



12 GeV Upgrade Project

DESIGN CRITERIA DOCUMENT

WBS 642

Beam Envelope Limit System (BELS)

Revision 0

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Technical Custodian: JLab Safety Systems Group

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Beam Envelope Limit System

Approvals

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ACRONYMS

AC	Alternating current
ALARA	As Low As Reasonably Achievable
BELS	Beam Envelope Limit System
BLA	Beam Loss Accounting
BLIC	Beam Loss Ion Chamber
BLM	Beam Loss Monitor
CEBAF	Continuous Electron Beam Accelerator Facility
DC	Direct Current
DOE	Department of Energy
EHS&Q	Environment, Health, Safety, and Quality
FSD	Fast Shutdown
GeV	Giga-electron Volt = Billion electron volts
JLab	Thomas Jefferson National Accelerator Facility
Linac	Linear accelerator
MPS	Machine Protection System
PSS	Personnel Safety System
rf/RF	Radio frequency
SRD	System requirements document
SSG	Safety Systems Group

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1 Scope

This report identifies the codes, standards, practices and methods to be used in the design of the Beam Envelope Limit System (BELS) for the Continuous Electron Beam Accelerator Facility (CEBAF) 12 GeV Upgrade Project. In summary, the 12GeV project will involve:

- Increasing the beam energy to 12GeV
- Adding five new cryomodules and RF HPAs to each linear accelerator (linac).
- Adding a fifth pass dipole electromagnet string (Arc 10) to the West Arc.
- Replacing several electromagnet power supplies to support higher energy beam transport.
- Upgrading experimental equipment in the existing experimental Halls A, B, C.
- Construction of a photon Tagger and experimental Hall D complex.
- Expansion of existing infrastructure, e.g. power, service buildings, conduits, to support doubling the beam energy to 12GeV.

Additions and modifications to the existing CEBAF BELS are required to ensure continued operation within specified envelopes.

2 System Description and Introduction

The beam envelope limit system is an engineered hardware and software function that verifies beam operations for the CEBAF accelerator are within the DOE approved safety envelopes. BELS works in conjunction with other engineering controls and administrative procedures to reduce the risk of the following events:

- Combined average beam power in excess of the CEBAF Operations Envelope of 900 kW
- Combined average beam power in excess of the CEBAF Safety Envelope of 1 MW

The BELS achieves these objectives by:

- Measuring and averaging beam energy and current then deriving total beam power for all high power beam dumps
- Providing an operator settable power limit between 50kW and 900 kW
- Providing operator warnings of exceeding beam power limits
- Shutting off beam if operators are not responsive to the warnings

3 References & Standards

This section contains references, regulations, and standards implemented fully or in part at JLab. The responsible engineer determines the extent to which each of these industrial standards is applied. In the event of a conflict between Industrial and Laboratory standards, the Laboratory standard supersedes the Industrial standard.

3.1 DOE Orders, Regulations, and Standards

3.1.1 DOE Order 420.2b Safety of Accelerator Facilities

3.2 Jefferson Laboratory Requirements, Standards, and Guidelines

3.2.1 Jefferson Lab EH&S Manual

3.2.1.1 Appendix 2410-T2 TJNAF Work Smart Standards Set

3.2.1.2 Chapter 3210 Hazard Identification and Characterization

3.2.1.3 Chapter 6200 Jefferson Lab's Electrical safety program

3.2.2 Jefferson Lab Beam Envelope Limit System 12GeV Systems Requirement Document

3.2.3 Jefferson Lab Quality Assurance Plan

4 Design Requirements and Standards

4.1 Lifecycle Management

The 12 GeV BELS systems shall be managed under the existing SSG lifecycle model for non-PSS systems. This model includes design basis documentation, requirements management, systems specifications, commissioning, ongoing operations, and decommissioning.

4.2 Drawing and Document Numbering

BELS documents shall be uniquely numbered using the existing JLAB document numbering requirements. All BELS drawings, specifications, requirements, and user documentation shall fall under JLab configuration control.

Drawing numbers are based on the JLAB standard documentation numbering guidelines. All BELS drawings are managed under the Personnel Safety System (PSS) documentation system. All drawings start with the letter 'and are numbered sequentially. The first four digits identify each drawing. The fifth character denotes the original drawing size, e.g. ANSI A, B, C, D. The final two characters denote the drawing level such as "assembly" and "schematic diagram." An example of a complete drawing number is: S0292D01

The drawing title hierarchically describes the following:

Title Level	Example
Major System	Personnel Safety System
Area or Major Assembly	Beam Envelope Limit

	System
Subsystem	Current Transducers
Drawing Type	Wiring Diagram

Table 1: JLab BELS Drawing Number Scheme

Where ever practical, existing BELS drawings shall be modified to reflect changes associated with the addition of the 12GeV BELS system. This is to avoid duplication of functions among several drawings.

Documents other than drawings that form the design basis of the BELS shall be managed under the JLab Safety System Group design guidelines.

4.3 Principal Design Tools

Several design tools are used in the design, modeling, and development of the BELS. The primary tools are:

- 4.3.1 AutoCad version 2006 or later (Autodesk): All drawings other than electrical circuits
- 4.3.2 ProWorx32 (Schneider Automation): Schneider PLC configuration and programming
- 4.3.3 Excel (Microsoft) version 2003 or later: Calculation of reliability, magnet transfer function
- 4.3.4 Geant version 4.0 or later: Calculation of beam damage to arbitrary structures

5 Quality Assurance and Testing

The 12GeV Beam Envelope Limit Systems shall be designed, developed, and managed under the JLab Quality Assurance Plan. This plan, based on ISO-9000-2000, identifies key requirements pertaining to work processes and output.

Personnel involved in the management and design of the 12GeV BELS upgrade shall be qualified to do so as evidenced by a combination of education and experience. Likewise, personnel performing the installation and maintenance of BELS systems shall also be trained and qualified to do so. Unless justified by analysis and transmitted in writing, the fail-safe state of BELS functions shall shut off the electron beam.