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Report R16-01-02

ANSI Design Test Report ANSI 52-8L Glass Bells Catalog # PSN160146

This design test report records the results of laboratory tests performed on the ANSI 52-8L Glass Bells which met or exceeded all performed tests of these standards:

ANSI/NEMA C29.2B-2013, "American National Standard for Insulators Wet Process Porcelain and Toughened Glass— Transmission Suspension Type"

A handwritten signature in blue ink, appearing to read "B. Besouw".

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Contents

8.2.1	LOW-FREQUENCY DRY FLASHOVER TEST.....	3
8.2.2	LOW-FREQUENCY WET FLASHOVER TEST.....	4
8.2.3	CRITICAL IMPULSE FLASHOVER TESTS – POSITIVE AND NEGATIVE	5
8.2.4	RADIO-INFLUENCE VOLTAGE TEST.....	8
8.2.5	THERMAL-MECHANICAL LOAD CYCLE TEST	9
8.2.6	THERMAL SHOCK TEST	10
8.2.7	RESIDUAL STRENGTH TEST.....	11
8.2.8	IMPACT TEST	13
8.2.9	COTTER KEY TEST	14
8.3.5	PUNCTURE TEST	15
8.3.6	VERIFICATION OF COUPLING LOCK SYSTEM	16



8.2.1 LOW-FREQUENCY DRY FLASHOVER TEST

Test Procedure

Three insulators shall be tested in accordance with 4.2 of ANSI C29.1. Failure of the average dry flashover value of these three insulators to equal or exceed 95 percent of the rated dry flashover value, 95% of 80kV = 76kV, shall constitute failure to meet the requirements of this standard.

Test Results

All samples tested met the requirements of Section 8.2.1 of ANSI/NEMA C29.2B - 2013. Table 1 shows individual results of the Low Frequency Dry Flashover Test.

	Unit 1		Unit 2		Unit 3	
	Uncorrected kV _{RMS}	Corrected kV _{RMS}	Uncorrected kV _{RMS}	Corrected kV _{RMS}	Uncorrected kV _{RMS}	Corrected kV _{RMS}
1	85	93	83	91	83	91
2	88	97	86	94	84	92
3	84	92	87	96	86	94
4	84	92	82	90	85	93
5	86	94	86	94	83	91
6	88	97	81	88	84	92
7	90	99	88	97	85	93
8	90	99	86	94	85	93
9	88	97	88	97	88	97
10	87	96	87	96	86	94
Average	87	96	85	94	85	93

Table 1



8.2.2 LOW-FREQUENCY WET FLASHOVER TEST

Test Procedure

Three insulators shall be tested in accordance with 4.3 of ANSI C29.1. Failure of the average dry flashover value of these three insulators to equal or exceed 90 percent of the rated wet flashover value, 90% of 50kV = 45kV, shall constitute failure to meet the requirements of this standard.

Test Results

All samples tested met the requirements of Section 8.2.2 of ANSI/NEMA C29.2B - 2013. Table 2 shows individual results of the Low Frequency Wet Flashover Test.

	Unit 1		Unit 2		Unit 3	
	Uncorrected kV _{RMS}	Corrected kV _{RMS}	Uncorrected kV _{RMS}	Corrected kV _{RMS}	Uncorrected kV _{RMS}	Corrected kV _{RMS}
1	54	56	52	54	54	56
2	53	54	52	54	54	56
3	53	54	54	56	51	53
4	56	58	53	55	51	52
5	52	54	53	54	54	55
6	53	55	52	53	52	54
7	51	53	52	53	53	55
8	51	53	53	54	54	56
9	52	54	52	54	52	54
10	51	53	52	53	51	52
Average	53	54	52	54	53	54

Table 2



8.2.3 CRITICAL IMPULSE FLASHOVER TESTS – POSITIVE AND NEGATIVE

Test Procedure

Three insulators shall be subjected to a critical impulse flashover test, positive and three to the critical impulse flashover test, negative, in accordance with 4.7 of ANSI C29.1. Failure of the average critical impulse flashover value of these three insulators to equal or exceed 92 percent of the rated critical impulse flashover value, 92% of 125kV = 115kV Positive / 92% of 130kV = 120kV Negative, shall constitute failure to meet the requirements of this standard.

Test Results

All samples tested met the requirements of Section 8.2.3 of ANSI/NEMA C29.2B - 2013. Tables 3, 4 and 5 show individual results of the Critical Impulse Flashover Test.

Unit 1										
Impulse	Positive					Negative				
	Charge (kV)	FO/FW	Impulse (kV)	FO Time (μS)	Corrected Impulse (kV)	Charge (kV)	FO/FW	Impulse (kV)	FO Time (μS)	Corrected Impulse (kV)
1	37	FO	134	3.8	141	36	FO	131	4.68	137
2	36	FO	131	5.8	137	35	FW	126		132
3	35	FW	128		134	36	FW	130		136
4	36	FO	133	3.2	139	37	FO	134	4.68	140
5	35	FW	129		135	36	FW	130		136
6	36	FW	132		138	37	FO	135	3.48	141
7	38	FO	139	3.2	146	36	FW	130		136
8	37	FO	131	4.6	137	37	FO	136	3.48	142
9	36	FW	131		137	36	FO	131	5.48	137
10	37	FO	133	5.2	139	35	FW	126		132
11	36	FW	129		135	36	FO	131	4.68	137
12	37	FO	134	5	141	35	FW	129		134
13	35	FW	127		133	36	FO	134	4.68	140
14	36	FW	131		137	35	FO	126	5.88	132
15	37	FO	134	4.6	141	34	FW	122		127
16	36	FW	129		135	35	FW	126		132
17	35	FW	127		133	36	FO	131	4.08	137
18	36	FO	131	3.8	137	35	FW	128		133
19	35	FW	124		130	36	FO	130	5.48	136
20	36	FO	132	5.4	138	35	FW	126		132
Average			131		137			130		136

Table 3



Unit 2										
Impulse	Positive					Negative				
	Charge (kV)	FO/FW	Impulse (kV)	FO Time (μS)	Corrected Impulse (kV)	Charge (kV)	FO/FW	Impulse (kV)	FO Time (μS)	Corrected Impulse (kV)
1	38	FO	139	3.17	146	37	FO	136	4.2	142
2	37	FO	134	4.77	141	36	FW	131		137
3	36	FW	131		137	37	FO	136	5.8	142
4	37	FO	133	4.77	139	36	FO	131	5.8	137
5	36	FW	129		135	35	FW	129		134
6	37	FO	133	5.17	139	36	FO	132	5	138
7	36	FW	129		135	35	FW	129		134
8	37	FO	133	4.77	139	36	FW	134		140
9	36	FW	129		135	37	FO	137	4.8	143
10	37	FW	132		138	36	FW	131		137
11	38	FO	137	3.17	143	37	FO	136	4.8	142
12	35	FW	122		128	36	FW	131		137
13	36	FW	128		134	37	FW	135		141
14	37	FO	134	3.77	141	38	FO	139	4	146
15	36	FW	127		133	37	FW	135		141
16	37	FO	131	5.97	137	38	FO	139	3.6	146
17	36	FW	127		133	37	FO	135	4.4	141
18	37	FO	131	4.17	137	35	FW	125		131
19	36	FW	131		137	36	FW	130		136
20	37	FO	135	4.17	142	37	FO	134	5.8	140
Average			131		138			133		139

Table 4



Unit 3										
Impulse	Positive					Negative				
	Charge (kV)	FO/FW	Impulse (kV)	FO Time (μS)	Corrected Impulse (kV)	Charge (kV)	FO/FW	Impulse (kV)	FO Time (μS)	Corrected Impulse (kV)
1	37	FO	134	5	141	36	FO	131	4.48	137
2	36	FW	131		137	35	FW	128		134
3	37	FO	131	5.37	137	36	FO	131	6.48	137
4	35	FW	128		134	35	FW	128		134
5	36	FW	132		138	36	FW	130		136
6	37	FO	135	4.17	142	37	FO	132	6.08	139
7	36	FO	131	4.97	137	36	FO	130	4.88	136
8	35	FW	128		134	35	FW	126		132
9	36	FO	132	4.77	138	36	FW	129		135
10	35	FW	127		133	37	FW	134		140
11	36	FO	131	2.97	137	38	FO	137	4.28	144
12	35	FW	128		134	37	FO	132	4.88	139
13	36	FW	131		137	36	FW	130		136
14	37	FO	135	3.57	142	37	FO	135	3.28	141
15	36	FW	132		138	36	FW	130		136
16	37	FW	134		141	37	FW	135		141
17	38	FO	139	3.37	146	38	FO	139	3.48	146
18	37	FO	137	5.17	143	37	FO	135	3.68	141
19	36	FW	131		137	36	FW	130		136
20	37	FO	135	3.57	142	37	FO	134	4.48	140
Average			132		138			132		138

Table 5



8.2.4 RADIO-INFLUENCE VOLTAGE TEST

Test Procedure

Three insulators shall be tested in accordance with 4.9 of ANSI C29.1. All insulators shall have less than 50 μ V RIV at 10kV supplied voltage.

Test Results

All samples tested met the requirements of Section 8.2.4 of ANSI/NEMA C29.2B - 2013. Tables 6 show individual results of the Radio Influence Voltage Test.

Unit	RIV @ 10kV _{RMS} (μ V)	50 μ V RIV (kV _{RMS})
1	1.00	17.3
2	1.00	25.9
3	1.00	25.0

Table 6



8.2.5 THERMAL-MECHANICAL LOAD CYCLE TEST

Test Procedure

Ten assembled insulators shall be subjected to the thermal-mechanical load cycle test. The insulators, which may be connected in series or parallel provided each is equally loaded, shall be subjected to four 24 hour cycles of ambient air cooling and heating with a simultaneously applied minimum tensile load maintained at 60 percent of the rated combined mechanical and electrical strength of the insulators as described in Figure 8. Each 24 hour cycle shall start with a cooling period during which a low temperature of -22°F (-30°C) shall be maintained for at least a four hour period. A heating period will follow the cooling period.

During the heating period a high temperature of 104°F (40°C) shall be maintained for at least a four hour period. During the four hour extreme temperature periods, the ambient air temperature shall be maintained at the specified extreme temperature within 9°F (5°C). The rate of temperature change is not specified. The tensile load shall be applied at room temperature before starting the first thermal cycle. The tensile load shall be completely removed and reapplied after the first, second and third 24 hour thermal cycle. After the fourth thermal cycle, upon cooling to room temperature, the tensile load shall be removed. The ten insulators shall then be subjected to a Combined Mechanical and Electrical test in accordance with 5.2 of ANSI C29.1. The criteria for determining conformance with the standard are as given in 8.3.4 with the exception that no re-test procedure is applicable in this case.

Test Results

All samples tested met the requirements of Section 8.2.5 of ANSI/NEMA C29.2B - 2013. Tables 7 show individual results of the Thermal-Mechanical Load Cycle Test.

Unit	Ultimate Load (lbs)	Failure mode
1	50,943	Cap
2	54,914	Cap
3	52,598	Cap
4	47,526	Glass
5	48,297	Cap
6	51,582	Cap
7	52,926	Cap
8	49,289	Cap
9	52,488	Cap
10	53,700	Cap
Average \bar{X}	51,426	
St. Dev. S	2,402.7	

Table 7

$$\bar{X} \geq \text{Rating} + 3 \times S$$

$$51,426\text{lbs} \geq 36,000\text{lbs} + 3 \times 2,402.7\text{lbs}$$

$$51,426\text{lbs} \geq 43,208\text{lbs}$$



8.2.6 THERMAL SHOCK TEST

Test Procedure

Five insulators shall be tested for ten complete cycles in accordance with 5.5 of ANSI C29.1. The temperature of the hot water bath shall be approximately 205°F (96°C), and the temperature of the cold water bath shall be approximately 39°F (4°C). Failure of any insulator shall constitute failure to meet the requirements of this standard.

Test Results

All samples tested met the requirements of Section 8.2.6 of ANSI/NEMA C29.2B - 2013. Table 8 shows individual results of the Thermal Shock Test.

Unit	Uncorrected kV _{RMS}	Corrected kV _{RMS}
1	82	89
2	86	94
3	82	90
4	87	96
5	83	91

Table 8



8.2.7 RESIDUAL STRENGTH TEST

Test Procedure

Twenty-five insulators shall have the shells broken off. No portion of the shell shall remain outside the maximum diameter of the cap. Each unit shall then be subjected to a mechanical-strength test in accordance with 5.1 of ANSI C29.1. The criteria for determining conformance to this standard are:

$$\bar{X}_R \geq (1.2 \times \text{proof load}) + 1.645 \times S_R$$

Where:

\bar{X}_R = average residual strength of 25 units

S_R = standard deviation of residual strength of the 25 units tested

Proof load = tension proof load (18,000lbs)

Test Results

All samples tested met the requirements of Section 8.2.7 of ANSI/NEMA C29.2B - 2013. Table 9 shows individual results of the Residual Strength Test.

$$37,329\text{lbs} \geq (1.2 \times 18,000\text{lbs}) + 1.645 \times 3,623\text{lbs}$$

$$37,329\text{lbs} \geq 27,397\text{lbs}$$



Unit	Ultimate Tensile Load (lbs)	Failure mode
1	38,183	Pin pulled out
2	32,160	Pin pulled out
3	37,404	Pin pulled out
4	34,852	Pin pulled out
5	32,640	Pin pulled out
6	38,248	Pin pulled out
7	36,758	Pin pulled out
8	30,570	Pin pulled out
9	40,087	Pin pulled out
10	39,409	Pin pulled out
11	36,308	Pin pulled out
12	43,048	Pin pulled out
13	35,105	Pin pulled out
14	35,666	Pin pulled out
15	38,932	Pin pulled out
16	33,483	Pin pulled out
17	38,955	Pin pulled out
18	40,606	Pin pulled out
19	43,843	Pin pulled out
20	38,974	Pin pulled out
21	37,868	Pin pulled out
22	39,302	Pin pulled out
23	29,766	Pin pulled out
24	39,672	Pin pulled out
25	41,375	Pin pulled out
Average \bar{X}_R	37,329	
Standard Deviation S_R	3,623	

Table 9



8.2.8 IMPACT TEST

Test Procedure

Three insulators shall be tested in accordance with 5.1.2.2 of ANSI C29.1. All insulators shall receive an impact of 60inch-lbs.

Test Results

All samples tested met the requirements of Section 8.2.8 of ANSI/NEMA C29.2B - 2013. Table 10 shows individual results of the Impact Test.

Unit	2000lbs Applied	Impact Passed	Uncorrected kV_{RMS}	Corrected kV_{RMS}
1	✓	✓	82	90
2	✓	✓	81	89
3	✓	✓	81	89

Table 10



8.2.9 COTTER KEY TEST

Test Procedure

For three test samples of ball-and-socket insulators, the disengagement force of the cotter key shall be between 25 and 150 pounds (111 and 667 Newton) force for three locking-to-unlocking operations. The cotter key shall be placed in the locking position and a tension load applied to the eye of the cotter key along its axis by means of an appropriate device. The loading shall be gradually increased until the cotter key moves to the unlocking position.

Test Results

All samples tested met the requirements of Section 8.2.9 of ANSI/NEMA C29.2B - 2013. Table 11 shows individual results of the Cotter Key Test.

Unit	Operation 1 (lbf)	Operation 2 (lbf)	Operation 3 (lbf)
1	64.7	72.4	76.0
2	80.5	74.4	84.3
3	74.2	113.3	94.9

Table 11



8.3.5 PUNCTURE TEST

Test Procedure

Five assembled insulators shall be selected at random and tested in accordance with 4.11 of ANSI C29.1. The criterion for determining conformance to this standard is: No puncture shall occur below the specified puncture voltage (110kV). To provide information the test voltage may be raised until puncture occurs, and the puncture voltage recorded. The re-test procedure in section 4.4 is applicable to this test.

Test Results

All samples tested met the requirements of Section 8.3.5 of ANSI/NEMA C29.2B - 2013. Table 12 shows individual results of the Puncture Test.

Unit	Voltage kV _{RMS}
1	118.4
2	130.8
3	127.9
4	121.7
5	129.0

Table 12



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Report R16-01-02

8.3.6 VERIFICATION OF COUPLING LOCK SYSTEM

Test Procedure

Six ball-and-socket insulators shall be coupled in 3 strings of two units with the cotter key in the locking position. Each string shall then be subjected to an attempt to disengage the ball from the socket, applying relative movements by hand representative of those encountered in use. The disengagement of any ball shall constitute failure of the lot to meet the requirements of this standard.

Test Results

All samples tested met the requirements of Section 8.3.6 of ANSI/NEMA C29.2B - 2013.