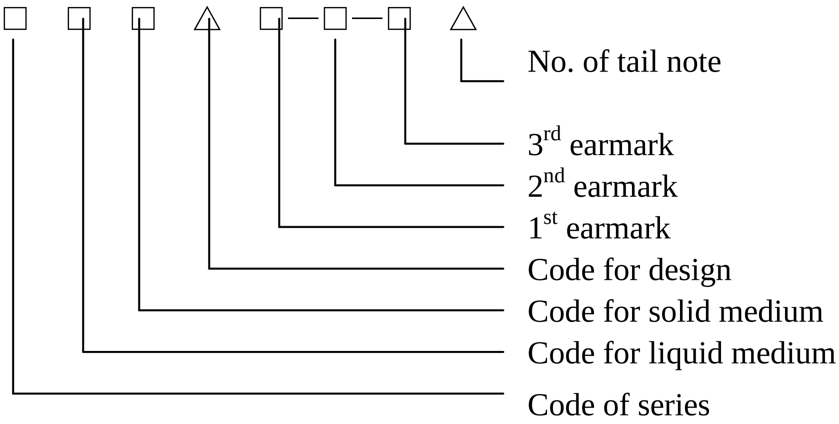
Content

I. General Brief

1.1 This instruction pamphlet applies to Shunt Capacitor (capacitor hereafter) for 50Hz AC power system; such capacitor is used to raise power net Q-factor, lower line loss and improve voltage quality, so as to bring generator and power consumption facilities into fully play.

1.2 The capacitor includes BWF, BFF, BFM, BAM and etc models. The relevant symbols stand for:



E.g. (1) BWF 10.5—50—1

(2) BFF$_R$11—100—3W

(3) BAMr11 $\sqrt{3}$—200—1wh

1.2.1 Code of series B—shunt capacitor

1.2.2 Code for liquid medium: W—12-alkyl benzene; F—2-arylethane; A—benzyl toluene.

1.2.3 Code for solid medium: F—Film on paper compound medium; M—Film medium.

1.2.4 Code for design: R—Discharge resistance; r—internal fuse.

1.2.5 1st earmark (rated voltage) 10.5—rated voltage 10.5KV; 11—rated voltage 11KV.

1.2.6 2nd earmark (rated capacity) 50—rated capacity 50kvar; 100—rated capacity 100kvar.

1.2.7 3rd earmark (phase numbers) 1—single phase; 3—3phases.

1.2.8 Tail note number W-Outdoor model; h—horizontal; tail-free means indoor model.

II. Main Performance Targets

2.1 The ambient temperature for capacitor installed shall be –40℃–+45℃, hereinto, –25℃ –+45℃ for model BFF, and the rest are of –40℃–+45℃. The altitude shall not be higher than 1000m. Special notes are needed when ordering for capacitors used above the altitude of 1000m.

2.2 The main technical parameters and dimensions of the capacitors aare shown in table 5 and annexed figures.

2.3 The medium between poles of the capacitor can endure one of the following 2 voltage tests with a period of 10 seconds.

a. Voltage at working frequency: Ut=(~) 2.15Un
b. DC: Ut (–)= 4.3Un

2.4 The insulation level between shell and terminals of the capacitor shall stand to the test voltages listed in table 1.

III. Structure Characteristics

3.1 The capacitor is composed of shell and the core, and the shell is made up of plate welded; there are ceramic lead conduits on the shell, and lugs are welded on both side walls of the shell; lugs on one side of the shell are equipped with screws for earthing.

3.2 The core of the capacitor is composed of several elements and insulation pieces; the element is made up of rolling up aluminum foils, which is used as pole, and in-between film-paper compound medium or full film medium. The elements of inner core are connected in certain serial or parallel ways, so as to meet different requirements for voltages or capacities.

3.3 capacitor with internal fuses means that each element in the core is equipped with a fuse; when some element breakdowns, the other element—which is in good order— parallel to it shall discharge to it and burn off the fuse in m-seconds and thus to expel the fault element and keep the capacitor go on running as well.

3.4 The internal wiring of 6kv, 10kv 3-P capacitors are of delta mode, and each phase is equipped with discharge resistor.

IV. Installation & Debug

4.1 Before installation, the user shall inspect first the externality of the capacitor, check the content of the nameprint is in line with what ordered, and check if any damage to shell, ceramic conduit or lead conductive rod, and if there is any seepage.

4.2 The ambient temperature shall be in line with relevant temperature class.

4.3 The field for capacitor installation shall be free of serious vibration, hazardous gases or steam, free of conductive or explosive dusts as well.

4.4 Capacitor may be mounted on steel brackets, and when layout in plied way, it is better not to exceed 5 layers, and each layer shall not exceed 2 rows; in order to keep a good ventilation, the interval between each 2 layers shall not be closer than 100mm, and the interval between rows shall not be smaller than 200mm; for indoor capacitor, the elevation between capacitor bottom and the floor shall not be smaller than 200mm, and 300mm for outdoor products; the net interval between top of device and layer top shall not be smaller than 1000mm.

4.5 The partition wall, which shall prevent good ventilation, shall not be mounted in the level layer; the exhaustion for cooling air shall be mounted on top of each group of capacitors.

4.6 Before capacitors are to be mounted on the brackets, allocate once the capacitors, so that the rate of each serial section for capacity max and min shall not exceed 1.03, and the rate of capacity max and min between each phase shall not exceed 1.06.

4.7 The connect wiring for capacitors shall be flex cords; when connecting, the torque, which conductive rods shall bear: M12<15Nm, M16<30 Nm. Keep nameprint out-ward for the convenience of inspection.

4.8 When the rated voltage of the capacitor is in line with system voltage, it is applicable to ground the shell directly, and keep the earthing part well conducted. When the rated voltage of single-phase capacitor is lower than the system voltage, use delta connection mode or in the serial way, just keep the capacitor shell insulated to the ground, and the insulation level shall not be lower than the system voltage.

4.9 When the rated voltage of single-phase are of 6.6/$\sqrt{3}$ kV and 11 $\sqrt{3}$ kV, and are applied to

10kV system with delta connection mode, it is applicable to earthing the shell directly..

4.10 Besides the abovementioned, the following points shall be considered:

(1) When capacitor is directly parallel to inductive motor, in order to prevent self-excitation at the moment of sudden cutting of motor from power to cause voltage raise on capacitor to its rated value maximum, it is a must to let the rated current of the capacitor be smaller or equal to 90% that of the idle current of the motor.

(2) When the site system harmonic fraction, it is better to consider add in serial reactor.

4.11 The 3-P capacitors, no mater of delta connection or star-join, the capacitance measured between any two terminals shall be indicated with C_1, C_2 and C_3; and in case that can meet the symmetrical requirements stipulated in article 4.6, then the capacitance Q of capacitor shall be calculated from the formula: $Q=\frac{2}{3}(C_1+C_2+C_3)\,wU_n^2 \times 10^{-3}$

Hereinto: C_1, C_2 and C_3 are all counted by μF: Un counted in kV, Q counted in kvar.

4.12 Before putting the capacitor into production, perform acceptance test first; the aim of this test is to inspect whether it suffers any damage during transportation, so as to ensure that the capacitor to be put into production is complete and in good order. The test shall be carried out after GB3983.2 “High Voltage Shunt Capacitor” or SD205 “Technical Conditions of High Voltage Shunt Capacitor”; the following items are recommended:

a. Capacitance measurement;

b. Voltage endurance test. The voltage for test shall be 70% of that of the exit shop test or even lower;

c. Capacitance re-measured.

The digital capacitance-meter may be used for measurement of capacitance; when current-voltage method, use ampere meter and voltammeter with higher precision to measure capacitance, lest reading precision affected.

4.13 In case any doubt in performing test, contact the manufacturer in time.

V. Use & Preventive Maintenance

5.1 The rated voltage of capacitor shall not be lower than the max operation voltage of the system the capacitor connected in; and it is also needed to consider the voltage rising when capacitor connected in. In order to deduct the influence of harmonic and other factors, when in serial reactor connected, the voltage on terminals shall be higher than the system running voltage, then it is a must to select capacitor with higher rated voltage.

5.2 When light loaded, the terminal voltage shall be much higher; under such cases, cut off part or all capacitors.

5.3 The max working frequency voltage permitted for the capacitor and relevant intervals are shown in table 3.

5.4 When put in capacitor, especially when put in for running with energized other capacitors in a parallel way, it is probable to occur transient super-current. In order to lower such a transient current to the level that capacitor and relative equipment can stand of, it is applicable to put in reactor to the power circuit.

5.5 Except that the light-load no longer than 5min voltage rising (cf. Table 2), the capacitors are prohibited to run under conditions regulated in article 2.7. In case the current in capacitor exceeds the stipulated value of article 2.7, while the voltage keeps still within the range stipulated in table 3, then it is necessary to measure the main harmonic for selection of best solution. The measures under works to lower current:

(1) Move some or all capacitors to other parts of the system;

(2) Put in reactor into the power circuit, so as to lower the harmonic frequency under that of main disturbance harmonica frequency;

(3) Increase the capacitance connected to capacitors nearby rectifier.

5.6 The rated current of high voltage breaker used for cutting in and out capacitor-group shall be 1.5 times of that of rated current of the capacitor-group, and it is necessary to select the re-breakdown free high voltage breaker; for high voltage breaker used for cutting off short-circuit failure, its rated off power current shall be larger than the short circuit current of the site system.

5.7 Applicable protective measures are necessary for the capacitor-group; the ways of protection includes internal fuse, exterior fuse, and relay and etc protection measures. The internal fuse and exterior fuse are the first safety protection, and the relay is the second protection. The relay protection includes delta open circuit voltage protection, voltage dynamic difference protection and bridge current dynamic difference protection, neutral point un-balanced voltage or current protection and etc.

5.8 When exterior fuse is selected for capacitor protection, the rated current of the fuse shall be selected following characteristics of the rated fuse and its flood current when connected, generally, 1.5 times that of the rated current of the capacitor.

5.9 For capacitors easily attacked by super voltage from lightning, select agreeable arrester for atmospheric super voltage protection; and the arrester shall be equipped as near as possible to the capacitor. The arrester shall be able to bear the discharge current especially from the large capacity capacitors.

5.10 When the mother wire voltage is higher than the voltage for the capacitor to be put in under long period working voltage regulated in table 3, it is prohibited to put in the capacitor.

5.11 There is the danger of partial discharging when the temperature of medium in the capacitor is lowering to the lower limit against the relevant temperature class. When after a period of time the capacitor exited from working and the temperature of its internal medium may lower to the lower limit, or under, of relevant temperature class, it is necessary to avoid putting the capacitor into running.

5.12 When ambient temperature exceeds the up limit of relevant temperature class of the capacitor, manual cooling (such as installing fan) is needed, or just exit the capacitor from running.

5.13 The site temperature inspection and the inspection of the hottest spot of the capacitor shell maybe performed by Hg thermometer, and keep well the record (especially in summer).

5.14 It is suggested to inspect the externality of the capacitor, which is in production, daily; in case that wall expansion is found, stop using lest any accident.

5.15 The surface of conduits of the capacitor shall not accumulate with dirt, lest short-circuit flashing.

5.16 All the electric connectors (alive bus bar, fuse, discharge coil, breaker, grounding cable and etc) of the capacitor group must reliably fitted; any abnormal contact shall probably cause arc to lead HF oscillation, which shall yield to super heat and super voltage to capacitor. Therefore, it is suggested to inspect all connectors of the capacitor equipment periodically.

5.17 During the procession of the capacitor running, once alarm appears or switch tripping or etc condition, it is a must to find out the cause first; before cause shot, it is prohibited to switch on again.

5.18 The discharge of the capacitor groups shall be carried out automatically once the capacitor group exits from running; in order to protect the capacitor group, the auto-discharge device shall directly be parallel connected (free of inter-relay, gate switch, or fuse and etc). For capacitor group with non-special discharge device (such as: voltage mutual inductor for high voltage capacitor), and capacitor group directly connected to motor, may not be equipped with discharge device.

5.19 Before contacting with conductive parts of the capacitor, which has check out the power net, even it has automatically discharged, it is still necessary to perform a procedure of discharge alone with an insulated and grounded metal bar.

VI Repairing

6.1 In case leaking is found during operation or transportation, amend by soldering.

6.2 Oil leaks from the crack of the ceramic conduit, amend with tin-lead soldering material, only pay attention to that the iron temperature shall not be super heat, lest the silver plating peeling off.

6.3 In case the damage of insulation of capacitor to the ground occurs, or the $tg\theta$ increases, or open circuit occurs, only carry to maintenance shop with special facilities.

VII. Transportation & Storing

7.1 The capacitor must be packed in water-safe plastic bags, and then packed in wooden box. When transiting the wooden box, it is prohibited to keep the box up side down or roll the box.

7.2 When transiting capacitors, it is prohibited to hold on the capacitor conduit, lest damaging the soldering part of the capacitor and causing oil leaking.

7.3 During storing or keeping, the capacitor shall b kept upright, with the conduit upward.

VIII. The Ascertaining of Rated Capacity for Installation

8.1 As is known that the load power is P, the cosØ before compensation is $\cos Ø_1$, and it is needed to increase to $\cos Ø_2$, calculate the needed capacitance Q with following formula:

$$Q = P\left(\sqrt{\frac{1}{\cos^2 \Phi_1} - 1} - \sqrt{\frac{1}{\cos^2 \Phi_2} - 1}\right)(\text{kvar})$$

It is also applicable to check out from table 4 according to $\cos Ø_1$ and $\cos Ø_2$ of the needed compensation kW value per kW load, and then times by load power P.

e.g.: $\cos Ø_1$=0.6, $\cos Ø_2$=0.9; follow table to find that the needed compensation capacitance of capacitor power value is 0.85kW; in case the load power P=100kW, the total capacity of the compensation capacitor shall be 100 x 0.85 = 85kW.

Table 4

Before Compensation	Kvar needed for $\cos Ø_2$ kvar per kW load												
	0.70	0.75	0.80	0.82	0.84	0.86	0.88	0.90	0.92	0.94	0.96	0.98	1.00
0.30	2.16	2.30	2.42	2.48	2.53	2.59	2.65	2.70	2.76	2.82	2.89	2.98	3.18
0.36	1.66	1.80	1.93	1.98	2.03	2.08	2.14	2.19	2.25	2.31	2.38	2.48	2.68
0.40	1.27	1.41	1.54	1.60	1.65	1.70	1.76	1.81	1.87	1.93	2.00	2.09	2.29
0.45	0.97	1.11	1.24	1.29	1.34	1.40	1.45	1.50	1.56	1.62	1.69	1.75	1.99
0.50	0.71	0.85	0.98	1.04	1.09	1.14	1.20	1.25	1.31	1.37	1.44	1.53	1.73
0.52	0.62	0.76	0.89	0.95	1.00	1.05	1.11	1.16	1.22	1.28	1.35	1.44	1.64
0.54	0.54	0.68	0.81	0.86	0.92	0.97	1.02	1.08	1.14	1.20	1.27	1.36	1.56
0.56	0.46	0.60	0.73	0.78	0.84	0.89	0.94	1.00	1.05	1.12	1.19	1.28	1.48
0.58	0.39	0.52	0.66	0.71	0.76	0.81	0.87	0.92	0.98	1.04	1.11	1.20	1.41
0.60	0.31	0.45	0.58	0.64	0.69	0.74	0.80	0.85	0.91	0.97	1.04	1.13	1.33
0.62	0.25	0.39	0.52	0.57	0.62	0.67	0.73	0.78	0.84	0.90	0.97	1.06	1.27
0.64	0.18	0.32	0.45	0.51	0.56	0.61	0.67	0.72	0.87	0.84	0.91	1.00	1.20
0.66	0.12	0.26	0.39	0.45	0.49	0.55	0.60	0.66	0.71	0.78	0.85	0.94	1.14
0.68	0.06	0.20	0.33	0.38	0.43	0.49	0.54	0.60	0.65	0.72	0.79	0.88	1.08
0.70		0.14	0.27	0.33	0.38	0.43	0.49	0.54	0.60	0.66	0.73	0.82	1.02
0.72		0.08	0.22	0.27	0.32	0.37	0.43	0.48	0.54	0.60	0.67	0.76	0.97
0.74		0.03	0.16	0.21	0.26	0.32	0.37	0.43	0.48	0.55	0.62	0.71	0.91
0.76			0.11	0.16	0.21	0.26	0.32	0.37	0.43	0.44	0.56	0.65	0.86
0.78			0.05	0.11	0.16	0.21	0.27	0.32	0.38	0.39	0.51	0.60	0.80
0.80				0.05	0.10	0.16	0.21	0.27	0.33	0.33	0.46	0.55	0.75
0.82					0.05	0.10	0.16	0.22	0.27	0.28	0.40	0.49	0.70
0.84						0.05	0.11	0.16	0.22	0.23	0.35	0.44	0.65
0.86							0.06	0.11	0.17	0.19	0.30	0.39	0.59
0.88								0.06	0.11	0.17	0.25	0.33	0.54
0.90									0.06	0.12	0.19	0.28	0.48
0.92										0.06	0.13	0.22	0.43
0.94											0.07	0.16	0.36

Table 5

SN	Model	Rated V kV	Rated Capacity kvar	Norn Capacitance μF	Dimension mm						DWG No.	Wt. kg	Ceramic Conduit Apron (pc)
					L	B	h	H	H_1	D			
1	BFM6.3—12—1W	6.3	12	0.96	325	110	120	370	90	/	1	20	5
2	BFM6.3—25—1W	6.3	25	2.01	325	110	190	440	110	/	1	23	5
3	BFM6.3—30—1W	6.3	30	2.41	325	110	190	440	110	/	1	25	5
4	BFM6.3—50—1W	6.3	50	4.01	325	110	290	540	180	/	1	28	5
5	BFM6.6/ $\sqrt{3}$ —50—1W	6.6 $\sqrt{3}$	50	10.97	325	115	330	550	220	/	1	30	5
6	BFM6.6/ $\sqrt{3}$ —100—1W	6.6 $\sqrt{3}$	100	21.94	440-	143	330	550	180	107	2	35	5
7	BFM6.6/ $\sqrt{3}$ —200—1W	6.6 $\sqrt{3}$	200	43.88	440	180	430	680	280	137	3	50	6
8	BFM6.6/ $\sqrt{3}$ —334—1W	6.6 $\sqrt{3}$	334	73.27	440	180	660	950	490	137	3	70	6
9	BFM7.2/ $\sqrt{3}$ —50—1W	7.2 $\sqrt{3}$	50	9.21	325	110	290	540	180	/	1	28	5
10	BFM7.2/ $\sqrt{3}$ —100—1W	7.2 $\sqrt{3}$	100	18.43	440	143	300	550	180	107	2	35	5
11	BFM7.2/ $\sqrt{3}$ —200—1W	7.2 $\sqrt{3}$	200	36.86	440	180	430	690	280	137	3	50	6
12	BFM11/ $\sqrt{3}$ —12—1W	11 $\sqrt{3}$	12	0.96	325	110	120	370	90	/	1	20	5
13	BFM11/ $\sqrt{3}$ —25—1W	11 $\sqrt{3}$	25	2.01	325	110	190	440	110	/	1	23	5
14	BFM11/ $\sqrt{3}$ —30—1W	11 $\sqrt{3}$	30	2.41	325	110	190	440	110	/	1	25	5
15	BFM11/ $\sqrt{3}$ —50—1W	11 $\sqrt{3}$	50	4.01	325	110	290	540	180	/	1	28	5
16	BFM11/ $\sqrt{3}$ —100—1W	11 $\sqrt{3}$	100	21.94	440	143	290	535	180	107	2	35	5
17	BFM11/ $\sqrt{3}$ —200—1W	11 $\sqrt{3}$	200	15.79	440	180	400	680	266	137	3	50	6
18	BFM11/ $\sqrt{3}$ —300—1W	11 $\sqrt{3}$	300	23.69	440	180	580	860	400	137	3	71	6

19	BFM11/$\sqrt{3}$—334—1W	11$\sqrt{3}$	334	26.37	440	180	630	920	456	137	3	77	6
20	BFM11—25—1W	11	25	0.66	325	110	190	440	110	/	1	23	5
21	BFM11—30—1W	11	30	0.79	325	110	190	440	110	/	1	25	5
22	BFM11—50—1W	11	50	1.32	325	110	290	540	180	/	1	28	5
23	BFM11—100—1W	11	100	2.63	440	143	290	535	180	107	2	35	5
24	BFM11—200—1W	11	200	5.26	440	180	400	680	266	137	3	50	6
25	BFM11—300—1W	11	300	8	440	180	580	860	400	137	3	71	6
26	BFM11—334—1W	11	334	8.79	440	180	630	920	456	137	3	77	6
27	BFM12/$\sqrt{3}$—100—1W	12$\sqrt{3}$	100	6.64	440	143	290	535	180	107	2	35	5
28	BFM12/$\sqrt{3}$—200—1W	12$\sqrt{3}$	200	13.27	440	180	400	680	266	137	3	50	6
29	BFM12/$\sqrt{3}$—300—1W	12$\sqrt{3}$	300	20	440	180	580	860	400	137	3	71	6
30	BFM12/$\sqrt{3}$—334—1W	12$\sqrt{3}$	334	22.15	440	180	630	920	456	137	3	77	6
31	BFM12—100—1W	12	100	2.21	440	143	290	535	180	107	2	35	5
32	BFM12—200—1W	12	200	4.42	440	180	400	680	255	137	3	50	6
33	BFM12—300—1W	12	300	6.63	440	180	580	860	400	137	3	71	6
34	BFM12—334—1W	12	334	7.39	440	180	630	920	456	137	3	77	6
35	BFMR11—36—3W	12	36	0.95	440	125	240	460	117	107	4	30	4
36	BFMR11—65—3W	11	65	1.71	665	140	240	485	216	107	5	27	5
37	BFMR11—100—3W	11	100	2.63	560	115	380	630	240	107	6	50	5
38	BFMR11—200—3W	11	200	5.26	665	143	500	745	356	107	7	75	5
39	BFMR11—300—3W	11	300	7.90	665	180	500	745	356	137	8	90	5