VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

September 16, 1994

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

Serial No. 94-487
NL&P/ETS R4
Docket Nos. 50-280
50-281
50-338
50-339
License Nos. DPR-32
DPR-37
NPF-4
NPF-7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2
NORTH ANNA POWER STATION UNITS 1 AND 2
REQUEST FOR ADDITIONAL INFORMATION
MOLDED CASE CIRCUIT BREAKERS

Virginia Electric and Power Company reports entitled, "The Analytical Assessment of Fault Current Interrupting Capability of As-Installed Configuration of 480V MCC Molded Case Circuit Breaker Only and Combination Molded Case Circuit Breaker Starter Units," were provided to the NRC during the North Anna and Surry Electrical Distribution System Functional Inspections. Per your letter of August 5, 1994, additional information pertaining to the fault current capability and application of these molded case circuit breakers is provided in the attachment.

This issue has been reviewed by each station's SNSOC and it has been determined that operation with the installed 480V Molded Case Circuit Breakers does not result in an unreviewed safety question.

Should you have any questions or require additional information, please contact us.

Very truly yours,

Robert F. Saunders for

James P. O'Hanlon
Senior Vice President - Nuclear

Attachment

220030

A001 1/1

cc: U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, N. W.
Suite 2900
Atlanta, Georgia 30323

Mr. M. W. Branch
NRC Senior Resident Inspector
Surry Power Station

Mr. R. D. McWhorter
NRC Senior Resident Inspector
North Anna Power Station

Attachment
Additional Information for
Molded Case Circuit Breakers (MCCB)

North Anna Units 1 & 2

1. Does the manufacturer support the use of the MCCBs in this manner? Provide a copy of relevant correspondence between VEPCO and Klockner Moeller regarding the use of the NZM6 and NZM9 MCCBs in applications which exceed their manufacturer's fault current rating. Additionally, provide the manufacturer information regarding the fault current rating for the Klockner Moeller NZM6 and NZM9 MCCBs (1970-72 vintage).

Response:

The manufacturer, Klockner Moeller, has not provided the information requested by Virginia Electric and Power Company regarding the margin for the fault-current ratings of these breakers. Klockner Moeller produced test results for a similar breaker showing test failure at 18 ka. However, the actual test acceptance criteria were not included, nor was the capability of the breakers between 14 ka and 18 ka defined. A copy of the Klockner Moeller letter is enclosed. Because Klockner Moeller did not provide additional information, a more detailed analysis of actual installation adequacy was undertaken and a report entitled "Analytical Assessment of Fault Current Interrupting Capability of As-Installed Configurations of 480V MCC Molded Case Circuit Breaker Only and Combination Molded Case Circuit Breaker Starter Units" was completed for North Anna.

Manufacturer's fault current ratings based on catalog information:

	1970			1973		
	NZM6	NZM9	NZMH9	NZM6	NZM9	NZMH9
240VAC Symm rms A	18000	18000	45000	18000	22000	65000
480VAC Symm rms A	-	not provided	-	14000	18000	35000
600VAC Symm rms A	14000	14000	25000	14000	14000	25000

The detailed analysis determined that the Klockner Moeller NZM6-63U and NZM6-100/6U circuit breakers are capable of interrupting the worst case fault current (three phase bolted fault currents). This analysis is applicable to the NZM9 MCCBs also. Therefore, plant operation with the installed 480V MCCBs does not create an unreviewed safety question.

2. When assuming the worst case conditions for the fault current calculation, was it assumed that the emergency diesel generator (EDG) was operating in parallel with the grid as part of a load test? If so, what is the relative contribution to the fault current from the EDG?

Response:

The fault current calculation (EE-0324) includes the EDGs in parallel to the system on a limited basis. Analysis was done for non-accident conditions both with and without the EDGs in parallel to determine the effect that this would have on available fault currents. The addition of an EDG resulted in not more than a 138 amp increase in the fault current at 480VAC motor control centers (MCC). The calculation shows that worst-case fault currents are associated with accident conditions, not with generator testing during normal plant operation. This EDG contribution accounted for less than 1% of the total fault current, which is not considered significant.

3. As part of the Appendix R, "Fire Hazard Analysis," it is required that systems needed for the safe shutdown of the plant be kept isolated from the fire hazard and remain in an operable condition. Are any of the Klockner Moeller NZM6 or NZM9 MCCBs credited for isolating equipment required for safe shutdown from a fire hazard? If so, are any of these breakers outside of their manufacturer's fault current rating?

Response:

There are Klockner Moeller 480VAC NZM6 and NZM9 MCCBs relied upon for isolation of Non-Appendix R circuits from Appendix R power supplies. Proper coordination of these breakers is required to ensure that fire induced failure of non-safe shutdown cables will not result in loss of a power source that is necessary to support safe shutdown. Non-Appendix R circuits which share a common power supply have not been physically traced to determine fire zone exposure.

Maximum fault current values calculated for several safety-related MCCs required for 10CFR50 Appendix R exceed the manufacturer's fault current ratings for Klockner Moeller NZM6 and NZM9 molded case circuit breakers. These fault currents do not exceed the ratings documented in the analysis performed in the assessment report mentioned under the answer for Question 1.

4. Are any of the Klockner Moeller NZM6 or NZM9 MCCBs used as isolation devices between safety-related and non-safety-related equipment or as protection for containment penetrations? If so, are these breakers in applications which exceed their manufacturer's fault current rating?

Response:

North Anna Power Station is not designed to Reg. Guide 1.75, therefore, a safety-related circuit breaker qualifies as an acceptable isolation device between a safety-related power supply and a nonsafety-related circuit. Accordingly, there are Klockner Moeller NZM6 and NZM9 circuit breakers used as isolation devices between nonsafety-related circuits and safety-related MCCs.

Additionally, there are both safety-related and non-safety-related Klockner Moeller NZM6 and NZM9 circuit breakers supplying circuits inside containment. Those circuit breakers provide primary electrical containment protection. For Unit 2, secondary electrical containment protection is provided predominately by breakers or fuses. Adequately rated Westinghouse type HFB are used for Unit 2 secondary electrical containment penetration circuit breakers.

As described in question 3 above, available fault current at the source side of the motor control center MCCBs exceeds the manufacturer's breaker ratings in several cases, but not the increased rating documented in the analysis. This remains true for safety-related circuit breakers which provide isolation and provide penetration protection.

5. In addition to the above cases, identify the number of Klockner Moeller NZM6 and NZM9 MCCBs that are used in safety-related applications?

Response:

The original plant design used the subject circuit breakers in each combination cubicle (i.e., compartments also containing starters). MCC compartments without starters were equipped with higher interrupting NZMH9 circuit breakers. The replacement models for the NZM6 and NZM9 MCCBs are adequately rated for the credible fault current.

The estimated number of safety-related NZM6 and NZM9 circuit breakers was obtained based on the station one line diagrams and a field verification performed for Unit 1 in July 1989. Unit 2 is expected to be similar. The estimated number of NZM9 breakers in use is 16 for Unit 1 and 22 for Unit 2 and they will continue to be used in their existing application, since the fault currents for these breakers do not exceed the ratings documented in the referenced analysis. The NZM6 breakers with significant safe shut-down roles (73 breakers for Unit 1 and 71 breakers for Unit 2) have been replaced by higher rated type NZMH4 MCCBs, due to 10CFR Part 21 defect concerns. The remaining NZM6 breakers determined as non-essential for safe shut-down (147 for Unit 1 and 133 for Unit 2) will continue to be used in their existing applications, since the fault current for these breakers do not exceed the ratings documented in the referenced analysis.

6. What has been North Anna's experience with electrical faults in the past?

Response:

At North Anna, the MCC circuit breakers (Klockner-Moeller) have been exposed to short circuits in the past (due to motor windings becoming grounded, cable faults, etc.). No catastrophic breaker failures (where the circuit breaker actually came apart or resulted in loss of the entire MCC) were identified. When a breaker is exposed to a fault, the circuit is tested and the fault is cleared prior to re-energization. If no fault is detected on the circuit and a problem with the breaker is suspected, the breaker is tested and replaced as necessary.

Surry Units 1 & 2

1. Did the Surry staff contact the manufacturer of the FB and FA MCCBs regarding the ability of the breakers to interrupt currents outside their manufacturer fault current rating? If so, did the manufacturer support the use of the FA and FB MCCBs in this manner?

Response:

Virginia Electric and Power Company contacted Underwriter's Laboratories, Cutler Hammer, and Westinghouse regarding fault current rating of the subject breakers. Underwriter's Laboratories verified the existence of test information for FB molded case circuit breakers (MCCB) without starters. Cutler Hammer was contacted and verified the existence of test information for FB breakers used in conjunction with Cutler Hammer starters. This test information applies directly to the Surry MCCB applications. Both Cutler Hammer and Underwriter's Laboratories stated that Westinghouse would have to grant their permission for us to have access to the test data.

A letter was sent to Westinghouse requesting permission to review the FA and FB breaker test data. No formal written response was obtained from Westinghouse. During a telephone conversation in early 1992 with Westinghouse, they stated that they would not grant access to the test information and that they would not support our position that the breaker ratings were conservative. Therefore, a more detailed analysis of actual installation adequacy was undertaken and a report entitled "Analytical Assessment of Fault Current Interrupting Capability of As-Installed Configurations of 480V MCC Molded Case Circuit Breaker Only and Combination Molded Case Circuit Breaker Starter Units" was completed for Surry.

With the exception of 36 breakers, this analysis determined that the Westinghouse FA and FB safety-related circuit breakers are capable of interrupting the worst case fault current (three phase bolted fault currents). Although these 36 safety-related breakers do not conform to the original design requirements or industry standards for breaker interrupting ratings, these breakers remain operable to perform their intended function, since:

1. Most faults at 480V are arcing faults (per IEEE-141) which may typically be as low as 89 percent of the three phase bolted fault currents. The most likely faults are line to line arcing faults which could be as low as 74 percent of the three phase bolted fault current. The 480V system is ungrounded with ground detection installed. Detection and repair of single phase ground conditions further reduce the likelihood of three phase faults from occurring.

2. The fault current values decrease to within the manufacturer's ratings as the distance from the MCC increases, in proportion to the conductor size. For example, it has been calculated that for the worst case available fault current approximately two circuit feet of #12 AWG or eleven circuit feet of #4 AWG is required to reduce the fault current to within the analyzed circuit breaker rating.

3. The four safety-related motor control centers containing the subject breakers are located in the Unit 1 and Unit 2 Emergency Switchgear Rooms. Those areas are relatively free of hazards. Cable raceway and adjacent mounted equipment are seismically mounted and the areas are not subject to missiles or high energy line breaks.

Therefore, continued plant operation with the installed 480V MCCBs does not create an unreviewed safety question.

A standing Design Change Package was approved to provide for replacement of those safety-related breakers in service, where the calculated maximum three-phase bolted fault current exceeds the increased ratings documented in the analytical assessment. It is our intent to complete the replacement of these breakers over the next two scheduled refueling outages for each unit. The second refueling outages are currently scheduled for May 1996 and April 1997 for Units 2 and 1, respectively.

2. When assuming the worst case conditions for the fault current calculation, was it assumed that the emergency diesel generator (EDG) was operating in parallel with grid as part of a load test? If so, what is the contribution to the fault current from the EDG?

Response:

The fault current calculation (EE-0334) included the EDGs in parallel to the system on a limited basis. Analysis was done for non-accident conditions both with and without the EDGs in parallel to determine the effect this would have on available fault currents. The addition of an EDG resulted in not more than a 75 amp increase in the fault current at 480VAC MCCs. The calculation shows that worst-case fault currents are associated with accident conditions, not with EDG testing during normal plant operation. This EDG contribution accounted for less than 1% of the total fault current, which is not considered significant.

3. As part of the Appendix R, "Fire Hazard Analysis," it is required that systems, needed for the safe shutdown of the plant, be kept isolated from a fire hazard and remain in an operable condition. Are any of the Westinghouse FA and FB MCCBs credited as isolating equipment required for safe shutdown from a fire hazard? If so, are any of these breakers outside of their manufacturer's fault current rating?

Response:

There are Westinghouse 480VAC FA and FB MCCBs relied upon for isolation of Non-Appendix R circuits from Appendix R power supplies. Proper coordination of these breakers is required to ensure that fire induced failure of nonsafe shutdown cables will not result in loss of a power source that is necessary to support safe shutdown. Non-Appendix R circuits which share a common power supply have not been physically traced to determine fire zone exposure.

Maximum fault current values calculated for several safety-related motor control centers required for 10CFR50 Appendix R, designated 1(2)H1-1, 1(2)H1-2, 1(2)J1-1, and 1(2)J1-2, exceed the manufacturer's fault current ratings for type FA and FB molded case circuit breakers. These breakers are identified in exhibit 2 of the assessment report entitled "Analytical Assessment of Fault Current Interrupting Capability of As-Installed Configurations of 480V MCC Molded Case Circuit Breaker Only and Combination Molded Case Circuit Breaker Starter Units."

The 36 circuit breakers not bounded by the referenced analysis identified in Question 1 provide either Appendix R isolation or are used for Appendix R safe shutdown equipment.

4. Are any of the Westinghouse FA and FB MCCBs used as isolation devices between safety-related and non-safety-related equipment or as protection for containment penetrations? If so, are these breakers in applications which exceed their manufacturer's fault current rating?

Response:

Surry Power Station is not designed to Reg. Guide 1.75, therefore, a safety-related circuit breaker qualifies as an acceptable isolation device between a safety-related power supply and a nonsafety-related circuit. Accordingly, there are Westinghouse FA and FB MCCBs used as isolation devices between non-safety related circuits and safety-related MCCs.

Additionally, there are both safety-related and non-safety-related Westinghouse FA and FB circuit breakers supplying circuits inside containment. Those circuit breakers provide electrical containment penetration overcurrent protection.

As described in question 3 above, available fault current at the source side of the motor control center MCCBs exceeds the manufacturer's breaker ratings in several cases. This remains true for circuit breakers serving as safety-related isolation devices and providing penetration protection. In addition, of 36 circuit breakers not bounded by the referenced analysis identified in Question 1, several provide isolation between safety-related and nonsafety-related equipment.

5. In addition to the above cases, identify the number of Westinghouse FA and FB MCCBs that are used in safety-related applications?

Response:

Original plant motor control centers were equipped with type FA, FB, and JA breakers. There are a number of higher rated circuit breakers, Westinghouse type HFB for example, that have been installed by various Design Changes.

The number of safety-related FA and FB circuit breakers can be obtained from Exhibit 2 of the subject report. The breakers shown here are in MCCs with high fault current, in excess of manufacturer's ratings. These safety-related circuit breakers include those discussed in questions 3 and 4.

MCC	Circuit Breakers	Combination Starters
IH1-1	12*	20
IH1-2	2	68
IJ1-1	6*	17
IJ1-2	6	58
2H 1 - 1	10*	22
2H 1-2	6	66
2J1-1	8*	22
2J1-2	8	61

* available fault current exceeds analyzed ratings for the circuit breakers. These breakers will be replaced as stated in the response to Question 1.

6. In the submittal, Surry included a Underwriter's Laboratory fault circuit test document #28-9672-1 for the FB and HFB MCCBs. In this document the current for the test is listed as 25,020 Amps for the system. Is this the current value for the source used in the test circuit or the current seen by the MCCBs under test?

Response:

Industry standards do not require that circuit breaker interrupting tests show that a breaker actually interrupts rated current. The fault source shall be capable of producing the rated current and the breaker should successfully interrupt a short. In actuality, the breaker will not likely pass the full current due to the test configuration. This statement is reflected in the Cutler Hammer test, performed in accordance with UL 508. A copy of the test report is included in the assessment report referenced under the response to Question 3. Further discussions of this issue are provided under sections 3.1, 3.1.2 and 3.1.4 of the subject assessment report.

7. What has been Surry's experience with electrical faults in the past?

Response:

At Surry, MCC circuit breakers have been exposed to short circuits in the past (due to motor windings becoming grounded, cable faults, etc.). No catastrophic breaker failures (where the circuit breaker actually came apart or resulted in loss of the entire MCC) were identified. Typically, when a breaker is exposed to a fault, the circuit is tested and the fault is cleared prior to re-energization. If no fault is detected on the circuit and a problem with the breaker is suspected, the breaker is tested and replaced as necessary.

Klockner
MOELLER

February 15, 1990

Mr. K. S. Berger, Supervisor/Electrical Engineering
Virginia Power
Innsbrook Technical Center
Electrical Engineering - Power Station
5000 Dominion Boulevard
Glen Allen, VA 23060

RE: NORTH ANNA POWER STATION MOTOR CONTROL CENTERS,
SHORT CIRCUIT WITHSTAND CAPACITY OF COMBINATION MOTOR CONTROLLERS

Dear Mr. Berger:

In follow-up to our January 19, 1990, meeting with you at the Innsbrook Technical Center, we would like to advise you of the latest information we received from our product design/development and lab personnel on the above subject:

After our meeting with you, we have again relayed Virginia Power's intentions to our people in product design/development, i.e., to evaluate and test some of the presently installed NZM6-63/62.. and NZM6-100/62 circuit breaker combination motor controllers for short circuit current withstand capacity at the newly calculated, 19,000 amps rms, symmetrical at 510 volts maximum level.

Please refer to the attached copy of the telefax correspondence and computer analysis sheets we received on the unsuccessful short circuit current interrupting tests performed with the NZM6-100/ZM6-100 non-current-limiting thermal/magnetic circuit breakers at 18,000 amps rms symmetrical, 480 volts. Subsequent telephone discussions of this subject with our product experts indicate to us that the added resistance of the motor starter circuit (incorporating the contactor and thermal overload relay) would not result in any significant increase in short circuit current withstand capacity.

We also learned that the laboratory would likely require six spare motor starter units, each of the various circuit breaker, contactor and overload relay combinations and a testing fee of $15,000 per day. Based on an estimated 3-days long test program, the testing costs of $45,000 would have to be paid by Virginia Power.

Corporate Office 25 Forge Parkway Franklin, Massachusetts 02038 Tel: (508) 520-7080 Telefax: (508) 520-7084 Telex: 94-8434

Please review this latest information and advise us in writing at your earliest convenience of your preferred course of action for the further handling of this matter.

Sincerely,

KLOCKNER-MOELLER CORPORATION

I. Kantor
Manager - Engineered Products

IK:pmc

Enclosures (4)

cc: Mr. R. Boehling - Virginia Power

TELEFAX/MESSAGE		KLÖCKNER - M O E L L E R	
from	Klöckner Moeller Tel.0228/602290	to	: K-M/USA
Name	KVV/Rathmann	Name	: H. Schneider
City	D-5300 Bonn 1 P.O. Box 1880	City	: Franklin
Fax-Nr.	0228/602817	Fax-No.:	508-520-7084
		Pages	: 4
		Date	: 9. Februar 1990

Ref.: Your Fax of February 6,1990
Circuit Breakers for VEPCO

With our Fax of 89-12-1 we had already informed you that tests on NZM6-100/ZM6-100 with 18 kA at 480 V were not successful. Enclosed we send you the computer analysis about these tests where it is stated that the devices failed in the subsequent high potential tests. Therefore it would be a nonsense to perform tests with higher values.

We have no test data available for complete motor starter combinations with NZM6 circuit breakers and contactors. These combinations were selected according to the short circuit rating of the circuit breakers without any further tests.

Best Regards

STOSSANLAGE: 2 ON-LINE COMPUTERANALYSIS

DATUM : 23.11.89

UA-NR : 1349 TYPE: NZM6-100/ZM6-100

BESONDERE AENDERUNG DES GERAETES:
DECKEL AUS SBM 17.300 TROGAMID T ENTSPR. 1Z123-74.148 AUSF.2
EINSPEISUNG VON: OBEN GEHAEUSE: OHNE
PRUEFUNG NACH : IEC 157-1 P-1
SPANNUNG [V EFF]: 480.00 FREQUENZ: 50.00

STROM [KA EFF]: IK-R: 17.70 IK-S: 18.76 IK-T: 17.94 COSPHI: 0.24

MASSTAB: RBEMOHM]: 0.50 MUEV]: 1000 MIEKA]: 50
BEZUGSWERTE: 12.00 80.00 70.00 60.00 10.00 400.00 6.00 0.00 W-FAKTOREN: 1.0 2.0 1.0 2.0 4.0 1.0 1.0 0.0
GERAET-NR: 5

	UPH	IPH	ID	I^2T	KID	KI^2T	UIT	EB	TS	TEB	TI	DEB	PEB	TPEB	T2	T3
	MS	MS	KA	10^4A^2S	%	%	KWS	V	MS	MS	MS	V/MS	KW	MS	MS	MS
STOSSNUMMER: / 3743 EIN - AUS RST																
R	0.30	6.07	19.42	168.64	63.8	26.1	24.06	463	0.0	12.0	12.0	63.59	6.681	6.6	0.0	3.9
S	2.93	8.70	20.44	168.91	70.0	27.8	19.05	266	0.0	8.7	8.7	53.33	4.664	5.1	0.0	3.0
T	6.27	2.04	11.08	42.48	29.6	52.7	16.45	403	0.0	12.6	12.6	29.72	4.280	8.7	0.0	3.0
BEFUND:																
STOSSNUMMER: / 3744 EIN - AUS RST																
R	6.00	1.77	8.30	38.84	23.5	32.9	11.95	506	0.3	11.4	11.7	35.67	3.474	8.7	0.6	5.1
S	9.93	5.70	20.35	145.64	37.8	24.4	26.80	469	1.5	9.6	11.1	78.89	7.284	5.1	0.3	5.4
T	2.37	8.14	20.06	172.02	48.8	26.9	15.81	201	0.0	9.0	9.0	45.78	3.826	5.4	0.6	4.5
BEFUND: I.O.																E
MITTELW:			16.64	129.42	48.9	31.8	19.02	385	0.3	10.5	10.8	51.16				
H																
REL. MW :			0.72	0.62	1.43	1.89	0.53	0.96		0.57		0.00	0.89			

ZUSTAND DES SCHALTGERAETES NACH DER PRUEFUNG:

ISOLATIONSWIDERSTAND R-U S-V T-W

HOCHSPANNUNGSPRUEFUNG 1 MIN 0,96 KV nicht 1.0 not Ok ←

GRENZWERTE KV DURCHHUB

R-S 4.2 U-V 5.4 R-U 3.4 RU-SV 4.4 R-HEBEL/ERDE 2.2 R R R R
S-T 5 V-W 2.2 S-V 4.4 SV-TW * S-HEBEL/ERDE 2.3 S S S S
R-T 5 U-W 2.3 T-W 4.7 RU-TW * T-HEBEL/ERDE 1.9 T T T T

* kein einschalten

THERMISCHER NENNSTROM: A GEHALTEN: JA NEIN

DABEI UEBERTEMPERATUR DER ANSCHLUSSKLEMMEN:

R S T

U V W

ABGESENKTER STROM : A GEHALTEN

Kriechstrom bei 480 V
mA

R-U 2.67
S-V 2.27
T-W 0.91
RU-SV 57.3
SV-TW 17.7
RU-TW 12.2

9409220164-01

STOSSANLAGE: 2 O N - L I N E C O M P U T E R A N A L Y S I S
DATUM : 23.11.87
VA-NR : 1349 TYPE: NZM6-100/ZM6-100

BESONDERE AENDERUNG DES GERAETES:
DECKEL AUS GSM 17.500 TROGAMID T ENTSPR. 1Z123-74.148 AUSF.2
EINSPEISUNG VON: OBEN GEHAEUSE: OHNE
PRUEFUNG NACH : IEC 157-1 P-1
SPANNUNG [V EFF]: 480.00 FREQUENZ: 50.00

STROM [KA EFF]: IK-R: 17.70 IK-S: 18.76 IK-T: 17.94 COSPHI: 0.24

MASSTAB: RBE[OHM]: 0.50 MUE[V]: 1000 MI[KA]: 50
BEZUGSWERTE: 12.00 80.00 70.00 60.00 10.00 400.00 4.00 0.00 W-FAKTOREN: 1.0 2.0 1.0 2.0 4.0 1.0 1.0 0.0
GERAET-NR: 4

	UPH	IPH	ID	I^2T	KID	KI^2T	UIT	EB	TS	TEB	TI	DEB	PEB	TPEB	T2	T3
	MS	MS	KA	10^4A^2S	%	%	KWS	V	MS	MS	MS	V/MS	KW	MS	MS	MS
STOSSNUMMER: / 3741 AUS RST																
R	0.30	6.07	19.87	176.27	64.2	27.3	24.07	443	0.0	12.0	12.0	53.57	6.665	6.6	0.0	4.5
S	2.93	8.70	19.91	163.13	67.5	26.8	18.20	262	0.0	8.4	8.4	51.19	4.371	5.1	0.0	2.7
T	6.27	2.04	11.37	62.72	30.4	52.9	16.36	413	0.0	12.6	12.6	47.28	4.476	8.7	0.0	3.0
BEFUND: VERKLINKUNGSSCHWIERIGKEITEN																
STOSSNUMMER: / 3742 EIN - AUS RST																
R	2.70	8.47	19.72	192.87	69.8	33.4	13.35	200	0.9	9.0	9.9	52.56	3.857	4.2	0.0	4.2
S	6.03	1.80	8.88	21.21	23.6	16.1	1.99	193	0.0	5.4	5.4	44.00	0.678	2.7	0.6	1.8*
T	9.97	5.74	19.03	129.97	36.9	20.8	24.28	494	1.5	7.5	9.0	125.83	7.172	4.2	0.3	4.2
BEFUND: I.O.																
MITTELW:			16.41	124.36	48.7	29.5	16.37	334	0.4	9.1	9.5	62.41				
REL. MW :			0.73	0.64	1.44	2.03	0.61	0.84		0.66		0.00	0.96			

ZUSTAND DES SCHALTGERAETES NACH DER PRUEFUNG:

ISOLATIONSWIDERSTAND R-U S-V T-W

HOCHSPANNUNGSPRUEFUNG 1 MIN 0,96 KV nicht i.O. not OK ←

GRENZWERTE KV DURCHHUB

R-S 4,7 U-V 800V R-U 3,9 RU-SV 2* R-HEBEL/ERDE 24V R R R R
S-T 4,8 V-W 6* S-V 2.2 SV-TW 1,1* S-HEBEL/ERDE 14V S S S S
R-T 5 U-W 17* T-W 3,9 RU-TW 38* T-HEBEL/ERDE 16° T T T T

Kriechstrom bei 480 V
mA

R-U 3,98
S-V 7,48
T-W 1,71
RU-SV 93,2
SV-TW 25,6
RU-TW 18,0

THERMISCHER NENNSTROM: A GEHALTEN: JA NEIN

DABEI UEBERTEMPERATUR DER ANSCHLUSSKLEMMEN:

R S T

U V W

ABGESENKTER STROM : A GEHALTEN

9409220164-02

STOSSANLAGE: 2   O N - L I N E   C O M P U T E R A N A L Y S I S
DATUM : 23.11.89
VA-NR : 1349   TYPE: NZM6-100/ZM6-100

BESONDERE AENDERUNG DES GERAETES:
DECKEL AUS SBM 17.500 TROGAMID T ENTSPR. 1Z123-74.148 AUSF.2
EINSPEISUNG VON: OBEN   GEHAEUSE: OHNE
PRUEFUNG NACH : IEC 157-1 P-1
SPANNUNG [V EFF]: 480.00   FREQUENZ: 50.00

STROM [KA EFF]: IK-R: 17.70   IK-S: 18.76   IK-T: 17.94   COSPHI: 0.24

MASSTAB: RB[KOHM]: 0.50   MU[V]: 1000   MI[KA]: 50
BEZUGSWERTE: 12.00 80.00 70.00 60.00 10.00 400.00 6.00 0.00   W-FAKTOREN: 1.0 2.0 1.0 2.0 4.0 1.0 1.0 0.0
GERAET-NR: 6

	UPH	IPH	ID	I^2T	KID	KI^2T	UIT	EB	TB	TEB	TI	DEB	PEB	TPEB	T2	T3
	MS	MS	KA	10^4A^2S	%	%	KWS	V	MS	MS	MS	V/MS	KW	MS	MS	MS
STOSSNUMMER: / 3745 EIN - AUS RST																
R	0.60	6.37	19.62	169.43	64.6	25.2	22.92	443	0.0	11.4	11.4	53.59	6.400	6.3	0.0	4.8
S	2.93	8.70	19.67	153.49	66.7	25.2	17.63	283	0.0	8.1	8.1	53.10	4.542	4.8	0.0	3.0
T	6.27	2.04	12.15	44.73	32.5	54.6	16.47	413	0.0	12.6	12.6	55.97	4.526	8.7	0.0	2.7
BEFUND:																
STOSSNUMMER: / 3746 EIN - AUS RST																
R	3.30	9.07	18.59	143.77	48.6	30.0	13.40	282	0.6	7.8	8.4	53.52	3.231	3.9	0.3	4.5
S	6.63	2.40	12.10	59.39	29.2	42.3	17.51	447	0.3	11.7	12.0	34.67	5.103	8.1	0.6	5.1
T	0.27	6.04	21.18	196.77	68.6	29.8	25.93	439	0.3	11.1	11.4	78.89	7.011	6.6	1.8	4.5
BEFUND: 1.O.																E
MITTELW: H			17.22	131.26	55.0	34.5	18.98	388	0.2	10.4	10.6	54.96				
REL. MW :			0.70	0.61	1.27	1.74	0.53	0.97		0.57		0.00	0.86			

ZUSTAND DES SCHALTGERAETES NACH DER PRUEFUNG:

ISOLATIONSWIDERSTAND   R-U   S-V   T-W

HOCHSPANNUNGSPRUEFUNG 1 MIN *0,96* KV *nicht 1.0 not OK* ←

Kriechstrom bei 480V

GRENZWERTE KV   DURCHHUB

R-S *3,8*	U-V *1k*	R-U *4,0*	RU-SV *1k*	R-HEBEL/ERDE *2k*	R	R	R	R
S-T *5,0*	V-W *1k*	S-V *3,0*	SV-TW *3k*	S-HEBEL/ERDE *1.5*	S	S	S	S
R-T *5,0*	U-W *1.5*	T-W *3,6*	RU-TW *4k*	T-HEBEL/ERDE *1.8*	T	T	T	T

R-U 2.94
S-V 2.47
T-W 0.47

RU-SV 56.7
SV-TW 17.9
RU-TW 18.7

THERMISCHER NENNSTROM: A GEHALTEN: JA NEIN

DABEI UEBERTEMPERATUR DER ANSCHLUSSKLEMMEN:

R S T

U V W

ABGESENKTER STROM : A GEHALTEN

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