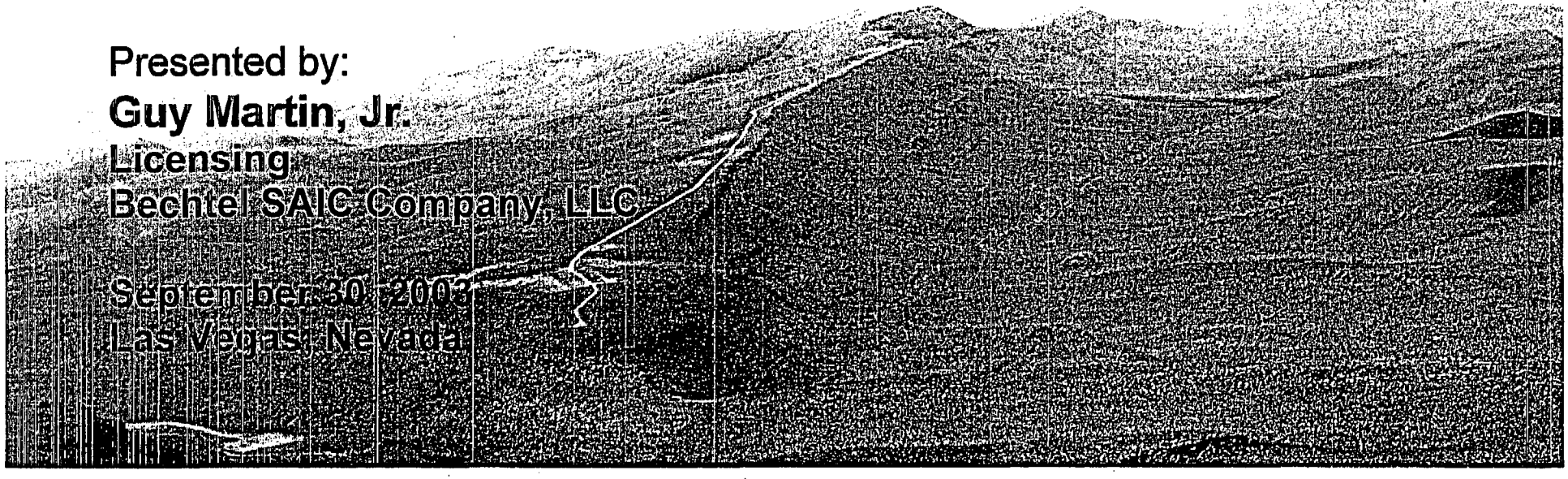
U.S. Department of Energy
Office of Civilian Radioactive Waste Management

YUCCA MOUNTAIN PROJECT

Key Technical Issue Preclosure (PRE) 3.01

Presented to:
DOE/NRC Technical Exchange on Aircraft Hazards Analysis



Presented by:
Guy Martin, Jr.
Licensing
Bechtel SAIC Company, LLC

September 30, 2003
Las Vegas, Nevada

ATTACHMENT 3

Key Technical Issue Preclosure (PRE) 3.01

- **"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 the map in June 2002. DOE agrees to participate in an Appendix 7 meeting which will be scheduled after the plan and map are provided."**

Key Technical Issue Preclosure (PRE) 3.01

- **The DOE Report "Identification of Aircraft Hazards" Provides:**
  - **Initial data collection**
  - **Vicinity map**
- **The DOE Report "Frequency Analysis of Aircraft Hazards for License Application" Provides:**
  - **Estimation of aircraft hazards**

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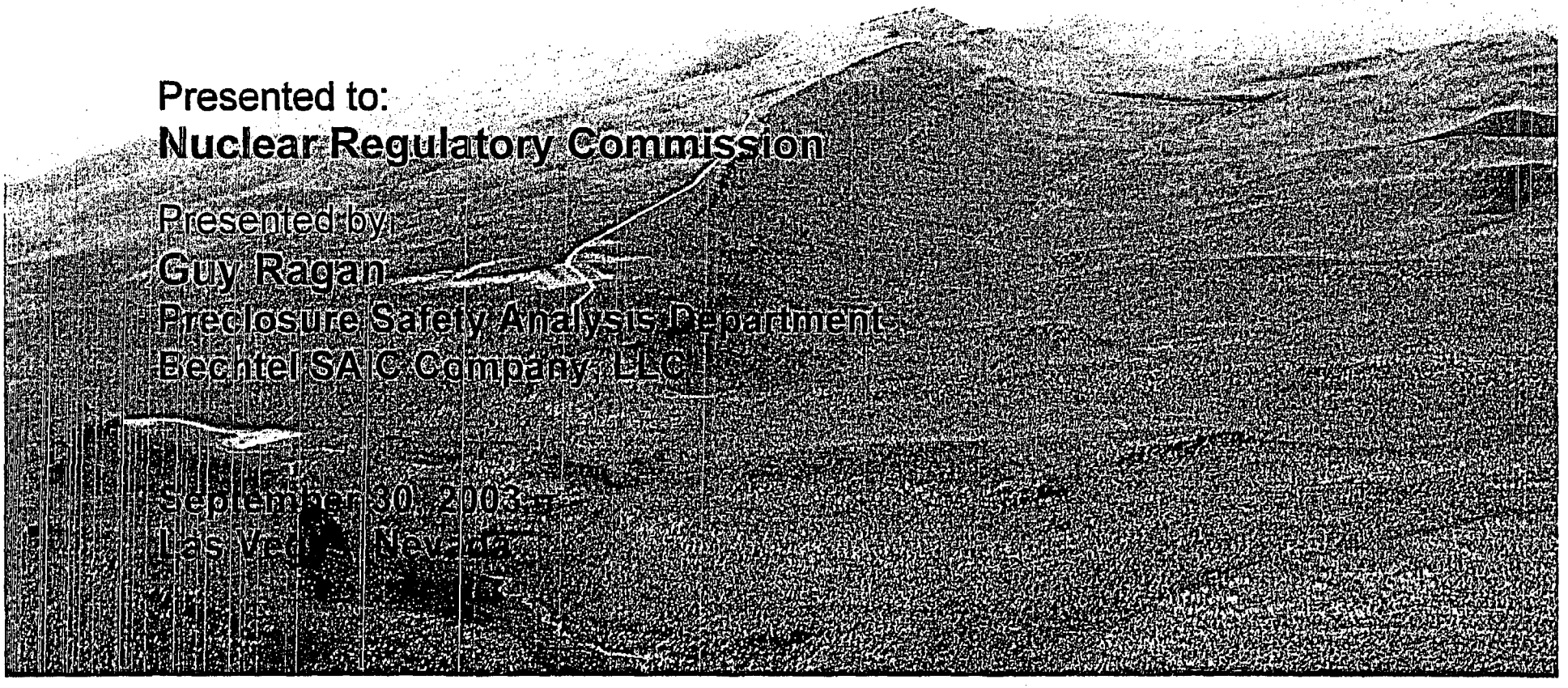
Summary of *Identification of Aircraft Hazards*, TDR-WHS-RL-000001 REV 00



Presented to:
Nuclear Regulatory Commission

Presented by:
Guy Ragan
Preclosure Safety Analysis Department
Bechtel SAIC Company, LLC

September 30, 2003
Las Vegas, Nevada

Purpose of the Report

- Describe aircraft related activities over a wide regional setting surrounding the repository
- Provide a map delineating the vicinity to be considered for detailed frequency analysis
- Identify those aircraft related activities that require quantitative frequency analysis

Scope of the Report

- Aircraft:
  - Military
  - Commercial
  - General aviation and other civilian
- Airspace features:
  - Nevada Test and Training Range (NTTR)
  - Nevada Test Site (NTS)
  - Edwards R-2508 Range Complex
  - Military training routes (MTRs)
  - Low altitude tactical navigation (LATN) areas
  - Commercial and civilian routes
  - Airports

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Regional Setting

- Include all airspace features in the vicinity of Yucca Mountain
  - Commercial airports to the south
  - Tonopah Airport and Tonopah Test Range to the north
  - Air Force Range complexes to the east and west
- Exclude areas beyond those selected above
  - Fallon Naval Air Station to the north
  - Edwards Air Force Base to the south
- The selected regional setting extends 100 miles from the repository site

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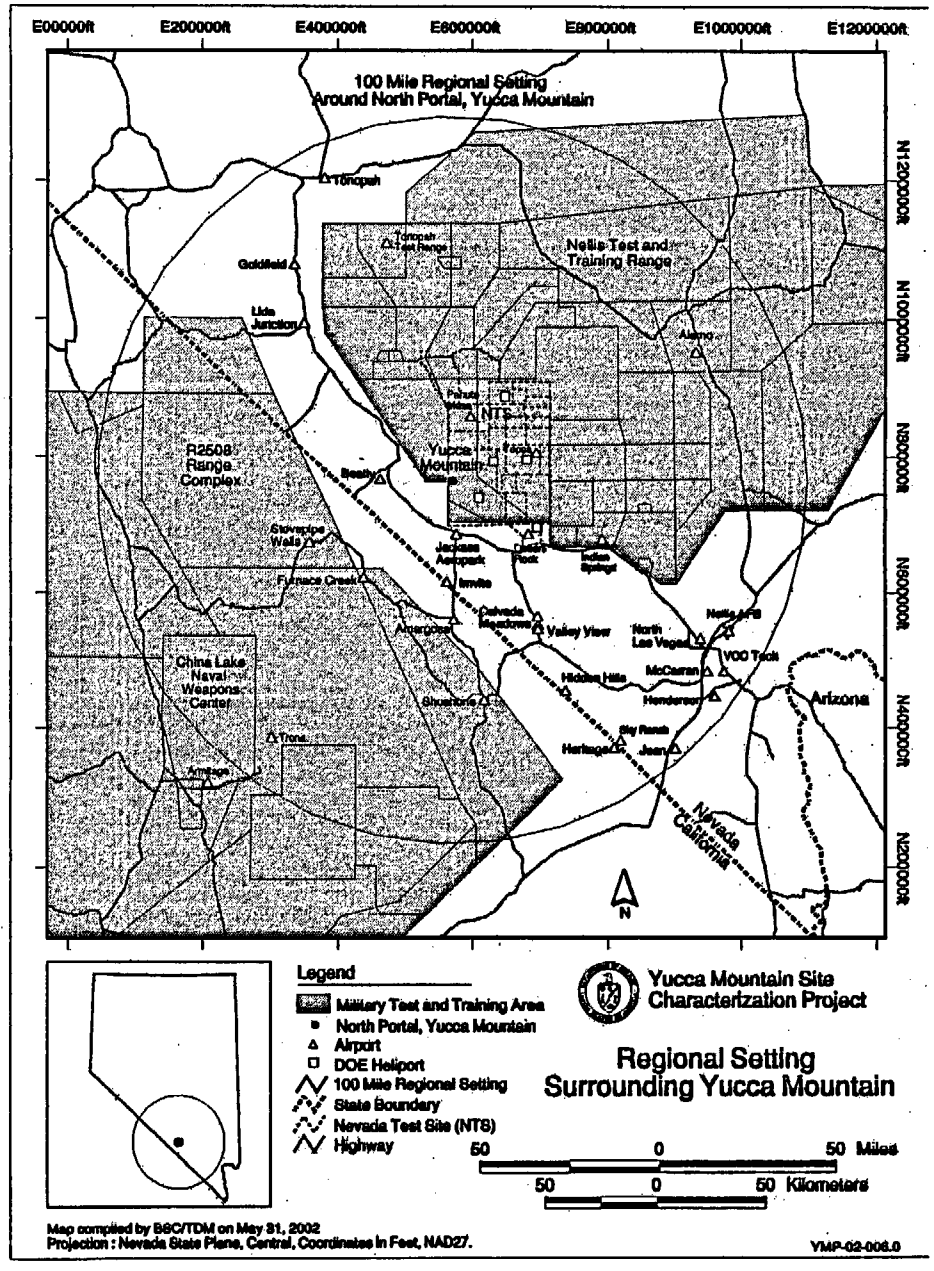
Regional Setting



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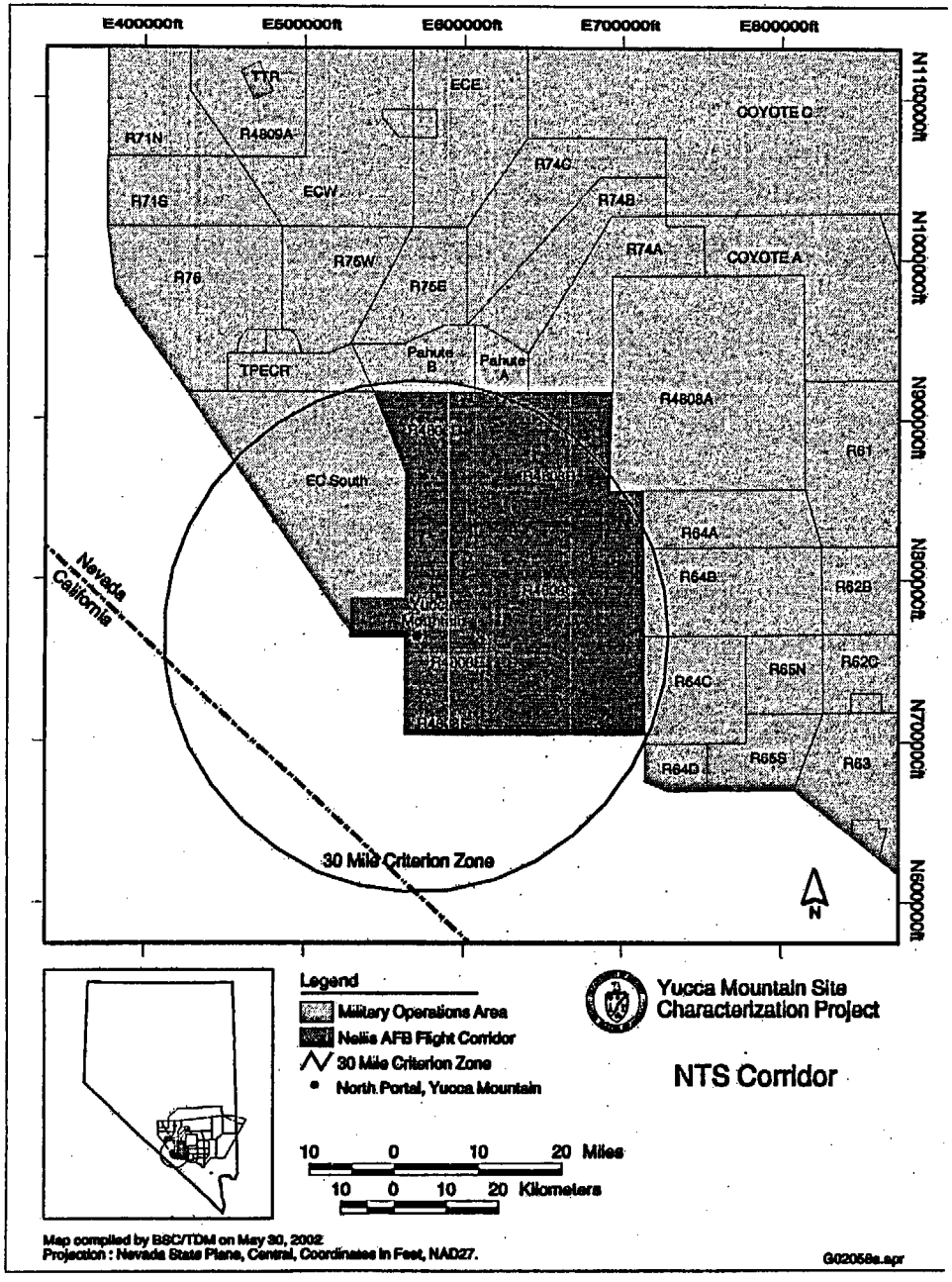
Nevada Test Site

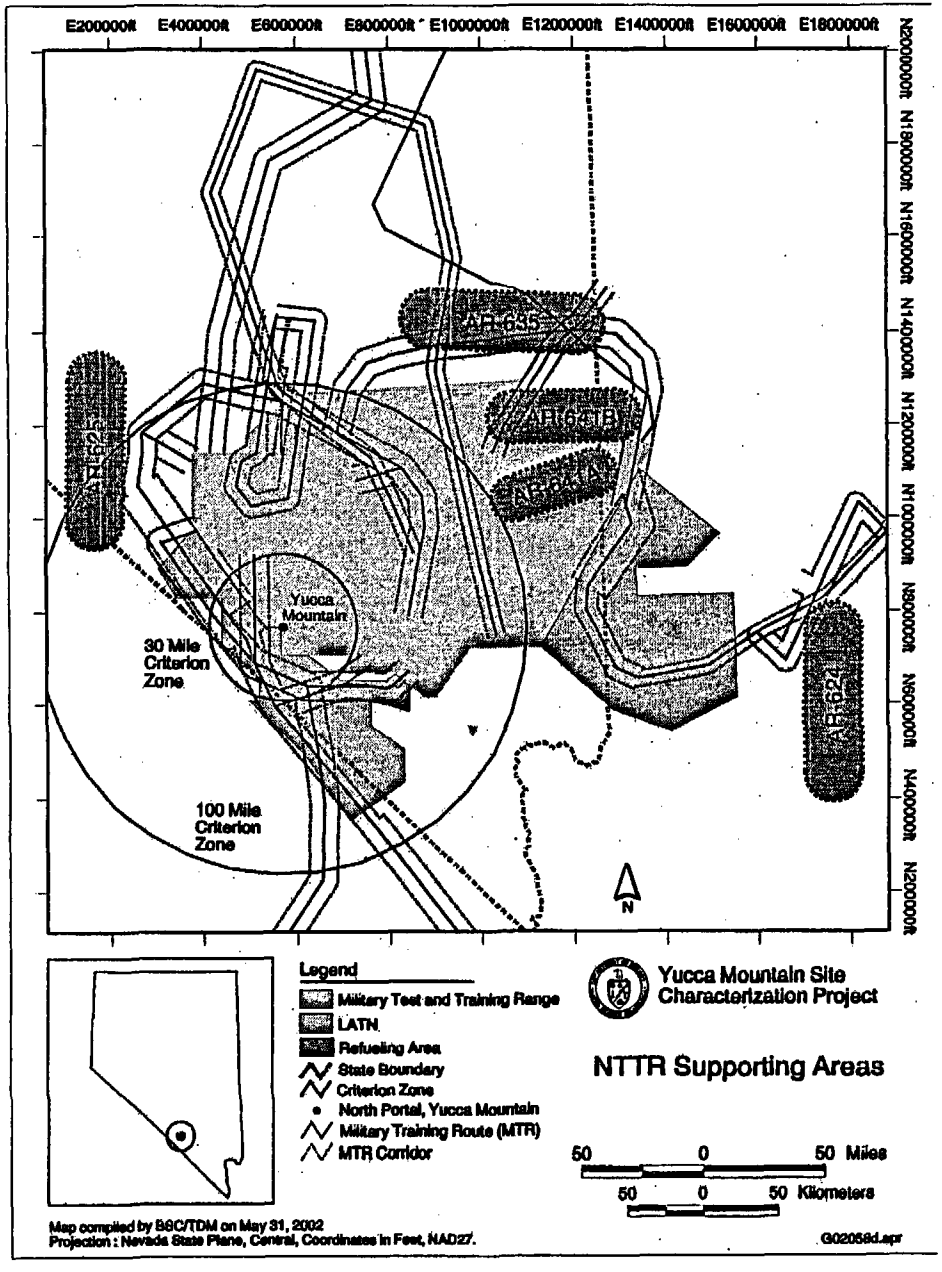
- DOE retains exclusive and continuous control of the Nevada Test Site (NTS) airspace.
- Commercial aircraft are allowed to use a small area at the southwest corner of NTS, 7 miles from the repository site (R-4808S).
- An agreement between DOE and the Air Force allows military aircraft into portions of the NTS airspace with restrictions to reduce the hazards to facilities and operations within the NTS.

Nevada Test Site



Airspace that Supports the Nevada Test and Training Range (NTTR)

- Unrestricted airspace surrounding the NTTR include:
  - Low Altitude Tactical Navigation (LATN) areas for A-10s and helicopters to practice random selection of navigation points and low-altitude tactical formations
  - Military Training Routes allow training at airspeeds in excess of 250 knots between 500 and 1,000 feet above ground level
  - Air Refueling Tracks are used to refuel aircraft. One track is partially located within 100 miles of the repository



Airspace that Supports the Nevada Test and Training Range

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Qualitative Screening

- Screening is necessary to identify credible hazards
- Event credibility can be established qualitatively using defensible screening criteria
- Events not screened out require a quantitative determination of frequency

Basis for Screening Approach

- Describe aircraft-related facilities and equipment
- Evaluate distance from repository surface facilities
- Consider initiating events that could cause an effect on repository surface facilities
- Consider likely scenarios following an initiating event
- Evaluate the likelihood that repository surface facilities could be affected

Screening Criteria

- The following hazards do not pose a hazard to repository surface facilities
  - Aircraft training activities in restricted areas and military operations areas located more than 30 miles away
  - Aircraft refueling activities more than 30 miles away
  - Fired ordnance
  - Hung ordnance
  - Large multi-engine aircraft above 18,000 feet above sea level
  - Aircraft flying on military training routes more than 20 miles away
  - Aircraft training more than 30 miles away
  - Aircraft taking off and landing at airports more than 10 miles away
  - Aircraft flying on federal airways and jet routes whose edges are located more than 25 miles away

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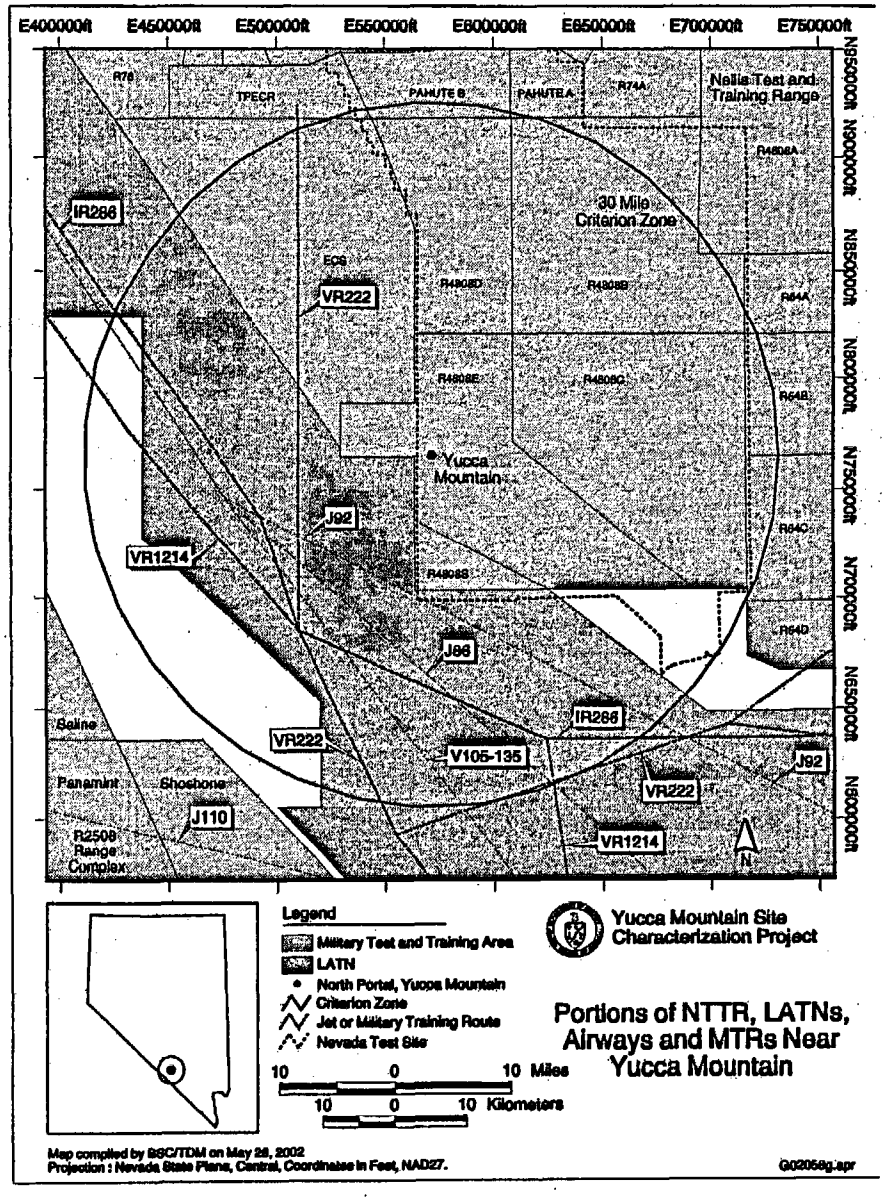
Potential Hazards Screened Out

- Military operations areas on the Nevada Test and Training Range (NTTR) and the R-2508 Complex
- The 70 Series Ranges in the restricted areas of the NTTR
- The 60 Series Ranges in the NTTR with the exception of R64
- Ordnance fired from aircraft on the NTTR
- Aerial refueling areas
- Civilian and military airports

Applicable Aircraft Hazards

- Civilian and military aircraft in the public airspace to the southwest of Yucca Mountain
- Air Force flights over the Nevada Test Site (NTS) and Electronic Combat Range South (see ECS, next slide)
- DOE and Air Force helicopters on the NTS

Vicinity Map



Summary

- The report *Identification of Aircraft Hazards* and this meeting fulfill the PRE 3.01 agreement between DOE and NRC:
  - Provide a plan for identification and estimation of aircraft hazards consistent with NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants.*
  - 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 a 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.

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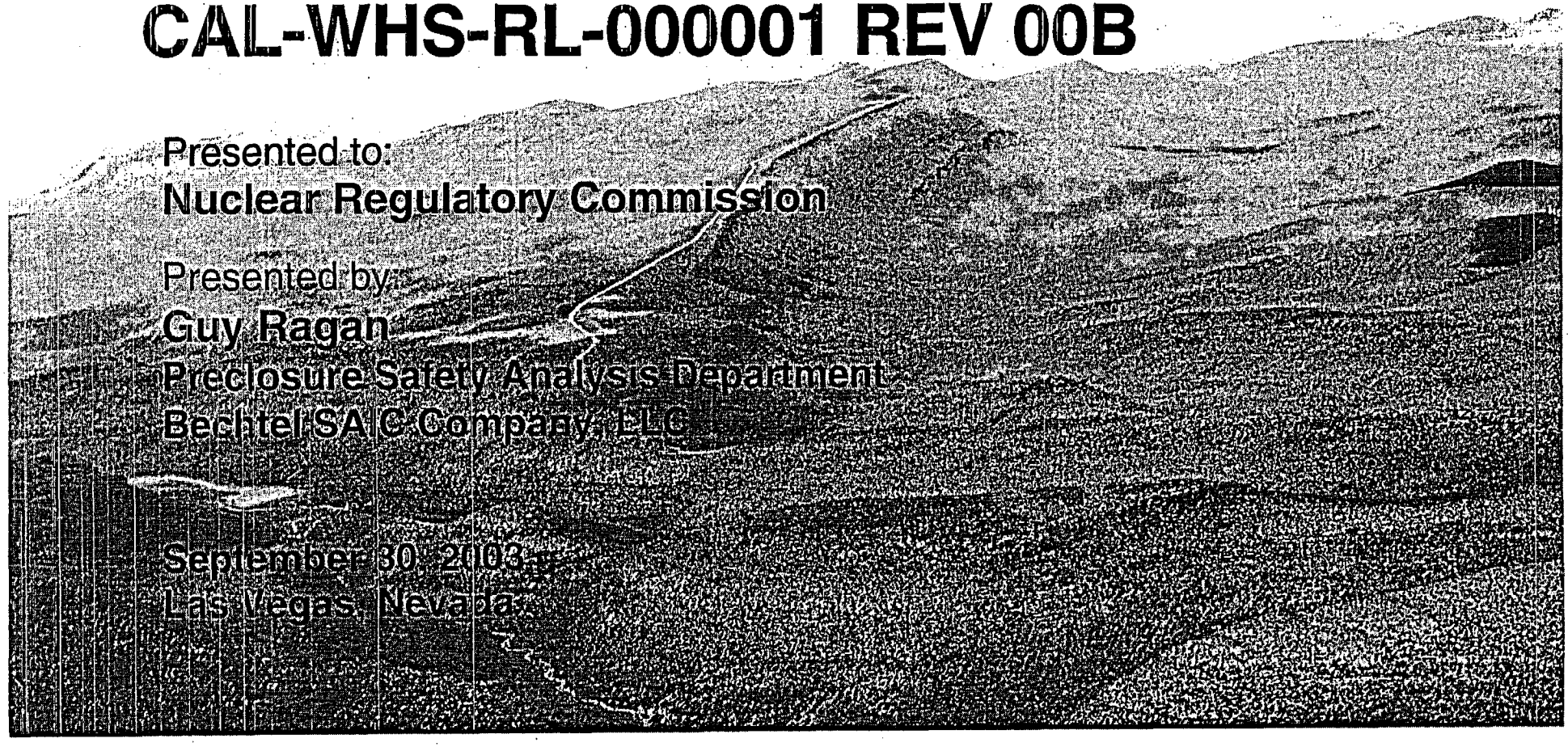
Summary of *Frequency Analysis of Aircraft Hazards for License Application,* CAL-WHS-RL-000001 REV 00B



Presented to:
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Guy Ragan
Preclosure Safety Analysis Department
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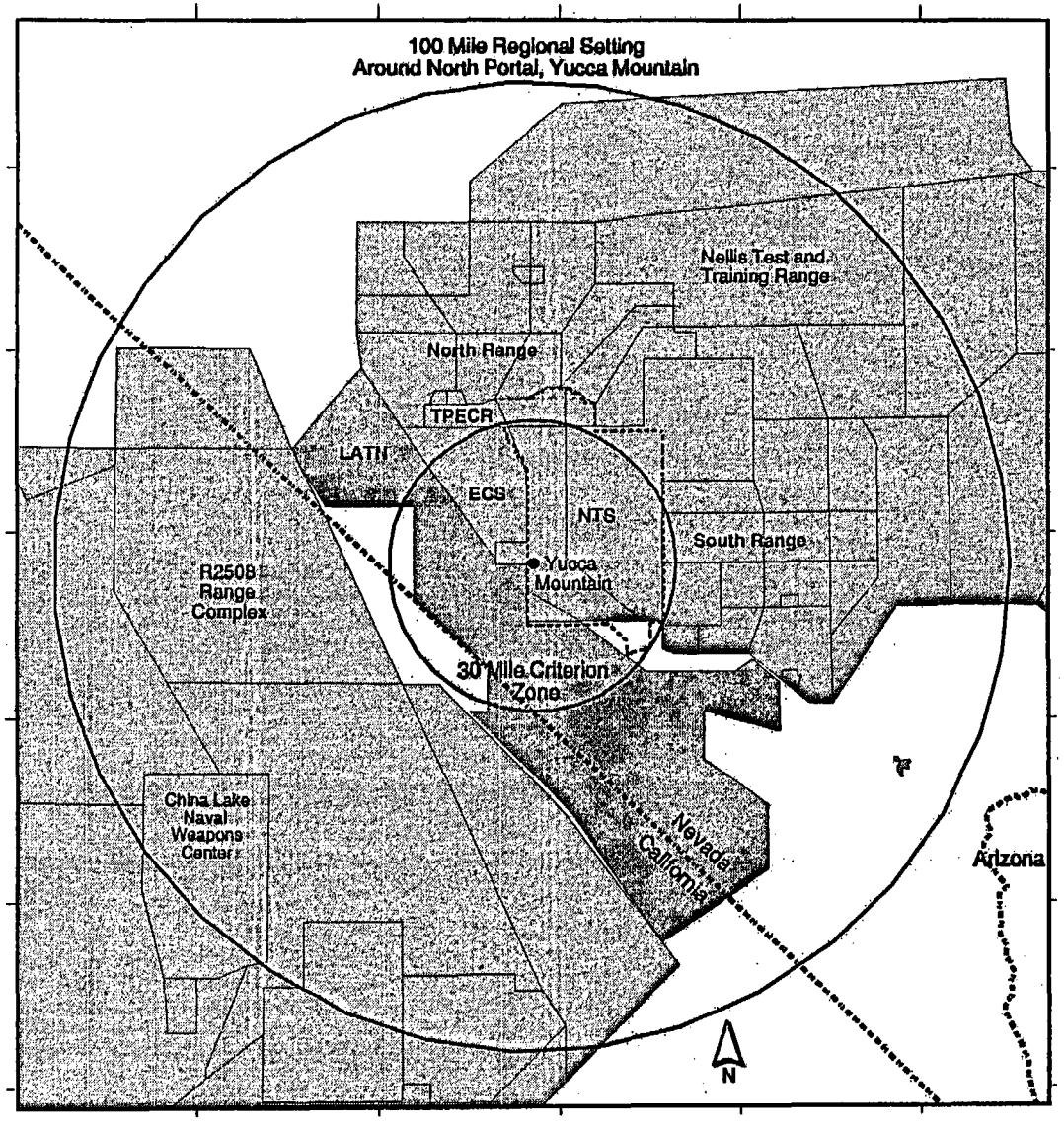
September 30, 2003
Las Vegas, Nevada

Applicable Aircraft Hazards

- Civilian and military aircraft in the public airspace to the southwest of Yucca Mountain
- Air Force flights over the Nevada Test Site and Electronic Combat Range South (see ECS, next slide) including dropped objects
- DOE and Air Force helicopters on the Nevada Test Site

Airspace Surrounding Yucca Mountain



Legend	
ECS	Electronic Combat Range South
LATN	Low Altitude Training and Navigation area
NTS	Nevada Test Site
TPECR	Tolicha Peak Electronic Combat Range

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Annual Flight Frequencies

Flight Area Specific area or aircraft type	Annual Number of Flights
Nevada Test Site Airspace	
Nevada Test Site box	19,000
Repository box (6 × 7 mile)	1,700
Public Airspace	
Air carrier	85,000
Air taxi	13,000
Turbojet	15,000
Turboprop	5,300
Piston	5,700
Small Military	3,300
Large Military	840

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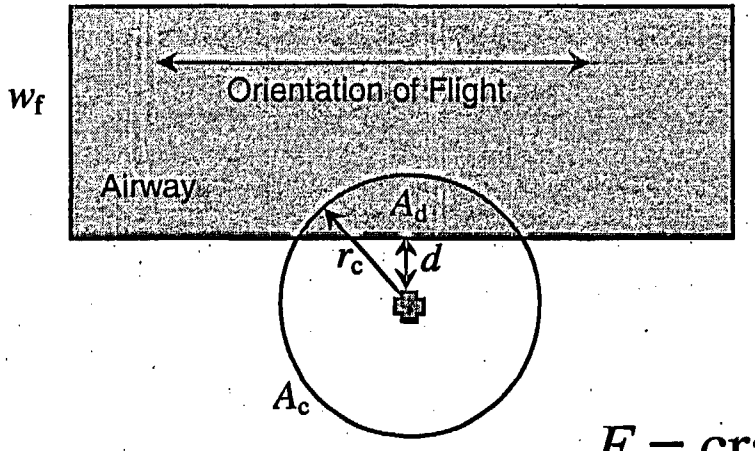
Model for civilian and military flights in public airspace



$$F = \frac{N\lambda}{w_f}\frac{A_d}{A_c}A_{eff}$$

F = crash frequency (y^{-1})

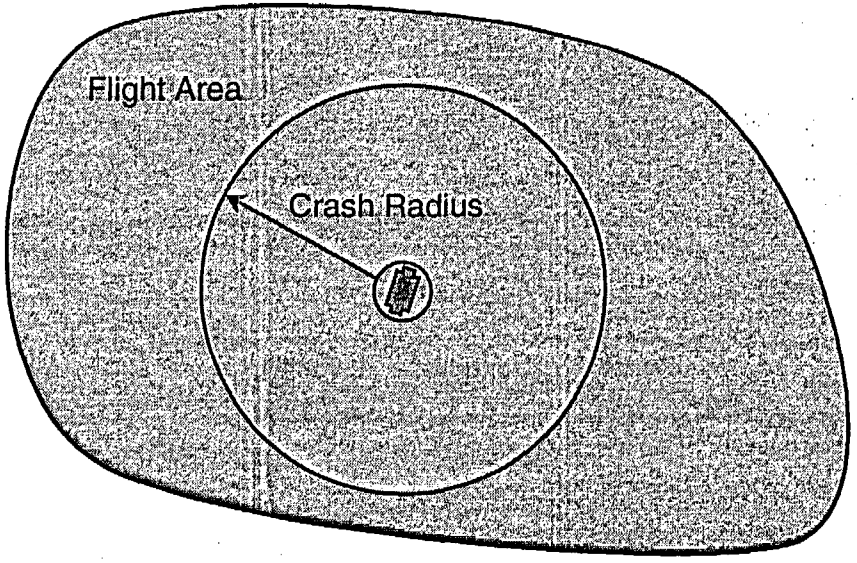
N = flight frequency through airway (y^{-1})

λ = crash rate (mi^{-1})

A_{eff} = effective area of facility (mi^2)

r_c = crash radius

Model for fixed-wing flights over NTS



For a facility completely within the flight area:

$$F = \frac{N\lambda\pi}{L_f} A_{eff}$$

F = crash frequency (y^{-1})
N = flight frequency over flight area (y^{-1})
λ = crash rate (mi^{-1})
A_{eff} = effective area of facility (mi^2)
L_f = perimeter of flight area (mi)

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Model for dropped objects

$$F = \frac{N\alpha\pi}{LD} A_{\text{eff}}$$

F = hit frequency (y^{-1})
N = flight frequency over flight area (sortie/y)
α = drop rate ($sortie^{-1}$)
A_{eff} = effective area of facility (mi^2)
L = perimeter of flight area (mi)
D = conservatively representative distance of flights (mi)

Key Assumptions

- Analysis based on 2002 design
- Support areas of buildings are omitted
- Crash ranges for aircraft in the public airspace:
  - 10 mi for air taxis and general aviation aircraft
  - 25 mi for air carriers
  - 30 mi for military aircraft
- Crash range for helicopters: 1/4 mile
- Crash range < 8 mi for aircraft below 10,000 ft above mean sea level in the public airspace

Inputs Used (Sources)

- Dimensions of surface structures (project design documents)
- Characteristics of representative aircraft
  - Impact angles (DOE-STD-3014-96)
  - Wingspans (DOE-STD-3014-96)
  - Skid distances (DOE-STD-3014-96)
- Distance and width of the airway (Federal Aviation Administration [FAA], maps)
- Flight frequencies on the corridor by aircraft type (FAA)
- Flight frequencies over Nevada Test Site (Nellis)
- Crash rates per unit distance by aircraft type (Kimura et al. 1996)
- Dropped-object rate (United States Air Force Safety Center)

Results

- Potential for aircraft crash into surface facilities
  - Crash hit frequency below the screening threshold derived from 10 CFR 63 and a 100-year operational period (1 in a million per year or 10^{-6} y^{-1})
  - Conservatively estimated frequency: 5×10^{-7} y^{-1}
- Potential for dropped object hits
  - Object strike frequency below screening threshold
  - Conservatively estimated frequency: 6×10^{-7} y^{-1}
- Helicopters
  - DOE and military helicopters must maintain 1/4-mile horizontal separation from radiological facilities
  - Repository heliport must be at least 1/4-mile from radiological facilities

References

- DOE-STD-3014-96. 1996. *DOE Standard, Accident Analysis for Aircraft Crash into Hazardous Facilities.* Washington, D.C.: U.S. Department of Energy.
- Kimura, C.Y.; Glaser, R.E.; Mensing, R.W.; Lin, T.; Haley, T.A.; Barto, A.B.; and Stutzke, M.A. 1996. *Data Development Technical Support Document for the Aircraft Crash Risk Analysis Methodology (ACRAM) Standard.* UCRL-ID-124837. Livermore, California: Lawrence Livermore National Laboratory.
- NRC (U.S. Nuclear Regulatory Commission) 1981. "Aircraft Hazards." Chapter 3, Section 3.5.1.6 of *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants.* LWR Edition. NUREG-0800, Rev. 2. Washington, D.C.: U.S. Nuclear Regulatory Commission.