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June 9, 2003
Contract No. NRC-02-02-012
Account No. 20.06002.01.102

U.S. Nuclear Regulatory Commission
ATTN: Dr. Mysore S. Nataraja
Division of Waste Management
Two White Flint North
Mail Stop 7-C6
Washington, DC 20555

Subject: Repository Design and Thermal-Mechanical Effects Key Technical Issue Intermediate
Milestone No. 20.06002.01.102.331, Review of DOE Aircraft Crash Hazards
Reports—Letter Report

Dear Dr. Nataraja:

Attached is the Center for Nuclear Waste Regulatory Analyses document entitled "NRC Review of DOE Document Pertaining to Preclosure Agreement PRE.03.01." This document fulfills the requirements for the subject milestone, which is due June 10, 2003.

This report summarizes the staff review of DOE first report "Identification of Aircraft Hazards" in response to NRC-DOE Agreement PRE.03.01. The DOE aircraft hazards report presents description of different flight-related activities within a radius of 100 miles from the North Portal. The staff reviewed this report based on the information presented by the DOE, information obtained by the staff independently, and experience gained in the Private Fuel Storage Facility aircraft crash hazard analysis. The staff identified need for additional information, and appropriate and justifiable rationale for many conclusions presented in the DOE report. This review has been conducted by the CNWRA staff in collaboration with the NRC aircraft hazards expert Dr. Kazimieras M. Campe.

If you have any questions concerning this milestone, please contact me at 210-522-5151 or Amit Ghosh at 210-522-3314.

Sincerely,



Asadul H. Chowdhury, Manager
Mining, Geotechnical, and
Facility Engineering

AHC:cap
Attachment

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NRC Review of DOE Document Pertaining to Preclosure Agreement PRE.03.01

The U.S. Nuclear Regulatory Commission (NRC) goal of issue resolution during this interim preclicensing period is to assure the U.S. Department of Energy (DOE) has assembled enough information on a given issue for NRC to accept a license application for review. Resolution by the NRC staff during preclicensing does not prevent anyone from raising any issue for NRC consideration during the licensing proceedings. Also, and just as importantly, resolution by the NRC staff during preclicensing does not prejudice what the NRC staff evaluation of that issue will be after its licensing review. Issues are resolved by the NRC staff during preclicensing when staff have no further questions or comments about how DOE is addressing an issue. Pertinent new information could raise new questions or comments on a previously resolved issue.

This enclosure addresses Preclosure Agreement PRE.03.01, which was reached between DOE and NRC during a technical exchange and management meeting.¹ This agreement pertains to the assessment of hazards from potential aircraft crashes onto the surface facilities at the proposed repository. The agreement calls for identification of potential flight activities in the environment surrounding the proposed repository before undertaking a systematic approach to estimate the annual frequency of aircraft potentially crashing onto the surface facilities. The first part of this agreement is addressed by DOE in Bechtel SAIC Company, LLC (2002), which is the subject of this review.

Preclosure Agreement PRE.03.01

Wording of the Agreement: Preclosure Agreement PRE.03.01 states, "Provide a plan for identification and estimation of aircraft hazards for the license application. This plan should be consistent with the guidelines in NUREG-0800 and other applicable DOE standards, as appropriate, to a nuclear waste repository. Provide a map delineating the vicinity to be considered in the detailed analysis, taking into consideration available information for civilian and military aircraft, including information from federal and local agencies concerning how such activities may reasonably change. Participate in an Appendix 7 meeting to discuss the aircraft hazards plan, initial data collection and analysis, development of the vicinity map, and the appropriate level of detail for analyses to be presented in the license application assessment. DOE agrees with the request and will provide the plan and map in June 2002. DOE agrees to participate in an Appendix 7 meeting which will be scheduled after the plan and map are provided."

¹Reamer, C.W. "U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Pre-Closure Safety (July 24-26, 2001)." Letter (August 14) to S. Brocoun, DOE. Washington, DC: NRC. 2001.

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NRC Review

Background:

DOE, as a part of a license application for the proposed geologic repository at Yucca Mountain, must present a safety analysis of the repository operations area for the preclosure period. This analysis is necessary to demonstrate compliance with the preclosure performance objectives of 10 CFR 63.111 that meet the requirements specified in 10 CFR 63.112. A preclosure safety analysis requires a systematic examination of the site; design; potential hazards, initiating events, and event sequences; and radiological dose consequences to the public and workers. DOE (CRWMS M&O, 1999a) conducted an analysis to estimate the hazards to the proposed repository at Yucca Mountain from potential aircraft crashes using the suggested methodology of NRC (1981) and DOE (1996) and concluded the annual frequency of this initiating event is less than 10^{-6} . Consequently, DOE (CRWMS M&O, 1999b; DOE, 2001; Bechtel SAIC Company, LLC, 2001) excluded the aircraft crash hazard from the list of credible hazards requiring further consideration.

NRC (1981) specifies that the probability of aircraft crash is considered to be less than about 10^{-7} per year by inspection if the distance from the facility (e.g., a nuclear power plant) meets all the following requirements:

- (a) The facility-to-airport distance D is between 8 and 16 km [5 and 10 statute miles], and the projected annual number of operations is less than $500 \times D^2$, or the facility-to-airport distance D is greater than 16 km [10 statute miles], and the projected annual number of operations is less than $1,000 \times D^2$ (D is in miles).
- (b) The facility is at least 8 km [5 statute miles] from the edge of military training routes, including low-level training routes, except for those associated with a usage greater than 1,000 flights per year, or where activities (such as practice bombing) may create an unusual stress situation.
- (c) The facility is at least 3.1 km [2 statute miles] beyond the nearest edge of a federal airway, holding pattern, or approach pattern.

If the previous proximity criteria are not satisfied or if sufficiently hazardous military activities are identified, a detailed review of aircraft crash hazards must be performed (NRC, 1981).

Civilian Radioactive Waste Management System Management and Operating Contractor (CRWMS M&O) (1999a) concluded that only proximity criterion (c) of NRC (1981) was not satisfied for military aviation because the facility is within 3.2 km [2 statute miles] of the nearest edge of a federal airway, holding pattern, or approach pattern and, therefore, an analysis estimating the annual crash frequency of military aviation needed to be provided. Therefore, CRWMS M&O (1999a) provided an estimate of the military aircraft crash hazard for the proposed repository.

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The NRC staff disagreed¹ with the conclusion that criterion (b) of NRC (1981) had been met for the proposed repository site. The number of flights per year, as considered in CRWMS M&O (1999a), exceeded 1,000 by a significant margin (12 to 15 times), and these flights create unusual stress situations as they are flown in the restricted airspaces conducting combat maneuvers, bombing runs, or both. It should be noted also the previous screening criteria are for nuclear power plants, none of which are located under a restricted military airspace. Therefore, criterion (b) was not satisfied and, consequently, a detailed analysis would be necessary, in accordance with NRC (1981). The annual aircraft crash probability at the proposed facility will be the summation of probabilities from all types of aircraft engaged in different operations.

The NRC staff also stated that the information provided lacked sufficient detail to develop an understanding of activities conducted near the proposed repository by U.S. military aircraft that may have an impact on the proposed repository operations. For example, no information on flight paths for an aircraft flying in the vicinity of the proposed site was provided. Similarly, information was lacking on nearby areas where training activities, such as air-to-air and air-to-ground combat training, are conducted that may affect the safety of the proposed repository during the preclosure period. No justification was provided for classifying all military aircraft flights in the vicinity of the potential repository surface facilities as normal inflight mode. Additionally, CRWMS M&O (1999a) assumed 29 percent of all aircraft would be F-16s, 63 percent would be F-15s, and 7 percent would be A-10s. No basis however, was provided for these assumptions. Data from Nellis Air Force Base, presented in Table 7.2-3 of CRWMS M&O (1999a), contradicted these assumptions. CRWMS M&O (1999a) did not provide information on the ordnance carried onboard these aircraft. Moreover, CRWMS M&O (1999a) assumed that information provided by Nellis Air Force Base to DOE in 1997 on expected air traffic and types of aircraft currently flying through restricted airspace R-4808N is representative of aircraft flying at the time of repository operation, without providing justification.

Based on review of CRWMS M&O (1999a), the NRC staff concluded that exclusion of aircraft crash hazard during the preclosure period was premature. There was significant lack of specific information about the potential aircraft activities in the vicinity of the proposed site. Explicit and inherent assumptions and the technical bases used in the analysis were not justified adequately. Additionally, uncertainties in the data, compounded by lack of specific information, were not characterized adequately. The NRC staff communicated these issues to DOE at the Technical Exchange and Management Meeting for Preclosure Safety.

DOE agreed at this Technical Exchange and Management Meeting for Preclosure Safety that exclusion of this hazard was premature and stated it had completed only preliminary analysis on this topic. DOE further committed to include a more extensive evaluation in the license application. And, DOE agreed to develop a vicinity map with aircraft types and activities identified including military and commercial aircraft, commercial general aviation, DOE aircraft, and aircraft chartered by DOE. The map would include aircraft flying through airways and inside

¹Reamer, C.W. "U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Pre-Closure Safety (July 24-26, 2001)." Letter (August 14) to S. Brocoun, DOE. Washington, DC: NRC. 2001.

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the restricted airspaces and those operating at nearby airports. The vicinity map would also include the flight paths of military aircraft inside the restricted airspaces in addition to military training routes, target areas within the range, and use of airspace for other activities. The DOE Yucca Mountain Project Office would analyze information collected by the DOE/Nevada Operations Office on the number of overflights by military aircraft through a 11.2-km [7-mi] square box centered on the location of the Waste Handling Building and through the Nevada Test Site (NTS). DOE also committed to work with the U.S. Air Force to obtain available information regarding future flight activities, aircraft types, and changes in military missions. DOE also agreed to obtain information from the DOE/Nevada Operations Office regarding potential changes to flight activities in the DOE controlled airspace over the Nevada Test Site. And, DOE agreed to collect information on the flight modes of military aircraft in the vicinity of the proposed site and use it in the revised analysis. DOE confirmed that, in the revised analysis, it would appropriately account for emergency aircraft, ordnance carried onboard the aircraft while flying in the vicinity of the proposed site, and helicopters. DOE also agreed to collect information from the U.S. Air Force on air-to-ground and air-to-air combat training activities that may be conducted in the vicinity of the proposed site. Additionally, DOE agreed to sum the annual crash frequencies from all sources. Consequently, DOE and NRC reached agreement PRE.03.01.

DOE Report: DOE submitted the report Bechtel SAIC Company, LLC (2002), as a partial response to agreement PRE.03.01. Bechtel SAIC Company, LLC (2002) provides information about the flight environment within a radius of 160 km [100 statute miles] of the North Portal of the proposed repository at Yucca Mountain. The discussion given next is summarized from Bechtel SAIC Company, LLC (2002). The airspace within this region includes

1. Nevada Test and Training Range (NTTR) (which includes the proposed repository facility at Yucca Mountain)
2. R-2508 Range Complex including China Lake Naval Weapons Center
3. Airspace supporting the NTTR
4. Civilian, DOE, and military airports and airfields
5. Federal airways
6. Ground-to-ground missile testing at the NTTR
7. Kistler Corporation.

NTTR: NTTR consists of airspace, land, and infrastructure for use by the military. The airspace and land are divided into restricted areas (R-4806E, R-4806W, R-4807A, R-4807B, and R-4809 excluding R-4809A, which is controlled by DOE) and military operating areas (MOAs) (Reveille and Desert). The restricted areas are divided into North Range and South Range separated by the NTS.

North Range: The North Range is approximately 7,284 km² [1.8 million acres] of withdrawn land. Restricted airspaces R-4807A, R-4807B, and R-4809 belong to the North Range. The North Range contains three electronic combat ranges (Tonopah, Tolicha Peak, and Electronic Combat South), four unmanned weapons delivery subranges, Tonopah Test Range, and Pahute Mesa area, which is operated by DOE.

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Restricted area R-4807A includes 70 Series ranges, Tolicha Peak Electronic Combat, and Electronic Combat South Ranges. The 70 Series ranges are divided into several additional sub-ranges, the closest ones with tactical targets (Ranges 74B and 74C) are approximately 58 km [36 mi] from the proposed site for the surface facilities. The closest boundary of the Electronic Combat South Range is approximately 8 km [5 mi] from the site for the proposed surface facilities. It is a manned electronic combat threat simulator range and does not have any bombable targets. No ordnance dropping is permitted within the Electronic Combat South Range. Ceasar corridor, 4,267 m [14,000 ft] above mean sea level, overlies the Electronic Combat South Range and is used for recovery from the northern ranges to Nellis Air Force Base. Tolicha Peak Electronic Combat range is located at the southwest corner of R-4807A. It is a manned combat threat simulator range. No ordnance dropping is permitted there.

Restricted airspace R-4807B (Pahute Mesa) is used as an annex to the NTS by DOE. The U.S. Air Force is allowed to use this airspace for overflight. The closest boundary of R-4807B is approximately 48 km [30 mi] from the North Portal area.

R-4809 contains the Tonopah Electronic Combat range. The Tonopah Electronic Combat Range is also a manned electronic combat threat simulator range located approximately 79 km [49 mi] from the North Portal area. No ordnance dropping is permitted within this range. The Tonopah Test Range Airfield is located within this range and can be used for diverting aircraft experiencing in-flight emergencies. The closest boundary of R-4809 is at least 79 km [49 mi] from the North Portal area.

South Range: The South Range is approximately 4,856 km² [1.2 million acres] of withdrawn land and contains five areas used for weapons delivery. This range is subdivided into restricted areas R-4806E and R-4806W. R-4806E is used primarily for air-to-air training, and the closest boundary is approximately 100 km [62 mi] from the proposed repository surface facilities. R-4806W contains the 60 Series ranges. These ranges are used for conventional bombing and for gunnery testing and training. Additionally, the U.S. Air Force Thunderbirds Demonstration Squadron frequently practices in one of those ranges. The closest boundary of these ranges to the proposed surface facilities is approximately 43 km [27 mi].

NTS: The NTS is operated by DOE and lies underneath restricted areas R-4808N and R-4808S. R-4808N is exclusively and continuously controlled by DOE and is divided into restricted airspaces R-4808A, R-4808B, R-4808C, R-4808D, and R-4808E. The surface facilities of the proposed repository would be located beneath restricted airspace R-4808E. R-4808S is jointly used by the NTS, Nellis Air Traffic Control Facility, and Federal Aviation Administration (FAA) Los Angeles Air Route Traffic Control Center for overflights by civilian aircraft. R-4808A is not used for any flight training activities. Any overflight through this space is by emergency aircraft or other aircraft on approved missions subjected to restrictions.

DOE permits military aircraft to transit R-4808 across the Nevada Test Site for entering or exiting the ranges in the north. Aircraft flying through this space are not restricted to any specific corridor. Consequently, direct overflights of the proposed location of the surface facilities are possible by some aircraft.

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R-2508 Complex Including China Lake Naval Weapons Center: This airspace is located west and southwest of the proposed repository site. The airspace and associated land are currently used and managed by Edwards Air Force Base, National Training Center, Fort Irwin, and Naval Air Warfare Center Weapons Division, China Lake. The closest boundary of this complex is approximately 58 km [36 mi] from the North Portal.

Airspace Supporting NTTR: There are several airspace support activities at NTTR. These activities include (1) low altitude training navigation (LATN) areas, (2) military training routes (IR-286, VR-222, VR-1214, IR-279, and IR-282), and (3) air refueling tracks.

(1) LATN Areas: LATN areas are located east and southwest of NTTR for use by A-10s and helicopters to practice random selection of navigational points and low altitude tactical formation flying between 33 and 457 m [100 and 1,500 ft] above ground level. The LATN area southwest of NTTR is approximately 1.6 km [1 mile] from the proposed repository surface facilities. The U.S. Air Force uses LATN areas when airspace within NTTR is not available for this type of training. Approximately 30 to 35 A-10 sorties are conducted weekly in the southwest LATN area.

(2) Military Training Routes: Military training routes IR-286, VR-222, and VR-1214 are close to the North Portal area. IR-286 is 30 km [16 nautical miles (18.4 statute miles)] wide. The closest edge of this route is approximately 8 km [5 mi] from the North Portal area. Approximately 21 annual sorties use this route. VR-222 is 19 km [10 nautical miles (11.6 statute miles)] wide. The closest edge is approximately 6.4 km [4 mi] from the North Portal area. Approximately 550 annual sorties are estimated to use this route. VR-1214 is 19 km [10 nautical miles] wide. The North Portal area is approximately 21 km [13 mi] from the closest edge of this route. The last segment of IR-279 enters restricted airspace R-4809. Approximately 155 sorties use this route annually. Approximately 12 sorties annually use route IR-282. The last segment of this route enters restricted airspace R-4807A. Bechtel SAIC Company, LLC (2002) did not provide information on the distances of these two military training routes from the North Portal area.

(3) Air Refueling Tracks: Bechtel SAIC Company, LLC (2002) identified three air refueling tracks within the 160-km [100-mi] region that are used to support activities in NTTR. The closest edge of any of these refueling tracks is 126 km [78 mi] from the North Portal area.

Civilian, and Military Airports and Airfields: Bechtel SAIC Company, LLC (2002) listed all the airports within 160 km [100 mi] of the North Portal of the proposed repository at Yucca Mountain. Airports and airfields with a high volume of traffic and within reasonable proximity to the proposed repository site have been discussed with more details about flight operations. Discussions of flight operations are given for Indian Springs Air Force Auxiliary Field, Tonopah Test Range Airfield, Nellis Air Force Base, Desert Rock Airport, Pahute Mesa Airstrip, Yucca Airstrip, Beatty Airport, Jackass Aeropark, Furnace Creek Airport, Invite Airfield, McCarran International Airport, and North Las Vegas Airport.

Nellis Air Force Base is approximately 145 km [90 mi] from the North Portal area. Operations (takeoffs and landings) totaling 62,421 took place at Nellis Air Force Base in 2001. Indian Springs Air Force Auxiliary Field is approximately 72 km [45 mi] from the North Portal area and

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is located on the southern boundary of R-4806. It provides basing for operations for unmanned aerial vehicles and support for aircraft staging. It is also used as an emergency/divert base for NTTR operations and is the primary training base for the Thunderbirds Air Demonstration Squadron. Bechtel SAIC Company, LLC (2002) states, "... the flight activity at this airfield can change as new test and development programs are introduced." Two hundred operations took place at Tonopah Test Range Airfield in 2001. This airfield is approximately 106 km [66 mi] from the North Portal area.

McCarran International Airport is approximately 143 km [89 mi] east-southeast of the North Portal, having 476,511 total annual operations that include 281,214 air carriers; 71,998 air taxi; 15,777 local aircraft; 89,038 itinerant private aircraft; and 18,484 military aircraft operations. North Las Vegas Airport is approximately 132 km [82 mi] east-southeast of the North Portal. Annual operations include 77,559 air taxi; 116,264 local aircraft; 81,479 itinerant private aircraft; and 84 military aircraft operations totaling 275,386. Beatty Airport is approximately 34 km [21 mi] west of the North Portal and has 1,005 annual operations. The Jackass Aeropark, located approximately 24 km [15 mi] from the North Portal, has 604 operations annually. The Furnace Creek Airport is located approximately 60 km [37 mi] from the North Portal with annual operations totaling 10,200. Invite Airfield, owned by a division of Floridin Company, is approximately 45 km [28 mi] south of the North Portal. Currently it is inactive and has zero operations.

Desert Rock Airport is approximately 43 km [27 mi] from the North Portal. The runway is oriented in such a way that landings and takeoffs are toward the northeast/southwest. Based on information from the DOE Airspace office, 330 operations have taken place each year since 1995. Pahute Mesa Airstrip is approximately 29 km [18 mi] from the North Portal with an estimated 80 operations annually. The Yucca Airstrip has not been used since 1995.

Federal Airways: Bechtel SAIC Company, LLC (2002) listed all the airways within 160 km [100 mi] of the North Portal of the proposed repository at Yucca Mountain. Only two jet routes, J86 and J92, and two Victor routes, V105 and V135, are within 32 km [20 mi] from the North Portal area.

Jet route J86 departs from McCarran International Airport and continues toward the Beatty Very High Frequency Omnidirectional Range Station, the Tactical Air Navigation (VORTAC), or both where it joins with jet route J92. The width of this airway (J86) is 35 km [22 mi], and the boundary is 11 km [7 mi] from the North Portal, which is the closest distance from the North Portal and the R-4808S boundary. Route J92 is 35 km [22 mi] wide and goes to Reno, Nevada. Aircraft flying in this route can be as close as 11 km [7 mi] to the North Portal. Victor routes V105-V135 begin south of the NTS and head northwest paralleling NTTR and then split. V105 continues to Reno. V135 terminates at Tonopah Airport. The width of both these airways is 35 km [22 mi]. The nearest point of these airways to the North Portal is approximately 11 km [7 mi].

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Ground-to-Ground Missile Testing at the NTS: No launches of ground-to-ground missiles have been conducted in Area 26 since June 2000. Area 26 is approximately 23 km [14 mi] from the North Portal. Bechtel SAIC Company, LLC (2002) stated no launches are anticipated in the near future. Additionally, there are no forecasts testing would be started again in future.

Kistler Corporation: The Kistler Aerospace Corporation is developing a reusable space launch vehicle and has plans to use part of Area 18 of the NTS for operations. Bechtel SAIC Company, LLC (2002) stated no launches are anticipated in the near future.

Staff Comments: Staff has reviewed the report prepared by Bechtel SAIC Company, LLC (2002) and developed the following comments. DOE needs to provide the requested additional information and rationale in response to the comments.

1. A significant portion of the information regarding NTTR and associated activities has been taken from the U.S. Air Force (1996, 1999). Therefore, information presented is at least 4 years old. DOE should commit to updating all information used in aircraft crash hazard analysis for a license application. Some information, such as the number and type of aircraft flown and mode of flight, can be time-dependent. Hence, it is important to use the latest data available. Projected estimates also are needed in cases where there is evidence of data trending, because current conditions may not be applicable at the end of the facility license.
2. In Section 5.1.4, Ordnance Used at the Nevada Test and Training Range, Bechtel SAIC Company, LLC (2002) stated, "the range operating agency must ensure that weapon safety footprints exist for all aircraft, weapons, and tactics authorized for a given target and event on the range." A similar and more detailed discussion of safety footprints is provided in Section 6.2.1.3, Ordnance Fired from Aircraft. DOE should determine how this information translates into the likelihood of ordnance impacting the North Portal. For example, Section 6.2.1.3 indicates there are procedures for dealing with safety footprints that may extend beyond the boundaries of the range to be employed. In the event that off-range hazard cannot be eliminated, the procedure is for the range operating agency to assess the hazard and "make an informed decision" on its acceptability. DOE should determine, as a minimum, the degree of compatibility of the hazards acceptance criteria used by the range operating agency and NRC. Bechtel SAIC Company, LLC (2002) showed the locations of the north and south target sites in Figure 7. DOE should provide the safety footprint information superimposed on these locations of the target sites to demonstrate that any structures, systems, and components important to safety would not be affected by any ordnance accidentally delivered outside the intended region. An alternate approach is to map historical data of actual off-range ordnance deliveries and use the data to estimate the likelihood of ordnance impacting the North Portal. Results of this assessment should be included in the aircraft crash hazard analysis.
3. From the discussion in Section 5.1.4.1, Air-to-Ground Ordnance, of Bechtel SAIC Company, LLC (2002), the flight paths for air-to-ground ordnance (rockets and cruise missiles) with respect to the proposed repository location are not clear. No information

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has been provided regarding the number of each type of weapon used annually, safety precautions taken to ensure that weapons do not fly or impact outside the intended region, and region(s) of discharge and impact. Additionally, Section 6.2.1.3, Ordnance Fired from Aircraft, of Bechtel SAIC Company, LLC (2002) did not provide any information on testing cruise missiles, including the tests performed at Tonopah Test Range. All necessary information should be provided.

4. In Section 6.2.1.1, Training More Than 30 Miles from the North Portal at Yucca Mountain, Bechtel SAIC Company, LLC (2002) stated, "... range safety practices will preclude the activities from having an adverse impact on Yucca Mountain Project (YMP) operations." No information, however, has been provided on range safety practices. Additionally, no rationale or basis has been provided for this conclusion.
5. Bechtel SAIC Company, LLC (2002) defined air refueling of aircraft as a routine operation and stated that required safety practices would prevent a crash. Any damage to the fighter aircraft being refueled would be localized, and the aircraft could recover to a suitable airfield, Bechtel SAIC Company, LLC (2002) did not provide any basis (e.g., historical crash data however, for these assumptions. Although air refueling is routine, it is still a hazardous activity and has caused aircraft crashes (e.g., crash of an F-16 aircraft on 23 January, 1992 that involved air refueling).
6. DOE should clarify the statement, "... inert or live ordnance that is hung unsecured must be jettisoned from the aircraft." Ordnance is considered hung when it does not jettison when ordered. DOE should specify the safety precautions and actions taken for with hung ordnance. In addition, DOE should provide the flight paths for recovery to Nellis Air Force Base or Indian Springs Air Force Auxiliary Field in case of hung ordnance. DOE should also clarify what is meant by "critical inflight emergencies" that would allow an aircraft with hung ordnance to transit through restricted airspace/area R-4808N.
7. In Section 6.2.1.5, Large Multi-Engine Aircraft within the 30-Mile Criterion Zone, Bechtel SAIC Company, LLC (2002) stated aircraft with engine failure would still be able to return to the base. This assumption should be clarified to indicate it refers to multiengine aircraft. Furthermore, the likelihood of losing power to all engines should be stated to make the assumption valid.
8. In Section 6.2.2.2, Military Training Routes, Bechtel SAIC Company, LLC (2002) concluded that aircraft flying on military training routes located more than 32 km [20 mi] from the North Portal at Yucca Mountain do not pose a hazard to that facility. It is not clear if Bechtel SAIC Company, LLC (2002) considered zooming operations by pilots experiencing inflight emergencies.
9. In Section 6.2.2.2, Military Training Routes, Bechtel SAIC Company, LLC (2002) argued that selection of the 32-km [20-mi] criterion zone is conservative when comparing it with

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proximity criterion (b) of NRC (1981). However, comparison with this criterion is not appropriate because the three criteria in NUREG-0800 were established to determine if a detailed analysis is required for a facility (e.g., a nuclear power plant) to assess aircraft crash hazard.

10. In several sections of the report (e.g., Appendix G; Section 6.3.1.1.2, Desert MOA; Section 6.3.1.1.3, 70 Series Ranges; Section 6.3.1.1.4, Electronic Combat Ranges; and Section 6.3.1.1.6, 60 Series Ranges), Bechtel SAIC Company, LLC (2002) claimed a pilot experiencing problems would direct the aircraft away from the Yucca Mountain site. For example, Section 6.3.1.1.2, Desert MOA, states, "... if the aircraft has glide capability and depending on the altitude, the pilot will direct the aircraft away from the range boundaries to a suitable ejection area within one of the valleys located in the Coyote MOA; the pilot would eject and the aircraft would most likely crash into the surrounding mountains of the Coyote MOA." Similarly, Section 6.3.1.1.4, Electronic Combat Ranges, states, "... pilots preparing to eject would avoid the mountainous western and southern areas resulting in the aircraft moving away from Yucca Mountain." Section 6.3.1.1.3, 70 Series Ranges, states, "... range 75E/W has a mountain range that borders the eastern boundary and several radioactive contaminated areas adjacent to the southern border (Pahute Mesa) that make those areas unattractive for pilot ejection." Section 6.3.1.1.6, 60 Series Ranges, states that "if the aircraft has glide capability and depending on the altitude, the pilot will direct the aircraft away from mountainous terrain." It also states, "... a suitable ejection area is within the flatter terrain found in Indian Springs Valley."

Pilot actions in ejection site selection and aircraft direction prior to ejection are achievable if there is sufficient time and control of the aircraft. Emergency procedures require pilots to perform numerous actions that may encroach on the pilot's ability to exercise the appropriate ejection options. Even with sufficient time and control, other factors (e.g., weather, visibility, or ground feature recognition) may limit the ejection options available to the pilot. Hence, the likelihood of successful ejection location (where the pilot ejects from the aircraft) and aircraft impact location (where the aircraft impacts after the pilot has ejected from the aircraft) needs to be estimated.

11. In Section 6.3.1.1.5, Ordnance, Bechtel SAIC Company, LLC (2002) concluded that instructions from operating and controlling agencies of NTTR provide assurance that weapon training activities would not pose a credible hazard to the proposed repository operations. No information however, has been provided for the safety instructions that would prohibit ordnance used in training activities from impacting any safety-related structures, systems, and components at the proposed repository.
12. In Section 6.1, Qualitative Approach to Hazard Screening, Bechtel SAIC Company, LLC (2002) stated it "screened out event sequences considered not credible" using "criteria based on qualitative and quantitative bases that include distance, flight characteristics and pilot actions." It is not clear what quantitative information has been used to characterize flight activities and pilot actions. No information has been presented on the mode of flight, which is an essential element of flight characteristics, used to determine the appropriate crash rate for a particular aircraft (DOE, 1996; Kimura et al., 1996).

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Additionally, no initiating events and event sequences have been identified in the report. Therefore, it is not clear how some event sequences were eliminated without information on the frequency of occurrence or estimated dose consequences. DOE should identify the initiating events and event sequences and provide an analysis using Probabilistic Safety Assessment methodology, including the estimated frequency of occurrences and associated uncertainties, to eliminate event sequences. Additionally, DOE should identify the qualitative (description and characteristics of the facilities and equipment, distance of the activity from the North Portal, identification of initiating events that could occur during the activity, identification of probable event sequences following the initiating event, and determination of the credibility of these off-normal event sequences impacting the repository facilities and operations) and quantitative (distance, flight characteristics, and pilot action) parameters used in assessing potential hazards for each case. Moreover, DOE should define what is meant by off-normal events in the context of 10 CFR Part 63.

13. In Section 5.8, Commercial Rocket Launch and Retrieval, Bechtel SAIC Company, LLC (2002) should update this information because Kistler Aerospace Corporation has received approval from the FAA for operations in Area 18 of the NTS. A safety analysis is needed to demonstrate that operations by Kistler Aerospace Corporation in Area 18 would not pose any undue hazard to the proposed repository.
14. Many statements in Appendix G are not substantiated by rationale, bases, or historical data. For example, the Appendix states, "... it is expected that in a controllable situation at high altitudes, the pilot would eject between 10,000 and 15,000ft AMSL (approximately 5,000 and 10,000 feet AGL assuming a ground elevation of 5,000 feet) after unsuccessful restart." No basis for such expectation has been presented. Similarly, while discussing gravity-induced loss of consciousness of the pilot, it is stated, "... if the aircraft is at a high altitude and not in vertical descent, the pilot will regain control and a crash is averted." No basis for such an expectation has been presented. Also, stated in Appendix G is that "a disabling event at high altitudes would result in either immediate descent of the aircraft with pilot ejection or a controlled descent, providing time for pilot action prior to ejection." Again, no basis has been provided. Bechtel SAIC Company, LLC (2002) stated, "... [a]n engine fire could result in an immediate pilot ejection. It is expected that this would result in an in-flight explosion of the aircraft or a nearby crash of the aircraft depending on its altitude, speed, and direction." Again, no actuarial information or rationale has been presented to justify such expectations. In this Appendix, it is stated pilot errors resulting in crash are caused by midair collisions with other aircraft or collisions with the ground. In making this conclusion, Bechtel SAIC Company, LLC (2002) did not include crashes that originated because of pilots losing situational and/or positional awareness. DOE needs to update Appendix G with defensible and acceptable information from, or references to, authoritative sources.
15. It is not clear for which year the flight information given in Table 1 of Bechtel SAIC Company, LLC (2002) was compiled. DOE should clarify the year of this information and source from which the number of flights in each military training route was estimated. Similarly, other information should be identified by year.

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16. Several figures in this report, such as Figure 4 and Figure 7, are not legible. DOE should provide better quality figures. Additionally, some figures, such as Figure 2, lost detail when scanned from the original source. These figures need to be updated if vital information was lost in the scanning process.

Additional Information Needed

Based on the staff review, as outlined previously, many issues are unresolved. In several cases, sufficient information has not been provided to make a conclusion. In some cases, conclusions have been reached without considering alternate, more probable scenarios. In other cases, either inadequate or unacceptable bases or information has been provided. Therefore, the staff conclude that additional information, appropriate rationale, and alternate scenarios are needed to determine/render conclusions with respect to aircraft hazards.

Status of Agreement

Preclosure Agreement PRE.03.01 requires additional information. This report is a first step toward resolving this agreement.

References

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