Subject: Technology tie-up for (a) Gas Insulated Circuit Breaker (GCB) for Gas Insulated Substation applications (b) Gas Insulated Substation (GIS) & Hybrid GIS (H-GIS)

1) Introduction:

This Expression of Interest (EoI) seeks response from prospective collaborators who are meeting the requirements of this EoI and are willing to be associated with BHEL through a License & Technology Collaboration Agreement (TCA) on long term basis to enable BHEL to design & manufacture the following products:

a. Dead Tank Gas Insulated Circuit Breaker for Gas Insulated Substation applications and
b. Gas Insulated Substation (GIS) & Hybrid GIS.

1.1) About Bharat Heavy Electricals Limited:

BHEL is a leading state owned company, wherein Government of India is holding 63.06% of its equity. BHEL is an integrated power plant equipment manufacturer and one of the largest engineering and manufacturing organization in India, catering to the core infrastructure sectors of Indian economy viz. energy, transportation, heavy engineering industry, defence, renewable and non-conventional energy. The energy sector covers generation, transmission and distribution equipment for hydro, thermal, nuclear and solar photo voltaic. BHEL has been in this business for more than 50 years and BHEL supplied equipment account for more than 57% of the total thermal generating capacity in India. BHEL is also listed in Indian stock exchanges. The company has 17 manufacturing units, 4 power sector regions, 8 service centers, 4 overseas offices and 15 regional offices besides host of project sites spread all over India and abroad. The annual turnover of BHEL for the year 2017-18 was US$ 4.28 Billion*. BHEL's highly skilled and committed manpower of approximately 37500 employees, the state-of-the-art manufacturing facilities and latest technologies, has helped BHEL to deliver a consistent track record of performance. To position leading state owned companies as "Global Industrial giant" and as a recognition for their exemplary performance, Government of India categorized BHEL as "Maharatna Company" in 2013, empowering the company with enhanced autonomy in decision making. With the current order book exceeding US$ 18.13 Billion*, BHEL is poised for excellent future growth. Our ongoing major technology tie-ups include agreements with GE Technology GmbH, Switzerland (for Once through Boilers and Coal Pulverisers); Siemens, Germany (for Steam Turbines, Generators and Condensers); Metso Automation Inc., Finland (for Control & Instrumentation); MHI, Japan (for Pumps); MHPS, Japan (for Flue Gas Desulfurization Systems); Vogt Power International, USA (for HRSG); GENP, Italy (for Compressors); Turbo Lufttechnik, Germany (for Fans), Sheffield Forge Masters International, UK (for Forgings), Kawasaki Heavy Industries Ltd., Japan (for Stainless Steel Metro Coaches & Bogies) and Indian Space Research Organisation (for Space Grade Lithium Ion Cells). More details about the entire range of BHEL's products and operations are available at www.bhel.com.

BHEL has a wide and rich experience in the design and manufacture of HV (Indoor/outdoor) and EHV (outdoor) switchgears of up to 400 kV class. Its production units are equipped with latest and state of art manufacturing facilities. The in-house ultra-high voltage testing facilities are equipped to test equipments up to 1100 kV as per IEC standards.

[*Note: Currency conversion rate considered: 1 US $= Rs. 65.07 as on 31st March 2018]

1.2) Future Power Generation and Transmission Requirement in India:

Govt. of India has envisaged an investment of Rs. 2,60,000 Cr INR towards development of transmission systems in India upto 2022. Accordingly, a large number of substations / switchyards (including GIS) up to 800 kV are planned in the country. It is estimated that about more than 30% of the substation requirement in the next 5 years will be for GIS/ Hybrid GIS.

In order to meet such market requirements of GIS and to upgrade the present level of technology for EHV Gas Insulated Substation (GIS) & Hybrid GIS, BHEL intends to enter into a TCA with a leading technology provider. The scope of technology transfer should be sufficient to enable BHEL to design, manufacture, market, supply. test, erect, commission, repair and service the Dead Tank EHV Gas Insulated Circuit Breaker and Gas Insulated Substation (GIS) (GIS & Hybrid GIS (H-GIS)).

The detailed terms and conditions for such a paid-up license agreement can be mutually agreed upon.

2) Scope of cooperation:

BHEL therefore seeks a partner for entering into a Technology Collaboration Agreement (TCA) for state of the art & proven, following products/system:

A. Dead tank Gas Insulated Circuit Breaker in the range of 72.5 kV to 800 kV for GIS application. Indicative scope of technology transfers of the same is furnished in **Annexure-1A**.

And/or

B. Gas Insulated Substation (GIS) & Hybrid GIS (H-GIS) in the range of 36 kV to 800 kV. Indicative scope of technology transfers of the same is furnished in **Annexure-2A**.

3) Prequalification requirements (PQR):

A. Gas Circuit Breaker
Prospective Collaborator/OEM should have designed, engineered, manufactured/got manufactured, type tested (as per IEC or equivalent standard to the technical parameters specified in **Annexure-1D**) Gas insulated circuit breaker in the range of 72.5 kV to 800 kV. **(Prospective collaborator is required to substantiate this PQR by providing '*type test certificate*' from certified test labs like CESI, KEMA, KERI etc. as documentary evidence)**

And / Or

B. GIS System
Prospective Collaborator/OEM should have designed, manufactured, type tested (As per IEC or equivalent standard to the technical parameters specified in **Annexure-2D**), supplied and supervised erection & commissioning of Gas Insulated Switchgear (GIS) circuit breaker bays of respective voltage class (36 kV to 800 kV) or above voltage class of at least two (2) nos. Gas Insulated Switchgear (GIS) circuit breaker bays# in one (1) GIS Substation or Switchyard during the last seven (7) years and these bays must be in satisfactory operation* for:

1. At least two (2) years for GIS/Hybrid GIS upto 420 kV range and
2. One (1) year for GIS/Hybrid GIS for 765/800 kV range

as on the closing date of EoI.

(Prospective collaborator is required to substantiate this PQR by providing performance certificate and satisfactory operation certificate issued by end client/customer as documentary evidence)

Note:

A. In case Prospective collaborator/OEM fulfils the PQR for any specific voltage class mentioned above at 3 A and 3 B, they may also submit their proposal accordingly.
B. * Satisfactory operation means certificate issued by the Employer certifying the operation without any adverse remark.
C. # For the purpose of qualifying requirement, one no. of circuit breaker bay shall be considered as a bay used for controlling a line or a transformer or a reactor or a bus section or a bus coupler and comprising of at least one circuit breaker, one disconnector and three nos. of single phase CTs / Bushing CTs.

4) Brief Description of EoI Process:

The response shall necessarily be accompanied with details on company background, technical features/ product catalogue, reference list, Satisfactory operation certificates, performance certificates, audited annual financial reports for last 3 (three) years including auditor's report etc.

A summary of experience and response is to be provided as per **Annexure-1B** & **Annexure-1C** for Gas Insulated Circuit Breaker and as per **Annexure-2B** & **Annexure-2C** for Gas Insulated Substation (GIS) & Hybrid GIS (H-GIS).

5) Schedule of EoI & contact details:

5.1 Schedule of EoI:

The schedule of EoI shall be as follows -

Sl. No.	Description	Date
1.	Issue of EoI document	15.12.2018
2.	Last date for submission of EoI response	09.01.2019

5.2 Contact Details:

The respondent shall submit their response with all annexures duly signed to the following official:

Deputy General Manager (Technology Licensing)
Corporate Technology Management
Bharat Heavy Electricals Limited
BHEL House, Siri Fort
New Delhi – 110049, India
Phone: +91 11 66337218 / 7198
Fax: +91 11 26492974
Email: techeoi@bhel.in

6) Miscellaneous:

6.1.1) Right to accept or reject any or all Applications:

a) Notwithstanding anything contained in this EoI, BHEL reserves the right to accept or reject any Application and to annul the EoI Process and reject all Applications, at any time

without any liability or any obligation for such acceptance, rejection or annulment and without assigning any reasons thereof. In the event that BHEL rejects or annuls all the Applications, it may, at its discretion, invite all eligible Prospective Collaborators to submit fresh Applications.

b) BHEL reserves the right to disqualify any Applicant during or after completion of EoI process, if it is found there was a material misrepresentation by any such Applicant or the Applicant fails to provide, within the specified time, supplemental information sought by BHEL.

c) BHEL reserves the right to verify all statements, information and documents submitted by the Applicant in response to the EoI. Any such verification or lack of such verification by BHEL shall not relieve the Applicant of his obligations or liabilities hereunder nor will it affect any rights of BHEL.

6.1.2) Governing Laws & Jurisdiction:

The EoI process shall be governed by, and construed in accordance with, the laws of India and the Courts at New Delhi (India) shall have exclusive jurisdiction over all disputes arising under, pursuant to and / or in connection with the EoI process.

Annexure-1A

Indicative Scope of Technology Transfer under a License Agreement for Dead Tank Gas insulated Circuit Breaker (GCB) for GIS Application

(a)	Transfer of state of the art technology relating to the design, engineering, manufacture, assembly, quality control, testing, installation, commissioning, maintenance & operation of 72.5kV to 800kV Dead Tank Gas Insulated Circuit Breakers suitable for GIS application
(b)	Information to enable BHEL to source/procure the items, which the prospective collaborator sources from outside (as they are not manufactured by the prospective collaborator) for use in the above Dead Tank Gas Insulated Circuit Breaker
(c)	Transfer of applicable proprietary / outsourced computer programs with including logics and source code if any.
(d)	Improvement/modification/developments/up gradations carried out by the prospective collaborator over the duration of the technology transfer agreement for taking care of new market requirements and obsolescence of components used in the system.
(e)	Transfer of Site feedback and troubleshooting information
(f)	Training of BHEL engineers for design, manufacture, assemble, quality control / quality assurance, test, install, commissioning, maintenance & operation of the above Dead Tank Gas Insulated Circuit Breaker.
(g)	Deputation of prospective collaborator's experts to assist BHEL in absorbing the technology for licensed products
(h)	Support through engineering services from prospective collaborator's design office / manufacturing facilities for licensed products
(i)	Help to BHEL to set up manufacturing and testing facilities

(SIGNATURE)

Annexure-1B

Prospective Collaborator's Confirmation on Dead Tank Gas insulated Circuit Breaker (GCB) for GIS Application

Sl. No.	Requirement	prospective collaborator response YES/NO and remarks if any
(a)	Whether the prospective collaborator is an Original Equipment Manufacturer (OEM) of Dead Tank Gas Insulated Circuit Breaker (GCB).	
(b)	Whether the prospective collaborator Gas Insulated Circuit Breaker Products meet the minimum technical requirements specified in Annexure-1 D.	
(c)	Whether the prospective collaborator Gas Insulated Circuit Breaker Products of 72.5kV to 800kV are successfully type tested as per relevant IEC and others standards specified in Annexure-1 D.	
(d)	Whether the prospective collaborator Gas Insulated Circuit Breaker of 72.5 kV, 145 kV, 245 kV, 420 kV, 800 kV meets the PQR mentioned in clause 3 A of this document.	
(e)	Whether details of company background, product catalogues have been enclosed.	
(f)	Whether prospective collaborator's detailed reference list as per Annexure-1 C has have been enclosed.	
(g)	Whether prospective collaborator's annual financial reports for last 3 years have been enclosed.	
(h)	Whether type test certificate of 72.5 kV, 145 kV, 245 kV, 420 kV, 800 kV circuit breakers from certified test labs like CESI, KEMA, KERI etc.as documentary evidence has been enclosed.	
(i)	Whether the prospective collaborator owns the IPRs for the technology being proposed for transfer under the TCA, or has the unencumbered right from the owner of the IPRs to sub-license the technology.	
(j)	If the prospective collaborators GIS Products of 72.5kV to 800kV are successfully type tested, please provide details of test lab where type tests were conducted and the test dates, for each of the respective voltage class.	

(SIGNATURE)

Annexure-1C

Reference List: The prospective collaborator shall furnish a summary of reference for Dead Tank Gas insulated Circuit Breaker (GCB) for GIS Application as detailed below for major supplies in last 7 years

(A) : 72.5kV GCB

Sl. No.	Contract No. & Date	Customer	No of Bays	Year Of Delivery	Year of commissioning
1.					
2.					
3.					
4.					
5.					

(B): 145kV GCB

Sl. No.	Contract No. & Date	Customer	No of Bays	Year Of Delivery	Year of commissioning
1.					
2.					
3.					
4.					
5.					

(C): 245kV GCB

Sl. No.	Contract No. & Date	Customer	No of Bays	Year Of Delivery	Year of commissioning
1.					
2.					
3.					
4.					
5.					

(D): 420kV GCB

Sl. No.	Contract No. & Date	Customer	No of Bays	Year Of Delivery	Year of commissioning
1.					
2.					
3.					
4.					
5.					

(E): 800kV GCB

Sl. No.	Contract No. & Date	Customer	No of Bays	Year Of Delivery	Year of commissioning
1.					
2.					
3.					
4.					
5.					

(SIGNATURE)

Annexure-1D

(As per Excel Sheet enclosed for Circuit Breaker)

(SIGNATURE)

Parameters	Unit	72.5kV	145kV	245kV	420kV	800kV
Rated voltage	kV	72.5	145	245	420	765
Rated Normal Current	A	2500/3150/4000	2500/3150/4000	2500/3150/4000	3150/4000/5000	3150/4000/5000
Rated Frequency	Hz	50/60	50/60	50/60	50/60	50/60
Symmetrical breaking current	kA	31.5/40	40	50	50/63	50
Rated Power Freq. voltage 60 sec.	kV RMS	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203
Rated Lightning Impulse Voltage	kVp	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203
Rated Switching Impulse Voltage	kVp	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203
Rated short circuit making current / peak withstand current Circuit breaker	kAp	80.5/102	102	127.5	127.5/160.65	127.5
Rated short circuit making current / peak withstand current - Earthling Switch	kAp	80.5/102	102	127.5	127.5/160.65	127.5
Rated out of Phase current with voltage factor2.0 for CB	kA	7.875 / 10	10	12.5	12.5 / 15.75	12.5
Rated short line fault breaking current L75/L90 for CB	kA	23.6/28.3 for 31.5kA 30/36 for 40kA	30/36 for 40kA	37.5/45	37.5/45 for 50 kA 47.25/56.7 for 63kA	37.5/45
Rated Capacitive switching current (Line charging & cable charging) with voltage factor 1,4 (Amps) for CB as per IEC 62271-100	A	10	50	125	400 for Line Charging 600 for Cable charging	900
Rated shunt reactor switching current with overvoltage as per IEC 62271-110	A	630/200	315/100	315/100	315/100	315/100
Maximum Closing Time (ms)CB	ms	100	100	100	100	100
Rated break time (opening time + arcing time)ms CB		Less than or equal to 60 (3 Cycles)	Less than or equal to 60 (3 Cycles)	Less than or equal to 60 (3 Cycles)	Less than or equal to 40 (2 Cycles)	Less than or equal to 40 (2Cycles)
CB Operation		Gang	Gang	IPO (Individual pole operated)	IPO (Individual pole operated)	IPO (Individual pole operated)
Rated operation sequence CB		O-0.3s-CO-180s-CO	O-0.3s-CO-180s-CO	O-0.3s-CO-180s-CO	O-0.3s-CO-180s-CO	O-0.3s-CO-180s-CO

Parameters	Unit	72.5kV	145kV	245kV	420kV	800kV
Breaks per pole CB		1	1	1	1 or 2(single break preffered)	2/4(Without Grading capacitors preferred, 2 break design preferred)
Class (CB)		M2/C2/E2	M2/C2/E2	M2/C2/E2	M2/C2/E2	M2/C2/E2
Rated short time withstand current	kA for 3 sec	31.5 kA for 3 sec. 40kA for 3 sec.	40 kA for 3 sec.	50 kA for 3 sec.	50 kA for 3 sec. 63kA for 3 sec.	50 kA for 3 sec.
SF6 Leak rate		Less than 0.5% /Annum (0.2% per annum preferred)	Less than 0.5% /Annum (0.2% per annum preferred)	Less than 0.5% /Annum (0.2% per annum preferred)	Less than 0.5% /Annum (0.2% per annum preferred)	Less than 0.5% /Annum (0.2% per annum preferred)
Operating mechanism Breaker		Spring-Spring (close/open), Hydro Mechanical spring (Spring-Spring preferred)	Spring-Spring (close/open), Hydro Mechanical spring, (Spring-Spring preferred)	Spring-Spring (close/open), Hydro Mechanical spring, (Spring-Spring preferred)	Spring-Spring (Close & Open), Hydraulic , Hydro Mechanical Spring (Spring-Spring preferred)	Spring-Spring (Close & Open), Hydraulic , Hydro Mechanical Spring
Enclosure		Circuit Breaker: 3 Phase Common	Circuit Breaker: 3 Phase Common	Circuit Breaker: Single Phase	Circuit Breaker: Single phase	Circuit Breaker: Single Phase
Installation		Indoor / out door	Indoor / out door	Indoor / out door	Indoor / out door	Indoor / out door
Provision for Pre insertion resistor (PIR)					PIR variant , 400 ohms per phase, Minimum insertion time 8ms	PIR variant , 450 ohms per phase, Minimum insertion time 9ms
Applicable standards		IEC 62271-1	IEC 62271-1	IEC 62271-1	IEC 62271-1	IEC 62271-1
		IEC-62271-100	IEC-62271-100	IEC-62271-100	IEC-62271-100	IEC-62271-100
		IEC 62271-110	IEC 62271-110	IEC 62271-110	IEC 62271-110	IEC 62271-110
		IEC62271-203	IEC62271-203	IEC62271-203	IEC62271-203	IEC62271-203
		Any other standards applicable for GIS	Any other standards applicable for GIS	Any other standards applicable for GIS	Any other standards applicable for GIS	Any other standards applicable for GIS

Annexure-2A

Indicative Scope of Technology Transfer under a License Agreement for GIS and Hybrid GIS system

(a)	Transfer of state of the art technology relating to the design, engineering, technology, manufacture, assembly, quality control, testing, installation, commissioning, maintenance & operation of 36kV to 800kV GIS (GIS & Hybrid GIS (H-GIS))
(b)	Information to enable BHEL to source/procure the items, which the OEM sources from outside (as they are not manufactured by the OEM) for use in the above GIS & Hybrid GIS
(c)	Transfer of applicable computer programs with source code if any
(d)	Improvement/modification/developments/up gradations carried out by the OEM over the duration of the technology transfer agreement for taking care of new market requirements and obsolescence of components used in the system.
(e)	Transfer of Site feedback and troubleshooting information
(f)	Training of BHEL engineers in the design & manufacture assemble, quality control / quality assurance, test, install, commissioning, maintain & operate the above GIS & Hybrid GIS.
(g)	Deputation of OEM's experts to assist BHEL in absorbing the technology for licensed products
(h)	Support through engineering services from OEM's design office / manufacturing facilities for licensed products
(i)	Help to BHEL to set up manufacturing and testing facilities

(SIGNATURE)

Annexure-2B

Prospective Collaborator's Confirmation on GIS and H-GIS System

Sl. No.	Requirement	OEM response YES/NO and remarks if any
(a)	Whether the prospective collaborator is an Original Equipment Manufacturer (OEM) of GIS (GIS & Hybrid GIS (H-GIS))	
(b)	Whether the prospective collaborator of GIS (GIS & Hybrid GIS (H-GIS)) meet the minimum technical requirements specified in Annexure-2D.	
(C)	Whether the OEM of GIS (GIS & Hybrid GIS (H-GIS)) Products of 36 kV to 800kV are successfully type tested as per relevant IEC and others standards specified in Annexure-2D	
(d)	Whether the prospective collaborator of GIS (GIS & Hybrid GIS (H-GIS)) Products of 36 kV to 800kV meets the PQR mentioned in clause 3 B of this document.	
(e)	Whether details of company background, product catalogues have been enclosed.	
(f)	Whether prospective collaborator's detailed reference list (including performance certificates, satisfactory operation certificates) as per Annexure-2C has have been enclosed.	
(g)	Whether prospective collaborator's annual financial reports for last 3 years have been enclosed.	
(h)	Whether type test certificate of 36 kV, 72.5 kV, 145 kV, 245 kV, 420 kV, 800 kV of GIS (GIS & Hybrid GIS (H-GIS)) GIS Products from certified test labs like CESI, KEMA, KERI etc. has been enclosed.	
(i)	Whether performance certificate and satisfactory operation certificate issued by end client / customer as documentary evidence to meet the clause 3 B has been enclosed.	
(j)	Whether the prospective collaborator owns the IPRs for the technology being proposed for transfer under the TCA, or has the unencumbered right from the owner of the IPRs to sub-license the technology.	
(k)	If the prospective collaborators GIS Products of 36 kV to 800kV are successfully type tested, please provide details of test lab where type tests were conducted and the test dates, for each of the respective voltage class.	

(SIGNATURE)

Annexure-2C

Reference List: The prospective collaborator shall furnish a summary of reference for GIS and H-GIS System as detailed below for major supplies in last 7 years

(A) : 36kV GIS (GIS & Hybrid GIS (H-GIS))

Sl. No.	Contract No. & Date	Customer	No of Bays	Year Of Delivery	Year of commissioning
1.					
2.					
3.					
4.					
5.					

(B) 72.5kV GIS (GIS & Hybrid GIS (H-GIS))

Sl. No.	Contract No. & Date	Customer	No of Bays	Year Of Delivery	Year of commissioning
1.					
2.					
3.					
4.					
5.					

(C): 145kV GIS (GIS & Hybrid GIS (H-GIS))

Sl. No.	Contract No. & Date	Customer	No of Bays	Year Of Delivery	Year of commissioning
1.					
2.					
3.					
4.					
5.					

(D): 245kV GIS (GIS & Hybrid GIS (H-GIS))

Sl. No.	Contract No. & Date	Customer	No of Bays	Year Of Delivery	Year of commissioning
1.					
2.					
3.					
4.					
5.					

(E): 420kV GIS (GIS & Hybrid GIS (H-GIS))

Sl. No.	Contract No. & Date	Customer	No of Bays	Year Of Delivery	Year of commissioning
1.					
2.					
3.					
4.					
5.					

(F): 800kV GIS (GIS & Hybrid GIS (H-GIS))

Sl. No.	Contract No. & Date	Customer	No of Bays	Year Of Delivery	Year of commissioning
1.					
2.					
3.					
4.					
5.					

(SIGNATURE)

Annexure-2 D

(As per Excel Sheet enclosed for GIS System)

(SIGNATURE)

Parameters	Unit	36kV	72.5kV	145kV	245kV	420kV	800kV
Rated voltage	kV	36	72.5	145	245	420	765
Rated Normal Current	A	630/1250/1600/2000/2500/3150/4000	2500/3150/4000	2500/3150/4000	2500/3150/4000	3150/4000/5000	3150/4000/5000
Rated Frequency	Hz	50/60	50/60	50/60	50/60	50/60	50/60
Symmetrical breaking current	kA	31.5/40	31.5/40	40	50	50/63	50
Rated Power Freq. voltage 60 sec.	kV RMS	As per IEC 62271-200	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203
Rated Lightning Impulse Voltage	kVp	As per IEC 62271-200	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203
Rated Switching Impulse Voltage	kVp	As per IEC 62271-200	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203	As per IEC 62271-203
Rated short circuit making current / peak withstand current Circuit breaker	kAp	80/100	80.5/102	102	127.5	127.5/160.65	127.5
Rated short circuit making current / peak withstand current - Earthling Switch	kAp	80/100	80.5/102	102	127.5	127.5/160.65	127.5
Rated out of Phase current with voltage factor2.0 for CB	kA	7.875 / 10	7.875 / 10	10	12.5	12.5 / 15.75	12.5
Rated short line fault breaking current L75/L90 for CB	kA	NA	23.6/28.3 for 31.5kA 30/36 for 40kA	30/36 for 40kA	37.5/45	37.5/45 for 50 kA 47.25/56.7 for 63kA	37.5/45
Rated Capacitive switching current (Line charging & cable charging) with voltage factor 1,4 (Amps) for CB as per IEC 62271-100	A	10	10	50	125	400 for Line Charging 600 for Cable charging	900
Rated shunt reactor switching current with overvoltage as per IEC 62271-110	A	NA	630/200	315/100	315/100	315/100	315/100
Maximum Closing Time (ms)CB	ms	100	100	100	100	100	100
Rated break time (opening time + arcing time)ms CB		Less than or equal to 60 (3 Cycles)	Less than or equal to 60 (3 Cycles)	Less than or equal to 60 (3 Cycles)	Less than or equal to 60 (3 Cycles)	Less than or equal to 40 (2 Cycles)	Less than or equal to 40 (2Cycles)
CB Operation		Gang	Gang	Gang	IPO (Individual pole operated)	IPO (Individual pole operated)	IPO (Individual pole operated)
Rated operation sequence CB		O-0.3s-CO-180s-CO	O-0.3s-CO-180s-CO	O-0.3s-CO-180s-CO	O-0.3s-CO-180s-CO	O-0.3s-CO-180s-CO	O-0.3s-CO-180s-CO
Breaks per pole CB		1	1	1	1	1 or 2(single break preffered)	2/4(Without Grading capacitors preferred, 2 break design preferred)
Class (CB)		M2/C2/E2	M2/C2/E2	M2/C2/E2	M2/C2/E2	M2/C2/E2	M2/C2/E2
Rated short time withstand current	kA for 3 sec	31.5 kA for 3 sec. 40kA for 3 sec.	31.5 kA for 3 sec. 40kA for 3 sec.	40 kA for 3 sec.	50 kA for 3 sec.	50 kA for 3 sec. 63kA for 3 sec.	50 kA for 3 sec.

Parameters	Unit	36kV	72.5kV	145kV	245kV	420kV	800kV
SF6 Leak rate		Less than 0.1% /Annum	Less than 0.5% /Annum (0.2% per annum preferred)	Less than 0.5% /Annum (0.2% per annum preferred)	Less than 0.5% /Annum (0.2% per annum preferred)	Less than 0.5% /Annum (0.2% per annum preferred)	Less than 0.5% /Annum (0.2% per annum preferred)
Operating mechanism Breaker		Spring-Spring (close/open)	Spring-Spring (close/open), Hydro Mechanical (Spring-Spring preferred)	Spring-Spring (close/open), Hydro Mechanical (Spring-Spring preferred)	Spring-Spring (close/open), Hydro Mechanical (Spring-Spring preferred)	Spring-Spring (Close & Open), Hydraulic , Hydro Mechanical Spring	Spring-Spring (Close & Open), Hydraulic , Hydro Mechanical Spring
Disconnecting switch & maintenance earthling Switch operating mechanism		Motor (Manual in case of emergency)	Motor (Manual in case of emergency)	Motor (Manual in case of emergency)	Motor (Manual in case of emergency)	Motor (Manual in case of emergency)	Motor (Manual in case of emergency)
Fast acting earthing switch operating mechanism		Spring -spring mechanism	Spring -spring mechanism	Spring -spring mechanism	Spring -spring mechanism	Spring -spring mechanism	Spring -spring mechanism
Enclosure		3 Phase common	Circuit Breaker: 3 Phase Common	Circuit Breaker: 3 Phase Common	Circuit Breaker: Single Phase	Circuit Breaker: Single phase	Circuit Breaker: Single Phase
		Integral part of Busbar Chamber	Disconnecting & earthing Switch: 3 Phase Common	Disconnecting & earthing Switch: 3 Phase Common	Disconnecting & earthing Switch: 1 Phase	Disconnecting & earthing Switch: 1 Phase	Disconnecting & earthing Switch: 1 Phase
		Cable termination enclosure	Feeder Bus: 3 Phase Common	Feeder Bus: 3 Phase Common	Feeder Bus: 1 Phase	Feeder Bus: 1 Phase Common	Feeder Bus: 1 Phase
		3 Phase Common	Main Bus: 3 Phase Common	Main Bus: 3 Phase Common	Main Bus: 3 phase common (preferred) or Single phase	Main Bus: 3 Phase Common or 1 phase	Main Bus: Single phase
Installation		Indoor	Indoor / out door	Indoor / out door	Indoor / out door	Indoor / out door	Indoor / out door
Circuit arrangements		Single bus/ Double Bus arrangement	Single bus arrangement	Single bus arrangement	Single bus arrangement	Single bus arrangement	Single bus arrangement
(SF6 Gas Insulated Switchgears of each rated voltage are essentially designed as standardized modules, so that all kinds of buses and feeders can be built up by the arrangement of these modules)		Single Bus/Double Bus	Single bus arrangement with By- pass bus	Single bus arrangement with By- pass bus	Single bus arrangement with By- pass bus	Single bus arrangement with By- pass bus	Single bus arrangement with By- pass bus
		Single Bus/Double Bus	Double Bus arrangement	Double Bus arrangement	Double Bus arrangement	Double Bus arrangement	Double Bus arrangement
		Single Bus/Double Bus	Double bus arrangement with By- pass isolator	Double bus arrangement with By- pass isolator	Double bus arrangement with By- pass isolator	Double bus arrangement with By- pass isolator	Double bus arrangement with By- pass isolator
		NA	One and Half Circuit breaker arrangement	One and Half Circuit breaker arrangement	One and Half Circuit breaker arrangement	One and Half Circuit breaker arrangement	One and Half Circuit breaker arrangement
		NA	Ring Bus arrangement	Ring Bus arrangement	Ring Bus arrangement	Ring Bus arrangement	Ring Bus arrangement
		NA	Main And transfer Bus arrangement	Main And transfer Bus arrangement	Main And transfer Bus arrangement	Main And transfer Bus arrangement	Main And transfer Bus arrangement

Parameters	Unit	36kV	72.5kV	145kV	245kV	420kV	800kV
		Common 3 Phase	Bus Coupler	Bus Coupler	Bus Coupler	Bus Coupler	Bus Coupler
		Common 3 phase	Bus Sectionaliser	Bus Sectionaliser	Bus Sectionaliser	Bus Sectionaliser	Bus Sectionaliser
Provision for Pre insertion resistor (PIR)						PIR variant , 400 ohms per phase, Minimum insertion time 8ms	PIR variant , 450 ohms per phase, Minimum insertion time 9ms
Applicable standards		IEC 62271-1	IEC 62271-1	IEC 62271-1	IEC 62271-1	IEC 62271-1	IEC 62271-1
		IEC-62271-100	IEC-62271-100	IEC-62271-100	IEC-62271-100	IEC-62271-100	IEC-62271-100
		IEC-62271-102	IEC-62271-102	IEC-62271-102	IEC-62271-102	IEC-62271-102	IEC-62271-102
		IEC 62271-110	IEC 62271-110	IEC 62271-110	IEC 62271-110	IEC 62271-110	IEC 62271-110
		IEC62271-200	IEC62271-203	IEC62271-203	IEC62271-203	IEC62271-203	IEC62271-203
		IEC62271-300	IEC62271-300	IEC62271-300	IEC62271-300	IEC62271-300	IEC62271-300
		IEC62271-305	IEC62271-305	IEC62271-305	IEC62271-305	IEC62271-305	IEC62271-305
			IEC 62271-209	IEC 62271-209	IEC 62271-209	IEC 62271-209	IEC 62271-209