BSC

Study Cover Sheet

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YUCCA MOUNTAIN PROJECT

WASTE PACKAGE TRANSPORT AND EMPLACEMENT VEHICLE ITS STANDARDS IDENTIFICATION STUDY

(Study Title)

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800-30R-HE00-01200-000-002 March 2008

CONTENTS

Page

TABLES

Page

ACRONYMS

BSC	Bechtel SAIC Company, LLC
DOE	Department of Energy
ITS	important to safety
ITWI	important to waste isolation
SSC	structures, systems, and components
TEV	transport and emplacement vehicle
WP	waste package

1. INTRODUCTION

To date, the project has established important to safety (ITS) performance requirements for structures, systems, and components (SSCs) based on identification and categorization of event sequences that may result in a radiological release. These performance requirements are defined within the *Basis of Design for the TAD Canister–Based Repository Design Concept* (Reference 7.1.1). Further, SSCs credited with performing safety functions are classified as ITS. In turn, performance confirmation for these SSCs is sought through the use of consensus codes and standards.

The purpose of this ITS standards identification study is to identify applicable codes and standards for the waste package (WP) transport and emplacement vehicle (TEV) ITS SSCs. Further this ITS standards identification study will form the basis for selection and the extent of applicability of each code and standard. Application of industry codes and standards, where available, provides established performance levels and service factors based on equipment usage and performance.

This ITS standards identification study is based on the design development completed for License Application only. Accordingly, identification of ITS SSCs beyond those defined within the *Basis of Design for the TAD Canister-Based Repository Design Concept* (Reference 7.1.1) and the *Preliminary Preclosure Nuclear Safety Design Bases* (Reference 7.1.2) are based on designs that may be subject to further development during detail design. Furthermore, the results of this study will be subject to evaluation as part of a follow-on gap analysis study.

Based on the results of this ITS standards identification study the gap analysis will evaluate each code and standard to ensure each ITS performance requirement is fully satisfied. When a performance requirement is not fully satisfied, a "gap" is highlighted. Thereafter, the gap analysis study will identify supplemental requirements to augment the code or standard to meet performance requirements. Further, the gap analysis will identify non-standard areas of the design that will be subject to a Development Plan. Non-standard components and non-standard design configurations are defined as areas of the design that do not follow standard industry practices or codes and standards; where performance confirmation cannot be readily sought through use of consensus standards.

The study contained in this document has been developed by Subsurface Engineering / Mechanical in its work regarding ITS codes and standards identification for Emplacement and Retrieval. Yucca Mountain Project personnel from Subsurface Engineering / Mechanical should be consulted before use of this ITS standards identification study for purposes other than those stated herein or used by individuals other than authorized personnel in Subsurface Engineering / Mechanical.

2. QUALITY ASSURANCE

This informal study was prepared in accordance with EG-PRO-3DP-G04B-00016, *Engineering Studies* (Reference 7.1.4). This engineering study is not subject to requirements of the *Quality Management Directive* (Reference 7.1.3) document.

3. USE OF COMPUTER SOFTWARE

No computer software used.

4. WASTE PACKAGE TRANSPORT AND EMPLACEMENT VEHICLE FUNCTIONAL DESCRIPTION

The function of the WP transport and emplacement vehicle (TEV) is to transfer a WP and its associated emplacement pallet from a predetermined loadout area within a surface facility, through the North Portal, down the Access Main, and onto the final emplacement position within the emplacement drift. The TEV can be used for WP and emplacement pallet removal, relocation, and retrieval where the process is a reversal of the emplacement procedure.

The TEV is designed to be radiologically shielded, electrically powered, self-propelled, rail-based, and remotely controlled. It will run on standard crane rails and is capable of operating within the surface facilities, North Portal, Access Main, and the emplacement drifts bounding envelope and environment.

To perform its tasks the TEV has two basic functions. It must be able to lift and lower a WP and pallet and it must be able to carry the WP with pallet from a surface facility to an emplacement drift, or vice versa.

5. ITS REQUIREMENTS

The ITS requirements identified in this study, are taken from the *Basis of Design for the TAD Canister-Based Repository Design Concept* (Reference 7.1.1) and the *Preliminary Preclosure Nuclear Safety Design Bases* (Reference 7.1.2). Furthermore, the TEV is identified as ITS but not ITWI (Reference 7.1.1, Section 14.1.2).

Each requirement identified has been assigned its own requirement number and is highlighted in an italic font in this document. The TEV design features implemented to meet the requirement are shown after the requirement statement, including the code and standard reference listed in Section 5.5.

5.1 NUCLEAR SAFETY DESIGN BASES REQUIREMENT 1

The mean probability of runaway of a TEV that can result in a potential breach of a waste package shall be less then or equal to 2.0 x 10^{-09} per transport (Reference 7.1.1, Section 14.2.3.1.1).

For a load of 50-99 tons, Paragraph 5333.1 of ASME NOG-1-2004 (Reference 7.2.1) states the bridge or crane recommended “fast” speed is 150 feet per minute or 1.7 miles per hour with a design tolerance of ±10 percent. Therefore, the drive motors, gearboxes, driveshafts, and wheels are sized and selected to maintain the recommended speed during ascent and descent of 2.5 percent grade (Reference 7.1.1, Section 9.9.2.2.4). The drive motors have a maximum speed and overspeed would cause motor seizure. If the power to the drive motors is decreased or removed,

the high gearbox ratios provide rotational drag to slow or stop the TEV. The drive motors transfer power to the gearboxes through eight large-diameter, splined driveshafts. The motors selected for the main drive have a maximum speed, coupled with the selected high ratio gearbox, and the selected wheel diameters, the nominal speed that can be achieved is 150 feet per minute. Each drive motor has an integral disc brake, which is applied by a command to slow or stop. Upon loss of power, the drive motor integral disc brakes are mechanically applied. Additionally, the TEV has two rail brakes, which are applied when parked and during loss of power. Table 5.1-1 contains the identified SSC and ITS functions.

Table 5.1-1: Requirement 1 Identified ITS Functions

SSC	ITS Function	Code and Standard Reference
Drive Motors	To prevent overspeed from excessive electrical current	Section 6.1
Drive Motor Integral Disc Brakes	To stop the TEV during loss of power and prevent TEV movement while stopped.	Section 6.2
Gearboxes	To limit speed through gearing	Section 6.3
Driveshafts	To prevent free wheeling, using splined shafts	Section 6.4
Drive Wheels	The limited rotational speed combined with wheel diameter limits TEV speed	Section 6.5
Rail Brakes	To stop the TEV during loss of power and prevent TEV movement while stopped.	Section 6.6

5.2 NUCLEAR SAFETY DESIGN BASES REQUIREMENT 2

The mean frequency of tipover of the TEV due to the spectrum of seismic events shall be less than or equal to 2.0 x 10^{-06} /yr. (Reference 7.1.1, Section 14.2.3.1.1).

This performance requirement cannot be demonstrated by the application of an industry code and standard. Further discussion will be in the gap analysis study. The conceptual design maintains as wide as practicable rail gauge (considering the emplacement drift operating envelope) and low center of gravity. This design configuration ensures vehicle stability and minimizes the potential for vehicle tipover. Table 5.2-1 contains the identified SSC and ITS functions.

Table 5.2-1: Requirement 2 Identified ITS Functions

SSC	ITS Function	Code and Standard Reference
Center of Gravity / Stability	The low center of gravity of the loaded vehicle coupled with the wide rail gauge will ensure stability and prevent tipover	Section 6.12

5.3 NUCLEAR SAFETY DESIGN BASES REQUIREMENT 3

The mean frequency of derailment of the TEV at the loadout station due to the spectrum of seismic events shall be less than or equal to 1.0 x 10^{-04} /yr. (Reference 7.1.1, Section 14.2.3.1.1).

To prevent TEV derailment loadout station during a seismic event, the seismic restraints restrict lateral movement to the surface facility crane rails. Per Paragraph 4457 (Reference 7.2.1), a restraint may be used to prevent overturning of the gantry. Seismic restraints or anti-lift features attached to the underside of the TEV chassis consist of an "L" shaped fabrication of sufficient size and capacity to limit the vertical lift during a seismic event. The fabrications are located at the front and the back of the TEV, positioned to the outer side of both rails, and placed so that the leg of the "L" shape projects under the railhead.

Table 5.3-1: Requirement 3 Identified ITS Functions

SSC	ITS Function	Code and Standard Reference
Seismic Restraints	To prevent the TEV from derailment during a seismic event.	Section 6.11

5.4 NUCLEAR SAFETY DESIGN BASES REQUIREMENT 4

The mean frequency of ejection of a waste package from the TEV due to the spectrum of seismic events shall be less than or equal to 2.0 x 10^{-04} /yr. (Reference 7.1.1, Section 14.2.3.1.1).

The front shield doors, locks, and hinges are designed to withstand a WP impact from within the TEV and remain intact. The shielded enclosure front shield doors, drives, hinges and locks are designed and constructed in accordance with the recommendations of *Design Guides for Radioactive Material Handling Facilities and Equipment* (Reference 7.2.2). The guidance provided relates to shield doors, anticipated load combinations, considerations for the design of hinges, door drive systems, and safety devices. Table 5.4-1 contains the identified SSCs and ITS functions.

Table 5.4-1: Requirement 4 Identified ITS Functions

SSC	ITS Function	Code and Standard Reference
Front Shield Door Locks	To restrain the front shield doors from WP impact while in the closed position	Section 6.8
Front Shield Doors	To restrain the WP during WP impact while in the closed position	Section 6.13
Front Shield Door Hinges	To restrain the front shield doors from WP impact while in the closed position	Section 6.14

5.5 NUCLEAR SAFETY DESIGN BASES REQUIREMENT 5

The mean probability of inadvertent TEV door opening shall be less than or equal to 1.0 x 10^{-07} per transport (Reference 7.1.1, Section 14.2.3.1.1).

The circuitry for the front shield door locks and for the rear shield door is designed such that movement can only be accomplished within dedicated areas. An ITS switch on the TEV is hardwired in the actuator circuitry. An external arm, which is placed in dedicated operational areas (the WP loadout rooms of the surface nuclear facilities and inside the subsurface facility emplacement drift turnouts), actuates the switch. This hardwired interlock ensures that the front

shield door locks and rear shield door are allowed to move only in these non-operational (unoccupied) areas. This switch is located on the TEV such that inadvertent actuation is unlikely. Table 5.5-1 contains the identified SSCs and ITS functions.

Table 5.5-1: Requirement 5 Identified ITS Functions

SSC	ITS Function	Code and Standard Reference
Rear Shield Door Actuators	To move the rear shield door in dedicated areas only	Section 6.7
Front Shield Door Locks	To restrain the front shield doors while in the closed position, and unlock in dedicated areas only	Section 6.8
Circuitry (Hardwired Interlock)	Interlocking of the front shield door locks and the rear shield door to permit operation in designated areas only	Section 6.9
Interlock Switch	To open and close its contact when actuated by external arm	Section 6.10

6. APPLICABLE CODES AND STANDARDS

This ITS standards identification study consisted of an evaluation of industry consensus codes and standards to identify applicability to the ITS SSCs. The codes and standards were selected based upon their applicability to the requirements of the ITS SSCs, in particular within a nuclear environment. The evaluation of the identified industry codes and standards (see Section 7.2) looked at the applicable sections of each code and standard. This was done to ensure that the design, construction, installation, testing, and operations were all analyzed to show how each of the particular SSCs will satisfy the ITS requirements.

Note: The extent of the applicability of each code and standard identified will be further defined through the completion of a subsequent gap analysis study.

6.1 DRIVE MOTORS

Table 6.1-1: Drive Motors Applicable Codes and Standards

Applicable Code or Standard	Section/ Para.	Title
ASME NOG-1-2004	5000	*Mechanical (Reference 7.2.1)*
ASME NOG-1-2004	5141	*General Mechanical Components (Reference 7.2.1)*
ASME NOG-1-2004	5150–(a)	*Critical Items (Reference 7.2.1)*
ASME NOG-1-2004	5440	*Bridge Drives (Reference 7.2.1)*
ASME NOG-1-2004	6000	*Electrical Components (Reference 7.2.1)*
ASME NOG-1-2004	6470	*Motors (Reference 7.2.1)*
ASME NOG-1-2004	7000	*Inspection and Testing (Reference 7.2.1)*
ASME NOG-1-2004	7220	*Electrical Documentation (Reference 7.2.1)*
ASME NOG-1-2004	7253	*Electrical Requirements (Reference 7.2.1)*

6.2 DRIVE MOTOR INTEGRAL DISC BRAKES

Table 6.2-1: Drive Motor Integral Disc Brakes Applicable Codes and Standards

Applicable Code or Standard	Section/ Para.	Title
ASME NOG-1-2004	5000	*Mechanical (Reference 7.2.1)*
ASME NOG-1-2004	5141	*General Mechanical Components (Reference 7.2.1)*
ASME NOG-1-2004	5150–(a)	*Critical Items (Reference 7.2.1)*
ASME NOG-1-2004	5443	*Bridge Brakes (Reference 7.2.1)*
ASME NOG-1-2004	6000	*Electrical Components (Reference 7.2.1)*
ASME NOG-1-2004	6423	*Trolley and Bridge Brakes (Reference 7.2.1)*
ASME NOG-1-2004	7000	*Inspection and Testing (Reference 7.2.1)*
ASME NOG-1-2004	7220	*Electrical Documentation (Reference 7.2.1)*
ASME NOG-1-2004	7253	*Electrical Requirements (Reference 7.2.1)*

6.3 DRIVE GEARBOXES

Table 6.3-1: Drive Gearboxes Applicable Codes and Standards

Applicable Code or Standard	Section/ Para.	Title
ASME NOG-1-2004	5000	*Mechanical (Reference 7.2.1)*
ASME NOG-1-2004	5141	*General Mechanical Components (Reference 7.2.1)*
ASME NOG-1-2004	5150–(a)	*Critical Items (Reference 7.2.1)*
ASME NOG-1-2004	5440	*Bridge Drives (Reference 7.2.1)*
ASME NOG-1-2004	5457	*Gear Cases, Enclosures, and Guards (Reference 7.2.1)*

6.4 DRIVESHAFTS

Table 6.4-1: Driveshafts Applicable Codes and Standards

Applicable Code or Standard	Section/ Para.	Title
ASME NOG-1-2004	5000	*Mechanical (Reference 7.2.1)*
ASME NOG-1-2004	5150–(a)	*Critical Items (Reference 7.2.1)*
ASME NOG-1-2004	5453	*Axles – Bridge and Trolley (Reference 7.2.1)*
ASME NOG-1-2004	B5476	*Basic Stress Equations (Reference 7.2.1)*

6.5 DRIVE WHEELS

Table 6.5-1: Wheels Applicable Codes and Standards

Applicable Code or Standard	Section/ Para.	Title
ASME NOG-1-2004	5000	*Mechanical (Reference 7.2.1)*
ASME NOG-1-2004	5150–(a)	*Critical Items (Reference 7.2.1)*
ASME NOG-1-2004	5452	*Wheels – Bridge and trolley (Reference 7.2.1)*

6.6 RAIL BRAKES

Table 6.6-1: Rail Brakes Applicable Codes and Standards

Applicable Code or Standard	Section/ Para.	Title
ASME NOG-1-2004	5000	*Mechanical (Reference 7.2.1)*
ASME NOG-1-2004	5141	*General Mechanical Components (Reference 7.2.1)*
ASME NOG-1-2004	5150–(a)	*Critical Items (Reference 7.2.1)*
ASME NOG-1-2004	5443	*Bridge Brakes (Reference 7.2.1)*
ASME NOG-1-2004	6000	*Electrical Components (Reference 7.2.1)*
ASME NOG-1-2004	6420	*Friction Brakes (Reference 7.2.1)*
ASME NOG-1-2004	6423	*Trolley and Bridge Brakes (Reference 7.2.1)*
ASME NOG-1-2004	7000	*Inspection and Testing (Reference 7.2.1)*
ASME NOG-1-2004	7220	*Electrical Documentation (Reference 7.2.1)*

6.7 REAR SHIELD DOOR ACTUATORS

Table 6.7-1: Rear Shield Door Actuators Applicable Codes and Standards

Applicable Code or Standard	Section/ Para.	Title
ASME NOG-1-2004	6000	*Electrical Components (Reference 7.2.1)*
ASME NOG-1-2004	6470	*Motors (Reference 7.2.1)*
ASME NOG-1-2004	7000	*Inspection and Testing (Reference 7.2.1)*
ASME NOG-1-2004	7220	*Electrical Documentation (Reference 7.2.1)*
ASME NOG-1-2004	7253	*Electrical Requirements (Reference 7.2.1)*
Doman, D.R. 1988	Guide Number 4	*Access Doors and Transfer Devices for Personnel and Equipment (Reference 7.2.2)*

6.8 FRONT SHIELD DOOR LOCKS

Table 6.8-1: Front Shield Door Locks Applicable Codes and Standards

Applicable Code or Standard	Section/ Para.	Title
ASME NOG-1-2004	4000	*Requirements for Structural Components (Reference 7.2.1)*
ASME NOG-1-2004	6000	*Electrical Components (Reference 7.2.1)*
ASME NOG-1-2004	7000	*Inspection and Testing (Reference 7.2.1)*
ASME NOG-1-2004	7220	*Electrical Documentation (Reference 7.2.1)*
ASME NOG-1-2004	7253	*Electrical Requirements (Reference 7.2.1)*
Doman, D.R. 1988	Guide Number 4	*Access Doors and Transfer Devices for Personnel and Equipment (Reference 7.2.2)*

6.9 CIRCUITRY FOR HARDWIRED INTERLOCK

Table 6.9-1: Circuitry for Hardwired Interlock Applicable Codes and Standards

Applicable Code or Standard	Section/ Para.	Title
ASME NOG-1-2004	6000	*Electrical Components (Reference 7.2.1)*
ASME NOG-1-2004	6440	*Limit Switches (Reference 7.2.1)*
ASME NOG-1-2004	7000	*Inspection and Testing (Reference 7.2.1)*
ASME NOG-1-2004	7220	*Electrical Documentation (Reference 7.2.1)*
ASME NOG-1-2004	7253	*Electrical Requirements (Reference 7.2.1)*
IEEE 323-2003	Entire	*IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations (Reference 7.2.3)*
IEEE 336-2005	Entire	*IEEE Guide for Installation, Inspection, and Testing for Class 1E Power, Instrumentation, and Control Equipment at Nuclear Facilities. (Reference 7.2.4)*
IEEE 344-2004	Entire	*IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations (Reference 7.2.5)*
IEEE 383-2003	Entire	*Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations (Reference 7.2.6)*
IEEE 384-1992 (REAF 1998)	Entire	*Standard Criteria for Independence of Class 1E Equipment and Circuits. (Reference 7.2.7)*

6.10 INTERLOCK SWITCH

Table 6.10-1: Interlock Switch Applicable Codes and Standards

Applicable Code or Standard	Section/ Para.	Title
ASME NOG-1-2004	6000	*Electrical Components (Reference 7.2.1)*
ASME NOG-1-2004	6440	*Limit Switches (Reference 7.2.1)*
ASME NOG-1-2004	7000	*Inspection and Testing (Reference 7.2.1)*
ASME NOG-1-2004	7220	*Electrical Documentation (Reference 7.2.1)*
ASME NOG-1-2004	7253	*Electrical Requirements (Reference 7.2.1)*
IEEE 323-2003	Entire	*IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations (Reference 7.2.3)*
IEEE 336-2005	Entire	*IEEE Guide for Installation, Inspection, and Testing for Class 1E Power, Instrumentation, and Control Equipment at Nuclear Facilities. (Reference 7.2.4)*
IEEE 344-2004	Entire	*IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations (Reference 7.2.5)*
IEEE 383-2003	Entire	*Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations (Reference 7.2.6)*
IEEE 384-1992 (REAF 1998)	Entire	*Standard Criteria for Independence of Class 1E Equipment and Circuits. (Reference 7.2.7)*

6.11 SEISMIC RESTRAINTS

Table 6.11-1: Seismic Restraints Applicable Codes and Standards

Applicable Code or Standard	Section/ Para.	Title
ASME NOG-1-2004	4000	*Requirements for Structural Components (Reference 7.2.1)*
ASME NOG-1-2004	4457	*Gantry Stability (Reference 7.2.1)*

6.12 CENTER OF GRAVITY / STABILITY

Table 6.12-1: Center of Gravity / Stability Applicable Codes and Standards

Applicable Code or Standard	Section/ Para.	Title
ASME NOG-1-2004	4000	*Requirements for Structural Components (Reference 7.2.1)*
ASME NOG-1-2004	4457	*Gantry Stability (Reference 7.2.1)*

6.13 FRONT SHIELD DOORS

Table 6.13-1: Front Shield Doors Applicable Codes and Standards

Applicable Code or Standard	Section/ Para.	Title
ASME NOG-1-2004	4000	*Requirements for Structural Components (Reference 7.2.1)*
Doman, D.R. 1988	Guide Number 4	*Access Doors and Transfer Devices for Personnel and Equipment (Reference 7.2.2)*

6.14 FRONT SHIELD DOOR HINGES

Table 6.14-1: Front Shield Door Hinges Applicable Codes and Standards

Applicable Code or Standard	Section/ Para.	Title
ASME NOG-1-2004	4000	*Requirements for Structural Components (Reference 7.2.1)*
Doman, D.R. 1988	Guide Number 4	*Access Doors and Transfer Devices for Personnel and Equipment (Reference 7.2.2)*

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7.2 CODES AND STANDARDS

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7.2.5 *IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*

IEEE Std 344-2004. 2005. *IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.* New York, New York: Institute of Electrical and Electronics Engineers. TIC: 258050.

7.2.6 *Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations*

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7.2.7 *Standard Criteria for Independence of Class 1E Equipment and Circuits*

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