RAI Volume 2, Chapter 2.1.3, First Set, Number 1: Describe the process, including any procedures, which is used during the design phase to evaluate and select alternatives for design features that will facilitate permanent closure and decontamination, or decontamination and dismantlement.

Section 1.12.1 of the SAR, described the requirements and criteria that will be applied in the design of the repository to facilitate permanent closure and decontamination, or decontamination and dismantlement. However, the applicant has not described the process for evaluating and selecting alternatives for appropriate design features. The applicant has not described how features that support waste minimization and worker safety are incorporated into the design and how ALARA principles are considered for decontamination and dismantlement activities. The staff needs the information to verify compliance with 10 CFR 63.21 (c) (8).

1. RESPONSE

The process for developing and evaluating alternatives to select design concepts and features that will meet the safety and operational requirements for the surface nuclear facilities and facilitate decontamination, dismantlement and permanent closure is part of the overall process for managing technical, programmatic and regulatory requirements and the systematic incorporation of these requirements into the repository design.

Managing requirements and the flow down of requirements that form the bases for design is in accordance with the *Quality Assurance Requirement and Description* (DOE 2009) document and includes maintaining a technical baseline that addresses requirements, NRC regulations such as 10 CFR 63.21(c)(8), regulatory guidance such as NUREG-1575 (NRC 2000), NUREG-1757 (Banovac et al. 2006; Schmidt et al. 2006), Regulatory Guide 8.8 and YMRP Section 2.1.3.2, and design codes and standards. Requirements and parameters applicable to the design process as it relates to decontamination, dismantlement and closure are identified in the *Project Design Criteria* (BSC 2007) and the *Basis of Design for the TAD Canister-Based Repository Design Concept* (BSC 2008), which are implemented through design procedures and desktop information. These design procedures and desktop information documents incorporate checklists which include line items for waste minimization techniques, features that minimize potential contamination levels in buildings during operations and contribute to low dosage potential during decontamination and dismantlement, and features that will maintain as low as is reasonably achievable (ALARA) occupational and public radiation exposures during closure.

The specific design process most related to consideration of design features that will facilitate decontamination and dismantlement is the ALARA review process. ALARA reviews are coordinated by nuclear and radiological engineering personnel. These reviews focus on the incorporation of ALARA features in the design of repository systems. The process uses checklists to systematically assess design attributes and features that contribute to ALARA during operations and may facilitate decontamination and dismantlement. The checklists address such topics as: facility layout; equipment location; pumps, tanks, sample stations, and instruments; decontamination provisions; leakage collection provisions and floor drains; and tools. Design features that facilitate decontamination, dismantlement, and decommissioning are similar to those that reduce contamination and ease maintenance activities during operations. Of more than 150 items on the ALARA design considerations checklist for a facility, approximately half of them involve considerations to limit the generation and spread of contamination or features which provide ample access for or simplify maintenance activities such as removal of components.

As each engineering discipline team develops design concepts and products, alternatives are evaluated to identify and incorporate design features that will support repository operations by ensuring that potential worker doses are maintained ALARA. In addition to controlling worker doses during operations, addressing ALARA for operations also provides for evaluation and incorporation of features to facilitate dismantlement and closure as well as waste minimization and worker health and safety during decontamination and dismantlement activities. The ALARA reviews are conducted twice during design development; once during preliminary design and again during detailed design with a focus on the design configuration of the structures, systems, and components, bulk and penetration shielding, contamination control, operations, and maintainability.

Engineers and selected managers undergo ALARA training to introduce them to the principles of radiation physics and methods that can be used to make potential worker exposures ALARA. This ALARA training incorporates regulatory guidance, such as that contained in Regulatory Guide 8.8, and project-specific requirements for the repository. The purpose of this training is to bring personnel to a level of understanding of radiation control and protection so that they are able to prepare design solutions that will result in ALARA doses to workers in all phases of operation, including decommissioning. This training approach clarifies ALARA principles and reduces or eliminates design rework that could result from ALARA-related comments provided during product technical review. Additionally, this training approach ensures that design products address the health and safety of workers, the public, and the environment, and incorporates aspects of the Environmental Management System, including pollution prevention and waste minimization.

The ALARA process also includes desktop information for conducting cost-benefit analysis. During development of the preliminary design, the utility of cost-benefit analysis is limited, but during development of the detailed design, cost-benefit analysis receives more emphasis as discrete, detailed design alternatives are considered. The desktop information addresses identification of reasonable options, performance of dose assessment, determination of cost, and selection of an alternative.

The Yucca Mountain Project has established design procedures and desktop information documents to control and guide development of studies, calculations and analyses, specifications, and engineering drawings. The procedures provide a controlled and systematic process for developing design concepts and products that incorporate and address safety, operational and performance requirements, and integrate ALARA principles to support worker health and safety during repository operations and subsequent decontamination, dismantlement and closure. When developing and evaluating design concepts and alternatives, the discipline engineering teams utilize the procedures and desktop information as they define design issues, confirm safety, evaluate performance and functionality criteria, identify possible design alternatives, assess performance of the alternatives versus criteria and requirements, and select the optimal design alternative. This process of developing and evaluating design concepts and alternatives includes evaluation of the preclosure safety analysis, the use of procedural and desktop information checklists, design product checking, independent technical reviews, management reviews, ALARA reviews, and may be supported by value engineering studies and external independent reviews. Figure 1 provides an overview of the design process, including the ALARA reviews.

The independent technical reviews implemented for each design product are performed by a multidisciplinary engineering team that is tasked with confirming procedural compliance and verifying the adequacy and responsiveness of the design. These reviews assess whether design bases and parameters are properly implemented, including safety, functionality, operability, maintainability, constructability, environmental considerations, ALARA, and human factors. In addition to independent technical reviews, development of design products includes a separate technical product checking process that confirms inputs, basis and appropriateness of design assumptions, compliance with procedural requirements and checklists, and technical correctness of product results.

The resources that support the engineering teams include a variety of discipline engineers and technical specialists. The expertise and capabilities of these individuals provide the engineering teams with appropriate skills to perform the work needed to accomplish each task identified within a design area scope of work. The engineering team members involved in preparing studies, calculations and analyses, drawings, specifications, and performing checking and technical reviews are required to maintain up-to-date training in those procedures that are used to implement design tasks.

Implementation of the design development and alternatives evaluation process conducted during the development of the conceptual and preliminary design has resulted in the features that are described in the license application. One such feature that has been incorporated into the repository design that has significant ALARA benefits and facilitates the decontamination, dismantlement, and decommissioning of the surface facilities is the selection of a predominantly-canistered approach for receipt of the incoming commercial SNF. (All the naval SNF, HLW, and DOE SNF are received in canisters.) Implementation of the predominantly-canistered approach is consistent with a "start clean, stay clean" philosophy and results in most of the facility areas being maintained free of contamination because the exterior surfaces of the canisters are expected to be free of loose surface contamination. The configuration of the surface facilities using the predominantly-canistered approach for receipt of incoming waste, results in only one facility, the WHF, in which uncanistered commercial SNF is handled. The other surface facilities only handle canistered waste forms.

Another design feature that supports decontamination and dismantlement through implementation of ALARA is a facility physical design that includes laydown areas for maintenance and also facilitates decontamination, dismantlement, and decommissioning activities. The laydown areas allow for pre-staging of tools and consumables, and provide space envelopes around the equipment that simplify removal and dismantlement by reducing congestion and providing space to perform manual actions. In the CRCF, there are North and

South laydown areas in room 2004 on the second floor of the CRCF for work on the canister transfer machines. Near these lay down areas are removable, shielded hatches that allow access to the maintenance rooms below (rooms 1012 and 1033). This feature of the design allows equipment to be removed from the vicinity of potential radiological hazards so that possible decontamination, dismantlement, and decommissioning activities could be performed in a more conducive environment. These laydown areas and hatches are shown on SAR Figures 1.2.4-2 and 3.

In SAR Section 1.2.4.2.4.13 (page 1.2.4-45), the design of the waste package transfer trolley is described. The configuration is shown on SAR Figure 1.2.4-88. The enclosure of the trolley encases the waste package and emplacement pallet assembly on all sides, with the exception of the top. A shield ring, which is placed on top when in the vertical position, allows only a portion of the waste package to protrude, which greatly reduces the potential for spread of contamination during the handling process.

In the WHF, each of the pool water treatment system ion exchangers is provided with compressed air connections for backflushing. The process valves in this system are ball valves to minimize the collection points for radioactive sediment or resin. These system features are shown on SAR Figure 1.2.5-59.

The radiation zone maps in SAR Section 1.10 show that the facility is laid out such that access to higher radiation zones is through lower radiation zones. The confinement zone figures for each facility show that the HVAC systems are configured to have air flow from areas of lower potential contamination to areas of higher potential contamination.

In conclusion, the above describes the procedures and desktop information used in the design processes during the design phase to evaluate and select alternatives for design features that will facilitate permanent closure and decontamination, or decontamination and dismantlement of the surface facilities. The selected features, while principally selected for ALARA purposes during handling operations, also facilitate decontamination and dismantlement by limiting the radioactive sources and spread of contamination, and by separating the worker from radiological hazards or reducing the time required in the vicinity of radiological hazards. The examples demonstrate the incorporation of these design features in the preliminary design.

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

4. REFERENCES

Banovac, K.L.; Buckly, J.T.; Johnson, R.L.; McCann, G.M.; Parrott, J.D.; Schmidt, D.W.; Shepherd, J.C.; Smith, T.B.; Sobel, P.A.; Watson, B.A.; Widmayer, D.A.; and Youngblood, T.H. 2006. *Consolidated Decommissioning Guidance: Decommissioning Process for Materials Licensees*. NUREG-1757, Vol. 1, Rev. 2. Washington, D.C.: U.S. Nuclear Regulatory Commission. ACC: MOL.20071001.0116.

BSC (Bechtel SAIC Company) 2007. *Project Design Criteria Document*. 000-3DR-MGR0-00100-000-007 CBCN 017. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071016.0005; ENG.20071108.0001; ENG.20071220.0003; ENG.20080107.0001; ENG.20080107.0002; ENG.20080107.0016; ENG.20080107.0017; ENG.20080131.0006; ENG.20080305.0002; ENG.20080305.0011; ENG.20080305.0012; ENG.20080306.0009; ENG.20080313.0004; ENG.20080710.0001; ENG.20081112.0006; ENG.20081114.0004; ENG.20090109.0005.

BSC 2008. *Basis of Design for the TAD Canister-Based Repository Design Concept*. 000-3DR-MGR0-00300-000-003 CBCN 001. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20081006.0001; ENG.20090217.0001.

DOE (U.S. Department of Energy) 2009. *Quality Assurance Requirements and Description*. DOE/RW-0333P, Rev. 21. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.20090102.0004.

NRC (U.S. Nuclear Regulatory Commission) 2000. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM*). NUREG-1575, Rev. 1. Washington, D.C.: U.S. Nuclear Regulatory Commission. ACC: MOL.20051101.0242.

Regulatory Guide 8.8, Rev. 3. 1978. *Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will be as Low as is Reasonably Achievable*. Washington, D.C.: U.S. Nuclear Regulatory Commission. TIC: 238609.

Schmidt, D.W.; Banovac, K.L.; Buckley, J.T.; Esh, D.W.; Johnson, R.L.; Kottan, J.J.; McKenney, C.A.; McLaughlin, T.G.; and Schneider, S. 2006. *Consolidated Decommissioning Guidance: Characterization, Survey, and Determination of Radiological Criteria*. NUREG-1757, Vol. 2, Rev. 1. Washington, D.C.: U.S. Nuclear Regulatory Commission. ACC: MOL.20071001.0089.

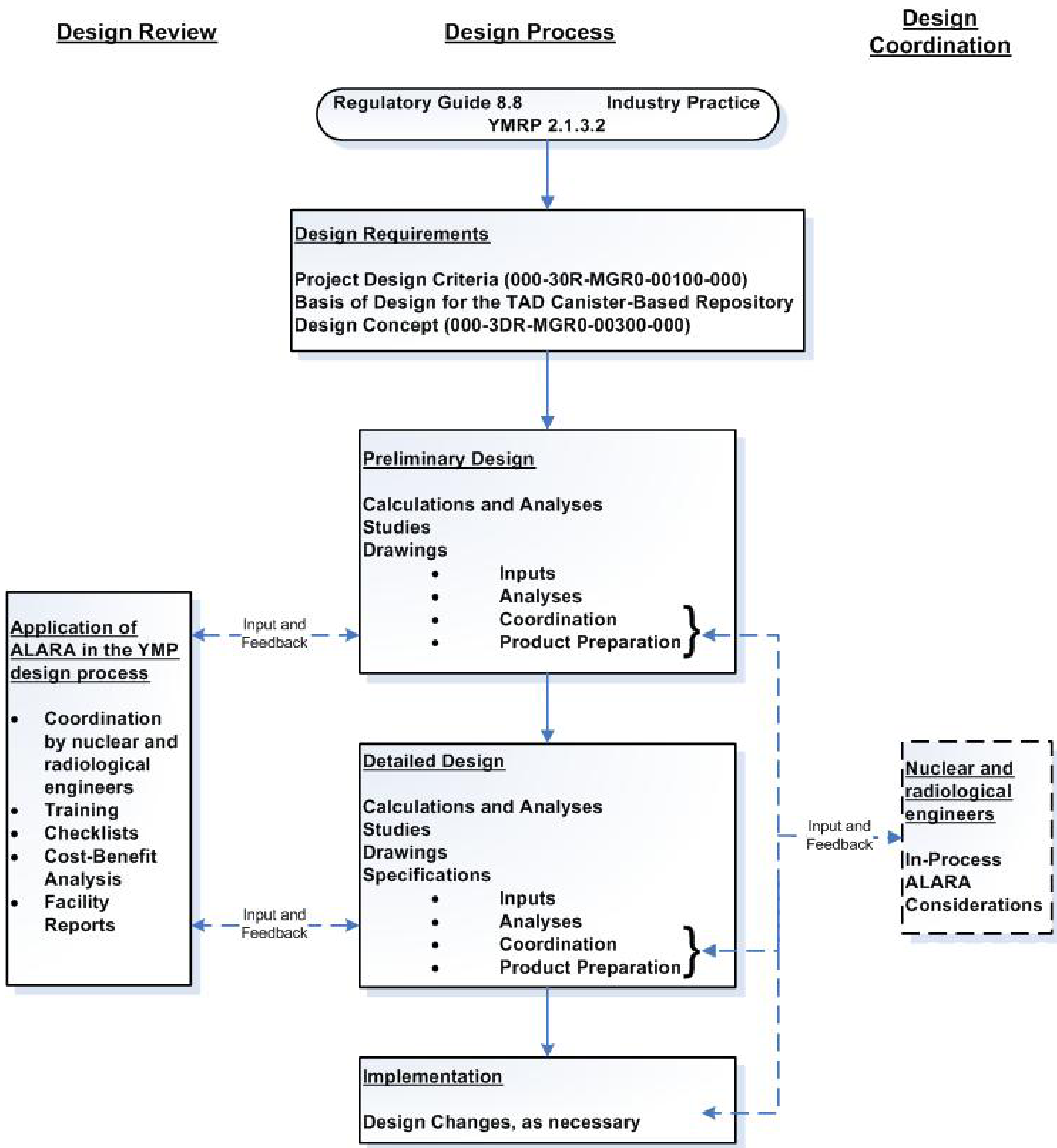

Figure 1. Overview of Design and ALARA Processes

RAI Volume 2, Chapter 2.1.3, First Set, Number 2: Describe the process used during the design phase to ensure that features that support waste minimization and worker safety are incorporated into the design and that ALARA principles are considered for decontamination and dismantlement activities.

Section 1.12.1 of the SAR, described the requirements and criteria that will be applied in the design of the repository to facilitate permanent closure and decontamination, or decontamination and dismantlement. However, the applicant has not described the process for evaluating and selecting alternatives for appropriate design features. The applicant has not described how features that support waste minimization and worker safety are incorporated into the design and how ALARA principles are considered for decontamination and dismantlement activities. The staff needs the information to verify compliance with 10 CFR 63.21 (c) (8).

1. RESPONSE

The ALARA review process along with the basic engineering processes and procedures, both of which are described in the response to RAI 2.2.1.3-001, are used during the design phase to ensure that features that support waste minimization and the health and safety of workers are incorporated into the design and that ALARA principles and radiological hazard mitigation are considered for decontamination, dismantlement, and decommissioning activities. While the principal focus of ALARA during the design phase is reducing occupational exposures during waste handling operations, many of the design features also minimize waste, mitigate radiological hazards, and provide a suitable working environment for decontamination, dismantlement, and decommissioning activities.

Design requirements including those related to minimizing radioactive waste and radioactive contamination of facility spaces, and providing worker radiation safety are identified in the *Project Design Criteria* (BSC 2007) and the *Basis of Design for the TAD Canister-Based Repository Design Concept* (BSC 2008). The engineering procedures for studies, calculations and analyses, drawings and specifications control the systematic development of the design in accordance with the established requirements. ALARA is a routine consideration during the design development, and is specifically addressed with ALARA reviews as described in the response to RAI 2.2.1.3-001. Of the more than 150 items listed on the ALARA design considerations checklist for a facility, more than 30 of them involve considerations to address radioactive waste minimization and worker radiation safety. Many of the other considerations, while not explicitly addressing waste minimization or the health and safety of workers, indirectly contribute to these two objectives by reducing the quantity of radioactive material, the extent of contamination, and the time and complexity of component removal at the end of the facility operating life. The designs developed for Yucca Mountain Project SSCs incorporate features to ensure that potential worker doses are ALARA, functional and performance requirements for equipment are met, and the equipment configuration facilitates eventual decontamination and dismantlement.

Integrating ALARA requirements and principles into the evaluation of design concepts at the preliminary and detailed phases of design supports the systematic process of evaluating alternatives against requirements, criteria, and other design inputs that leads to a more refined, complete, and responsive design configuration. Integrating ALARA during design development and evaluation of alternative concepts facilitates consideration of design features that address:

- Controlling radioactive material
- Minimizing radioactive contamination of personnel, equipment, and areas
- Minimizing onsite generation of low-level radioactive waste and effluents
- Using remote controlled systems and shielded handling equipment to limit potential radiation exposures.

The following discussion provides examples of how specific design features that support ALARA are incorporated into the design of SSCs, and how these features support operational capabilities, and eventual decontamination, dismantlement, and decommissioning. Specific design features to facilitate decontamination, dismantlement, and permanent closure are also described in SAR Sections 1.12.1 and 1.12.3.

The initial design decision to manage spent nuclear fuel in sealed canisters within the nuclear facilities, except the Wet Handling Facility, reduces the potential for contamination of areas and consequently reduces the potential for subsequent decontamination.

The design considerations mentioned in SAR Section 1.12.1 parallel the considerations identified in YMRP, Section 2.1.3.2, and also include:

- Lined pool in the WHF to limit leakage and seepage into the surrounding concrete walls (SAR Section 1.2.5.3.2 and Figure 1.2.5-58)
- Confinement systems to control the spread of potential airborne radioactivity (SAR Section 1.2.2.3 and Table 1.2.2-13)
- High-efficiency particulate air (HEPA) filters to reduce the airborne radioactivity source terms (SAR Section 1.2.2.3.1).

Within the WHF, the use of a lined pool and curbs and berms is part of the process of incorporating design features that support waste minimization and the health and safety of workers as well as ALARA principles for decontamination and dismantlement. The development of the design for the WHF pool is based, in part, on requirements for consideration of decontamination and dismantlement as presented in Section 4.2.12.3.7 of the *Project Design Criteria* (BSC 2007). These requirements identify features that include:

- Interior finishes that have non-porous surfaces for ease of decontamination

- Special protective coatings for areas not covered with stainless steel cladding

- Protective coatings that are qualified and capable of surviving an event sequence without adversely affecting SSCs needed for mitigation of the event sequence.

In addition to these requirements for the configuration of the WHF pool, the pool water treatment system also incorporates ALARA design considerations (SAR Sections 1.2.5.3.2.1.1 and 1.2.5.3.2.2) that are intended to:

- Remove crud and particulates using filters
- Remove radionuclides to maintain low radioactivity levels in the pool
- Skim the surface of the pool water to remove crud and particulates
- Vacuum the pool walls and floors to remove crud and particulates.

Other ALARA considerations that are identified on the desktop information checklist for systems involving radioactive liquids include:

- Provisions to flush the entire system
- Flush connections with quick connect/disconnect fittings
- Equipment drains connected directly to a drainage collection system
- Minimize crud traps in mechanical joints
- Minimize low points and dead legs in piping.

These features not only reduce personnel exposures during operations, but also limit the contamination of the facility and simplify the activities that must be addressed during decontamination, dismantlement, and decommissioning.

The process of incorporating ALARA principles for decontamination and dismantlement is also applied to the design of HVAC systems for the surface nuclear facilities. The surface facilities utilize multiple barriers, including the HVAC systems, to mitigate the potential release of radioactivity and spread of airborne radioactive contamination. The HVAC systems include features to ensure reliable confinement and filtration of radiological releases. The HVAC systems in the surface nuclear facilities are designed to:

- Maintain airflow from areas of lesser contamination potential to areas of greater contamination potential

- Remove potentially contaminated airborne particulates from the exhaust

- Provide a release point to the atmosphere via continuously monitored discharge.

A key design feature of the HVAC systems for the surface nuclear facilities is the use of HEPA filters. Requirements for design of the HEPA filters (*Project Design Criteria* (BSC 2007), Section 4.9.2.2) ensure that the air filtration system design provides reliable confinement and filtration of potential radiological releases. The HVAC filtration system is supported by ductwork that may convey air that is potentially contaminated. Requirements for the ductwork

(*Project Design Criteria* (BSC 2007), Section 4.9.2.2.12) ensure that the design minimizes accumulation or trapping of potential contaminants and that the system is designed with access doors or hatches at strategic and accessible locations for such activities as radiation surveys and decontamination.

Finally, radioactive waste minimization and worker radiation safety do not solely depend on the design of the facilities, but are also highly dependent upon the planning for decontamination, dismantlement, and decommissioning and the operational radiation protection program. The planning activities for decontamination and dismantlement of the surface facilities are described in SAR Section 1.12.3. Based upon the facility assessments conducted during the planning phase, the radiation protection practices described in SAR Section 5.11.3 will be implemented. Radioactive material and contamination control along with radiation protection training will minimize waste generation and increase operator familiarity with the planned activities. Worker radiation safety will be accomplished through radiological postings, radiological access controls, onsite dose controls, internal and external dose monitoring, air sampling, and respiratory protection, as required.

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

4. REFERENCES

BSC (Bechtel SAIC Company) 2007. *Project Design Criteria Document*. 000-3DR-MGR0-00100-000-007 CBCN 017. Las Vegas, Nevada: Bechtel SAIC Company.
ACC: ENG.20071016.0005; ENG.20071108.0001; ENG.20080305.0002; ENG.20080305.0011; ENG.20080305.0012; ENG.20071220.0003; ENG.20080107.0001; ENG.20080107.0002; ENG.20080107.0016; ENG.20080107.0017; ENG.20080131.0006; ENG.20080306.0009; ENG.20080313.0004; ENG.20080710.0001; ENG.20081112.0006; ENG.20081114.0004; ENG.20090109.0005.

BSC 2008. *Basis of Design for the TAD Canister-Based Repository Design Concept*. 000-3DR-MGR0-00300-000-003. Las Vegas, Nevada: Bechtel SAIC Company.
ACC: ENG.20081006.0001; ENG.20090212.0008.