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		☐ NON QUALITY	

EVALUATION OF POTENTIAL

HIGH VOLTAGE SOURCES INTO

UNIT 1 AND 2 COMPUTERS

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DCC15.0-A REV. 1

EVALUATION OF POTENTIAL HIGH VOLTAGE SOURCES INTO UNIT 1 and 2 COMPUTERS

1.0 SCOPE

The purpose of this SEA is to identify and evaluate potential high voltage sources which could migrate through the plant computers to safety-related systems and prevent these safety systems from meeting their minimum performance requirements. SEA-EE-181 and SEA-EE-182 evaluated the affects of potential high voltages developed from current transformers and potential transformers respectively. SEA-EE-180, SEA-EE-183, SEA-EE-184 and SEA-EE-221 evaluated the affects of impressed 120 VAC and 250 VDC voltages on safety-related systems connected to the computers. SEA-EE-204 evaluated the affects of potential high voltages developed from generator DC field circuits. The above potential voltage sources are not included in this SEA.

2.0 CONCLUSIONS AND RECOMMENDATIONS

2.1 CONCLUSIONS

The analysis in Section 5 of this SEA shows that there are no potential high voltage sources, which have not been previously evaluated, that could migrate through the plant computers to safety systems and prevent these safety systems from their minimum performance requirements.

High voltage cables (480 VAC and higher) are not potential sources since these cables do not come in contact with the computer input cables. Rotating machine and distribution transformer temperature sensors are not high voltage sources into the computer since one lead of these devices is connected to ground or through insulating film disc devices preventing high voltages from developing at the sensor outputs.

2.2 RECOMMENDATIONS

The present practice of connecting one lead of rotating machine and transformer temperature sensors directly to ground or through insulating film disc devices to ground should be continued. This assures that high voltages are not developed at the sensors output in the event the sensor insulation breaks down.

3.0 INPUTS AND ASSUMPTIONS

3.1 INPUTS

Current transformers, potential transformers and control raceway impressed voltage faults have been previously evaluated and are not included in this SEA.

Only in-plant electrical AC and DC systems are considered as potential high voltage sources to the computers.

No OFF-SITE transients are considered in this SEA.

All Class 1E and non-Class 1E potential high voltage sources are to be evaluated.

This study covers inputs to the Units 1 and 2 computers.

3.2 ASSUMPTIONS

This study is based on as-built drawings and documents issued as of the date of task initiation.

4.0 METHOD

The AC and DC systems were reviewed to determine potential high voltage sources into the computer.

The results of this review were examined to determine which sources were previously evaluated.

The Susquehanna SES Units 1 and 2 Computer I/O Specification Listing dated November 8, 1989 was reviewed to identify computer points which could be high voltage sources.

The identified computer point input circuits were evaluated to determine if these devices are potential high voltage sources into the computer and their impact on Class 1E circuits connected to the computer.

5.0 RESULTS

The results of the review of in-plant AC and DC systems showed that the only potential high voltages into the computer which have not been previously evaluated are:

- o High voltage cable faults (i.e. 480 VAC and higher).
- o Temperature sensing devices from rotating machines and distribution transformer windings (i.e. RTD's and thermocouples).

The high voltage cables are not potential voltage sources into the plant computer since these cables run in different and separate raceway systems than the computer input cables and do not come in contact with the computer cables.

The 480 VAC cables and computer input cables could be in close proximity in motor-control centers, motor-operated valves and terminal boxes. In the event 480 VAC cables bridge to computer cables, the resulting impressed voltages could be 277 VAC. This is the expected voltage since the computer cable shields are grounded, thus an impressed voltage fault is phase to ground (277 VAC). The affects of this magnitude fault are the

same as analyzed in SEA-EE-180, SEA-EE-183, SEA-EE-184 and SEA-EE-221. Therefore, further consideration for these faults is not required.

The computer points derived from rotating machine and distribution transformers RTD's and thermocouples are listed in Attachment 1. All of these temperature sensors have one lead connected directly to ground or connected to ground through insulating film disc devices. The direct connections hold the sensors at ground potential at all times assuring that high voltages are not developed at their outputs. (See attached GEI-50930B, Pgs. 1 and 2). The insulating film disc devices are designed to function by electrically breaking down the disc dielectric reducing the sensor to ground potential if the potential at the sensor attains a valve above a predetermined safe value. (See attached GEK 7605A and GEI 74417C). This value is well below that considered safe for instruments.

Thus, the physical connections of the RTD's and thermocouples prevent high voltages from developing on their outputs. Therefore, these devices are not high voltage sources to the computer and evaluation of the Class 1E circuits connected to the computer does not require further consideration.

6.0 REFERENCES

6.1 SEA-EE-180, Rev. 0.

6.2 SEA-EE-181, Rev. 1.

6.3 SEA-EE-182, Rev. 0.

6.4 SEA-EE-183, Rev. 0.

6.5 SEA-EE-184, Rev. 0.

6.6 SEA-EE-221, Rev. 0.

6.7 Susquehanna SES Units 1 and 2 I/O Specification Listing, dated November 8, 1989.

6.8 IOM 78 RHR Motors.

6.9 IOM 527 Core Spray Motors.

6.10 IOM 119 Turbine Generator.

6.11 SEA-EE-204, Rev. 1.

ATTACHMENT 1

UNITS 1 & 2 COMPUTER POINT	DESCRIPTION	TYPE DEVICE
AET 21	ESWS PP Motor A Stator Temp.	RTD
AET 22	ESWS PP Motor B Stator Temp.	RTD
AET 23	ESWS PP Motor C Stator Temp.	RTD
AET 24	ESWS PP Motor D Stator Temp.	RTD
GHT 11	Generator Stator Slot Temp.	RTD
GHT 12	Generator Stator Slot Temp.	RTD
GHT 13	Generator Stator Slot Temp.	RTD
GHT 14	Generator Stator Slot Temp.	RTD
GHT 15	Generator Stator Slot Temp.	RTD
GHT 16	Generator Stator Slot Temp.	RTD
GHT 17	Generator Stator Slot Temp.	RTD
GHT 18	Generator Stator Slot Temp.	RTD
GHT 19	Generator Stator Slot Temp.	RTD
GHT 20	Generator Stator Slot Temp.	RTD
GHT 21	Generator Stator Slot Temp.	RTD
GHT 22	Generator Stator Slot Temp.	RTD
GNT 04	Generator Hi-Volt Bush Temp.	T/C
GNT 05	Generator Hi-Volt Bush Temp.	T/C
GNT 06	Generator Hi-Volt Bush Temp.	T/C
GNT 07	Generator Hi-Volt Bush Temp.	T/C
GNT 08	Generator Hi-Volt Bush Temp.	T/C
GNT 09	Generator Hi-Volt Bush Temp.	T/C
GET 01	Alternator Slot Temp.	RTD
GET 02	Alternator Slot Temp.	RTD
GET 03	Alternator Slot Temp.	RTD
GET 04	Alternator Slot Temp.	RTD
GET 05	Alternator Slot Temp.	RTD
GET 06	Alternator Slot Temp.	RTD
CPT 10	CP Motor A Stator Temp.	RTD
CPT 20	CP Motor B Stator Temp.	RTD
CPT 30	CP Motor C Stator Temp.	RTD
CPT 40	CP Motor D Stator Temp.	RTD
WCT 10	CWP Motor A Stator Temp.	RTD
WCT 20	CWP Motor B Stator Temp.	RTD
WCT 30	CWP Motor C Stator Temp.	RTD
WCT 40	CWP Motor D Stator Temp.	RTD
NDT 01	CRD PP Motor A Stator Temp.	RTD
NDT 02	CRD PP Motor B Stator Temp.	RTD

ATTACHMENT 1

UNITS 1 & 2 COMPUTER POINT	DESCRIPTION	TYPE DEVICE
NHT 05	RHR PP Motor A Stator Temp.	RTD
NHT 06	RHR PP Motor B Stator Temp.	RTD
NHT 07	RHR PP Motor C Stator Temp.	RTD
NHT 08	RHR PP Motor D Stator Temp.	RTD
NST 01	C Spray PP Motor A Stator Temp.	RTD
NST 02	C Spray PP Motor B Stator Temp.	RTD
NST 03	C Spray PP Motor C Stator Temp.	RTD
NST 04	C Spray PP Motor D Stator Temp.	RTD
YTT 03	SUXFRMR 10 Temp.	RTD
YTT 04	SUXFRMR 20 Temp.	RTD
YTT 06	ESSXFMR 101 Temp.	RTD
YTT 07	ESSXFMR 201 Temp.	RTD
YTT 16	ESSXFMR 111 Temp.	RTD
YTT 17	ESSXFMR 211 Temp.	RTD
YTT 01	MNXFMR 1A Temp. (2A)	RTD
YTT 02	MNXFMR 1B Temp.	RTD
YTT 05	UNIT AUX XFMR (12)	RTD
YTT 08	MNXFMR 2B Temp.	RTD
YTT 09	MNXFMR 2C Temp.	RTD

jpa/msc004i(17)

RESISTANCE TEMPERATURE DETECTORS

DESCRIPTION

A resistance temperature detector (RTD) is a resistance element, usually made of copper, and adjusted to 10 ohms at 25 C. Operation of the RTD is based on the principle that the electrical resistance of a metallic conductor varies linearly with its temperature.

APPLICATION

The RTD and its associated equipment is designed for use with generators, transformers, and other apparatus to determine winding, gas, and liquid temperatures. The equipment consists of two parts: the switchboard equipment which usually includes a temperature meter, test resistor, transfer switch, and leads; and the machine equipment which usually includes the resistance temperature detectors, leads, and terminal block with grounding connections.

A typical circuit utilizing the RTD is shown in Fig. 1. That part which is to the right of the dotted line is the Temperature Meter which is outside the machine, and that part to the left is the RTD located inside the machine. Part of the circuit is a Wheatstone Bridge which consists of the RTD as one arm and three fixed resistors of negligible temperature coefficient as the other three arms. The bridge is excited by a constant d-c potential which is obtained through a constant voltage transformer and a copper oxide reactifier. A d-c milliammeter is connected across corners of the bridge. The reading of this instrument depends on the current flowing through it, and this current depends only on the resistance of the RTD (since the other resistances of the bridge are fixed.) The resistance of the RTD depends upon its temperature and thus the scale of the d-c milliammeter is calibrated directly in degrees. The temperature of the RTD then, (which is the approximate temperature of armature windings of a generator, for example) is indicated by the d-c milliammeter.

In order to prevent any change in lead resistance (due to ambient temperature change) from affecting the temperature meter, the RTD is connected in the circuit so that there is equal lead resistance in two ratio arms of the Wheatstone Bridge. Redrawing Fig. 1 with the lead resistance included (Fig. 2), it can be seen that the lead resistance from "A" to the detector element is in one arm and lead resistance from "B" to the other side of the detector element is in the other arm. Any change in these lead resistances will appear in the two arms and the net effect will be no change in current through the d-c milliammeter. It is common practice to ground one lead of each RTD, because it is recognized that a

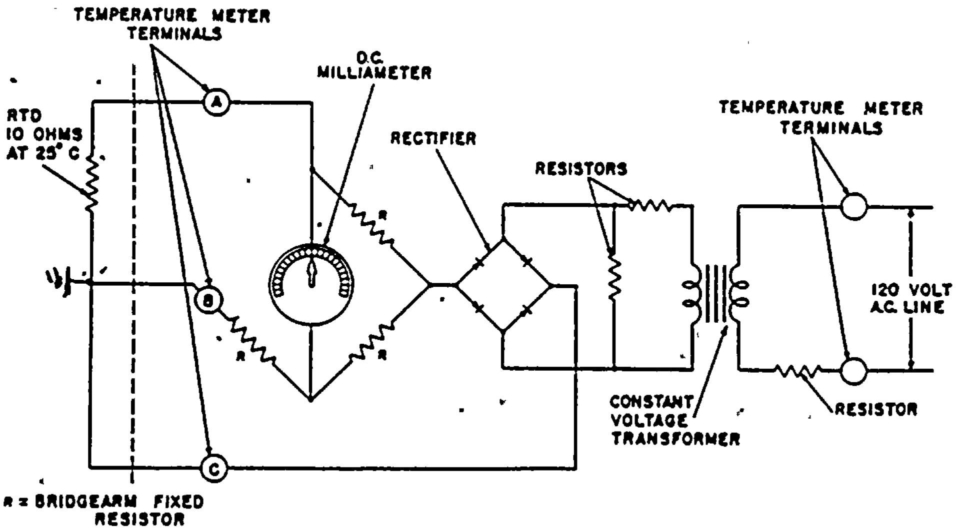


Fig. 1. RTD and temperature meter circuit (124C909)

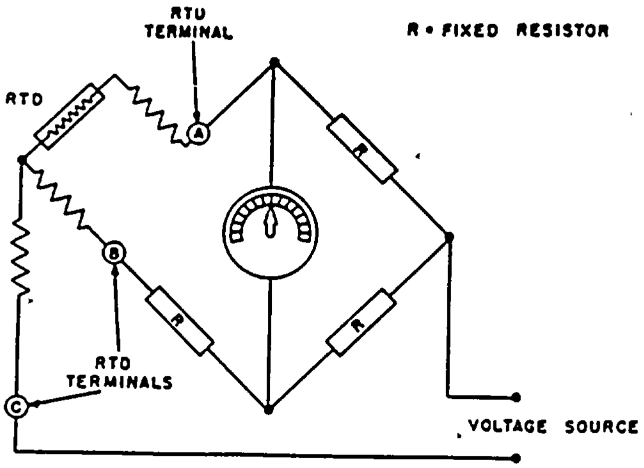


Fig. 2. RTD and Wheatstone Bridge circuit (762A123)

breakdown in stator coil insulation to an RTD element in a machine is possible. The RTD's are thus held at ground potential at all times assuring the safety of an operator The "B" lead is usually the one which is grounded on a generator. This makes it possible to connect all the "B" leads to a common grounding strip at the terminal board on the generator, and run a single lead from this strip to the temperature meter. See Fig. 3. The leads from the RTD's are brought out to the terminal board in sheathed cable and conduit to protect them from physical damage and from contact with high-voltage coils.

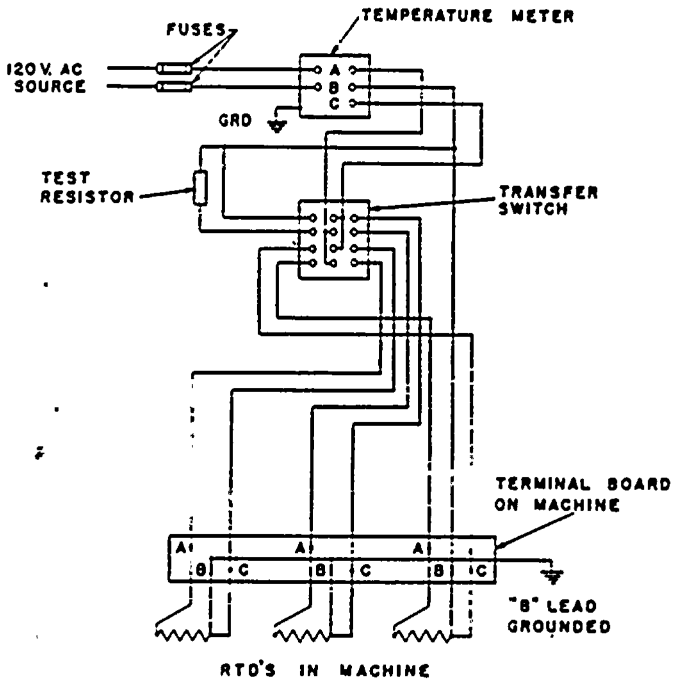


Fig. 3. RTD connections (124C908)

A test resistor is usually provided for periodically checking the calibration of the temperature meter. This resistor has a value of resistance of 11.73 ohms, which corresponds to the resistance of a detector at a temperature of 70 C. A transfer switch is used to connect the temperature meter to any one of several detectors in the machine. The design is such that the contacts are opened and closed in proper sequence when transferring from one detector to another. Another position connects to the calibrated test resistor to check the temperature meter at the 70-degree point. The construction of RTD's is shown in Fig. 4. Each detector has three leads designated as "A," "B," and "C." The resistance of the element itself is the total resistance from "A" to "B" or "A" to "C" minus the lead resistance "B" to

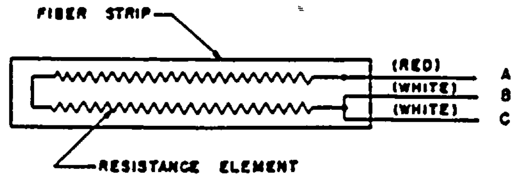


Fig. 4. RTD construction (762A122)

"C." The detectors are made in three principal types: the molded strip for installation in stator slots next to the winding of rotating machines, the sheath type for installation in air ducts, and the immersion type for use in liquids.

MOLDED-STRIP TYPE

The resistance wire of these detectors is molded into a fiberglass strip which is approximately 1/16-in. thick and trimmed to slot width. All molded-strip detectors are noninductively wound to cancel the extraneous voltage induced in them.

Molded-strip detectors are used in generators to detect the approximate temperature of armature coils and are known as "coil RTD's." They are located between coil sides in the slot and in the air or hydrogen discharge section of the stator where they will detect the highest temperatures. For reference to the slots in which each RTD is located, and the axial position in the slots, see the RTD portion of the connection outline. In some cases the connection outline contains instructions concerning which coil RTD's should be connected to the temperature meter. The remaining ones are reserved as spares to be used in the event that any of the other RTD's become inoperative.

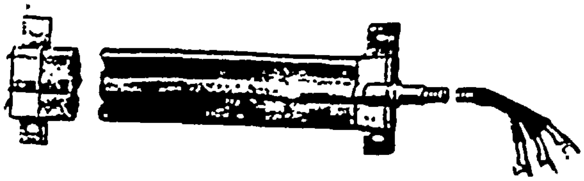


Fig. 5. Sheath-type RTD
(1026247)

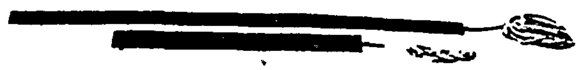


Fig. 6. Molded strip-type RTD
(581353)

Coil RTD's <u>do not</u> detect copper temperature. The reason is that there is a temperature drop from the copper to the RTD through the coil insulation. The RTD temperature may be 5 to 10 C lower than copper temperature in smaller machines, and may be as much as 30 C lower in the larger machines. The temperature difference is affected by the following variables:

1. insulation thickness
2. slot width
3. cooling medium (air or hydrogen)
4. hydrogen pressure (slightly)
5. armature current

A further discussion of this subject can be found in A.I.E.E. paper No. 55-118 entitled "Turbine-Generator Stator Winding Temperatures at Various Hydrogen Pressures" by J. R. M. Alger, C. E. Kilbourne and D. S. Snell.

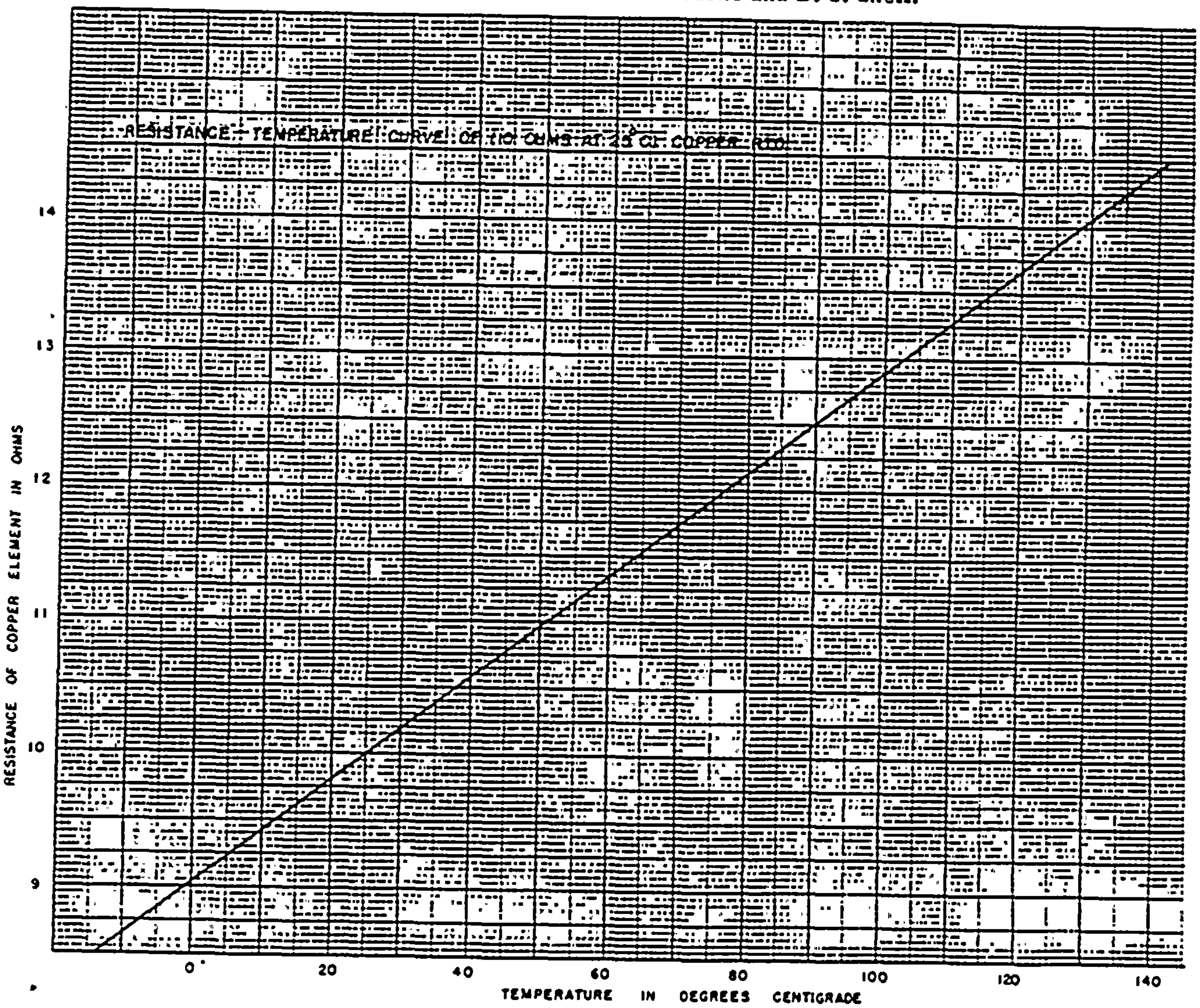


Fig. 7. Resistance temperature curve of copper RTD
(10 ohms at 25 C)

SHEATH TYPE

This detector is contained in a copper housing which provides a convenient means of attaching the unit to the stator frame.

Sheath detectors may be used in generators to detect air or hydrogen temperature. They are normally provided on all machines with internal water-to-gas heat exchangers and on other machines upon request by the customer. On smaller generators there is usually one RTD at the discharge side of each cooler. On larger machines, and whenever requested, there are two RTD's in each cooler; one at the inlet side of the cooler, and the other at the discharge side.

Sheath-type RTD's may be used to determine effectiveness of the air or hydrogen coolers. They detect the average temperature of the air or hydrogen stream in which they are located.

GENERAL ELECTRIC

3-75 (1M)

TERMINAL BOARD WITH PROTECTIVE DEVICE FOR TEMPERATURE METER

The terminal board, Fig. 1, consists essentially of the insulating disk film cutouts (42), a grounding strip (37), connection terminal (38) and contact clips (41). The contact clips connect with the leads from the temperature detectors and temperature meter and hold the disk film cutout against the grounding strip. Part (46) serves as a ground connection and also as a stud for attaching the protective device to its grounded support on the stator frame.

The function of the protective device is to protect the temperature meter and the switchboard operator in the event that a dangerous potential should be given accidentally to any or all of the temperature detectors which are located in the generator armature core. This is accomplished by the breaking down of the insulating disk film cutouts, bringing the detector or detectors to ground potential.

The insulating disk film cutout consists of two thin aluminum disks separated by a copper-oxide film, the latter having such a dielectric strength that its puncture voltage is well below that considered safe for indicating instrument.

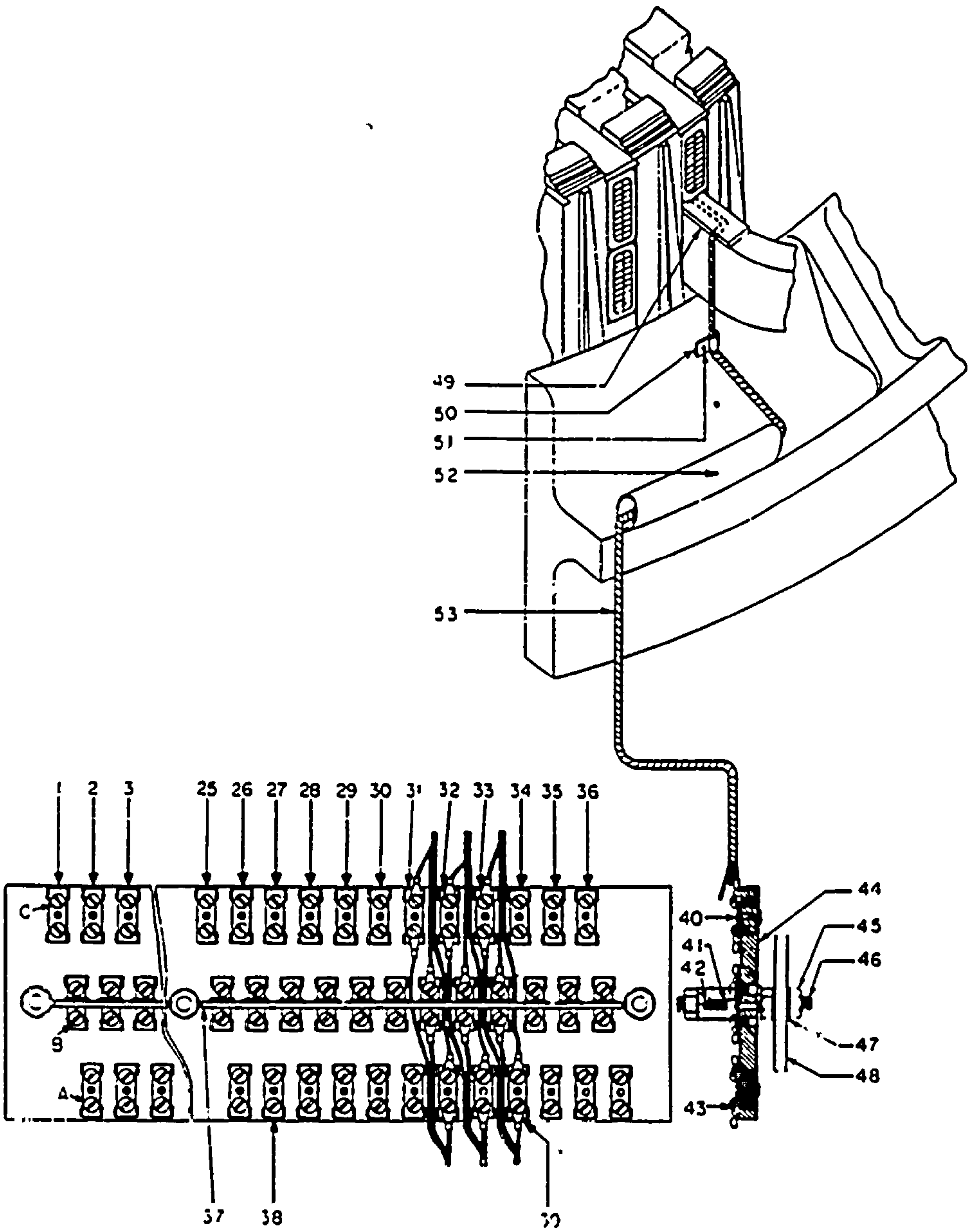
The leads from the temperature detectors are connected with the leads from the temperature meter through the connection terminal (38). The "A" (red) leads from the temperature detectors and the temperature meter are connected to the "A" connection terminal, while the remaining leads from each temperature detector and the temperature meter are connected to the "B" and "C" connection terminal.

OPERATION

If the potential of any temperature detector should attain a value above the predetermined safe value, through a failure of the armature coil insulation, the insulating film of the cutout for this detector would break down, thus reducing the potential of the detector to ground potential.

CARE

Under ordinary conditions the protective device requires no attention. However, if a breakdown of an insulating disk film cutout should occur, the cutout must be replaced before further temperature readings can be taken. After correcting the condition leading to the breakdown, replace the damaged disk film cutout with a new one.



NOMENCLATURE

1 - 36 Typical connectors for resistance temperature detectors - ungrounded type
37 Grounding strip
38 Connection terminal
39 Lead terminal
40 Rivet semi-tubular
41 Contact clip
42 Disk cutout
43 External tooth washer
44 Base
45 Nut for stud
46 Support stud
47 Washer
48 Mounting bracket
49 Temperature detector located in armature slot
50 Lead support
51 Screw hole
52 Conduit pipe
53 Armored leads

Fig. 1. Terminal board for resistance temperature detectors—ungrounded type
Dwg. 871D420

GENERAL ELECTRIC

TERMINAL BOARD WITH PROTECTIVE DEVICE FOR THERMOCOUPLES

DESCRIPTION

The terminal board, Fig. 1 (see other side), consists essentially of the insulating disk film cutouts (41), a grounding strip (37), connection strips (1-36), and contact clips (40). The latter connect with the leads from the temperature detectors and temperature meter and hold the disk film cutout against the grounding strip. The various parts are contained within a dust-tight metal box. Part (42) serves as a ground connection and also as a stud for attaching the protective device to its grounded support on the stator frame.

The function of the protective device is to protect the temperature meter and the switchboard operator in the event that a dangerous potential should be given accidentally to any or all of the temperature detectors which are located in the generator armature core. This is accomplished by the breaking down of the insulating disk film cutouts, bringing the detector or detectors to ground potential.

The insulating disk film cutout consists of two thin aluminum disks separated by a copper-oxide film, the latter having such a dielectric strength that its puncture voltage is well below that considered safe for the indicating instrument.

The leads from the temperature detectors are connected with the leads from the temperature meter through the connection terminal (1-36). See Table I for color-coded connection instructions.

OPERATION

If the potential of any temperature detector should attain a value above the predetermined safe value, through a failure of the armature coil insulation, the insulating film of the cutout for this detector would break down, thus reducing the potential of the detector to ground potential.

CARE

Under ordinary conditions the protective device requires no attention. However, if a breakdown of an insulating disk film cutout should occur, the cutout must be replaced before further temperature readings can be taken. After correcting the condition leading to the breakdown, remove the cover of the protective device by removing the nuts from the studs (42), and replace the damaged disk film cutout with a new one.

NOMENCLATURE

1-36	Typical connectors for thermocouples
37	Grounding strip
38	Connection terminal
39	Lead terminal
40	Contact clip
41	Disk cutout
42	Stud
43	Rivet
44	External tooth washer
45	Washer
46	Nut
47	Mounting support
48	Terminal board
49	Thermocouple located on flange shield
50	Screw
51	Lead support
52	Thermocouple lead

TABLE I

Type	-"B" Terminal	-"A" Terminal
Copper-Constantan	Blue	Red
Iron-Constantan	White	Red
Chromel-Constantan	Purple	Red
Chromel-Alumel	Yellow	Red

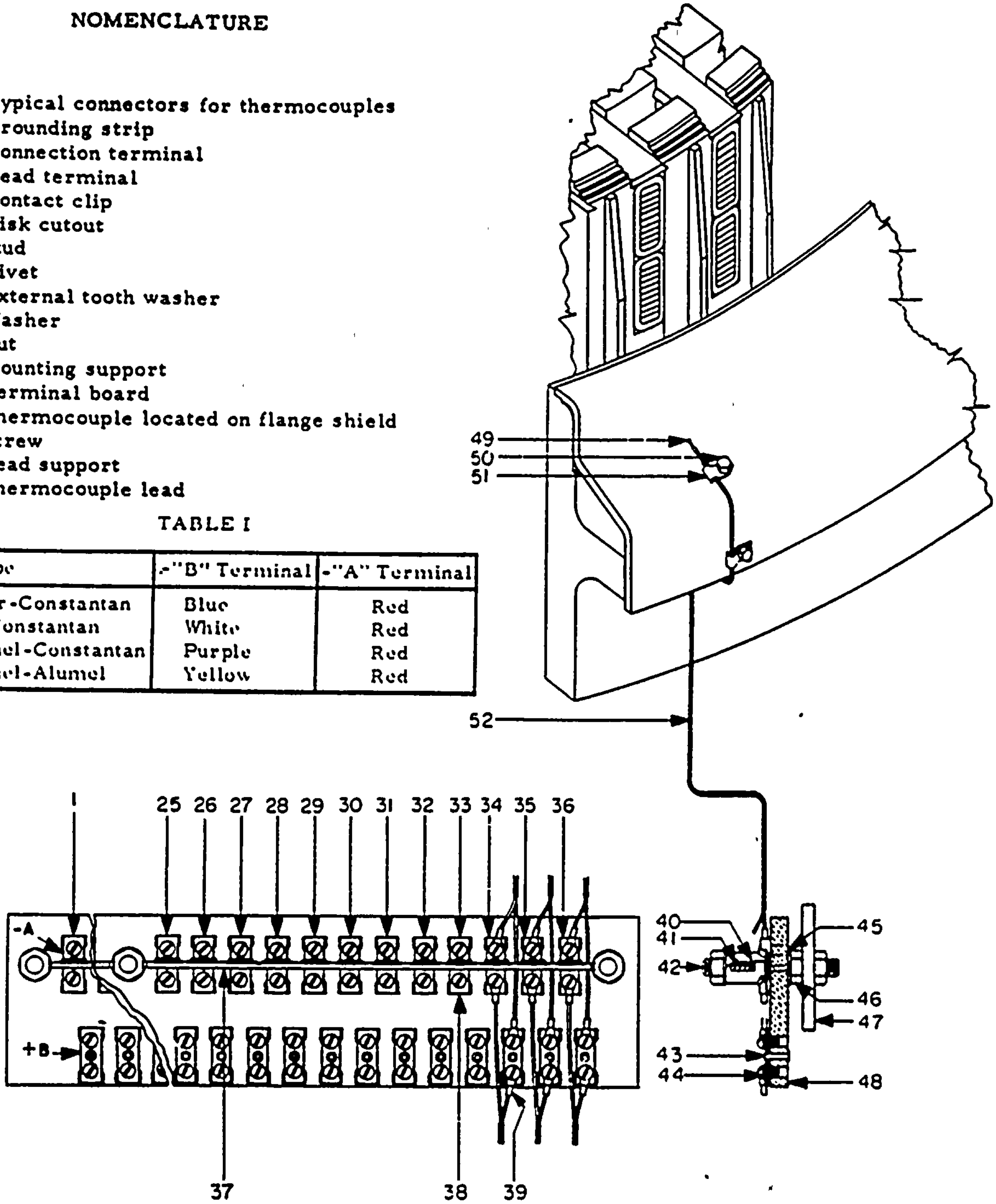


Fig. 1. Terminal board
(Dwg. 871D588)

NRCAN

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