22-010524-CLN-01

TO: DISTRIBUTION
FROM: C NEUMEYER
SUBJECT: RECOMMENDATIONS TO ENHANCE RELIABILITY OF CHI

This memo presents recommendations for equipment and procedural changes to reduce the probability of compromises to the inner and outer vacuum vessel electrical integrity.

Equipment Changes

1) The TFTR ground monitoring system should be implemented on NSTX ASAP. This system uses transformer coupling to induce a small AC voltage between 90 and 250Hz on the ground circuit. A transformer coupled phase detector is used to sense current flow can detect ground faults with impedance as high as 250Ω. A horn is sounding on detection of a ground fault. In addition, a tracer wire is connected to a automatic circuit which places a second ground on the system on a periodic basis which tests the system and confirms continuity of the main ground. The system consists of 28 channels, each operating at a particular frequency, and includes a supervisory PLC. For NSTX, only two channels are required (one for the inner vessel, one for the outer), and the PLC is not required. If possible, it would be desirable to increase the sensitivity above 250Ω.

2) Modifications should be made to the CHI circuitry to facilitate hipot testing between the inner and outer vacuum vessel. The existing system is shown in figure 1. There are several features which prevent its effective use:

- The lopot scheme can only test both lines to ground, not line to line. Line to line testing is very important for CHI, because a fault at the machine would lead to extensive damage to the NSTX vacuum vessel;
- The presence of the 1kV surge suppressors, connected line to line, limits the ability to test above the nominal 1kV power supply level, which is required to demonstrate a voltage withstand margin;
- The presence of the CHI voltage divider which measures the voltage between inner and outer vacuum vessel limits the ability to measure the insulation resistance between the inner and outer vacuum vessel.

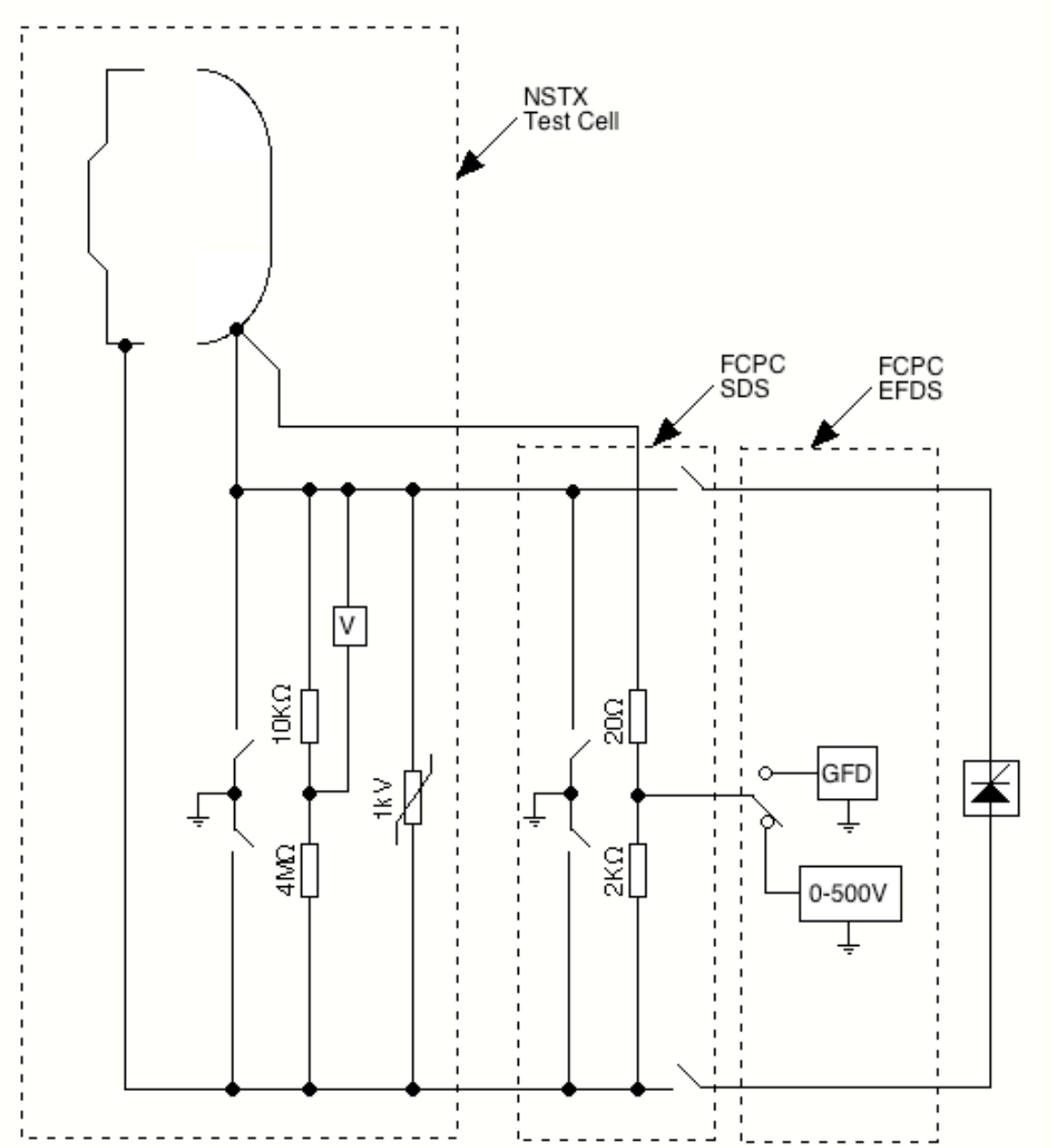

Figure 1 – Existing CHI Grounding

The modifications are shown in figure 2. They consist of:

- Addition of new cable from CHI SDS to EFDS cabinet such that the terminal of each grounding resistor is available in the EFDS;
- Addition of two new HV contactors (e.g. Ross type) in the EFDS such that each line can be selected individually for hipot;
- Restoration of 3kV capability at the EFDS hipot tester;
- Reconfiguration of the surge arresters in the NTC for 3(+Δ)kV conduction voltage;
- Addition of a new HV contactor (e.g. Ross type) in the NTC, under control via the FCPC EFDS cabinet, which can disconnect the CHI voltage divider during hipot test.

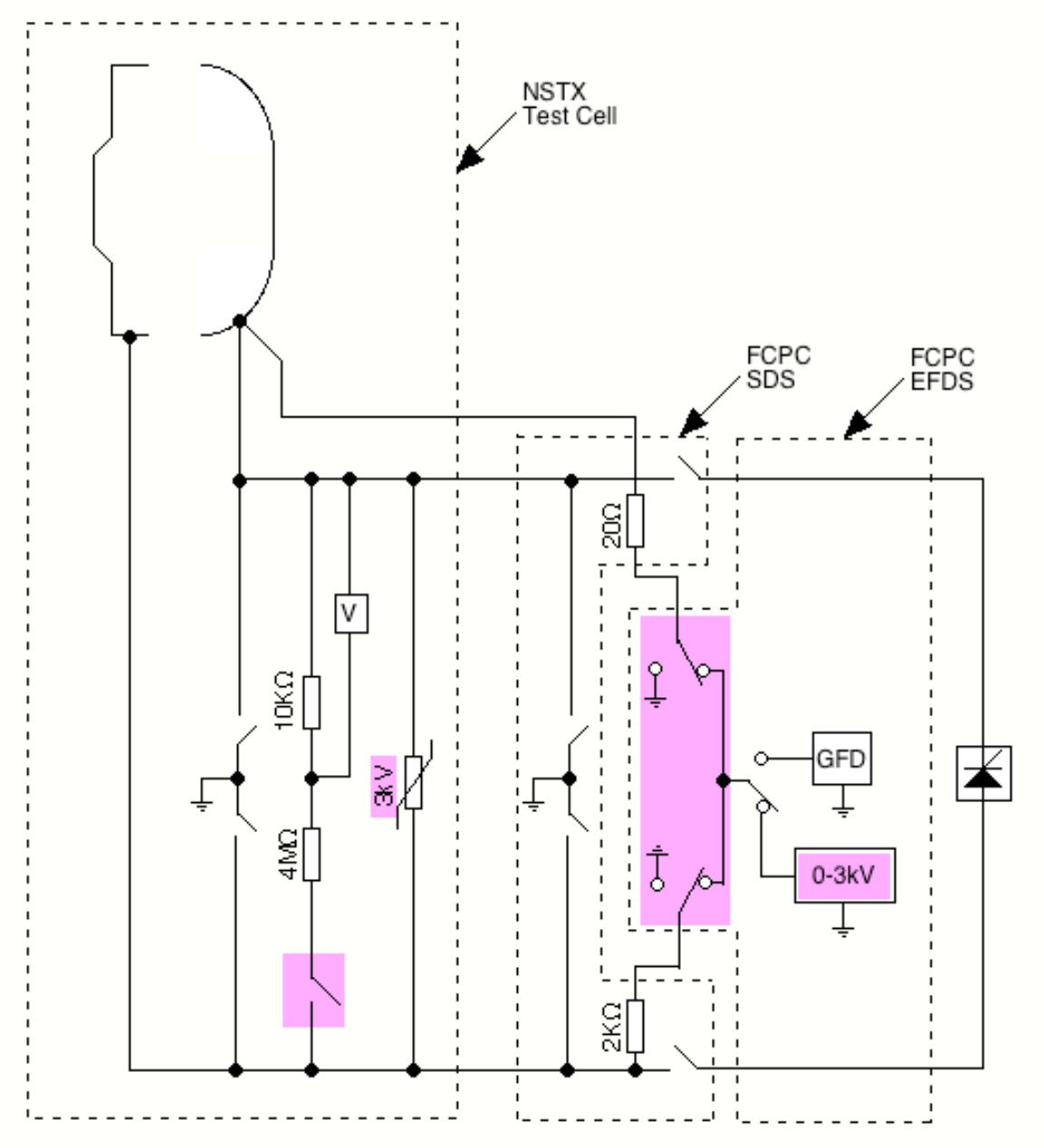

Figure 2 – Proposed CHI Grounding

Using the revised scheme, the CHI system can be tested at any time, without accessing the SDS cabinets and breaking connections, without breaking the voltage divider or surge arresters connections in the test cell, at suitable voltage levels, e.g. 3kV on the inner vessel with the outer grounded, and 500V on the inner and outer vessel combined. The test at 3kV is especially important as it demonstrates the line to line electrical integrity with standard margin over operating voltage.

The increase of the arrester level from 1kV to 3(+Δ)kV will retain adquate protection, considering that the system is designed to withstand 5kV.

At the 3kV level, if the EFDS hipot tester accidentally rises to that level during test of another system, it would not be catastrophic, since all systems are designed for testing at ≥ 3kV, including TF. If necessary, surge arresters can be installed in the EFDS cabinet to cover this failure mode.

3) Identification Scheme

A color identification system should be established in the test cell to aid in the identification of compnents (cables, tray, racks) associated with the critical Class III and Class IV systems.

Procedural Changes

1) With the proposed changes, the CHI system should be tested, via the EFDS cabinet, both line to line and line to ground, more frequently, and certainly prior to any CHI operation following a period of test cell access. Administrative procedures should be revised to reflect the latter requirement. Now that the local grounding switch has been installed in the NTC, the local grounding cable on the outer vessel and the jumper between ring bus bars, and the removal of flex links, can be dispensed with. If this is done, then the line to line and line to ground test can be done every run day along with the regular coil lopots.

2) Installation procedures should include a review by someone identified as a "grounding czar" for sign-off prior to, and after, installation. In general, more

3) The importance of voltage isolation of components in contact with the inner and outer vacuum vessel needs to be emphasized to all project participants, perhaps via a training session. Information concerning same should be given to visiting collaborators.

4) COEs and machine techs should become more aware of controlled access activities in the NTC, escorting personnel when possible, and inspecting work after its completion, keeping in mind issues of voltage isolation, magnetic materials, etc.. Perhaps a logbook should be stationed at the NTC door in which accessors can note time and date of entry and work performed. Then any work performed after hours can be inspected the next day.

cc:

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NSTX File