National Spherical Torus Experiment

NSTX Second Neutral Beam

GENERAL REQUIREMENTS DOCUMENT

NSTX-RQMTS-GRD-108

Revision 0

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1 Introduction

The NSTX is the world's highest performance ST research facility and is the centerpiece of the U.S. ST research program. Since starting operation in 1999, NSTX has established the attractiveness of the low-aspect-ratio tokamak ST concept characterized by strong intrinsic plasma shaping and enhanced stabilizing magnetic field line curvature.

This General Requirements Document (GRD) defines the overall engineering requirements for the Neutral Beam Upgrade.

Criteria given in the last revision of the GRD[1] for the original NSTX Project shall still apply except where superceded by information contained herein.

2 General Engineering Requirements

2.1 Scope

2.1.1 Second Neutral Beamline

A TFTR neutral beamline will be decontaminated, reconditioned to the same status as the existing beamline on NSTX and installed at Bay K of NSTX in such a way that its three beams are tangent to the radii: 130 cm, 120 cm, and 109.4 cm. Beamline #1 and beamline #2 shall be configured so that they can operate together or separately to support experiments.

2.1.2 Modification of NSTX Device for a Second Neutral Beamline

a. Various parts of the NSTX device shall be evaluated and modified as necessary in order to operate with a second neutral beamline including (but not limited to):

- Vacuum vessel (VV)
- Internal hardware, including Beam Dump tiles

b. Various parts of the NSTX device shall be modified as necessary in order to provide geometric fit with new or modified parts associated with the upgrade. This will include removing a significant number of electronics racks and diagnostics.

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[1] NSTX General Requirements Document, NSTX-RQMTS-GRD-018, Rev. 2, December 8, 1998 .

2.1.3 Modification of Supporting Subsystems and Equipment

All supporting subsystems and equipment shall be evaluated and modified as necessary in order to operate with a second neutral beamline

- Internal hardware including the beam dump
- Auxiliary Systems
  - Vacuum pumping systems
  - Cooling water systems
  - Gas Injection systems
  - Bakeout systems
- Diagnostic systems
- Electrical power systems
- I&C systems

2.2 Performance

For engineering purposes each NBI beam line shall be assumed to deliver a maximum power to the plasma as indicated in Table 2-1.

Table 2-1 – NBI Power To Plasma per Beam Line

Pulse length (sec)	Power to Plasma (MW)
5	5.0
4	5.4
3	6.0
2	6.8
1.5	7.5
1.25	8.2
1	9.0

2.3 Material Selection

a. Magnetic Permeability

- All materials to be used in the torus and peripheral equipment ($R \leq 3.0$ m, $|Z| \leq 3.0$m) must have a relative magnetic permeability ≤ 1.02 unless otherwise authorized by the Project.
- All welds and attaching hardware, e.g. nut and bolts, used in the torus and peripheral equipment ($R \leq 3.0$ m, $|Z| \leq 3.0$m) must have a relative permeability not to exceed 1.20 unless otherwise authorized by the Project.

b. All materials utilized within the primary vacuum boundary shall be on the PPPL Vacuum Committee approved list, or shall be approved by the committee.

c. All materials utilized within the primary vacuum boundary shall be designed to withstand the anticipated temperatures during plasma operation and bakeout which is 150°C except for the CSC, IBD, OBD, and PPs which shall be baked out at 350°C.

2.4 General Electrical Isolation Requirements

a. All instrumentation shall be isolated via optical and/or magnetic (isolation transformer) means prior to exiting the test cell boundary. The isolation shall be rated to withstand a one minute DC hipot test at 5kV.

b. All ancillary components which are in mechanical contact with the vacuum vessel shall be electrically isolated from the vacuum vessel. The isolation shall be rated to withstand a one minute AC hipot test at 2 kV AC rms.

c. Conducting loops formed by metallic structures within a radius of 3 meters from the centerline of the torus shall be broken by insulating breaks. The insulation shall be rated to withstand a one minute AC hipot test at 2 kV AC rms.

3 Subsystem Requirements

No changes to existing NBI system are required (nominal operating requirement 80kV/5.33MW/5s).

The vacuum pumping system will require a new pump duct which is to be mounted on the bottom of the neutral beam to vacuum vessel duct.

4 ES&H Requirements

4.1 General Guidelines

The design, manufacture, fabrication, construction, installation, test, operation, maintenance, modification, and eventual decontamination and decommissioning of the NSTX including all features associated with the Neutral Beam Upgrade shall be accomplished in a manner that will protect personnel, visitors, the public, property and the environment from injury. Pursuant to this policy, the NSTX Neutral Beam Upgrade Project shall:

- Comply with all applicable Federal, State, Local, and PPPL ES&H regulations;
- Assess and minimize the risks inherent in the NSTX program;
- Actively encourage ES&H awareness on the part of NSTX personnel and visitors.

In particular, NSTX shall be designed and operated in accordance with DOE Orders and PPPL Environment, Safety and Health Directives. In the event of conflicts between DOE Orders and PPPL Environment, Safety and Health Directives, DOE Orders shall take precedence.

4.2 Seismic Requirements

The seismic design criteria outlined in the GRD of the original NSTX Project shall apply[2].

4.3 Radiological Design Objectives

The radiological design criteria outlined in the GRD of the original NSTX Project shall apply. The NSTX Neutral Beam Upgrade will not significantly alter the radiological performance of NSTX and therefore no additional analysis is required.

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[2] NSTX Seismic Design Analysis Report, 71-990611-JHC-01, June 11, 1999