13-960320-CLN-01

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SUBJECT: CENTER STACK ELECTRICAL INSULATION AND GROUNDING

The following figure depicts the various conducting and insulating elements in the center stack. These are:

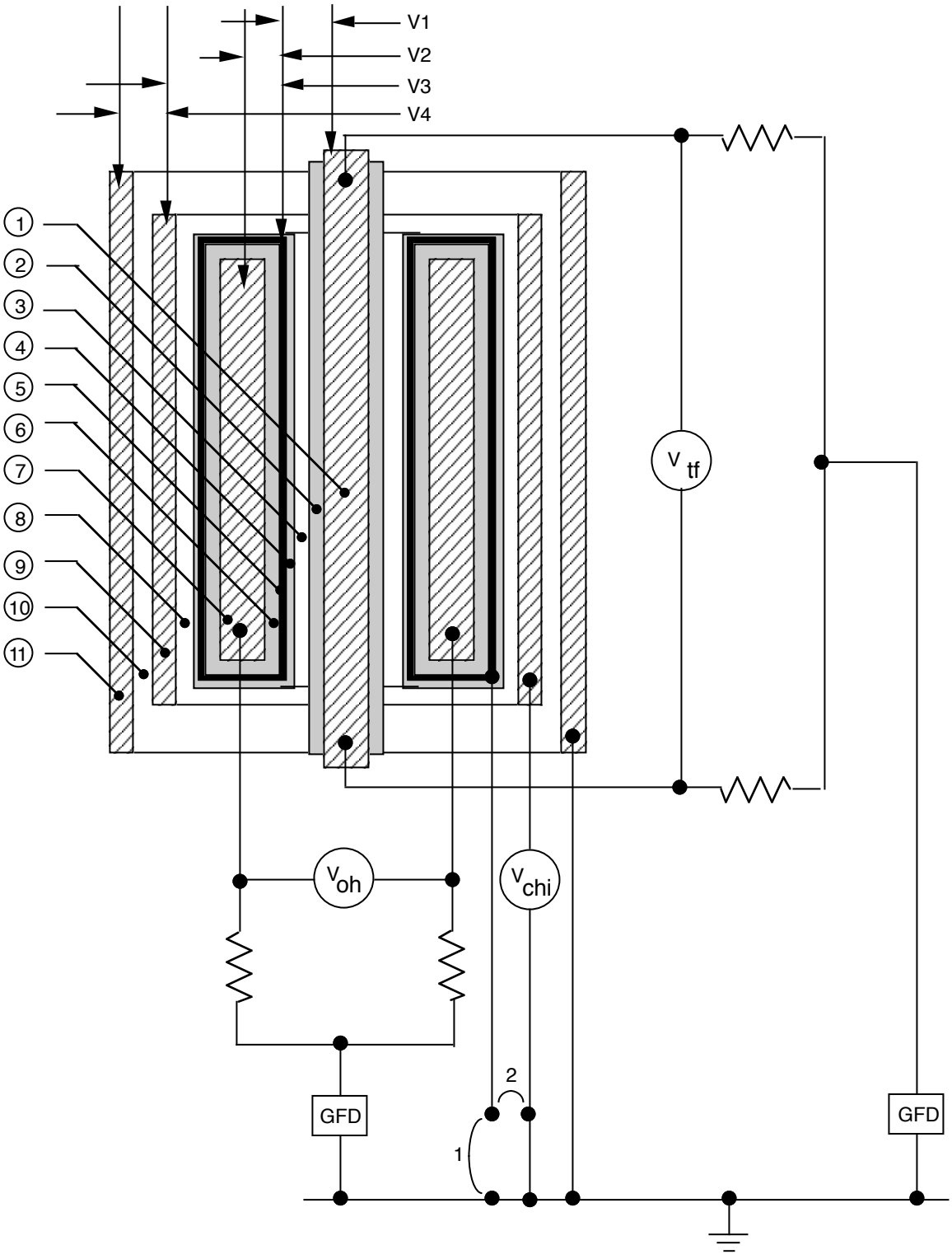
1 - TF inner leg conductors
2 - TF groundwall insulation
3 - air gap
4 - OH outer protective wrap
5 - OH electrostatic shield, a.k.a. ground plane
6 - OH groundwall insulation
7 - OH conductor
8 - gap filled with Microsil
9 - center stack casing
10 - ceramic break between center stack casing and vacuum vessel
11 - vacuum vessel

The three power circuits involved are the TF, OH, and CHI. The TF and OH can be grounded through a resistor network and ground current sensor, which means that a single fault between these circuits and ground can be current limited, detected, and non-destructive. The CHI power supply will apply a voltage between the center stack casing and the outer vacuum vessel. Since the outer vacuum vessel must be solidly grounded (various appendages to the vessel will depend on this, I suppose) a single fault between the center stack casing (the (+) CHI electrode) and ground will not be current limited.

The maximum power supply voltages are listed in the following table).

Circuit	**Vmax operating**
	(kV DC)
TF[1]	1.5
OH[2]	10.0
CHI[3]	1.0

[1]Based on 2 series C-site MG @ 750V each
[2]Estimate
[3]Based on NSTX Physics Validation Review, Blue Book viewgraphs from T. Jarboe



General practice calls for the use of electrostatic shields for operating voltages > 5kV; thus only the OH coil is shown with a shield.

The voltage impressed across the insulating elements depends on the status of the OH electrostatic shield. Two possible cases are considered herein (jumpers 1 and 2 shown on figure). In Case 1 the OH electrostatic shield is grounded, and in Case 2 it is tied to the potential of the center stack.

The following table indicates the voltage stresses V1, V2, V3, and V4 for the two cases, assuming the maximum addition of power supply voltages:

	Insulation	**Case1**	**Case 2**
		(kV DC)	(kV DC)
V1	TF groundwall + air gap + OH outer wrap	1.5	2.5
V2	OH groundwall	10.0	11.0
V3	OH outer wrap + Microsil	1.0	0.0
V4	Ceramic break	1.0	1.0

With regard to faults, the failure of an insulating barrier which holds off the CHI power supply voltage could be destructive. In Case 1 this failure would result in damage to the OH coil outer wrap and electrostatic shield. In Case 2 this failure would result in damage to the OH groundwall insulation. In either case it may be possible to make the connection of the electrostatic shield slightly resistive so as to limit fault current flow but not negate the shielding effect, but this remains to be demonstrated.

Based on the above considerations it seems that the Case 1 connection is favorable, even though it depends on the outer wrap of the OH coil to withstand voltage.

Assuming that the OH electrostatic shield is grounded, the recommended hipot voltage for the various insulating elements (based on the 2E+1kV rule) would be as indicated in the following table.

Insulation	**Hipot**
	(kV DC)
TF groundwall	4.0
OH groundwall	21.0
OH outer wrap	3.0
Ceramic break	3.0

cc:

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