

TECHNICAL SPECIFICATIONS

CHAPTER 3D-SURGE ARRESTER (SA)

for

PACKAGE KC-6

of

KOSHI CORRIDOR 220kV TRANSMISSION LINE PROJECT

IFB No.: KOSHI/NEA/KC-6

**Procurement of Design, Supply, Installation, Testing and
Commissioning of 220kV(GIS)/132kV Substation Expansion at
Dhungesanghu Substation**



नेपाल विद्युत प्राधिकरण

(नेपाल सरकारको स्वामित्व)

Nepal Electricity Authority

(A Government of Nepal Undertaking)

Chapter 3D-Surge Arresters

1. GENERAL

- 1.1. The Surge arresters shall conform to **IEC: 60099-4 (latest edition)** except to the extent modified in the specification and shall also be in accordance with requirements under Chapter 2-GTR.
- 1.2. The Surge Arrestors shall be designed for use in the geographic and meteorological conditions as given in Chapter 2-GTR and Chapter 1- PSR.

2. DUTY REQUIREMENTS

- 2.1. The surge arresters shall be of **Station High Duty (SH) / Station Medium Duty (SM)/Station Low Duty (SL) as per requirement** and gapless type without any series or shunt gaps.
- 2.2. The surge arresters shall be capable of discharging over-voltages occurring during switching of unloaded transformers, reactors and long lines.
- 2.3. 420 kV class Surge arresters shall be capable of discharging of severe re- energisation switching surges on a 400kV, 450km long line with Surge impedance of 300 ohms and capacitance of 11.986nF/km and over voltage factor of 2.3 p.u. Similarly, 800kV class Surge arresters shall be capable of discharging of severe re- energisation switching surges on a 765kV, 450km line with Surge impedance of 270 ohms and capacitance of 13 nF/km.
- 2.4. 420kV class arrester shall be capable of discharging energy equivalent to **Station High Duty (SH) class of IEC with thermal energy (Wth) of 12 kJ/kV for a 420kV system** followed immediately by 50 Hz energization with a sequential voltage profile as specified below:
 - 650 kVp for 3 peaks
 - 575 kVp for 0.1 second
 - 550 kVp for 1 second
 - 475 kVp for 10 seconds
- 2.5. 245/145/72.5 kV class arrester shall be capable for discharging energy equivalent to **Station Medium Duty (SM) class of IEC with thermal energy (Wth) of minimum 7 kJ/kV for 245/145/72.5 kV system** followed by procedure as per IEC.
- 2.6. 36/12 kV class arrester shall be capable for discharging energy equivalent to **Station Low Duty (SL) class of IEC with thermal energy (Wth) of minimum 4 kJ/kV for 36/12 kV system** followed by procedure as per IEC.
- 2.7. The surge arresters shall be suitable for withstanding forces as defined in Chapter 2- GTR.



2.8. The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

2.9. The surge arresters are being provided to protect the following equipment whose insulation levels are indicated in the table given below: -

Equipment to be protected	Lightning impulse(kVp) for 420 kV system	Switching surge(kV) for 420 kV system	Lightning impulse (kVp) for 245 kV	Lightning Surge (kVp) for 145 kV system	Lightning Surge (kVp) for 72.5kV system	Lightning Surge (kVp) for 36kV system
Power transformer	±1300	±1050	±950	± 550	± 250	± 170
Reactor	± 1300	±1050	± 950	± 550		
Instrument Transformer	±1425	±1050	± 1050	±650	± 325	±170
CB/Isolator Phase to ground	±1425	±1050	± 1050	± 650	± 325	± 170
CB/Isolator Across open contacts	±1425 (-/+240)	± 900 (-/+345)	±1050 (for CB) ± 1200 (for Isolator)	± 750 (for Isolator)	± 375(for Isolator)	± 180(for Isolator)

2.10. The duty cycle of CB installed in 420/245/145/72.5/36 kV System of the Employer shall be O-0.3 sec-CO-3 min-CO. The Surge Arrester shall be suitable for such circuit breaker duties in the system.

3. CONSTRUCTIONAL FEATURES

The features and constructional details of surge arresters shall be in accordance with requirement stipulated hereunder:

3.1. The non-linear blocks shall be of sintered metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent mechanical and electrical properties even after repeated operations.

3.2. **The surge arrester offered shall be of Design A (for 336kV and above SA) and Design A/Design B for <336kV SA.**

a. **Design A type arresters must be** fitted with pressure relief devices suitable for preventing violent failure of insulator housing and providing path for flow of rated fault currents in the event of arrester failure.

b. **Design B arrester should be embedded, all the components free of bubbles and gaps thus preventing partial discharge and moisture ingress. This type of design must have ability to control the cracking or tearing**



open of housing due to arc action and thereby avoiding violent shattering.

- 3.3. Outer insulator of surge arrester shall be porcelain/polymer conforming to requirements stipulated in Chapter 2-GTR.** Terminal connectors shall conform to requirements stipulated under Chapter 2-GTR. The outer insulator housing shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage upto the maximum design value for arrester. **Arresters shall not fail due to arrester insulator contamination.**
- 3.4. Seals **(for design A arresters)** shall be provided in such a way that these are always effectively maintained even when discharging rated lightning current.
- 3.5. The end fittings shall be made of corrosion proof material and preferably be nonmagnetic.
- 3.6. The name plate shall conform to the requirements of IEC incorporating the year of manufacture.
- 3.7. The following details shall be furnished for quality checks:
- a. The heat treatment cycle details along with necessary quality checks used for individual blocks and insulation layer formed across each block.
 - b. Metalizing coating thickness for reduced resistance between adjacent discs.
- 3.8. The manufacturer will submit Data for rejection rate of ZnO blocks during manufacturing/operation for the past three years.
- 3.9. The sealing arrangement **(for design A arresters)** of the Surge Arrester stacks shall be done incorporating grooved flanges with the O-rings/elliptical cross-section gaskets of Neoprene or Butyl rubber.
- 3.10. Arresters shall be of hermetically sealed units, self-supporting construction, suitable for mounting on tubular/lattice support structures.

4. FITTINGS AND ACCESSORIES

- 4.1. Arresters shall be complete with insulating base having provision for bolting to flat surface of structure.
- 4.2. Self contained discharge counters, suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit along with necessary connection arrangement. Suitable leakage current meters should also be provided. The reading of milliammeter and counters shall be visible through an inspection glass panel. The terminals shall be robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends. The surge counter shall be provided with a potential free contact rated for 220/110 Volt (DC) which shall close whenever a surge is recorded by



the surge monitor. Necessary arrangement shall be provided for extending the contact information to Substation Automation System/RTU.

- 4.3. Surge monitor consisting of discharge counters and milliammeters should be suitable to be mounted on support structure of the arrester and should be tested for IP66 degree of protection. The standard supporting structure for surge arrester should be provided with a mounting pad, for fixing the surge monitor. The surge monitor should be suitable for mounting on this standard insulating mounting pad. Also all nuts, bolts, washers etc. required for fixing the surge monitor shall be supplied by the Contractor. The arrangement for Surge Monitor enclosure fixing to the structure shall be at its rear/bottom. Connection between the Surge Arrester base and Surge Monitor shall be through a 2.0 m (minimum) long insulated copper rod/strip of at least 75 sq.mm cross sectional area or **PVC insulated flexible copper cable of at least 70 Sqmm**. The cable shall be terminated at rear/bottom side of the Surge Monitor. The gaskets of the surge monitors shall be of Neoprene, Butyl or equivalent material.
- 4.4. Grading/corona rings shall be provided on each complete arrester unit, as required. Suitable terminal connectors shall be supplied by the Contractor.

5. TESTS

- 5.1. In accordance with the requirements stipulated under Chapter 2-GTR, the surge arresters should have been type tested as per **latest IEC** and shall be subjected to routine and acceptance tests in accordance with **latest IEC**.
- 5.2. Test reports for all type tests **as per latest IEC-60099-4** including following additional type tests shall also be submitted for the Employer's review:
 - a. **Seismic withstand test as per Annexure-C of Chapter 2-GTR.**
 - b. **Corona Extinction Voltage test as per Annexure-B of Chapter 2-GTR.**
 - c. **Cantilever test on complete arrester as per requirement of Annexure-I.**
- 5.3. (a) **Acceptance Tests:**
 - a. Measurement of power frequency reference voltage of the arrester units.
 - b. Lightning Impulse Residual voltage on arrester units as per IEC.
 - c. Internal Ionisation or partial Discharge test.
- (b) **Special Acceptance Test:**
 - a. Thermal stability test on three sections as per IEC Clause 9.2.2.
 - b. Aging test for Zinc oxide blocks is to be carried out on 3 samples for 72 hours at maximum continuous over voltage



(MCOV) and at a temperature of 115°C. Acceptance norm being I_r (resistive current)/watt loss shall remain or decrease at the end of 72 hrs from the value taken after 1 hour of start of test.

- c. Watt loss test.

(c) Routine Tests:

- a. Sealing test: Water dip test at 1.5m depth from top of Surge Arrestor for 30 minutes shall be performed during assembly of Surge Arrestor stacks (followed by other routine tests, i.e. P.D. Measurement, Reference Voltage, Residual Voltage & IR measurement).
- b. Measurement of reference voltage.
- c. Residual voltage test of arrester unit.
- d. Internal Ionisation test or partial discharge test.
- e. Verticality check on completely assembled Surge arresters as a sample test on each lot.

(d) Routine Tests on Surge Monitors:

- a. The Surge monitors shall be connected in series with the test specimens during residual voltage and current impulse withstand tests to verify efficacy of the same. Additional routine/ functional tests with one 100A and 10kA current impulse (8/20 micro sec.) shall also be performed on the Surge monitor.
- b. Surge monitors shall be routinely tested for water dip test at 1.5m depth for 30 minutes. No water vapours shall be visible on the monitor glass.

(e) Routine Tests on insulators

All routine tests shall be conducted on the hollow column insulators as per IEC 62155. Polymer housing shall be tested in accordance to IEC-61462.

6. MANDATORY SPARES

Mandatory spares shall be as per BPS.

7. TECHNICAL PARAMETERS

The technical parameters shall be as per enclosed Annexure-I.

8. PRE-COMMISSIONING TESTS

- 8.1. An indicative list of tests is given below:

- a. Operation check of LA



counters.

- b. Insulation resistance measurement
- c. Capacitance and Tan delta measurement of individual stacks.
- d. Third harmonic resistive current measurement (to be conducted after energisation.)

8.2. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment manufacturer or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates at his own cost.



ANNEXURE-I**Technical Parameters for 400kV, 220kV and 132kV Surge Arresters (with Polymer/Porcelain Housing)**

Sl. No.	Description	Unit	420kV SA	245kV SA	145kV SA
1	Nominal System Operating voltage	kV, rms	400	220	132
2	Rated frequency	Hz	50	50	50
3	No. of Poles	No.	1	1	1
4	Design ambient temperature	°C	50	50	50
5	Rated arrester voltage	kV	336	216	120
6	Continuous operating voltage at 50 deg.C	kV	267	168	102
7	Nominal discharge current		20 kA of 8/20 microsecond wave	10 kA of 8/20 microsecond wave	10 kA of 8/20 microsecond wave
8	Discharge current at which insulation co-ordination will be done		20 kA of 8/20 microsecond wave	10 kA of 8/20 microsecond wave	10 kA of 8/20 microsecond wave
9	Rated thermal energy rating Wth	kJ/kV of rated arrester voltage	12kJ/kV	7kJ/kV	7kJ/kV
10	Repetitive charge transfer rating Qrs in coulombs	C	2.4C	1.6C	1.6C
11	Max. switching surge residual voltage	kVp	670(at 2kA) 650 (at 500A)	500 (at 1kA)	280 (at 1kA)
12	Max. residual voltage at				
i)	5kA	kVp	-	560	310
ii)	10 kA nominal discharge current	kVp	800	600	330
iii)	20 kA nominal discharge current	kVp	850	-	-
iv)	Steep fronted wave residual voltage at 20 kA	kVp	925	-	-
13	Arrester classification		Station High duty(SH)	Station Medium duty (SM)	Station Medium duty(SM)
14	High current short duration test value(4/10 micro second wave)	kAp	100	100	100
15	Current for pressure relief test	kA rms	63	50	40
16	Low current long duration test value	As per IEC			
17	Insulation Level				



Sl. No.	Description	Unit	420kV SA	245kV SA	145kV SA
a)	Full wave impulse withstand voltage (1.2/50 microsec.)				
i)	Arrester Housing	kVpeak	As per latest IEC:60099-4	As per latest IEC:60099-4	As per latest IEC:60099-4
b)	Switching impulse withstand voltage (250/2500 micro-second) dry/wet				
i)	Arrester Housing	kV peak	As per latest IEC:60099-4	-NA-	-NA-
c)	One minute power frequency dry/wet withstand voltage				
i)	Arrester Housing	kV rms	-NA-	As per latest IEC:60099-4/IS 15086 part 4	As per latest IEC:60099-4/IS 15086 part 4
18	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz. in all positions	micro volts	500 at 266 kVrms	500 at 156 kVrms	500 at 92 kVrms
19	Minimum Creepage distance	mm	As per Chapter-GTR	As per Chapter-GTR	As per Chapter-GTR
20	Cantilever Strength (for 1 minute withstand test)	kg	350	150	150
21	Maximum deflection at above cantilever load	mm	200	125	50
22	Seismic acceleration		As per Chapter PSR	---	---
23	Partial Discharge at 1.05 COV		≤ 10pC	≤ 10pC	≤ 10pC
24	System neutral earthing		Effectively Earthed	Effectively Earthed	Effectively Earthed

Note: The above insulation levels are applicable for altitude up to 1000 meters above

M.S.L. For higher altitudes, suitable correction factor as per relevant IEC shall be applied.



Technical parameters for 72.5kV, 36 kV and 11 kV Surge Arresters (with Porcelain /Polymer Housing)

Sl. No.	Description	Unit	72.5kV SA	36kV SA	12kV SA
1	Nominal System Operating voltage	kV, rms	66kV	33kV	11kV
2	Rated frequency	Hz	50	50	50
3	No. of Poles	No.	1	1	1
4	Design ambient temperature	°C	50	50	50
5	Rated arrester voltage	kV	60	30	9
6	Continuous operating voltage at 50 deg.C	kVrms	51	25	7.2
7	Nominal discharge current	kA	10 kA of 8/20 microsecond wave		
8	Discharge current at which insulation co- ordination will be done	kA	10 kA of 8/20 microsecond wave		
9	Rated thermal energy rating Wth	kJ/kV of rated arrester voltage	7	4	4
10	Repetitive charge transfer rating Qrs in coulombs	C	1.6	1	1
11	Max. switching surge residual voltage	kVp	136 (at 1kA)	72 (at 1kA)	22.4 (at 1kA)
12	Max. residual voltage at				
i)	5kA	kVp	160	85	26
ii)	10 kA nominal discharge current	kVp	170	90	28
iii)	20 kA nominal discharge current	kVp	190	-	--
iv)	Steep fronted wave residual voltage at 10 kA	kVp	190	-	--
13	Arrester designation		Station Medium duty (SM)	Station Low duty (SL)	Station Low duty (SL)
14	High current short duration test value(4/10 micro second wave)	kArms	100	100	100
15	Current for pressure relief test	kAp	40	31.5	25
16	Low current long duration test value		As per IEC		
17	Insulation Level				
a)	Full wave impulse withstand voltage (1.2/50 microsec.)				



Sl. No.	Description	Unit	72.5kV SA	36kV SA	12kV SA
i)	Arrester Housing	kVpeak	As per latest IEC:60099-4	As per latest IEC:60099- 4	As per latest IEC:60099-4
b)	One minute power frequency dry/wet withstand voltage				
i)	Arrester Housing	kV rms	As per latest IEC:60099-4	As per latest IEC:60099- 4	As per latest IEC:60099-4
18	Minimum Creepage distance	mm	As per Chapter-GTR	As per Chapter-GTR	As per Chapter-GTR
19	Cantilever Strength (for 1 minute withstand test)	kg	150	150	150
20	Maximum deflection at above cantilever load	mm	20	20	20

Note: The above insulation levels are applicable for altitude up to 1000 meters above

M.S.L. For higher altitudes, suitable correction factor as per relevant IEC shall be applied.