National Transmission & Despatch Company Limited

(National Power Control Center)

DC BIPOLE LOW POWER COMMISSIONING DESPATCH PROCEDURE OF MATIARI & LAHORE CONVERTER STATION

15022021-NPCC-DCDP V 1.9

February, 2021

DC BIPOLE LOW POWER COMISSIOINING DESPATCH PROCEDURE OF

MATIARI & LAHORE CONVERTER STATION

±660kV HVDC MATIARI-LAHORE, PROJECT, PAKISTAN (V 1.9)

Document Number :	15022021-NPCC-DCDP V 1.9	
Reference Document Number : PMLTC/CET	Matiari-Lahore ±660kV HVDC Transmission Project Commissioning Tests-Bipole Low Power System Tests ProgramV4-updated 29-01-2020	
Issue Date :	15-02-2021	
Prepared by:		**NPCC**
Review by NTDC Working Group:		
Review by M/S HATCH:		
Review by PMLTC:		
Review by M/S CESI:		
Approved by Commissioning Committee:		
Engr. Muhammad Ayub General Manager System Operation NPCC	Dr. Chang Yong Chief Engineer (PMLTC)	Mr. Aldo Danielli Independent Engineer M/S CESI
Sign:	Sign:	Sign:
Disseminated for information and implementation to all concerned.		

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References

[1] Matiari-Lahore ±660kV HVDC Transmission Project Commissioning Tests-Bipole Low Power System Tests ProgramV4-updated 29-01-2021

[2] Lahore Converter station SLD document number DCL00, dated: 17-08-2020, Rev-00.

[3] Matiari Converter station SLD document number DCM01, dated: 13-10-2020, Rev-01.

1 General Conditions

1.1. This dispatch procedure is issued for operational co-ordination during "Commissioning Tests Plan" of the HVDC System/switchyard at both Matiari/Lahore Converter stations of ±660kV HVDC Matiari –Lahore project as per reference information provided by Pakistan Matiari Lahore Transmission Company (PMLTC) through CE HVDC [1].

1.2. Scope of this dispatch procedure includes first-time energization/testing/the commissioning of DC system in the HVDC switchyard at ±660kV Matiari and Lahore Converter station.

1.3. The authorized representatives from PMLTC and NPCC (list of despatcher on duty and key personnel to be provided later) shall confirm in writing the revision number of the Commissioning Test Plans [1] to be followed throughout the testing prior to start of testing. Any changes made to the test plan once testing has started shall be noted and approved in writing by both the authorized representatives from PMLTC and NPCC.

1.4. The authorized personnel (2 personnel) as identified by PMLTC shall remain at NPCC during whole DC commissioning period.

1.5. PMLTC shall provide the 24/7 duty roster along with names/designation of authorized operational staff of Matiari and Lahore converter station to NPCC.

1.6. It shall be the responsibility of PMLTC and Test Director to establish desired safe communications during entire commissioning period with the authorized control room operators at Matiari-Lahore Converter station regarding requirement of switching etc. for the scheduled test item.

1.7. The operator at Matiari and Lahore Converter Station shall be well conversant with the prudent practices and SOPs regarding compliance to the instructions of system operator (NPCC authorized dispatcher on duty).

1.8. CET/PMLTC shall attach this dispatch procedure (15022021-NPCC-DCDP V 1.9), including its all annexures with commissioning test program.

1.9. The commissioning director appointed by CET shall be responsible for coordination and compliance of NPCC Instructions.

1.10. The test director(s) shall re-submit final adjusted test plan three days in advance at 10:00 Hrs to NPCC along with Sequence of Operation (SOO) and re-confirm the next day test plan one day in advance at 10:00 Hrs every day.

1.11. The test schedule (time and date) of each test item of the DC station system/switchyard of the Lahore

and Matiari Converter stations shall be approved by General Manager (System Operations, NPCC) with mutual understanding of PMLTC/CE HVDC NTDC one day before commencement of the test.

1.12. It shall be the discretion of NPCC to carry out all operations/switching through remote control whether through passing telephonic instructions to control room operators at concerned substations or by NPCC system operator himself through SCADA/OWS in presence of Chinese expert at NPCC.

1.13. Prior to each test, the test director (XIE GUOPING) of China Electric Power Research Institute shall notify the relevant departments, participating in test, through the tele-conference call system dial-in number (to be determined), in the converter station.

1.14. The test director shall be identified by PMLTC prior to the start of testing daily.

1.15. The NPCC authorized dispatcher on duty shall be identified by NPCC prior to the start of testing daily.

1.16. NPCC shall manage the AC system parameters according to the requirements of the commissioning (as mentioned in commissioning program).

1.17. Operators of Matiari and Lahore converter stations are responsible for equipment status report and the execution of the operation orders issued by NPCC.

1.18. The test director(s) shall seek permission from **NPCC** regarding switching of any HVAC and HVDC switchgear(s) to meet the test requirement as per agreed test activity of the commissioning program.

1.19. NPCC upon request of Test Director shall impart instructions to the authorized operational personnel on duty in control room of Matiari and Lahore Converter stations. The communication procedure shall be as follows:

i. NPCC authorized dispatcher shall identify themselves.
ii. NPCC authorized dispatcher shall state the instruction to be followed
iii. Operation personnel on duty in the control room of Matiari and Lahore Converter station shall identify themselves.
iv. Operation personnel on duty in the control room of Matiari and Lahore Converter stations shall acknowledge the instruction by repeating the instruction back to the authorized NPCC dispatcher, to re-confirm the instruction.
v. NPCC authorized dispatcher shall confirm the instruction to be followed and approve execution.
vi. Operation personnel on duty in the control room of Matiari and Lahore Converter stations shall acknowledge confirmation to execute the operation.
vii. Operation personnel on duty in the control room of Matiari and Lahore Converter stations shall then execute the operation and shall inform NPCC after execution.
viii. NPCC authorized dispatcher shall acknowledge, that operation has been executed, by verifying the status from OWS/ SCADA.
ix. Any delay in execution of instructions/operations by PMLTC shall be communicated by stating the cause/reason of delay.
x. All the communications between NPCC and PMLTC operation personnel shall be recorded

on both sides.

2 Pre-requisites to the commissioning:

2.1 **PMLTC** shall ensure that the final SLDs [2] have been approved and issued by N**PCC** and equipment's code in the switchyards, control room panels and relay rooms has been marked as per approved SLDs. The switching sequences during and after the commissioning shall be performed as per Dispatch Code/ nomenclature of the approved SLDs [2].

2.2 Round the clock healthy voice-communication (Hotline, direct dialing etc..) between the control room of Matiari/Lahore Converter stations and **NPCC** shall be ensured by PMLTC.

2.3 CET/PMLTC shall submit commissioning plan along with sequence of operation to NPCC during the commissioning/energization process. CET/PMLTC shall also inform NPCC its possible effects on AC system under operation.

2.4 PMLTC shall provide the "Power Curves", which are to be used during commissioning, 3 days prior to the start of commissioning to NPCC.

2.5 Prior to commissioning, **PMLTC** and CE HVDC NTDC shall ensure the provision of real time data through OWS and SCADA in NPCC control centers for supervisory control and monitoring.

2.6 The commissioning test program [1] shall be confirmed by **PMLTC** and **Chief Engineer HVDC, NTDC** as the final version.

2.7 **PMLTC** shall submit the final version of the commissioning test program document to all related participants, before start of the commissioning test.

2.8 Chief Engineer HVDC, NTDC will record and issue the list of representatives nominated by all stakeholders and re-issue the changings in list of representatives during commission / testing activities.

2.9 Chief Engineer HVDC, NTDC shall prepare the methodology to ensure clear coordination and decision making during the commissioning / testing.

2.10 PMLTC shall provide fully functional Stability Control System to ensure power system stability and reliability during DC commissioning.

2.11 DC commissioning tests A1, A2 and A3 for Matriari and Lahore converter stations respectively, have been successfully completed, including Open Line Test with DC line, and DC lines of both poles Pole-I and Pole-II have been successfully energized.

2.12 The results of DC commissioning tests A1, A2 and A3 for Matriari and Lahore converter stations respectively, including all graphs/charts related to pole power, current, voltages, firing angles and extinction angles, tap positions etc... have been approved by all concerned NTDC formations (Asset management, Protection & Control, Project Delivery, TSG, Design department) and Owner Engineer (M/S HATCH).

2.13 Approval of NTDC authority is required before conducting AC line fault tests.

2.14 Relevant personnel from Asset Management, protection and control, TSG, CE (HVDC) must be at the site to witness the AC line fault test.

2.15 Optional tests may or may not be carried out by NPCC as per the then system prevailing conditions

3 Energization and Clearance Certificate for Equipment Status

3.1 Provision of Clearance Certificate by PMLTC/CE HVDC NTDC to NPCC

Prior to energization of DC switch yard or any of its component and pre- energization commissioning test(s); PMLTC through CE HVDC, NTDC, shall submit an energization message/clearance certificate (Bipole DC Transmission Line and the relevant component of DC system at Lahore and Matiari Converter stations) along with certificate of Readiness / Synchronization, by the consultant to Director Power Control, NPCC by verifying the following:

i. The construction of primary, secondary and auxiliary infrastructure of all equipment involved in the start-up and commissioning of DC Yard at both Matiari and Lahore converter stations have been completed.

ii. The construction personnel have been evacuated from the site, and the infrastructure construction grounding wires have been removed.

iii. All required main protection and backup protection have been put into operation, automation, communication, defense lines and remedial actions system etc has been implemented and functioning properly.

iv. The pre-energization tests including sub system on site tests of the circuit/equipment to be energized have been performed by the concerned formations and results found satisfactory.

v. The measuring and debugging equipment required for the system commissioning of DC System substation is ready. The relevant equipment on the measuring point has been connected, and the safety measures have been taken.

vi. Therefore, NPCC is requested to initiate switching/ operations for energization of ±660kV HVDC Matiari - Lahore system as per approved commissioning program.

vii. NPCC shall ensure that the AC system is normal and shall allow CET to commence the commissioning test.

viii. Director Power Control, NPCC shall acknowledge the clearance certificate of the energization.

4 Safety Precautions during Commissioning Tests:

Prior to energization of DC switch yard, Bipole DC Transmission Line or any of its component and pre-energization commissioning test(s); PMLTC shall make sure following:

4.1 During the test, CET/PMLTC is responsible for on-site safety measures at both converter stations to ensure that they do not affect the operation of equipment.

4.2 During the commissioning of DC system, PMLTC will be responsible for taking on-site safety measures, as per requirement of the commissioning and NEPRA Codes (Power Safety Codes, Grid Codes etc.) and international standards, to ensure equipment and personnel safety at both Matiari and Lahore Converter stations.

4.3 At Matiari and Lahore converter stations, the test equipment or external equipment should be properly tagged /locked out, or use the black, red and white tape belt and other warning signs/ equipment.

5 Commissioning Procedure:

The procedure for the commissioning of DC system is as follows:

5.1 Commissioning director shall seek formal permission from NPCC before initiating any commissioning test.

5.2 NPCC will manage the operation of AC system to meet the requirements of commissioning tests as planned for a particular day.

5.3 If in any case, the commissioning work cannot be carried out in accordance with the commissioning plan due to undesired AC system / Power grid conditions, test plan of that day shall be rescheduled by NPCC, with co-ordination of CE-HVDC and PMLTC.

5.4 NPCC instructions to be followed by all concerned during the commissioning of HVDC system in view of prevailing system conditions.

6 Disturbance Handling:

During the test, CET/PMLTC is responsible for on-site safety measures at both converter stations to ensure human safety and stable operation of equipment. The scope of responsibilities in the event of disturbance handling during the commissioning of DC system is as follows:

6.1 NPCC is responsible for the switching operation and disturbance management of AC system of the associated grid stations/plants connected with the converter stations, and PMLTC is responsible for the switching operation and disturbance management of Matiari and Lahore Converter stations and Bipole DC Transmission Line.

6.2 In case there is any problem or equipment fault occurred with the AC system during the commissioning test, NPCC will coordinate with relevant NTDC Asset Management to fix it. In case there is any problem or equipment fault occurred at Matiari and Lahore Converter stations and Bipole DC Transmission Line, PMLTC will fix it.

6.3 During the commissioning, if any equipment under test depicts abnormal behavior, the commissioning director is responsible for managing the disturbance.

6.4 During the commissioning, if an emergent situation arises that endangers personal safety and poses serious threat to the main equipment, the operators may not wait for the commissioning director order and is permitted to immediately stop the DC system, and inform NPCC.

6.5 If the DC system is out of service due to an abnormal AC system or fault, the converter station operator shall immediately report the disturbance to NPCC.

7 Equipment Status Report (ESR) before start of commissioning tests:

Commissioning Directors at both Matiari and Lahore converter stations shall submit following ESR to NPCC prior to commissioning test each day as follows:

7.1 AC breakers controlling converter transformer of pole I and II at both Matiari/Lahore C/S are in cold standby state or otherwise.

7.2 Complete DC switchgear at Matiari/Lahore C/S is in *cold standby state.

7.3 DC line of pole I and II at both Matiari/Lahore C/S is in *cold standby state.

7.4 All AC filters at both Matiari/Lahore C/S are in "Ready for Operation" condition.

7.5 AC lines and the remaining 500 kV equipment at both Matiari/Lahore C/S is in normal operation.

*Cold Standby: All switch gears (Breakers, isolators, earth switches) are in open/off state

8 Commissioning Test Startup Procedure:

Commissioning Directors at both Matiari and Lahore converter stations shall seek a telephonic permission from NPCC, to formally start the tests as mentioned in the approved plan of that particular day after receiving the acknowledgement of "Commissioning Application" (as mentioned in 4.3) from NPCC. The prerequisites and Test steps related to each individual tests are described below:

8.1 Initial Operation Tests, Joint Power Control, Normal Power Direction, Bi-Pole Ground Return

Follow the sequence described in "Annexure-D-I" and "Test Plan (A4).

8.2 Pole Compensation, Joint Power Control, Normal Power Direction, Bi-Pole Ground Return

Follow the sequence described in "Annexure-D-II" and "Test Plan (A4).

8.3 Automatic Power Curve Control Test, Joint Power Control, Bi-Pole Ground Return

Follow the sequence described in "Annexure-D-III" and "Test Plan (A4).

8.4 Normal/Reduced Voltage Operation, Joint Power Control, Bi-Pole Ground Return

Follow the sequence described in "Annexure-D-IV" and "Test Plan (A4).

8.5 Backup Control, Joint Power Control, Bi-Pole Ground Return

Follow the sequence described in "Annexure-D-V" and "Test Plan (A4).

8.6 Pole Compensation by Disturbance tests, Joint Power Control, Normal Power Direction, Bi-Pole Ground Return

Follow the sequence described in "Annexure-D-VI" and "Test Plan (A4).

8.7 Operation with Station Ground Test, Joint Power Control, Normal Power Direction, Bi-Pole Ground Return

Follow the sequence described in "Annexure-D-VII" and "Test Plan (A4).

8.8 Disturbances, Joint Power Control, Bi-Pole Ground Return

Follow the sequence described in "Annexure-D-VIII" and "Test Plan (A4).

8.9 Frequency Control Test, Joint Power Control, Bi-Pole Ground Return

Follow the sequence described in “Annexure-D-IX” and “Test Plan (A4).

8.10 Initial Operation Tests, Bi-Pole Ground Return Operation, Reversed Power Direction, Joint Power Control

Follow the sequence described in “Annexure-D-X” and “Test Plan (A4).

8.11 Protective Trip X, Y, and Z, Reversed Power Direction, Joint Power Control, Normal Power Direction, Bi-Pole Ground Return

Follow the sequence described in “Annexure-D-XI” and “Test Plan (A4).

8.12 Pole Compensation and disturbance test, Reversed Power Direction, Joint Power Control, Bi-Pole Ground Return

Follow the sequence described in “Annexure-D-XII” and “Test Plan (A4).

8.13 AC/DC Line Faults, Joint Power Control, Bi-Pole Ground Return

Follow the sequence described in “Annexure-D-XIII” and “Test Plan (A4).

Bipole Low Power Tests Dispatch Matrices
All these tests will be performed in Bipolar Mode.
Sequence as mentioned in sequence table shall be followed
General conditions and System configurations must be selected as indicated before performing each test.
There are four voltage reactors available at Matiari and two LV reactors available at Lahore converter station.

Matiari—Lahore ±660kV HVDC Project
The Schedule for Bipole System Commissioning Tests

Sr. No.	Test Block	Commissioning Items	Mode	Item Designations	Sub-item Designation	Power imported from AC Network (MW)
Bipole Low Power System Test						
All tests above must be sucessful before executing these tests						
All tests in LP 12,13,14,15 should be performed in sequence. May not proceed with suceeding tests within the block other than ramping tests if any test in the block fails. May not proceed with following block tests until each test block is complete.						
Bipole Low Power Operational Tests						
1	LP-12	2.3.1	BPGR	Initial Operation Tests, Normal Power Direction	Start/Stop Pole, Manual Deblock/Block	400
2		3.3.1	BPGR	Pole Compensation	Normal Power Direction, Bipolar Power Ramping	800
3		3.3.2	BPGR	Pole Compensation	Normal Power Direction, Bipole Operation, Pole 2 Power Ramping	800
4		3.3.3	BPGR	Pole Compensation	Normal Power Direction, Bipole Operation, Pole 1 Power Ramping	800
5		7.3.1	BPGR	Automatic Power Curve Control Test	Automatic Power Curve Control test in Matiari Converter Station	600
6		7.3.2	BPGR	Automatic Power Curve Control Test	Automatic Power Curve Control test in Lahore Converter Station	600
7		5.3.1	BPGR	Reduced Voltage Operation	Reduced Voltage Operation Test	600
8		9.3.1	BPGR	Backup Control	Bipole Start/Stop in Backup Panel at Matiari	400
9		9.3.1	BPGR	Backup Control	Bipole Start/Stop in Backup Panel at Lahore	400
10		9.3.2	BPGR	Backup Control	Bipole Ramp up/down in Backup Panel	600
Bipole Low Power Disturbance Tests						
11	LP-13	3.3.4	BPGR	Pole Compensation by disturbance	Pole-2 Trip, Power Transfer at Normal Voltage	800
12		3.3.4	BPGR	Pole Compensation by disturbance	Pole-1 Trip, Power Transfer at Normal Voltage	800
13		3.3.5	BPGR	Pole Compensation by disturbance	Pole-1 Trip, Power Transfer at Reduced Voltage	800
14		3.3.5	BPGR	Pole Compensation by disturbance	Pole-2 Trip, Power Transfer at Reduced Voltage	800
15		4.3.1	BPGR	Operation with Station Ground	Start/Stop Bipole with Station Grounding at Matiari & LAHORE Converter Station	600
16		6.3.1	BPGR	Disturbances	Pole Trip, Open Line Fault at Electrode at Lahore	400
17		6.3.1	BPGR	Disturbances	Pole Trip, Open Line Fault at Electrode at Matiari	400
18		6.3.2	BPGR	Disturbances	Pole-1 in Operation while Pole-2 Undergoing Open Line Test	400
19		6.3.2	BPGR	Disturbances	Pole-2 in Operation while Pole-1 Undergoing Open Line Test	400
20		6.3.3	BPGR	Disturbances	Bipole Operation, Simulate Electrode Line Unbalance Fault	600
21		6.3.4	BPGR	Disturbances	Simulation of IDNC CT Transmitter Power Source Fault	400
22		6.3.5	BPGR	Disturbances	AC Auxiliary Power 400 V Switchover	400
23		8.3.1	BPGR	Frequency Control Test	Frequency Control test in Matiari Converter Station	500
24		8.3.2	BPGR	Frequency Control Test	Frequency Control test in Lahore Converter Station	500

Matiari—Lahore ±660kV HVDC Project
The Schedule for Bipole System Commissioning Tests

Sr. No.	Test Block	Commissioning Items	Mode	Item Designations	Sub-item Designation	Power imported from AC Network (MW)
Bipole Low Power Tests -Reverse Power Direction						
25	LP-14	10.3.1	BPGR	Initial Operation Tests, Reversed Power Direction	Start/Stop Bipole	400
26		10.3.2	BPGR	Initial Operation Tests, Reversed Power Direction	Control System Switchover	400
27		11.3.1	BPGR	Protective Trip X, Y, and Z, Reversed Power Direction	Protective Trip X in Rectifier with Telecommunication	400
28		11.3.2	BPGR	Protective Trip X, Y, and Z, Reversed Power Direction	Protective Trip Y in Inverter with Telecommunication	400
29		11.3.3	BPGR	Protective Trip X, Y, and Z, Reversed Power Direction	Protective Trip Z in Rectifier with Telecommunication	400
30		12.3.1	BPGR	Pole Compensation and disturbance test, Reversed Power Direction	Bipole Power Ramping	800
31		12.3.2	BPGR	Pole Compensation and disturbance test, Reversed Power Direction	Bipole Operation, Pole 2 Power Ramping with/without Telecommunication	600
32		12.3.2	BPGR	Pole Compensation and disturbance test, Reversed Power Direction	Bipole Operation, Pole 1 Power Ramping with/without Telecommunication	600
33		12.3.3	BPGR	Pole Compensation and disturbance test, Reversed Power Direction	Simulated Pole1 DC Line Fault (only Lahore)	400
34		12.3.4	BPGR	Pole Compensation and disturbance test, Reversed Power Direction	Simulated Pole2 DC Line Fault (only Lahore)	400
Bipole Low Power Tests -AC and DC Line Fault Tests						
35	LP-15	13.3.1	BPGR	DC Line Faults	DC Line Faults at Pole 1 near Rectifier, Normal Power Direction	400
36		13.3.2	BPGR	DC Line Faults	Pole 2 Reduced Voltage, DC Line Faults at Pole 2 near Rectifier, Normal Power Direction	400
37		13.3.3	BPGR	DC Line Faults	DC Line Faults at Pole 1 near Inverter, Normal Power Direction	400
38		13.3.4	BPGR	DC Line Faults	Pole 1 Reduced Voltage, DC Line Faults at Pole 1 near Inverter, Normal Power Direction	400
39		13.3.5	BPGR	DC Line Faults	Pole 1 Reduced Voltage, DC Line Faults at Pole 2 near Inverter, Normal Power Direction	400
40		13.3.6	MR	DC Line Faults	DC Line Faults at Pole 2 near Inverter, Metallic Return Operation, Normal Power Direction	200
41		13.3.4	BPGR	DC Line Faults	Fault in Pole 2 at connection, with Pole-I running at 200 MW.	400
42		13.3.5	BPGR	DC Line Faults	DC Line Faults at Pole 1 near Rectifier, Reverse Power Direction	400
43		13.3.6	BPGR	DC Line Faults	DC Line Faults at Pole 2 near Inverter, Reverse Power Direction	400
44		13.3.7	BPGR	AC Line Faults	AC Line Faults at Rectifier, Normal Power Direction (Optional)	400
45		13.3.8	BPGR	AC Line Faults	AC Line Faults at Inverter, Normal Power Direction (Optional)	400

Bipole Low Power Operational Tests

1-Initial Operation Tests,

Test Objective	The objective is to check the function of bipole deblock and block.					
Condition	**Sr. No.**	**Station**	**Action**	**Equipment/ Configuration**	**State of Equipment/configuration**	**Description**
Pre-Test Conditions & Configurations (AC/DC)	1	AC side at Matiari & Lahore C/S	Voltage Limits	Utmost efforts will be made to maintain the voltages within ±5% range. However, reactive compensation devices installed at both converter stations can be used, if needed, to control the voltages keeping in view the then prevailing system conditions.		
	2		AC Yard of Lahore & Matiari Converter Station is in normal Position		CLOSED State	All bays including Filter Banks are complete and energized with no component in maintenance state.
	3	DC Side at Matiari C/S	Both Poles will operate in Bipole Ground Return Mode see Status Table "BP-GR"			BI-Pole Mode of Operation
	4	General Preconditions	Converter transformer protection and the charging protection of corresponding converter AC bus breaker are put into operation.			
	5		All the Prerequisites as mentioned in DC Dispatch Plan should be met.			
	6		Visual inspections of AC switchyard, AC filter yard, DC yard and DC valve hall prior first energization or switching.			
	7		All electrical connections are available.			
	8		Protection settings and protective circuits trip sequences tests must be completed.			
	9		AC-switchyard and associated protections and sequences, including breaker failure protection, must be active.			
	10		Correct grounding of all equipment is available.			
	11		Thyristor valve cooling in operation for 24 hours, no water leakage observed.			
	12		Thyristor valves and valve hall is cleaned.			
	13		Converter transformers are demagnetized.			
	14		Set tap changer to position giving lowest valve voltage			
	15		Monopole Low Power Tests have been successfully completed.			
	16		Both sides AC system of Matiari & Lahore C/S are capable to supply and accept the power (400 MW) for the test. Availability of N-1 contingency on parallel AC corridor. AC system short circuit level has been measured at both Matiari and Lahore converter stations and it is confirmed to be suitable for the tested power.			
	17	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Direction	Normal		Matiari to Lahore
	18		Return	Ground		Ground Return Mode
	19		Udc Mode	Normal		±660kV
	20		Telecom Mode	Operational		
	21		Master Station	Matiari		
	22	Configuration Setting at Lahore & Matiari C/S DC side	Station Control (SC)	A	ACTIVE	Can be changed to B during test
	23			B	Standby	
	24		Pole Control (PCP)	A	ACTIVE	
	25			B	Standby	
	26		Transmission Control Mode	Power	ACTIVE	HVDC will operate in power control mode.
	27		Station Control Mode	Joint	ACTIVE	Matiari & Lahore will operate jointly.
	28		Reactive Power Control Mode	Automatic	ACTIVE	Automatically Switch in/out the AC Filters/Reactors
	29		Reactive Power Control Variable	Q-Control	ACTIVE	Reactive Power exchange between AC Yard of Converter Station and NTDC system will be automatically controlled.

Testing Start Up Sequence

Start/Stop Bi-Pole, Manual Deblock/Block (Sr. No. 1) (A4 2.3.1)	30	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	31	Matiari/Lahore C/S DC side	Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	32	Matiari	Start the BiPole	Power	400 MW	
	33			Ramp Rate:	50MW/Min	
	34		Wait to achieve Target Value	Max Time	5 min	
	35		Verify Performance indicators	Firing angle (α)	15°±2.5°	
	36			DC Voltages	±660kV	
	37			RPC Operation	BP-11/13 , HP24/36	
	38	Lahore		Extinction Angle (γ)	17°	
	39			DC Voltages	Range to be mentioned	
				RPC Operation	2xHP12/24	
	40	Matiari/Lahore	Verify stable operation at minimum power.			
	41		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	42	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	43	Lahore		HP-12/24, HP-12/24		
	44	Matiari	Stop the BiPole			
	45		Verify Performance parameters	Retard, Reduced Current		Block without BPP
	46	Lahore		Alpha angle	90	Block with BPP
Test Acceptance Criteria	47	Matiari/Lahore C/S	The voltage of the AC system should be within the specified limits (450-550kV)			
	48		All Operations executed successfully			
	49		The synchronizing voltage and the phasing of the firing control signals are correct.			
	50		All thyristor check-back signals are available.			
	51		Measuring system and controls remain operational. No transients on switchover of PCP or SC systems.			
	52		Measuring quantities are available and the values are within the specified range and phase.			
	53		No abnormal corona discharges and no operation of surge arresters shall occur at energized equipment.			
	54		No Stuck Condition			
	55		No False Tripping by DC Protection System			
	56		All the sequence as recorded in OWS should be documented, All the Charts related to pole power,current, voltages, firing angles and extinction angles, tap positions. Should be recorded and documented. TFR data in Comtrade format to be captured and recorded.			
	57		No Tripping in AC side of converter Station			

Bipole Low Power Operational Tests

2-Pole Compensation

Test Objective	The test objective is to check the pole compensation function.					
Condition	**Sr. No.**	**Station**	**Action**	**Equipment/ Configuration**	**State of Equipment/configuration**	**Description**
Pre-Test Conditions & Configurations (AC/DC)	1	AC side at Matiari & Lahore C/S	Voltage Limits	Utmost efforts will be made to maintain the voltages within ±5% range. However, reactive compensation devices installed at both converter stations can be used, if needed, to control the voltages keeping in view the then prevailing system conditions.		
	2		AC Yard of Lahore & Matiari Converter Station is in normal Position		CLOSED State	All bays including Filter Banks are complete and energized with no component in maintenance state.
	3	DC Side at Matiari C/S	Both Poles will operate in Bipole Ground Return Mode see Status Table "BP-GR"			BI-Pole Mode of Operation
	4	General Preconditions	Converter transformer protection and the charging protection of corresponding converter AC bus breaker are put into operation.			
	5		All the Prerequisites as mentioned in DC Dispatch Plan should be met.			
	6		Visual inspections of AC switchyard, AC filter yard, DC yard and DC valve hall prior first energization or switching.			
	7		All electrical connections are available.			
	8		Protection settings and protective circuits trip sequences tests must be completed.			
	9		AC-switchyard and associated protections and sequences, including breaker failure protection, must be active.			
	10		Correct grounding of all equipment is available.			
	11		Thyristor valve cooling in operation for 24 hours, no water leakage observed.			
	12		Thyristor valves and valve hall is cleaned.			
	13		Converter transformers are demagnetized.			
	14		Set tap changer to position giving lowest valve voltage			
	15		Initial Operation Tests, Normal Power Direction (Annex-D-I must be successful)			
	16		Both sides AC system of Matiari & Lahore C/S are capable to supply and accept the power (800 MW) for the test. Availability of N-1 contingency on parallel AC corridor. AC system short circuit level has been measured at both Matiari and Lahore converter stations and it is confirmed to be suitable for the tested power.			
	17	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Direction	Normal		Matiari to Lahore
	18		Return	Ground		Ground Return Mode
	19		Udc Mode	Normal		±660kV
	20		Telecom Mode	Operational		
	21		Master Station	Matiari		
	22	Configuration Setting at Matiari & Lahore C/S DC side	Station Control (SC)	A	ACTIVE	Can be changed to B during test
	23			B	Standby	
	24		Pole Control (PCP)	A	ACTIVE	
	25			B	Standby	
	26		Transmission Control Mode	Power	ACTIVE	HVDC will operate in power control mode.
	27		Station Control Mode	Joint	Active	Matiari & Lahore will operate jointly.
	28		Reactive Power Control Mode	Automatic	ACTIVE	Automatically Switch in/out the AC Filters/Reactors
	29		Reactive Power Control Variable	Q-Control	ACTIVE	Reactive Power exchange between AC Yard of Converter Station and NTDC system will be automatically controlled.

Testing Start Up Sequence

Normal Power Direction, Bipolar Power Ramping (Sr. No. 2) (A4 3.3.1)	30	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	31		Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	32	Matiari	Start the BiPole	Power	400 MW	
	33			Ramp Rate:	50MW/Min	
	34		Wait to achieve Target Value	Max Time	5 min	
	35		Verify Performance indicators	Firing angle (α)	15°±2.5°	
	36			DC Voltages	±660kV	
	37			RPC Operation	BP-11/13 , HP24/36	
	38	Lahore		Extinction Angle (γ)	17°	
	39			DC Voltages	Range to be mentioned	
	40			RPC Operation	2xHP12/24	
	41	Matiari/Lahore	Verify stable operation at minimum power			
	42	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	43	Lahore		HP-12/24, HP-12/24		
	44	Matiari	Ramp Up	400 MW	600 MW	50 MW/min
	45		Verify (During Ramping)	PCP-A ,SC-A	ACTIVE	
	46		Manual Switch Control System (During Ramping)	PCP-A to	PCP-B	
	47			PCP-B to	PCP-A	
	48			SC-A to	SC-B to	
	49			SC-B to	SC-A to	
	50	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	51			PCP-A & SC-A is active		
	52			power reaches the reference value after ramping is completed		
	53			No Transients or unexpected delays		
	54	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 200 MW with DC System. (Sudden load sharing from AC corridor to DC corridor will happen in next step)			
	55	Matiari	Ramp Up	600 MW	800 MW	999 MW/min
	56	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	57			power reaches the reference value after ramping is completed		
	58			No Transients		
	59	Matiari	Ramp Down	800 MW	600 MW	50 MW/min
	60		Verify (During Ramping)	PCP-A & SC-A	ACTIVE	
	61		Manual Switch Control System (During Ramping)	PCP-A to	PCP-B	
	62			PCP-B to	PCP-A	
	63			SC-A to	SC-B to	
	64			SC-B to	SC-A to	
	65	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	66			PCP-A & SC-A is active		
	67			power reaches the reference value after ramping is completed		
	68			No Transients or unexpected delays		
	69	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 200 MW with DC System. (Sudden load sharing from DC corridor to AC corridor will happen in next step)			
	70	Matiari	Ramp Down	600 MW	400 MW	999 MW/min
	71	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	72			power reaches the reference value after ramping is completed		
	73			No Transients		
	75	Matiari	Ramp Up	400 MW	800 MW	50 MW/min
	76	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	77			power reaches the reference value after ramping is completed		
	78			No Transients		

Normal Power Direction, Bipole Operation, Pole 2 Power Ramping (Sr. No. 3) (A4 3.3.2)	79	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	80		Verify Pole-I and Pole-II is in stable Bi-Pole Power Control Mode at 800 MW in sequence to test above.			
	81		Order Pole-2 in Pole Power Control Mode, (Pole-I is in Bi-Pole Power Control Mode)			
	82	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	83			Pole Power Control Mode achieved successfully in Pole 2		
	84			No Transients		
	85		Order Pole-2 in Pole Current Control Mode, (Pole-I is in Bi-Pole Power Mode)			
	86	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	87			Pole Current Control Mode achieved successfully in Pole 2		
	88			No Transients		
	89	Lahore	Initiate Sequence of Master Station			
	90		Ramp Up Pole-2	606 Amps	700 Amps	50 Amps/Min
	91	Lahore	Verify (During Ramping)	PCP-A	ACTIVE	
	92		Manual Switch Control System (During Ramping)	PCP-A to	PCP-B	
	93			PCP-B to	PCP-A	
	94			SC-A to	SC-B to	
	95			SC-B to	SC-A to	
	96	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	97			PCP-A & SC-A is active		
	98			current reaches the reference value after ramping is completed		
	99			No Transients		
	100	Lahore	Ramp Up Pole-2	700 Amps	800 Amps	50 Amps/Min
	101		Order Pole-2 in Pole Power Control Mode, (Pole-I is in Bi-Pole Power Mode) during ramping			
	102	Matiari /Lahore	Verify	No transfer to pole power control in pole 2 while ramping		
	103			Continuous Steady Operation of the transmission		
	104			current reaches the reference value after ramping is completed		
	105			No Transients		
	106	Matiari	Initiate Sequence of Master Station			
	107		Ramp Down Pole-2	800 Amps	700 Amps	50 Amps/Min
	108	Matiari	Verify (During Ramping)	PCP-A	ACTIVE	
	109		Manual Switch Control System (During Ramping)	PCP-A to	PCP-B	
	110			PCP-B to	PCP-A	
	111			SC-A to	SC-B to	
	112			SC-B to	SC-A to	
	113	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	114			PCP-A is active		
	115			current reaches the reference value after ramping is completed		
	116			No Transients		
	117	Matiari	Ramp Up Pole-2	700 Amps	606 Amps	50 Amps/Min
	118		Disable the telecommunication in both channels during the ramping process.			
	119	Matiari /Lahore	Verify	The Emergency Current Control mode would be automatically activated.		
	120			The ramping of pole2 would be continued at a reduced ramp rate, and the current reference value would be reached when the telecommunication is disabled,		
	121			No Transients		
	122		Verify Two poles are in stable operation at 800MW.			
	123	Matiari	Enable the telecommunication in both channels.			
	124		order pole 2 in Bipolar Power Control Mode			

Normal Power Direction, Bipole Operation, Pole 1 Power Ramping (Sr. No. 4) (A4 3.3.3)	125	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	126		Verify Pole-I and Pole-II is in stable Bi-Pole Power Control Mode at 800 MW in sequence to test above.			
	127		Order Pole-1 in Pole Power Control Mode, (Pole-2 is in Bi-Pole Mode)			
	128	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	129			Pole Power Control Mode achieved successfully in Pole 1		
	130			No Transients		
	131		Order Pole-1 in Pole Current Control Mode, (Pole-2 is in Bi-Pole Power Mode)			
	132	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	133			Pole Current Control Mode achieved successfully in Pole 1		
	134			No Transients		
	135	Lahore	Initiate Sequence of Master Station			
	136		Ramp Up Pole 1	606 Amps	700 Amps	50 Amps/Min
	137		Verify (During Ramping)	PCP-A	ACTIVE	
	138		Manual Switch Control System (During Ramping)	PCP-A to	PCP-B	
	139			PCP-B to	PCP-A	
	140			SC-A to	SC-B to	
	141			SC-B to	SC-A to	
	142	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	143			PCP-A & SC-A is active		
	144			current reaches the reference value after ramping is completed		
	145			No Transients		
	146	Lahore	Ramp Up Pole 1	700 Amps	800 Amps	50 Amps/Min
	147		Order Pole-1 in Pole Power Control Mode, (Pole-2 is in Bi-Pole Power Mode) during ramping			
	148	Matiari /Lahore	Verify	No transfer to pole power control in pole 1 while ramping		
	149			Continuous Steady Operation of the transmission		
	150			current reaches the reference value after ramping is completed		
	151			No Transients		
	152	Matiari	Initiate Sequence of Master Station			
	153		Ramp Down Pole 1	800 Amps	700 Amps	50 Amps/Min
	154	Matiari	Verify (During Ramping)	PCP-A & SC-A	ACTIVE	
	155		Manual Switch Control System (During Ramping)	PCP-A to	PCP-B	
	156			PCP-B to	PCP-A	
	157			SC-A to	SC-B to	
	158			SC-B to	SC-A to	
	159	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	160			PCP-A & SC-A is active		
	161			current reaches the reference value after ramping is completed		
	162			No Transients		
	163	Matiari	Ramp Down Pole 1	700 Amps	606 Amps	50 Amps/Min
	164		Disable the telecommunication in both channels during the ramping process.			
	165	Matiari /Lahore	Verify	The Emergency Current Control mode would be automatically activated.		
	166			current reaches the reference value after ramping is completed		
	167			No Transients		
	168		Verify Two poles are in stable operation at 800MW			
	169	Matiari	Enable the telecommunication in both channels			
	170		Order pole 1 in Bipolar Power Control Mode			
Test Acceptance Criteria	171	Matiari/Lahore C/S	The voltage of the AC system should be within the specified limits (450-550kV)			
	172		All Operations executed successfully			
	173		The synchronizing voltage and the phasing of the firing control signals are correct.			
	174		All thyristor check-back signals are available.			
	175		Measuring system and controls remain operational. No transients on switchover of PCP or SC systems.			
	176		Measuring quantities are available and the values are within the specified range and phase.			
	177		No abnormal corona discharges and no operation of surge arresters shall occur at energized equipment.			
	178		No Stuck Condition			
	179		No False Tripping by DC Protection System			
	180		All the sequence as recorded in OWS should be documented, All the Charts related to pole power,current, voltages, firing angles and extinction angles, tap positions. Should be recorded and documented. TFR data in Comtrade format to be captured and recorded.			
	181		No Tripping in AC side of converter Station			

Bipole Low Power Operational Tests

3-Automatic Power Curve Control Test

Test Objective	The test is to check the basic function of automatic power curve control of DC system.

Condition	Sr. No.	Station	Action	Equipment/ Configuration	State of Equipment/configuration	Description
Pre-Test Conditions & Configurations (AC/DC)	1	AC side at Matiari & Lahore C/S	Voltage Limits	Utmost efforts will be made to maintain the voltages within ±5% range. However, reactive compensation devices installed at both converter stations can be used, if needed, to control the voltages keeping in view the then prevailing system conditions.		
	2		AC Yard of Lahore & Matiari Converter Station is in normal Position		CLOSED State	All bays including Filter Banks are complete and energized with no component in maintenance state.
	3	DC Side at Matiari C/S	Both Poles will operate in Bipole Ground Return Mode see Status Table "BP-GR"			BI-Pole Mode of Operation
	4	General Preconditions	Converter transformer protection and the charging protection of corresponding converter AC bus breaker are put into operation.			
	5		All the Prerequisites as mentioned in DC Dispatch Plan should be met.			
	6		Visual inspections of AC switchyard, AC filter yard, DC yard and DC valve hall prior first energization or switching.			
	7		All electrical connections are available.			
	8		Protection settings and protective circuits trip sequences tests must be completed.			
	9		AC-switchyard and associated protections and sequences, including breaker failure protection, must be active.			
	10		Correct grounding of all equipment is available.			
	11		Thyristor valve cooling in operation for 24 hours, no water leakage observed.			
	12		Thyristor valves and valve hall is cleaned.			
	13		Converter transformers are demagnetized.			
	14		Air humidity and temperature in valve hall are within expected limits.			
	15		Pole Compensation (Annex-D-II must be successful)			
	16		Both sides AC system of Matiari & Lahore C/S are capable to supply and accept the power (600 MW) for the test. Availability of N-1 contingency on parallel AC corridor. AC system short circuit level has been measured at both Matiari and Lahore converter stations and it is confirmed to be suitable for the tested power.			
	17		OLT has been finished.			
	18		Both sides of AC system is capable to supply the power for the test.			
	19	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Direction	Normal		Matiari to Lahore
	20		Return	Ground		Ground Return Mode
	21		Udc Mode	Normal		±660 kV
	22		Telecom Mode	Operational		
	23		Master Station	Matiari		
	24	Configuration Setting at Lahore & Matiari C/S DC side	Station Control (SC)	A	ACTIVE	Can be changed to B during test
	25			B	Standby	
	26		Pole Control Protection (PCP)	A	ACTIVE	
	27			B	Standby	
	28		Transmission Control Mode	Power	ACTIVE	HVDC will operate in power control mode.
	29		Station Control Mode	Joint	Active	Matiari & Lahore will operate jointly.
	30		Reactive Power Control Mode	Automatic	ACTIVE	Automatically Switch in/out the AC Filters/Reactors
	31		Reactive Power Control Variable	Q-Control	ACTIVE	Reactive Power exchange between AC Yard of Converter Station and NTDC system will be automatically controlled.

Testing Start Up Sequence

Automatic Power Curve Control test	32	Matiari	Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	33		Verify Matiari is Master Station.			
	34	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	35	Matiari & Lahore	Start the BiPole	Power	400 MW	
	36			Ramp Rate:	50 MW/Min	
	37		Wait to achieve Target Value	Max Time	5 min	
	38	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	39			DC Voltages	±660kV	
	40			Electrode Current	<30 Amps	
	41			RPC Operation	BP-11/13 , HP24/36	
	42	Lahore		Extinction Angle (γ)	17°	
	43			DC Voltages	Range to be mentioned	
	44			RPC Operation	2xHP12/24	
	45	Matiari/Lahore	Verify stable operation & Normal start at reduced with minimum power			
	46		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	47	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	48	Lahore		2xHP12/24		
Automatic Power Curve Control test in Matiari Converter Station (Sr. No. 5) (A4 7.3.1)	49	Matiari	Set the bipole power curve and then switch the bipolar power control to automatic power control			
	50		Bipole Automatic Power Curve Setting	Bipolar power 400MW lasts for 15 minutes.		
	51			The power ramps up from 400MW to 500MW at a rate of 7MW/min.Manually switch the system during the power ramping up, including pole control and DC station control system.		
	52			The bipolar power 500MW lasts for 30 minutes		
	53			The power ramps up from 500MW to 600MW at a rate of 7MW/min.		
	54			The bipolar power 600MW lasts for 30 minutes		
	55			The power ramps down from 600MW to 500MW at a rate of 7MW/min.		
	56			The bipolar power 500MW lasts for 30 minutes.		
	57			The power ramps down from 500MW to 400MW at a rate of 7MW/min.		
	58		During the power ramping down, click the "Hold" button on OWS to verify that the power stops ramping down. And switch the bipolar power control to manual power control.			
	59		Manually ramp down the power to 400MW.			
Automatic Power Curve Control test in Lahore Converter Station (Sr. No. 6) (A4 7.3.2)	60	Lahore	Initiate Master Sequence at Lahore Station			
	61		Set the bipole power curve and then switch the bipolar power control to automatic power control			
	62		BipolE Automatic Power Curve Setting	Bipolar power 400MW lasts for 15 minutes.		
	63			The power ramps up from 400MW to 500MW at a rate of 7MW/min.Manually switch the system during the power ramping up, including pole control and DC station control system.		
	64			The bipolar power 500MW lasts for 30 minutes		
	65			The power ramps up from 500MW to 600MW at a rate of 7MW/min.		
	66			The bipolar power 600MW lasts for 30 minutes		
	67			The power ramps down from 600MW to 500MW at a rate of 7MW/min.		
	68			The bipolar power 500MW lasts for 30 minutes.		
	69			The power ramps down from 500MW to 400MW at a rate of 7MW/min.		
	70		During the power ramping down, click the "Hold" button on OWS to verify that the power stops ramping down. And switch the bipolar power control to manual power control.			
	71		Manually ramp down the power to 400MW.			

Test Acceptance Criteria	72	Matiari/Lahore C/S	The voltage of the AC system should be within the specified limits (450-550kV)	
	73		All Operations executed successfully	
	74		The synchronizing voltage and the phasing of the firing control signals are correct.	
	75		All thyristor check-back signals are available.	
	76		Measuring system and controls remain operational. No transients on switchover of PCP or SC systems.	
	77		Measuring quantities are available and the values are within the specified range and phase.	
	78		No abnormal corona discharges and no operation of surge arresters shall occur at energized equipment.	
	79		No Stuck Condition	
	80		No False Tripping by DC Protection System	
	81		All the sequence as recorded in OWS should be documented, All the Charts related to pole power,current, voltages, firing angles and extinction angles, tap positions. Should be recorded and documented. TFR data in Comtrade format to be captured and recorded.	
	82		No Tripping in AC side of converter Station	

Bipole Low Power Operational Tests

4-Normal/Reduced Voltage Operation

Test Objective	The test objective is to check the DC system performance during reduced voltage operation.

Condition	Sr. No.	Station	Action	Equipment/ Configuration	State of Equipment/configuration	Description
Pre-Test Conditions & Configurations (AC/DC)	1	AC side at Matiari & Lahore C/S	Voltage Limits	Utmost efforts will be made to maintain the voltages within ±5% range. However, reactive compensation devices installed at both converter stations can be used, if needed, to control the voltages keeping in view the then prevailing system conditions.		
	2		AC Yard of Lahore & Matiari Converter Station is in normal Position		CLOSED State	All bays including Filter Banks are complete and energized with no component in maintenance state.
	3	DC Side at Matiari C/S	Both Poles will operate in Bipole Ground Return Mode see Status Table "BP-GR"			BI-Pole Mode of Operation
	4	General Preconditions	Converter transformer protection and the charging protection of corresponding converter AC bus breaker are put into operation.			
	5		All the Prerequisites as mentioned in DC Dispatch Plan should be met.			
	6		Visual inspections of AC switchyard, AC filter yard, DC yard and DC valve hall prior first energization or switching.			
	7		All electrical connections are available.			
	8		Protection settings and protective circuits trip sequences tests must be completed.			
	9		AC-switchyard and associated protections and sequences, including breaker failure protection, must be active.			
	10		Correct grounding of all equipment is available.			
	11		Thyristor valve cooling in operation for 24 hours, no water leakage observed.			
	12		Thyristor valves and valve hall is cleaned.			
	13		Converter transformers are demagnetized.			
	14		Air humidity and temperature in valve hall are within expected limits.			
	15		Automatic Power Curve Control Test (Annex-D-III must be successful)			
	16		Both sides AC system of Matiari & Lahore C/S are capable to supply and accept the power (600 MW) for the test. Availability of N-1 contingency on parallel AC corridor. AC system short circuit level has been measured at both Matiari and Lahore converter stations and it is confirmed to be suitable for the tested power.			
	17		OLT has been finished.			
	18		Both sides of AC system is capable to supply the power for the test.			
	19	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Direction	Normal		Matiari to Lahore
	20		Return	Ground		Ground Return Mode
	21		Udc Mode	Reduced		±462kV
	22		Telecom Mode	Operational		
	23		Master Station	Matiari		
	24	Configuration Setting at Lahore & Matiari C/S DC side	Station Control (SC)	A	ACTIVE	Can be changed to B during test
	25			B	Standby	
	26		Pole Control Protection (PCP)	A	ACTIVE	
	27			B	Standby	
	28		Transmission Control Mode	Power	ACTIVE	HVDC will operate in power control mode.
	29		Station Control Mode	Joint	Active	Matiari & Lahore will operate jointly.
	30		Reactive Power Control Mode	Automatic	ACTIVE	Automatically Switch in/out the AC Filters/Reactors
	31		Reactive Power Control Variable	Q-Control	ACTIVE	Reactive Power exchange between AC Yard of Converter Station and NTDC system will be automatically controlled.

Testing Start Up Sequence

Reduced Voltage Operation Test (Sr. No. 7) (A4 5.3.1)	32	Matiari	Set manually REDUCED VOLTAGE mode (70% of nominal voltage) in pole 1 from Matiari.			
	33		Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	34	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	35	Matiari & Lahore	Start the Pole-1,	Power	400 MW	
	36			Ramp Rate:	50 MW/Min	
	37		Wait to achieve Target Value	Max Time	5 min	
	38	Matiari	Verify Performance indicators	Firing angle (α)	>15°±2.5° (expected pole 1), 15°±2.5° (pole 2),	Record the Firing angle and transformer tap
	39			DC Voltages (Pole-I)	462 kV	
	40			DC Voltages (Pole-II)	660 kV	
	41			Electrode Current	<30 Amps	
	42			RPC Operation	BP-11/13 , HP24/36	
	43	Lahore		Extinction Angle (γ)	>17° (expected pole 1), 17° (pole 2)	Record the Firing angle and transformer tap
	44			DC Voltages	Range to be mentioned	
	45			RPC Operation	2xHP12/24	
	46	Matiari & Lahore	Verify stable operation & Normal start at reduced with minimum power			
	47		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	48	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	49	Lahore		2xHP12/24		
	50	Matiari	Order Reduced Voltages (462kV) in Pole-II			
	51		Verify Pole 2 DC Voltages is ramping down to Reduced Voltages without change in power and reach the specified volatges smoothly and without any interruption.			
	52	Matiari/Lahore	Verify	DC Voltages (Pole-I)	462 kV	Record the Firing angle and transformer tap at both stations
	53			DC Voltages (Pole-II)	462 kV	Record the Firing angle and transformer tap at both stations
	54			Electrode Current	<30 Amps	
	55	Matiari	Ramp Up	400 MW	600 MW	100 MW
	56	Matiari/Lahore	Verify DC Voltage remains unchanged as dc power ramps up and reaches the specified power smoothly and without any interruption.			
	57	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 200 MW with DC System. (Sudden load sharing from DC corridor to AC corridor will happen in next step)			
	58		Ramp Down	600 MW	400 MW	999 MW
	59	Matiari/Lahore	Verify DC Voltage remains unchanged as dc power ramps down quickly and reaches the specified power smoothly and without any interruption.			
	60	Matiari/Lahore	Stop the Pole			
	61		Verify Performance parameters	Retard, Reduced Current		Block without BPP
	62	Lahore		Alpha angle	90	Block with BPP
Test Acceptance Criteria	63	Matiari/Lahore C/S	The voltage of the AC system should be within the specified limits (450-550kV)			
	64		All Operations executed successfully			
	65		The synchronizing voltage and the phasing of the firing control signals are correct.			
	66		All thyristor check-back signals are available.			
	67		Measuring system and controls remain operational. No transients on switchover of PCP or SC systems.			
	68		Measuring quantities are available and the values are within the specified range and phase.			
	69		No abnormal corona discharges and no operation of surge arresters shall occur at energized equipment.			
	70		No Stuck Condition			
	71		No False Tripping by DC Protection System			
	72		All the sequence as recorded in OWS should be documented, All the Charts related to pole power,current, voltages, firing angles and extinction angles, tap positions. Should be recorded and documented. TFR data in Comtrade format to be captured and recorded.			
	73		No Tripping in AC side of converter Station			

Bipole Low Power Operational Tests

5-Backup Control

Test Objective	The test is to check the deblock/block function from backup control.					
Condition	**Sr. No.**	**Station**	**Action**	**Equipment/ Configuration**	**State of Equipment/configuration**	**Description**
Pre-Test Conditions & Configurations (AC/DC)	1	AC side at Matiari & Lahore C/S	Voltage Limits	Utmost efforts will be made to maintain the voltages within ±5% range. However, reactive compensation devices installed at both converter stations can be used, if needed, to control the voltages keeping in view the then prevailing system conditions.		
	2	AC side at Matiari & Lahore C/S	AC Yard of Lahore & Matiari Converter Station is in normal Position		CLOSED State	All bays including Filter Banks are complete and energized with no component in maintenance state.
	3	DC Side at Matiari C/S	Both Poles will operate in Bipole Ground Return Mode see Status Table "BP-GR"			BI-Pole Mode of Operation
	4	General Preconditions	Converter transformer protection and the charging protection of corresponding converter AC bus breaker are put into operation.			
	5	General Preconditions	All the Prerequisites as mentioned in DC Dispatch Plan should be met.			
	6	General Preconditions	Visual inspections of AC switchyard, AC filter yard, DC yard and DC valve hall prior first energization or switching.			
	7	General Preconditions	All electrical connections are available.			
	8	General Preconditions	Protection settings and protective circuits trip sequences tests must be completed.			
	9	General Preconditions	AC-switchyard and associated protections and sequences, including breaker failure protection, must be active.			
	10	General Preconditions	Correct grounding of all equipment is available.			
	11	General Preconditions	Thyristor valve cooling in operation for 24 hours, no water leakage observed.			
	12	General Preconditions	Thyristor valves and valve hall is cleaned.			
	13	General Preconditions	Converter transformers are demagnetized.			
	14	General Preconditions	Air humidity and temperature in valve hall are within expected limits.			
	15	General Preconditions	Reduced Voltage Operation (Annex-D-IV must be successful)			
	16	General Preconditions	Both sides AC system of Matiari & Lahore C/S are capable to supply and accept the power (600 MW) for the test. Availability of N-1 contingency on parallel AC corridor. AC system short circuit level has been measured at both Matiari and Lahore converter stations and it is confirmed to be suitable for the tested power.			
	17	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Direction	Normal		Matiari to Lahore
	18	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Return	Ground		Ground Return Mode
	19	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Udc Mode	Normal		±660 kV
	20	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Telecom Mode	Operational		
	21	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Master Station	Matiari		
	22	Configuration Setting at Matiari & Lahore C/S DC side	Station Control (SC)	A	ACTIVE	Can be changed to B during test
	23	Configuration Setting at Matiari & Lahore C/S DC side	Station Control (SC)	B	Standby	
	24	Configuration Setting at Matiari & Lahore C/S DC side	Pole Control Protection (PCP)	A	ACTIVE	
	25	Configuration Setting at Matiari & Lahore C/S DC side	Pole Control Protection (PCP)	B	Standby	
	26	Configuration Setting at Matiari & Lahore C/S DC side	Transmission Control Mode	Power	ACTIVE	HVDC will operate in power control mode.
	27	Configuration Setting at Matiari & Lahore C/S DC side	Station Control Mode	Joint	Active	Matiari & Lahore will operate jointly.
	28	Configuration Setting at Matiari & Lahore C/S DC side	Reactive Power Control Mode	Automatic	ACTIVE	Automatically Switch in/out the AC Filters/Reactors
	29	Configuration Setting at Matiari & Lahore C/S DC side	Reactive Power Control Variable	Q-Control	ACTIVE	Reactive Power exchange between AC Yard of Converter Station and NTDC system will be automatically controlled.

Testing Start Up Sequence

Bipole Start/Stop in Backup Panel at Matiari (Sr. No. 8) (A4 9.3.1)	30	Matiari	Switch DC Local Control Interface from 'REMOTE' to 'LOCAL'.			
	31	Matiari/Lahore C/S DC	Verify Ready for Operation Conditions.			
	32	Matiari	Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	33		Start the BIPOLE	Power	400 MW	
	34			Ramp Rate:	50 MW/Min	
	35		Wait to achieve Target Value	Max Time	5 min	
	36		Verify Performance indicators	Firing angle (α)	15°±2.5°	
	37			DC Voltages	±660kV	
	38			RPC Operation	BP-11/13 , HP24/36	
	39	Lahore		Extinction Angle (γ)	17°	
	40			DC Voltages	Range to be mentioned	
	41			RPC Operation	2xHP12/24	
	42	Matiari/Lahore	Verify stable operation & Normal start with minimum power			
	43		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	44		normal start behavior and stable operation at minimum power			
	45	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	46	Lahore		2xHP12/24		
	47	Matiari	Stop the Pole			
	48		Verify Performance parameters	Retard, Reduced Current		
	49	Lahore		Alpha angle	90	
	50	Matiari/Lahore	Verify normal stop behavior			
	51	Matiari	Switch DC Local Control Interface from 'LOCAL' to 'REMOTE'.			
Bipole Start/Stop in Backup Panel at Lahore (Sr. No. 9) (A4 9.3.1)	52	Lahore	Switch DC Local Control Interface from 'REMOTE' to 'LOCAL'.			
	53		Initiate the sequence of MASTER station.			
	54	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	55	Lahore	Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	56		Start the BIPOLE	Power	400 MW	
	57			Ramp Rate:	50 MW/Min	
	58		Wait to achieve Target Value	Max Time	5 min	
	59	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	60			DC Voltages	±660kV	
	61			RPC Operation	BP-11/13 , HP24/36	
	62	Lahore		Extinction Angle (γ)	17°	
	63			DC Voltages	Range to be mentioned	
	64			RPC Operation	2xHP12/24	
	65	Matiari/Lahore	Verify stable operation & Normal start at reduced with minimum power			
	66		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	67		normal start behavior and stable operation at minimum power			
	68	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	69	Lahore		2xHP12/24		
	70	Matiari	Stop the Pole			
	71		Verify Performance parameters	Retard, Reduced Current		
	72	Lahore		Alpha angle	90	
	73	Matiari/Lahore	Verify normal stop behavior			
	74	Lahore	Confirm DC Local Control Interface is set to 'LOCAL'			

Bipole Ramp up/down in Backup Panel (Sr. No. 10) (A4 9.3.2)	75	Matiari	Switch DC Local Control Interface from 'REMOTE' to 'LOCAL'.			
	76		Initiate the sequence of MASTER station.			
	77	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	78	Matiari & Lahore	Start the Bi-Pole	Power	400 MW	
	79			Ramp Rate:	50 MW/Min	
	80		Wait to achieve Target Value	Max Time	5 min	
	81	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	82			DC Voltages	±660kV	
	83			RPC Operation	BP-11/13 , HP24/36	
	84	Lahore		Extinction Angle (γ)	17°	
	85			DC Voltages	Range to be mentioned	
	86			RPC Operation	2xHP12/24	
	87	Matiari/Lahore	Verify stable operation & Normal start at reduced with minimum power			
	88		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	89	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	90	Lahore		2xHP12/24		
	91	Matiari	Ramp Up	400 MW	500 MW	50 MW/Min
	92		Verify that the current reaches the reference value after each ramping is completed in both stations and that the ramping process is smooth and without disturbances.			
	93		Ramp Up	500 MW	600 MW	25 MW/Min
	94		Order STOP RAMPING (During Ramping).			
	95		Verify also that the ramp could stop while ramping and power reaches the reference value after each ramping is completed in both stations and that the ramping process is smooth and without disturbances.			
	96	Lahore	Initiate the sequence of MASTER station.			
	97		Ramp Down	600 MW	500 MW	50 MW/Min
	98		Verify that the power reaches the reference value after each ramping is completed in both stations and that the ramping process is smooth and without disturbances.			
	99		Ramp Down	500 MW	400 MW	25 MW/Min
	100		Order STOP RAMPING (During Ramping).			
	101		Verify also that the ramp could stop while ramping and power reaches the reference value after each ramping is completed in both stations and that the ramping process is smooth and without disturbances.			
	102	Matiari/Lahore	Switch DC Local Control Interface from 'LOCAL' to 'REMOTE'.			
	103	Matiari/Lahore	Stop the Bipole			
	104		Verify Performance parameters	Retard, Reduced Current		Block without BPP
	105	Lahore		Alpha angle	90	Block with BPP
Test Acceptance Criteria	106	Matiari/Lahore C/S	The voltage of the AC system should be within the specified limits (450-550kV)			
	107		All Operations executed successfully			
	108		The synchronizing voltage and the phasing of the firing control signals are correct.			
	109		All thyristor check-back signals are available.			
	110		Measuring system and controls remain operational. No transients on switchover of PCP or SC systems.			
	111		Measuring quantities are available and the values are within the specified range and phase.			
	112		No abnormal corona discharges and no operation of surge arresters shall occur at energized equipment.			
	113		No Stuck Condition			
	114		No False Tripping by DC Protection System			
	115		All the sequence as recorded in OWS should be documented, All the Charts related to pole power,current, voltages, firing angles and extinction angles, tap positions. Should be recorded and documented. TFR data in Comtrade format to be captured and recorded.			
	116		No Tripping in AC side of converter Station			

Bipole Low Power DisturbanceTests

6-Pole Compensation by Disturbance tests

Test Objective	The test objective is to check the pole compensation function.

Condition	Sr. No.	Station	Action	Equipment/ Configuration	State of Equipment/configuration	Description
Pre-Test Conditions & Configurations (AC/DC)	1	AC side at Matiari & Lahore C/S	Voltage Limits	Utmost efforts will be made to maintain the voltages within ±5% range. However, reactive compensation devices installed at both converter stations can be used, if needed, to control the voltages keeping in view the then prevailing system conditions.		
	2		AC Yard of Lahore & Matiari Converter Station is in normal Position		CLOSED State	All bays including Filter Banks are complete and energized with no component in maintenance state.
	3	DC Side at Matiari C/S	Both Poles will operate in Bipole Ground Return Mode see Status Table "BP-GR"			BI-Pole Mode of Operation
	4	General Preconditions	Converter transformer protection and the charging protection of corresponding converter AC bus breaker are put into operation.			
	5		All the Prerequisites as mentioned in DC Dispatch Plan should be met.			
	6		Visual inspections of AC switchyard, AC filter yard, DC yard and DC valve hall prior first energization or switching.			
	7		All electrical connections are available.			
	8		Protection settings and protective circuits trip sequences tests must be completed.			
	9		AC-switchyard and associated protections and sequences, including breaker failure protection, must be active.			
	10		Correct grounding of all equipment is available.			
	11		Thyristor valve cooling in operation for 24 hours, no water leakage observed.			
	12		Thyristor valves and valve hall is cleaned.			
	13		Converter transformers are demagnetized.			
	14		Set tap changer to position giving lowest valve voltage			
	15		Bipole Low Power Operational tests (Annex-D-I,II,III,IV,V must be successful)			
	16		Both sides AC system of Matiari & Lahore C/S are capable to supply and accept the power (800 MW) for the test. Availability of N-1 contingency on parallel AC corridor. AC system short circuit level has been measured at both Matiari and Lahore converter stations and it is confirmed to be suitable for the tested power.			
	17	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Direction	Normal		Matiari to Lahore
	18		Return	Ground		Ground Return Mode
	19		Udc Mode	Normal		±660kV
	20		Telecom Mode	Operational		
	21		Master Station	Matiari		
	22	Configuration Setting at Matiari & Lahore C/S DC side	Station Control (SC)	A	ACTIVE	Can be changed to B during test
	23			B	Standby	
	24		Pole Control (PCP)	A	ACTIVE	
	25			B	Standby	
	26		Transmission Control Mode	Power	ACTIVE	HVDC will operate in power control mode.
	27		Station Control Mode	Joint	Active	Matiari & Lahore will operate jointly.
	28		Reactive Power Control Mode	Automatic	ACTIVE	Automatically Switch in/out the AC Filters/Reactors
	29		Reactive Power Control Variable	Q-Control	ACTIVE	Reactive Power exchange between AC Yard of Converter Station and NTDC system will be automatically controlled.

Testing Start Up Sequence

Pole-2 Trip, Power Transfer at Normal Voltage (Sr. No. 11) (A4 3.3.4)	30	Matiari/Lahore	Verify Pole-I and Pole-II is in stable Bi-Pole Power Control Mode at 800 MW in sequence to test above.			
	31	Matiari	Verify Pole 2 valve cooling pump A is active			
	32		Switch off the AC power supply for the pump A in the valve cooling system in pole 2			
	33		Verify the pump B is put into operation.			
	34		Restore the AC power supply for the pump A in the valve cooling system in pole 2.			
	35		Switch off the AC power supply for the pump B in the valve cooling system in pole 2			
	36		Verify the pump A is put into operation.			
	37	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	38	Matiari	Switch off the AC power supply for the pump A in the valve cooling system to simulate Valve Cooling System Fault in Matiari in pole 2.			
	39		Verify Protection Functions	Y-block		
	40			Trip	Converter T/F AC Breakers	
	41			Pole IsolationSequence		
	42			Start Breaker Failure Protection		
	43			Set lockout relay for the tripped AC circuit breaker(s)		
	44	Lahore		Normal Y-stop sequence		
	45	Matiari/Lahore		No influence on Transmissted power		
	46	Matiari	Restore the AC power supply for the pumps A & B in the valve cooling system in pole 2.			
	47	Lahore	De-energize the converter transformer at pole 2 in LAHORE station.			
	48	Matiari/Lahore	Energize the converter transformer of pole 2.			
	49	Matiari/Lahore	Verify that energization of converter transformer does not result in commutation failure on Pole 1 and has no influence on the transmitted bipole power.			
	50	Matiari/Lahore	Order pole 2 in Pole Power Control.			
	51	Matiari	Start Pole 2	Power	200 MW	
	52			Ramp Rate:	50MW/Min	
	53	Matiari/Lahore	Order pole 2 in Bipolar Power Control Model.			
	54	Matiari/Lahore	Verify	the power of pole 2 will rapidly ramp to 400MW for sharing the bipole power.		
	55			there is no influence on the transmitted bipole power.		
	56			Right RPC ACTION		
Pole-1 Trip, Power Transfer at Normal Voltage (Sr. No. 12) (A4 3.3.4)	57	Matiari/Lahore	Verify Pole-I and Pole-II is in stable Bi-Pole Power Control Mode at 800 MW in sequence to test above.			
	58	Matiari	Verify pole 1 valve cooling pump A is active			
	59		Switch off the AC power supply for the pump A in the valve cooling system in pole 1			
	60		Verify the pump B is put into operation.			
	61		Restore the AC power supply for the pump A in the valve cooling system in pole 1			
	62		Switch off the AC power supply for the pump B in the valve cooling system in pole 1			
	63		Verify the pump A is put into operation.			
	64	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	65	Matiari	Switch off the AC power supply for the pump A in the valve cooling system to simulate Valve Cooling System Fault in Matiari in pole 1			
	66		Verify Protection Functions	Y-block		
	67			Trip	Converter T/F AC Breakers pole-1	
	68			Pole IsolationSequence		
	69			Start Breaker Failure Protection		
	70			Set lockout relay for the tripped AC circuit breaker(s)		
	71	Lahore		Normal Y-stop sequence		
	72	Matiari/Lahore		No influence on Transmissted power		
	73	Matiari	Restore the AC power supply for the pumps A & B in the valve cooling system in pole 1.			
	74	Lahore	De-energize the converter transformer at pole 1 in LAHORE station.			
	75	Matiari/Lahore	Energize the converter transformer of pole 1			
	76	Matiari/Lahore	Verify that energization of converter transformer does not result in commutation failure on Pole 1 and has no influence on the transmitted bipole power.			
	77	Matiari/Lahore	Order pole 1 in Pole Power Control.			
	78	Matiari	Start Pole 1	Power	200 MW	
	79			Ramp Rate:	50MW/Min	
	80	Matiari/Lahore	Order pole 1 in Bipolar Power Control Model.			
	81	Matiari/Lahore	Verify	the power of pole 1 will rapidly ramp to 400MW for sharing the bipole power.		
	82			there is no influence on the transmitted bipole power.		
	83			Right RPC ACTION		

Pole-1 Trip, Power Transfer at Reduced Voltage (Sr. No. 13) (A4 3.3.4)	84	Matiari/Lahore	Verify Pole-I and Pole-II is in stable Bi-Pole Power Control Mode at 800 MW in sequence to test above.			
	85	Matiari	Order pole 2 in REDUCED VOLTAGE (70% of nominal voltage).			
	86		Verify	order of pole 2 changed to reduced voltage successfully.		
	87			there is no influence on the transmitted bipole power.		
	88	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	89	Lahore	Simulate pole-I Pole Bus Differential Protection Stage 2TRIP			
	90		Verify	Z-block		
	91			Blocking of the converter with by-pass pair		
	92			Trip Action	Converter T/F AC Breakers of Pole-I	
	93			Pole IsolationSequence		
	94			Start Breaker Failure Protection		
	95			Set lockout relay for the tripped AC circuit breaker(s)		
	96	Matiari		Normal Y-stop sequence.		
	97	Matiari/Lahore		there is no influence on the transmitted bipolar power and the HVDC system is still in operation.		
	98	Matiari/Lahore	Switch pole 1 into Pole Power Control mode.			
	99	Matiari	Start Pole 1	Power	200 MW	
	100			Ramp Rate:	50MW/Min	
	101	Matiari/Lahore	Switch pole 1 into Bipolar Power Control Model mode.			
	102	Matiari/ Lahore	Verify	power of pole 1 would rapidly boost to 470MW for sharing the bipole power and ensuring electrode		
	103			there is no influence on the transmitted bipole power.		
	104		Order pole 2 in Normal VOLTAGE.			
	105		Verify that each pole is operating at 400MW (Bipole=800 MW)			
Pole-2 Trip, Power Transfer at Reduced Voltage (Sr. No. 14) (A4 3.3.5)	106	Matiari/Lahore	Verify Pole-I and Pole-II is in stable Bi-Pole Power Control Mode at 800 MW in sequence to test above.			
	107	Matiari	Order pole 1 in REDUCED VOLTAGE (70% of nominal voltage).			
	108		Verify	order of pole 1 changed to reduced voltage successfully.		
	109			there is no influence on the transmitted bipole power.		
	110	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	111	Lahore	Simulate pole-2 Pole Bus Differential Protection Stage 2TRIP			
	112		Verify	Z-block		
	113			Blocking of the converter with by-pass pair		
	114			Trip Action	Converter T/F AC Breakers of Pole-I	
	115			Pole IsolationSequence		
	116			Start Breaker Failure Protection		
	117			Set lockout relay for the tripped AC circuit breaker(s)		
	118	Matiari		Normal Y-stop sequence.		
	119	Matiari/Lahore		there is no influence on the transmitted bipolar power and the HVDC system is still in operation.		
	120	Matiari/Lahore	Switch pole 2 into Pole Power Control mode.			
	121	Matiari	Start Pole 2	Power	200 MW	
	122			Ramp Rate:	50MW/Min	
	123	Matiari/Lahore	Switch pole 2 into Bipolar Power Control Model mode.			
	124		Verify	power of pole 2 would rapidly boost to 470MW for sharing the bipole power and ensuring electrode		
	125			there is no influence on the transmitted bipole power.		
	126	Matiari	Order pole 1 in Normal VOLTAGE.			
	127		Verify that each pole is operating at 400MW (Bipole=800 MW)			
	128		Ramp Down	800 MW	400 MW	50 MW/min

Test Acceptance Criteria	129	Matiari/Lahore C/S	The voltage of the AC system should be within the specified limits (450-550kV)	
	130		All Operations executed successfully	
	131		The synchronizing voltage and the phasing of the firing control signals are correct.	
	132		All thyristor check-back signals are available.	
	133		Measuring system and controls remain operational. No transients on switchover of PCP or SC systems.	
	134		Measuring quantities are available and the values are within the specified range and phase.	
	135		No abnormal corona discharges and no operation of surge arresters shall occur at energized equipment.	
	136		No Stuck Condition	
	137		No False Tripping by DC Protection System	
	138		All the sequence as recorded in OWS should be documented, All the Charts related to pole power,current, voltages, firing angles and extinction angles, tap positions. Should be recorded and documented. TFR data in Comtrade format to be captured and recorded.	
	139		No Tripping in AC side of converter Station	

Bipole Low Power DisturbanceTests

7-Operation with Station Ground Test

Test Objective	The test objective is to check the function of electrode line balancing.

Condition	Sr. No.	Station	Action	Equipment/ Configuration	State of Equipment/configuration	Description
Pre-Test Conditions & Configurations (AC/DC)	1	AC side at Matiari & Lahore C/S	Voltage Limits	Utmost efforts will be made to maintain the voltages within ±5% range. However, reactive compensation devices installed at both converter stations can be used, if needed, to control the voltages keeping in view the then prevailing system conditions.		
	2		AC Yard of Lahore & Matiari Converter Station is in normal Position		CLOSED State	All bays including Filter Banks are complete and energized with no component in maintenance state.
	3	DC Side at Matiari C/S	Both Poles will operate in Bipole Ground Return Mode see Status Table "BP-GR"			BI-Pole Mode of Operation
	4	General Preconditions	Converter transformer protection and the charging protection of corresponding converter AC bus breaker are put into operation.			
	5		All the Prerequisites as mentioned in DC Dispatch Plan should be met.			
	6		Visual inspections of AC switchyard, AC filter yard, DC yard and DC valve hall prior first energization or switching.			
	7		All electrical connections are available.			
	8		Protection settings and protective circuits trip sequences tests must be completed.			
	9		AC-switchyard and associated protections and sequences, including breaker failure protection, must be active.			
	10		Correct grounding of all equipment is available.			
	11		Thyristor valve cooling in operation for 24 hours, no water leakage observed.			
	12		Thyristor valves and valve hall is cleaned.			
	13		Converter transformers are demagnetized.			
	14		Air humidity and temperature in valve hall are within expected limits.			
	15		Pole Compensation by disturbance (Annex-D-VI must be successful)			
	16		Both sides AC system of Matiari & Lahore C/S are capable to supply and accept the power (600 MW) for the test. Availability of N-1 contingency on parallel AC corridor. AC system short circuit level has been measured at both Matiari and Lahore converter stations and it is confirmed to be suitable for the tested power.			
	17	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Direction	Normal		Matiari to Lahore
	18		Return	Ground		Ground Return Mode
	19		Udc Mode	Normal		±660kV
	20		Telecom Mode	Operational		
	21		Master Station	Matiari		
	22	Configuration Setting at Matiari & Lahore C/S DC side	Station Control (SC)	A	ACTIVE	Can be changed to B during test
	23			B	Standby	
	24		Pole Control Protection (PCP)	A	ACTIVE	
	25			B	Standby	
	26		Transmission Control Mode	Power	ACTIVE	HVDC will operate in power control mode.
	27		Station Control Mode	Joint	Active	Matiari & Lahore will operate jointly.
	28		Reactive Power Control Mode	Automatic	ACTIVE	Automatically Switch in/out the AC Filters/Reactors
	29		Reactive Power Control Variable	Q-Control	ACTIVE	Reactive Power exchange between AC Yard of Converter Station and NTDC system will be automatically controlled.

Testing Start Up Sequence

Start/Stop Bipole with Station Grounding at Matiari & LAHORE Converter (Sr. No. 15) (A4 4.3.1)	30	Matiari/Lahore C/S DC	Verify Poles are Blocked and qualify Ready for Operation Conditions.			
	31	Matiari	Instruct to Close NGBS (Manually)	NGBS	Closed	
	32		Instruct to Open MRTB (Manually)	MRTB	OPEN	now Matiari is at station grounding.
	33	Lahore	Instruct to Close NGBS (Manually)	NGBS	Closed	
	34		Instruct to Open WN3Q11 (Manually)	WN3Q11	OPEN	now Matiari is at station grounding.
	35	Matiari/ Lahore	Verify Pole 1 and Pole 2 in Bipolar Power Control Mode respectively			
	36	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing for upto 600 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	37	Matiari	Start the BiPole	Power	400 MW	
	38			Ramp Rate:	50MW/Min	
	39		Wait to achieve Target Value	Max Time	5 min	
	40		Verify Performance indicators	Firing angle (α)	15°±2.5°	
	41			DC Voltages	±660kV	
	42			RPC Operation	BP-11/13 , HP24/36	
	43	Lahore		Extinction Angle (γ)	17°	
	44			DC Voltages	Range to be mentioned	
	45			RPC Operation	2xHP12/24	
	46	Matiari/Lahore	Verify stable operation at minimum power.			
	47		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	48	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	49	Lahore		HP-12/24, HP-12/24		
	50	Matiari	Ramp Up	400 MW	600 MW	50 Amps/Min
	51	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	52			current reaches the reference value after ramping is completed		
	53			NBGS current<30 A		
	54			No Transients		
	55	Matiari	Ramp Down	600 MW	400 MW	50 Amps/Min
	56	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	57			current reaches the reference value after ramping is completed		
	58			NBGS current<30 A		
	59			No Transients		
	60	Matiari	Stop the Bipole			
	61		Verify Performance parameters	Retard, Reduced Current		Block without BPP
	62	Lahore		Alpha angle	90	Block with BPP
	63	Matiari	Instruct to Close MRTB (Manually)	MRTB	Close	
	64	Lahore	Instruct to Close WN3Q11 (Manually)	WN3Q11	Close	
	65	Matiari/Lahore	Instruct to Open NGBS (Manually)	NBGS	OPEN	Now both stations in ground return configuration
Test Acceptance Criteria	66	Matiari/Lahore C/S	The voltage of the AC system should be within the specified limits (450-550kV)			
	67		All Operations executed successfully			
	68		The synchronizing voltage and the phasing of the firing control signals are correct.			
	69		All thyristor check-back signals are available.			
	70		Measuring system and controls remain operational. No transients on switchover of PCP or SC systems.			
	71		Measuring quantities are available and the values are within the specified range and phase.			
	72		No abnormal corona discharges and no operation of surge arresters shall occur at energized equipment.			
	73		No Stuck Condition			
	74		No False Tripping by DC Protection System			
	75		All the sequence as recorded in OWS should be documented, All the Charts related to pole power,current, voltages, firing angles and extinction angles, tap positions. Should be recorded and documented. TFR data in Comtrade format to be captured and recorded.			
	76		No Tripping in AC side of converter Station			

Bipole Low Power DisturbanceTests

8-Disturbances

Test Objective: The test is to check the DC system performance during the disturbance.

Condition	Sr. No.	Station	Action	Equipment/ Configuration	State of Equipment/configuration	Description
Pre-Test Conditions & Configurations (AC/DC)	1	AC side at Matiari & Lahore C/S	Voltage Limits	Utmost efforts will be made to maintain the voltages within ±5% range. However, reactive compensation devices installed at both converter stations can be used, if needed, to control the voltages keeping in view the then prevailing system conditions.		
	2		AC Yard of Lahore & Matiari Converter Station is in normal Position		CLOSED State	All bays including Filter Banks are complete and energized with no component in maintenance state.
	3	DC Side at Matiari C/S	Both Poles will operate in Bipole Ground Return Mode see Status Table "BP-GR"			BI-Pole Mode of Operation
	4	General Preconditions	Converter transformer protection and the charging protection of corresponding converter AC bus breaker are put into operation.			
	5		All the Prerequisites as mentioned in DC Dispatch Plan should be met.			
	6		Visual inspections of AC switchyard, AC filter yard, DC yard and DC valve hall prior first energization or switching.			
	7		All electrical connections are available.			
	8		Protection settings and protective circuits trip sequences tests must be completed.			
	9		AC-switchyard and associated protections and sequences, including breaker failure protection, must be active.			
	10		Correct grounding of all equipment is available.			
	11		Thyristor valve cooling in operation for 24 hours, no water leakage observed.			
	12		Thyristor valves and valve hall is cleaned.			
	13		Converter transformers are demagnetized.			
	14		Air humidity and temperature in valve hall are within expected limits.			
	15		Operation with Station Ground (Annex-D-VII must be successful)			
	16		Both sides AC system of Matiari & Lahore C/S are capable to supply and accept the power (600 MW) for the test. Availability of N-1 contingency on parallel AC corridor. AC system short circuit level has been measured at both Matiari and Lahore converter stations and it is confirmed to be suitable for the tested power.			
	17	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Direction	Normal		Matiari to Lahore
	18		Return	Ground		Ground Return Mode
	19		Udc Mode	Normal		±660 kV
	20		Telecom Mode	Operational		
	21		Master Station	Matiari		
	22	Configuration Setting at Lahore & Matiari C/S DC side	Station Control (SC)	A	ACTIVE	Can be changed to B during test
	23			B	Standby	
	24		Pole Control Protection (PCP)	A	ACTIVE	
	25			B	Standby	
	26		Transmission Control Mode	Power	ACTIVE	HVDC will operate in power control mode.
	27		Station Control Mode	Joint	Active	Matiari & Lahore will operate jointly.
	28		Reactive Power Control Mode	Automatic	ACTIVE	Automatically Switch in/out the AC Filters/Reactors
	29		Reactive Power Control Variable	Q-Control	ACTIVE	Reactive Power exchange between AC Yard of Converter Station and NTDC system will be automatically controlled.

Testing Start Up Sequence

Pole Trip, Open Line Fault at Electrode at Lahore (Sr. No. 16) (A4 6.3.1)	30	Matiari / Lahore	Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	31	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	32	Matiari & Lahore	Start the Pole-1,	Power	400 MW	
	33			Ramp Rate:	50 MW/Min	
	34		Wait to achieve Target Value	Max Time	5 min	
	35	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	36			DC Voltages	±660kV	
	37			RPC Operation	BP-11/13 , HP24/36	
	38	Lahore		Extinction Angle (γ)	17°	
	39			DC Voltages	Range to be mentioned	
	40			RPC Operation	2xHP12/24	
	41	Matiari/Lahore	Verify stable operation & Normal start at minimum power			
	42		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	43	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	44	Lahore		2xHP12/24		
	45	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	46	Lahore	Instruct Test Director to simulate Electrode Line Open Circuit Protection Stage 2 Action, and then the NBGS would be automatically closed.			
	47		Verify NBGS closed			
	48		Instruct to Open WN3Q11 (Manually)	WN3Q11	OPEN	
	49	Matiari	Simulate Pole Bus Differential Protection Stage 2TRIP			
	50	Matiari/Lahore	Verify	Pole-I Tripped		
	51			Pole-2 consecutively trip because of overcurrent on the NBGS at Lahore		
	52	Lahore	Instruct to Close WN3Q11 (Manually)			
	53		Instruct to open NBGS			
Pole Trip, Open Line Fault at Electrode at Matiari (Sr. No. 17) (A4 6.3.1)	54	Matiari	Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	55	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	56	Matiari & Lahore	Start the Pole-1,	Power	400 MW	
	57			Ramp Rate:	50 MW/Min	
	58		Wait to achieve Target Value	Max Time	5 min	
	59	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	60			DC Voltages	±660kV	
	61			RPC Operation	BP-11/13 , HP24/36	
	62	Lahore		Extinction Angle (γ)	17°	
	63			DC Voltages	Range to be mentioned	
	64			RPC Operation	2xHP12/24	
	65	Matiari/Lahore	Verify stable operation & Normal start at minimum power			
	66		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	67	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	68	Lahore		2xHP12/24		
	69	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	70	Matiari	Instruct Test Director to simulate Electrode Line Open Circuit Protection Stage 2 Action, and then the NBGS would be automatically closed.			
	71		Verify	NBGS is closed		
	72		Instruct to Open WN3Q1			
	73	Matiari	Simulate Pole Bus Differential Protection Stage 2TRIP Pole 2			
	74	Matiari/Lahore	Verify	Pole 2 Tripped		
	75			Pole 1 consecutively trip because of overcurrent on the NBGS at Matiari		

Pole-1 in Operation while Pole-2 Undergoing Open Line Test (Sr. No. 18) (A4 6.3.2)	76	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	77	Matiari & Lahore	Start the Bi-pole	Power	400 MW	
	78			Ramp Rate:	50 MW/Min	
	79		Wait to achieve Target Value	Max Time	5 min	
	80	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	81			DC Voltages	±660kV	
	82			RPC Operation	BP-11/13 , HP24/36	
	83	Lahore		Extinction Angle (γ)	17°	
	84			DC Voltages	Range to be mentioned	
	85			RPC Operation	2xHP12/24	
	86	Matiari/Lahore	Verify stable operation & Normal start at minimum power			
	87		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	88	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	89	Lahore		2xHP12/24		
	90	Matiari	Verify pole 1 and pole 2 in Bipolar Power Control Mode respectively.			
	91	Matiari/Lahore	Stop pole 2			
	92		Verify	Retard, Reduced Current		Block without BPP
	93	Lahore		Alpha angle	90	Block with BPP
	94	Matiari/Lahore		pole 1 rapidly boosts power for compensation		
	95			Verify there is no influence on the transmitted		
	96	Matiari/Lahore	initiate the sequence of Closing Valve Hall Ground Switches, and the converters in both stations are in GROUNDED condition.			
	97	Matiari/Lahore	Verify	Steady operation in pole 1		
	98			No transient change in bipole power		
	99			Sequential control fulfilled		
	100	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions of Pole-2			
	101	Lahore	Instruct to Open WP2Q11			
	102		Verify WP2Q11 open			
	103	Matiari	Verify WP2Q11 closed			
	104	Matiari	set Pole 2 in separate control and OLT automatic control mode.			
	105	Matiari	Initiate the automatic open line test with line on pole 2.			
	106	Matiari/Lahore	Verify	Steady operation in pole 1		
	107			No transient change in bipole power		
	108			Sequential control fulfilled		
	109			Open line test completes successfully on Pole 2		
	110	Lahore	Instruct to close WP2Q11			
	111		Verify WP2Q11 closed			
	112	Matiari	Instruct to open WP2Q11			
	113		Verify WP2Q11 open			
	114	Lahore	Initiate the automatic open line test with line on pole 2.			
	115	Matiari/Lahore	Verify	Steady operation in pole 1		
	116			No transient change in bipole power		
	117			Sequential control fulfilled		
	118			Open line test completes successfully on Pole 2		
	119	Matiari/Lahore	Stop Pole 1			

Pole-2 in Operation while Pole-1 Undergoing Open Line Test (Sr. No. 19) (A4 6.3.2)	120	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	121	Matiari & Lahore	Start the Bi-pole	Power	400 MW	
	122			Ramp Rate:	50 MW/Min	
	123		Wait to achieve Target Value	Max Time	5 min	
	124	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	125			DC Voltages	±660kV	
	126			RPC Operation	BP-11/13 , HP24/36	
	127	Lahore		Extinction Angle (γ)	17°	
	128			DC Voltages	Range to be mentioned	
	129			RPC Operation	2xHP12/24	
	130	Matiari/Lahore	Verify stable operation & Normal start at minimum power			
	131		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	132	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	133	Lahore		2xHP12/24		
	134	Matiari/Lahore	Verify pole 1 and pole 2 in Bipolar Power Control Mode respectively.			
	135	Matiari/Lahore	Stop pole 1			
	136	Matiari	Verify	Retard, Reduced Current		Block without BPP
	137	Lahore		Alpha angle	90	Block with BPP
	138	Matiari/Lahore		pole 2 rapidly boosts power for compensation		
	139			Verify there is no influence on the transmitted bipolar power.		
	140	Matiari/Lahore	initiate the sequence of Closing Valve Hall Ground Switches, and the converters in both stations are in GROUNDED condition.			
	141		Verify	Steady operation in pole 2		
	142			No transient change in bipole power		
	143			Sequential control fulfilled		
	144	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions of Pole-1			
	145	Lahore	Instruct to Open WP1Q11			
	146		Verify WP1Q11 open			
	147	Matiari	set Pole 1 in separate control and OLT automatic control mode.			
	148	Matiari	Initiate the automatic open line test with line on pole 1.			
	149	Matiari/lahore	Verify	Steady operation in pole 1		
	150			No transient change in bipole power		
	151			Sequential control fulfilled		
	152			Open line test completes successfully on Pole 1		
	153	Lahore	Instruct to close WP1Q11			
	154		Verify WP2Q11 WP1Q11 closed			
	155	Matiari	Instruct to open WP1Q11			
	156		Verify WP2Q11 open			
	157	Lahore	Initiate the automatic open line test with line on pole 1.			
	158	Matiari/lahore	Verify	Steady operation in pole 1		
	159			No transient change in bipole power		
	160			Sequential control fulfilled		
	161			Open line test completes successfully on Pole 1		
	162	Matiari/Lahore	Stop Pole 2			

Bipole Operation, Simulate Electrode Line Unbalance Fault (Sr. No. 20) (A4 6.3.3)	163	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	164	Matiari & Lahore	Start the Bi-pole	Power	400 MW	
	165			Ramp Rate:	50 MW/Min	
	166		Wait to achieve Target Value	Max Time	5 min	
	167	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	168			DC Voltages	±660kV	
	169			RPC Operation	BP-11/13 , HP24/36	
	170	Lahore		Extinction Angle (γ)	17°	
	171			DC Voltages	Range to be mentioned	
	172			RPC Operation	2xHP12/24	
	173	Matiari/Lahore	Verify stable operation & Normal start at minimum power			
	174		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	175	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	176	Lahore		2xHP12/24		
	177	Matiari	Verify pole 1 and pole 2 in Bipolar Power Control Mode respectively.			
	178		Order pole 2 in Pole Power Control Mode.			
	179		Ramp Up power of Pole-2	200 MW	400 MW	50 MW/min
	180	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 600 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	181	Lahore	Instruct Test Commander to simulate the Electrode Line Unbalance Fault			
	182	Matiari/Lahore	Verify	Electrode line unbalance protection acts correctly		
	183			Electrode line current < 30A		
	184			The power of pole 2 would decrease to 200MW for balancing the electrode line current.		
Simulation of IDNC CT Transmitter Power Source Fault (Sr. No. 21) (A4 6.3.4)	185	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	186	Matiari & Lahore	Start the Bi-pole	Power	400 MW	
	187			Ramp Rate:	50 MW/Min	
	188		Wait to achieve Target Value	Max Time	5 min	
	189	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	190			DC Voltages	±660kV	
	191			RPC Operation	BP-11/13 , HP24/36	
	192	Lahore		Extinction Angle (γ)	17°	
	193			DC Voltages	Range to be mentioned	
	194			RPC Operation	2xHP12/24	
	195	Matiari/Lahore	Verify stable operation & Normal start at minimum power			
	196		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	197	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	198	Lahore		2xHP12/24		
	199	Matiari	Verify pole 1 and pole 2 in Bipolar Power Control Mode respectively.			
	200	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	201	Matiati	Instruct Test Commander to Simulate fault of PI IDNC CT transmitter power source in active system (e.g. PCPA) at Matiari/Terminal LAHORE station separately by turn off the corresponding power source			
	202	Matiari/Lahore	Verify	continuing steady operation of the transmission		
	203			active system is switched.		
	204			No transient or unexpected time delay		

AC Auxiliary Power 400 V Switchover (Sr. No. 22) (A4 6.3.5)	205	Matiari	Verify pole 1 and pole 2 in Bipolar Power Control Mode respectively.			
	206	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	207	Matiari & Lahore	Start the Bi-pole	Power	400 MW	
	208			Ramp Rate:	50 MW/Min	
	209		Wait to achieve Target Value	Max Time	5 min	
	210	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	211			DC Voltages	±660kV	
	212			RPC Operation	BP-11/13 , HP24/36	
	213	Lahore		Extinction Angle (γ)	17°	
	214			DC Voltages	Range to be mentioned	
	215			RPC Operation	2xHP12/24	
	216	Matiari/Lahore	Verify stable operation & Normal start at minimum power			
	217		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	218	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	219	Lahore		2xHP12/24		
	220	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	221	Matiari	Instruct to Manually Open Switch	111	Open	
	222		Verify automatic action of following switches	411	OFF	
	223			410	ON	
	224		Instruct to Manually CLOSE Switch	111	CLOSE	
	225		Verify automatic action of following switches	411	ON	
	226			410	OFF	
	227		Instruct to Manually OPEN Switch	112	Open	
	228		Verify automatic action of following switches	412	OFF	
	229			410	ON	
	230		Instruct to Manually CLOSE Switch	112	CLOSE	
	231		Verify automatic action of following switches	412	ON	
	232			410	OFF	
	233		Instruct to Manually OPEN Switch	121	OPEN	
	234		Verify automatic action of following switches	421	OFF	
	235			420	ON	
	236		Instruct to Manually CLOSE Switch	121	OPEN	
	237		Verify automatic action of following switches	421	ON	
	238			420	OFF	
	239		Instruct to Manually OPEN Switch	122	OPEN	
	240		Verify automatic action of following switches	422	OFF	
	241			420	ON	
	242		Instruct to Manually CLOSE Switch	122	CLOSE	
	243		Verify automatic action of following switches	422	ON	
	244			420	OFF	
	245	Lahore	Instruct to Manually Open Switch	111	Open	
	246		Verify automatic action of following switches	411	OFF	
	247			410	ON	
	248		Instruct to Manually CLOSE Switch	111	CLOSE	
	249		Verify automatic action of following switches	411	ON	
	250			410	OFF	
	251		Instruct to Manually OPEN Switch	112	Open	
	252		Verify automatic action of following switches	412	OFF	
	253			410	ON	
	254		Instruct to Manually CLOSE Switch	112	CLOSE	
	255		Verify automatic action of following switches	412	ON	
	256			410	OFF	
	257		Instruct to Manually OPEN Switch	121	OPEN	
	258		Verify automatic action of following switches	421	OFF	
	259			420	ON	
	260		Instruct to Manually CLOSE Switch	121	OPEN	
	261		Verify automatic action of following switches	421	ON	
	262			420	OFF	
	263		Instruct to Manually OPEN Switch	122	OPEN	
	264		Verify automatic action of following switches	422	OFF	
	265			420	ON	
	266		Instruct to Manually CLOSE Switch	122	CLOSE	
	267		Verify automatic action of following switches	422	ON	
	268			420	OFF	

Test Acceptance Criteria	269	Matiari/Lahore C/S	The voltage of the AC system should be within the specified limits (450-550kV)	
	270		All Operations executed successfully	
	271		The synchronizing voltage and the phasing of the firing control signals are correct.	
	272		All thyristor check-back signals are available.	
	273		Measuring system and controls remain operational. No transients on switchover of PCP or SC systems.	
	274		Measuring quantities are available and the values are within the specified range and phase.	
	275		No abnormal corona discharges and no operation of surge arresters shall occur at energized equipment.	
	276		No Stuck Condition	
	277		No False Tripping by DC Protection System	
	278		All the sequence as recorded in OWS should be documented, All the Charts related to pole power,current, voltages, firing angles and extinction angles, tap positions. Should be recorded and documented. TFR data in Comtrade format to be captured and recorded.	
	279		No Tripping in AC side of converter Station	

Bipole Low Power DisturbanceTests

9-Frequency Control Test

Test Objective	The test is to check the basic function of frequency control of DC system					
Condition	**Sr. No.**	**Station**	**Action**	**Equipment/ Configuration**	**State of Equipment/configuration**	**Description**
Pre-Test Conditions & Configurations (AC/DC)	1	AC side at Matiari & Lahore C/S	Voltage Limits	Utmost efforts will be made to maintain the voltages within ±5% range. However, reactive compensation devices installed at both converter stations can be used, if needed, to control the voltages keeping in view the then prevailing system conditions.		
	2	AC side at Matiari & Lahore C/S	AC Yard of Lahore & Matiari Converter Station is in normal Position		CLOSED State	All bays including Filter Banks are complete and energized with no component in maintenance state.
	3	DC Side at Matiari C/S	Both Poles will operate in Bipole Ground Return Mode see Status Table "BP-GR"			BI-Pole Mode of Operation
	4	General Preconditions	Converter transformer protection and the charging protection of corresponding converter AC bus breaker are put into operation.			
	5	General Preconditions	All the Prerequisites as mentioned in DC Dispatch Plan should be met.			
	6	General Preconditions	Visual inspections of AC switchyard, AC filter yard, DC yard and DC valve hall prior first energization or switching.			
	7	General Preconditions	All electrical connections are available.			
	8	General Preconditions	Protection settings and protective circuits trip sequences tests must be completed.			
	9	General Preconditions	AC-switchyard and associated protections and sequences, including breaker failure protection, must be active.			
	10	General Preconditions	Correct grounding of all equipment is available.			
	11	General Preconditions	Thyristor valve cooling in operation for 24 hours, no water leakage observed.			
	12	General Preconditions	Thyristor valves and valve hall is cleaned.			
	13	General Preconditions	Converter transformers are demagnetized.			
	14	General Preconditions	Air humidity and temperature in valve hall are within expected limits.			
	15	General Preconditions	Disturbances (Annex-D-VIII must be successful)			
	16	General Preconditions	Both sides AC system of Matiari & Lahore C/S are capable to supply and accept the power (500 MW) for the test. Availability of N-1 contingency on parallel AC corridor. AC system short circuit level has been measured at both Matiari and Lahore converter stations and it is confirmed to be suitable for the tested power.			
	17	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Direction	Normal		Matiari to Lahore
	18	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Return	Ground		Ground Return Mode
	19	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Udc Mode	Normal		±660 kV
	20	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Telecom Mode	Operational		
	21	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Master Station	Matiari		
	22	Configuration Setting at Lahore & Matiari C/S DC side	Station Control (SC)	A	ACTIVE	Can be changed to B during test
	23	Configuration Setting at Lahore & Matiari C/S DC side	Station Control (SC)	B	Standby	
	24	Configuration Setting at Lahore & Matiari C/S DC side	Pole Control Protection (PCP)	A	ACTIVE	
	25	Configuration Setting at Lahore & Matiari C/S DC side	Pole Control Protection (PCP)	B	Standby	
	26	Configuration Setting at Lahore & Matiari C/S DC side	Transmission Control Mode	Power	ACTIVE	HVDC will operate in power control mode.
	27	Configuration Setting at Lahore & Matiari C/S DC side	Station Control Mode	Joint	Active	Matiari & Lahore will operate jointly.
	28	Configuration Setting at Lahore & Matiari C/S DC side	Reactive Power Control Mode	Automatic	ACTIVE	Automatically Switch in/out the AC Filters/Reactors
	29	Configuration Setting at Lahore & Matiari C/S DC side	Reactive Power Control Variable	Q-Control	ACTIVE	Reactive Power exchange between AC Yard of Converter Station and NTDC system will be automatically controlled.

Testing Start Up Sequence

Frequency Control Test	30	Matiari/Lahore	Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	31	Matiari	Verify Matiari is Master Station.			
	32	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	33	Matiari & Lahore	Start the BiPole	Power	400 MW	
	34			Ramp Rate:	50 MW/Min	
	35		Wait to achieve Target Value	Max Time	5 min	
	36	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	37			DC Voltages	±660 kV	
	38			Electrode Current	<30 Amps	
	39			RPC Operation	BP-11/13 , HP24/36	
	40	Lahore		Extinction Angle (γ)	17°	
	41			DC Voltages	Range to be mentioned	
	42			RPC Operation	2xHP12/24	
	43	Matiari/Lahore	Verify stable operation & Normal start at minimum power			
	44		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	45	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	46	Lahore		2xHP12/24		
Frequency Control Test in Matiari Converter Station (Sr. No. 23) (A4 8.3.1)	47	Matiari	Verify	The DC power corresponding to 1Hz of frequency change is 1000MW		
	48			The frequency deviation deadband is ±0.1Hz.		
	49			Upper and lower output limits of frequency control is ±200MW.		
	50		NPCC makes sure, parallel AC corridor has margin for sharing 200 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	51		Simulate the frequency of the AC power grid connected the Matiari station to 49.8Hz, with a difference of 0.1Hz (0.1Hz has been subtracted from the deadband), and the duration is 5000ms.			
	52		Verify	The DC power ramps down about 100MW.		
	53			After the frequency deviation disappears, the DC transmission power will automatically return to the value before the test.		
	54		Simulate the frequency of the AC power grid connected the Matiari station to 50.2Hz, with a difference of 0.1Hz (0.1Hz has been subtracted from the deadband), and the duration is 5000ms.			
	55		Verify	The DC power ramps up about 100MW.		
	56			After the frequency deviation disappears, the DC transmission power will automatically return to the value before the test.		
Frequency Control Test in Lahore Converter Station (Sr. No. 24) (A4 8.3.2)	57	Lahore	Initiate Master Sequence at Lahore Station			
	58		Verify	The DC power corresponding to 1Hz of frequency change is 1000MW		
	59			The frequency deviation deadband is ±0.1Hz.		
	60			Upper and lower output limits of frequency control is ±200MW.		
	61		NPCC makes sure, parallel AC corridor has margin for sharing 200 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	62		Simulate the frequency of the AC power grid connected the Matiari station to 49.8Hz, with a difference of 0.1Hz (0.1Hz has been subtracted from the deadband), and the duration is 5000ms.			
	63		Verify	The DC power ramps up about 100MW.		
	64			After the frequency deviation disappears, the DC transmission power will automatically return to the value before the test.		
	65		Simulate the frequency of the AC power grid connected the Matiari station to 50.2Hz, with a difference of 0.1Hz (0.1Hz has been subtracted from the deadband), and the duration is 5000ms.			
	66		Verify	The DC power ramps down about 100MW.		
	67			After the frequency deviation disappears, the DC transmission power will automatically return to the value before the test.		

Test Acceptance Criteria	68	Matiari/Lahore C/S	The voltage of the AC system should be within the specified limits (450-550kV)	
	69		All Operations executed successfully	
	70		The synchronizing voltage and the phasing of the firing control signals are correct.	
	71		All thyristor check-back signals are available.	
	72		Measuring system and controls remain operational. No transients on switchover of PCP or SC systems.	
	73		Measuring quantities are available and the values are within the specified range and phase.	
	74		No abnormal corona discharges and no operation of surge arresters shall occur at energized equipment.	
	75		No Stuck Condition	
	76		No False Tripping by DC Protection System	
	77		All the sequence as recorded in OWS should be documented, All the Charts related to pole power,current, voltages, firing angles and extinction angles, tap positions. Should be recorded and documented. TFR data in Comtrade format to be captured and recorded.	
	78		No Tripping in AC side of converter Station	

Bipole Low Power Tests

10-Initial Operation Tests, Bi-Pole Ground Return Operation, Reversed Power Direction

Test Objective	The test is to check the basic function of DC system during reversed power direction.

Condition	Sr. No.	Station	Action	Equipment/ Configuration	State of Equipment/configuration	Description
Pre-Test Conditions & Configurations (AC/DC)	1	AC side at Matiari & Lahore C/S	Voltage Limits	Utmost efforts will be made to maintain the voltages within ±5% range. However, reactive compensation devices installed at both converter stations can be used, if needed, to control the voltages keeping in view the then prevailing system conditions.		
	2		AC Yard of Lahore & Matiari Converter Station is in normal Position		CLOSED State	All bays including Filter Banks are complete and energized with no component in maintenance state.
	3	DC Side at Matiari C/S	Both Poles will operate in Bipole Ground Return Mode see Status Table "BP-GR"			BI-Pole Mode of Operation
	4	General Preconditions	Converter transformer protection and the charging protection of corresponding converter AC bus breaker are put into operation.			
	5		All the Prerequisites as mentioned in DC Dispatch Plan should be met.			
	6		Visual inspections of AC switchyard, AC filter yard, DC yard and DC valve hall prior first energization or switching.			
	7		All electrical connections are available.			
	8		Protection settings and protective circuits trip sequences tests must be completed.			
	9		AC-switchyard and associated protections and sequences, including breaker failure protection, must be active.			
	10		Correct grounding of all equipment is available.			
	11		Thyristor valve cooling in operation for 24 hours, no water leakage observed.			
	12		Thyristor valves and valve hall is cleaned.			
	13		Converter transformers are demagnetized.			
	14		Air humidity and temperature in valve hall are within expected limits.			
	15		Frequency Control Test (Annex-D-IX must be successful)			
	16		Both sides AC system of Matiari & Lahore C/S are capable to supply and accept the power (400 MW) for the test. Availability of N-1 contingency on parallel AC corridor. AC system short circuit level has been measured at both Matiari and Lahore converter stations and it is confirmed to be suitable for the tested power.			
	17	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Direction	Reverse		Lahore to Matiari
	18		Return	Ground		Ground Return Mode
	19		Udc Mode	Normal		±660kV
	20		Telecom Mode	Operational		
	21		Master Station	Matiari		
	22	Configuration Setting at Lahore & Matiari C/S DC side	Station Control (SC)	A	ACTIVE	Can be changed to B during test
	23			B	Standby	
	24		Pole Control Protection (PCP)	A	ACTIVE	
	25			B	Standby	
	26		Transmission Control Mode	Power	ACTIVE	HVDC will operate in power control mode.
	27		Station Control Mode	Joint	Active	Matiari & Lahore will operate jointly.
	28		Reactive Power Control Mode	Automatic	ACTIVE	Automatically Switch in/out the AC Filters/Reactors
	29		Reactive Power Control Variable	Q-Control	ACTIVE	Reactive Power exchange between AC Yard of Converter Station and NTDC system will be automatically controlled.

Testing Start Up Sequence

BiPole Start/Stop (Sr. No. 25) (A4 10.3.1)	30	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	31		Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	32	Lahore	Start the BIPOLE	Power	400 MW	
	33			Ramp Rate:	50 MW/Min	
	34		Wait to achieve Target Value	Max Time	5 min	
	35	Lahore	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	36			DC Voltages	±660 kV	
	37			RPC Operation	2xHP12/24	
	38	Matiari		Extinction Angle (γ)	17°	
	39			DC Voltages	Range to be mentioned	
	40			RPC Operation	BP-11/13 , HP24/36	
	41	Matiari/Lahore	Verify stable operation & Normal start at reduced with minimum power			
	42		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	43	Lahore	Verify RPC action	2xHP12/24		
	44	Matiari		BP-11/13, HP-24/36		
	45	Matiari/Lahore	Stop the Bipole			
	46	Lahore	Verify Performance parameters	Y-Block		
	47			Retard, Reduced Current		Block without BPP
	48	Matiari		Y-Block		
	49			Alpha angle	90	Block with BPP
Control System Switchover (Sr. No. 26) (A4 10.3.2)	50	Lahore	Verify Ready for Operation Conditions.			
	51		Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	52		Start the Pole-1	Power	400 MW	
	53			Ramp Rate:	50 MW/Min	
	54	Matiari	Verify	PCP-A	ACTIVE	
	55		Switch Control System	PCP-A to	PCP-B	
	56		Verify	Continuous Steady Operation of the transmission		
	57			PCP-B is active		
	58			No Transients or unexpected delays		
	59		Switch Control System	PCP-B to	PCP-A	
	60		Verify	Continuous Steady Operation of the transmission		
	61			PCP-A is active		
	62			No Transients or unexpected delays		
	63		Verify	SC-A	ACTIVE	
	64		Switch Control System	SC-A to	SC-B	
	65		Verify	Continuous Steady Operation of the transmission		
	66			SC-B is active		
	67			No Transients or unexpected delays		
	68		Switch Control System	SC-B to	SC-A	
	69		Verify	Continuous Steady Operation of the transmission		
	70			SC-A is active		
	71			No Transients or unexpected delays		
	72	Lahore	Verify	PCP-A	ACTIVE	
	73		Switch Control System	PCP-A to	PCP-B	
	74		Verify	Continuous Steady Operation of the transmission		
	75			PCP-B is active		
	76			No Transients or unexpected delays		
	77		Switch Control System	PCP-B to	PCP-A	
	78		Verify	Continuous Steady Operation of the transmission		
	79			PCP-A is active		
	80			No Transients or unexpected delays		
	81		Verify	SC-A	ACTIVE	
	82		Switch Control System	SC-A to	SC-B	
	83		Verify	Continuous Steady Operation of the transmission		
	84			SC-B is active		
	85			No Transients or unexpected delays		
	86		Switch Control System	SC-B to	SC-A	
	87		Verify	Continuous Steady Operation of the transmission		
	88			SC-A is active		
	89			No Transients or unexpected delays		
	90	Matiari/Lahore	Stop the Bipole			
	91	Lahore	Verify Performance parameters	Retard, Reduced Current		
	92	Matiari		Alpha angle	90°	

Test Acceptance Criteria	93	Matiari/Lahore C/S	The voltage of the AC system should be within the specified limits (450-550kV)	
	94		All Operations executed successfully	
	95		The synchronizing voltage and the phasing of the firing control signals are correct.	
	96		All thyristor check-back signals are available.	
	97		Measuring system and controls remain operational. No transients on switchover of PCP or SC systems.	
	98		Measuring quantities are available and the values are within the specified range and phase.	
	99		No abnormal corona discharges and no operation of surge arresters shall occur at energized equipment.	
	100		No Stuck Condition	
	101		No False Tripping by DC Protection System	
	102		All the sequence as recorded in OWS should be documented, All the Charts related to pole power,current, voltages, firing angles and extinction angles, tap positions. Should be recorded and documented. TFR data in Comtrade format to be captured and recorded.	
	103		No Tripping in AC side of converter Station	

Bipole Low Power Tests

11-Protective Trip X, Y, and Z, Reversed Power Direction

Test Objective	The test objective is to check the protection trip function.					
Condition	**Sr. No.**	**Station**	**Action**	**Equipment/ Configuration**	**State of Equipment/configuration**	**Description**
Pre-Test Conditions & Configurations (AC/DC)	1	AC side at Matiari & Lahore C/S	Voltage Limits	Utmost efforts will be made to maintain the voltages within ±5% range. However, reactive compensation devices installed at both converter stations can be used, if needed, to control the voltages keeping in view the then prevailing system conditions.		
	2	AC side at Matiari & Lahore C/S	AC Yard of Lahore & Matiari Converter Station is in normal Position		CLOSED State	All bays including Filter Banks are complete and energized with no component in maintenance state.
	3	DC Side at Matiari C/S	Both Poles will operate in Bipole Ground Return Mode see Status Table "BP-GR"			BI-Pole Mode of Operation
	4	General Preconditions	Converter transformer protection and the charging protection of corresponding converter AC bus breaker are put into operation.			
	5	General Preconditions	All the Prerequisites as mentioned in DC Dispatch Plan should be met.			
	6	General Preconditions	Visual inspections of AC switchyard, AC filter yard, DC yard and DC valve hall prior first energization or switching.			
	7	General Preconditions	All electrical connections are available.			
	8	General Preconditions	Protection settings and protective circuits trip sequences tests must be completed.			
	9	General Preconditions	AC-switchyard and associated protections and sequences, including breaker failure protection, must be active.			
	10	General Preconditions	Correct grounding of all equipment is available.			
	11	General Preconditions	Thyristor valve cooling in operation for 24 hours, no water leakage observed.			
	12	General Preconditions	Thyristor valves and valve hall is cleaned.			
	13	General Preconditions	Converter transformers are demagnetized.			
	14	General Preconditions	Air humidity and temperature in valve hall are within expected limits.			
	15	General Preconditions	Initial Operation Tests, Reversed Power Direction (Annex-D-X must be successful)			
	16	General Preconditions	Both sides AC system of Matiari & Lahore C/S are capable to supply and accept the power (400 MW) for the test. Availability of N-1 contingency on parallel AC corridor. AC system short circuit level has been measured at both Matiari and Lahore converter stations and it is confirmed to be suitable for the tested power.			
	17	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Direction	Reversed		Lahore to Matiari
	18	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Return	Ground		Ground Return Mode
	19	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Udc Mode	Normal		±660kV
	20	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Telecom Mode	Operational		
	21	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Master Station	Matiari		
	22	Configuration Setting at Matiari & Lahore C/S DC side	Station Control (SC)	A	ACTIVE	Can be changed to B during test
	23	Configuration Setting at Matiari & Lahore C/S DC side	Station Control (SC)	B	Standby	
	24	Configuration Setting at Matiari & Lahore C/S DC side	Pole Control Protection (PCP)	A	ACTIVE	
	25	Configuration Setting at Matiari & Lahore C/S DC side	Pole Control Protection (PCP)	B	Standby	
	26	Configuration Setting at Matiari & Lahore C/S DC side	Transmission Control Mode	Power	ACTIVE	HVDC will operate in power control mode.
	27	Configuration Setting at Matiari & Lahore C/S DC side	Station Control Mode	Joint	Active	Matiari & Lahore will operate jointly.
	28	Configuration Setting at Matiari & Lahore C/S DC side	Reactive Power Control Mode	Automatic	ACTIVE	Automatically Switch in/out the AC Filters/Reactors
	29	Configuration Setting at Matiari & Lahore C/S DC side	Reactive Power Control Variable	Q-Control	ACTIVE	Reactive Power exchange between AC Yard of Converter Station and NTDC system will be automatically controlled.

Testing Start Up Sequence

Protective Trip X in Rectifier with Telecommunication (Sr. No. 27) (A4 11.3.1)	30	Lahore	Verify Ready for Operation Conditions.			
	31		Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	32		Start the Pole-1	Power	400 MW	
	33			Ramp Rate:	50 MW/min	
	34		Wait to achieve Target Value	Max Time	5 min	
	35		Verify Performance indicators	Firing angle (α)	15°±2.5°	
	36			DC Voltages	±660 kV	
	37			RPC Operation	2xHP12/24	
	38	Matiari		Extinction Angle (γ)	17°	
	39			DC Voltages	Range to be mentioned	
	40			RPC Operation	BP-11/13 , HP24/36	
	41	Matiari/Lahore	Verify stable operation at minimum power.			
	42		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	43	Lahore	Verify RPC action	2xHP12/24		
	44	Matiari		BP-11/13 , HP24/36		
	45	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	46	Lahore	Simulate Valve short Circuit Protection Stage 2 TRIP in Pole 1			
	47		Verify Protection Functions	X-block		
	48			Trip Action	Converter T/F AC Breakers	
	49			Set lockout relay for the tripped AC circuit breaker(s)		
	50			Start Breaker Failure Protection		
	51			Pole IsolationSequence		
	52	Matiari		Normal Y-block sequence		
	53	Matiari/Lahore	Verify there is no influence on the transmitted bipolar power.			
	54	Matiari	Stop Pole 2			
	55	Lahore	Verify Performance parameters	Retard, Reduced Current		Block without BPP
	56			Alpha angle	90	Block with BPP
Protective Trip Y in inverter with TELECOM (Sr. No. 28) (A4 11.3.2)	57	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	58	Matiari	Start the Bipole	Power	400 MW	
	59			Ramp Rate:	50 MW/min	
	60		NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	61		Simulate Station Ground Overcurrent Protection Action in Pole 1			
	62	Lahore	Verify Protection Functions	Y-block		
	63			Retard and start by-pass pair		
	64			Trip Action	Converter T/F AC Breakers	
	65			Pole IsolationSequence		
	66			Set lockout relay for the tripped AC circuit breaker(s)		
	67			Start Breaker Failure Protection		
	68	Matiari		Pole Isolation		
	69	Matiari/Lahore C/S DC side	Verify there is no influence on the transmitted bipolar power.			
	70	Matiari	Stop Pole 2			
Protective Trip Z in rectifier with TELECOM (Sr. No. 29) (A4 11.3.3)	71	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	72	Lahore	Start the Bipole	Power	400 MW	
	73			Ramp Rate:	50 MW/min	
	74		NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	75		Simulate Pole Bus Differential Protection Stage-2 Trip in Pole 2			
	76		Verify Protection Functions	Z-block		
	77			Trip Action	Converter T/F AC Breakers	
	78			Pole IsolationSequence		
	79			Start Breaker Failure Protection		
	80			Set lockout relay for the tripped AC circuit breaker(s)		
	81	Matiari		Normal Y-block sequence		
	82	Matiari	Stop Pole 1			

Test Acceptance Criteria	83	Matiari/Lahore C/S	The voltage of the AC system should be within the specified limits (450-550kV)	
	84		All Operations executed successfully	
	85		The synchronizing voltage and the phasing of the firing control signals are correct.	
	86		All thyristor check-back signals are available.	
	87		Measuring system and controls remain operational. No transients on switchover of PCP or SC systems.	
	88		Measuring quantities are available and the values are within the specified range and phase.	
	89		No abnormal corona discharges and no operation of surge arresters shall occur at energized equipment.	
	90		No Stuck Condition	
	91		No False Tripping by DC Protection System	
	92		All the sequence as recorded in OWS should be documented, All the Charts related to pole power,current, voltages, firing angles and extinction angles, tap positions. Should be recorded and documented. TFR data in Comtrade format to be captured and recorded.	
	93		No Tripping in AC side of converter Station	

Bipole Low Power Tests

12- Pole Compensation and disturbance test, Reversed Power Direction

Test Objective	The test objective is to check the pole compensation during reversed power direction.

Condition	Sr. No.	Station	Action	Equipment/ Configuration	State of Equipment/configuration	Description
Pre-Test Conditions & Configurations (AC/DC)	1	AC side at Matiari & Lahore C/S	Voltage Limits	Utmost efforts will be made to maintain the voltages within ±5% range. However, reactive compensation devices installed at both converter stations can be used, if needed, to control the voltages keeping in view the then prevailing system conditions.		
	2		AC Yard of Lahore & Matiari Converter Station is in normal Position		CLOSED State	All bays including Filter Banks are complete and energized with no component in maintenance state.
	3	DC Side at Matiari C/S	Both Poles will operate in Bipole Ground Return Mode see Status Table "BP-GR"			BI-Pole Mode of Operation
	4	General Preconditions	Converter transformer protection and the charging protection of corresponding converter AC bus breaker are put into operation.			
	5		All the Prerequisites as mentioned in DC Dispatch Plan should be met.			
	6		Visual inspections of AC switchyard, AC filter yard, DC yard and DC valve hall prior first energization or switching.			
	7		All electrical connections are available.			
	8		Protection settings and protective circuits trip sequences tests must be completed.			
	9		AC-switchyard and associated protections and sequences, including breaker failure protection, must be active.			
	10		Correct grounding of all equipment is available.			
	11		Thyristor valve cooling in operation for 24 hours, no water leakage observed.			
	12		Thyristor valves and valve hall is cleaned.			
	13		Converter transformers are demagnetized.			
	14		Set tap changer to position giving lowest valve voltage			
	15		Protective Trip X, Y, and Z, Reversed Power Direction (Annex-D-XI must be successful)			
	16		Both sides AC system of Matiari & Lahore C/S are capable to supply and accept the power (800 MW) for the test. Availability of N-1 contingency on parallel AC corridor. AC system short circuit level has been measured at both Matiari and Lahore converter stations and it is confirmed to be suitable for the tested power.			
	17	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Direction	Reversed		Matiari to Lahore
	18		Return	Ground		Ground Return Mode
	19		Udc Mode	Normal		±660kV
	20		Telecom Mode	Operational		
	21		Master Station	Matiari		
	22	Configuration Setting at Matiari C/S DC side	Station Control (SC)	A	ACTIVE	Can be changed to B during test
	23			B	Standby	
	24		Pole Control (PCP)	A	ACTIVE	
	25			B	Standby	
	26		Transmission Control Mode	Power	ACTIVE	HVDC will operate in power control mode.
	27		Station Control Mode	Joint	Active	Matiari & Lahore will operate jointly.
	28		Reactive Power Control Mode	Automatic	ACTIVE	Automatically Switch in/out the AC Filters/Reactors
	29		Reactive Power Control Variable	U-Control	ACTIVE	Reactive Power exchange between AC Yard of Converter Station and NTDC system will be automatically controlled.

Pre-Test Conditions & Configurations (AC/DC)	30	Configuration Setting at Lahore C/S DC side	Station Control (SC)	A	ACTIVE	Can be changed to B during test
	31			B	Standby	
	32		Pole Control (PCP)	A	ACTIVE	
	33			B	Standby	
	34		Transmission Control Mode	Power	ACTIVE	HVDC will operate in power control mode.
	35	Configuration Setting at Lahore C/S DC side	Station Control Mode	Joint	Active	Matiari & Lahore will operate jointly.
	36		Reactive Power Control Mode	Automatic	ACTIVE	Automatically Switch in/out the AC Filters/Reactors
	37		Reactive Power Control Variable	Q-Control	ACTIVE	Reactive Power exchange between AC Yard of Converter Station and NTDC system will be automatically controlled.
Testing Start Up Sequence						
Bipolar Power Ramping (Sr. No. 30) (A4 12.3.1)	38	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	39		Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	40	Lahore	Start the BiPole	Power	400 MW	
	41			Ramp Rate:	50MW/Min	
	42		Wait to achieve Target Value	Max Time	5 min	
	43		Verify Performance indicators	Firing angle (α)	15°±2.5°	
	44			DC Voltages	±660 kV	
	45			RPC Operation	2xHP12/24	
	46	Matiari		Extinction Angle (γ)	17°	
	47			DC Voltages	Range to be mentioned	
	48			RPC Operation	BP-11/13 , HP24/36	
	49	Matiari/Lahore	Verify stable operation at minimum power			
	50	Lahore	Verify RPC action	2xHP12/24		
	51	Matiari		BP-11/13 , HP24/36		
	52	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	53	Matiari	Activate the emergency stop push-button in pole 2 in Matiari Station.			
	54	Matiari/Lahore	Verify	there is no influence on the transmitted bipolar power.		
	55	Matiari	Initiate Pole Power Control for Pole 2			
	56	Matiari	Start the Pole-2	Power	200 MW	
	57			Ramp Rate:	50MW/Min	
	58	Lahore	Wait to achieve Target Value	Max Time	5 min	
	59		Verify Performance indicators	Firing angle (α)	15°±2.5°	
	60			DC Voltages	±660 kV	
	61			RPC Operation	2xHP12/24	
	62	Matiari		Extinction Angle (γ)	17°	
	63			DC Voltages	Range to be mentioned	
	64			RPC Operation	BP-11/13 , HP24/36	
	65	Matiari/Lahore	Verify stable operation at minimum power			
	66	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	67	Lahore		HP-12/24, HP-12/24		
	68	Matiari	Order pole 2 in Bipolar Power Control Model.			
	69	Matiari/Lahore	Verify	there is no influence on the transmitted bipolar power.		
	70	Matiari	Ramp Up	400 MW	800 MW	50 MW
	71	Lahore	Verify (During Ramping)	PCP-A	ACTIVE	
	72		Manual Switch Control System (During Ramping)	PCP-A to	PCP-B	
	73		Manual Switch Control System	PCP-B to	PCP-A	
	74		Verify (During Ramping)	SC-A	ACTIVE	
	75		Manual Switch Control System (During Ramping)	SC-A to	SC-B	
	76		Manual Switch Control System	SC-B to	SC-A	

Bipolar Power Ramping (Sr. No. 30) (A4 12.3.1)	77	Matiari	Verify (During Ramping)	PCP-A	ACTIVE	
	78		Manual Switch Control System (During Ramping)	PCP-A to	PCP-B	
	79		Manual Switch Control System	PCP-B to	PCP-A	
	80		Verify (During Ramping)	SC-A	ACTIVE	
	81		Manual Switch Control System (During Ramping)	SC-A to	SC-B	
	82		Manual Switch Control System	SC-B to	SC-A	
	83	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	84			PCP-A & SC-A is active		
	85			power reaches the reference value after ramping is completed		
	86			No Transients or unexpected time delays		
	87	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 200 MW with DC System. (Sudden load sharing from AC corridor to DC corridor will happen in next step)			
	88	Matiari	Ramp Down	800 MW	400 MW	50 MW
	89	Lahore	Verify (During Ramping)	PCP-A	ACTIVE	
	90		Manual Switch Control System (During Ramping)	PCP-A to	PCP-B	
	91		Manual Switch Control System	PCP-B to	PCP-A	
	92		Verify (During Ramping)	SC-A	ACTIVE	
	93		Manual Switch Control System (During Ramping)	SC-A to	SC-B	
	94		Manual Switch Control System	SC-B to	SC-A	
	95	Matiari	Verify (During Ramping)	PCP-A	ACTIVE	
	96		Manual Switch Control System (During Ramping)	PCP-A to	PCP-B	
	97		Manual Switch Control System	PCP-B to	PCP-A	
	98		Verify (During Ramping)	SC-A	ACTIVE	
	99		Manual Switch Control System (During Ramping)	SC-A to	SC-B	
	100		Manual Switch Control System	SC-B to	SC-A	
	101	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	102			PCP-A is active		
	103			power reaches the reference value after ramping is completed		
	104			No Transients or unexpected time delays		
	105	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 200 MW with DC System. (Sudden load sharing from AC corridor to DC corridor will happen in next step)			
	106	Matiari	Ramp Up	400 MW	800 MW	999 MW
	107	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	108			power reaches the reference value after ramping is completed		
	109			No Transients		
Bipole Operation, Pole 2 Power Ramping with / without Telecom. Reverse Power Direction (Sr. No. 31) (A4 12.3.2)	110	Matiari /Lahore	Verify Pole-I and Pole-II is in stable Bi-Pole Power Control Mode at 800 MW in sequence to test above.			
	111		Order Pole-2 in Pole Power Control Mode, (Pole-I is in Bi-Pole Mode)			
	112	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	113			Pole Power Control Mode achieved successfully in Pole 2		
	114			No Transients		
	115	Lahore	Order Pole-2 in Pole Current Control Mode, (Pole-I is in Bi-Pole Power Mode)			
	116	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	117			Pole Current Control Mode achieved successfully in Pole 2		
	118			No Transients		
	119	Matiari	Ramp Up	606 Amps	800 Amps	50 Amps/Min
	120	Lahore	Verify (During Ramping)	PCP-A	ACTIVE	
	121		Manual Switch Control System (During Ramping)	PCP-A to	PCP-B	
	122			PCP-B to	PCP-A	
	123	Matiari	Verify (During Ramping)	PCP-A	ACTIVE	
	124		Manual Switch Control System (During Ramping)	PCP-A to	PCP-B	
	125			PCP-B to	PCP-A	
	126	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	127			PCP-A is active		
	128			current reaches the reference value after ramping is completed		
	129			No Transients		
	130	Lahore	Ramp Down	800 Amps	606 Amps	50 Amps/Min
	131		Disabled the telecommunication in both channels in Pole 2 during the ramping process			
	132	Matiari /Lahore	Verify	Emergency Pole Current Control will be activated in Pole-2		
	133			Pole 1 telecom remains on and Pole 1 is in Bipole Power Control.		
	134			The ramping would be continuing with a reduced ramp rate and the current reference value would be reached when the telecommunication is disabled		
	135			No Transients		
	136	Matiari/Lahore	Verify Two poles are in stable operation at 800MW			
	137	Matiari	Restore the telecommunication of Pole-2			

Bipole Operation, Pole 1 Power Ramping with / without Telecom. Reverse Power Direction (Sr. No. 32) (A4 12.3.2)	138	Matiari	Order Pole 2 in Bipolar Power Control Model.			
	139	Matiari /Lahore	Verify Pole-I and Pole-II is in stable Bi-Pole Power Control Mode at 800 MW			
	140		Order Pole-1 in Pole Power Control Mode, (Pole-2 is in Bi-Pole Mode)			
	141	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	142			Pole Power Control Mode achieved successfully in Pole 1		
	143			No Transients		
	144	Lahore	Order Pole-1 in Monopolar Current Control Mode, (Pole-2 is in Bi-Pole Power Mode)			
	145	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	146			Pole Current Control Mode achieved successfully in Pole 1		
	147			No Transients		
	148	Matiari	Ramp Up	606 Amps	800 Amps	50 Amps/Min
	149	Lahore	Verify (During Ramping)	PCP-A	ACTIVE	
	150		Manual Switch Control System (During Ramping)	PCP-A to	PCP-B	
	151			PCP-B to	PCP-A	
	152	Matiari	Verify (During Ramping)	PCP-A	ACTIVE	
	153		Manual Switch Control System (During Ramping)	PCP-A to	PCP-B	
	154			PCP-B to	PCP-A	
	155	Matiari /Lahore	Verify	Continuous Steady Operation of the transmission		
	156			PCP-A is active		
	157			current reaches the reference value after ramping is completed		
	158			No Transients		
	159	Lahore	Ramp Down	800 Amps	606 Amps	50 Amps/Min
	160		Disabled the telecommunication in both channels in Pole 1 during the ramping process			
	161	Matiari /Lahore	Verify	Emergency Pole Current Control will be activated in Pole-1		
	162			Pole 2 telecom remains on and Pole 2 is in Bipole Power Control.		
	163			The ramping would be continuing with a reduced ramp rate and the current reference value would be reached when the telecommunication is disabled.		
	164			No Transients		
	165	Matiari	Verify Two poles are in stable operation at 800MW			
	166	Matiari	Restore the telecommunication of Pole-1			
Simulated Pole1 DC Line Fault (only Lahore) (Sr. No. 33) (A4 12.3.3)	167	Matiari	Order Pole 1 in Bipolar Power Control Model.			
	168	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	169		Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	170	Lahore	Start the BIPOLE	Power	400 MW	
	171			Ramp Rate:	50 MW/Min	
	172		Wait to achieve Target Value	Max Time	5 min	
	173	Lahore	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	174			DC Voltages	±660kV	
	175			RPC Operation	2xHP12/24	
	176	Matiari		Extinction Angle (γ)	17°	
	177			DC Voltages	Range to be mentioned	
	178			RPC Operation	BP-11/13 , HP24/36	
	179	Matiari/Lahore	Verify stable operation & Normal start at minimum power			
	180	Lahore	Verify RPC action	2xHP12/24		
	181	Matiari		BP-11/13 , HP24/36		
	182	Lahore	Make sure PCP-A is active Simulate Pole1 a DC Line Fault by activating the DC line protection in PCPA			
	183	Lahore	Verify the firing angle has been retarded in Lahore station			
	184	Matiari/ Lahore	Verify that pole1 quickly recovers within the expected time delays.			
	185	Lahore	Change all the modified settings back to original value.			

Simulated Pole2 DC Line Fault (only Lahore) (Sr. No. 34) (A4 12.3.4)	186	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	187		Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	188	Lahore	Start the BIPOLE	Power	400 MW	
	189			Ramp Rate:	50 MW/Min	
	190		Wait to achieve Target Value	Max Time	5 min	
	191	Lahore	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	192			DC Voltages	±660kV	
	193			RPC Operation	2xHP12/24	
	194	Matiari		Extinction Angle (γ)	17°	
	195			DC Voltages	Range to be mentioned	
	196			RPC Operation	BP-11/13 , HP24/36	
	197	Matiari/Lahore	Verify stable operation & Normal start at reduced with minimum power			
	198	Lahore	Verify RPC action	2xHP12/24		
	199	Matiari		BP-11/13 , HP24/36		
	200	Lahore	Make sure PCP-A is active Simulate Pole2 a DC Line Fault by activating the DC line protection in PCPA			
	201	Lahore	Verify the firing angle has been retarded in Lahore station			
	202	Matiari/ Lahore	Verify that pole2 quickly recovers within the expected time delays.			
	203	Lahore	Change all the modified settings back to original value.			
Test Acceptance Criteria	204	Matiari/Lahore C/S	The voltage of the AC system should be within the specified limits (450-550kV)			
	205		All Operations executed successfully			
	206		The synchronizing voltage and the phasing of the firing control signals are correct.			
	207		All thyristor check-back signals are available.			
	208		Measuring system and controls remain operational. No transients on switchover of PCP or SC systems.			
	209		Measuring quantities are available and the values are within the specified range and phase.			
	210		No abnormal corona discharges and no operation of surge arresters shall occur at energized equipment.			
	211		No Stuck Condition			
	212		No False Tripping by DC Protection System			
	213		All the sequence as recorded in OWS should be documented, All the Charts related to pole power,current, voltages, firing angles and extinction angles, tap positions. Should be recorded and documented. TFR data in Comtrade format to be captured and recorded.			
	214		No Tripping in AC side of converter Station			

Condition

13-AC/DC Line Faults

Test Objective	The test objective is to check DC control and protection system function during the DC line fault.

Condition	Sr. No.	Station	Action	Equipment/ Configuration	State of Equipment/configuration	Description
Pre-Test Conditions & Configurations (AC/DC)	1	AC side at Matiari & Lahore C/S	Voltage Limits	Utmost efforts will be made to maintain the voltages within ±5% range. However, reactive compensation devices installed at both converter stations can be used, if needed, to control the voltages keeping in view the then prevailing system conditions.		
	2		AC Yard of Lahore & Matiari Converter Station is in normal Position		CLOSED State	All bays including Filter Banks are complete and energized with no component in maintenance state.
	3	DC Side at Matiari C/S	Both Poles will operate in Bipole Ground Return Mode see Status Table "BP-GR"			BI-Pole Mode of Operation
	4	General Preconditions	Converter transformer protection and the charging protection of corresponding converter AC bus breaker are put into operation.			
	5		All the Prerequisites as mentioned in DC Dispatch Plan should be met.			
	6		Visual inspections of AC switchyard, AC filter yard, DC yard and DC valve hall prior first energization or switching.			
	7		All electrical connections are available.			
	8		Protection settings and protective circuits trip sequences tests must be completed.			
	9		AC-switchyard and associated protections and sequences, including breaker failure protection, must be active.			
	10		Correct grounding of all equipment is available.			
	11		Thyristor valve cooling in operation for 24 hours, no water leakage observed.			
	12		Thyristor valves and valve hall is cleaned.			
	13		Converter transformers are demagnetized.			
	14		Air humidity and temperature in valve hall are within expected limits.			
	15		Pole Compensation and disturbance test, Reversed Power Direction (Annex-D-XII must be			
	16		Both sides AC system of Matiari & Lahore C/S are capable to supply and accept the power (400 MW) for the test. Availability of N-1 contingency on parallel AC corridor. AC system short circuit level has been measured at both Matiari and Lahore converter stations and it is confirmed to be suitable for the tested power.			
	17		Confirm DC line restart function is enabled			
	18		NTDC authority approval required before conducting AC Fault Tests (Optional)			
	19	DC Configuration Selection (Automatically apply to both Lahore and Matiari)	Direction	Normal		Matiari to Lahore
	20		Return	Ground		Ground Return Mode
	21		Udc Mode	Normal		±660 kV
	22		Telecom Mode	Operational		
	23		Master Station	Matiari		
	24	Configuration Setting at Matiari & Lahore C/S DC side	Station Control (SC)	A	ACTIVE	Can be changed to B during test
	25			B	Standby	
	26		Pole Control Protection (PCP)	A	ACTIVE	
	27			B	Standby	
	28		Transmission Control Mode	Power	ACTIVE	HVDC will operate in power control mode.
	29		Station Control Mode	Joint	ACTIVE	Matiari & Lahore will operate jointly.
	30		Reactive Power Control Mode	Automatic	ACTIVE	Automatically Switch in/out the AC Filters/Reactors
	31		Reactive Power Control Variable	Q-Control	ACTIVE	Reactive Power exchange between AC Yard of Converter Station and NTDC system will be automatically controlled.

Testing Start Up Sequence

DC Line Faults at Pole 1 near Rectifier, Normal Power Direction (Sr. No. 35) (A4 13.3.1)	32	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	33		Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	34	Matiari & Lahore	Start the BIPOLE	Power	400 MW	
	35			Ramp Rate:	50 MW/Min	
	36		Wait to achieve Target Value	Max Time	5 min	
	37	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	38			DC Voltages	±660 kV	
	39			RPC Operation	BP-11/13 , HP24/36	
	40	Lahore		Extinction Angle (γ)	17°	
	41			DC Voltages	Range to be mentioned	
	42			RPC Operation	2xHP12/24	
	43	Matiari/Lahore	Verify stable operation & Normal start at minimum power			
	44		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	45	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	46	Lahore		2xHP12/24		
	47	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	48	Matiari	DC Line Faults at Pole 1 near Rectifier should be initiated in line with the guidance in DC Line Faults Tests Program.			
	49	Lahore/ Matiari	Verify	DC line traveling wave protection and derivative protection operated		
	50			Order down in rectifier from DC line protections.		
	51			DC line successfully restarted to full voltage on first attempt		
	52			The actual distance would be same as that shown on the LFL indication		
Pole 2 Reduced Voltage, DC Line Faults at Pole 2 near Rectifier, Normal Power Direction (Sr. No. 36) (A4 13.3.2)	53	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	54	Matiari & Lahore	Start the BiPole	Power	400 MW	
	55			Ramp Rate:	50 MW/Min	
	56		Wait to achieve Target Value	Max Time	5 min	
	57	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	58			DC Voltages	±660 kV	
	59			RPC Operation	BP-11/13 , HP24/36	
	60	Lahore		Extinction Angle (γ)	17°	
	61			DC Voltages	Range to be mentioned	
	62			RPC Operation	2xHP12/24	
	63	Matiari/Lahore	Verify stable operation & Normal start at minimum power			
	64		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	65	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	66	Lahore		2xHP12/24		
	67	Matiari	Order pole 2 in REDUCED VOLTAGE (70% of nominal voltage).			
	68		Verify dc voltage ramps down to 70% (462kV)			
	69	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	70	Matiari	DC Line Faults at Pole 2 near Rectifier should be initiated in line with the guidance in DC Line Faults Tests Program.			
	71	Matiari/Lahore	Verify	DC line traveling wave protection and derivative protection operated		
	72			Order down in rectifier from DC line protections.		
	73			DC line -successfully restarted to pre-disturbance reduced voltage on first attempt		
	74			The actual distance would be same as that shown on the LFL indication		

DC Line Faults at Pole 1 near Inverter, Normal Power Direction (Sr. No. 37) (A4 13.3.3)	75	Matiari	Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	76	Matiari & Lahore	Start the BIPOLE	Power	400 MW	
	77			Ramp Rate:	50 MW/Min	
	78		Wait to achieve Target Value	Max Time	5 min	
	79	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	80			DC Voltages	±660 kV	
	81			RPC Operation	BP-11/13 , HP24/36	
	82	Lahore		Extinction Angle (γ)	17°	
	83			DC Voltages	Range to be mentioned	
	84			RPC Operation	2xHP12/24	
	85	Matiari/Lahore	Verify stable operation & Normal start at minimum power			
	86		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	87	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	88	Lahore		2xHP12/24		
	89	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	90	Lahore	DC Line Faults at Pole 1 near Inverter should be initiated in line with the guidance in DC Line Faults Tests Program.			
	91	Lahore/ Matiari	Verify	DC line traveling wave protection and derivative protection operated		
	92			Order down in rectifier from DC line protections.		
	93			DC line successfully restarted to full voltage on first attempt		
	94			The actual distance would be same as that shown on the LFL indication		
Pole 1 Reduced Voltage, DC Line Faults at Pole 1 near Inverter, Normal Power Direction (Sr. No. 38) (A4 13.3.4)	95	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	96	Matiari	Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	97	Matiari & Lahore	Start the BiPole,	Power	400 MW	
	98			Ramp Rate:	50 MW/Min	
	99		Wait to achieve Target Value	Max Time	5 min	
	100	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	101			DC Voltages	±660 kV	
	102			RPC Operation	BP-11/13 , HP24/36	
	103	Lahore		Extinction Angle (γ)	17°	
	104			DC Voltages	Range to be mentioned	
	105			RPC Operation	2xHP12/24	
	106	Matiari/Lahore	Verify stable operation & Normal start at minimum power			
	107		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	108	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	109	Lahore		2xHP12/24		
	110	Matiari/Lahore	Order pole 1 in REDUCED VOLTAGE (70% of nominal voltage-462 kV).			
	111	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	112	Lahore	DC Line Faults at Pole 1 near Inverter with the guidance in DC Line Faults Tests Program.			
	113	Matiari/Lahore	Verify	DC line traveling wave protection and derivative protection operated		
	114			Order down in rectifier from DC line protections.		
	115			DC line successfully restarted to pre-disturbance reduced voltage on first attempt		
	116			The actual distance would be same as that shown on the LFL indication		

Pole 1 Reduced Voltage, DC Line Faults at Pole 2 near Inverter, Normal Power Direction (Sr. No. 39) (A4 13.3.5)	117	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	118	Matiari	Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	119	Matiari & Lahore	Start the BiPole,	Power	400 MW	
	120			Ramp Rate:	50 MW/Min	
	121		Wait to achieve Target Value	Max Time	5 min	
	122	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	123			DC Voltages	±660 kV	
	124			RPC Operation	BP-11/13 , HP24/36	
	125	Lahore		Extinction Angle (γ)	17°	
	126			DC Voltages	Range to be mentioned	
	127			RPC Operation	2xHP12/24	
	128	Matiari/Lahore	Verify stable operation & Normal start at reduced power			
	129		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	130	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	131	Lahore		2xHP12/24		
	132	Matiari/Lahore	Order pole 1 in REDUCED VOLTAGE (70% of nominal voltage 462kV).			
	133	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	134	Lahore	DC Line Faults at Pole 2 near Inverter with the guidance in DC Line Faults Tests Program.			
	135	Matiari/Lahore	Verify	DC line traveling wave protection and derivative protection operated		
	136			Order down in rectifier from DC line protections.		
	137			DC line-successfully restarted to full voltage on first attempt		
	138			The actual distance would be same as that shown on the LFL indication		
DC Line Faults at Pole 2 near Inverter, Metallic Return Operation, Normal Power Direction (Sr. No. 40) (A4 13.3.6)	139	Matiari/Lahore C/S DC side	Order pole 2 TRANSFER TO METALLIC RETURN			
	140		Verify Ready for Operation Conditions.			
	141	Matiari & Lahore	Start the BiPole,	Power	200 MW	
	142			Ramp Rate:	50 MW/Min	
	143		Wait to achieve Target Value	Max Time	5 min	
	144	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	145			DC Voltages	-660 kV	
	146			RPC Operation	BP-11/13 , HP24/36	
	147	Lahore		Extinction Angle (γ)	17°	
	148			DC Voltages	Range to be mentioned	
	149			RPC Operation	2xHP12/24	
	150	Matiari/Lahore	Verify stable operation & Normal start at minimum power			
	151		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	152	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	153	Lahore		2xHP12/24		
	154	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	155	Lahore	DC Line Faults at Pole 2 near Inverter with the guidance in DC Line Faults Tests Program.			
	156	Matiari/Lahore	Verify	DC line traveling wave protection and derivative protection operated		
	157			Order down in rectifier from DC line protections.		
	158			DC line successfully restarted to full voltage on first attempt		
	159			The actual distance would be same as that shown on the LFL indication		

Fault in Pole 2 at neutral connection, with Pole-I running at 200 MW.(See Figure Below) (Sr. No. 41)	160	Matiari/Lahore	Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	161	Matiari & Lahore	Start the Pole 1	Power	400 MW	
	162			Ramp Rate:	50 MW/Min	
	163		Wait to achieve Target Value	Max Time	5 min	
	164	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	165			DC Voltages	+660 kV	
	166			RPC Operation	BP-11/13 , HP24/36	
	167	Lahore		Extinction Angle (γ)	17°	
	168			DC Voltages	Range to be mentioned	
	169			RPC Operation	2xHP12/24	
	170	Matiari/Lahore	Verify stable operation & Normal start at reduced with minimum power			
	171		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	172	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	173	Lahore		2xHP12/24		
	174	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	175	Matiari/Lahore	Apply solid fault in pole 2 on the neutral bus on the valve side of the neutral bus smoothing reactor as per attached one line diagram.			
	176	Matiari	Connect but **Do Not Start/Deblock** Pole 2			
	177	Lahore/ Matiari	Verify	Pole 2 -Pole differential protection operates and causes the Pole 2 to isolate by opening the Pole 2 NBS followed by opening the Pole 2 DC line disconnect switch.		
	178			Pole 2 -Pole differential protection operates. Bipole neutral differential protection **does not** operate. Pole 1 - Pole differential protection does not trip Pole 1 - converter transformer **does not trip** due to saturation (over fluxing protection).		
	179			Initiate a TFR manual trigger when the operator issues the Pole 2 connect command to ensure that signals are captured.		
	180			Collect and save all data records.		
DC Line Faults at Pole 1 near Rectifier, Reverse Power Direction (Optional) (Sr. No. 42)	181	Matiari/Lahore	Verify Reverse Power Direction mode			
	182	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	183		Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	184	Matiari & Lahore	Start the BIPOLE	Power	400 MW	
	185			Ramp Rate:	50 MW/Min	
	186		Wait to achieve Target Value	Max Time	5 min	
	187	Lahore	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	188			DC Voltages	±660 kV	
	189			RPC Operation	2xHP12/24	
	190	Matiari		Extinction Angle (γ)	17°	
	191			DC Voltages	Range to be mentioned	
	192			RPC Operation	BP-11/13, HP-24/36	
	193	Matiari/Lahore	Verify stable operation & Normal start at reduced with minimum power			
	194		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	195	Lahore	Verify RPC action	2xHP 12/24		
	196	Matiari		BP-11/13, HP-24/36		
	197	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	198	Lahore	DC Line Faults at Pole 1 near Rectifier should be initiated in line with the guidance in DC Line Faults Tests Program.			
	199	Lahore/ Matiari	Verify	DC line traveling wave protection and derivative protection operated		
	200			Order down in rectifier from DC line protections.		
	201			DC line -successfully restarted to full voltage on first attempt		
	202			The actual distance would be same as that shown on the LFL indication		

DC Line Faults at Pole 2 near Inverter, Reverse Power Direction (Optional) (Sr. No. 43)	203	Matiari/Lahore	Verify Reverse Power Direction mode			
	204	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	205		Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	206	Matiari & Lahore	Start the BIPOLE	Power	400 MW	
	207			Ramp Rate:	50 MW/Min	
	208		Wait to achieve Target Value	Max Time	5 min	
	209	Lahore	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	210			DC Voltages	±660 kV	
	211			RPC Operation	2xHP12/24	
	212	Matiari		Extinction Angle (γ)	17°	
	213			DC Voltages	Range to be mentioned	
	214			RPC Operation	BP-11/13, HP-24/36	
	215	Matiari/Lahore	Verify stable operation & Normal start at reduced with minimum power			
	216		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	217	Lahore	Verify RPC action	2xHP 12/24		
	218	Matiari		BP-11/13, HP-24/36		
	219	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	220	Matiari	DC Line Faults at Pole 2 near Inverter should be initiated in line with the guidance in DC Line Faults Tests Program.			
	221	Lahore/ Matiari	Verify	DC line traveling wave protection and derivative protection operated		
	222			Order down in rectifier from DC line protections.		
	223			DC line successfully restarted to full voltage on first attempt		
	224			The actual distance would be same as that shown on the LFL indication		
AC Line Faults at Rectifier, Normal Power Direction (Optional) (Sr. No. 44) (A4 13.3.7)	225	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	226		Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	227	Matiari & Lahore	Start the BiPole,	Power	400 MW	
	228			Ramp Rate:	50 MW/Min	
	229		Wait to achieve Target Value	Max Time	5 min	
	230	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	231			DC Voltages	±660 kV	
	232			RPC Operation	BP-11/13 , HP24/36	
	233	Lahore		Extinction Angle (γ)	17°	
	234			DC Voltages	Range to be mentioned	
	235			RPC Operation	2xHP12/24	
	236	Matiari/Lahore	Verify stable operation & Normal start at reduced with minimum power			
	237		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	238	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	239	Lahore		2xHP12/24		
	240	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	241	Matiari	AC Line Faults at Rectifier should be initiated in line with the guidance in AC Line Faults Tests Program.			
	242	Matiari/Lahore	Verify	Low AC voltage at rectifier is detected. TFR operates to record dc system performance during fault and recovery.		
	243			DC system restores to normal operation after the clearance of AC line fault.		

AC Line Faults at Invert er, Normal Power Direction (Optional) (Sr. No. 45)	244	Matiari/Lahore C/S DC side	Verify Ready for Operation Conditions.			
	245		Verify Pole-I and Pole-II is in Bi-Pole Power Control Mode.			
	246	Matiari & Lahore	Start the BiPole,	Power	400 MW	
	247			Ramp Rate:	50 MW/Min	
	248		Wait to achieve Target Value	Max Time	5 min	
	249	Matiari	Verify Performance indicators	Firing angle (α)	15°±2.5°	
	250			DC Voltages	±660 kV	
	251			RPC Operation	BP-11/13 , HP24/36	
	252	Lahore		Extinction Angle (γ)	17°	
	253			DC Voltages	Range to be mentioned	
	254			RPC Operation	2xHP12/24	
	255	Matiari/Lahore	Verify stable operation & Normal start at reduced with minimum power			
	256		Perform normal inspections (visual and acoustical) while pole is deblocked.			
	257	Matiari	Verify RPC action	BP-11/13, HP-24/36		
	258	Lahore		2xHP12/24		
	259	AC Network	NPCC makes sure, parallel AC corridor has margin for sharing 400 MW with DC System. (Sudden load sharing from DC corridor to AC corridor can happen in next step in case of DC system failure)			
	260	Lahore	AC Line Faults at Inverter should be initiated in line with the guidance in AC Line Faults Tests Program.			
	261	Matiari/Lahore	Verify	Low AC voltage at rectifier is detected.		
	262			Commutation failure occurs.		
	263			DC system restores to normal operation after the clearance of AC line fault.		
Test Acceptance Criteria	264	Matiari/Lahore C/S	The voltage of the AC system should be within the specified limits (450-550kV)			
	265		All Operations executed successfully			
	266		The synchronizing voltage and the phasing of the firing control signals are correct.			
	267		All thyristor check-back signals are available.			
	268		Measuring system and controls remain operational. No transients on switchover of PCP or SC systems.			
	269		Measuring quantities are available and the values are within the specified range and phase.			
	270		No abnormal corona discharges and no operation of surge arresters shall occur at energized equipment.			
	271		No Stuck Condition			
	272		No False Tripping by DC Protection System			
	273		All the sequence as recorded in OWS should be documented, All the Charts related to pole power, current, voltages, firing angles and extinction angles, tap positions. Should be recorded and documented. TFR data in Comtrade format to be captured and recorded.			
	274		No Tripping in AC side of converter Station			

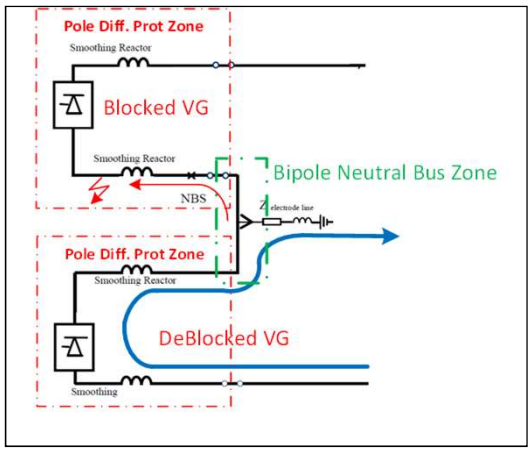

Figure related to test at Sr. No. 41

Status Tables-A

Note O/C indcates postion can be open or closed

Reference names			P1-MR	P2-MR	P1-GR	P2-GR	P1-ISOLAT	P2-ISOLAT	Mat-P1-GR		Mat-P2-GR		Mat-DCY-Main
Reference names			**Mat-P1-MR**	**Mat-P2-MR**	**Mat-P1-GR**	**Mat-P2-GR**	**Mat-P1-ISOLAT**	**Mat-P2-ISOLAT**					
			Metallic Return - Pole 1	**Metallic Return - Pole 2**	**Ground Return - Pole 1**	**Ground Return - Pole 2**	**Isolation Mode-Pole 1**	**Isolation Mode-Pole 2**	**Maintenance Mode - Pole 1 (With DC line)**	**Maintenance Mode - Pole 1 (Without DC line)**	**Maintenance Mode - Pole 2 (With DC line)**	**Maintenance Mode - Pole 2 (Without DC line)**	**Maintnance Mode - DC Yard**
Matiari - Pole 1													
1	Valve Hall	U1E1	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
2		U1E2	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
3		U1E3	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
4		U1E4	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
5	Pole-I	WN1Q1(NBS)	CLOSED	O/C	CLOSED	O/C	OPEN	O/C	OPEN	OPEN	O/C	O/C	OPEN
6		WN1Q11	CLOSED	OPEN	CLOSED	OPEN	OPEN	O/C	OPEN	OPEN	O/C	O/C	OPEN
7		WN1Q12	CLOSED	OPEN	CLOSED	OPEN	OPEN	O/C	OPEN	OPEN	O/C	O/C	OPEN
8		WP1Q11	CLOSED	OPEN	CLOSED	O/C	OPEN	OPEN	OPEN	OPEN	O/C	O/C	OPEN
9		WP1Q10	OPEN	CLOSED	OPEN	OPEN	O/C	OPEN	OPEN	CLOSED	O/C	O/C	OPEN
10		P1E11	OPEN	OPEN	OPEN	O/C	OPEN	O/C	CLOSED	OPEN	O/C	O/C	CLOSED
11		P1E12	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
12		N1E11	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
13		N1E12	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
14	DC Filters	WF1Q11	CLOSED	O/C	CLOSED	O/C	CLOSED	O/C	OPEN	OPEN	O/C	O/C	OPEN
15		WF1Q12	CLOSED	O/C	CLOSED	O/C	CLOSED	O/C	OPEN	OPEN	O/C	O/C	OPEN
16		WF1Q13	CLOSED	O/C	CLOSED	O/C	CLOSED	O/C	OPEN	OPEN	O/C	O/C	OPEN
17		WF1Q14	CLOSED	O/C	CLOSED	O/C	CLOSED	O/C	OPEN	OPEN	O/C	O/C	OPEN
18		F1E11	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
19		F1E12	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
20		F1E13	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
21		F1E14	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
Matiari - Pole 2													
1	Valve Hall	U2E1	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
2		U2E2	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
3		U2E3	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
4		U2E4	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
5	Pole-II	WN2Q1(NBS)	O/C	CLOSED	O/C	CLOSED	O/C	OPEN	O/C	O/C	OPEN	OPEN	OPEN
6		WN2Q11	OPEN	CLOSED	OPEN	CLOSED	O/C	OPEN	O/C	O/C	OPEN	OPEN	OPEN
7		WN2Q12	OPEN	CLOSED	OPEN	CLOSED	O/C	OPEN	O/C	O/C	OPEN	OPEN	OPEN
8		WP2Q11	OPEN	CLOSED	O/C	CLOSED	O/C	OPEN	O/C	O/C	OPEN	OPEN	OPEN
9		WP2Q10	CLOSED	OPEN	OPEN	OPEN	OPEN	O/C	O/C	O/C	OPEN	CLOSED	OPEN
10		P2E11	OPEN	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	OPEN	CLOSED
11		P2E12	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
12		N2E11	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
13		N2E12	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
14	DC Filters	WF2Q11	O/C	CLOSED	O/C	CLOSED	O/C	CLOSED	O/C	O/C	OPEN	OPEN	OPEN
15		WF2Q12	O/C	CLOSED	O/C	CLOSED	O/C	CLOSED	O/C	O/C	OPEN	OPEN	OPEN
16		WF2Q13	O/C	CLOSED	O/C	CLOSED	O/C	CLOSED	O/C	O/C	OPEN	OPEN	OPEN
17		WF2Q14	O/C	CLOSED	O/C	CLOSED	O/C	CLOSED	O/C	O/C	OPEN	OPEN	OPEN
18		F2E11	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
19		F2E12	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
20		F2E13	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
21		F2E14	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
Matiari - Common													
1	NBGS	WGQ1	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	O/C	O/C	O/C	O/C	OPEN
2		WGQ10	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	O/C	O/C	O/C	O/C	OPEN
3		WNQ12	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	O/C	O/C	O/C	O/C	OPEN
4	MRTB	WN3Q1	OPEN	OPEN	CLOSED	CLOSED	O/C	O/C	O/C	O/C	O/C	O/C	OPEN
5		WN3Q11	CLOSED	CLOSED	CLOSED	CLOSED	O/C	O/C	O/C	O/C	O/C	O/C	OPEN
6		WN3Q12	CLOSED	CLOSED	CLOSED	CLOSED	O/C	O/C	O/C	O/C	O/C	O/C	OPEN
7		WN3Q13	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	O/C	O/C	O/C	O/C	OPEN
8		N3E11	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	O/C	O/C	O/C	O/C	CLOSED
9		N3E12	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	O/C	O/C	O/C	O/C	CLOSED
10	GRTS	WNQ1	CLOSED	CLOSED	OPEN	OPEN	O/C	O/C	O/C	O/C	O/C	O/C	OPEN
11		WNQ11	CLOSED	CLOSED	CLOSED	CLOSED	O/C	O/C	O/C	O/C	O/C	O/C	OPEN
12		NE11	OPEN	OPEN	OPEN	OPEN	O/C	O/C	O/C	O/C	O/C	O/C	CLOSED
13		NE12	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	O/C	O/C	O/C	O/C	CLOSED
14	Electrode Station	WEQ11	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	O/C	O/C	O/C	O/C	OPEN
15		WEQ12	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	O/C	O/C	O/C	O/C	OPEN
16		EE-11	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	O/C	O/C	O/C	O/C	CLOSED
17		EE-12	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	O/C	O/C	O/C	O/C	CLOSED

Status Tables-A

Note O/C indcates postion can be open or closed

Reference names			Lah-P1-MR	Lah-P2-MR	Lah-P1-GR	Lah-P2-GR	Lah-P1-ISOLAT	Lah-P2-ISOLAT					
			Metallic Return - Pole 1	Metallic Return - Pole 2	Ground Return - Pole 1	Ground Return - Pole 2			Maintenance Mode - Pole 1 (With DC line)		Maintenance Mode - Pole 2 (With DC line)		Maintnance Mode - DC Yard
Lahore Pole 1													
1	Valve Hall	U1E1	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
2		U1E2	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
3		U1E3	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
4		U1E4	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
5	Pole-I	WN1Q1(NBS)	CLOSED	O/C	CLOSED	O/C	OPEN	O/C	OPEN	OPEN	O/C	O/C	OPEN
6		WN1Q11	CLOSED	OPEN	CLOSED	OPEN	OPEN	O/C	OPEN	OPEN	O/C	O/C	OPEN
7		WN1Q12	CLOSED	OPEN	CLOSED	OPEN	OPEN	O/C	OPEN	OPEN	O/C	O/C	OPEN
8		WP1Q11	CLOSED	OPEN	CLOSED	O/C	OPEN	O/C	OPEN	OPEN	O/C	O/C	OPEN
9		WP1Q10	OPEN	CLOSED	OPEN	OPEN	O/C	OPEN	OPEN	CLOSED	O/C	O/C	OPEN
10		P1E11	OPEN	OPEN	OPEN	O/C	OPEN	O/C	CLOSED	OPEN	O/C	O/C	CLOSED
11		P1E12	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
12		N1E11	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
13		N1E12	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
14	DC Filters	WF1Q11	CLOSED	O/C	CLOSED	O/C	CLOSED	O/C	OPEN	OPEN	O/C	O/C	OPEN
15		WF1Q12	CLOSED	O/C	CLOSED	O/C	CLOSED	O/C	OPEN	OPEN	O/C	O/C	OPEN
16		WF1Q13	CLOSED	O/C	CLOSED	O/C	CLOSED	O/C	OPEN	OPEN	O/C	O/C	OPEN
17		WF1Q14	CLOSED	O/C	CLOSED	O/C	CLOSED	O/C	OPEN	OPEN	O/C	O/C	OPEN
18		F1E11	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
19		F1E12	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
20		F1E13	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
21		F1E14	OPEN	O/C	OPEN	O/C	OPEN	O/C	CLOSED	CLOSED	O/C	O/C	CLOSED
Lahore Pole 2													
1	Valve Hall	U2E1	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
2		U2E2	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
3		U2E3	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
4		U2E4	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
5	Pole-II	WN2Q1(NBS)	O/C	CLOSED	O/C	CLOSED	O/C	OPEN	O/C	O/C	OPEN	OPEN	OPEN
6		WN2Q11	OPEN	CLOSED	OPEN	CLOSED	O/C	OPEN	O/C	O/C	OPEN	OPEN	OPEN
7		WN2Q12	OPEN	CLOSED	OPEN	CLOSED	O/C	OPEN	O/C	O/C	OPEN	OPEN	OPEN
8		WP2Q11	OPEN	CLOSED	O/C	CLOSED	O/C	OPEN	O/C	O/C	OPEN	OPEN	OPEN
9		WP2Q10	CLOSED	OPEN	OPEN	OPEN	OPEN	O/C	O/C	O/C	OPEN	CLOSED	OPEN
10		P2E11	OPEN	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	OPEN	CLOSED
11		P2E12	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
12		N2E11	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
13		N2E12	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
14	DC Filters	WF2Q11	O/C	CLOSED	O/C	CLOSED	O/C	CLOSED	O/C	O/C	OPEN	OPEN	OPEN
15		WF2Q12	O/C	CLOSED	O/C	CLOSED	O/C	CLOSED	O/C	O/C	OPEN	OPEN	OPEN
16		WF2Q13	O/C	CLOSED	O/C	CLOSED	O/C	CLOSED	O/C	O/C	OPEN	OPEN	OPEN
17		WF2Q14	O/C	CLOSED	O/C	CLOSED	O/C	CLOSED	O/C	O/C	OPEN	OPEN	OPEN
18		F2E11	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
19		F2E12	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
20		F2E13	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
21		F2E14	O/C	OPEN	O/C	OPEN	O/C	OPEN	O/C	O/C	CLOSED	CLOSED	CLOSED
Lahore Common Neutral													
1	NBGS	WGQ1 [NBGS]	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	O/C	O/C	O/C	O/C	OPEN
2		WNQ12	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	O/C	O/C	O/C	O/C	OPEN
3		WGQ10	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	O/C	O/C	O/C	O/C	OPEN
4	MRTB (Metallic Return Transfer Bus)	WN3Q11	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	O/C	O/C	O/C	O/C	OPEN
5		N3E11	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	O/C	O/C	O/C	O/C	CLOSED
6		N3E12	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	O/C	O/C	O/C	O/C	CLOSED
7	GRTS(Ground Return Transfer Switch)	WNQ11	CLOSED	CLOSED	OPEN	OPEN	O/C	O/C	O/C	O/C	O/C	O/C	OPEN
8		NE11	OPEN	OPEN	OPEN	OPEN	O/C	O/C	O/C	O/C	O/C	O/C	CLOSED
9		NE12	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	O/C	O/C	O/C	O/C	CLOSED
10	Electrode Station	WEQ11	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	O/C	O/C	O/C	O/C	OPEN
11		WEQ12	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	O/C	O/C	O/C	O/C	OPEN
12		EE-11	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	O/C	O/C	O/C	O/C	CLOSED
13		EE-12	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	O/C	O/C	O/C	O/C	CLOSED

Status Tables-B

Ready For Energization

These condition must be met before energizing C/T/F	
1	Valve Hall Locked
2	Valve Hall Man Door Closed
3	Valve Cooling is Ok and Running
4	NO Emergency Stop Orders (ESOF)
5	Ground Switches Open at AC side
6	Ground Switches Open at DC side

Ready For Operation

These Conditions must be met before Deblocking the Valve	
1	No Emergency Fault
2	No Protectiion Trip Orders
3	Tap Changer Ready
4	Pole Connected
5	Valve Energized
6	Valve Blocked
7	System/Station level control selected
8	Power Direction Selected
9	No inhibit SigO/Cl from measuring Devices.

Status Tables-B

Pre-condition	Pole-1 is isolated				
Switch Operation Sequence	Transfer from Pole 2 GR to Pole 2 MR on Pole 1 Conductor				
	Matiari CS		Lahore CS		
1	NE11	OPEN	NE11		OPEN
2	WNQ11	CLOSED	WNQ11		CLOSED
3	WP2Q10	CLOSED	WP2Q10		CLOSED
4	WNQ1(GRTS)	CLOSED	/		/
5	WN3Q1(MRTB)	OPEN	/		/
6	WN3Q11	OPEN	/		/
7	WN3Q12	OPEN	/		/
Pre-condition	Pole-1 is isolated				
Switch Operation Sequence	Transfer from Pole 2 MR on Pole 1 conductor to Pole 2 GR				
	Matiari CS		Lahore CS		
1	WN3Q11	CLOSED	/		/
2	WN3Q12	CLOSED	/		/
3	WN3Q1(MRTB)	CLOSED	/		/
4	WNQ1(GRTS)	OPEN	/		/
5	WP2Q10	OPEN	WP2Q10		OPEN
6	WNQ11	OPEN	WNQ11		OPEN
7	NE11	CLOSED	NE11		CLOSED
Pre-condition	Pole-2 is isolated				
Switch Operation Sequence	Transfer from GR to MR on Pole 2 Conductor				
	Matiari CS		Lahore CS		
1	NE11	OPEN	NE11		OPEN
2	WNQ11	CLOSED	WNQ11		CLOSED
3	WP1Q10	CLOSED	WP1Q10		CLOSED
4	WNQ1(GRTS)	CLOSED	/		/
5	WN3Q1(MRTB)	OPEN	/		/
6	WN3Q11	OPEN	/		/
7	WN3Q12	OPEN	/		/
Pre-condition	Pole-2 is isolated				
Switch Operation Sequence	Transfer from MR on Pole 2 conductor to GR				
	Matiari CS		Lahore CS		
1	WN3Q11	CLOSED	/		/
2	WN3Q12	CLOSED	/		/
3	WN3Q1(MRTB)	CLOSED	/		/
4	WNQ1(GRTS)	OPEN	/		/
5	WP1Q10	OPEN	WP1Q10		OPEN
6	WNQ11	OPEN	WNQ11		OPEN
7	NE11	CLOSED	NE11		CLOSED

Status Tables-B

Switch Operation Sequence	Transfer from BPGR to MR Pole-1 on Pole 2 Conductor
	The sequnce of transition is:
1	BPGR ==>Stop or Block Pole1
2	Stop or Block Pole1==> Monopolar GR Pole 2
3	Monopolar GR Pole 2==> Isolate Pole 1
4	Isolate Pole 1==>Pole1 Isolated Both Stations
5	Pole1 Isolated Both Stations==>P2 GR to Metallic Return on Pole 1 Conductor
Switch Operation Sequence	**Transfer from BPGR to MR Pole-2 On Pole 1 Conductor**
	The sequnce of transition is:
1	BPGR ==>Stop or Block Pole 2
2	Stop or Block Pole 2==> Monopolar GR Pole 1==>Isolate Pole 2
3	Monopolar GR Pole 1==>Isolate Pole 2
4	Isolate Pole 2==> Pole2 Isolated Both Stations
5	Pole2 Isolated Both Stations==>P1 GR to Metallic Return on Pole 2 Conductor

Status Tables-B

Switch Operation Sequence	Transfer from MR Pole-1 on Pole 2 Conductor to BPGR
	The sequnce of transition is:
1	MR Pole 1 ==> GR Pole 1
2	GR Pole 1==> Pole 2 is Isolated
3	Pole 2 is Isolated==> Connect Pole 2 both stations
4	Connect Pole 2 both stations==>Start Pole2
Switch Operation Sequence	**Transfer from MR Pole-2 on Pole 1 Conductor to BPGR**
	The sequnce of transition is:
1	MR Pole 2==> GR Pole 2
2	GR Pole 2==> Pole 1 is Isolated
3	Pole 1 is Isolated==> Connect Pole 1 both stations
4	Connect Pole 1 both stations==>Start Pole 1
Switch Operation Sequence	**Transfer from BPGR to GR Pole-1**
	This transition happens automatically when Pole 2 is blocked or tripped, the
1	Stop or trip pole 2 ==> Isolate Pole 2
2	Isolate Pole 2==> Pole 2 is Isolated
Switch Operation Sequence	**Transfer from BPGR to GR Pole-2**
	This transition happens automatically when Pole 1 is blocked or tripped, the
1	Stop or trip pole 1 ==> Isolate Pole 1
2	Isolate Pole 1==> Pole 1 is Isolated
Switch Operation Sequence	**Transfer from GR Pole-1 to BPGR**
	This transition happens when you connect and start Pole2 when Pole 1 is
1	Pole 2 is isolated==> Connect Pole 2==>Pole 2 is connected
2	Connect Pole 2==>Pole 2 is connected
3	Pole 2 is connected ==>Start Pole 2 (now in BPGR)
Switch Operation Sequence	**Transfer from GR Pole-2 to BPGR**
	This transition happens when you connect and start Pole 1 when Pole 2 is
1	Pole 1 is isolated==> Connect Pole 1
2	Connect Pole 1==>Pole 1 is connected
3	Pole 1 is connected ==>Start Pole 1 (now in BPGR)

Status Tables-B

Switch Operation Sequence	Start Pole
	The sequnce of transition is:
1	Open Valve Hall Grounding Switches
2	when the first switch is opened, the sequence will open the next one and so on.
3	Pole Connect
4	Connect DC Filter
Switch Operation Sequence	**Stop Pole**
	The sequnce of transition is:
1	Close Valve Hall Grounding Switches
2	when the close indication has reached the first switch, the sequence will close the next one and so on.
3	Pole Disconnect
4	Disconnect DC Filter
Switch Operation Sequence	**Pole Connect**
	The sequnce of transition is:
1	Close the disconnector(WNQ11)
2	Close the ground return neutral bus disconnector
3	Close the metallic return neutral bus disconnector
4	Close the neutral bus switch (WNQ1)
5	Close the pole line disconnector (WPxQ11), x=1 or 2 depending on Pole1 or Pole respectively
6	Pole is Connected
Switch Operation Sequence	**Pole Isolate**
	The sequnce of transition is:
1	Open the pole line disconnector (WPxQ11), x=1 or 2 depending on Pole1 or Pole respectively
2	When UDL voltage is low, open the neutral bus switch
3	Open the ground return disconnector
4	Open the metallic return neutral bus disconnector
5	Pole is isolated