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MOL.19981221.0203

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Design Analysis Cover Sheet

Complete only applicable items.

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Page: 1 Of: 28

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11. REMARKS

Document prepared, checked, and reviewed under DI# B00000000-01717-0200-00136.

This document has three numbered TBVs.
TBV-1034 addresses the types and number of military aircraft flying in the vicinity of the potential repository.
TBV-1035 addresses limitations on DOE/NVO helicopter flight routes.
TBV-690 addresses the preclosure period.

This analysis was prepared and completed under QAP-3-9 Rev 8 because checking and design review was completed prior to issuance of AP-3.10Q Rev 0.

This analysis based its Crash Hit Frequency Evaluation Criteria (Section 4.2) on the 64 FR 8640, the NRC Proposed Rule 10 CFR 63. A review has determined that the changes made to the proposed rule 10 CFR 63 by the "Revised Interim Guidance Pending Issuance of New U.S. Nuclear Regulatory Commission (NRC) Regulations (Revision 01, July 22,1999), For Yucca Mountain, Nevada," dated September 3, 1999 do not impact the basis for this criteria.

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Design Analysis Revision Record

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2. DESIGN ANALYSIS TITLE
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CONTENTS

TABLES

FIGURES

1. PURPOSE

Aircraft crashes were determined to be potentially applicable to the potential repository at Yucca Mountain in the *Preliminary MGDS Hazards Analysis* (CRWMS M&O 1996). This determination was conservatively based on limited knowledge of the flight data in the area of concern and the crash data on aircraft of the type flying near the repository. It is intended that the MGR Aircraft Crash Frequency Analysis will meet the requirements of the U.S. Nuclear Regulatory Commission (NRC) NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants* (NRC 1987). As such it will establish the frequency of aircraft crashes into radioactive material control facilities at the repository. The results of this analysis will determine if an aircraft crash event is credible and warrants performing consequence analyses needed to quantify the risk of public exposure to radioactive materials.

2. QUALITY ASSURANCE

In accordance to QAP-2-0, *Conduct of Activities*, the Quality Assurance (QA) program applies to this analysis since it determines whether aircraft crashes need to be considered as a design basis event requiring detailed accident analyses. These subsequent detailed analyses could potentially identify quality-affecting items subject to QA controls.

This document uses qualified, accepted, and existing data. According to NLP-3-15, *To Be Verified (TBV) and To Be Determined (TBD) Monitoring System*, data that will be used as part of a verified design package to be released to another organization need to be controlled as TBV in accordance with NLP-3-15. Since the results of this analysis could impact other organizations, all existing data will be controlled with numbered TBV's.

3. METHOD

The primary approach to be used in this analysis is defined in NUREG-0800 (NRC 1987). Section 3.5.1.6, *Aircraft Hazards*, of this NUREG addresses aircraft hazards to nuclear power plant; however, this same methodology can be applied to other nuclear facilities. The NUREG includes proximity criteria, which, if met, would dismiss the event by inspection. If the proximity criteria are not met, a detailed review of the aircraft hazards must be performed. The NUREG defines a process to be used by the NRC staff in reviewing the applicant's assessment of aircraft hazards. This process includes models for determining the probability of an aircraft crash at the MGR site from airways, airports, and designated airspaces. The total aircraft hazard probability at the repository equals the sum of the individual probabilities obtained from these models. The aircraft crash hazard defined in CRWMS M&O (1996), involves military aircraft flying through the R4808N restricted airspace (DMA 1995) over the Nevada Test Site (NTS) which includes the site of the potential repository surface facilities. These aircraft are at high altitudes in an enroute/inflight phase while inside the R4808N airspace. Although they are not flying in standard Federal Aviation Administration (FAA) airways, they fly within specifically defined areas. The model provided in NUREG-0800 (NRC 1987) for airways was used to approximate the crash frequency and determine if the event is credible. The interpretation of the NUREG-0800 (NRC 1987) airways model and the frequency analysis are presented in Section 7.2. This section will also determine the contribution, if any, from the airport and airspace models as required by NUREG-0800 (NRC 1987).

Because use of the NUREG-0800 (NRC 1987) airway model may be conservative for this application, another model was evaluated to provide a comparative analysis. Details of this other model and the resultant analysis are provided in Section 7.3.

4. DESIGN INPUTS

4.1 Design Parameters

This analysis does not perform a design function; however the following qualified or accepted values were used for the following parameters.

4.1.1 The effective crash area bounds the design presented in the Surface Nuclear Facilities Space Program Analysis and the Repository Surface Design Site Layout Analysis.
Basis: CRWMS M&O 1997a and CRWMS M&O 1997b
Data Status: Qualified
This parameter is used in Section 7.2.4.

4.1.2 The coordinates of the repository facility location are 36° 51' and 116° 25'.
Basis: CRWMS M&O 1997b, Figure 8 and CRWMS M&O 1999
Data Status: Qualified
This parameter is used in Section 7.2.2.

4.1.3 There are no airports within 10 statute miles of the potential repository surface facilities at Yucca Mountain.
Basis: DMA 1995 and Redding 1998
Data Status: Accepted. The data taken from official maps and State of Nevada reports to the FAA are considered generally accepted by the scientific and engineering community.
This parameter is used in Section 7.1.

4.1.4 The crash rate per mile used in the analysis varies by aircraft type as listed in the analysis.
Basis: DOE 1996
Data Status: Accepted. The data is part of the DOE standard, which has been accepted by the engineering community that performs safety analysis.
This parameter is used in Section 7.2.1.

4.2 Criteria

Crash Hit Frequency Evaluation Criteria: The results of the MGR Aircraft Crash Frequency Analysis will be compared with an evaluation criterion that determines if a crash hit event is credible. A crash hit event is defined as an aircraft impacting a potential repository surface radiological control facility that has sufficient radionuclide inventory to exceed the proposed rule 10 CFR 63 (64 FR 8640) dose limits if released. The event is not credible and needs no further analysis if it meets the following criteria:

The Crash Hit Frequency of an aircraft into a radiological control facility from all types of aircraft shall be less than 1E-6/year. The proposed rule 10 CFR 63 (64 FR 8640) defines Category 2 events as other natural and human-induced events that have at least one chance in 10,000 of occurring before permanent closure of the MGR. The performance requirement for retrieval is assumed to require 100 years (Asumption 4.3.5) from the time of initial spent nuclear fuel/high-level waste receipts until permanent closure of the repository.

Design Criteria: This analysis does not perform a design function; however, this analysis is an input to Design Basis Event (DBE) analysis, which, in turn, affects design. Therefore, YMP/CM-0023, *Repository Design Requirement Document* (DOE 1994) requirements for DBEs are indirect requirements for this analysis. Although this document is only applicable to Viability Assessment design, the following requirement from Section 3.2.4.6 C, *Aircraft*, of this document is considered applicable to the License Application design.

"Unless the safety analysis can demonstrate that the risk from an aircraft crashing into the facility is acceptable, potential aircraft crashes shall be considered among the spectrum of man made missiles that confinement structures must be designed to withstand or against which they must be protected."

4.3 Assumptions

4.3.1 The data provided by Nellis Air Force Base (NAFB), are assumed to represent the expected air traffic counts at the time of repository operation.
Basis: Tullman 1997, Long 1997, and LLNL 1998
Data Status: Existing (TBV-1034)
This assumption is used in Section 7.2.3.

4.3.2 The types of aircraft currently flying through the R4808N restricted airspace are assumed to represent those flying at the time of repository operation.
Basis: Tullman 1997
Data Status: Existing (TBV-1034)
This assumption is used in Section 7.2.1, 7.2.3, 7.2.4, and 7.3.

4.3.3 Aircraft during transit through the R4808N restricted airspace are assumed to be randomly distributed across the width of the airspace.

Basis: Attachment V
Data Status: Existing (TBV-1034)
This assumption is used in Section 7.2.2.

4.3.4 DOE Nevada Operations (NVO) will adjust their helicopter routes to maintain a two-mile separation with the repository surface facilities.

Basis: Attachment VI
Data Status: Existing (TBV-1035)
This assumption is used in Section 7.1.3.

4.3.5 The preclosure period (from the beginning of repository operations to permanent closure) is assumed to be 100 years.

Basis: This assumption is based on the performance requirement for retrievability in the *Monitored Geologic Repository Requirements Document* (YMP 1999, Requirement 3.2(H)). A preclosure operational period of 100 years is considered conservative since the MGR waste handling and emplacement activities are expected to span less than 40 years.
Data Status: Existing (TBV-690)
This assumption is used in Section 4.2.

4.4 Codes and Standards

4.4.1 Proposed 10 CFR 63 (64 FR 8640).

4.4.2 NUREG-0800 (NRC 1987).

5. REFERENCES

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6. USE OF COMPUTER SOFTWARE

This analysis uses Microsoft® Excel as computational support software. The analysis also uses BestFit for Windows Version 2.0d in determining uncertainty ranges on the input data. BestFit is licensed to the CRWMS M&O by Palisade Corporation, 31 Decker Road, Newfield, NY 14867. Industry standard spreadsheet programs and statistical software such as Microsoft® Excel and BestFit are not subject to the software control requirements specified in procedure AP-SI.1Q, *Software Management*.

7. DESIGN ANALYSIS

7.1 Application of NUREG-0800 Proximity Criteria

Section 3.5.1.6.II of NUREG-0800 (NRC 1987) defines proximity criteria, which are applied to the various types of aircraft flying in the regional airspace surrounding the repository surface facility. These criteria, identified as requirements in the NUREG, are listed below. According to the NUREG, the probability is considered below the threshold for further evaluation if the distances from the plant (repository surface facilities) meet all of these requirements:

(a) The plant-to-airport distance, D, is between 5 and 10 statute miles, and the projected annual number of operations is less than $500D^2$ or the plant-to-airport distance D is greater than 10 statute miles, and the projected annual number of operations is less than $1000D^2$.

(b) The plant is at least 5 statute miles from the edge of military training routes, including low-level training routes, except for those associated with a usage greater than 1000 flights per year, or where activities (such as practice bombing) may create an unusual stress situation.

(c) The plant is at least 2 statute miles beyond the nearest edge of a federal airway, holding pattern, or approach pattern.

With regard to requirement (a), there are no airports within 10 statute miles of the potential repository surface facilities (Section 4.1.3). Using the criterion for annual number of operations less than $1000D^2$ for airports beyond 20 miles from the repository requires over 400,000 operations per year. There are a number of small airports or isolated landing fields in the region, which have very few operations per day (Redding 1998). Therefore, with the exception of the Department of Energy (DOE) and military airfields, no small airports beyond 20 miles will be addressed in this analysis with regards to requirement (a). Airports beyond 30 miles must exceed 900,000 operations per year using the $1000D^2$ criterion. This is almost double the capacity of the largest airport in the Southern Nevada area, McCarran International Airport, located ~100 miles away, with ~472,000 operations in 1997 (Attachment VII), therefore, no airports beyond 30 miles will be addressed in this analysis with regard to requirement (a).

7.1.1 Commercial Aircraft

Requirement (a)

Commercial aircraft utilize one of two airports, McCarran or North Las Vegas, which are both beyond 30 miles from the repository site. Limited charter aircraft utilize the Tonopah Airport, which is also beyond 30 miles of the site. As such requirement (a) is met for commercial aircraft.

Requirement (b)

Requirement (b) is not applicable to commercial aircraft.

Requirement (c)

Commercial aircraft flying in the region nearest to the potential repository site utilize the nearest federal airway identified in NOAA (1997) as airway number V105-135. The distance from the nearest edge of this 10-mile-wide airway and the repository surface facilities, as determined from NOAA (1997), is 11 statute miles which meets the criteria for requirement (c).

There are no holding or approach patterns for commercial aircraft in the vicinity of the repository site.

7.1.2 Private Aircraft

Requirement (a)

Private aircraft mainly utilize the two airports identified in Section 7.1.1, which are beyond the area of concern. All other airports or airfields in the region are small with low traffic counts. Those located within 20 miles from the repository site are listed in Table 7.1-1.

Table 7.1-1. Commercial/Private Airports within 20 miles from Repository Site

Airport	D, miles	1000 D^2	Total Operations/year (Redding 1998)
Beatty	20	400,000	1005
Frans Star	19	361,000	50
Jackass	14	196,000	504

As can be seen from Table 7.1-1, operations at these small airports are far below the limiting criteria and requirement (a) is met for private aircraft.

Requirement (b)

Requirement (b) is not applicable to private aircraft.

Requirement (c)

Private aircraft flying in the region nearest the potential repository site utilize the nearest federal airway identified in NOAA (1997) as airway number V105-135. The distance from the nearest edge of this 10-mile-wide airway and the repository surface facilities as determined from NOAA (1997) is 11 statute miles which meets the criteria for requirement (c).

Aircraft flying under visual flight rules (VFR) are not required to stay within the airway. However, because the Nevada Test Site is under restricted airspace, the closest point from the repository surface facilities to the edge of the restricted airspace is 2 statute miles (DMA 1995). Due to the configuration of the NTS boundary (DMA 1995), it would not be feasible for aircraft to fly closer than 4.5 statute miles from the surface facility. Permission may be granted by DOE on a per flight basis for private aircraft to fly through a small section of the restricted airspace defined as R-4808S (DMA 1995). The nearest edge of this airspace to the repository surface facilities is 4.5 statute miles. The requirements (c) are also met under these conditions.

There are no holding or approach patterns for private aircraft in the vicinity of the repository site.

7.1.3 Department of Energy Aircraft

Requirement (a)

Department of Energy (DOE) aircraft, or aircraft chartered by DOE, may utilize any airfield or landing strip within the NTS. Those located in the vicinity of the potential repository site are listed in Table 7.1-2.

Table 7.1-2. DOE Airports within 30 miles from Repository Site

Airport	D, miles	1000 D^2	Operations/yr	Reference
Desert Rock	26	676,000	Total DOE/NTS	Attach. VI
Yucca	23	529,000	54,000	
Pahute Mesa	20	400,000		

As can be seen from Table 7.1-2, requirement (a) is met for DOE aircraft.

Requirement (b)

Requirement (b) is not applicable to DOE aircraft.

Requirement (c)

Aircraft chartered by DOE to fly between the Desert Rock airfield at the NTS and laboratories in California and New Mexico utilize the nearest federal airway identified in NOAA (1997) as V105-135 until they begin their approach to the Desert Rock airfield. The approach pattern would be outside the restricted area and at least 10 miles from the repository facilities (DMA 1995). The distance from the nearest edge of the V105-135 ten-mile wide airway and the repository surface facilities as determined from NOAA 1997 is 11 statute miles which meets the criteria for requirement (c).

Helicopters routinely fly in most areas within the NTS restricted airspace. During 12 weeks per year, helicopters fly 24 sorties per day, 5 days per week, along 40 Mile Wash located 1.5 miles from the site of the potential repository surface facilities. Therefore the number of helicopter flights which come within 2 miles of the repository surface facilities averages 1440 per year. Per Assumption 4.3.4, this route will be adjusted such that it is outside the two-mile criteria of requirement (c), therefore, requirement (c) will be met.

There are no holding or approach patterns for DOE aircraft in the vicinity of the repository site.

7.1.4 Military Aircraft

Requirement (a)

Military aircraft which fly in the regional airspace utilize one of three airports; Nellis AFB, Tonopah Test Range, and Indian Springs AF Auxiliary Base all of which are only located greater than 30 miles from the repository site. Therefore, requirement (a) is met for military aircraft.

Requirement (b)

Several military training routes (MTRs) are located in the Nellis and Las Vegas area. Generally, MTRs are established below 10,000 feet for operations in excess of 250 knots. Typically these routes are flown at 500 to 1000 feet above ground level at speeds averaging 450 to 480 knots. However some segments may extend to higher altitudes due to terrain or climb and descent requirements. There are instrument flight rules (IFR) and visual flight rules (VFR) military training routes. Normal width of the route from the centerline is five miles for IFR MTR routes and 5 to 10 miles for VFR MTR routes, although some segments of these routes may be as narrow as two and as wide as 20 miles (Air Force 1995).

According to NOAA (1997), the closest MTR to Yucca Mountain is VR1225 with its centerline approximately 12 miles from the repository surface facility. The NTS restricted airspace prevents flights using the MTR from entering this airspace. Therefore, requirement (b) is met.

Requirement (c)

The Air Force has a classified memorandum of understanding (MOU) with NVO which allows them to fly through DOE restricted airspace defined as R-4308N in order to transition between the 60 and 70 series ranges of the Nellis AFB Range, Figure 7-1.1. The transition area encompasses all of R-4308N, as defined in a memorandum from RMO Director (USAF) to Distribution (Irving 1977), so that the entire area is available for each aircraft to fly through any portions needed when transiting through the area. Using current coordinates for the location of the repository surface facilities, these facilities are located on the western edge but within the area encompass by the R4308N airspace. Assuming that this airspace is analogous to a flight corridor, Requirement (c) is not met and a detailed analysis to estimate the annual crash hit frequency is provided in the following sections.

7.2 Analysis of Aircraft Crash Hit Frequency - NUREG Model

An analysis is performed in this section using the NUREG-0800 (NRC 1987) model to estimate the crash hit frequency. Section 7.3 provides a comparative analysis using an alternate model.

NUREG-0800 (NRC 1987) states that its model *"gives a conservative upper bound on aircraft impact probability if care is taken in using values for the individual factors that are meaningful and conservative."* Each factor, which makes up the models, will be addressed separately in the analysis to develop the case that the values selected for these factors are meaningful and conservative. The values for these factors will be developed using input from the Nellis Air Force Base (NAFB), the Air Force Safety Center, repository design, and other studies on aircraft risk analysis.

The NUREG airways model, included in Section 3.5.1.6.III.2 of NUREG-0800 (NRC 1987) is a four factor formula.

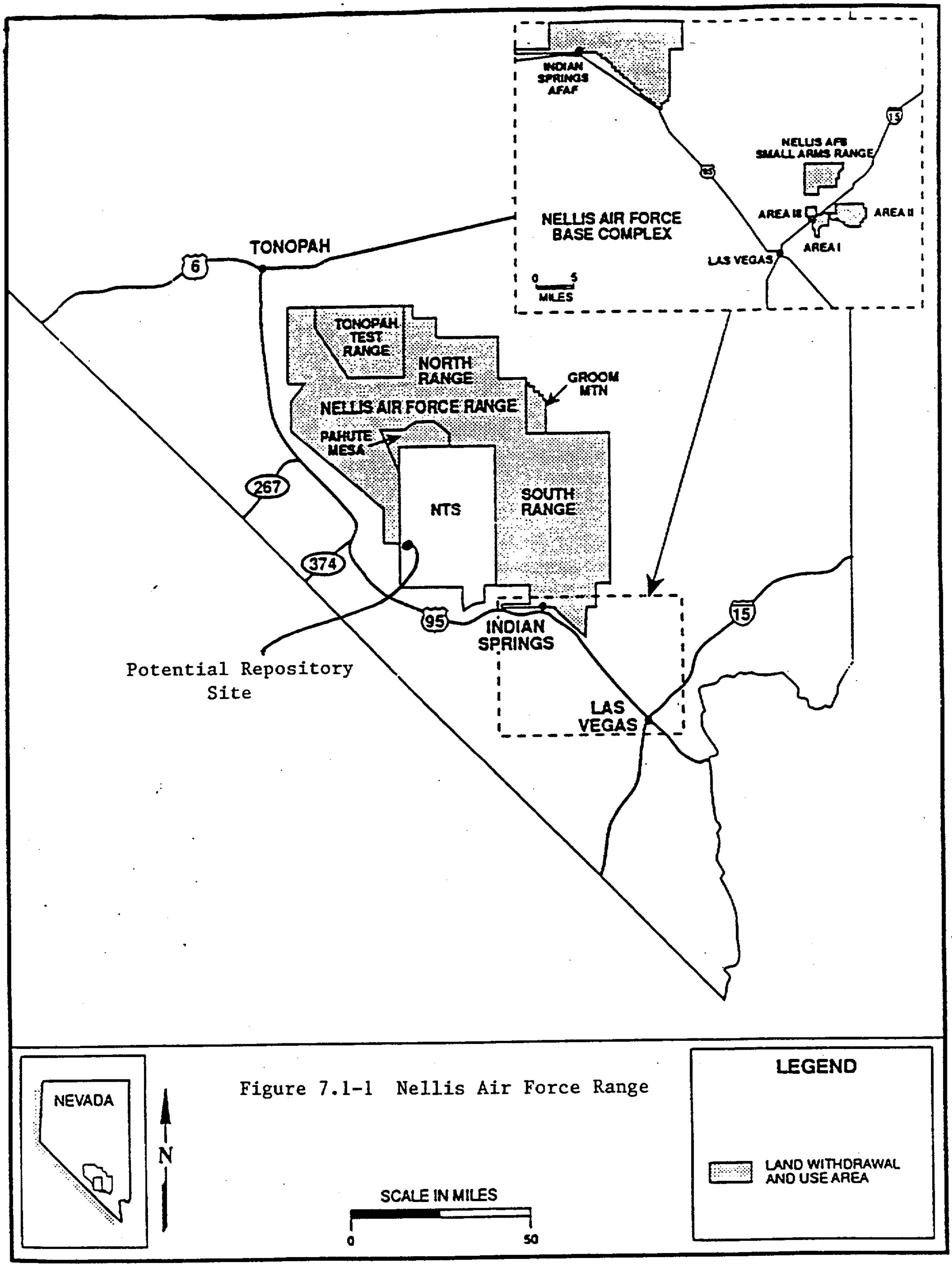

Figure 7.1-1 Nellis Air Force Range

NUREG Airways Model

$$P_{FA} = CNA_{eff}(1/w) \qquad \text{Eq. 7.2-1}$$

where:

P_{FA} = the frequency per year of an aircraft crashing into the plant

C = inflight crash rate per mile

N = number of flights per year along the airway/corridor

w = width of airway/corridor (plus twice the distance from the airway edge to the site when the site is outside the airway) in miles

A_{eff} = effective area of plant in square miles

Each factor may involve more than one aircraft type, flight corridor, or effective area. The level of detail of the analysis depends on available data and requires conservative assumptions when documented data are not available. The following sections address the factors individually to provide a defensible basis for values used in the analysis.

7.2.1 In-Flight Crash Rate per Mile, C

According to Tullman (1997), F-15 and F-16 attack/fighter aircraft routinely fly through the R-4308N restricted area of the NTS. Also, according to Tullman (1997), it is conceivable that any aircraft in the Department of Defense inventory, or other NATO country, could fly these routes. Because specific data on aircraft type are not routinely recorded for each flight, the crash rate used in the analysis is for the small-attack/fighter-aircraft group rather than for specific aircraft type. Comparative data on specific aircraft types provided below show the different crash rates. Section 7.2.5 addresses the sensitivity of using the group rate versus specific aircraft. Selecting the small-aircraft group rather than an all-aircraft group is not only representative of actual conditions but is also conservative, since crash rates for larger military aircraft are lower.

DOE (1996) was used in selecting the in-flight crash rate. In preparing this standard, the authors performed extensive research on available aircraft crash data including data on Air Force aircraft of the type used by NAFB for missions in their range. Data analysis included partitioning into specific modes of flight and conversion from flight hours to miles flown. The following discussions are taken from this standard or its supporting documents.

Portions of an aircraft flight are distinctly different due to the configuration of the aircraft and/or the conditions under which the flight is taking place. For all aircraft, there are three main flight phases:

1. Takeoff phase, which includes the takeoff roll and the initial climb;
2. In-flight phase, which includes the climb to cruise, cruise/in-flight, and the descent from cruise; and
3. Landing phase, which includes the landing approach and the landing roll.

For military aviation, the in-flight phase may involve a number of different modes. In-flight mishaps were partitioned into "normal" and "special." Special in-flight mishaps include low-altitude and maneuvering operations mishaps. According to Tullman (1997), the in-flight mode for aircraft flying in the area of the potential repository surface facilities is considered "normal."

LLNL (1996), Table 4.8, page 4-11, provides in-flight crash frequencies for military aircraft during normal and special operations. Table 7.2-1 is taken from the data provided in this reference.

Table 7.2-1. In-Flight Crash Rate per Mile

Aircraft Type	Crash Rate/Mile, C	Reference
F-16 Fighter	3.86E-08	LLNL 1996
A-10 Attack	3.14E-08	LLNL 1996
F-15 Fighter	6.25E-09	LLNL 1996
Small Attack/Fighter	1.84E-08	LLNL 1996
Large Bomber/Cargo	1.90E-09	LLNL 1996

In order to meet the intent of NUREG-0800 (NRC 1987) that "*care is taken in using values for the individual factors that are meaningful and conservative*," the following comparison from another source is provided.

The Air Force Safety Center provided lifetime crash data values for A-10, F-15 and F-16 aircraft (Attachment VIII). These values include crash data for all flight phases and are provided on "per 100,000 hours" basis. The basis for the crash rates in Table 7.2-1 were also derived from per hour input similar to those shown in Table 7.2-2. To convert from per hour to per mile basis, LLNL (1996), page 4-4, derived an estimate of in-flight crash rates based on an analysis of the expected number of miles flown for each aircraft type. Table 7.2-2 compares the per hour basis in LLNL (1996), Table 4.1, page 4-6, to the value obtained from the Air Force Safety Center. This comparison provides added assurance that values in Table 7.2-1 are meaningful and should be acceptable for use in this analysis.

Table 7.2-2. Crash Data Comparison

Aircraft Type	All Phase Crash Rate per 100,000 flight hours	
	LLNL 1996 Table 4.1	Attachment VIII
A-10	2.62	2.55
F-15	2.74	2.49
F-16	5.06	4.41

7.2.2 Corridor Width, w

This factor considers the probability that a crash can occur at some distance orthogonal to the aircraft flight path. The basis for using w is not provided in NUREG-0800 (NRC 1987), however, since it refers to the width of the airway, it will be used in this analysis as the width of the area flown by military aircraft in route to the Nellis Air Force Range.

According to Irving (1997), the entire R-4808N airspace can be used to transition aircraft between the 60 and 70 series ranges of the Nellis Air Force Range. The east-west width of R-4808N in the area that includes the repository surface facilities is approximately 29 miles according to DMA (1995). Per assumption 4.3.3, aircraft are randomly distributed across this width as they fly north or south to access or exit the Nellis Air Force Range.

Given the NUREG-0800 (NRC 1987) definition of w and assuming that the area used to transition into the Nellis Air Force Range can be considered analogous to a flight corridor,

w = width of corridor + 2 (the distance, ≤ 2 miles, of the facility from the edge of the corridor if located outside of corridor).

Based on information provided in DMA (1995) and Irving (1977) regarding the transition airspace and on Section 4.1.2 regarding facility location: w = 29 miles + 2(0 miles) = 29 miles.

7.2.3 Number of Flights per Year, N

Data was requested from NAFB on the number of flights in the vicinity of the repository surface facilities. Specifically, Nellis provided data on the number of flights flown through R4808N. According to Tullman (1977), the flight records are only kept for 90 days. The data provided by NAFB (Tullman 1997 and Long 1997) for two 90-day periods are listed in Table 7.2-3.

Because of the limited data available, there will be considerable uncertainty in the N values. Statistical analysis was performed on the above data to quantify these uncertainties and develop a conservative estimate of the total number of flights per year. The monthly total values in Table 7.2-3 were input into the BestFit computer program, which predicted the values provided in Table 7.2-4.

Table 7.2-3. NAFB Data on Number of Flights

Month	Multi-Engine	F-16	Fraction F-16	Total
September 96	not avail.	not avail.	not avail.	498
October 96	not avail.	not avail.	not avail.	1363
November 96	not avail.	not avail.	not avail.	1138
April 97	761	288	0.275	1049
May 97	835	494	0.372	1329
June 97	749	232	0.236	981

Table 7.2-4. Number of Flights with Uncertainty

Predicted Monthly Total Number of Flights near Yucca Mountain		
BestFit Distribution	Normal	Normal
Number of Data Points	6	5 (Sept-96 excluded)
Mean	1059.67	1172.67
90% confidence level	1461.85	1388.25
95% confidence level	1575.87	1449.55

Because the September 1996 number of flights, 498, is considerably below the mean, a case was also run with that data point left out. As can be seen from Table 7.2-4, the mean is higher for this case but the 90% and 95% values are lower. Based on this, the distribution developed from all available data points is considered more conservative and will be used in the analysis. Attachment I provides the BestFit Results.

For the base case crash frequency analysis, annual N values for the small-aircraft group can be determined from Table 7.2-4. To address the sensitivity of using the group N values versus N values by aircraft type, the following unqualified Nellis AFB observations are used to determine N values for F-16, F-15, and A-10 aircraft provided in Table 7.2-5.

a) From Table 7.2-3, 29% of the flights during a typical year are with F-16s and 71% are with multi-engine aircraft based on the average of the fraction of F-16s during April, May, and June 1997.

b) The multi-engine aircraft are 90% F-15s and 10% A-10s (Assumption 4.3.2).

Table 7.2-5. N Values for Crash Frequency Analysis

Airspace	Aircraft	N, Mean Flights/yr	N, Flights/yr 90% Confidence	N, Flights/yr 95% Confidence
R4808N	F-16	3688	5087	5484
R4808N	F-15	8126	11209	12084
R4808N	A-10	903	1245	1343
R4808N	All	12717	17541	18911

The baseline value used for the number of flights through DOE/NVO restricted airspace R-4808N in LLNL (1998), page 7, is 13,000 flights per year, which is essentially the same as the mean N provided in Table 7.2-5.

7.2.4 Effective Area of Facilities, A_{eff}

The effective area represents the ground surface area surrounding a facility such that if an unobstructed aircraft were to crash within the area, it would impact the facility, either by direct fly-in or skid into the facility. The effective area depends on the length, width, and height of the facility, as well as on the aircraft's wingspan, flight path angle, heading angle relative to the placement of the facility, and the length of its skid. For the base case analysis with the small-aircraft group parameters, the aircraft type that gives the largest effective area will be used.

The effective area consists of the fly-in area and the skid area. The fly-in area consists of the footprint area and the shadow area. The footprint is the facility area that an aircraft would hit on its descent even if the facility height were zero. The shadow area is the facility area that an aircraft would hit on its descent, but which it would have missed if the facility height were zero.

The skid area is based on a skid distance, which has been determined based on mishap reports. Judgement must be used by the analyst regarding when a "significant" part of the skidding aircraft still exists rather than it being just debris. The skid distance was selected from DOE (1996), Table B-18, page B-29, for small military aircraft. Values are provided for either the takeoff or landing phase; however, DOE (1996) recommends using the takeoff skid length for crashes that occur during the in-flight phase.

Section 3.5.1.6.III.7 of NUREG-0800 (NRC 1987) states that the effective area should include the shadow area, the skid area, and the plant area, but it does not list equations for calculating these areas. The following equations for calculating the skid and fly-in areas are based on DOE (1996, page B-26).

$$A_{eff} = (A_f + A_s)3.59\text{E-}8\ mi^2/ft^2 \qquad \text{Eq. 7.2.4-1}$$

where:

$$A_f = A_{fp} + A_{shad} \qquad \text{Eq. 7.2.4-2}$$

$$A_{fp} = (L + ws)W \qquad \text{Eq. 7.2.4-3}$$

$$A_{shad} = (L + ws)H\cot\phi \qquad \text{Eq. 7.2.4-4}$$

and

$$A_s = (L + ws)S \qquad \text{Eq. 7.2.4-5}$$

where:

A_f	=	effective fly-in area, ft^2
A_{fp}	=	footprint area, ft^2
A_{shad}	=	shadow area, ft^2
A_s	=	effective skid area, ft^2
ws	=	aircraft wingspan, feet
H	=	facility height, feet
$\cot\phi$	=	mean of the cotangent of the aircraft impact angle
L	=	length of the facility, feet
W	=	width of the facility, feet
S	=	aircraft skid distance, feet

The flight routes of concern run in the north-south direction. The building and parking lot orientations are approximately 45° from the direction of flight. The equations above conservatively assume that the flight path is perpendicular to the long axis of these facilities.

The potential repository surface facilities include three buildings and two parking areas, which will contain radioactive materials. Radioactive material enters the site via truck or rail shipping casks. These may be parked in designated parking areas until they can be handled within the Carrier Preparation Building (CPB), one of the three buildings considered. The other two buildings include the Waste Handling Building (WHB) and the Waste Treatment Building (WTB) for site generated radioactive waste. The dimensions and orientation of the parking areas, CPB, WTB, and WHB are based on CRWMS M&O (1997a) and CRWMS M&O (1997b), which bound alternative designs being studied. The bounding A_{eff} conservatively assumes that all these facilities, if impacted by an aircraft, could provide a radionuclide release, which would exceed site boundary limits. Since it is anticipated that the basis will be developed to show that only the WHB will be of concern, a best estimate A_{eff} has also been determined for comparative analysis.

The effective area calculations were performed with a Microsoft® Excel spreadsheet using the equations defined above. Aircraft type was a variable in these analyses because both wing span and skid distance impact the effective area results. Table 7.2-6 summarizes the results and detailed spreadsheets are provided in Attachment II.

Table 7.2-6. Effective Area by Aircraft Type

Aircraft Type	Effective Area, Square Miles, A_{eff}	
	Bounding	**Best Estimate**
F-16 Fighter	7.74E-02	3.63E-02
F-15 Fighter	7.90E-02	3.69E-02
A-10 Attack	8.12E-02	3.78E-02

7.2.5 Aircraft Crash Hit Frequency, P_{FA}

A bounding case analysis was performed using the small-aircraft group parameters defined in the previous sections. A sensitivity case was analyzed using the unqualified aircraft mix shown on Table 7.2-6. A best estimate case was also developed to include both the aircraft mix and the best estimate A_{eff}.

Microsoft® Excel spreadsheets (Attachment III) were used to calculate P_{FA} using values developed in the previous sections for each parameter in equation 7.2-1. Results of these calculations are summarized on Table 7.2-7.

NUREG-0800 (NRC 1987) also requires an evaluation of aircraft crash probabilities due to airports, designated airspaces, and holding patterns (Section 3.5.1.6.III.3, 4, and 5) if these facilities and activities cannot be eliminated using the proximity criteria defined in NUREG Section 3.5.1.6 II.

Table 7.2-7. Aircraft Crash Hit Frequency, P_{FA} - NUREG Model

N Value Basis	Aircraft Crash Hit Frequency/yr, P_{FA}		
	Bounding Case	**Sensitivity Case**	**Best Estimate Case**
Mean	6.55E-07	5.98E-07	2.80E-07
90% Confidence	9.04E-07	8.24E-07	3.86E-07
95% Confidence	9.74E-07	8.89E-07	4.16E-07

Civilian and military airports were evaluated in Section 7.1 where it was determined that no airports were located within 14 miles of the repository site and no airport traffic could get in the vicinity of the site due to airspace restrictions on the NTS. The probability of an aircraft crash from airports is therefore considered negligible.

As stated in Section 7.1.4, Requirement (c), the Air Force has an MOU with DOE/NVO allowing them access into DOE's restricted airspace for ingress and egress to the Nellis Air Force Range. This access is not considered a designated airspace and has been evaluated in the previous section as an aviation corridor. Therefore, there are no contributions from designated airspaces involved in this analysis.

DOE/NVO's restricted airspace has no established holding patterns within its boundaries for either commercial or military aircraft. Tullman (1977) discusses the possibility of a future refueling anchor over south portion of R-4808N that may increase the number of aircraft in the area. However, the projected increase is expected to be within the 95% confidence N values used in the analysis.

Section 3.5.1.6 III. 6 of NUREG-0800 (NRC 1987) requires that the total aircraft hazard probability at the site equals the sum of the individual probabilities obtained from all sources discussed above. Because it has been shown that there is no contribution to the total aircraft hazard from airports, airspaces, and holding patterns, it can be concluded that the only contributor to this hazard is the potential for crashes resulting from flights in aviation corridors as determined by equation 7.2.1. These results are provided in Table 7.2-7.

7.3 Analysis of Aircraft Crash Frequency - Comparative Model

A crash hit frequency analysis, LLNL (1998), for the Nevada Test Site has recently been completed as part of a DOE facility safety analysis. A model was developed in this analysis to address the Air Force overflights of DOE's R-4808N restricted area. This analysis determined a crash hit frequency in the 1E-8 to 1E-7 per year range for the Device Assembly Facility located within the R-4808N restricted area. The model, The

Uniform Overflight Density Model, was applied to the Yucca Mountain repository surface facilities to provide a comparative analysis to the NUREG Airways Model.

In this model the aircraft crash frequency equals the product of the number of aircraft, which overfly a particular area, the probability that the aircraft crashes in that particular area, and the probability that the aircraft hits a facility in this particular area. The Overflight Density Model is developed in detail in LLNL (1998) and the resultant equation for the special case of the NTS is equation 15 (page 11) of LLNL (1998). This equation is defined below:

$$F = (N_t/A_t)A_{eff}\lambda\,(4/\pi)\,(A_t/\pi)^{1/2} \qquad \text{Eq. 7.3-1}$$

where:

F = aircraft crash hit frequency per year

N_t = number of flights/year over the NTS (R-4808N) = N in Section 7.2

A_t = area of the NTS (R-4808N), mi^2

A_{eff} = effective area of facility, mi^2 = A_{eff} in Section 7.2

λ = inflight crash rate per mile = C in Section 7.2

To be conservative, the particular area into which an aircraft could crash should be set equal to the smaller of either the NTS area, A_t, or the area A_p, which can be derived from the radius, R_p.

where:

A_p = the area that could potentially be hit by an aircraft in distress, mi^2

R_p = radius of A_p, mi

$$R_p = gh \qquad \text{Eq. 7.3-2}$$

where:

g = the aircraft glide ratio = $(L/D)_{max}$
h = the altitude of the aircraft, mi
$(L/D)_{max}$ = the maximum lift-drag ratio

$$R_p = (L/D)_{max}\,h \qquad \text{Eq. 7.3-3}$$

NASA (1985) lists $(L/D)_{max}$ values for selected high performance fighter aircraft but not for the F-15, F-16, or A-10, therefore values for similar aircraft will be used. According to this reference $(L/D)_{max}$ is proportional to the wing aspect ratio, A, divided by the zero-lift drag coefficient, $C_{d,0}$. A = (wing span)^2 / wing area. $C_{d,0}$ is proportional to the aircraft weight, W. Therefore, $(L/D)_{max}$ is proportional to A/W. Comparing the data in NASA (1985) shows that A/W for the F-4 aircraft is smaller than for the F-15, F-16, and A-10. It can be concluded, therefore that the $(L/D)_{max}$ for the F-4 will also be smaller. To be conservative, the lower value will lead to a higher F. Therefore, using the F-4 value from NASA (1985, page 491), of 8.58 for $(L/D)_{max}$ will bound the values for the other aircraft.

According to Irving (1977), the lowest aircraft altitude for routes defined in Section 7.2.2, flown by NAFB aircraft in the in-flight mode near Yucca Mountain, could be 14,000 feet.

Per equation 7.3-3, R_p = 8.58 (14,000 feet/5280 feet/mile) = 22.75 miles

$$A_p = \pi R_p^2 = 1626 \text{ mi}^2 \qquad \text{Eq. 7.3-4}$$

According to LLNL (1998, page 18), A_t, the area of the NTS (R-4808N) is equal to 1350 mi^2. If this area is assumed circular, its radius, R_t is equal to $(A_t/\pi)^{1/2}$ or 20.73 miles. Because R_t and A_t are smaller than R_p and A_p, A_t is used in Equation 7.3-1.

The Uniform Overflight Density Model analysis on crash hit frequency was performed with Microsoft® Excel worksheets in Attachment V for the bounding, best estimate, and the sensitivity cases discussed in Section 7.2.5. The results, provided in Table 7.3-1, show slightly lower crash frequencies than determined by the NUREG Airways Model.

Table 7.3-1. Aircraft Crash Hit Frequency, F - Uniform Overflight Density Model

	Aircraft Crash Hit Frequency/yr, F		
N Value Basis	**Bounding Case**	**Sensitivity Case**	**Best Estimate Case**
Mean	3.71E-07	3.39E-07	1.59E-07
90% Confidence	5.12E-07	4.67E-07	2.19E-07
95% Confidence	5.52E-07	5.04E-07	2.36E-07

8. SUMMARY AND CONCLUSIONS

8.1 Summary

The objective of this analysis was to determine if the aircraft crash external event could be clearly and conservatively screened out from further consideration in detail DBE analyses. The criteria for this screening as provided in Section 4.2 is repeated below.

The Crash Hit Frequency of an aircraft into a radioactive material confinement facility from all types of aircraft shall be less than 1E-6/year.

NUREG-0800 (NRC 1987) provided one approach for making this determination. This included both proximity criteria and analytical models to be used in the event that the proximity criteria were not met. Application of the proximity criteria clearly established that the potential repository site met all criteria with the exception of its proximity to military traffic flying to and from the Nellis AFB Range. Concerns regarding commercial, private, and DOE airports, and resultant air traffic, were eliminated by applying the proximity criteria. However, from input provided by NAFB, there are no restrictions preventing military aircraft from flying near the potential site. As a result, the NUREG-0800 model and other models were applied to determine the aircraft crash hit frequency.

NUREG-0800 further states that its model will give a conservative upper bound on aircraft crash hit frequency if care is taken in using values for the individual factors that are meaningful and conservative. An effort was made to determine and select values for the individual factors used in each model. The values for crash rates, effective areas, and NTS distances and areas are not anticipated to change over time. The number of flights through the R-4808N restricted area could change as future operations change at NAFB.

Only limited flight data was available from NAFB and a conservative approach was used where uncertainty existed. This involved a determination of the number of flights per year based on limited data from NAFB. Statistical methods were used to develop 90% and 95% confidence levels for the number of flights involved given the current operations. .

Two different models were used in the analysis. The results of each model are listed in Tables 7.2-7 and 7.3-1. From these results it can be seen that the crash hit frequency ranges from 1.59E-07/year for the best-estimate case using the Uniform Overflight Density Model to 9.74E-07/year for the bounding case using the NUREG model.

8.2 Conclusions

It can be concluded that under the conservative NUREG-0800 model and at a 95% confidence level for N, given current NAFB operations, the frequency for an aircraft crash into the repository surface facilities is below the 1E-06/year evaluation criterion. Therefore, the aircraft crash external event at a potential repository at Yucca Mountain is not considered a credible event.

9. ATTACHMENTS

Attachment I:	BestFit Results for Different Confidence Intervals
Attachment II:	Determination of Values for A_{eff}, Effective Area
Attachment III:	Determination of Crash Hit Frequency - NUREG Model
Attachment IV:	Determination of Crash Hit Frequency - Uniform Overflight Density Model
Attachment V:	E-mail , E. Tullman to R. Morissette, "FW:AF Memorandum," dated 9/22/98
Attachment VI:	E-mail, J. Wood to R. Morissette, "RE: Reference Documentation," dated 4/8/98
Attachment VII:	McCarran International Airport Statistics
Attachment VIII:	E-mail, E. Tullman to R. Morissette, "FW: Accident Rates," dated 5/22/98

ATTACHMENT I—BestFit Results for Different Confidence Intervals

This attachment includes printouts form the BestFit program used to analyze the Nellis Air Force Base flight data. Two cases were run on BestFit—one with the monthly flight totals for six-months and a second with a monthly flight totals for five-months (September 96 left out). The input and results of the first case are provided on Page I-2 through I-7. The input data is taken from Table 7.2-3. The input and results of the second case are provided on pages I-8 through I-13. Two distributions were selected from BestFit, the Weibull and the Normal. The Normal Distribution was selected for the analysis because it provided the most conservative 90% and 95% confidence values.

All the values provided on the following pages of this attachment are *number of flights per month.* BestFit does not include units in the printouts. In the output tables, the mean, mode median, standard deviations, and the target values are number of *flights per month.*

BestFit input data from Table 7.2-3

Data #	Flights/month
1	498
2	981
3	1049
4	1138
5	1329
6	1363

Number of Classes (bars on the histogram) = 4 (as suggested by the BestFit Program)

	Input Distribution	Weibull	Logistic
Parameter 1		4.748341	1059.666667
Parameter 2		1162.463723	171.894037
Parameter 3			
Formula		Weibull(4.75,1.16e+3)	Logistic(1.06e+3,1.72e+2)
Minimum	498		
Maximum	1363		
Mean	1059.666667	1064.148217	1059.666667
Mode	1038.625	1105.987478	1059.666667
Median	1049	1076.111495	1059.666667
Standard Deviation	313.834139	255.504236	311.781295
Variance	9.85E+04	6.53E+04	9.72E+04
Skewness	-1.141443	-0.213549	0
Kurtosis	1.947037	2.745836	4.2
Histogram	(498.0,1363.0,{1.0,0.0,3.0,2.0})		
Minimum	498	498	498
Maximum	1363	1363	1363
P1	1	0.441018	0.469898
P2	0	1.193714	1.211954
P3	3	1.934252	1.880012
P4	2	1.676094	1.388987
#Classes	4		
Interval Width	216.25		
Results			
Chi-Square			
Test Value		2.552022	2.745973
Confidence		>0.46	>0.43
Rank		1	2
Kolmogorov-Smirnov			
Test Value		0.193586	0.220878
Confidence		>0.1	>0.15 *
Rank		1	3
Anderson-Darling			
Test Value		0.387449	0.34025
Confidence		>0.25	>0.15 *
Rank		3	1
Confidence			
Chi-Square			
Adjusted Value		2.552022	2.745973
Critical Value @ .75		1.212533	1.212533
Critical Value @ .5		2.365974	2.365974
Critical Value @ .25		4.108345	4.108345
Critical Value @ .1		6.251389	6.251389
Critical Value @ .05		7.814728	7.814728
Critical Value @ .025		9.348404	9.348404
Critical Value @ .01		11.344867	11.344867

	Input Distribution	Weibull	Logistic
Kolmogorov-Smirnov			
Adjusted Value		0.474186	0.577462
Critical Value @ .15			1.138
Critical Value @ .1		0.76	1.224
Critical Value @ .05		0.819	1.358
Critical Value @ .025		0.88	1.48
Critical Value @ .01		0.944	1.628
Anderson-Darling			
Adjusted Value		0.390613	0.34025
Critical Value @ .25		0.474	
Critical Value @ .15			1.61
Critical Value @ .1		0.637	1.933
Critical Value @ .05		0.757	2.492
Critical Value @ .025		0.877	3.07
Critical Value @ .01		1.038	3.857
Targets			
#1 Value	498	723.694869	681.976864
#1 Percentile%	10%	10%	10%
#2 Value	594.6	847.600788	821.370932
#2 Percentile%	20%	20%	20%
#3 Value	884.4	935.595392	914.021217
#3 Percentile%	30%	30%	30%
#4 Value	1008.2	1009.117343	989.969632
#4 Percentile%	40%	40%	40%
#5 Value	1049	1076.111495	1059.666667
#5 Percentile%	50%	50%	50%
#6 Value	1102.4	1141.257449	1129.363701
#6 Percentile%	60%	60%	60%
#7 Value	1176.2	1208.807848	1205.312117
#7 Percentile%	70%	70%	70%
#8 Value	1290.8	1285.005466	1297.962401
#8 Percentile%	80%	80%	80%
#9 Value	1342.6	1385.676933	1437.35647
#9 Percentile%	90%	90%	90%
#10 Value	1352.8	1464.639966	1565.79817
#10 Percentile%	95%	95%	95%

	Normal	Erlang	Gamma
Parameter 1	1059.666667	11	10.408401
Parameter 2	313.834139	96.333333	101.808783
Parameter 3			
Formula	(1.06e+3,3.14e+2)	(11.00,96.33)	(10.41,1.02e+2)
Minimum			
Maximum			
Mean	1059.666667	1059.666667	1059.666667
Mode	1059.666667	963.333333	957.857884
Median	1059.666667	1027.734325	1025.930444
Standard Deviation	313.834139	319.501521	328.456046
Variance	9.85E+04	1.02E+05	1.08E+05
Skewness	0	0.603023	0.619923
Kurtosis	3	3.545455	3.576457
Histogram			
Minimum	498	498	498
Maximum	1363	1363	1363
P1	0.580505	0.668132	0.701829
P2	1.239296	1.496343	1.480609
P3	1.645664	1.636859	1.591738
P4	1.359263	1.149529	1.127762
#Classes			
Interval Width			
Results			
Chi-Square			
Test Value	2.959056	3.425594	3.527834
Confidence	>0.39	>0.33	>0.31
Rank	3	6	7
Kolmogorov-Smirnov			
Test Value	0.234371	0.273225	0.277068
Confidence	>0.15	>0.15 *	>0.15 *
Rank	4	5	6
Anderson-Darling			
Test Value	0.357886	0.544992	0.533749
Confidence	>0.15	>0.15 *	>0.15 *
Rank	2	5	4
Confidence			
Chi-Square			
Adjusted Value	2.959056	3.425594	3.527834
Critical Value @ .75	1.212533	1.212533	1.212533
Critical Value @ .5	2.365974	2.365974	2.365974
Critical Value @ .25	4.108345	4.108345	4.108345
Critical Value @ .1	6.251389	6.251389	6.251389
Critical Value @ .05	7.814728	7.814728	7.814728
Critical Value @ .025	9.348404	9.348404	9.348404
Critical Value @ .01	11.344867	11.344867	11.344867

	Normal	Erlang	Gamma
Kolmogorov-Smirnov			
Adjusted Value	0.653074	0.714318	0.724367
Critical Value @ .15	0.774	1.138	1.138
Critical Value @ .1	0.819	1.224	1.224
Critical Value @ .05	0.895	1.358	1.358
Critical Value @ .025	0.955	1.48	1.48
Critical Value @ .01	1.035	1.628	1.628
Anderson-Darling			
Adjusted Value	0.347945	0.544992	0.533749
Critical Value @ .25			
Critical Value @ .15	0.576	1.61	1.61
Critical Value @ .1	0.656	1.933	1.933
Critical Value @ .05	0.787	2.492	2.492
Critical Value @ .025	0.918	3.07	3.07
Critical Value @ .01	1.092	3.857	3.857
Targets			
#1 Value	657.48195	676.331922	666.502086
#1 Percentile%	10%	10%	10%
#2 Value	795.537524	785.792917	778.108095
#2 Percentile%	20%	20%	20%
#3 Value	895.091903	871.851509	866.098698
#3 Percentile%	30%	30%	30%
#4 Value	980.157857	950.2701	946.437741
#4 Percentile%	40%	40%	40%
#5 Value	1059.666667	1027.734325	1025.930444
#5 Percentile%	50%	50%	50%
#6 Value	1139.175477	1109.310168	1109.767801
#6 Percentile%	60%	60%	60%
#7 Value	1224.24143	1201.229258	1204.372282
#7 Percentile%	70%	70%	70%
#8 Value	1323.795809	1315.020036	1321.665221
#8 Percentile%	80%	80%	80%
#9 Value	1461.851383	1484.173099	1496.337718
#9 Percentile%	90%	90%	90%
#10 Value	1575.876128	1634.02712	1651.348743
#10 Percentile%	95%	95%	95%

BestFit input data from Table 7.2-3

Data #	Flights/month
7	981
8	1049
9	1138
10	1329
11	1363

Number of Classes (bars on the histogram) =3 (as suggested by the BestFit Program)

	Input Distribution	Normal	InverseGaussian
Parameter 1		1172	1172
Parameter 2		168.742407	7.01E+04
Parameter 3			
Formula		(1.17e+3,1.69e+2)	(1.17e+3,7.01e+4)
Minimum	981		
Maximum	1363		
Mean	1172	1172	1172
Mode	1044.666667	1172	1142.986848
Median	1138	1172	1162.315551
Standard Deviation	168.742407	168.742407	151.514531
Variance	2.85E+04	2.85E+04	2.30E+04
Skewness	0.138359	0	0.387836
Kurtosis	0.863261	3	3.250694
Histogram	(981.0,1363.0,{2.0,1.0,2.0})		
Minimum	981	981	981
Maximum	1363	1363	1363
P1	2	1.132268	1.340395
P2	1	1.505213	1.676362
P3	2	1.132268	1.04434
#Classes	3		
Interval Width	127.333333		
Results			
Chi-Square			
Test Value		1.499573	1.471993
Confidence		>0.47	>0.47
Rank		7	4
Kolmogorov-Smirnov			
Test Value		0.223921	0.250706
Confidence		>0.15	>0.15 *
Rank		1	8
Anderson-Darling			
Test Value		0.286976	0.335344
Confidence		>0.15	>0.15 *
Rank		2	5
Confidence			
Chi-Square			
Adjusted Value		1.499573	1.471993
Critical Value @ .75		0.575364	0.575364
Critical Value @ .5		1.386294	1.386294
Critical Value @ .25		2.772589	2.772589
Critical Value @ .1		4.60517	4.60517
Critical Value @ .05		5.991465	5.991465
Critical Value @ .025		7.377759	7.377759
Critical Value @ .01		9.21034	9.21034

	Input Distribution	Normal	InverseGaussian
Kolmogorov-Smirnov			
Adjusted Value		0.583583	0.603014
Critical Value @ .15		0.774	1.138
Critical Value @ .1		0.819	1.224
Critical Value @ .05		0.895	1.358
Critical Value @ .025		0.955	1.48
Critical Value @ .01		1.035	1.628
Anderson-Darling			
Adjusted Value		0.229581	0.335344
Critical Value @ .25			
Critical Value @ .15		0.576	1.61
Critical Value @ .1		0.656	1.933
Critical Value @ .05		0.787	2.492
Critical Value @ .025		0.918	3.07
Critical Value @ .01		1.092	3.857
Targets			
#1 Value	981	955.753235	985.40126
#1 Percentile%	10%	10%	10%
#2 Value	981	1029.982986	1042.783679
#2 Percentile%	20%	20%	20%
#3 Value	1015	1083.511406	1086.289789
#3 Percentile%	30%	30%	30%
#4 Value	1049	1129.249686	1124.929155
#4 Percentile%	40%	40%	40%
#5 Value	1093.5	1172	1162.315551
#5 Percentile%	50%	50%	50%
#6 Value	1138	1214.750314	1200.932834
#6 Percentile%	60%	60%	60%
#7 Value	1233.5	1260.488594	1243.663928
#7 Percentile%	70%	70%	70%
#8 Value	1329	1314.017014	1295.581342
#8 Percentile%	80%	80%	80%
#9 Value	1346	1388.246765	1371.099117
#9 Percentile%	90%	90%	90%
#10 Value	1354.5	1449.555614	1436.657697
#10 Percentile%	95%	95%	95%

	Erlang	Logistic	Weibull
Parameter 1	61	1172	8.863269
Parameter 2	19.213115	92.424023	1239.453463
Parameter 3			
Formula	Erlang(61.00,19.21)	Logistic(1.17e+3,92.42)	Weibull(8.86,1.24e+3)
Minimum			
Maximum			
Mean	1172	1172	1172.901479
Mode	1152.786885	1172	1222.825124
Median	1165.601887	1172	1189.244981
Standard Deviation	150.059223	167.638634	158.092671
Variance	2.25E+04	2.81E+04	2.50E+04
Skewness	0.256074	0	-0.54567
Kurtosis	3.098361	4.2	3.194281
Histogram			
Minimum	981	981	981
Maximum	1363	1363	1363
P1	1.285952	1.107846	0.952759
P2	1.690309	1.722135	1.59479
P3	1.089666	1.107846	1.444182
#Classes			
Interval Width			
Results			
Chi-Square			
Test Value	1.438921	1.739721	1.58684
Confidence	>0.48	>0.41	>0.45
Rank	2	11	10
Kolmogorov-Smirnov			
Test Value	0.252015	0.245364	0.243658
Confidence	>0.15 *	>0.15 *	>0.1
Rank	13	6	5
Anderson-Darling			
Test Value	0.346384	0.34611	0.379991
Confidence	>0.15 *	>0.15 *	>0.25
Rank	10	9	11
Confidence			
Chi-Square			
Adjusted Value	1.438921	1.739721	1.58684
Critical Value @ .75	0.575364	0.575364	0.575364
Critical Value @ .5	1.386294	1.386294	1.386294
Critical Value @ .25	2.772589	2.772589	2.772589
Critical Value @ .1	4.60517	4.60517	4.60517
Critical Value @ .05	5.991465	5.991465	5.991465
Critical Value @ .025	7.377759	7.377759	7.377759
Critical Value @ .01	9.21034	9.21034	9.21034

	Erlang	Logistic	Weibull
Kolmogorov-Smirnov			
Adjusted Value	0.606163	0.590164	0.544837
Critical Value @ .15	1.138	1.138	
Critical Value @ .1	1.224	1.224	0.76
Critical Value @ .05	1.358	1.358	0.819
Critical Value @ .025	1.48	1.48	0.88
Critical Value @ .01	1.628	1.628	0.944
Anderson-Darling			
Adjusted Value	0.346384	0.34611	0.383389
Critical Value @ .25			0.474
Critical Value @ .15	1.61	1.61	
Critical Value @ .1	1.933	1.933	0.637
Critical Value @ .05	2.492	2.492	0.757
Critical Value @ .025	3.07	3.07	0.877
Critical Value @ .01	3.857	3.857	1.038
Targets			
#1 Value	984.273119	968.923665	961.531837
#1 Percentile%	10%	10%	10%
#2 Value	1044.204762	1043.873098	1046.487698
#2 Percentile%	20%	20%	20%
#3 Value	1088.912265	1093.689323	1103.35507
#3 Percentile%	30%	30%	30%
#4 Value	1128.115882	1134.525284	1148.989429
#4 Percentile%	40%	40%	40%
#5 Value	1165.601887	1172	1189.244981
#5 Percentile%	50%	50%	50%
#6 Value	1203.909657	1209.474716	1227.288386
#6 Percentile%	60%	60%	60%
#7 Value	1245.812173	1250.310677	1265.685537
#7 Percentile%	70%	70%	70%
#8 Value	1296.066717	1300.126902	1307.820935
#8 Percentile%	80%	80%	80%
#9 Value	1367.952066	1375.076335	1361.749675
#9 Percentile%	90%	90%	90%
#10 Value	1429.25652	1444.136895	1402.787115
#10 Percentile%	95%	95%	95%

ATTACHMENT II—Determination of Values for A_{eff}, Effective Area

This attachment calculates the effective area of the repository surface facilities as described in Section 7.2.4 and provides the resultant spreadsheets.

The equations listed in Section 7.2.4 have been incorporated in this spreadsheet.

The values, and their bases, used for the variables of each equation are defined in the worksheet.

Two areas were determined for each aircraft type. The bounding case assumes all surface facilities, which could contain radioactive materials. The best estimate case assumes that only the Waste Handling Building provides the potential for releases, which could exceed dose limits at the boundary.

TABLE II-1. AIRCRAFT CRASH EFFECTIVE AREA CALCULATIONS - A-10 - BOUNDING CASE

BUILDING	L, feet	W, feet	H, feet	A1-SHAD	A2-FTPRT	A3-SKID	A(eff), sqft	A(eff), sqmile
WHB	540	536	117	587223	320260	146985	1054468	3.78E-02
WTB	260	200	60	160020	63500	78105	301625	1.08E-02
CPB	160	120	33.17	60602	26100	53505	140207	5.03E-03
PARK-TRUCK	200	100	10.5	22712	25750	63345	111807	4.01E-03
PARK-RAIL	1200	150	15	158445	188625	309345	656415	2.35E-02
TOTAL				989001	624235	651285	2264521	8.12E-02

WHB = Waste Handling Building
WTB = Site-Generated Waste Treatment Building
CPB = Carrier Preparation Building
PARK-TRUCK = Parking area for loaded truck casks and carriers
PARK-RAIL = Parking area for loaded rail casks and carriers
L = Length of building or area (CRMWS M&O 1997a and CRMWS M&O 1997b)
W = Width of building or area (CRMWS M&O 1997a and CRMWS M&O 1997b)
R = Diagnoal distance of building or area
H = Height of building or parked casks (CRWMS M&O 1997a and CRWMS M&O 1997b)
A1-SHAD = Shadow Area, sqft = (L + ws) H * COT of crash angle
A2-FTPRT = Footprint Area, sqft = (L + ws) W
A3-SKID = Skid Area, sqft = (L + ws) S
A(eff) = Effective Area = A1-SHAD + A2-FTPRT + A3-SKID

Skid dist, S, ft =	246	DOE (1996)	TABLE B-18
Wing span, ws, ft =	57.5	LLNL (1996)	TABLE 4.20
COT of crash angle =	8.4	DOE (1996)	TABLE B-17

TABLE II-2. AIRCRAFT CRASH EFFECTIVE AREA CALCULATIONS - A-10 - BEST ESTIMATE CASE

BUILDING	L, feet	W, feet	H, feet	A1-SHAD	A2-FTPRT	A3-SKID	A(eff), sqft	A(eff), sqmile
WHB	540	536	117	587223	320260	146985	1054468	3.78E-02
TOTAL	540	536	117	587223	320260	146985	1054468	3.78E-02

WHB = Waste Handling Building
L = Length of building or area (CRMWS M&O 1997a and CRMWS M&O 1997b)
W = Width of building or area (CRMWS M&O 1997a and CRMWS M&O 1997b)
R = Diagnoal distance of building or area
H = Height of building or parked casks (CRWMS M&O 1997a and CRWMS M&O 1997b)
A1-SHAD = Shadow Area, sqft = (L + ws) H * COT of crash angle
A2-FTPRT = Footprint Area, sqft = (L + ws) W
A3-SKID = Skid Area, sqft = (L + ws) S
A(eff) = Effective Area = A1-SHAD + A2-FTPRT + A3-SKID

Skid dist, S, ft =	246	DOE (1996)	TABLE B-18
Wing span, ws, ft =	57.5	LLNL (1996)	TABLE 4.20
COT of crash angle =	8.4	DOE (1996)	TABLE B-17

TABLE II-3. AIRCRAFT CRASH EFFECTIVE AREA CALCULATIONS - F-16 - BEST ESTIMATE CASE

BUILDING	L, feet	W, feet	H, feet	A1-SHAD	A2-FTPRT	A3-SKID	A(eff), sqft	A(eff), sqmile
WHB	540	536	117	563144	307128	140958	1011230	3.63E-02
TOTAL	540	536	117	563144	307128	140958	1011230	3.63E-02

WHB = Waste Handling Building
L = Length of building or area (CRMWS M&O 1997a and CRMWS M&O 1997b)
W = Width of building or area (CRMWS M&O 1997a and CRMWS M&O 1997b)
R = Diagnoal distance of building or area
H = Height of building or parked casks (CRWMS M&O 1997a and CRWMS M&O 1997b)
A1-SHAD = Shadow Area, sqft = (L + ws) H * COT of crash angle
A2-FTPRT = Footprint Area, sqft = (L + ws) W
A3-SKID = Skid Area, sqft = (L + ws) S
A(eff) = Effective Area

Skid dist, S, ft =	246	DOE (1996)	TABLE B-18
Wing span, ws, ft =	33	LLNL (1996)	TABLE 4.20
COT of crash angle =	8.4	DOE (1996)	TABLE B-17

TABLE II-4. AIRCRAFT CRASH EFFECTIVE AREA CALCULATIONS - F-16 - BOUNDING CASE

BUILDING	L, feet	W, feet	H, feet	A1-SHAD	A2-FTPRT	A3-SKID	A(eff), sqft	A(eff), sqmile
WHB	540	536	117	563144	307128	140958	1011230	3.63E-02
WTB	260	200	60	147672	58600	72078	278350	9.98E-03
CPB	160	120	33.17	53775	23160	47478	124413	4.46E-03
PARK-TRUCK	200	100	10.5	20551	23300	57318	101169	3.63E-03
PARK-RAIL	1200	150	15	155358	184950	303318	643626	2.31E-02
TOTAL				940500	597138	621150	2158788	7.74E-02

WHB = Waste Handling Building
WTB = Site-Generated Waste Treatment Building
CPB = Carrier Preparation Building
PARK-TRUCK = Parking area for loaded truck casks and carriers
PARK-RAIL = Parking area for loaded rail casks and carriers
L = Length of building or area (CRMWS M&O 1997a and CRMWS M&O 1997b)
W = Width of building or area (CRMWS M&O 1997a and CRMWS M&O 1997b)
R = Diagnoal distance of building or area
H = Height of building or parked casks (CRWMS M&O 1997a and CRWMS M&O 1997b)
A1-SHAD = Shadow Area, sqft = (L + ws) H * COT of crash angle
A2-FTPRT = Footprint Area, sqft = (L + ws) W
A3-SKID = Skid Area, sqft = (L + ws) S
A(eff) = Effective Area

Skid dist, S, ft =	246	DOE (1996)	TABLE B-18
Wing span, ws, ft =	33	LLNL (1996)	TABLE 4.20
COT of crash angle =	8.4	DOE (1996)	TABLE B-17

TABLE II-5. AIRCRAFT CRASH EFFECTIVE AREA CALCULATIONS - F-15 - BOUNDING CASE

BUILDING	L, feet	W, feet	H, feet	A1-SHAD	A2-FTPRT	A3-SKID	A(eff), sqft	A(eff), sqmile
WHB	540	536	117	572972	312488	143418	1028878	3.69E-02
WTB	260	200	60	152712	60600	74538	287850	1.03E-02
CPB	160	120	33.17	56561	24360	49938	130859	4.69E-03
PARK-TRUCK	200	100	10.5	21433	24300	59778	105511	3.78E-03
PARK-RAIL	1200	150	15	156618	186450	305778	648846	2.33E-02
TOTAL				960296	608198	633450	2201944	7.90E-02

WHB = Waste Handling Building
WTB = Site-Generated Waste Treatment Building
CPB = Carrier Preparation Building
PARK-TRUCK = Parking area for loaded truck casks and carriers
PARK-RAIL = Parking area for loaded rail casks and carriers
L = Length of building or area (CRMWS M&O 1997a and CRMWS M&O 1997b)
W = Width of building or area (CRMWS M&O 1997a and CRMWS M&O 1997b)
R = Diagnoal distance of building or area
H = Height of building or parked casks (CRWMS M&O 1997a and CRWMS M&O 1997b)
A1-SHAD = Shadow Area, sqft = (L + ws) H * COT of crash angle
A2-FTPRT = Footprint Area, sqft = (L + ws) W
A3-SKID = Skid Area, sqft = (L + ws) S
A(eff) = Effective Area

Skid dist, S, ft =	246	DOE (1996)	TABLE B-18
Wing span, ws, ft =	43	LLNL (1996)	TABLE 4.20
COT of crash angle =	8.4	DOE (1996)	TABLE B-17

TABLE II-6. AIRCRAFT CRASH EFFECTIVE AREA CALCULATIONS - F-15 - BEST ESTIMATE CASE

BUILDING	L, feet	W, feet	H, feet	A1-SHAD	A2-FTPRT	A3-SKID	A(eff), sqft	A(eff), sqmile
WHB	540	536	117	572972	312488	143418	1028878	3.69E-02
TOTAL	540	536	117	572972	312488	143418	1028878	3.69E-02

WHB = Waste Handling Building
L = Length of building or area (CRMWS M&O 1997a and CRMWS M&O 1997b)
W = Width of building or area (CRMWS M&O 1997a and CRMWS M&O 1997b)
R = Diagnoal distance of building or area
H = Height of building or parked casks (CRWMS M&O 1997a and CRWMS M&O 1997b)
A1-SHAD = Shadow Area, sqft = (L + ws) H * COT of crash angle
A2-FTPRT = Footprint Area, sqft = (L + ws) W
A3-SKID = Skid Area, sqft = (L + ws) S
A(eff) = Effective Area

Skid dist, S, ft =	246	DOE (1996)	TABLE B-18
Wing span, ws, ft =	43	LLNL (1996)	TABLE 4.20
COT of crash angle =	8.4	DOE (1996)	TABLE B-17

ATTACHMENT III—Determination of Crash Hit Frequency - NUREG Model

This attachment calculates the cash hit frequencies using the NUREG model as defined in Section 7.2 and provides the resultant spreadsheets.

$P_{FA} = CNA_{eff}$ (1/w)

where:

P_{FA} = crash hit frequency/year
C = inflight crash rate/mile
N = number of flights/year
A_{eff} = A(eff) = effective area of the surface facilities, square miles
w = width of corridor plus twice the distance from corridor edge to site, miles

The equation above, as listed in Section 7.2, has been incorporated into this spreadsheet. Because of Excel formatting limitations, P_{FA} = P(fa) and A_{eff} = A(eff)

The values, and their basis, are defined in Section 7.2.

The number of flights, N, for each aircraft type are calculated in this spreadsheet using the fractions determined in Section 7.2.3, as summarized below.

<u>Aircraft mix used in sensitivity and best estimate cases:</u>

N, F-16 = 0.29 of total flights/yr
N, F-15 = 0.9(0.71) of total flights/yr
N, A-10 = 0.1(0.71) of total flights/yr

TABLE III-1. AIRCRAFT CRASH FREQUENCY - NUREG MODEL - BEST ESTIMATE CASE

	Mean	90%	95%
Total flights/month	1059.67	1461.85	1575.87
Total flights/year	12716	17542	18910
w	29		

Case	Aircraft	C	N	A(eff)	w	1/w	P(fa)
Mean	F-16	3.86E-08	3688	3.63E-02	29	3.45E-02	1.78E-07
Mean	F-15	6.25E-09	8126	3.69E-02	29	3.45E-02	6.46E-08
Mean	A-10	3.14E-08	903	3.78E-02	29	3.45E-02	3.70E-08
Mean	TOTAL						2.80E-07
90% Confidence	F-16	3.86E-08	5087	3.63E-02	29	3.45E-02	2.46E-07
90% Confidence	F-15	6.25E-09	11209	3.69E-02	29	3.45E-02	8.91E-08
90% Confidence	A-10	3.14E-08	1245	3.78E-02	29	3.45E-02	5.10E-08
90% Confidence	TOTAL						3.86E-07
95% Confidence	F-16	3.86E-08	5484	3.63E-02	29	3.45E-02	2.65E-07
95% Confidence	F-15	6.25E-09	12083	3.69E-02	29	3.45E-02	9.61E-08
95% Confidence	A-10	3.14E-08	1343	3.78E-02	29	3.45E-02	5.50E-08
95% Confidence	TOTAL						4.16E-07

TABLE III-2. AIRCRAFT CRASH FREQUENCY - NUREG MODEL - SENSITIVITY CASE

	Mean	90%	95%
Total flights/month	1059.67	1461.85	1575.87
Total flights/year	12716	17542	18910
w	29		

Case	Aircraft	C	N	A(eff)	w	1/w	P(fa)
Mean	F-16	3.86E-08	3688	7.74E-02	29	3.45E-02	3.80E-07
Mean	F-15	6.25E-09	8126	7.90E-02	29	3.45E-02	1.38E-07
Mean	A-10	3.14E-08	903	8.12E-02	29	3.45E-02	7.94E-08
Mean	TOTAL						5.98E-07
90% Confidence	F-16	3.86E-08	5087	7.74E-02	29	3.45E-02	5.24E-07
90% Confidence	F-15	6.25E-09	11209	7.90E-02	29	3.45E-02	1.91E-07
90% Confidence	A-10	3.14E-08	1245	8.12E-02	29	3.45E-02	1.10E-07
90% Confidence	TOTAL						8.24E-07
95% Confidence	F-16	3.86E-08	5484	7.74E-02	29	3.45E-02	5.65E-07
95% Confidence	F-15	6.25E-09	12083	7.90E-02	29	3.45E-02	2.06E-07
95% Confidence	A-10	3.14E-08	1343	8.12E-02	29	3.45E-02	1.18E-07
95% Confidence	TOTAL						8.89E-07

TABLE III-3. AIRCRAFT CRASH FREQUENCY - NUREG MODEL - BOUNDING CASE

	Mean	90%	95%
Total flights/month	1059.67	1461.85	1575.87
Total flights/year	12716	17542	18910
w	29		

Case	Aircraft	C	N	A(eff)	w	1/w	P(fa)
Mean	All Small F/A	1.84E-08	12716	8.12E-02	29	3.45E-02	6.55E-07
90% Confidence	All Small F/A	1.84E-08	17542	8.12E-02	29	3.45E-02	9.04E-07
95% Confidence	All Small F/A	1.84E-08	18910	8.12E-02	29	3.45E-02	9.74E-07

ATTACHMENT IV—Determination of Crash Hit Frequency - Uniform Overflight Density Model

This attachment calculates the crash hit frequencies using the Uniform Overflight Density model and provides the resultant spreadsheets.

The equations listed in Section 7.3 have been incorporated in these spreadsheets. Because of Excel formatting limitations, the parameters definitions were modified as shown below.

N_t = N(t)
A_t = A(t)
A_{eff} = A(eff)
R_t = R(t)

The parameter values, and their bases, are defined in Section 7.2 and 7.3.

The number of flights, N_t, for each aircraft type are calculated in these spreadsheets per Section 7.2.3 as summarized below.

Aircraft mix for best estimate and sensitivity cases:

N_t, F-16 = 0.29 of total flights/yr
N_t, F-15 = 0.9(0.71) of total flights/yr
N_t, A-10 = 0.1(0.71) of total flights/yr

TABLE IV-1. AIRCRAFT CRASH FREQUENCY - UNIFORM OVERFLIGHT DENSITY MODEL - BEST ESTIMATE CASE

	Mean	90%	95%
Total flights/month	1059.67	1461.85	1575.87
Total flights/year	12716	17542	18910
R(t), miles			20.73

Case	Aircraft	λ	N(t)	A(eff)	A(t)	R(t)	F
Mean	F-16	3.86E-08	3688	3.63E-02	1.35E+03	20.73	1.01E-07
Mean	F-15	6.25E-09	8126	3.69E-02	1.35E+03	20.73	3.66E-08
Mean	A-10	3.14E-08	903	3.78E-02	1.35E+03	20.73	2.10E-08
Mean	TOTAL		12716				1.59E-07
90% Confidence	F-16	3.86E-08	5087	3.63E-02	1.35E+03	20.73	1.39E-07
90% Confidence	F-15	6.25E-09	11209	3.69E-02	1.35E+03	20.73	5.05E-08
90% Confidence	A-10	3.14E-08	1245	3.78E-02	1.35E+03	20.73	2.89E-08
90% Confidence	TOTAL		17542				2.19E-07
95% Confidence	F-16	3.86E-08	5484	3.63E-02	1.35E+03	20.73	1.50E-07
95% Confidence	F-15	6.25E-09	12084	3.69E-02	1.35E+03	20.73	5.45E-08
95% Confidence	A-10	3.14E-08	1343	3.78E-02	1.35E+03	20.73	3.12E-08
95% Confidence	TOTAL		18910				2.36E-07

TABLE IV-2. AIRCRAFT CRASH FREQUENCY - UNIFORM OVERFLIGHT DENSITY MODEL - SENSITIVITY CASE

	Mean	90%	95%
Total flights/month	1059.67	1461.85	1575.87
Total flights/year	12716.04	17542.2	18910.44
R(t), miles			20.73

Case	Aircraft	λ	N(t)	A(eff)	A(t)	R(t)	F
Mean	F-16	3.86E-08	3688	7.74E-02	1.35E+03	20.73	2.15E-07
Mean	F-15	6.25E-09	8126	7.90E-02	1.35E+03	20.73	7.84E-08
Mean	A-10	3.14E-08	903	8.12E-02	1.35E+03	20.73	4.50E-08
Mean	TOTAL		12716				3.39E-07
90% Confidence	F-16	3.86E-08	5087	7.74E-02	1.35E+03	20.73	2.97E-07
90% Confidence	F-15	6.25E-09	11209	7.90E-02	1.35E+03	20.73	1.08E-07
90% Confidence	A-10	3.14E-08	1245	8.12E-02	1.35E+03	20.73	6.21E-08
90% Confidence	TOTAL		17542				4.67E-07
95% Confidence	F-16	3.86E-08	5484	7.74E-02	1.35E+03	20.73	3.20E-07
95% Confidence	F-15	6.25E-09	12084	7.90E-02	1.35E+03	20.73	1.17E-07
95% Confidence	A-10	3.14E-08	1343	8.12E-02	1.35E+03	20.73	6.69E-08
95% Confidence	TOTAL		18910				5.04E-07

TABLE IV-3. AIRCRAFT CRASH FREQUENCY - UNIFORM OVERFLIGHT DENSITY MODEL - BOUNDING CASE

	Mean	90%	95%
Total flights/month	1059.67	1461.85	1575.87
Total flights/year	12716	17542	18910
R(t), miles	20.73		

Case	Aircraft	λ	N(t)	A(eff)	A(t)	R(t)	F
Mean	TOTAL	1.84E-08	12716	8.12E-02	1.35E+03	20.73	3.71E-07
90% Confidence	TOTAL	1.84E-08	17542	8.12E-02	1.35E+03	20.73	5.12E-07
95% Confidence	TOTAL	1.84E-08	18910	8.12E-02	1.35E+03	20.73	5.52E-07

Attachment V: E-mail, E. Tullman to R. Morissette, "FW:AF Memorandum," dated 9/22/98

"Tullman, Edward J. LTC" <TULLMAN@doemail.nv.doe.gov> on 09/22/98 09:40:47 AM

To: Richard Morissette/YM/RWDOE
cc: "Carpenter, Gerald C." <CARPENTERGC@doemail.nv.doe.gov>, "Long, Christopher S., Col." <LONGC@doemail.nv.doe.gov>
Subject: FW: AF Memorandum

Dick,
Dennis Bee and I reviewed these answers and expanations to your questions. These seem reasonable to me and I trust you have accepted them also. This should close out your request. If you have additional questions, please do not hessitate to ask.
Ed

> -----Original Message-----
> From: Bee Dennis GS-12 57 OSS/OSAM [SMTP:dennis.bee@nellis.af.mil]
> Sent: Monday, September 21, 1998 1:44 PM
> To: 'Tullman, Edward J. LTC'
> Cc: Percival Wilhelm F COL RMO Commander; Carpenter, Gerald C.; Long,
> Christopher S., Col.; Morissette, Richard(YM);
> 'Robert_Thompson@notes.ymp.gov'; Beebe Kevin A MAJ 57 OSS/OSA/CC
> Subject: RE: AF Memorandum
>
> Sir - I discussed this with Bob Thompson (SAIC) and he advised that all
> of Dick Morissette's questions regarding A/C transitions over R-4808N
> are answered. The standard instrument arrival routes(STAR's) and
> standard instrument departure routes (SID's) that over flew Yucca Mtn
> are canceled. Per the letter signed by Col Irving, R-4808N is
> subdivided into areas A, B, C, & D. Areas B, C, & D can be scheduled
> for transition only, above 14,000 MSL. This means that aircraft will
> randomly fly through these subdivisions when scheduled and contact
> (Nellis ATC Facility) prior to exiting the airspace for recovery. In
> addition, NATCF will clear aircraft scheduled/tactical prior to the
> south boundary and the aircraft will transition R-4808N randomly until
> established in their work areas in R-4807A.
> V/R
> Dennis
>

Attachment VI: E-mail, J. Wood to R. Morissette, "RE: Reference Documentation," dated 4/8/98

"Wood, Jeryl L." <WOOD@doemail.nv.doe.gov> on 04/08/98 04:33:27 PM

To: "Morissette, Richard(YM)" <Richard_Morissette@notes.ymp.gov>
cc:
Subject: RE: Reference Documentation

Richard,

I concur with your document, with the following corrections:

1. First para, 3d line - change "operations by DOE aircraft..." to "operations by aircraft...."

2. Second para, 1st line - delete DOE/NVO and start with "Helicopters routinely...."

J L Wood

VERIFICATION OF DOE DATA AND ASSUMPTIONS For MGR AIRCRAFT CRASH FREQUENCY ANALYSIS (B00000000-01717-0200-00136 REV 00)

(The following was provided via telephone conversations)

DOE aircraft, or aircraft chartered by DOE, may utilize any airfield or landing strip within the NTS. Those located in the vicinity of the proposed repository site are listed in Table 7.1-2. The number of operations by ~~DOE~~ aircraft, in the restricted airspace defined as R-4808, is less than 54,000 operations/year (Reference 5.14).

Text changes per E-mail above RLM 4/8/98

Airport	D, miles
Desert Rock	26
Yucca	23
Pahute Mesa	20

~~DOE/NVO~~ helicopters routinely fly in most areas within the NTS restricted airspace. During 12 weeks per year, helicopters fly 24 sorties per day along 40 Mile Wash located 1.5 miles from the site of the proposed repository surface facilities. Therefore, the number of helicopter flights, which come within 2 miles of the repository surface facilities, averages 1440 per year. It is assumed that DOE/NVO will adjust their helicopter routes to maintain a two-mile separation with the repository surface facilities (Reference 5.14).

Attachment VII: McCarran International Airport Statistics

McCarran International Airport
Clark County Department of Aviation
Las Vegas, Nevada

To:	Dick Morissette
Company:	Yucca Mountain Project
Fax #:	295-4230
Subject:	Annual Operations at McCarran International
Date:	June 30, 1999
Pages:	6, including this cover sheet.

COMMENTS:

Mr. Morissette,

As requested, attached is the annual operational data for McCarran International Airport. The data for 1999 includes the months of January through May. If I may be of any further assistance, please call me at 261-5510.

Jeff Jacquart JJ

From the desk of...
Jeffrey Jacquart
Noise Abatement Officer

(702)-261-5510

JeffJ@DOA.MIA

Intentional obliterations do not impact the technical meaning or content of the record.

RPM 9/29/99

83500
STATISTICS
0021

MCCARRAN INTERNAT... AIRPORT
CLARK COUNTY DEPARTMENT OF AVIATION
1995 FAA CONTROL TOWER OPERATIONS
Prepared by: Donna Parker

1
01/18/96
15:08:43

McCarran Int'l Airport

Description	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
ITINERANT													
AIR CARRIER	21,635	19,948	22,706	21,687	21,836	20,946	21,417	21,503	21,040	22,514	21,447	21,837	258,516
AIR TAXI	7,047	9,149	8,854	8,668	9,754	10,153	9,931	10,982	8,343	8,291	6,897	6,152	104,221
GENERAL AVIATION	8,815	9,226	9,114	9,383	8,558	7,765	7,840	8,538	10,329	9,904	8,987	7,204	105,663
MILITARY	991	1,421	1,632	1,713	1,810	1,409	1,265	1,597	1,427	1,372	1,714	1,467	17,818
LOCAL													
GENERAL AVIATION	1,709	2,076	1,944	1,333	1,213	1,125	1,160	1,340	1,088	1,553	1,504	1,280	17,325
MILITARY	34	2	20	21	16	10		18	10	10	12	2	155
TOTAL	40,231	41,822	44,270	42,805	43,187	41,408	41,613	43,978	42,237	43,644	40,561	37,942	503,698

1995

Intentional obliterations do not impact the technical meaning or content of the record.

83500
STATISTICS
0021

MCCARRAN INTERNA... AL AIRPORT
CLARK COUNTY DEPART... OF AVIATION
1996 FAA CONTROL TOWER OPERATIONS
[redacted]

1
01/21/97
09:21:46

RPm 9/29/99

McCarran Int'l Airport

Description	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
ITINERANT													
AIR CARRIER	22,169	21,464	23,218	22,813	23,518	23,148	24,249	24,434	24,123	25,003	23,416	23,659	281,214
AIR TAXI	6,249	7,074	7,633	6,065	5,436	5,500	5,311	5,982	6,013	5,988	5,792	4,955	71,998
GENERAL AVIATION	8,786	7,819	8,037	7,360	7,315	7,164	6,599	6,683	7,264	7,365	8,121	6,525	89,038
MILITARY	1,410	1,357	1,747	1,825	1,806	1,641	1,317	1,433	1,655	1,509	1,319	1,465	18,484
LOCAL													
GENERAL AVIATION	1,359	1,448	1,465	1,323	1,377	1,302	1,274	1,292	977	1,180	1,380	1,350	15,727
MILITARY	6	4		10	6	16			2	2		4	50
TOTAL	39,979	39,166	42,100	39,396	39,458	38,771	38,750	39,824	40,034	41,047	40,028	37,958	476,511

1996

83500 MCCARRAN INTERNATIONAL AIRPORT 1
STATISTICS CLARK COUNTY DEPARTMENT OF AVIATION 01/22/98
0012 1997 FAA CONTROL TOWER OPERATIONS 15:06:22
Prepared by: Donna Parker

McCarran Int'l Airport

Description	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
ITINERANT													
AIR CARRIER	23,562	22,453	25,125	24,125	24,964	24,363	25,263	25,158	24,680	25,921	24,444		270,058
AIR TAXI	4,681	4,145	4,668	4,519	5,097	4,527	4,081	4,577	5,438	4,493	3,492	24,764	74,482
GENERAL AVIATION	7,110	6,640	8,812	8,026	8,252	8,077	8,094	8,125	6,974	8,813	7,611	3,125	89,659
MILITARY	1,781	1,383	1,594	1,664	1,781	1,818	1,786	1,891	1,933	2,047	1,757	6,395	25,830
LOCAL													
GENERAL AVIATION	1,066	1,302	1,606	932	1,088	825	847	1,008	592	857	665	676	11,464
MILITARY													
TOTAL	38,200	35,923	41,805	39,266	41,182	39,610	40,071	40,759	39,617	42,131	37,969	34,960	471,493

1997

Intentional obliterations do not impact the technical meaning or content of the record.

83500
STATISTICS
0012

MCCARRAN INTERNAT('AIRPORT
CLARK COUNTY DEPARTMEN. JF AVIATION
1998 FAA CONTROL TOWER OPERATIONS
Prepared by: Donna Parker

01:27/99
12:02:52

McCarran Int'l Airport

RPm 9/29/99

Description	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
ITINERANT													
AIR CARRIER	24,957	22,975	25,882	24,441	24,723	24,037	24,840	25,331	24,318	26,045	24,632	24,819	297,000
AIR TAXI	3,072	2,859	4,250	3,326	2,890	2,902	3,191	3,509	3,773	4,003	3,535	3,074	40,374
GENERAL AVIATION	7,827	5,916	7,442	7,034	7,632	7,012	7,182	7,895	8,374	11,113	8,729	7,558	93,714
MILITARY	1,805	1,789	2,128	1,907	2,030	2,215	2,310	2,768	2,980	3,142	2,911	2,799	28,784
LOCAL													
GENERAL AVIATION	704	565	548	650	752	854	1,010	1,373	1,271	986	1,178	927	10,818
MILITARY	2				8	6				1			17
TOTAL	38,367	34,104	40,250	37,348	38,035	37,026	38,533	40,876	40,716	45,290	40,985	39,177	470,707

1998

83500
STATISTICS
0013

MCCARRAN INTERNATIONAL AIRPORT
CLARK COUNTY DEPARTMENT OF AVIATION
AIRPORT ACTIVITY OVERVIEW
Prepared by: Donna Parker

2
06/17/99
10:38:55

McCarran Int'l Airport

Description	MAY 1999	MAY 1998	% INC/DEC	CY 1999	CY 1998	% INC/DEC
LANDINGS - Reporting Carr	14,713	13,800	6.6 %	72,996	66,973	9.0 %
FAA AIRCRAFT OPERATIONS:						
AIR CARRIER	26,213	24,723	6.0 %	131,182	122,978	6.7 %
AIR TAXI	7,166	2,890	148.0 %	28,352	16,387	73.0 %
GENERAL AVIATION	12,179	8,384	45.3 %	53,843	39,070	37.8 %
MILITARY	298	2,038	85.4-%	2,706	9,669	72.0-%
TOTAL OPERATIONS	45,856	38,035	20.6 %	216,083	188,104	14.9 %

Jan - May, 1999

Attachment VIII: E-mail, E. Tullman to R. Morissette, "FW: Accident Rates," dated 5/22/98

TULLMAN@doemail.nv.doe.gov on 05/22/98 08:46:45 AM

To: Richard Morissette
cc:
Subject: FW: Accident Rates

Just got this in from Maj Miller who also attended our recent meeting.
He pulled this data from the safety center web site. These numbers
appear to be improved. Hope this helps.
Ed

```
> -----Original Message-----
> From:       Miller Ray G MAJ AWC/SEF [SMTP:ray.miller@nellis.af.mil]
> Sent:       Thursday, May 21, 1998 11:43 AM
> To: tullman@nv.doe.gov
> Subject:    Accident Rates
> Importance: High
>
>
> Sir -
>
>      Here are the calculations for F-15C, F-15E, F-16, and A-10.  All
> of the statistics come from the AF Safety Center Web Site (
> www-afsc.saia.af.mil  ).  Looking at the stats you can see where the
> curve starts to level off.  Fewer years were subtracted from F-15C and
> Es because the F-15 was already established before they came around.
>
>
> A-10                                    total life
> 2.55/100,000 hours
>             Subtract first 8 years           CY 80     2.15/100,000
> hours
>
> F-16                                    total life
> 4.41/100,000 hours
>             Subtract first 8 years           CY 83     3.97/100,000
> hours
>
> F-15C                                        total life
> 2.49/100,000 hours
>             Subtract first 5 years           CY 84     2.14/100,000
> hours
>
> F-15E                                        total life
> 1.42/100,000 hours
>             Subtract first 4 years           CY 91     1.27/100,000
> hours
>
>
>      If you need further information, please let me know.
```