



Switchgear Maintenance Information

SMI NO 17-82

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SUBJECT: CIRCUIT BREAKER CONTACT RESISTANCE & TESTING

NOTE: This information is soley for the use of A&ES employees only.

Background:

Evaluating contact quality, (condition and pressure), via the micro-dimmer (or "ductor") test method has, over the last few years, become quite popular. Customers are adding this test to workscope specifications, and incorporating the requirement in their "bid" packages.

Manufacturers of low, medium and high voltage circuit breakers perform these tests in the factory as part of their quality assurance programs but have never published test values or acceptable test limits in their instruction books for LV/MV equipment (large HV/EHV oil circuit breakers do have this information contained in the instruction-maintenance manuals.) The reason for not publishing this information is possible customer misunderstanding i.e. if the published value is 50 micro ohms - the test shows 60 micro-ohms - is this acceptable or not? Overall the feeling is that the information would create more problems than it would solve, especially in the hands of the inexperienced.

However, in view of several recent shop "warranty" type failures that would probably have been prevented by utilizing this test method and an increasing number of customer requests, the following information is offered to A&ES Switchgear Specialists and a limited number of other interested personnel.

NOTE: The following tabulations were taken from confidential GE Product Department Application Engineering and Quality Control manuals. It is specifically for new General Electric type AK and AM breakers, it is however, reasonable to assume that other manufacturers breakers will similar micro-ohm resistance values, but you must check that manufacturer directly to be sure.



APPARATUS SERVICE DIVISION
GENERAL ELECTRIC COMPANY

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TABLE I - GE, AK BREAKERS

<u>BREAKER FRAME SIZE</u>	<u>TRIP DEVICE COIL AMPERES</u>	<u>MICRO-OHMS</u>
225 AMP ONLY	15	39,000
	20	15,000
	30	15,000
	40	8,800
225 & 600 AMP	50	4,100
	70	2,840
	90	2,800
	100	1,400
	125	1,400
	150	700
	175	700
	200	400
	225	400
600 AMP ONLY	250	330
	300	250
	350	250
	400	220
	500	220
	600	160
1600 AMP	200	380
	225	380
	250	280
	300	210
	350	210
	400	150
	500	150
	600	100
	800	100
	1000	80
	1200	80
	1600	80
3000 AMP	2000	20
	2500	20
	3000	20
4000 AMP	2000	20
	2500	20
	3000	20
	4000	20

TABLE II - GE AM BREAKERS

<u>BREAKER RATING</u>	<u>CURRENT RATING</u>	<u>MICRO-OHMS (MEASURED FRONT BUSHING TO REAR BUSHING)</u>	<u>NOTE</u>
AM-4.16-150	600 1200	75 50	(1)
AM-4.16-250	1200 2000	50 25	(1)
AM-4.16-350	1200 3000	50 20	(1)
AM-7.2-250	1200	50	(1)
AM-7.2-500	1200 2000	50 25	(1)
AM-13.8-150	1200	50	(1)
AM-13.8-250	1200 2000	50 25	(1)
AM-13.8-500	600 1200 2000	75 50 25	(1)
AM-13.8-750	1200 2000	50 30	(1)
AM-13.8-1000	1200 3000	50 20	(1)

TABLE III - GE POWER-VAC BREAKERS

VB-4.16/13/8	1200	40
VB-4.16/13.8	2000	35
VB-4.16/13.8	3000	15

NOTE (1): Micro-ohm readings in Table II are based on a hollow core, copper bushing stud, for solid core bushing studs - 40 micro-ohms is the correct value.

High Voltage Breakers - See the appropriate breaker maintenance manuals for test values.

CAUTION! The values furnished in tables I & II are based on the following:

1. Tests being made with a 100 ampere micro-ohmmeter, a 10 amp unit will give slightly different test values.
2. Values are for NEW BREAKERS - breakers that have been in service will test differently, due to the following factors:
 - Contact wear/erosion
 - Changes in contact pressure due to the changes (aging) in contact pressure springs
 - Wear - in contact links - pivot and sliding contact surfaces
 - Environmental effects - contamination, corrosion, etc.
 - Adjustments out of specification
 - Improper lubrication procedures, e.g. excessive contact grease (D50H47) on main movable/stationary contact surfaces and movable contact arm pivot area surfaces.

Causes of Variations in Test Results

1. Operator Error
 - a. Reading test set scale at a "parallex"
 - b. Poor connection pressure - test probe to contact surface
- NOTE: Generally 2 different people will get 2 slightly different test results
2. Equipment
 - a. Test leads or probes in poor condition
 - b. Micro-ohmmeter out of calibration
 3. Breaker Condition
 - a. Contact surface condition-deterioration
 - b. Contact hinge condition
 - c. Primary disconnect condition-either poor contact pressure, or poor contact surface

OVERALL- These are the primary factors involved in variances in test results - next we must consider interpretation of the tests.

Test Result Interpretation

General:

In that test results will be expressed in MICRO-OHMS - millionths of an ohm, recognize that factors otherwise considered at the most, subtle, can have a substantial effect.

Example - test procedure:

Variations in the amount of pressure the test set operation puts on the test probes will be directly reflected in the micro-ohm reading, to little pressure and the probe contact may not break through the normal oxide film on the contact surface, and may give a false reading.

Example - contacts:

Contact resistance readings will change slightly each time the breaker is opened and closed as the contact surfaces may not "seat" in exactly the same location each operation. Multiple, repetitive closing/opening operations generally cause slight decreases in the test results.

Problem Areas-Examples

1. Type AK Breakers - Poor connections at the movable contact assembly hinging area.
2. Type AM Breakers - Poor connections at the movable contact arm pivot assembly at the bottom of the primary bushings.

Conclusion:

Use the foregoing information in the context it is provided - specifically as a guide. If when performing these tests you get results which differ substantially from the tables, or vary between phases you know a problem exists. You then must determine where. If you have any problems or questions, contact the writer for recommendations.


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