Appendix A-1, Part 4)</u>		
3.4.1	The resistance to earth has been measured at the position of every earth electrode and of the main earth terminal. The results are satisfactory.	*Yes/No	*Yes/No
3.5	<u>Insulation Resistance (results recorded in Appendix A-1, Part 4)</u>		
3.5.1	The insulation resistance to earth is NOT less than 1 MΩ.	*Yes/No	*Yes/No
3.5.2	The insulation resistance between phases is NOT less than 1 MΩ.	*Yes/No	*Yes/No
3.5.3	The insulation resistance of all equipment between the exposed conductive parts and the live parts is NOT less than 0.5 MΩ when tested individually and separately and if there is no appropriate requirement (COP Code 21B (6)(f)).	*Yes/No	*Yes/No
3.5.4	The insulation resistance of electrical separation required for circuits of safety extra-low voltage equipment, or required for protection against indirect contact is tested with a voltage of 500V d.c. for one minute and is not less than 5MΩ.	*Yes/No/N.A.	*Yes/No/N.A.
3.6	<u>Polarity (COP Code 21B (7))</u>		
3.6.1	All fuses and single-poles devices are connected in the phase conductors only.	*Yes/No	*Yes/No
3.6.2	All wiring has been correctly connected to socket outlets and lampholders, etc.	*Yes/No	*Yes/No

Tested / Checked by _____
(Name of Contractor's Representative)

Signature _____

Witnessed by _____
(Name(s) of *PBSE/PBSI)

Signature(s) _____

		Items tested / checked by <u>Contractor</u>	Items witnessed by <u>PBSE/PBSI</u>
3.6.3	The outer or screwed contacts of centre-contact bayonet and Edison screw lampholders in circuits having an earthed neutral conductor is connected to that neutral conductor.	*Yes/No	*Yes/No
3.7	<u>Earth Fault Loop Impedance (COP Code 21B (8))</u>		
3.7.1	The earth fault loop impedance of all circuits have been found satisfactory for operation of the protective devices for earth fault protection, and the measurements as recorded on Appendix A-1, Part 4, are satisfactory.	*Yes/No	*Yes/No
3.8	<u>Functional Testing of Protective and Other Devices (COP Code 21B (9))</u>		
3.8.1	Simulation tests on the operation of devices for earth fault protection are satisfactory.	*Yes/No/N.A.	*Yes/No/N.A.
3.8.2	The rated tripping current shall cause the residual current circuit breaker to open within 0.3s or at any delay time declared by the manufacturer of the device.	*Yes/No	*Yes/No
3.8.3	Where the residual current circuit breaker has a rated tripping current not exceeding 30mA and has been installed to reduce the risk associated with direct contact, a residual current of 150mA should cause the circuit breaker to open within 40ms.	*Yes/No/N.A.	*Yes/No/N.A.
3.8.4	In no event should the test current be applied for a period exceeding one second.	*Yes/No	*Yes/No
3.8.5	Hand operation on protective devices such as miniature circuit breakers, moulded case circuit breakers, air circuit breakers, fused switches, switch-fuses and protective relays, etc. are satisfactory.	*Yes/No.	*Yes/No
3.8.6	Hand operation on all items of equipment such as isolators, switches and indicative devices are satisfactory.	*Yes/No	*Yes/No

Tested / Checked by _____
(Name of Contractor's Representative)

Signature _____

Witnessed by _____
(Name(s) of *PBSE/PBSI)

Signature(s) _____

		Items tested / checked by <u>Contractor</u>	Items witnessed by <u>PBSE/PBSI</u>
3.9	<u>Checking for Installations in Hazardous Environment</u> <u>(COP Code 21B (10))</u>		
3.9.1	The equipment is suitably protected according to the types of protection under COP Code 15. The integrity of the protection provided for the equipment is not jeopardised by the method of installation. No alteration that may invalidate the conditions of protection has been used.	*Yes/No/N.A.	*Yes/No/N.A.
3.9.2	No dust, foreign particles and deleterious substances are accumulated on the equipment. The equipment is free from condensation.	*Yes/No/N.A.	*Yes/No/N.A.
3.9.3	Lamps, fuses and replaceable parts of correct rating and types are used.	*Yes/No/N.A.	*Yes/No/N.A.
3.9.4	The surface temperature of all equipment is appropriate to the type of protection provided.	*Yes/No/N.A.	*Yes/No/N.A.
3.10	<u>Method of Compliance (COP Code 11)</u> <u>(for final circuits supply socket outlets and fixed equipment)</u>		
3.10.1	By automatic disconnection of the supply within 5s for fixed equipment.	*Yes/No	*Yes/No
3.10.2	By limitation of the protective conductor impedance concerned to values as permitted in COP Code 11.	*Yes/No	*Yes/No
3.10.3	By residual current devices having a rated residual current not exceeding 30mA for circuits supply socket outlets.	*Yes/No	*Yes/No
3.10.4	By automatic disconnection of the supply within 0.4s for circuits supplying fixed equipment outside equipotential zone or for circuits supplying any equipment inside a bathroom which is simultaneously accessible with exposed conductive parts of other equipment or with extraneous conductive parts.	*Yes/No	*Yes/No
3.10.5	By other approved methods as indicated in COMMENTS item below.	*Yes/No	*Yes/No
3.11	<u>Conditions of Wiring, Accessories and Equipment</u> <u>(COP Code 21A)</u>		
3.11.1	All cables, flexible cords, switches, plugs and socket outlets, accessories and equipment are found to be in good working conditions.	*Yes/No	*Yes/No

Tested / Checked by _____
(Name of Contractor's Representative)

Signature _____

Witnessed by _____
(Name(s) of *PBSE/PBSI)

Signature(s) _____

		Items tested / checked by <u>Contractor</u>	Items witnessed by <u>PBSE/PBSI</u>
3.12	<u>Sizes of Live Conductors (COP Code 21A)</u>		
3.12.1	All live conductors and their methods of insulation, in relation to design currents of circuits and to the operating currents of the protective devices, are properly selected and erected.	*Yes/No	*Yes/No
3.13	<u>Continuity of Lightning Down Conductors</u>		
3.13.1	All conductors and joints for lightning protection system are electrically and mechanically sound and correctly connected.	*Yes/No/N.A.	*Yes/No/N.A.
3.13.2	The continuity of each lightning down conductor has been checked and found satisfactory.	*Yes/No/N.A.	*Yes/No/N.A.
3.14	<u>Circuitry Check</u>		
3.14.1	All circuits including lighting and power circuits have been verified through switching operation that they are installed in accordance with the designated circuits.	*Yes/No	*Yes/No
3.15	<u>Charger and Battery Set</u>		
3.15.1	The original factory test certificates of the charger and battery have been checked and found satisfactory.	*Yes/No/N.A.	*Yes/No/N.A.
3.15.2	The charger is connected to the mains supply through a suitable rated fuse.	*Yes/No/N.A.	*Yes/No/N.A.
3.15.3	Batteries connections have been done properly.	*Yes/No/N.A.	*Yes/No/N.A.
3.15.4	Instruments, indicating lamps, fuses, relays and labels on battery charger are provided and installed properly.	*Yes/No/N.A.	*Yes/No/N.A.
3.15.5	The capacity of the charger is capable of recharging the batteries from fully discharged to fully charged within the specified duration.	*Yes/No/N.A.	*Yes/No/N.A.
3.15.6	The charger output on load with batteries disconnected is satisfactory.	*Yes/No/N.A.	*Yes/No/N.A.
3.15.7	The charger current on load with batteries disconnected is satisfactory.	*Yes/No/N.A.	*Yes/No/N.A.

Tested / Checked by _____
(Name of Contractor's Representative)

Signature _____

Witnessed by _____
(Name(s) of *PBSE/PBSI)

Signature(s) _____

		Items tested / checked by <u>Contractor</u>	Items witnessed by <u>PBSE/PBSI</u>
3.15.8	The capacity of batteries has been checked and tested by interrupting the mains input to the charger and actuation / operation of the connected devices and the results are satisfactory.	*Yes/No/N.A.	*Yes/No/N.A.
3.15.9	The functions and indications of charger fail / main fail / battery disconnected / boost charge / trickle charge, mains and battery have been checked and tested and the results are satisfactory.	*Yes/No/N.A.	*Yes/No/N.A.
3.16	<u>All Insulated Busbar Trunking System (AIBTS)</u>		
3.16.1	The bolts, nuts, screws, etc. for busbar supports, busbar connections have been checked for correct tightness in accordance with manufacturers' recommendations.	*Yes/No/N.A.	*Yes/No/N.A.
3.16.2	The AIBTS is properly and correctly installed and aligned.	*Yes/No/N.A.	*Yes/No/N.A.
3.16.3	The tests of insulation resistance are carried out in accordance with Clause 3.5 (Part 3, Appendix A-1).	*Yes/No/N.A.	*Yes/No/N.A.
3.16.4	No dust, foreign particles and deleterious substances are accumulated on the AIBTS. The AIBTS is free from condensation.	*Yes/No/N.A.	*Yes/No/N.A.

Tested / Checked by _____
(Name of Contractor's Representative)

Signature _____

Witnessed by _____
(Name(s) of *PBSE/PBSI)

Signature(s) _____

Items tested /
checked by
by Contractor

Items witnessed
by
PBSE/PBSI

3.17 Comments

*Yes/No

*Yes/No

Tested / Checked by _____
(Name of Contractor's Representative)

Signature _____

Witnessed by _____
(Name(s) of *PBSE/PBSI)

Signature(s) _____

Part 4 : Test Record attached to the Test Certificate

4.1 Earthing System of Electrical Installation

- i) Resistance to earth at position of each electrode (): _____
- ii) Resistance to earth at position of main earth terminal (): _____

4.2 Lightning Protection System (if provided)

- i) Resistance of each down conductor (): _____
- ii) Resistance to earth at position of each electrode (): _____

Tested / Checked by _____
(Name of Contractor's Representative)

Signature _____

Witnessed by _____
(Name(s) of *PBSE/PBSI)

Signature(s) _____

4.3 Earth Loop Impedance & Insulation Resistance Measurements

Circuit No. or Detail of Equipment	Earth Loop Imped. (Ohm)	Insulation Resistance to Earth (MegaOhm)	Insulation Resistance Between Phase/Poles (MegaOhm)				Remarks
			R-YBN	Y-RBN	B-RYN	N-RYB	

Notes : Sequence of testing the insulation resistance shall be as follows :

- a) Main switch/switchboard and outgoing circuits with sub-main switches being isolated;
- b) Sub-main switches/switchboards and outgoing circuits with final circuits boards being isolated; and
- c) Final circuit boards and final circuits.

Tested / Checked by _____
(Name of Contractor's Representative)

Signature _____

Witnessed by _____
(Name(s) of *PBSE/PBSI)

Signature(s) _____

Testing and commissioning progress chart “Electrical Installation”

Contract No. : _____

Contract Title : _____

Name of Contractor/Sub-contractor : _____

Contract Period : / /20 to / /20 * Revised/Actual Completion Date : / /20

Testing and Commissioning Progress Chart for Electrical Installation (Rev.) ⁽¹⁾																					
		Dates ⁽²⁾																		Remark	
Activities	Reference to Appendix A-1	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
1.	Visual Inspection	3.1																			
	G/F																				
	1/F																				
	2/F																				
	3/F																				
	4/F																				

	Submission of Record of Test																				
2.	Installation of protective devices	3.2																			
	G/F																				
	1/F																				
	2/F																				
	3/F																				
	4/F																				

	Submission of Record of Test																				
3.	Conductor continuity test	3.3																			
	G/F																				
	1/F																				
	2/F																				
	3/F																				
	4/F																				

	Submission of Record of Test																				

Testing and Commissioning Progress Chart “Electrical Installation”

Testing and Commissioning Progress Chart for Electrical Installation (Rev.) ⁽¹⁾																					
Dates ⁽²⁾																					Remark
Activities	Reference to Appendix A-1	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
4.	Earth electrode resistance test	3.4																			
	Submission of Record of Test																				
5.	Insulation resistance test	3.5																			
	G/F																				
	1/F																				
	2/F																				
	3/F																				
	4/F																				
	Submission of Record of Test																				
6.	Polarity test	3.6																			
	G/F																				
	1/F																				
	2/F																				
	3/F																				
	4/F																				
	Submission of Record of Test																				
7.	Earth fault loop impedance test	3.7																			
	G/F																				
	1/F																				
	2/F																				
	3/F																				
	4/F																				
	Submission of Record of Test																				

Testing and Commissioning Progress Chart “Electrical Installation”

Testing and Commissioning Progress Chart for Electrical Installation (Rev.) ⁽¹⁾																Remark				
		Dates ⁽²⁾																		
Activities	Reference to Appendix A-1		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
8.	Functional test of protective and other devices	3.8																		
	G/F																			
	1/F																			
	2/F																			
	3/F																			
	4/F																			
	Submission of Record of Test																			
9.	Checking for installations in hazardous environment	3.9																		
	Submission of Record of Test																			
10.	Method of compliance	3.10																		
	G/F																			
	1/F																			
	2/F																			
	3/F																			
	4/F																			
	Submission of Record of Test																			
11.	Conditions of Wiring, accessories, and equipment	3.11																		
	G/F																			
	1/F																			
	2/F																			
	3/F																			
	4/F																			
	Submission of Record of Test																			

Testing and Commissioning Certificate on Low Voltage Cubicle Switchboard Installation

Part 1 : Detail of Project

- 1.1 Project title (with location) :
- 1.2 * P.W.P. / Project No. :
- 1.3 * Contract/Sub-contract/Quotation No. :
- 1.4 * Contractor/Sub-contractor :
- 1.5 PBSE :
- 1.6 PBSI :

Part 2 : Declaration

- 2.1 I certify that the Low Voltage Cubicle Switchboard Installation as specified in the *Contract/Sub-contract/Quotation at the above location has been inspected, tested and commissioned in accordance with this procedure and/or any other procedures agreed between the PBSE and the Contractor. The results are satisfactory in the aspects as mentioned in Part 3 and/or as recorded in Part 4 of this Certificate, except as indicated in the COMMENTS items.
- 2.2 I also certify that site tests have been performed in accordance with the requirements set out in Appendix B-1 of this procedure and that the results are satisfactory. A record of the tests has been prepared and submitted to the PBSE.

Signature of Contractor's Representative _____

Full Name of Contractor's Representative _____

Designation of Contractor's Representative _____

Name and Stamp of Contractor _____

Date _____

Note : This certificate must be signed by a person authorized by the Firm/Company.

* Delete if not applicable

Items tested / checked by <u>Contractor</u>	Items witnessed by <u>PBSE/PBSI</u>
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Part 3. Items Inspected and Tested

3.1	<u>Visual Checks</u>		
3.1.1	<u>General Construction of Type Tested Assembly (TTA)</u>		
3.1.1.1	General construction and standard of finishing of TTA are satisfactory.	*Yes/No	*Yes/No
3.1.1.2	Levelling and alignment of TTA are satisfactory.	*Yes/No	*Yes/No
3.1.1.3	The TTA has been properly mounted.	*Yes/No	*Yes/No
3.1.1.4	Labels have been properly provided and installed.	*Yes/No	*Yes/No
3.1.1.5	Access for maintenance has been allowed.	*Yes/No	*Yes/No
3.1.1.6	The layout of the TTA is in conformity with the approved drawings.	*Yes/No	*Yes/No
3.1.1.7	The physical dimension of the TTA is in conformity with the approved drawings.	*Yes/No	*Yes/No
3.1.1.8	Danger notices and operation instructions have been adequately provided.	*Yes/No	*Yes/No
3.1.1.9	Earthing bar and earthing connections have been provided.	*Yes/No	*Yes/No
3.1.1.10	Earth wire has been installed for hinged front panels carrying L.V. equipment.	*Yes/No	*Yes/No
3.1.1.11	The bolts, nuts, washers and screws are of non-ferrous material.	*Yes/No	*Yes/No
3.1.1.12	Vermin proof has been satisfactorily provided.	*Yes/No	*Yes/No
3.1.1.13	The compartmentation of the TTA conforms with the specified requirements.	*Yes/No	*Yes/No

Tested / Checked by _____ Signature _____
(Name of Contractor's Representative)

Witnessed by _____ Signature(s) _____
(Name(s) of *PBSE/PBSI)

		Items tested / checked by <u>Contractor</u>	Items witnessed by <u>PBSE/PBSI</u>
3.1.2	<u>Main Busbars and Droppers/Risers</u>		
3.1.2.1	The busbar arrangements, including spacing and means of support, conform with the type-tested drawings.	*Yes/No	*Yes/No
3.1.2.2	Segregation between the busbar and the cubicle is in accordance with the specified 'Form'.	*Yes/No	*Yes/No
3.1.2.3	The dimensions of the busbars are adequate for the design loading.	*Yes/No	*Yes/No
3.1.2.4	The busbars have been electro-tinned.	*Yes/No	*Yes/No
3.1.2.5	Busbar links have been provided for installation of C.T.s.	*Yes/No	*Yes/No
3.1.2.6	Phase identifications have been provided for the busbars.	*Yes/No	*Yes/No
3.1.2.7	The bolts, nuts, screws etc. for busbar supports, busbar connections have been checked for correct tightness.	*Yes/No	*Yes/No
3.1.3	<u>Air Circuit Breaker (ACB)/Fuse Switches</u>		
3.1.3.1	The ACB ratings are in accordance with the approved working drawings.	*Yes/No	*Yes/No
3.1.3.2	Arc chutes are provided.	*Yes/No	*Yes/No
3.1.3.3	Shutters have been provided at the junction of busbar/ACB connection.	*Yes/No	*Yes/No
3.1.3.4	The number and rating of ACB/fuse switches are in conformity with the approved working drawings.	*Yes/No	*Yes/No
3.1.3.5	The fuse ratings are in conformity with the approved working drawings.	*Yes/No	*Yes/No
3.1.3.6	The fuses have been properly fixed.	*Yes/No	*Yes/No
3.1.3.7	The contact surfaces of the ACB/fuse switches have been kept clean.	*Yes/No	*Yes/No

Tested / Checked by _____ Signature _____
(Name of Contractor's Representative)

Witnessed by _____ Signature(s) _____
(Name(s) of *PBSE/PBSI)

		Items tested / checked by <u>Contractor</u>	Items witnessed by <u>PBSE/PBSI</u>
3.1.4	<u>Instrumentation and Protection</u>		
3.1.4.1	The Power Co.'s meter control fuses, meter board, cabling, etc. have been properly installed.	*Yes/No	*Yes/No
3.1.4.2	The type and range of the measuring instruments including digital multifunction meters and digital power analyzers are in accordance with those approved.	*Yes/No	*Yes/No
3.1.4.3	Type and range of protection relays including digital protection relays are in accordance with those approved.	*Yes/No	*Yes/No
3.1.4.4	The operating voltage of the shunt trip coil complies with the specification.	*Yes/No	*Yes/No
3.1.4.5	The battery charger and associated control/instrument comply with the specification.	*Yes/No	*Yes/No
3.1.4.6	The battery voltage and charging current have been checked and found satisfactory.	*Yes/No	*Yes/No
3.1.4.7	The capacity of the battery has been tested by tripping the ACB and results are satisfactory.	*Yes/No	*Yes/No
3.1.4.8	The capacity of the battery for digital multifunction meters/ digital power analyzers/ digital protection relays has been tested and results are satisfactory.	*Yes/No	*Yes/No
3.1.4.9	The re-charging time of the battery complies with the specification.	*Yes/No	*Yes/No
3.1.4.10	The control cables have been properly identified and connected.	*Yes/No	*Yes/No
3.1.4.11	Rubber grommets have been provided for holes through which control cables pass.	*Yes/No	*Yes/No

Tested / Checked by _____ Signature _____
(Name of Contractor's Representative)

Witnessed by _____ Signature(s) _____
(Name(s) of *PBSE/PBSI)

Appendix B-1

		Items tested / checked by <u>Contractor</u>	Items witnessed by <u>PBSE/PBSI</u>
3.1.5	<u>Incoming-outgoing Cables and Busbars</u>		
3.1.5.1.	Proper facilities have been provided for fixing of incoming/outgoing cables.	*Yes/No	*Yes/No
3.1.5.2.	Adequate space has been allowed for fixing of incoming/outgoing cables.	*Yes/No	*Yes/No
3.1.5.3.	The cables for termination have been soldered or properly fitted with sockets.	*Yes/No	*Yes/No
3.1.5.4.	Proper tightness of busbar/cable connection has been checked.	*Yes/No	*Yes/No
3.1.5.5.	Phase identification has been provided by approved means.	*Yes/No	*Yes/No
3.1.5.6.	Proper identification has been provided for each cable.	*Yes/No	*Yes/No
3.1.5.7	Unwanted openings have been sealed up.	*Yes/No	*Yes/No
3.1.6	<u>Miscellaneous</u>		
3.1.6.1	Portable earthing equipment as approved has been provided.	*Yes/No	*Yes/No
		*Yes/No	*Yes/No
3.1.6.2	Operating handles and keys c/w mounting board have been provided.	*Yes/No	*Yes/No
3.1.6.3	Spare fuses as agreed c/w mounting board have been provided.	*Yes/No	*Yes/No
		*Yes/No	*Yes/No
3.1.6.4	Hydraulic handling truck has been provided.	*Yes/No	*Yes/No
3.1.6.5	Rubber insulating mat has been provided.	*Yes/No	*Yes/No
		*Yes/No	*Yes/No
3.1.6.6	Schematic diagram has been framed and installed.	*Yes/No	*Yes/No
		*Yes/No	*Yes/No
3.1.6.7	Operation sequence instructions have been provided for interlock facilities.		

Tested / Checked by _____ Signature _____
(Name of Contractor's Representative)

Witnessed by _____ Signature(s) _____
(Name(s) of *PBSE/PBSI)

Appendix B-1

		Items tested / checked by <u>Contractor</u>	Items witnessed by <u>PBSE/PBSI</u>
3.2	<u>Site Tests</u>		
3.2.1	<u>Before connection of incoming supply the following tests have been carried out on site after the L.V. cubicle switchboard has been properly erected and visually inspected. The results are satisfactory.</u>		
3.2.1.1	Insulation test	*Yes/No	*Yes/No
3.2.1.2	Dielectric test	*Yes/No	*Yes/No
3.2.1.3	Polarity check for current transformers	*Yes/No	*Yes/No
3.2.1.4	Secondary injection test	*Yes/No	*Yes/No
3.2.1.5	Primary injection test	*Yes/No	*Yes/No
3.2.1.6	Electrical Resistance Test	*Yes/No	*Yes/No
3.2.1.7	Temperature-rise Limit Test (at factory / site)*	*Yes/No	*Yes/No
3.2.1.8	Functional Test	*Yes/No	*Yes/No
3.2.2	<u>After connection of incoming supply the following tests have been carried out and the results are satisfactory.</u>		
3.2.2.1	Voltage test	*Yes/No	*Yes/No
3.2.2.2	Phase sequence test	*Yes/No	*Yes/No
3.2.2.3	Functional test for digital power analyzer	*Yes/No	*Yes/No
3.2.3	<u>The above test results have been recorded in the "Test Records" as shown in Appendix B-1 Part 4 of this procedure.</u>	*Yes/No	*Yes/No

Tested / Checked by _____ Signature _____
(Name of Contractor's Representative)

Witnessed by _____ Signature(s) _____
(Name(s) of *PBSE/PBSI)

Items tested /
checked by
Contractor

Items witnessed
by
PBSE/PBSI

3.3 State any other tests that are considered necessary to meet the design intent.

Tested / Checked by _____ Signature _____
(Name of Contractor's Representative)

Witnessed by _____ Signature(s) _____
(Name(s) of *PBSE/PBSI)

Items tested /
checked by
Contractor

Items witnessed
by
PBSE/PBSI

3.4 Comments

Tested / Checked by _____ Signature _____
(Name of Contractor's Representative)

Witnessed by _____ Signature(s) _____
(Name(s) of *PBSE/PBSI)

Part 4 : Test Record attached to the Test Certificate

4.1 Test Records (Before connection of incoming supply)

4.1.1 Carry out insulation test using a 1000V d.c. megger.

Poles Measured		Insulation resistance with all switching devices open (MegaOhm)	Insulation resistance with all switching devices closed (MegaOhm)
R	E		
Y	E		
B	E		
R	Y		
Y	B		
B	R		
E	N		
R	N		
Y	N		
B	N		

Tested / Checked by _____ Signature _____
 (Name of Contractor's Representative)

Witnessed by _____ Signature(s) _____
 (Name(s) of *PBSE/PBSI)

4.1.2 Dielectric Test

4.1.2.1 The test shall be carried out with all switching devices closed

Test voltage : 2500V a.c., 50 Hz

Duration : 1 minute

Poles measured		Insulation resistance (MegaOhm)
Earth	R + Y + B + N	
N	R + Y + B + E	
R	Y + B + N + E	
Y	B + R + N + E	
B	R + Y + N + E	

4.1.2.2 After test at 4.1.2.1 another insulation test using 1000V d.c. megger shall be carried out with all switching devices closed.

Poles measured		Insulation resistance (MegaOhm)
R	E	
Y	E	
B	E	
R	Y	
Y	B	
B	R	
E	N	
R	N	
Y	N	
B	N	

Tested / Checked by _____ Signature _____
 (Name of Contractor's Representative)

Witnessed by _____ Signature(s) _____
 (Name(s) of *PBSE/PBSI)

4.1.2.3 Polarity Check for Current Transformers

		Satisfactory (√) Unsatisfactory (X) NOT completed (NC) NOT applicable (NA)	Remarks
Measurement CT	R		
	Y		
	B		
	N		
Protection CT	R		
	Y		
	B		
	N		

4.1.3 Secondary Injection Test

4.1.3.1 Overcurrent Relay

	Relay settings		Current inject (A)	Operating time (sec)	
	Current setting %	Time setting		Normal	Actual
R	50	1	5		
R	50	1	10		
R	100	0.5	10		
Y	50	1	5		
Y	50	1	10		
Y	100	0.5	10		
B	50	1	5		
B	50	1	10		
B	100	0.5	10		

Tested / Checked by _____ Signature _____
 (Name of Contractor's Representative)

Witnessed by _____ Signature(s) _____
 (Name(s) of *PBSE/PBSI)

4.1.3.2 Earth Fault Relay

	Relay settings		Current inject (A)	Operating time (sec)	
	Current setting %	Time setting		Normal	Actual
N	10	1	2.5		
N	10	1	5		
N	20	0.5	2		

4.1.4 Primary Injection Test

4.1.4.1 For overcurrent relays and earth fault relays set at specified settings

	Primary current (A)	Secondary current (A)				Spill current (A)
		R	Y	B	N	
R-Y						
Y-B						
B-R						
R-N						
Y-N						
B-N						

4.1.5 Electrical Resistance Test (Ductor Test)

Position (Positions of test should include all joints and connections. The followings are for reference only.)	Resistance (MicroOhm)
Joints on main busbars	
Connections between horizontal and vertical busbars	
Connections of ACB/fuse switches	

Tested / Checked by _____ Signature _____
(Name of Contractor's Representative)

Witnessed by _____ Signature(s) _____
(Name(s) of *PBSE/PBSI)

4.1.6 Temperature-rise Limit Test

Ambient Air Temperature at Location 1 _____ (°C)

Ambient Air Temperature at Location 2 _____ (°C)

Ambient Air Temperature at Location 3 _____ (°C)

No.	Position (Positions of test should include all joints and connections. The followings are for reference only.)	Temperature Rise At steady state (°C)	
		Test	Limit
1.	Supply connection R phase		
2.	Supply connection Y phase		
3.	Supply connection B phase		
4.	Horizontal busbars R phase		
5.	Horizontal busbars Y phase		
6.	Horizontal busbars B phase		
7.	Vertical busbars R phase		
8.	Vertical busbars Y phase		
9.	Vertical busbars B phase		
10.	Switchgear incoming terminal R phase		
11.	Switchgear incoming terminal Y phase		
12.	Switchgear incoming terminal B phase		
13.	Connection busbar to switchgear R phase		
14.	Connection busbar to switchgear Y phase		
15.	Connection busbar to switchgear B phase		

Tested / Checked by _____ Signature _____
(Name of Contractor's Representative)

Witnessed by _____ Signature(s) _____
(Name(s) of *PBSE/PBSI)

4.1.7 Functional Test

4.1.7.1 Air Circuit Breaker

Item	Check (where applicable)	Satisfactory (√) Unsatisfactory (X) NOT completed (NC) NOT applicable (NA)	Remarks
1.	Racking in and out of ACB		
2.	Operating of automatic shutter and padlock		
3.	Mechanical closing mechanism		
4.	Electrical closing mechanism		
5.	Mechanical tripping operation		
6.	Overcurrent trip operation		
7.	Earth leakage trip operation		
8.	Undervoltage release operation		
9.	Operation of castell key interlock		
10.	ACB panel door interlock		
11.	Mechanical ON/OFF indicator		
12.	Operation of auxiliary switches		
13.	Alignment of contacts mechanism		

4.1.7.2 Digital Protection Relay

Item	Check the following functions (where applicable)	Satisfactory (√) Unsatisfactory (X) NOT completed (NC) NOT applicable (NA)	Remarks
1.	Selection of relay characteristic curves		
2.	Fault recording function		
3.	Self-supervision features which monitor the control circuit of digital relay		
4.	Remote operation function		
5.	Communication facilities		

Tested / Checked by _____ Signature _____
(Name of Contractor's Representative)

Witnessed by _____ Signature(s) _____
(Name(s) of *PBSE/PBSI)

4.1.7.3 Fuseswitches/Switches/Automatic changeover Contactors

Item	Check (where applicable)	Satisfactory (√) Unsatisfactory (X) NOT completed (NC) NOT applicable (NA)	Remarks
1.	Operating of padlock and interlock		
2.	Mechanical closing mechanism		
3.	Electrical closing mechanism		

4.1.7.4 MCCB c/w overcurrent and/or earth leakage tripping devices

Item	Check (where applicable)	Satisfactory (√) Unsatisfactory (X) NOT completed (NC) NOT applicable (NA)	Remarks
1.	Overcurrent trip operation		
2.	Earth leakage trip operation		

4.2 Test Records (After connection of incoming supply)4.2.1 Voltage Test

	Voltage (V)
R-E	
Y-E	
B-E	
R-Y	
Y-B	
B-R	
E-N	
R-N	
Y-N	
B-N	

4.2.2 Phase Sequence Test

* Satisfactory / Unsatisfactory / NOT completed / NOT applicable

Tested / Checked by _____ Signature _____
(Name of Contractor's Representative)

Witnessed by _____ Signature(s) _____
(Name(s) of *PBSE/PBSI)

4.2.3 Functional Test for Digital Multi-function Meter or Power Analyzer

Item	Check the following functions of readings (where applicable)	Satisfactory (√) Unsatisfactory (X) NOT completed (NC) NOT applicable (NA)	Remarks
1.	True RMS value of line current for each phase		
2.	Neutral current		
3.	% current unbalance		
4.	True RMS value of phase-neutral voltage for each phase		
5.	True RMS value of line voltage for each phase		
6.	% voltage unbalance		
7.	Active power, kW for each phase and three-phase total		
8.	Reactive power, kVAr for each phase and three-phase total		
9.	Apparent power, kVA for each phase and three-phase total		
10.	Frequency, Hz		
11.	Power factor		
12.	Active energy, kWh for three-phase total with instantaneous and accumulated values		
13.	Demand current for each phase and three-phase average		
14.	Demand active power, three-phase total		
15.	Demand apparent power, three-phase total		
16.	Harmonic distortion for voltage and current, up to 30 th harmonic orders		
17.	Total harmonic distortion for voltage and current		
18.	Remote operation function		
19.	Communication facilities		

Tested / Checked by _____ Signature _____
(Name of Contractor's Representative)

Witnessed by _____ Signature(s) _____
(Name(s) of *PBSE/PBSI)

Testing and commissioning progress chart “Low Voltage Cubicle Switchboard Installation”

Contract No. : _____

Contract Title : _____

Name of Contractor/Sub-contractor : _____

Contract Period : ____ / ____ /20 ____ to ____ / ____ /20 * Revised/Actual Completion Date : ____ / ____ /20

Testing and Commissioning Progress Chart for Low Voltage Cubicle Switchboard Installation (Rev. ____)(1)		Dates (2)														Remark			
	Activities	Reference to Appendix B-1	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	
1.	Visual checks	3.1																	
	Submission of Record of Test																		
2.	Insulation test	4.1.1																	
	Submission of Record of Test																		
3.	Dielectric test	4.1.2.1 & 2																	
	Submission of Record of Test																		
4.	Current transformer polarity test	4.1.2.3																	
	Submission of Record of Test																		
5.	Secondary injection test	4.1.3.1 & 2																	
	Submission of Record of Test																		
6.	Primary injection test	4.1.4																	
	Submission of Record of Test																		
7.	Electrical resistance test (Ductor Test)	4.1.5																	
	Submission of Record of Test																		

