

## ASSESSMENT OF APPLICABILITY OF 10CFR830, SUBPART B TO NSTX WITH PLANNED UPGRADES

### REFERENCES:

1. Letter, J. Makiel (DOE-PSO) to A. Cohen (PPPL), "Hazard Assessment for the National Spherical Torus Experiment (NSTX) Upgrade Project", 5/20/09.
2. Letter, J. Levine (PPPL) to J. Faul (DOE-PSO), "Assessment of PPPL Radionuclide Inventories for Applicability of 10CFR830, Subpart B", 3/9/09.

Reference 1 requested an assessment of the planned major item of equipment (MIE) project for upgrades to NSTX with respect to its current status as a Below Hazard Category 3 facility. These planned upgrades consist of the installation of a new center stack (CS), and installation of a second neutral beam injector (NBI). Reference 1 asked that this assessment be performed considering the two components of the MIE project in aggregate, as well as individually. In addition, any impacts from other planned NSTX modifications outside the MIE project (none are known that would impact this assessment), as well as operational considerations involving experimental run time should be considered.

In March 2009, an assessment of existing PPPL radionuclide inventories, including those associated with NSTX, was performed to determine the status of the Laboratory with respect to 10CFR830 Subpart B applicability (i.e., to identify any Category 3 nuclear facilities). In that assessment, which was documented in Reference 2, the nuclear facility hazard categorization methodology of DOE-STD-1027-92 ("Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports", Change Notice No. 1) was used. In particular, this methodology requires that facilities or facility segments where there are combinations of radioactive materials should be designated as Category 3 if the sum of the ratios of the quantity of each material to the Category 3 thresholds in Table A.1 of the Standard exceeds one (e.g., [inventory of isotope A/threshold of isotope A] + [inventory of isotope B/threshold of isotope B] + [inventory of isotope n/threshold of isotope n] >1). Facilities designated as Category 3 must comply with the applicable requirements of 10CFR830, Subpart B. The Reference 2 assessment determined that PPPL has no facilities that would be designated Category 3 (or higher) nuclear facilities.

The NSTX experiment generates 2.5 MeV neutrons through the fusion of deuterium fuel, which results in activation of materials in nearby components including the torus vacuum vessel, center stack, support structure, and external poloidal field (PF) and toroidal field (TF) coils. Table 1, which is reproduced from Reference 2, provides the sum of the activities of each NSTX activation isotope (assuming approximately a year's worth of current NSTX generation of  $1E17$  neutrons), comparisons with the Category 3 thresholds, and summation of the radionuclide threshold ratios. As indicated in Table 1, the summation of NSTX radionuclide threshold ratios that determines nuclear facility status is dominated by three short-lived isotopes; Na-24, Mn-56, and Cu-64. These isotopes contribute 98.3% of the summation total, with Mn-56 alone representing 84.4% of the contribution. Thus, this assessment of the impacts of the MIE project on nuclear facility status focuses on these three principal radionuclides.

Table 2 lists the projected neutron production rates for the NSTX upgrades, along with the rates from current NSTX experiments. These rates are used to estimate the expected generation of the principal

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isotopes mentioned above with the upgrades in place. For this assessment, the following simplifying assumptions were made to conservatively estimate the NSTX radionuclide inventories:

- NSTX runs for two weeks for the year.
- During the first run week (Monday through Friday), NSTX generates its total neutrons for the year (from Table 2) less the amount to be generated during the second week.
- NSTX does not operate over the following weekend.
- NSTX generates the maximum daily amount of neutrons in Table 2 for each of five (5) consecutive days during the second run week (Monday through Friday).
- No decay of the three principal isotopes takes place during the first or second run weeks<sup>1</sup>.
- Normal decay of the three principal isotopes takes place during the interval between the end of the first run week and the beginning of the second run week (assumed to be 60 hours<sup>2</sup>).

The results of the assessment are shown in Table 3. The summation of radionuclide threshold ratios is shown for each NSTX upgrade possibility: second NBI only, new CS only, and new CS plus second NBI. Using the 98.3% contribution of the three principal isotopes to the summation total, as indicated above, the overall maximum summations of radionuclide threshold ratios would be:

A. 2<sup>nd</sup> NBI Only – 0.0196

B. New CS Only – 0.1475

C. New CS + 2<sup>nd</sup> NBI – 0.2950

All of these summations are <1.

The possibility that the production of daughter products from the decay of NSTX radionuclides could rise to the Category 3 thresholds has also been examined. As noted in Table 5 of Reference 2, most radionuclides generated by neutron activation (including the three principle ones) decay to stable isotopes. For those that don't, Mo-99 and Mo-101, the maximum inventories of the resultant decay products (Tc-99m and Tc-101) would be too small (1.8 Ci and 56 Ci, respectively, for the new CS + 2<sup>nd</sup> NBI upgrade) relative to their Category 3 thresholds (1.70E+04 Ci and 1.62E+05 Ci, respectively) to change the conclusions regarding the summation of the radionuclide threshold ratios indicated above.

It should be noted that when the residual TFTR tritium and PPPL source inventories reported in Reference 2 are also considered, the maximum summation of radionuclide threshold ratios for PPPL after implementation of the NSTX upgrades would be  $\leq 0.645$ , which is <1.

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<sup>1</sup> This is a conservative assumption. 96% of Mn-56 generated during an operating day would, for example, be expected to decay away in the intervening 12 hours before operations resume the next day.

<sup>2</sup> For example, the interval between 7:00 PM Friday and 7:00 AM the following Monday is 60 hours.

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### Conclusion

Based on the classification criteria of DOE-STD-1027-92 and the above discussion, NSTX would continue to be designated a Below Hazard Category 3 facility after implementation of all, or any part, of the planned MIE project. The requirements of 10CFR830, Subpart B would not apply to the NSTX Upgrade Project.

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