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UNITED STATES DEPARTMENT OF AGRICULTURE
Rural Electrification Administration

October 7, 1982

PEN AND INK REVISION OF REA SPECIFICIFICATION PE-80

SUBJECT: REA Specification for Gas Tube
Surge Arresters

In paragraph 4.26 the impulse transverse voltage maximum value of 50 volts line to line should read 100 volts line to line. It is possible for multielectrode tubes to have two gaps in the glow mode which will result in a line to line voltage of 100 volts or less after one (1) millisecond.

Please make the following pen and ink changes to paragraph 4.26 and Figure 1 as follows:

Change line to line voltage to 100 volts in both cases.

Disclaimer: The contents of this guidance document does not have the force and effect of law and is not meant to bind the public in any way. This document is intended only to provide clarity to the public regarding existing requirements under the law or agency policies.

Jack Van Mark
Acting Administrator

UNITED STATES DEPARTMENT OF AGRICULTURE
Rural Electrification Administration

July 1979

REA BULLEITN 345-83

SUBJECT: REA Specification PE-80 for
Gas Tube Surge Arresters

I. Purpose: To announce the issuance of a new REA Specification for Gas Tube Surge Arresters.

II. General: This specification covers requirements for multi-electrode gas tube surge arresters used to protect ccmmmica-tions circuits and equipments from damages due to foreign voltages and currents. It replaces PE-55, REA Specification for Two-Electrode Gas Tube Protectors and PE-56, REA Specification for Three-Electrode Gas Tube Protectors.

This specification becomes effective April 4, 1980. All gas tube surge arresters furnished for REA projects bid or on orders placed by REA borrowers after that date shall comply in all respects with the new REA Specification PE-80.

III. Availability of Specification: Copies of the new PE-80 will be furnished by REA upon request. Questions concerning the new specification may be referred to the Chief, Outside Plant Branch, Telephone Operations and Standards Division, Rural Electrifica-tion Administration, U.S. Department of Agriculture, Washington, D.C. 20250, telephone number 202-447-3827.

John V. Carlson

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SPECIFICATIONS:
Gas Tube Surge Arresters

REA Specification for
GAS TUBE SURGE ARRESTERS

REA BULLETIN 345-83
PE-80
JULY 1979

UNITED STATES DEPARIMENT OF AGRICULTURE
Rural Electrification Administration

REA SPECIFICATION FOR GAS TUBE SURGE ARRESTERS

1. GENERAL

1.1 This document specifies REA requirements for gas tube surge arresters, defined as: "A gap, or series of gaps, in an enclosed discharge medium, other than air at atmospheric pressure, designed to protect apparatus or personnel, or both, from high transient voltages." This document does not specify requirements applicable to complete protectors, nor does it specify total requirements for arresters employed within electronic devices where precise coordination between arrester performance and device withstand capability is highly critical.

1.2 Except as noted herein, testing shall be accomplished in accordance with the procedures set forth in IEEE Standard 465.1, 1977 "Test Specification for Gas Tube Surge-Protective Devices," hereinafter referred to as IEEE 465.1.

1.21 This document is organized as follows:

1.211 General information, such as failure criteria or sample selection, applicable to more than one test.

1.212 Detailed information applicable to a single test.

1.3 For the purpose of this specification, failure modes or end of life shall be as defined in IEEE 456.1, Paragraph 4.16 except as supplemented below:

1.31 Short Circuit Failure Mode: In this mode, the arrester shall become permanently short circuited and shall have an impedance of not more than one ohm.

1.32 Low Breakdown Failure Mode: In this mode, the arrester shall have a dc breakdown of less than that shown for the low voltage mode in Table A.

1.33 High Breakdown Failure Mode: In this mode, an arrester shall have dc or impulse breakdown in excess of any of the high voltage mode values shown in Table A.

1.34 Low Insulation Resistance Failure Mode: As defined in IEEE 465.1.

TABLE A - BREAKDOWN FAILURE LIMITS* VOLTS**

	BREAKDOWN FAILURE MODES		
	LOW VOLTAGE	HIGH VOLTAGE	
Rise Time of Breakdown Voltage Test Waveform / Primary Use	<100 V/sec. "DC"	<100 V/sec. "DC"	100 V/sec. IMPULSE
Special Low Voltage Protection	AS REQUIRED BY APPLICATION		
Station, MDF or General Purpose Protection	180	600	900
Cable Protection	250	1200	1500

*Line-to-Ground Measurements Only
**These values serve to indicate end of life after high energy testing. Acceptable limits for new tubes are covered in Tables B & C.

2. SAMPLE LOT SIZE AND SELECTIION

2.1 A minimum of 150 end-product samples (previously untested except for routine production tests) shall be selected at random from at least three production batches. Prior to the performance of any measurements, these units shall be numbered such that an approximately equal number of samples from each batch are used for each test.

2.2 DC Breakdown Voltage, Capacitance, Insulation Resistance, and Impulse Breakdown Voltage measurements described herein shall be performed for all 150 samples.

2.3 Those samples numbered 26 through 75 will then be subjected to the DC Holdover test; and the first time effect will be determined for samples 76 through 100. In the case of multielectrode arresters, Impulse Transverse Voltage will be measured utilizing samples 1 through 25.

2.4 Upon completion of the measurements describe above, units numbered 1 through 50 will be subjected to and classified under the Impulse

Life test, 51 through 100 shall be tested to determine Maximum AC Discharge Current, and 101 through 150 shall be tested to determine the Maximum Single Impulse Discharge classification.

2.5 In the case of the Maximum Single Impulse Discharge and AC Discharge Current Tests, 50 samples shall be subjected to the current level (Light, Medium, Heavy or Maximum) claimed by the manufacturer and described by Table E.

2.6 All test data shall be furnished to REA. Where applicable, histograms, probability plots, etc., may be included at the manufacturer's option. If desired, REA may witness the sample selection and measurement procedure.

3. ARRESTER CLASSIFICATION

3.1 Devices which are accepted by REA shall be classified in accordance with Paragraph 4.3 as light, medium, heavy, or maximum duty depending on their performance in the categories of Impulse Life, Maximum Single Impulse Discharge and AC Discharge Current Carrying Capacity.

4. REQUIREMENTS

4.1 Requirements are divided into two main categories as follows:

a. General Requirements.
b. Requirements for classifying as light, medium, heavy, or maximum duty.

4.2 General Requirements

4.21 DC Breakdown Voltage: For tubes which have not been subjected to high energy tests, the plus and minus three sigma values of dc breakdown voltage for a given polarity shall be within the limits shown in Table B when measured in accordance with Paragraph 4.1 of IEEE 465.1.Further, the average value shall be greater than the Minimum Average shown in Table B. A series of 5 breakdowns of each polarity shall be measured for each sample.

4.22 Capacitance: The capacitance of the tube shall be measured in accordance with Paragraph 4.2 of IEEE 465.1. The capacitance of any tube shall not exceed 5 pf when measured at either 1 kHz or 1 MHz.

4.23 Insulation Resistance: Insulation resistance shall be measured in accordance with Paragraph 4.3 of IEEE 465.1, using 100 Vdc for tubes having a nominal dc breakdown of 230 V or more and 50 Vdc for tubes having a nominal dc breakdown of less than 230 volts. Insulation resistance shall be greater than 100 megohms.

TABLE B - ACCEPTABLE LIMITS DC BREAKDOWN - VOLTS

Primary Use	(ALL TUBES) Line-to-Ground			Multi-Electrode Tubes Line-to-Line	
	-3σ Value	Minimum Average	+3σ Value	-3σ Value	+3σ Value
Special Low Voltage Protection	AS REQUIRED BY APPLICATION				
Station, MDF or General Purpose Protection	300	350	500	300	1000
Cable Protection	510	-	1000	510	1200

4.24 Impulse Breakdown Voltage: The plus and minus 3σ values of impulse breakdown voltage of tubes which have not been exposed to high energy surges when measured in accordance with Paragraph 4.4 of IEEE 465.1, shall be within the ranges specified in Table C. Further, the average value shall be less than the Maximum Average shown in Table C. A series of 5 breakdowns of each polarity, and each rate of rise shall be measured for each sample.

TABLE C - ACCEPTABLE LIMITS IMPULSE BREAKDOWN - VOLTS

Primary Use	100 V/μs Rise Line-to-Ground			10 kV/μs Rise Line-to-Ground		
	-3σ Value	Maximum Average	+3σ Value	-3σ Value	Maximum Average	+3σ Value
Special Low Voltage Protection	AS REQUIRED BY APPLICATION					
Station, MDF or General Purpose Protection	300	600	750	300	1000	1200
Cable Protection	510	-	1200	510	-	1600

4.241 Values for line-to-line impulse breakdown voltage of multi-electrode devices shall be no greater than twice those given for line-to-ground in Table C.

4.25 Holdover: The extinguishing voltage of the arresters shall be greater than shown in Table D at 200 mA when tested in accordance with IEEE 465.1, Paragraphs 4.9 or 4.10 employing a 500A 10 x·1000 µs current wave across each gap in lieu of the IEEE recommended 100A 10 x 1000. The tubes shall extinguish in 150 milliseconds or less.

4.251 Prior to testing, samples 26 to 50 shall be subjected to a total of 5% of the Impulse Life test requirement of Table E: testing 12 samples in one polarity and the remaining 13 in the opposite polarity.

4.252 Two-electrode tubes shall be tested in accordance with Paragraph 4.9 of IEEE 465.1 using the recommended values for C1 and R2 of Figure 4. Samples shall be subdivided, and tests run using surge and power supply polarities as follows:

Samples	Surge Polarity	Power Supply Polarity
26 - 31 and 51 - 56	+	-
32 - 37 and 57 - 62	+	+
38 - 43 and 63 - 68	-	-
44 - 50 and 69 - 75	-	+

4.253 Three-electrode tubes shall be tested in accordance with Paragraph 4.10 of IEEE 465.1 using the recommended values for R3, R4, R5, and C1, C2, and C3 of Figure 5. Samples shall be subdivided and tests run using surge polarities and power supply (PS) voltages and polarities as follows:

Samples	PS Voltage	PS Polarities	Surge Polarity
Station, MDF or General Purpose Protection			
26–37 and 51-62	75	Opposite	+
38-43 and 63-68	150	Same, Line +	+
44-50 and 69-75	150	Same, Line +	-
Cable Carrier Protection			
26 - 75	150	Opposite	+

TABLE D - DC HOLDOVER REQUIREMENTS – VOLTS

Primary Use	(Multi-Electrode Tubes) Line-to-Line	(All Tubes) Line-to-Ground
Special Low Voltage	AS REQUIRED BY APPLICATION	
Station, MDF or General Purpose Protection*	150	150
Cable Carrier Protection	300	150

*When Line-to-Line potential exceeds 130 V peak, carrier protection is applicable.

4.26 Impulse Transverse Voltage: When multielectrode devices which have not been subjected to high energy surges are tested in accordance with IEEE 465.1, Paragraph 4.12, a line-to-line voltage not exceeding the arrester's +3σ impulse breakdown at 100 V/μs per Table C may exist for not more than 5 μs. At the end of 5 μs, the line-to-line voltage shall be reduced to a value not greater than the arrester's +3σ dc breakdown, per Table B, and after 1 millisecond the line-to-line voltage shall not exceed 50 V, as shown in Figure 1. Any voltage in excess of this volt-time curve shall be considered a failure.

4.27 First Time Effect: When tested in accordance with Paragraph 4.271, arresters shall meet the Impulse Breakdown requirements of Paragraph 4.24 and DC breakdown requirements of Paragraph 4.21.

4.271 Arresters to be tested shall be encased in light excluding material so that no external light reaches the gas tube. This covering shall remain in place for the full test duration. Tests of dc and impulse breakdown shall be made in accordance with Paragraphs 4.21 and 4.24 and the results recorded. The devices shall then be stored for not less than 30 days in an unenergized condition. At the end of the storage period, one line-to-ground gap of each sample shall be subjected to one test of impulse breakdown at 100 V/μs or dc breakdown. Both impulse and dc breakdown in each polarity shall be measured however, 25% of the sample lot shall be used for each test condition.

4.28 Mechanical Reliability: The manufacturer shall demonstrate to REA's satisfaction that its product has sufficient mechanical ruggedness to withstand normal installation and maintenance procedures as well as shipping and storage and that production testing is such as to preclude the failure of arresters from normal mechanical stresses experienced in routine storage and use of the device.

4.3 Requirements for Classifying Tubes: Arresters shall be classified as light, medium, heavy, or maximum duty depending on their performance in categories of impulse life, maximum single impulse and 60 Hz current carrying capacity. The protector(s} in which the arrester is mounted for testing shall be identified and the classification shall apply only when utilized in that/those protector(s}. Table E sets forth the requirements for determination of this classification. Tests for failure by low insulation resistance, low or high dc breakdown, and both polarities of high impulse breakdown (100 V/µs) failure modes shall be conducted, in that order, after each Maximum Single Impulse Discharge Current Test, Impulse Life Test, and AC Discharge Current Test, utilizing the failure modes defined in Paragraph 1.3 of this specification. Note: Tests of dc and impulse breakdown may each consist of a single, low energy, firing, rather than the more elaborate procedures required in Paragraphs 4.21 and 4.24.

TABLE E - CLASSIFICATION CRITERIA

Test/Paragraph	Light	Medium	Heavy	Maximum
Maximum Single Impulse Discharge Current* Per Paragraph 4.31	≥5 kA	≥5 kA	≥10 kA	≥20 kA
Impulse Life Per Paragraph 4.32	≥10**	≥100	≥400	≥1000
AC Discharge Current* Per Paragraph 4.33	≥10A	≥20A	≥65A	≥200A

*Values of Current are given on a per line-to-ground gap basis. Multi-electrode devices shall be tested (with the given current value in each line-to-ground gap, and the total current) equally distributed between gaps.

**At 50A 10/1000 µs, life as per Paragraph 4.32 must equal or exceed 200 surges. One half of the allotted samples will be tested at 5OOA, the remainder of 50A.

4.31 The device shall be tested for Maximum Single Impulse in accordance with IEEE 465.1, Paragraph 4.5, employing the 8 x 20 µs current waveshape. A failure rate of not more than 6% shall be considered acceptable.

4.32 The device shall be tested for Impulse Life in accordance with IEEE 465.1, Paragraph 4.6 employing the 10 x 1000 µs waveshape at + and -500A* crest current. A 20% failure rate, shall be considered acceptable, however, not more than 6% of the samples may fail at less than half the specified number of impulses. Half the samples shall be tested in one polarity and the remainder in the opposite polarity. Tests

*For light duty tubes, see note on Table E.

for failure by low insulation resistance, low dc breakdown and high impulse breakdown (100 V/μs) failure modes shall be conducted, in that order, after every strike of the life test.

4.33 The device shall be tested for AC Discharge Current in accordance with Paragraph 4.7 of IEEE 465.1, employing a current discharge time of 11 cycles of 60 Hz. A failure rate of not more than 6% shall be considered acceptable.

5. MANUFACTURING QUALITY ASSURANCE

5.1 Manufacturers are required to perform tests which will assure that the gas tubes comply with the requirements of this specification on a production basis.

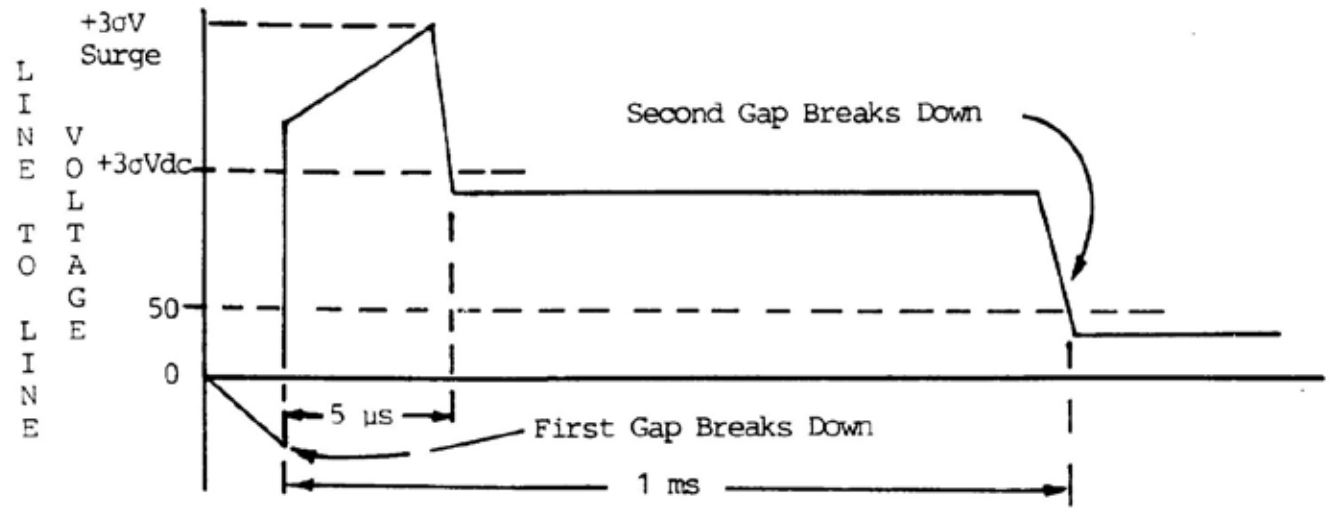
5.11 Every arrester supplied to REA borrowers shall be subjected to at least one impulse breakdown of each polarity at not less than 100 V/μs rate of rise and shall not be outside the 3σ values shown in Table C for 100 V/μs rise.

6. PRODUCT IDENTIFICATION

6.1 Color Codes: Each gas tube and arrester assembly shall be marked in a clear, permanent and distinctive manner to indicate the category of intended application. Those intended for special low voltage applications shall be distinguished by a green color, those employed for station, MDF or general purpose use shall employ orange, and arresters designed for cable protection shall be color coded slate. In each case a dot, stripe, or similar means of marking shall be employed.

6.2 Manufacturer's Identification: On each tube the manufacturer's name and part number and date code shall be indelibly marked.

ACCEPTABLE LIMITS FOR IMPULSE TRANSVERSE VOLTAGE TEST



MAXIMUM ACCEPTABLE TIME

FIGURE 1