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COGEMA DOCUMENT TITLE: SRTC - Gap Analysis Table

COGEMA DOCUMENT ID: COGEMA-C0115-EN-CLC-0025

REFERENCE: YMPC-C0115-00368/DE-L-SC-PA005391-00703

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Project No. & Title: C0115, COGEMA Operational Design Services

The assigned engineers are qualified to perform the attached calculations in accordance with COGEMA-C0115-EN-PRC-005, "Design Analysis/Calculations."

P. Kerrien / 6/9/05

Engineering Manager/Date

CALCULATION/ANALYSIS APPROVAL

	Name/Signature/Date
Originator:	B. Flanagan / 6/9/05
Checked By:	N. Labrecque / 6/9/05
Approved By:	P. Kerrien / 6/9/05
Other:	

RECORD OF REVISION

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0	Initial Issue
1	Continued on next page

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RECORD OF REVISION (Continued)

Rev.	Reason for Revision
1 (contd)	<p>Revised and expanded Section 1, Purpose; Section 3, Assumptions; and Section 5, Methodology, for clarity.</p> <p>Reformatted evaluation.</p> <p>Changed title of Section 7 to Discussion.</p> <p>Added a new Section 8, Results, which presents results obtained for the discussion section.</p> <p>Developed safety functions.</p> <p>Removed non-ITS features from the evaluation.</p> <p>Updated nuclear safety design bases requirements.</p> <p>Updated Appendix A table column headings to include generic SSCs and proposed SSCs.</p>
2	<p>Incorporation of Bechtel SAIC Company, LLC. comments provided in transmittal DE-XMTL-SDR-PA005391-00214.</p> <p>Section 1 revised to reflect current design development plan.</p> <p>Added new Section 3, Design Inputs.</p> <p>Section 4, 4th assumption revised to allow more than one SRTC design for vertical site-specific casks.</p> <p>Section 5 revised for SRTC interfaces and design elements expanded.</p> <p>Sections 6, 8, 9, and 10 revised to state that there are no design development requirements identified.</p> <p>Appendix A, Table 1 revised to clarify supplemental requirements.</p>

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1 PURPOSE

The purpose of this document is to review the existing SRTC design against the *Nuclear Safety Design Bases for License Application* (NSDB) [Ref. 10] requirements and to identify codes and standards and supplemental requirements to meet these requirements. If these codes and standards and supplemental requirements can not fully meet these safety requirements then a "gap" is identified. These gaps will be identified here and addressed using the *Site Rail Transfer Cart (SRTC) Design Development Plan* [Ref. 14].

The codes and standards, supplemental requirements, and design development requirements are provided in the SRTC and associated rails gap analysis table in Appendix A. Because SRTCs are credited with performing functions important to safety (ITS) in the NSDB [Ref. 10], design basis requirements are applicable to ensure equipment is available and performs required safety functions when needed.

The gap analysis table is used to identify design objectives and provide a means to satisfy safety requirements. To ensure that the SRTC and rail design perform required safety functions and meet performance criteria, this portion of the gap analysis table supplies codes and standards sections and the supplemental requirements and identifies design development requirements, if needed.

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The following documents were used in the preparation of this analysis:

2.1 DOCUMENTS

- [1] AISC (American Institute of Steel Construction) 1997. *Manual of Steel Construction, Allowable Stress Design*, 9th ed. Chicago, Illinois: American Institute of Steel Construction.
- [2] ANSI/AISC N690-1994. *American National Standard Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities*. Chicago, Illinois: American Institute of Steel Construction.
- [3] ASCE (American Society of Civil Engineers) 4-98, 2000. *Seismic Analysis of Safety-Related Nuclear Structures and Commentary*. Reston, Virginia: American Society of Civil Engineers.
- [4] ASME (American Society of Mechanical Engineers) NOG-1-2002, 2002. *Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)*. New York, New York: American Society of Mechanical Engineers.
- [5] ASME NQA-1-2000, 2001. *Quality Assurance Requirements for Nuclear Facility Applications*. New York, New York: American Society of Mechanical Engineers.
- [6] ASTM A 759-00, 2001. *Standard Specification for Carbon Steel Crane Rails*. West Conshocken, Pennsylvania: American Society for Testing and Materials.
- [7] AWS (American Welding Society) D1.1/D1.1M:2002, 2002. *Structural Welding Code—Steel*, 18th ed. Miami, Florida: American Welding Society.
- [8] AAR (Association of American Railroads) 2002. *Manual of Standards and Recommended Practices*.
- [9] BSC (Bechtel SAIC Company) 2005. *Cask Receipt and Return System Description Document*. 140-3YD-HC00-00100-000-000. Las Vegas, Nevada: Bechtel SAIC Company.
- [10] BSC 2005. *Nuclear Safety Design Bases for License Application*. BSC 000-30R-MGR0-00400-000-001. Las Vegas, Nevada: Bechtel SAIC Company.

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- [11] BSC 2004. *Preclosure Seismic Design Methodology for a Geologic Repository at Yucca Mountain*. BSCTDR-WHS-MD-000004, Rev. 1. Las Vegas, Nevada: Bechtel SAIC Company.
- [12] BSC 2004. *Project Design Criteria Document*. 000-3DR-MGR0-00100-000-003. Las Vegas, Nevada: Bechtel SAIC Company.
- [13] COGEMA 2004. *Justification of the Design Envelope for the Mechanical Handling Equipment*. COGEMA-C0115-RP-03-019, Rev. 2. Las Vegas, Nevada: COGEMA Inc.
- [14] COGEMA 2005. *Site Rail Transfer Cart (SRTC) Design Development Plan*. COGEMA-C0115-DDP-05-001, Rev. 1. Las Vegas, Nevada: COGEMA Inc. (BSC Standard Document No. V0-M00Z-QPA0-05391-00363-001-2)
- [15] 10 CFR Part 71. *Packaging and Transportation of Radioactive Material*. Readily available.

2.2 DRAWINGS

The following drawings were used in the preparation of this analysis:

- [A] *Cask Receipt and Return System Site Rail Transfer Cart (SRTC) Mechanical Equipment Envelope*. YMP-C0115-0725, Rev. B. (BSC Standard Document No. V0-M00Z-QPA0-05391-00119-001-2)
- [B] *Transp Cask Receipt/Return & Non-Nuclear Receipt Facilities, General Arrangement, Key Plan*. 140-P10-WHS0-00102-000-00A, Sheet 2.
- [C] *Transp Cask Receipt/Return & Non-Nuclear Receipt Facilities, General Arrangement, Ground Floor Plan A*. 140-P10-WHS0-00103-000-00A, Sheet 3.
- [D] *Transp Cask Receipt/Return & Non-Nuclear Receipt Facilities, General Arrangement, Ground Floor Plan B*. 140-P10-WHS0-00104-000-00A, Sheet 4.
- [E] *Transp Cask Receipt/Return & Non-Nuclear Receipt Facilities, General Arrangement, Buffer-Ground Floor Plan C*. 140-P10-WHS0-00105-000-00A, Sheet 5.

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- [F] *Transp Cask Receipt/Return & Non-Nuclear Receipt Facilities, General Arrangement, Sections A, B, & C. 140-P10-WHS0-00111-000-00A, Sheet 11.*
- [G] *Transp Cask Receipt/Return & Non-Nuclear Receipt Facilities, General Arrangement, Sections D, E, F & G. 140-P10-WHS0-00112-000-00A, Sheet 12.*
- [H] *Transp Cask Receipt/Return & Non-Nuclear Receipt Facilities, General Arrangement. Sections H, J & K. 140-P10-WHS0-00113-000-00A, Sheet 13.*
- [I] *Dry Transfer Facility #1/Remediation Facility, General Arrangement Ground Floor Plan B. 110-P10-WHS0-00109-000-00Ba.*
- [J] *Dry Transfer Facility #1/Remediation Facility, General Arrangement Section B. 110-P10-WHS0-00129-000-00B.*
- [K] *Dry Transfer Facility #1/Remediation Facility, General Arrangement Section C. 110-P10-WHS0-00130-000-00B.*
- [L] *Dry Transfer Facility #1/Remediation Facility, General Arrangement Section D. 110-P10-WHS0-00131-000-00B.*
- [M] *Canister Handling Facility, General Arrangement Ground Floor Plan. 190-P10-CH00-00103-000-00B.*
- [N] *Canister Handling Facility, General Arrangement Section C & D. 190-P10-CH00-00109-000-00B.*
- [O] *Canister Handling Facility, General Arrangement Section K & L. 190-P10-CH00-00113-000-00B.*

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3 DESIGN INPUT

- *Cask Receipt and Return System Site Rail Transfer Cart (SRTC) Mechanical Equipment Envelope* [Ref. A]. The mechanical equipment envelope is used to provide a preliminary design to which solutions to the ITS requirements are applied.
- *Cask Receipt and Return System Description Document* [Ref. 9]. This document is used as input to the functional description, Section 5 of this evaluation.
- *Nuclear Safety Design Bases for License Application* [Ref. 10]. This document is used to identify the ITS requirements for each equipment.
- *Preclosure Seismic Design Methodology for a Geologic Repository at Yucca Mountain* [Ref. 11]. This document provides the methodology and acceptance criteria for BDBGM seismic evaluations.
- *Project Design Criteria Document* [Ref. 12]. This document provides input to potentially applicable codes and standards that are referenced in this evaluation.

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Orig.: *BOF* Date: *6/8/05*SRTC – Gap Analysis TableProject No. & Title: C0115 – COGEMA ODSChecker: *HAJ* Date: *6/8/05***4 ASSUMPTIONS**

The following assumptions were used in the development of this analysis:

- Safety functions apply to the SRTC only when handling a loaded transportation cask without impact limiters or a loaded site-specific cask. (TBV-M-2-37)

Rationale: Two of three safety requirements state that the requirement is applicable when the impact limiters are removed. The speed limit safety function should also only apply when the impact limiters are removed. This assumption limits the areas where the safety functions apply (i.e., inside facilities). The nuclear safety design bases recognize that a transportation cask without impact limiters is typically only moved within structures [Ref. 10]. Similarly, if the SRTC is not handling loaded packages, the safety requirements do not apply.

- SRTC codes and standards follow crane trolley and not railcar design.

Rationale: The primary reasons for choosing the crane trolley approach is for seismic and nuclear facility considerations. Furthermore, railcar codes and standards are designed for use by the railroad industry. They are prescriptive as to details of arrangement and do not lend themselves to custom designs. Current envelope requirements prevent the use of standard railcar components and parts.

- The intermodal skid is provided with the cask. Consequently, the intermodal skid is not evaluated as part of this document. (TBV-M-2-38)

Rationale: This assumption relies on 10 CFR Part 71 [Ref. 15] transportation requirements and cask operating requirements to satisfy SRTC requirements. The intermodal skid accompanies the cask when it arrives at the Transportation Cask Receipt and Return Facility (TCRRF).

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- The SRTC may incorporate more than one design. One to transfer horizontal transportation casks and another to transfer vertical loaded site-specific casks. WPs are anticipated to be transferred by the transportation cask SRTC design.

Rationale: Vertical loaded site-specific casks may drive the design of the SRTC's seismically resistant platform due to its unique configuration and weight during seismic events. The seismic forces and moments imposed are expected to be substantially increased for the vertical site-specific cask. The two designs may be necessary to optimize the SRTC deck height for uprighting and lifting of the transportation casks.

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The SRTC is a rail based cart used to transport loaded transportation casks throughout the TCRRF and transportation cask buffer area (TCBA), and to the waste-processing facilities, namely the Dry Transfer Facility (DTF) and the Canister Handling Facility (CHF). The Fuel Handling Facility does not interface with SRTCs. The SRTC travels on a rail network and is moved by either the SRTC tractor or the SRTC positioner.

SRTCs are part of the cask receipt and return system and the SRTC buffer subsystem and are classified as ITS. The primary SRTC equipment number is 14B-MQ-HCB0-TT000001. Within the SRTC buffer subsystem, SRTC rails are classified as non-ITS. However, inside the building of the TCRRF, CHF and DTF, SRTC rails are classified as ITS [Ref. 10]. The rails adjacent to the CHF entrance vestibule are also classified as ITS for transport of the loaded site-specific cask.

The SRTC may be configured to accommodate all incoming casks through the use of cask-specific adapters or intermodal skid attachment points.

As with transportation casks, empty site-specific casks (non-ITS), and empty waste packages (non-ITS) are transported from the Waste Package Receipt Facility warehouse to the waste processing facilities using configured SRTCs routed through the SRTC buffer subsystem rail network.

The TCBA provides multiple locations where both loaded (with casks) and unloaded SRTCs are staged. When needed, the SRTC positioner aligns an SRTC with a storage location, to or from where an SRTC tractor moves the SRTC. The tractor also moves SRTCs between the waste-processing facilities and the TCBA.

The main functions of the SRTCs and its associated rails are to stage casks until needed and to transport casks and empty waste packages in or between facilities. SRTCs interface with the following equipment:

- The SRTC rail networks
- Specific adapters for cask/site-specific cask/waste package
- Intermodal skids
- The SRTC positioner (non-ITS)
- The SRTC tractor (non-ITS)

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- Cask handling cranes
- Cask lifting yokes
- Aging crawler/transporter for site-specific casks.

The design of the SRTC utilizes the design standards of the nuclear crane industry and the load carrying components are similar in concept to existing carts used at other nuclear facilities. The elements of the design take proven design concepts and employ these concepts for this application. The general utilization rate of the SRTC is relatively low for crane industry standards. However, the rated load of the SRTC is greater than the similar equipment used at other nuclear facilities.

The first three safety requirements presented in Appendix A, Table 1 also apply to the intermodal skids which are outside the scope of this document.

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6 METHODOLOGY

This analysis began with the statement of applicable gap analysis table requirements for the SRTC and rail system as set forth in NSDB [Ref. 10] and inserted in this document in Table 1 of Appendix A. Then, safety functions identified so that a design feature or proposed structure, system or component (SSC) could be applied.

Generic SSCs are intended to be major assemblies of the SRTC. Design features and proposed SSCs are defined as specific components of the SRTC needed to satisfy the safety functions. Examples of design features or proposed SSCs include brakes, wheels, structural frame supports, and mechanical devices.

For the development of the proposed SSC, a code and standard was determined and applicable sections were listed to guide its development. Any calculations, modeling, or testing required by the code or standard also was noted. Section 8 provides a basis for selecting the codes and standards, and also a basis for not using some codes and standards reviewed.

When a single code and standard does not adequately address the safety requirement then a supplemental requirement may be specified. These are requirements which supplement areas of the code or standard for additional criteria, calculations, modeling, and/or testing. If a safety function is still not adequately addressed then a "gap" is identified and a design development requirement is determined for the safety function. This process is repeated until all safety functions for a given requirement are determined and met. The design development requirements, if needed, are discussed in the *Site Rail Transfer Cart (SRTC) Design Development Plan* [Ref. 14].

This document only addresses safety functions performed by proposed SSCs associated with the SRTC. A code and standard not specifically supporting an item's identified safety function is not included.

The *Nuclear Safety Design Bases for License Application* (Appendix A, Table A-II) lists safety requirements for specific components. Table A-II was reviewed for all safety requirements pertaining to the SRTC. In addition to specific SRTC requirements, requirements from the facility SRTC rails were also included because the facility SRTC rails are specifically mentioned as ITS in Appendix A, Table A-I [Ref. 10].

The SRTC is a unique piece of equipment and many of the detailed design aspects are not determined at this time. No code or standard was found that is specifically intended for this

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type of equipment. By specifying codes and standards particular to a certain industry to parts of the SRTC, such as ASME NOG-1 [Ref. 4], the intent is not to drive the design toward that industry. Rather, the intent is to show that the required safety function can be satisfied by following relevant portions of selected codes or standards. As the design progresses, the codes and standards may need to be reviewed for applicability. In addition, the list may need to be updated to reflect applied design solutions.

The *Project Design Criteria Document* [Ref. 12] provides support for the development of preliminary and detailed design for SSCs. Applicable sections of this document were reviewed for codes and standards. For those items that may seem relevant but were not selected, brief justification is provided in Section 8.

Consistent with Section 1.5 of the *Project Design Criteria Document*, the codes and standards referenced provide a technical basis for design features. These codes and standards chosen for the structural design and mechanical components will enable acceptable seismic evaluation methodology and design criteria.

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7 COMPUTER SOFTWARE

No computer calculations were performed as part of this analysis. Standard office software was used to produce this document.

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8 DISCUSSION

8.1 BACKGROUND

Safety functions identified in this section shall only apply when an SRTC interfaces with a loaded cask without impact limiters or a loaded site-specific cask. The safety functions typically only apply to SRTCs in the TCRRF, DTF, and CHF. There are no safety functions associated with handling empty SRTCs, and SRTCs with empty waste packages or unloaded casks. The safety functions ensure that loaded casks remain secure in a safe configuration during and after postulated event sequences.

In the TCRRF, loaded transportation casks are transferred from the offsite conveyance to the SRTC. Some cask designs may require the cask impact limiters be removed to accomplish this transfer. Once cask impact limiters are removed, all SRTC safety functions apply in the TCRRF until the impact limiters are reinstalled.

In the DTF, impact limiters are removed from all loaded transportation casks. The casks are then lifted from the SRTC for further preparation. Once cask impact limiters are removed, all SRTC safety functions for the DTF apply until the loaded cask is lifted from the SRTC.

In the CHF, impact limiters are removed from all loaded transportation casks. The casks are then lifted from the SRTC for further preparation. The SRTC will also handle loaded site-specific casks from the designated area outside the entrance vestibule to the canister transfer cell in the CHF. Once the cask impact limiters are removed, all SRTC safety functions for the CHF apply until the loaded cask is lifted from the SRTC. Once a loaded site-specific cask is placed on the SRTC, all SRTC safety functions apply both in the CHF and outside the entrance vestibule until the loaded site-specific cask is lifted from the SRTC.

SRTCs will consist of steel assemblies and parts designed to support transportation casks containing radioactive material. Codes and standards for the assemblies and parts will comply with those commonly used for nuclear facilities.

Chosen design codes and standards are based on the assumption that the SRTC safety requirements are better addressed by following the design requirements of a crane trolley rather than a railcar (e.g. seismic and speed limit requirements). Although the SRTC does not include a hoist system or motor, most structural aspects are applicable and include conservatism for nuclear facilities. Also applicable are the mechanical components associated with a rail based cart. More flexibility and design options are available for the customized SRTC using codes and standards for a trolley rather than a railcar. Railcar codes

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and standards are not written to comply with the nuclear industry standards whereas ASME NOG-1 is. In this comparison, ASME NOG-1 [Ref. 4] provides more flexibility over the Association of American Railroads (AAR) [Ref. 8] for a rail-based vehicle. For example, the AAR standards and specifications are prescriptive as to details of configuration and arrangement for various parts of the railcar that may restrict the optimum design of specialized aspects of the SRTC. Furthermore, ASME NOG-1 addresses seismic analysis, including load combinations, and acceptance criteria whereas the AAR does not.

8.2 SAFETY FUNCTIONS

From the *Nuclear Safety Design Bases for License Application*, there are three ITS requirements identified in Table A-II and one ITS requirement in Table A-I [Ref. 10]. These requirements specify that:

- In instances when the SRTC moves a cask without impact limiters (typically only in structures), the SRTC shall prevent slapdown of the cask for loading conditions associated with a DBGM-2 seismic event. In addition, an analysis shall demonstrate that the SRTC transporting a cask without impact limiters has sufficient seismic design margin to ensure that a "no slapdown" safety function is maintained for loading conditions associated with a BDBGM seismic event.
- A speed limit for which SRTCs will be pulled/pushed by the SRTC tractor shall be established such that a collision with shield or airlock doors or other heavy objects does not overturn the SRTC or cause it to lose its load.
- In instances where the SRTC moves a cask without impact limiters (typically only in structures), an SRTC carrying a transportation cask or a site-specific cask shall not derail, and the transportation cask or site-specific cask shall not fall from the SRTC under normal operating conditions or as the result of a collision.
- Rails and rail anchorages in the structure shall be designed for loading conditions associated with a DBGM-2 seismic event. In addition, it shall be demonstrated that the rails and rail anchorages have sufficient seismic design margin to ensure that a "no derailment" safety function is maintained for loading conditions associated with a BDBGM seismic event.

These nuclear safety design bases are evaluated for all payloads where safety functions apply.

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The design features identified for each safety function are all structural/mechanical. As such, a review of potentially applicable consensus codes and standards was performed to identify applicability. The codes and standards reviewed include American Institute of Steel Construction (AISC) 1997 [Ref. 1], American National Standards Institute (ANSI)/AISC N690-1994 [Ref. 2], American Society of Civil Engineers (ASCE) 4-98 [Ref. 3], and American Society of Mechanical Engineers (ASME) NOG-1 [Ref. 4].

ASME NOG-1 was chosen for all mechanical design features as it directly applies to rail-based vehicles (crane components) used at nuclear facilities. ASME NOG-1 references common standards such as AISC 1997 and AWS D1.1 [Ref. 7] for applicability at the point of reference. As with AISC 1997, ASME NOG-1 specifies allowable stresses for structural components and also addresses crane rail requirements. ASME NOG-1 includes increased conservatism (for nuclear facilities) and also addresses features not covered by AISC, such as wheels, axles, bearings, brakes, deflections, and component alignments tailored for rail-based vehicles.

ASME NOG-1 satisfies each safety function and design feature without the need for multiple codes and standards. This standard contains requirements relevant to the design and specification of structural and mechanical components used in nuclear facilities. ASME NOG-1 invokes and conforms to ASME NQA-1 [Ref. 5], a standard quality assurance requirement for nuclear facilities where mechanical-handling equipment is used. ASME NOG-1 also contains seismic requirements and analytical techniques accepted by the nuclear industry. When practicable, the SRTC will be designed and specified in accordance with ASME NOG-1. In accordance with the *Project Design Criteria Document* [Ref. 12], Type I is specified for equipment handling a waste form. Because ASME NOG-1 is specifically written for cranes, this standard is only applicable as it relates to the SRTC design satisfying the safety requirements.

ANSI/AISC N690-1994 [Ref. 2] was reviewed as it applies to seismic analysis design, fabrication, and erection of steel safety-related structures for nuclear facilities. This standard was not chosen as it does not lend assistance in the design and evaluation of a rail-based vehicle beyond what is covered in ASME NOG-1. This standard does discuss the erection of crane rails and ANSI/AISC N690-1994 meets the minimum NOG-1 requirements. This standard also discusses anchor bolts and embedments that could be utilized by the facilities.

ASCE 4-98 [Ref. 3] was reviewed as it applied to seismic analysis of safety-related structures. This standard was not chosen as it does not include detailed design requirements and tends to apply more to building structures (not rail-based vehicles).

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AISC 1997 [Ref. 1] was reviewed as it is widely used for steel construction, including crane runway rail. This standard could be used for the steel design features but lends no assistance in the design of a rail-based vehicle. Without a more encompassing code or standard such as ASME NOG-1 for the design of the SRTC structural (not mechanical) components, AISC 1997 is a strong candidate to satisfy the allowable stress design considerations.

8.2.1 Safety Function: No Slapdown

Table 1 in Appendix A states the following ITS requirement:

In the instances when the SRTC moves a cask without impact limiters (typically only within structures), the SRTC shall prevent slapdown of the cask for loading conditions associated with a DBGGM-2 seismic event. In addition, an analysis shall demonstrate that the SRTC transporting a cask without impact limiters has sufficient seismic design margin to ensure that a “no-slapdown” safety function is maintained for loading conditions associated with a BDBGGM seismic event.

For further definition of the no-slapdown safety function see the NSDB, Section B.1.5 [Ref. 10].

The SRTC satisfies the no-slapdown safety function by restraining a loaded cask in its intended position and remaining in the upright position as a result of a seismic event. The components relied on to ensure the SRTC no-slapdown safety function is met are the load path SSCs such as the SRTC frame (including structural frame, trucks, wheels, axles, anti-tilting/anti-derailing devices), the SRTC rail, and the SRTC cask-specific adapters (including the intermodal skid).

The load path SSCs will be designed and evaluated using the allowable stress design approach identified in applicable sections of ASME NOG-1 [Ref. 4]. The wheels and rails will be properly sized in accordance with ASME NOG-1. Applicable sections include: NOG-4100, General; NOG-4200, Materials and Connections; NOG-4300, Design Criteria; NOG-4430, Trolley Frames; NOG-4440, End Truck and End Ties; NOG-4460, Rails; NOG-5450, Mechanical Components; NOG-5470, Analytical Procedures; NOG-5481, Seismic Analysis; and NOG-5531, Welded Construction. Further sections may also apply as the design progresses. ASME NOG-1 includes seismic and normal-operating-condition loading.

Inspections and acceptance testing performed by the manufacturer and at the site are identified as a general supplemental requirement applicable to all safety requirements.

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NOG-7000 covers inspection and testing; however, the applicability of this section must be reviewed against the SRTC design to identify the inspection and testing necessary to ensure the safety requirements are met. Inspection and testing candidates include material certifications, weld examinations and tests, assembly inspections, mechanical tests, and load tests.

Supplemental requirements are necessary to determine additional acceptance criteria for NOG-5470, Analytical Procedures and permissible analytical methods for NOG-5481, Seismic Analysis in association with the BDBGM seismic event. The seismic related calculations and/or analyses will be performed for BDBGM and for high confidence of low probability of failure seismic margin analysis. These will be performed to the methodologies identified in *Preclosure Seismic Design Methodology for a Geologic Repository Yucca Mountain* [Ref. 11].

It can be seen from the table in Appendix A that this nuclear safety design requirement can be satisfied through ASME NOG-1 and the supplemental requirements covering inspection, testing, and BDBGM seismic analyses criteria and methods. No design development requirements are identified for satisfying the “no slapdown” safety requirement.

8.2.2 Safety Function: Speed Limit

Table 1 in Appendix A states the following ITS requirement:

A speed limit for which SRTCs will be pulled/pushed by the SRTC tractor shall be established such that a collision with shield or airlock doors or other heavy objects does not overturn the SRTC or cause it to lose its load.

The motive force for the SRTC is provided by the SRTC tractor. The SRTC tractor is classified as non-ITS [Ref. 10]. Therefore, the SRTC must satisfy the speed limit safety function independent from the SRTC tractor.

Based on the speed limit safety requirement [Ref. 10], the speed limit safety function is satisfied using SRTC speed controls, and brakes. These controls are consistent with equipments specified in ASME NOG-1 [Ref. 4]. A design may include a speed limiting system (such as a centrifugal braking system) which does not rely on electrical power.

The over speed switch and brakes will be designed and evaluated using ASME NOG-1. Applicable sections include: NOG-5332, Trolley Speeds, NOG-5433, Trolley Brakes,

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NOG-5458, Bumpers and Stops, and NOG-6420, Friction Brakes. Further sections may also apply as the design progresses.

ASME NOG-1 includes loading conditions to be included in the design bases. The SRTC will incorporate a fail safe brake system. If an over speed occurs, the brakes will automatically engage.

Supplemental requirements are necessary to determine the acceptable collision speed in addition to NOG-5332, Trolley Speeds, and for acceptance criteria for the brake (over speed) switch in addition to NOG-5433, Trolley Brakes.

It is recommended that the speed limit function be controlled by the SRTC tractor (currently non-ITS) [Ref. 10]. There are significantly fewer SRTC tractors than SRTCs, which may optimize the design.

In conjunction with the speed limit during a collision, the SRTC satisfies the no-overturning and no-load-drop safety functions by restraining the loaded cask in its intended position and remaining in the upright position. The components relied on to ensure these safety functions are met are the following: Load path SSCs (including structural frame, trucks, wheels, axles, anti-tilting/anti-derailing devices) and the SRTC cask-specific adapters (including the intermodal skid).

The SRTC steel frame and interface will be designed and evaluated using the allowable stress design approach identified in applicable sections of ASME NOG-1. Applicable sections include: NOG-4100, General; NOG-4200, Materials and Connections; NOG-4300, Design Criteria; NOG-5450, Mechanical Components; NOG-5470, Analytical Procedures; and NOG-5531, Welded Construction. Further sections may also apply depending on the detailed design. ASME NOG-1 will include collision loads in the design bases.

Inspections and acceptance testing performed by the manufacturer and at the site are identified as a general supplemental requirement applicable to all safety requirements. NOG-7000 covers inspection and testing; however, the applicability of this section must be reviewed against the SRTC design to identify the inspection and testing necessary to ensure the safety requirements are met. Inspection and testing candidates include material certifications, weld examinations and tests, assembly inspections, mechanical tests, and load tests.

No design development requirements are identified for satisfying the speed limit safety requirement.

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SRTC – Gap Analysis TableProject No. & Title: C0115 – COGEMA ODSOrig.: ~~BOF~~ Date: 6/8/05Checker: ~~WJG~~ Date: 6/8/05**8.2.3 Safety Function: No Derailment**

The following ITS requirements identified from Table 1 in Appendix A state that:

In the instances where the SRTC moves a cask without impact limiters (typically only within structures), an SRTC carrying a transportation cask or a site-specific cask shall not derail, and the transportation cask or site-specific cask shall not fall from the SRTC under normal operating conditions or as the result of a collision.

The rails and rail anchorages within the structure shall be designed for loading conditions associated with a DBGM-2 seismic event. In addition, it shall be demonstrated that the rails and rail anchorages have sufficient seismic design margin to ensure that a "no-derailment" safety function is maintained for loading conditions associated with a BDBGM seismic event.

For further definition of the no-derailment and no fall down safety functions see the NSDB, Section B.1.15 and B.1.16 [Ref. 10].

The SRTC satisfies the no-derailment and no fall down safety functions by remaining upright on the rails and restraining the loaded cask in its intended position during normal operating conditions and as a result of a collision. The components relied upon to ensure the SRTC no-derailment safety function are an anti-derailing device attached to the structural frame (including structural frame, trucks, wheels, and axles), the SRTC rail, and the SRTC cask-specific adapters (including the intermodal skid).

A mechanical restraint to protect against derailment will be designed and evaluated using applicable sections of ASME NOG-1 [Ref. 4]. Applicable sections include: NOG-4100, General; NOG-4200, Materials and Connections; NOG-4300, Design Criteria; NOG-4430, Trolley Frames; NOG 4440, End Trucks and End Ties; NOG-4460, Rails; NOG-5450, General Mechanical Components; NOG-5470, Analytical Procedures; and NOG-5531, Welded Construction. Further sections may also apply depending on the detailed design.

To ensure the no fall down safety function is satisfied applicable sections of ASME NOG-1 are applied similar to Section 8.2.1 above for the no-slapdown safety function. Applicable sections include: NOG-4100, General; NOG-4200, Materials and Connections; NOG-4300, Design Criteria; NOG-5450, Mechanical Components; NOG-5470, Analytical Procedures; and NOG-5531, Welded Construction. Further sections may also apply depending on the detailed design.

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ASME NOG-1 includes the normal-operating-condition loading to be included in the design bases. This reference is chosen to design and analyze the SRTC frame, wheels, and rails to prevent derailment.

A collision evaluation to determine applicable loads is identified as a supplemental requirement for the no fall safety function. Inspections and acceptance testing performed by the manufacturer and at the site are identified as a general supplemental requirement applicable to all safety requirements. NOG-7000 covers inspection and testing; however, the applicability of this section must be reviewed against the SRTC design to identify the inspection and testing necessary to ensure the safety requirements are met. Inspection and testing candidates include material certifications, weld examinations and tests, assembly inspections, mechanical tests, and load tests.

No design development requirements are necessary to satisfy SRTC no-derailment and no fall safety functions.

The rails satisfy the no-derailment safety function by remaining structurally intact so that the SRTC remains upright for loading conditions associated with a seismic event. The components relied on to ensure the rail system no-derailment safety function is met are rails, joint bars/welds, stops, and fasteners/anchorage. The design features on the rail system will include proper sizing and anchorage for seismic loads. The rail system will be designed and evaluated using ASTM A-759 [Ref. 6] and applicable sections of ASME NOG-1. Applicable sections include: NOG-4100, General; NOG-4200, Materials and Connections; NOG-4300, Design Criteria; NOG-4460, Rails; NOG-5450, Mechanical Components; NOG-5470, Analytical Procedures; and NOG-5531, Welded Construction. Seismic and normal operating loads determined for the SRTC will be applied to the rails.

The rail concrete anchorage/embedment is considered a facility structural item and not covered by this Gap Analysis.

Supplemental requirements are necessary to determine additional acceptance criteria for NOG-5470, Analytical Procedures and permissible analytical methods for NOG-5481, Seismic Analysis in association with the BDBGM seismic event. The seismic related calculations and/or analyses will be performed for BDBGM and for high confidence of low probability of failure seismic margin analysis. These will be performed to the methodologies identified in *Preclosure Seismic Design Methodology for a Geologic Repository Yucca Mountain* [Ref. 11].

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A supplemental test requirement is identified to determine the seismic load capacity of the rail, especially horizontal loads. Crane rail standards [Ref. 6] do not provide material yield or ultimate strengths for a standard evaluation. Supplemental testing for the rail may be performed under other equipment, such as the cask trolley, and applied for all rail at the facilities including the SRTC rail.

No design development requirements are necessary to satisfy rail no-derailment safety functions.

8.3 APPLICABLE ENVIRONMENTAL AND OPERATIONAL REQUIREMENTS

The *Cask Receipt and Return System Description Document* [Ref. 9] currently identifies no environmental or operational requirements for the SRTC that may affect the chosen codes and standards at this stage of the design.

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9 RESULTS

As discussed in Section 8, codes and standards and supplemental requirements (when identified) for each generic SSC were chosen to meet safety requirements for the SRTC and its rails as set forth in NSDB [Ref. 10]. Table 1 in Appendix A summarizes these codes and standards and supplemental requirements. No design development requirements are identified.

The list of the codes and standards identified in Appendix A includes ASME NOG-1 [Ref. 4] and ASTM A-759 [Ref. 6]. The table lists the applicable sections of the above codes and standards identified to meet the requirements of the NSDB.

Supplemental requirements include:

- Inspection and testing applying NOG-7000 [Ref. 4] as applicable
- Analytical methods and acceptance criteria for the BDBGM seismic event
- Evaluations to determine the acceptable collision speed
- Acceptance criteria for a speed limit brake switch
- A collision evaluation to determine collision loads
- A test on the SRTC rail to determine the seismic load capacity.

The table identifies which SSCs the supplemental requirements are associated with to meet the requirements of the NSDB.

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10 CONCLUSION

By scrutinizing design bases requirements and implementing codes and standards and their related sections, the gap analysis table shows that SRTCs can be designed to meet design basis requirements. The ITS SSCs identified are based upon the current preliminary design and may change based on future design developments and configurations.

As shown in Table 1 of Appendix A, most of the NSDB [Ref. 10] are satisfied through the use of ASME NOG-1 [Ref. 4]. The additional supplemental requirements, including inspections and testing, analytical methods and acceptance criteria for the BDBGM seismic event, collision speed evaluations, brake switch criteria, and rail testing are included to show how the design fully satisfies the safety requirements. The supplemental requirements are anticipated to be written into the performance specification as mandatory requirements.

No design development requirements are identified. Design development requirements may be identified as the design progresses. The *Site Rail Transfer Cart (SRTC) Design Development Plan* [Ref. 14] provides a progressive approach and framework for developing design development activities addressing standard engineering design, procurement, and testing methods.

It is recommended that the speed limit function be controlled by the SRTC tractor. There are significantly fewer SRTC tractors than SRTCs which may optimize the design.

The three SRTC safety requirements apply to the intermodal skid which is outside the scope of this document.

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11 APPENDIX A

Table 1. Site Rail Transfer Cart and Rail Gap Analysis

Design Analysis/Calculation Title: SRTC – Gap Analysis Table

Project No. & Title: C0115, COGEMA ODS

Originator: ~~Raf~~ Date: 6/9/05

Checker: *WJL* Date: 6/9/05

Table 1. Site Rail Transfer Cart and Rail Gap Analysis

ITS Requirements and Engineering Solutions				Code and Standard Applicability							Supplemental Requirements				Design Development Requirements			
Req. Number	Requirement Text	Generic SSCs	Proposed SSCs	Code or Standard	Applicable Section	Section Description	Required Calculation	Required Modeling	Required Testing	Additional Criteria	Required Calculation	Required Modeling	Required Testing	Required Calculation	Required Drawings	Required Modeling	Required Testing	
1	In the instances when the SRTC moves a cask without impact limiters (typically only within structures), the SRTC shall prevent slapdown of the cask for loading conditions associated with a DBGM-2 seismic event. In addition, an analysis shall demonstrate that the SRTC transporting a cask without impact limiters has sufficient seismic design margin to ensure that a "no slapdown" safety function is maintained for loading conditions associated with a BDBGM seismic event.	Load path SSCs	Structural components: steel assemblies including the cask support structure and a device on the SRTC frame preventing the wheels from disengaging from the rail	ASME NOG-1	NOG-4100	General	Yes	No	No									
					NOG-4200	Materials and connections	Yes	No	No									
					NOG-4300	Design criteria	Yes	No	No									
					NOG-4430	Trolley frames	Yes	No	No									
					NOG-4440	End truck and end ties	Yes	No	No									
					NOG-4460	Rails	Yes	No	No									
					NOG-5450	Mechanical components	Yes	No	No									
					NOG-5470	Analytical procedures	Yes	No	No									
					NOG-5481	Seismic analysis	Yes	No	No	Analytical method and acceptance criteria for BDBGM seismic event	Yes	No	No					
					NOG-5531	Welded construction	No	No	No									
					NOG-7000	Inspection and testing	No	No	Yes	Determine applicable requirements	No	No	Yes					

Design Analysis/Calculation Title: SRTC – Gap Analysis Table

Project No. & Title: C0115 COGEMA ODS

Originator: BAF Date: 6/3/05

Checker: WJF Date: 6/8/05

ITS Requirements and Engineering Solutions				Code and Standard Applicability							Supplemental Requirements				Design Development Requirements			
Req. Number	Requirement Text	Generic SSCs	Proposed SSCs	Code or Standard	Applicable Section	Section Description	Required Calculation	Required Modeling	Required Testing	Additional Criteria	Required Calculation	Required Modeling	Required Testing	Required Calculation	Required Drawings	Required Modeling	Required Testing	
2	A speed limit for which SRTCs will be pulled/pushed by the SRTC tractor shall be established such that a collision with shield or airlock doors or other heavy objects does no overturn the SRTC or cause it to lose its load.	Load path SSCs	Structural components: interface between the casks and SRTC	ASME NOG-1	NOG-4100	General	Yes	No	No									
					NOG-4200	Materials and connections	Yes	No	No									
					NOG-4300	Design criteria	Yes	No	No									
					NOG-5450	Mechanical components	Yes	No	No									
					NOG-5470	Analytical procedures	Yes	No	No									
					NOG-5531	Welded construction	No	No	No									
					NOG-7000	Inspection and testing	No	No	Yes	Determine applicable requirements	No	No	Yes					
					ASME NOG-1	NOG-5332	Trolley Speeds	No	No	No	Acceptable collision speed	Yes	No	No				
						NOG-5433	Trolley Brakes	No	No	No	Acceptance criteria for brake switch	No	No	Speed Control				
						NOG-5458	Bumpers and Stops	Yes	No	No								
		SRTC brakes	Mechanical device: brakes preventing unintended movement; bumpers and stops	NOG-6420	Friction brakes	Yes	No	No										
	NOG-7000			Inspection and testing	No	No	Yes	Determine applicable requirements	No	No	Yes							

ITS Requirements and Engineering Solutions				Code and Standard Applicability							Supplemental Requirements				Design Development Requirements							
Req. Number	Requirement Text	Generic SSCs	Proposed SSCs	Code or Standard	Applicable Section	Section Description	Required Calculation	Required Modeling	Required Testing	Additional Criteria	Required Calculation	Required Modeling	Required Testing	Required Calculation	Required Drawings	Required Modeling	Required Testing					
3	In the instances where the SRTC moves a cask without impact limiters (typically only within structures) an SRTC carrying a transportation cask or a site-specific shall not derail and the transportation cask or site-specific cask shall not fall from the SRTC under normal operating conditions or as the result of a collision.	Load path SSCs	Structural components: frame and steel connection interface between the casks and SRTC	ASME NOG-1	NOG-4100	General	Yes	No	No	Collision evaluation	Yes	No	No									
					NOG-4200	Materials and connections	Yes	No	No													
					NOG-4300	Design criteria	Yes	No	No													
					NOG-5450	Mechanical components	Yes	No	No													
					NOG-5470	Analytical procedures	Yes	No	No													
					NOG-5531	Welded construction	No	No	No													
					NOG-7000	Inspection and testing	No	No	Yes	Determine applicable requirements	No	No	Yes									
				ASME NOG-1	NOG-4100	General	Yes	No	No													
					NOG-4200	Materials and connections	Yes	No	No													
					NOG-4300	Design criteria	Yes	No	No													
					NOG-4430	Trolley frames	Yes	No	No													
					NOG-4440	End truck and end ties	Yes	No	No													
					NOG-4460	Rails	Yes	No	No	Seismic load capacity	No	No	Yes									
					NOG-5450	Mechanical components	Yes	No	No													
					NOG-5470	Analytical procedures	Yes	No	No													
					NOG-5531	Welded construction	No	No	No													
					NOG-7000	Inspection and testing	No	No	Yes	Determine applicable requirements	No	No	Yes									

ITS Requirements and Engineering Solutions				Code and Standard Applicability							Supplemental Requirements					Design Development Requirements				
Req. Number	Requirement Text	Generic SSCs	Proposed SSCs	Code or Standard	Applicable Section	Section Description	Required Calculation	Required Modeling	Required Testing	Additional Criteria	Required Calculation	Required Modeling	Required Testing	Required Calculation	Required Drawings	Required Modeling	Required Testing			
4	The rails and rail anchorages within the structure shall be designed for loading conditions associated with a DBGM-2 seismic event. In addition, it shall be demonstrated that the rails and rail anchorages have sufficient seismic design margin to ensure that a "no derailment" safety function is maintained for loading conditions associated with a BDBGM seismic event.	Rail	Structural components: rail anchorage/ embedment to resist applied loads	ASME NOG-1	NOG-4100	General	Yes	No	No											
					NOG-4200	Materials and connections	Yes	No	No											
					NOG-4300	Design criteria	Yes	No	No											
					NOG-4460	Rails	Yes	No	No	Seismic load capacity	No	No	Yes							
					NOG-5450	Mechanical components	Yes	No	No											
					NOG-5470	Analytical procedures	Yes	No	No	Analytical method and acceptance criteria for BDBGM seismic event	Yes	No	No							
					NOG-5531	Welded construction	No	No	No											
				ASTM A-759	All	Carbon Steel Crane Rails	No	No	No											

NOTES: The requirement text (second column) is derived from *Nuclear Safety Design Bases for License Application* [Ref. 10].
Generic SSCs are intended to be major assemblies of the SRTC.
Proposed SSCs are intended to be design features and subassemblies of the Generic SSC.
The SRTC seismic loads will be applied to the rails.