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January 25, 2001

U.S. Nuclear Regulatory Commission
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Washington, D.C. 20555-0001

RISK ASSESSMENT OF ACCIDENTS INVOLVING CRUISE MISSILES
DOCKET NO. 72-22/TAC NO. L22462
PRIVATE FUEL STORAGE FACILITY
PRIVATE FUEL STORAGE L.L.C.

The purpose of this letter is to provide the NRC with additional information regarding the risk of accidents at the Private Fuel Storage Facility (PFSF) involving cruise missiles. The NRC requested the additional information associated with cruise missile testing on the Utah Test and Training Range (UTTR) in a teleconference between personnel from the NRC, the CNWRA, Private Fuel Storage, and Stone & Webster that took place on January 17, 2001. Enclosed with this letter is a report entitled "Risk Assessment of Cruise Missile Accidents Impacting Private Fuel Storage LLC Independent Spent Fuel Storage Installation," Revision 1, January 25, 2001 which contains the additional information requested by the NRC. The Report concludes that a cruise missile striking the PFSF is not a credible event.

The revisions to the enclosed Report from Revision 0 of the Report (as filed in conjunction with Applicant's Motion for Summary Disposition of Utah Contention K and Confederated Tribes Contention B on December 30, 2000) are identified by a bar in the right hand margin.

The NRC's questions from the January 17, 2001 teleconference and the information in the enclosed Report responding to the NRC's questions are summarized below.

NRC Question 1:

Is the drogue chute, discussed in conjunction with the FTS for the ALCM, considered part of the FTS per se (specifically, is it included in the overall reliability requirement that says that the FTS must be 99.9% reliable)? Do the FTSs for all cruise missiles use parachutes?

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PFS Response:

As discussed on page 29 of the enclosed Report, all FTSs used on cruise missiles are designed and built to common performance specifications, with identical reliability and certification requirements. Specifically, all FTSs must be 99.9 percent reliable at a 95 percent confidence level. The designs of FTSs on different models of cruise missile may vary (e.g., ALCM employs a parachute as an integral part of its FTS, while Tomahawk and ACM do not), but all FTSs must meet the same performance standards. Thus, the drogue chute used with the FTS for the ALCM is part of the FTS and it is included in the overall reliability requirement that an FTS be 99.9% reliable.

NRC Question 2:

A 50-knot wind is assumed in Figure 16A of Revision 0 of the Report (p. 33). Is a wind assumed in Figure 16B? The figure itself says it does not assume a wind.

PFS Response:

The enclosed Report (p. 33) has been revised to clarify that only the distances in Figure 16 A (which depict the impact footprints for the two extremes of vehicle weight, launch weight and empty weight) conservatively assume a 50-knot wind blowing in the most disadvantageous direction. Figure 16 B (which only depicts trajectory profile and not impact footprints) does not include wind.

NRC Question 3:

How does the FTS on the ACM compare with the FTS on the Tomahawk and the ALCM (in design and performance)?

PFS Response:

See response to the first question above. In addition, the enclosed Report as revised notes on page 33 (note 28) that because the FTSs on the Tomahawk, ALCM, and ACM are designed to common performance specifications, they all exhibit similar performance; and information is provided with respect to the missile impact area for the Tomahawk missile.

NRC Question 4 :

The Report (Revision 0) talks about "failures" that occurred during cruise missile tests on the UTTR. What is a test failure in the sense used in the Report? Is it a crash or is it some other malfunction that might not lead to a crash?

PFS Response:

The enclosed Report (p. 32) has been revised to clarify that, as used in the Report, the term "failure" is synonymous with the term "crash," which is defined as "a missile impacting the ground at an unintended point."

NRC Question 5:

Figure 9 in the Report (Revision 0) is described as "the military low-level route structure associated with UTTR" on page 12, but on page 15 it is labeled as "FLIP Military Route Planning Chart." Are both of these correct?

PFS Response:

Both are correct; FLIP is an acronym for Department of Defense "Flight Information Publication." The title to Figure 9 in the enclosed Report (p. 15) has been revised to clarify that it reflects the "Military Low-Level Route Structure Associated with UTTR."

NRC Question 6:

On page 32 of the Report (Revision 0), its states that all of the cruise missile crashes in the past 10 years have occurred on or within half a mile of the planned route, but page 33 and Figures 16A and B show that a missile could impact the ground more than half a mile down range of the point at which the FTS is activated. Is the half mile actually a lateral distance?

PFS Response:

The half mile referred to is the lateral distance from planned path of the missile. The enclosed Report has been revised at page 32 to clarify that the half mile referred to there is a lateral distance (i.e., perpendicular to the flight path).

NRC Question 7:

On page 36 of the Report (Revision 0), it says that "Cruise missile trajectories are tangential (as opposed to radial) to the PFSF, with a point of approach no closer than 10 nm [nautical miles] from the facility," but Figure 15 on page 27 shows a route that is radial to the PFSF at various points. How do you reconcile those two things?

PFS Response:

This sentence in the enclosed Report (p. 36) has been revised to clarify that "[a]t their closest point of approach to the PFSF, cruise missile flight trajectories are tangential (as opposed to radial) to the PFSF, coming no closer than 10 nm [nautical miles] from the facility." The points on the route shown in Figure 15 at which the trajectory is radial to the PFSF are to the south and west of Michael Army Airfield, more than 15 nautical miles from the PFSF and well beyond the downrange distance that a cruise missile would travel upon activation of the FTS system.

NRC Question 8:

Figures 7, 8 and 9 to the Report (Revision 0) are difficult to read.

PFS Response:

The color prints probably lost quality in the copying process and we are providing original color prints of these Figures to both the Staff and the Center.

NRC Question 9:

Exhibit 4 to the Declaration of George Wagner and David Girman filed in support of Applicant's Motion for Summary Disposition of Utah Contention K, December 30, 2000, is a one page summary of "Flight Termination Footprints" for the ALCM with Figure 3.1-4 illustrating the impact footprints of the air vehicle and drogue chute for the two extremes of vehicle weight, launch weight and empty weight. Figure 3.1-3 referenced in the summary was provided as Exhibit 16-B to the Report. Why are the other figures referenced in the summary not provided?

PFS Response:

Figure 3.1-4 attached as Exhibit 4 to the Wagner/Girman declaration is the same as Figure 16A in the Report. It was attached separately to the Wagner/Girman declaration to draw attention to the figure, since it contains the significant information on impact distances from point of activation of the FTS for both vehicle launch weight and empty weight. Figure 3.1-3 referenced in the one page summary that was included as part of Exhibit 4 to the Wagner/Girman declaration was also provided in the Report as Figure 16B to illustrate typical trajectory profiles. Our experts did not obtain all of the other figures referenced in the summary from the Air Force and they are not necessary for the understanding of the missile impact footprint distances depicted on Figure 3.1-4 (which are bounding for the ALCM), and as such are not referenced or included in the Report. In particular, the FTS compartment cover discussed in the summary weighs less than 10 pounds, and thus poses no threat to the PFSF.

If you have any questions regarding this submittal, please contact me at 303-741-7009.

Sincerely,

John L. Donnell

John L. Donnell
Project Director
Private Fuel Storage L.L.C.

Enclosure

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RISK ASSESSMENT

OF

CRUISE MISSILE ACCIDENTS

IMPACTING

PRIVATE FUEL STORAGE LLC

INDEPENDENT SPENT FUEL

STORAGE INSTALLATION

Revision 1 (January 25, 2001)

David N. Girman
Lt Colonel, USAF Reserve
George F. A. Wagner
Rear Admiral, USN (Ret)
Associates
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Page

REFERENCES:

A Technical Order (TO) 1B-52H-30-1 Aircrew Weapon Delivery Manual for AGM-129 Missiles

B. TO 1B-52H-30-4 Aircrew Weapon Delivery Manual for AGM-86 Missiles

C. Accident Investigation Board Report, United States Air Force AGM-129 Advanced Cruise Missile Serial Number 90-0061, 10 December 1997 Volume I of II

D. Tomahawk Flight Operations on the West Coast of the United States, Final Environmental Assessment

E. AFI 13-212 UTTR Supplement 1 (TEST), 1 April 1998

F. Air Force Manual 99-104 Armament/Munitions Test Process

G. AFI 13-212 Volume 1 Weapons Ranges

H. Tomahawk Test and Evaluation Directive Number 18A, Tomahawk Flight Test Planning

I. AFI 13-201 Air Force Airspace Management

J. Range Commanders Council Flight Termination Commonality Standard Document 319-99

K. GNC 02, JNC 043, TPC F16C and G18B, and JOG NK1210 Aeronautical Charts

L. Enroute High Altitude Enroute Chart H-3 and H-2

M. Enroute Low Altitude Enroute Chart L-7

N. Flip Military Route Planning Chart

O. General Dynamics Convair Division Advance Cruise Missile (ACM) Subsystem Familiarization Guide

P. Tomahawk Sea Launched Cruise Missile System Flight Termination System Report No. GDC-AUR-90-119

Q. Paper: Tomahawk Cruise Missile Testing on the Western Ranges

R. Response To Nuclear Waste Freedom Of Information Request (FOIA) from Hill AFB, UT Public Affairs Office

S. Advanced Cruise Missile (ACM) Operations Concepts and Procedures

T. Interview with Mr. Boe Hadley, Cruise Missile Senior Range Control Officer At Hill AFB, UT

U. Memo for Record Site Visit at 49th TESTS Squadron, Barksdale AFB, LA

INTRODUCTION

A commercially operated Independent Spent (Nuclear) Fuel and Storage Installation (ISFSI) is being established in the vicinity of the Utah Test and Training Range (UTTR). The land under the proposed storage is located on the Skull Valley Band of the Goshute Reservation.

The UTTR is utilized for testing of Department of Defense weapons system, including cruise missile, and there is concern for the hazard these missiles may pose to the ISFSI. This report addresses cruise missile testing on UTTR and addresses the risk to the ISFSI.

Any risk assessment of missile accidents impacting the proposed ISFSI, located at 40 24'50"N and 112 47'37"W, involves multiple aspects and many phases of flight operations and aerial maneuvers. This assessment examines cruise missile testing operations and activities in the area to determine the risk posed by cruise missile testing to the facility. Missile operations, routes and procedures are carefully examined and assessed to insure every possible aspect and angle is thoroughly covered.

Three types of cruise missiles have been flown in test flights on the UTTR: Air Launched Cruise Missile (ALCM, AGM-86), Tomahawk (BGM-109), and Advance Cruise Missile (ACM, AGM -129). All three are subsonic, autonomous missiles, which fly carefully pre-programmed flights along designated routes. Cruise missiles are normally launched at altitudes between 15,000 and 20,000 feet. Then they normally descend to operational altitudes as determined in the planned mission profile. Nominal enroute altitudes are usually below 10,000 feet down to 500 feet above ground level. Physical characteristics are:

	ALCM- AGM-86	Tomahawk BGM-109[1]	ACM - AGM - 129
Length	20' 9"	20' 6" (with booster)	20' 10"
Wing Span	12' 0"	8' 9"	10' 2.8"
Diameter	27 inches	20.4 inches	29.25"
Weight: Full	3,200 lbs.	2,300 lbs.	3,300 lbs.
Mission end	1,500 lbs.	1,500 lbs.	1,500 lbs.
Warhead: Diameter	23 inches	20"	24"
Weight	700 lbs.	1,000 lbs.	700 lbs.
Engine: Diameter	14"	12"	14"
Weight	210 lbs.	150 lbs.	210 lbs.
Speed	500 knots	450 knots	500 knots
Range	1,500 NM	1,000 NM	1,800+ NM

This risk assessment will be confined to determining the likelihood or probability of a missile accident impacting the proposed Independent Spent (Nuclear) Fuel Storage

[1] Tomahawk Flight Test Operations on the West Coast of the United States, page 2.2, Table 2-1

Installation (ISFSI). Any evaluation of crash impact effects on the proposed facility is beyond the scope of this assessment.

THE AGM 86 B MISSILE DESCRIPTION (Air Launched Cruise Missile or ALCM)

The AGM-86 is a first generation, subsonic, turbofan powered, winged missile. The ALCM will deliver a warhead in an air-to-ground mission with a high degree of accuracy at long range. During captive carry (see Definitions) the missile is hung on a B-52 wing pylon or carried in an internal bomb bay on a rotary launcher. During captive carry the missile's flight surfaces (wings, fin and elevon) and engine inlet are carried in a stowed position. After launch the missile's flight control surfaces are deployed and the engine provides thrust within a few seconds. Computer controlled navigation directs the missile to its target. The ALCM can carry both nuclear and conventional payloads (although it is never tested with a nuclear payload).

Figure 1: Air Launched Cruise Missile Schematic

TO 1B-52H-30-4

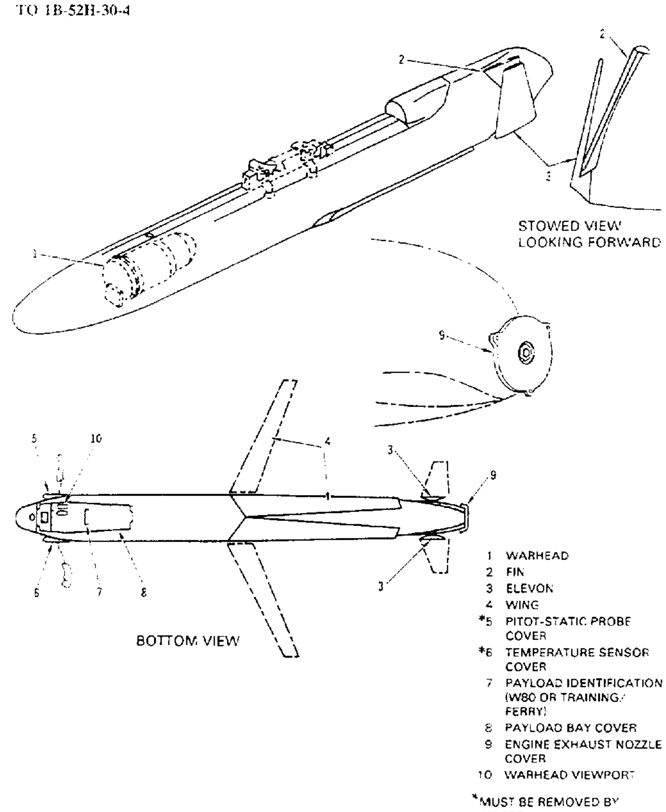


Figure 1-2. Missile General Arrangement

1-4

THE TOMAHAWK BGM-109 MISSILE DESCRIPTION

The Tomahawk Cruise Missile system was developed during the 70's to provide long-range standoff weaponry to the U.S. Navy. The system reached its Initial Operating Capability (IOC) in 1984 with deployment of the nuclear variant TOMAHAWK Land Attack Missile (TLAM/N). The Tomahawk Land Attack Missile with conventional warhead (TLAM/C) and a sub-munitions dispense variant (TLAM/D) followed. TLAM is launched from surface ships or submarines against land targets. The missile flies autonomously at subsonic speed along a pre-planned route for the entire mission, which is loaded into the missile as part of the launch sequence. Navigation accuracy is maintained through use of digital maps stored in the missile as part of the data load for the particular mission, using on-board sensors and a very accurate inertial measuring unit (IMU), now supplemented by Global Positioning System (GPS). Test flights of Tomahawk were flown to UTTR in the past, but none within the past decade. See Reference Q for additional information.

THE AGM 129 MISILE DESCRIPTION (Advanced Cruise Missile or ACM)

The AGM 129 is a second generation, subsonic turbofan powered, winged missile. It is an improved version of the AGM- 86 with improved stealth, greater range and forward swept wings. The ACM can only be carried on B-52 external pylons. Other design and mission features are similar to the ALCM.[2]

Figure 2: Advanced Cruise Missile Layout

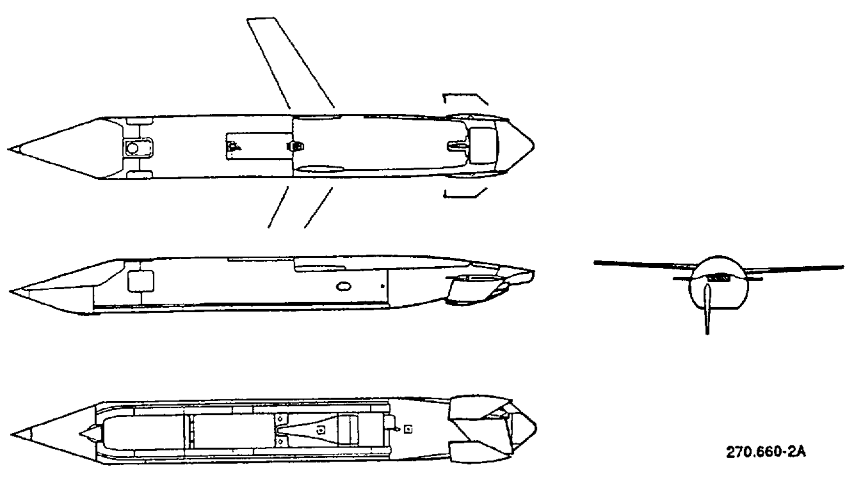
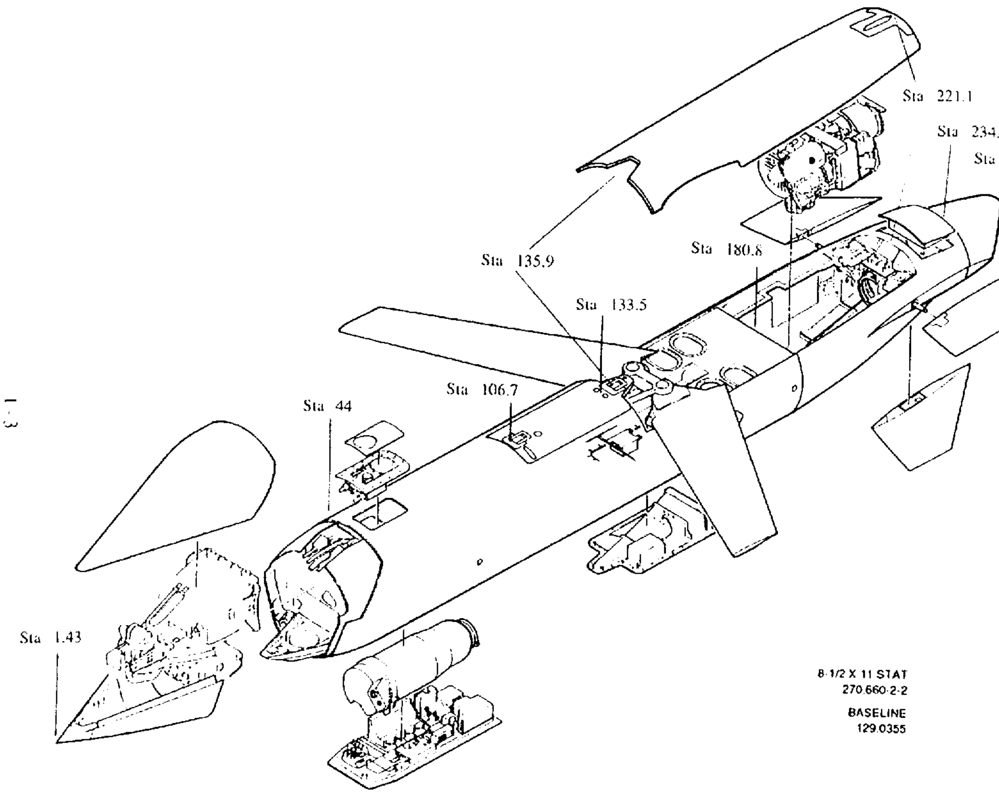


Figure 1.0-1 ACM General Arrangement

GENERAL DYNAMICS
Convair Division
ACM-TAE-91-001

[2] General Dynamics Convair Division ACM Subsystem Familiarization Guide Figure 1.0-1 & 1.0-2.

Figure 3: Advanced Cruise Missile Schematic



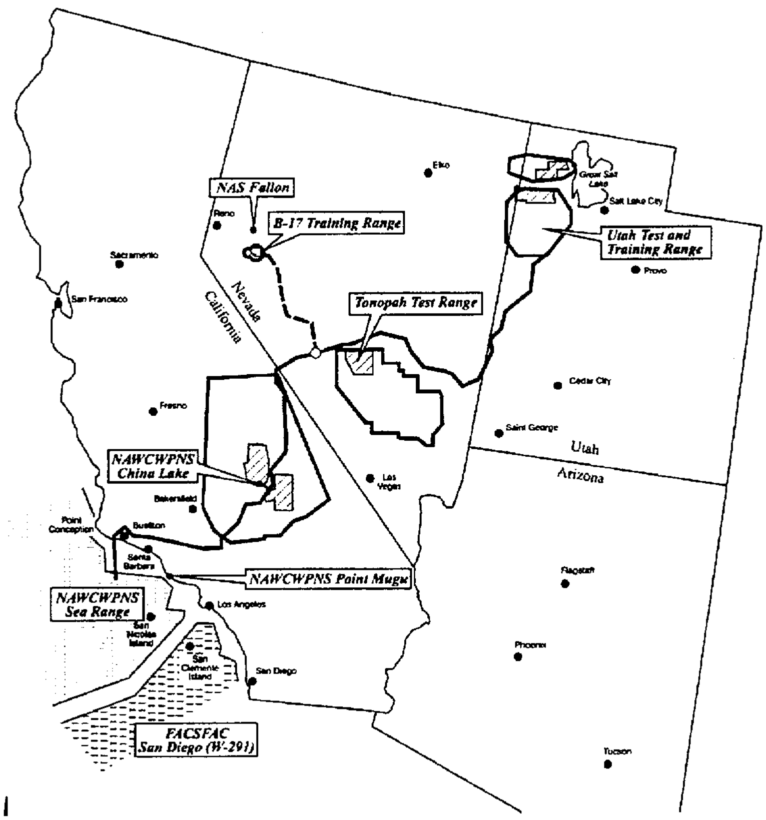
GENERAL DYNAMICS
Convair Division
ACM-TAE-91 001

Figure 1.0-2 ACM Structure

I: THE UTAH TEST and TRAINING RANGE (UTTR)

UTTR is part of the Western Range Complex, shown in the diagram below.[3]

Figure 4: Western Range Layout



The Utah Test and Training Range (UTTR) is an Air Combat Command (ACC) training range with infrastructure to support Large Footprint Weapons Testing. Air Launched Cruise Missile (ALCM), Tomahawk Land Attack Cruise Missiles (TLAM), and Advanced Cruise Missile (ACM) are Large Footprint Weapons, all of which have been and can be flown at UTTR.

UTTR is a designated Major Range Test Facility Base (MRTFB) under the Commander, 388 Fighter Wing (the 388 RANS), the designated operating agency for the range. UTTR activities are conducted in compliance with AFI (Air Force Instruction) 13-212, Volumes 1-3 and supplements. The UTTR is located in northwestern Utah and eastern Nevada. The Mission Control Center (MCC) is located off range at Hill AFB and is connected via microwave/fiber links. The large flat expanse of range has an average elevation of approximately 4,200 feet above sea level. On the North Range 348,767 acres are DoD owned, the South Range, including Dugway Proving Ground, there are 1,341,27 acres (14,595 acres extend into Nevada). Much of the UTTR airspace is over Bureau of Land Management (BLM) land. Ground operations on BLM land must be approved by BLM

[3] Tomahawk Flight Test Operations on the West Coast of the United States, Fig. 1-1

prior to the program commencement. Figure 10 shows the geographic area encompassing UTTR.

RANGE CAPABILITIES

Key capabilities of the UTTR used to support cruise missile tests are optical tracking, radar tracking, radio and telemetry relay, and ground stations capable of transmitting either remote control or flight termination instructions to the missile. All UTTR test areas are capable of munitions tracking, data collection and transfer, telemetry acquisition and recording, communications, mission control, and full data reduction. Test functions are remotely monitored and operated from the test Mission Control Center at Hill AFB, Utah

BOUNDARIES

Airspace boundaries do not necessarily coincide with the boundaries of the DoD land beneath this airspace. The UTTR encompasses 8,125 sq NM of restricted airspace, (approximately the size of the state of Massachusetts), which can be expanded to 17,000 sq NM (Massachusetts and Vermont) through adjacent Military Operating Areas (MOAs) (in an area 207 by 92 NM). Land space is 2,700 sq NM of DoD land and 14,300 sq NM of Bureau of Land Management, State of Utah, and a small amount of privately owned lands underlying the restricted air space and MOAs. This includes the land owned by the Skull Valley Indian Reservation. This large airspace and ground space allow for large safety footprints and long trajectory legs required by Precision Guided Munitions (PGMs) and cruise missiles. Major munitions test areas include: 12 targets for testing conventional munitions; four highly instrumented targets used for testing of PGMs, smart armament/munitions, and home on emitter seeking missiles; four cruise missile impact targets; and five air to surface tactical target complexes.

CONTROLLED AIRSPACE REGIONS

The Airspace over the UTTR consists of 10 Restricted Areas and 8 Military Operating Areas (MOAs). Restricted Areas,[4] Military Operating Areas and Special Use Airspace are military controlled airspaces to conduct operations and test and are defined on the Definitions page.

Within the UTTR, Restricted Areas and MOAs are as shown in Figures 7-11 with the following altitude limitations:[5]

[4] AFI 13 – 212 Volume 1 Weapons Ranges page 25
[5] AFI 13 – 212, UTTR Supplement (1) TEST, page 9, para 2.3

Restricted Areas	
R6404A	Surface to Flight Lever FL) 580 (58,000 feet)
R6404B	Surface to 13,000 Mean Sea Level (MSL)
R6404C	100' Above Ground Level (AGL) to FL280
R6404D	from, but not including, 13,000' MSL to FL 250
R6405	100' AGL to FL 580
R6406A	Surface to FL 580
R6406B	100' AGL to FL 580
R6407	Surface to FL 580
R6402A	Surface to FL 580
R6402B	100' AGL to FL 580

Military Operating Areas (MOAs)	
Lucin A	100' AGL to 9,000' MSL
Lucin B	100' AGL to 7,500' MSL
Lucin C	100' to 6,500' MSL
Sevier A	100' to 14,500' MSL
Sevier B	100' AGL to 9,500' MSL
Sevier C	14,500' MSL to, but not including FL 180
Sevier D	9,500' MSL to, but not including FL 180
Gandy	100' AGL to, but not including FL 180

The proposed storage area is located under Sevier B MOA in the South Range area of the UTTR as shown in Figure 5. It is important to note that Sevier B MOA is 118 nautical miles long from the North to the South, and is 38 nautical miles wide at its widest point from the east to the west. However, we are only concerned with the northernmost portion of the MOA, in Skull Valley. Northern Sevier B MOA dimensions are a maximum of 13nm to a minimum of 6nm wide from east to west.

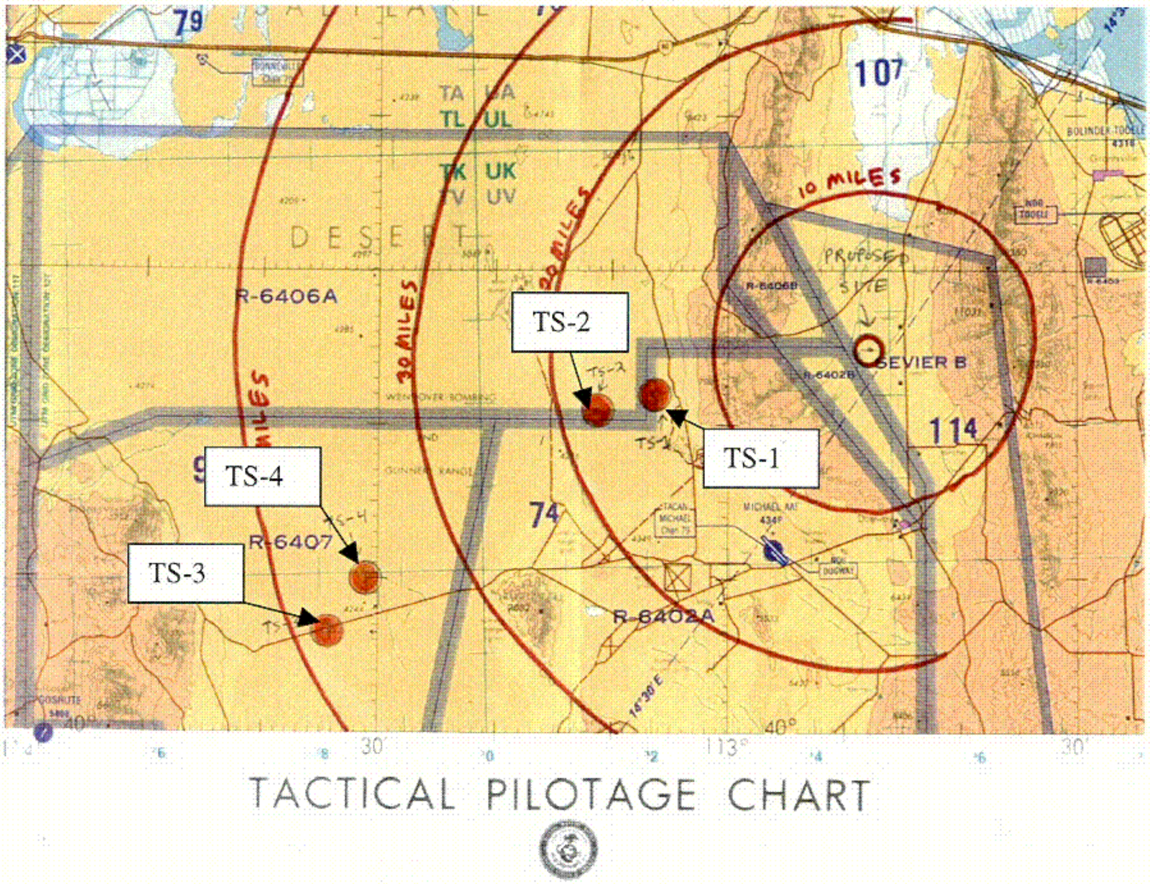
TARGET AREAS LOCATED ON THE UTTR RANGE

All cruise missile designated targets, TS-1 through TS-4, are located on the South Range, as follows:

	Latitude	Longitude
TS-1	40° 22' 22"	N113° 06' 37" W
TS-2	40° 21' 06"	N113° 11' 38" W
TS-3	40° 06' 50"	N113° 34' 15" W
TS-4	40° 08' 07"	N113° 31' 10" W

These are shown plotted on Figure 5.

Figure 5: Cruise Missile Primary Targets



TS-1 is the primary cruise missile target, and is located 15 nautical miles (17.0 statute miles) west of the proposed storage facility. TS-2 is 18.2 nautical miles (20.7 sm) west, TS-3, 37 nautical miles (42.0 sm) west and TS-4, 39.1 nautical miles (44.4 sm) west, are also authorized for use as targets for Flight Termination System (FTS) equipped cruise missiles. The TS-1 target is located in restricted area R-6402A. TS- 2 target is located in R6406A. TS-3 and TS-4 targets are located in R- 6407. Run in headings for all cruise missile tests are established by individual test requirements and safety reviews.[6]

AIR ACCESS

Air traffic control is maintained in the UTTR range by Clover Control[7] (299th Range Control Squadron [RCS]), Through a Letter of Agreement with the Salt Lake Air Route Traffic Control Center (ARTCC), Clover Control has been delegated control of the airspace that comprises the UTTR. Clover Control has proprietary control over what aircraft enter, exit, and the duration during which aircraft utilize their airspace and rangeland. Range airspace access is strictly controlled according to the range schedule.

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[6] AFI 13-212 UTTR Supplement (1) TEST, page 20
[7] AFI 13 –212, UTTR Supplement (1) TEST, page 9

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Figure 6 below depicts the UTTR Air Traffic Control Sectors, Figures 7 and 8 show, respectively, the high (above 18,000 feet) and the low (below 18,000 feet) civil routes. Figure 9 shows the military low-level route structure associated with UTTR.

Figure 6: UTTR Air Traffic Control Sectors

AFI 13-212, UTTR SUPPLEMENT 1 (TEST) 25

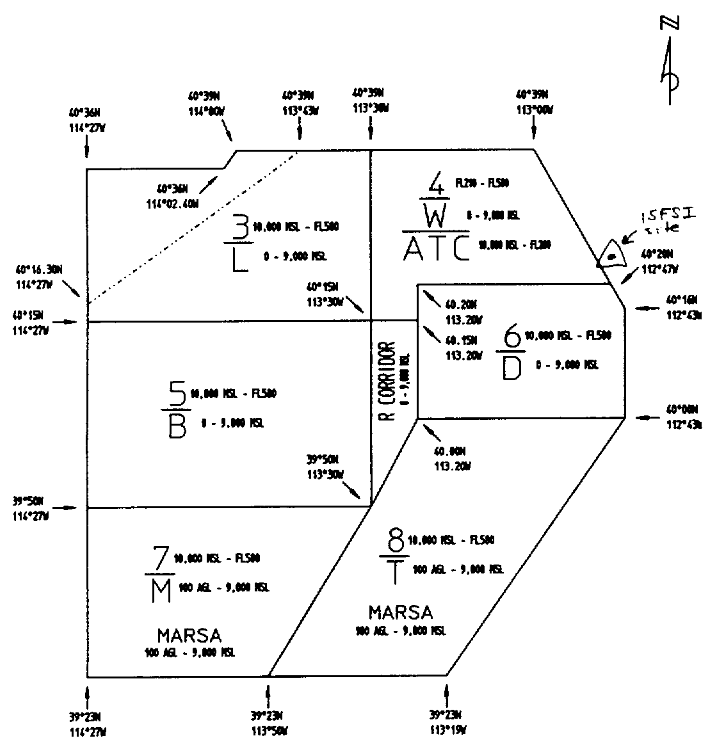
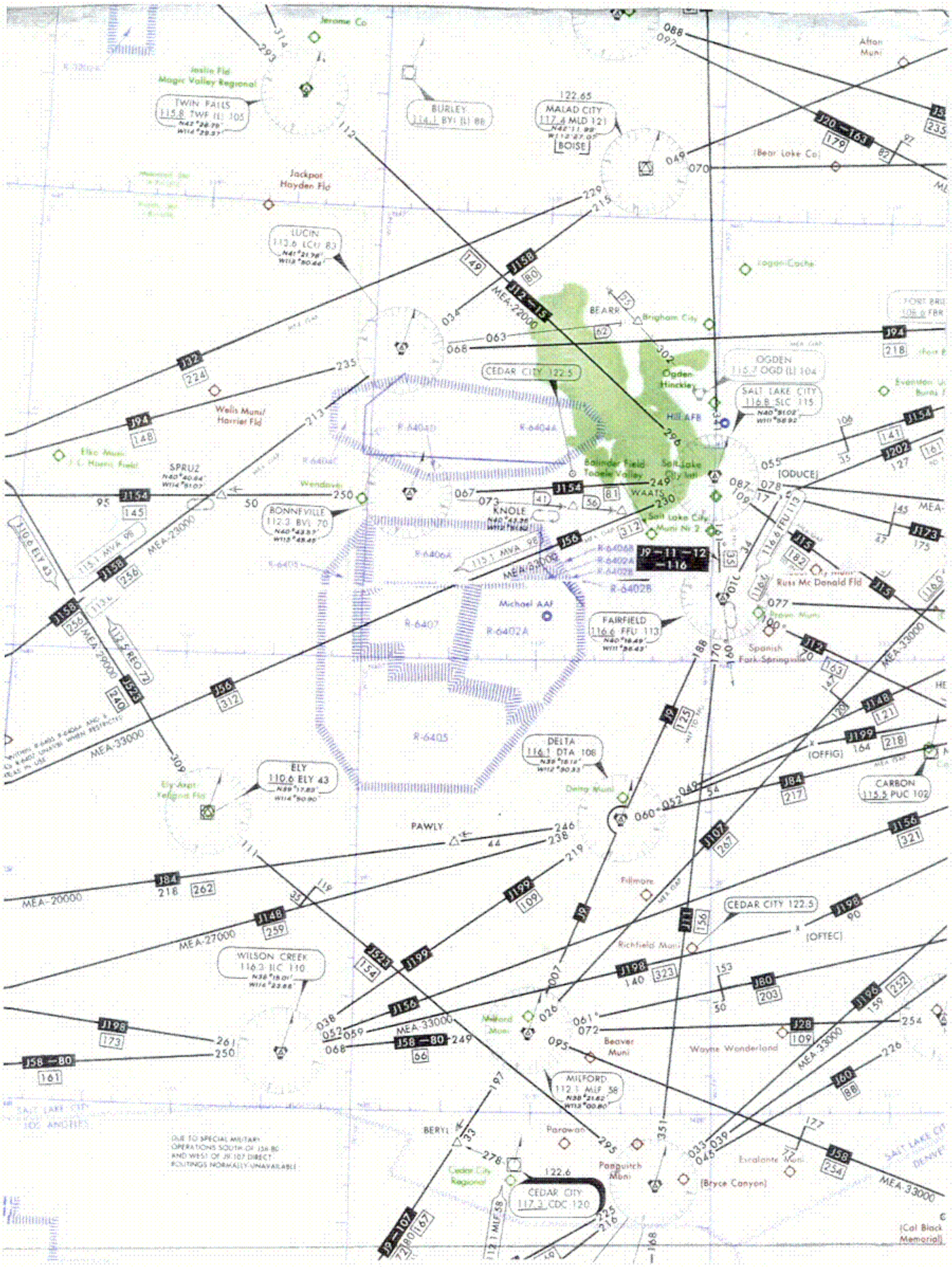


Figure 3. South Range High and Low Sectors.

Figure 7: High Enroute Chart Showing Restricted Airspace



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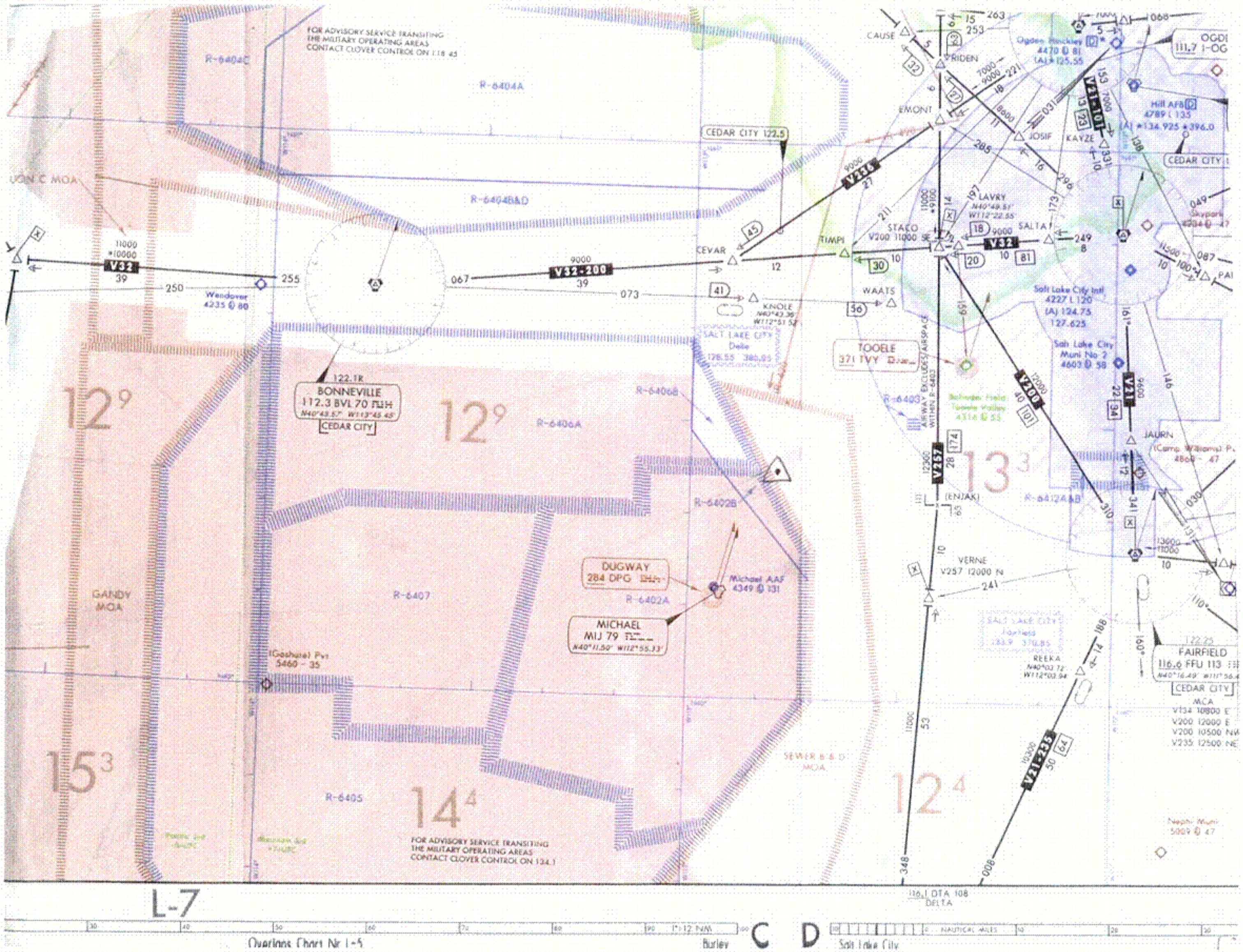
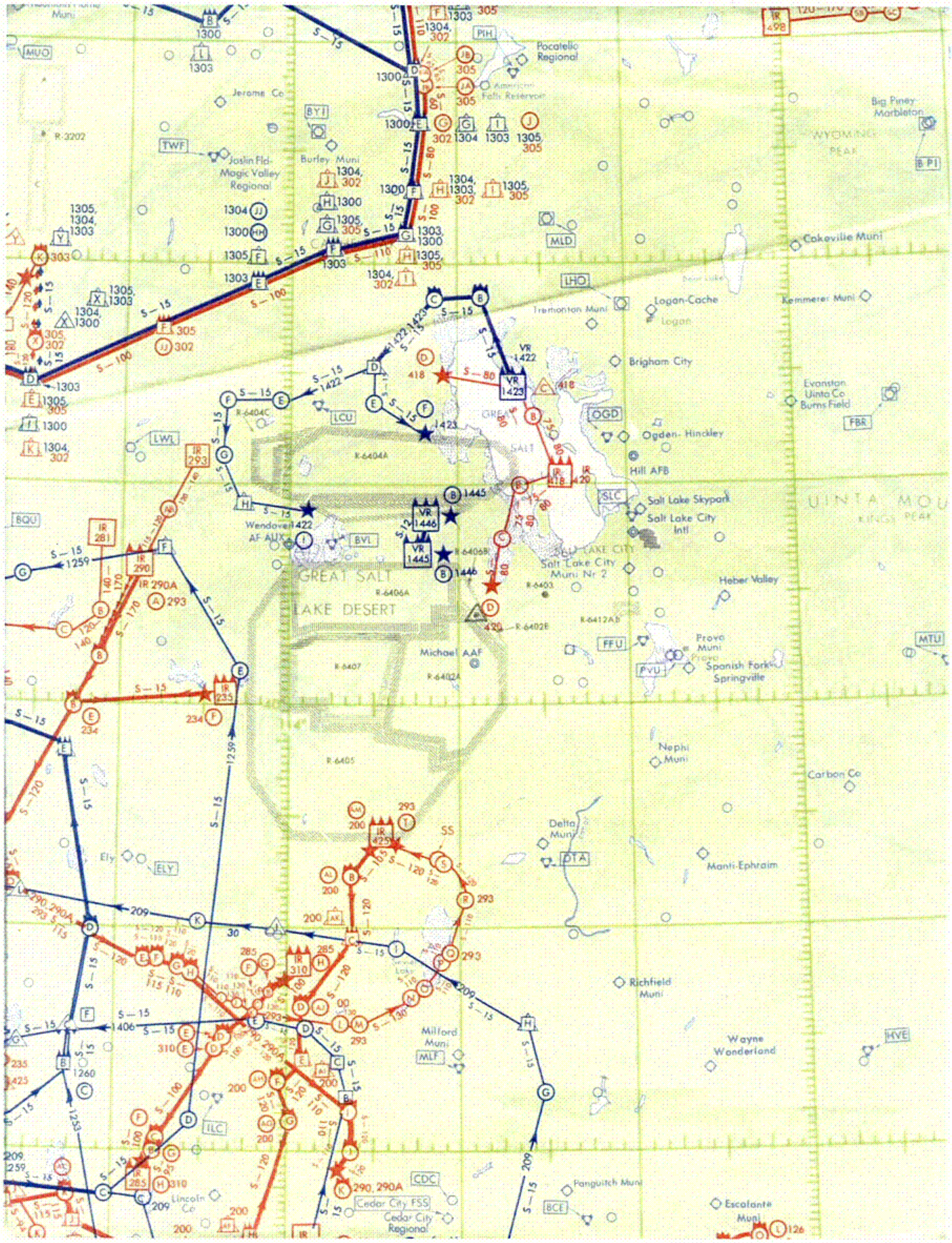


Figure 8: Low Enroute Chart Showing UTTR Close Up View

Figure 9: Military Low-Level Route Structure Associated with UTTR



See Figures 10, 11 & 12 for a scaled in view of the UTTR landmass, Restricted Airspace and Military Operating Area (MOA) regions. These Figures depict these areas from an

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overhead perspective from the macro scale to the micro view of the proposed storage facility. The storage site is depicted on each scaled chart by a star symbol.

Figure 10: Macro Overhead View of UTTR Airspace

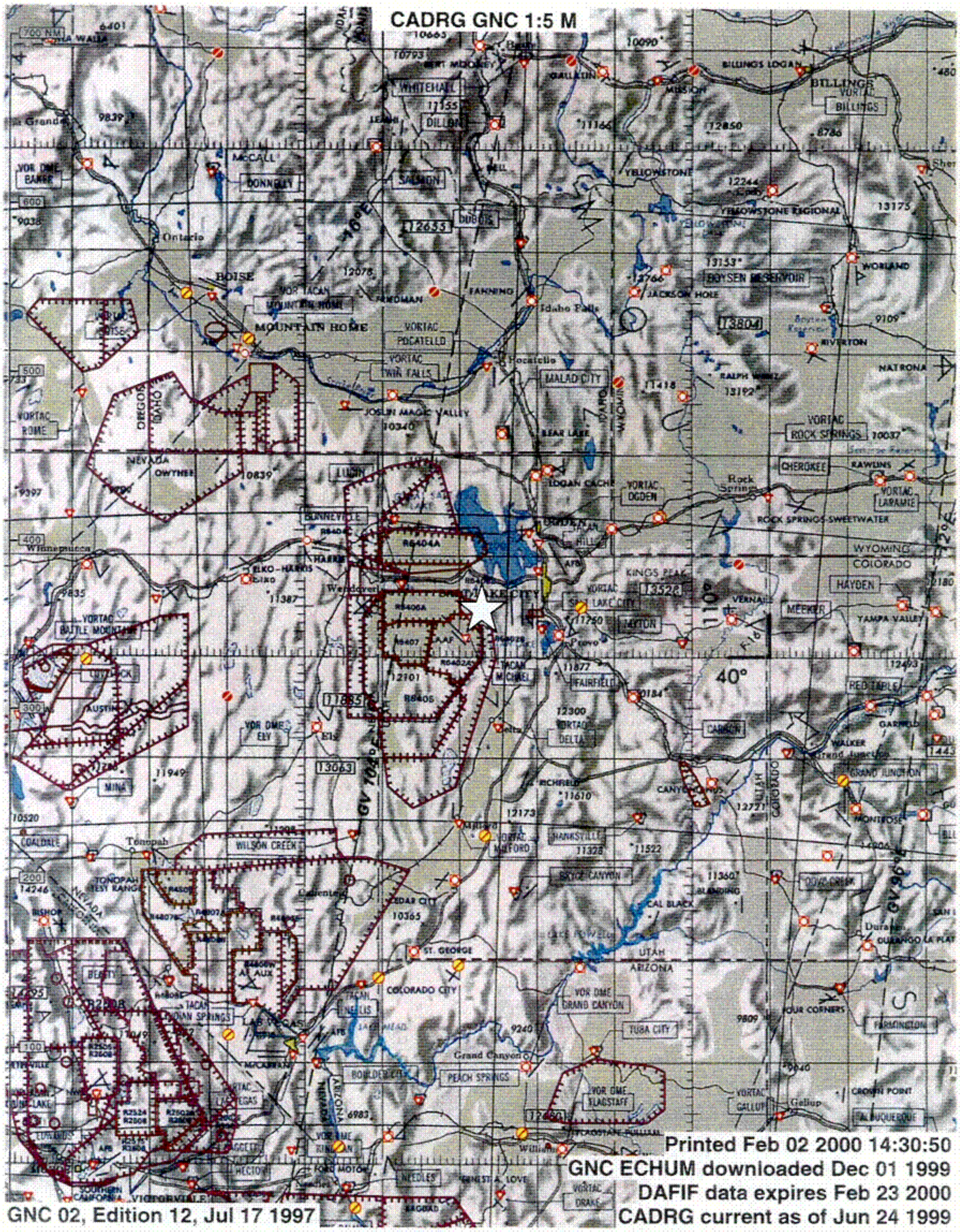

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Figure 11: Intermediate Overhead View of UTTR Airspace

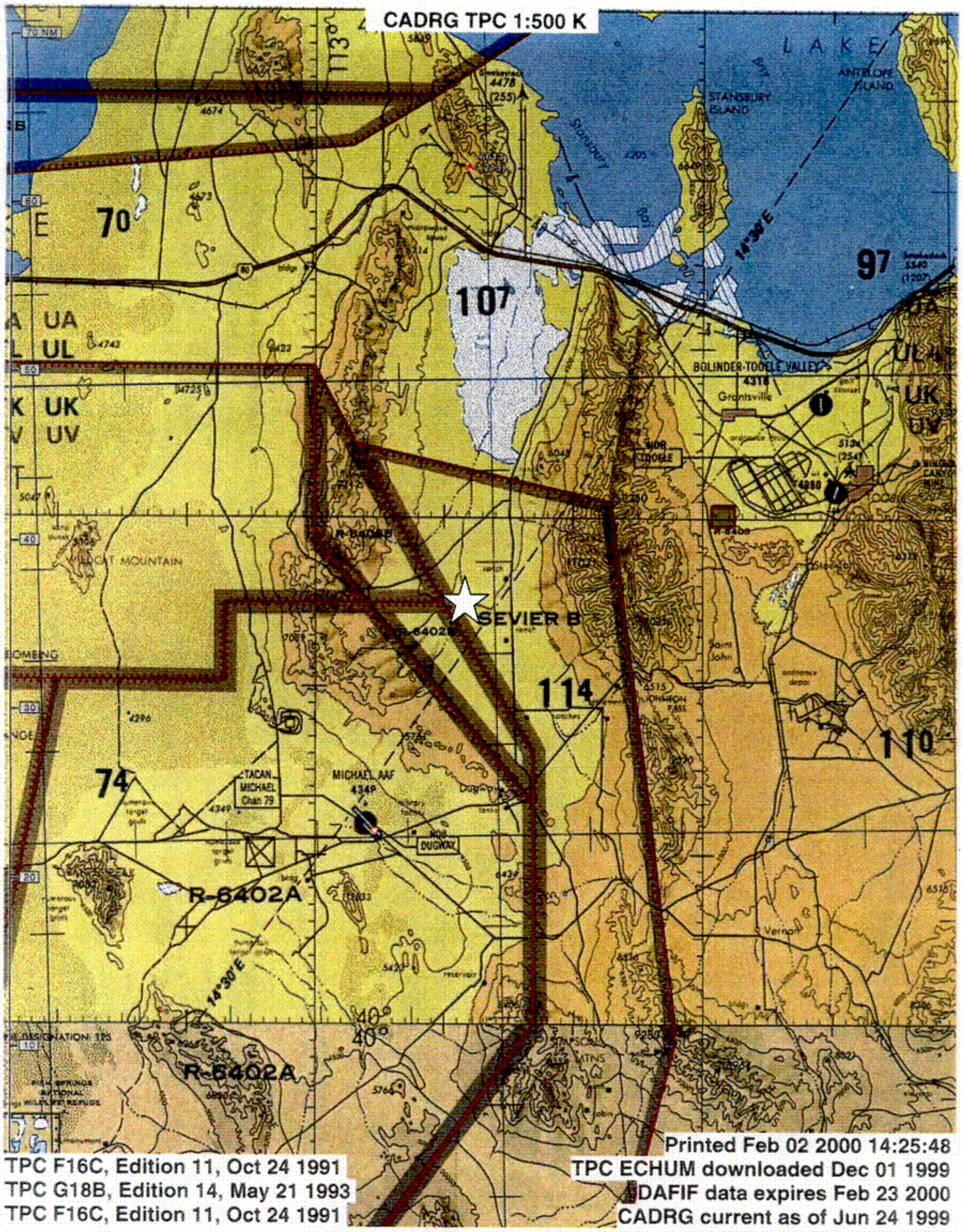

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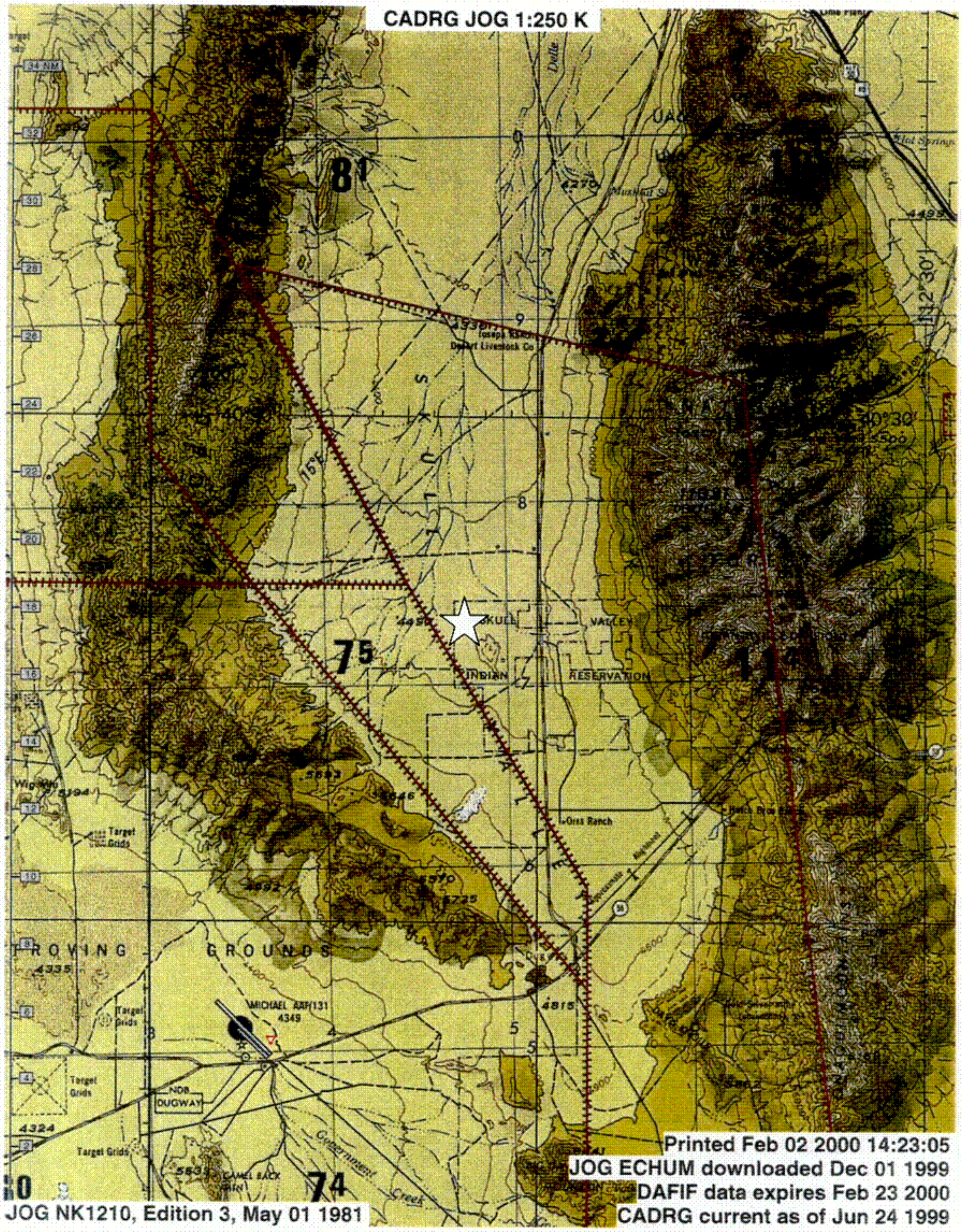
Figure 12: Micro View Showing Indian Reservation



<u>GROUND ACCESS</u>

Land access is also strictly controlled[8]. All personnel who require access to Department of Defense (DoD) land areas of the UTTR must receive proper authorization before

[8] AFI 13 –212, UTTR Supplement 1 (TEST) page 5 paragraph 1.5 Ground Party Requirements

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entering. Entry into U.S. Army (USA) property must be coordinated through the USA at Dugway Proving Ground.

II: CRUISE MISSILE TEST PLANNING

PLANNING PROCESS

Cruise Missile tests are strictly controlled events, with a comprehensive planning process in place that governs preparation for each test operation. Program offices, operating commands, and test organizations have been directed to employ a disciplined test process throughout all phases of an armament/munitions life cycle. This process applies to all testing including developmental, operational, and combined testing. Air Force Manual 99-104 Armament/Munitions is a 48-page source manual, which details weapons and the cruise missile test process. This testing is an iterative process intended to reduce risk[9].

Many regulations govern the conduct of cruise missile testing. These include Air Force regulations, Air Combat Command regulations, Utah Test and Training Range regulations and Aircraft technical orders. See References A, B, E, F, G and S.

The 49 TESTS Squadron located at Barksdale Air Force Base, Louisiana is the responsible test organization for Air Combat Command's cruise missile testing program. United States Strategic Command at Offutt Air Force Base in Omaha, Nebraska and Air Combat Command at Langley Air Force Base, Virginia has oversight of the cruise missile testing process.

Planning typically starts many months in advance of the test, to allow proper preparation and safety review of the test plan[10]. The methodical process includes tasks, with specific responsibilities assigned, for a safe and successful test. The steps in the process include:

- Integration of Objective and Compliance Criteria:
  - Integrate the proposed test objectives to ensure a complete and cohesive set of test requirements.
  - Construct a Test Plan that satisfies all of the objectives, while ensuring that the mission is safe, efficient and economical. **Safety is the over-riding concern.**
- Mission Planning:
  - Specify the Software and Testing Objectives
  - Specify the Missile Flight Route and Restrictions
  - Plan the Mission
  - Analyze and Validate the Planned Mission to ensure compliance
  - Distribute the Mission Plan for use
- Target Preparation

[9] Air Force Manual 99-104, page 10, para 2.3.1.2
[10] Tomahawk Test and Evaluation Directive Number 18A, Tomahawk Flight Test Planning.

    - Select target and validate its precise location
    - Develop mission scoring rules
    - Designate support system requirements for monitoring and scoring
- Missile Preparations
    - Designate configuration of missile for flight test
    - Validate the configuration
- Launch Platform Preparations
    - Designate the launch platform configuration for the test
    - Develop specific Test Operations Procedure
    - Train and Certify the launch platform and crew
- Test Operations and Contingency Planning:
    - Detailed Plan of operations for the test
    - Development of actions, procedures, contingency and emergency plans
- Data collection planning
- Mission Firing Plan:
    - Launch Platform procedures
    - Countdown timelines
    - Go/No Go decision criteria
    - Mission recovery or termination requirements
    - Contingency plan for anomalous events
    - Contingency plans and responses
- Data Distribution Plan
- Mission Scoring Plan
- System Readiness Assessment
    - Ensure all test elements are fully integrated and capable of carrying out the test, including firing unit, range and support assets.

Preparations for each and every cruise missile flight test are intensive and lengthy. With test missile and funding limitations, the plans are scrutinized throughout their development, with safety always the primary overriding principle, to ensure a successful test. Key items of concern throughout the planning for each test are:

- Achievability -- Are sufficient measurements, methods, test resources, and instrumentation available?
- Executability -- Can the objectives be accomplished within program constraints and limitations?
- Safety -- Can the test be performed safely?
- Utility -- Do the test objectives clearly and conclusively evaluate the desired feature?
- Cost -- Can the customers afford the cost of the objective?
- Schedule -- Is sufficient time available to accomplish the objective?
- Environmental Impacts -- Can the objectives be accomplished without adverse effects on the environment?

Two of these topics concern the focus of this risk assessment: Safety and Environmental Impacts. Test safety and environmental concerns are cornerstone-planning considerations

throughout the test planning and execution phases of every test. They are present at the genesis of any and all test concept and planning efforts and remain forefront through the end of the test.

III. CRUISE MISSILE TEST SAFETY REVIEW

Safety and risk reduction initiatives are built into every aspect and phase of cruise missile test operations[11]. Viability of existing weapons inventory is an essential function of the test and evaluation community. Another incumbent responsibility of this community is the minimization of the inherent risks to both civilian and military lives and property associated with such weapons testing[12]. The Air Force has a responsibility to protect the public to the maximum extent practicable from the hazards and effects associated with flight operations conducted on their ranges. To this end, a through safety review process is in place for weapons testing.

REVIEW PROCESS

The 388th Range Squadron develops cruise missile testing procedures that require operational hazard analysis and formal safety reviews of all test programs as well as safety reviews of particular test missions[13]. The safety review has established the following primary measures to minimize risks:

- Missile preparation
- Aircraft software preparation
- Carrier aircraft preflight inspection
- Missile loading by trained personnel, under supervision, with checklists
- Software and missile fault tests
- Missile ejection circuitry analysis
- Real time monitoring of launch circuitry by test personnel
- Routes planned to avoid property and personnel
- Remote Command and Control (RCC) capability to steer missile
- Flight Termination System (FTS)
- Weather minimums ensure chase aircraft can follow missile
- Advanced Range Instrumentation Aircraft (ARIA) relay of telemetry data to Mission Control Center (MCC)
- MCC real-time picture for timely safety decisions
- Remote control system and flight termination system parameters and plans keep missiles in safe areas
- Flight termination system components are independent of missile normal control mode
- Airborne Range Instrumentation Aircraft (ARIA):
- Crew member training on RCC/FTS
- ARIA relay of Telemetry Relay (lets test conductor know if missile is receiving FTS carrier signal)

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[11] Air Force Manual 99–104 Armament/Munitions Test Process, page 7; Figure 2.2 The Air Force Test and Evaluation Process

[12] AFI 13-201 Air Force Airspace Management page 26 & 27, Protection of Civilian Population and Communities

[13] AFI 13-212, UTTR Supplement 1 (TEST) page 14

- Radio relay from Mission Control Center (MCC) to chase aircraft
- FTS signal monitoring (so ARIA crew can warn chase or MCC of hazards)
- ARIA transmits of FTS carrier signal
- Weather criteria
  - Ensure chase aircraft can see missile and ground
  - Ensure chase aircraft can refuel from tankers
  - Criteria for test execution prevent exceeding these limits
- Four chase aircraft required (3 minimum for go)
- Tanker for refueling - required for go
- ARIA aircraft - required for go
- Operational MCC - required to go
- Ground recovery team - required for go
- Helicopter for recovery team required for go
- Contingency procedures to take if elements drop out
- Multiple tracking capabilities to monitor missile flight path at all times

The organization responsible for conducting operational tests of cruise missiles (49th Test Squadron at Barksdale AFB, LA) publishes detailed test instructions specifying additional safety criteria, test team membership and duties, and detailed checklists. In addition, they maintain a comprehensive lessons learned program from earlier tests[14].

APPROVAL PROCESS

Prior to each test, the Range Control Officer convenes a Safety Review Board (SRB) between 60 and 45 days before the start of testing. The SRB reviews the Operating Hazard Analysis and the approved test plans provided in advance to Range Safety[15]. The customer must be present at the SRB, and is bound to comply with all range restrictions and the procedures approved by the SRB.

The Range Test Director is responsible for and is the final decision making authority during all phases of test conduct and preparation. He also monitors mission development to ensure achievement of all flight objectives and ensures each test team member is assigned specific responsibilities. He along with the Range Control Officer convenes the Safety Review Board. Key personnel are listed in the ACM Operations and Procedures Manual[16] Additionally he uses teleconferences to conduct the briefing schedule as listed in References A, B, and C in the aforementioned manual.

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[14] AFI 13 – 212 Vol. I Weapons Ranges, Chapter 2, page 14, Ensuring Range Safety

[15] AFI 13-212, UTTR Supplement 1 (TEST) page 14, para 3.3

[16] ACM Operations Concepts and Procedures page 1 to 2.

IV. CRUISE MISSILE TEST EXECUTION

In preparation for each test, routine meetings are held shortly before the execution of the test to ensure that the test can be properly and safely conducted.. The program organization responsible for the system reviews and approves the specifics of the mission in a Mission Readiness Review, and the Range approves the accomplishment of the mission on its range as described in Section III.

A typical set of normal cruise missile test procedures are listed in the Advanced Cruise Missile (ACM) Operations and Concepts and Procedures manual, Reference S. These procedures optimize the launch aircraft and missile configuration, meteorological and atmospheric conditions and generally maximizes safety before the missile is launched. As part of the pre-launch process, briefings are conducted, mission readiness is assessed, communication, control and telemetry links are checked, range weather is confirmed, safety concepts are reconfirmed, remote command and flight termination system is checked and verified, air refueling procedures are discussed, air and ground range readiness is confirmed and photo chase requirements are double checked.[17]

Contingency operations are also heavily reviewed prior to any scheduled cruise missile launch. Mission Control evacuation plans are reviewed. Hung weapon and weapon jettison procedures are discussed. Loss of Advanced Range Instrumentation Aircraft (ARIA) UHF radio relay, loss of Remote Command and Control (RCC) are reviewed. Loss of visual contact with missile, loss of chase aircraft, loss of ARIA, loss of tankers, and chase aircraft radio loss are studied. Stern application of tested and proven checklists exists for these and other contingencies. Strict protocols derived from lessons learned are applied anytime deviations are noted before, during, and after missile free flights. Rigorous checklist disciplines during unusual situations maximize range safety at all times.

In planning each mission, buffer lines (also known as termination lines) define the areas on ranges or along planned route structure that the missile will not be allowed to penetrate. At the Utah Range a line 2 nautical miles inside any Warning Area, Restricted Area, or Military Operating Area (MOA) boundary are enforced. In our situation, no missile flights are conducted in Northern Sevier B MOA or in Restricted Areas R-6406B or R-6402B as stated by Mr. Don Good from 49th TESTS Squadron at Barksdale AFB, LA Skull Valley and the ISFSI are avoided by at least 10 nautical miles. See Reference U.

For cruise missile tests, given their autonomous nature, significant attention is given to closely tracking the missile throughout its flight. Each missile must have an approved Flight Termination System (FTS) installed so that it can be commanded to alter route or to terminate its flight by a human. While flying, the missile is literally tracked by eyeball by a pilot in a chase airplane to ensure that the missile is performing properly in flying characteristics as well as route compliance.

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[17] Advanced Cruise Missile (ACM) Operations Concepts and Procedures pages 24-28

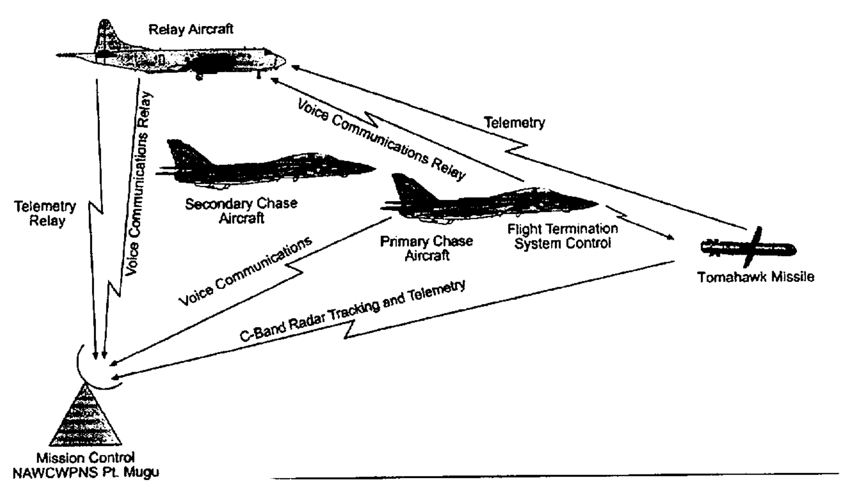
Typical airborne assets employed to conduct a cruise missile test for ALCM or ACM include:

- One B-52 mothership with the cruise missile loaded on either an external pylon in the case of the Advanced Cruise Missile or internally on a rotary launcher in for the Air Launched Cruise Missile.
- One E-135 Advanced Range Instrumentation Aircraft (ARIA) to control the missile if necessary and gather the telemetry stream containing vital missile parameters
- Four to eight F-16/F-14 chase aircraft with Remote Command and Control (RCC) pods to manually fly the missile in the event this becomes necessary.
- Two T-38 photo chase aircraft as mission needs dictate.
- Two KC-10 tankers or four KC-135 tankers to refuel the chase aircraft.
- And finally two to three helicopters to recover the missile and control the missile landing area.

All of these aircraft are operated under the control of the test conductor located at the range control facility on the ground, or airborne from the ARIA aircraft[18].

A typical mission, using Tomahawk as an example, is depicted in the following schematic[19]:

Figure 13: Typical Navy Enroute Formation During Mission



[18] Advanced Cruise Missile Operations Concepts and Procedures, page 14a
[19] Tomahawk Flight Test Operations on the West Coast of the United States, Fig. 2-7

In addition to the aircraft tracking the missile throughout its mission, the ground control station monitors the missile's performance and key operation parameters through the integrated telemetry system in the missile to detect malfunction or unexpected events. The ARIA aircraft has the ability to take control of the missile in flight and "manually fly" the missile should override of the pre-planned mission be necessary due to an unexpected airspace occurrence, in coordination with range control. Both range control and ARIA aircraft have the ability to terminate a missile's flight should it be detected operating abnormally in relation to flight or mission plan. The FTS provides both these abilities, and is described more fully in Section V.

Operations on Range for cruise missiles are conducted according to the pre-planned mission. When on-range, the missile's route is pre-planned to meet range restrictions. In planning each mission, buffer lines (also known as termination lines) define the areas on ranges or along planned route structure that the missile will not be allowed to penetrate. At the Utah Range a line 2 nautical miles inside any Warning Area, Restricted Area, or Military Operating Area (MOA) boundary are enforced. In our situation, it is legal to fly a missile in Sevier B MOA West of a line 2 nautical miles inside the eastern Sevier B MOA boundary, however this is no longer done due to the increasing manned presence in the area of the proposed storage facility[20]. There are 17 "no fly" areas in the Skull Valley. Cruise missile flights are prohibited over these areas. As such the test conductors at the 49th TESTS Squadron have elected to avoid the entire Skull Valley for cruise missile testing.

A standard, commonly flown cruise missile route is depicted in figures 14 and 15. It is split in to a north range half and a south range half due to sizing restrictions. The closest point of cruise missile approach to the PFSF site on this route is approximately 10 nautical miles (11.3 statute miles). The majority of the route as we can see is well to the west and south and north of the site.

[20] Interview with Mr. Boe Hadley, the UTTR Range Control Officer

Figure 14: North Range Cruise Missile Routing

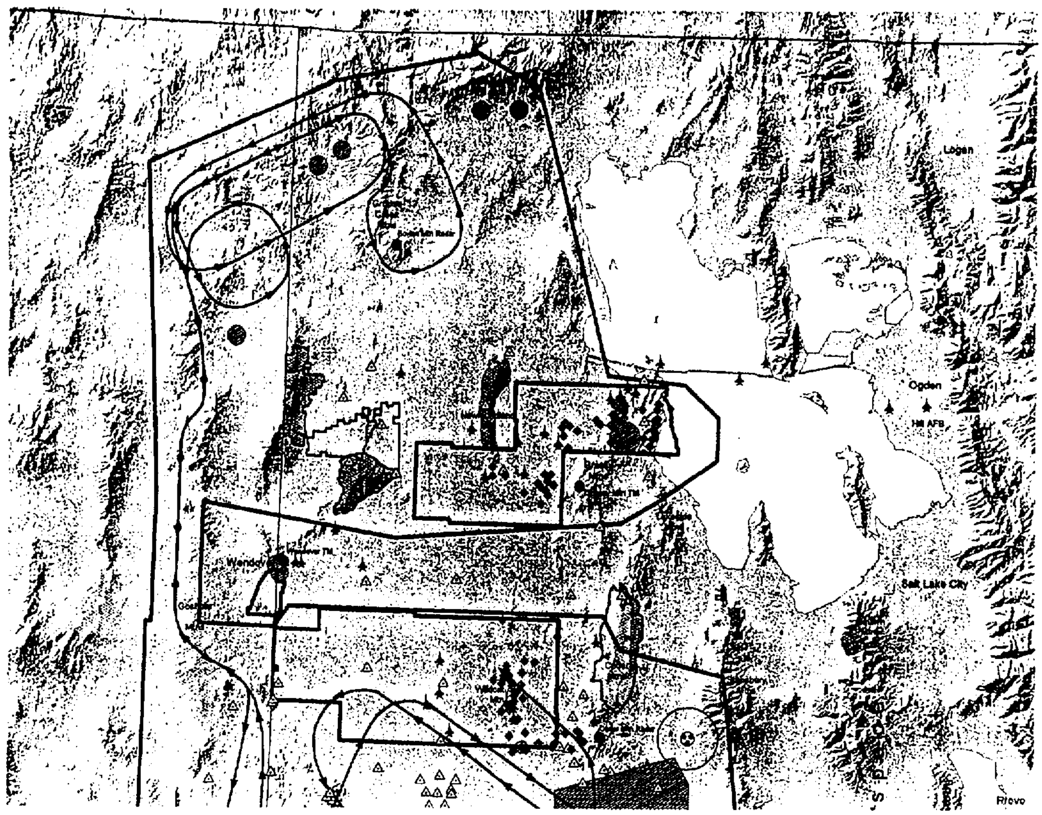
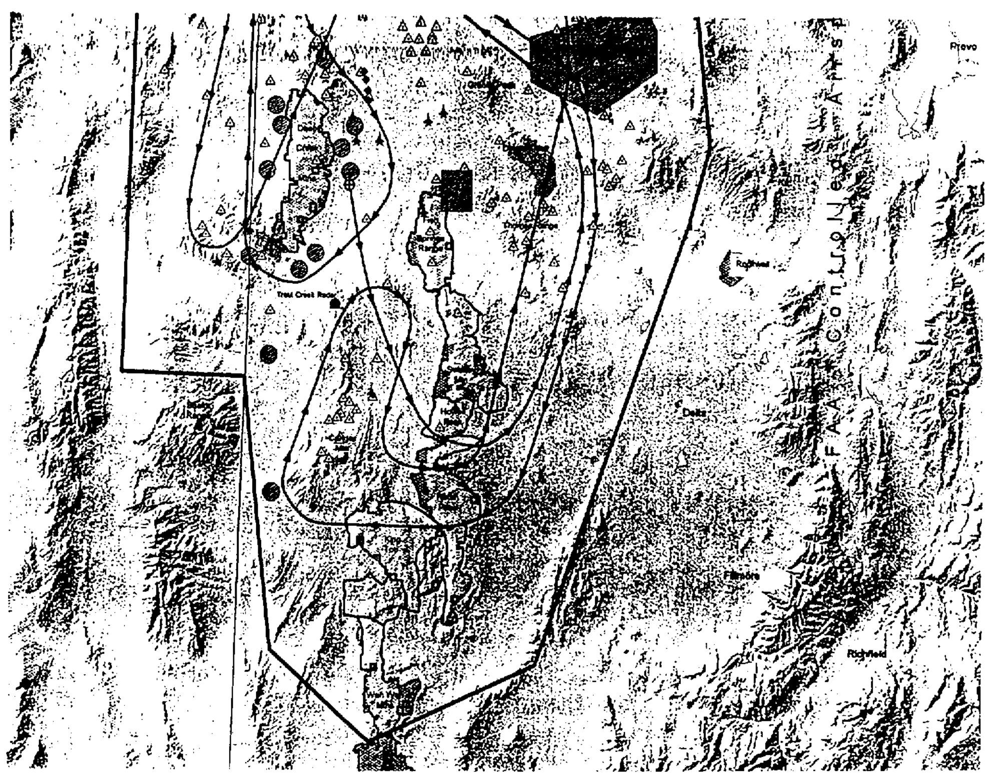


Figure 15: South Range Cruise Missile Routing



The closest point of the route to the PFSF occurs as the missile starts it run-in to the target areas.
Target areas are well defined in UTTR, with TS-1, TS-2, TS-3, and TS-4 the targets used for cruise missile testing (see Figure 5).

SUMMARY

Test operations are carefully planned and controlled throughout their duration. With painstaking procedures utilized to plan the mission and with continuous monitoring throughout the flight, each missile is under scrutiny of many "eyes" to ensure that it is performing according to plan. If any deviation is detected from the planned mission, control of the missile is "taken" by the chase or monitoring crews, and the missile flown to the contingency recovery point.

V: FLIGHT TERMINATION SYSTEMS (FTS) AND PROCEDURES

FTS REQUIREMENTS

Large footprint weapons (cruise missiles) with the capability to exceed UTTR land boundaries or endanger range assets, manned sites and sensitive areas must have an FTS designed, tested, documented and certified in accordance with Range Commander's Council (RCC) Standard 319-92 or latest revision. Compliance with this standard ensures that the FTS is compatible with the range systems and procedures.

The Range Commanders Council Document 319-99 also dictates FTS performance requirements for all FTSs on cruise missiles. This 750-page document details every aspect pertaining to Flight Termination Systems. Chapter Four details requirements for remotely piloted vehicles and cruise missiles, with 75-pages devoted to these vehicles. The standards are rigorous and redundant. There is no more thoroughly scrutinized subsystem on the cruise missile.[21]

Under RCC Document 319-99, all FTSs used on cruise missiles on the UTTR (and other ranges) are designed and built to common performance specifications, with identical reliability and certification requirements. Specifically, all FTSs must be 99.9 percent reliable at a 95 percent confidence level.[22] The designs of FTSs on different models of cruise missile may vary (e.g., ALCM employs a parachute as an integral part of its FTS, while Tomahawk and ACM do not), but all FTSs must meet the same performance standards.

A typical FTS designed and developed for the Tomahawk cruise missile is described in Reference J.

FTS APPROVAL / CERTIFICATION

The FTS must be approved for use on the range where it will be employed. Configuration approval is granted only after acceptance of the FTS report and successful demonstration of the complete system. The Range Squadron Safety Office participates in the design and development of any FTS which may eventually be used on the UTTR, to ensure compliance with RCC Standard 319-92, or the acceptance of any deviation from this standard. Systems approved for use on one program are not automatically authorized on another program. Any changes or modification to approved system, components or test procedures are reviewed by Range Safety Squadron, and a re-certification process may be necessary if substantive changes are contemplated.

During FTS system design, provisions are incorporated for the display of the following real-time telemetry and Time, Space, Position, Indicators (TSPI) parameters so the Range Safety Officer (RSO) can monitor the missile during flight:

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[21] Range Commanders Council Document 319-99 Flight Termination Systems Commonality Standard Ch 4

[22] Id., para 4.4.17.

- TSPI from a source independent of vehicle telemetry (two sources highly recommended).
- Test vehicle altitude, attitude and heading
- Radio Frequency signal strength at both FTS receivers
- Energy level (voltage) of primary and backup power supplies used to power the FTS receivers, sequencers, and termination mechanism
- Status of all safe-and-arm devices, lanyards, wing switches, etc.
- Status of all FTS tone logic signals, e.g. MONITOR, ARM, TERMINATE
- Temperature of temperature critical components such as batteries and receivers
- Fail-safe timer status
- Any other FTS parameters deemed necessary by the Range Safety Officer.

FTS PROCEDURES AND OPERATIONS

There are two key modes of terminating a cruise missile's flight using the FTS:

(1) By command from the range when the missile is detected operating improperly, such as deviating from plan, or if a range safety conditions requires terminating the flight. Safety officers can activate the FTS at any time. The Range Safety Officer at Mission Control and the Airborne Range Instrumentation Aircraft are both capable of terminating the cruise missile flight almost instantly.

(2) Loss of the constant carrier signal required to be received from the range or one of the supporting aircraft. At all times throughout the flight the cruise missile FTS must detect a signal that in effect permits the continued flight of the missile. If the missile does not detect the signal for a preset time, the FTS activates, causing the missile to tumble and crash. This arrangement is functionally equivalent to a dead-man switch. This accommodates a missile-losing signal (more importantly loss of telemetry feedback for monitoring the missile's health and status) should the missile reach a "shadow" zone in the flight. By manually terminating the carrier signal, the flight can be terminated in this manner as a secondary means.

In addition to providing flight termination means, the FTS also provides override capabilities to the range and support aircraft to redirect the missile's flight path should that be required. Override control is employed, for example, to remain clear of clouds, to redirect a missile if an anomaly is detected in flight (visually or through telemetry), or in the event the missile needs to be steered clear of unanticipated encroaching aircraft.

Before execution of the mission and early in flight, the FTS override system is tested in flight. Before a launch platform (bomber) launches a test cruise missile, the Mission Control Center (MCC) verifies that the missile's Remote Command and Control (RCC) and Flight Termination System (FTS) are working properly. Once launched, the missile override controls are quickly checked to ensure that positive control of the missile is

available and working properly. Throughout its flight, the missile transmits measurements that confirm it is receiving the authorizing signal (and the strength of that signal) to Mission Control via the telemetry stream, as well as critical operating parameters for the ground crew to monitor missile health and status.

RCC signals originate from the command and control panel of the aircraft monitoring the test missile in flight. These signals are received and decoded by the missile's range safety equipment and are transmitted to the missile guidance set which computes control signals for the engine and fins. Range safety commands are divided into three groups: manual control, on track control and emergency control. Manual control gives range safety personnel all axis control of the air vehicle. With on-track control the air vehicle can be commanded to climb, hold altitude, or descend on the planned track. Emergency control allows either commanded or loss of power termination. There are two methods of terminating air vehicle flight as described above. When flight terminate signals are received by the unit, the decoder and guidance set are bypassed and terminate signals go directly to the engine and fins. The terminal maneuver consists of the horizontal fins being commanded to null, the vertical fin is commanded to full leading edge right and the throttle is commanded to off.

COMMAND AND CONTROL DURING TESTING

The missile relays all instructions its remote control system receives at the same time it carries out those instructions. Mission Control at Hill AFB and the Airborne Range Instrumentation Aircraft (ARIA) monitor these signals throughout the missile's flight. The missile remote control system permits steering the cruise missile to avoid weather and hazards, and allows manual intervention in case of missile malfunctions. Mission Control at Hill AFB and the ARIA can take manual control of the missile. Range transmitters can relay any commands from Mission Control. These transmitters are on high terrain but they do not provide continuous line of sight communication to missiles flying at low altitudes. The preferred control platform is the ARIA aircraft, because its signals are less likely to be blocked by terrain. Soon after the missile is launched on every test, ARIA takes manual control of the missile to check its response. Because ARIA cannot see the missile it works with chase aircraft to check the missile's performance.

Fighters "chase" (fly in company and visually in contact with the missile) the missile throughout its entire flight to ensure safety. They remain behind the missile, monitoring its performance and heading. If the missile is tracking toward a cloud, or if another aircraft enters the range, or any other problem exists, the chase pilot tells the ARIA controllers how and where to steer the missile to keep its safe. Two fighters are always "on the missile" while the other two fighters are refueling from the tanker. Chase aircraft follow the missile until it completes its mission.

VI: CRUISE MISSILE SYSTEM TESTING AT UTTR

HISTORY

There have been 12 documented cruise missile crashes at the UTTR in the last 10 years, as shown in Table 1.[23] Seven were Air Launched Cruise Missiles (ALCM or CALCM, AGM 186B and AGM186C), and four were Advanced Cruise Missiles (ACM, AGM 129) (one was of unknown type).[24] Twelve ALCM/ACM cruise missile crashes occurred in approximately 80 flights during this timeframe, a failure (crash) rate of 15%. As of 1998, 197 Tomahawk tests had been conducted. In that population, four (4) missiles failed during the cruise phase and crashed on non-military land along the planned flight path. There have be no failures during the cruise phase in the last 52 of those 197 flights. Based on these data, there should be less than two- percent chance of cruise phase failure for Tomahawk cruise missiles, if Tomahawk testing was resumed at the UTTR.

The UTTR crash sites are listed in Table 1. None of the vehicles crashed within 10 nautical miles (nm) of the proposed ISFSI site. The closest crash site is 13 miles to the southwest. Another crashed 18 miles from the PFSF site and the remainder impacted more than 30 miles from the site, with the most distant 90 miles to the southwest. Assuming a nominal missile groundspeed of 420 knots, (all of the aforementioned vehicles are subsonic), the nearest cruise missile was almost 2 minutes flying time from the site. This is a long time considering that the FTS can be activated nearly instantaneously. All of the crashes over the past ten years have occurred on or within half a mile laterally of the planned route (10 seconds of flight time).[25] There has never been a cruise missile FTS failure at the UTTR. See Reference U.

Current plans call for approximately six cruise missile tests annually. These tests are Follow On Test and Evaluation launches conducted by the Air Combat Command's 49th Test Squadron. Basically these tests confirm the continuing viability of stockpile missiles that already exist in the USAF inventory. The flight characteristics of these missiles are well documented. Both the Advanced Cruise Missile (ACM) and the Air Launched Cruise Missile (ALCM) have been in the active inventory since the early 1990's. Tomahawk sea launched cruise missiles have been tested at UTTR in the past, with the last test there occurring in January 1988, but no flights are now scheduled for UTTR.

RANGE SAFETY

Cruise missiles and other unmanned systems are required to have profiles developed/ provided which avoid manned/inhabited locations. For vehicles with a range approved flight termination system on UTTR, manned locations shall be avoided by a horizontal distance equal to the AGL altitude or 3 NM above 18,000 ft AGL, 1 NM below 6,000 ft

[23] A "crash" is defined as a missile impacting the ground at an unintended point.
[24] Response to Freedom of Information Request from Hill AFB, UT Public Affairs page 1
[25] The planned route is the intended path of the missile in flight over the range and crashes have been within half a mile of that route laterally.

AGL.[26] According to Mr. Boe Hadley of the UTTR Range Control Squadron at Hill AFB, UT, cruise missile routing includes a 3-mile standard buffer distance from any UTTR airspace boundary (see Reference T).

Table 1 UTTR Cruise Missile Crashes From 1991 to 2000

Missile Type	Live Warhead?	Crash Date	Crash Location	On/Off DoD Land
ALCM	No	24 Jul 91	155 degrees at 10 miles from ENV VORTAC	On
ALCM	No	8 Oct 91	Near Highway 6 in Millard County	Off
ACM	Yes	16 Dec 92	SW of Granite Peak	On
ALCM	No	20 Apr 93	~10 miles SW of Granite Peak	On
CALCM	Yes	23 Jul 93	~20 miles W-SW of Wildcat	On
CALCM	Yes	29 Mar 94	~20 miles SW of Granite Peak	Off
ALCM	No	14 Sep 95	SW of Granite Peak	On
ACM	No	24 Jun 96	Sevier Dry Lake	Off
ACM	No	10 Dec 97	SW Bench of Cedar Mt	On
CALCM	Yes	9 Jun 98	~1/2 mile NW of TS-2A	On
ACM	No	23 Mar 00	Near Ibapah, NV	Off
unknown	No	27 Sep 00	~50 mi. S of Wendover, NV	Off

The US Air Force and US Navy have published Trajectories from Flight Termination profiles.[27] For example, in a worst case scenario for the ALCM (at 40,000 ft AGL), the missile travels no further than 4.5 nm after the terminate signal is given, as shown in Figure 16A and 16B below. At 5,000 ft AGL (where the missile typically cruises), the ALCM travels a maximum of 1.6 nm along track and 0.4 nm laterally (i.e., perpendicular to the flight path). The distances in Figure 16 A conservatively assume a 50-knot wind blowing in the most disadvantageous direction.[28]

[26] AFI 13-212 UTTR Supplement 1 (TEST) page 10 para 2.9.2

[27] E.g., Tomahawk Sea Launched Cruise Missile System Flight Termination System Report, pages 2-13 through 2-16; Boeing Technical Data for AGM-86 Missile page 92, Figs. 3.1-3, 3.1-4.

[28] As they are designed to common performance specifications under RCC Document 319-99, the FTSs on Tomahawk, ALCM, and ACM all exhibit similar performance. For example, the FTS for the Tomahawk is designed such that in the worst case the missile falls to the ground less than 2 nm along the missile flight path. Tomahawk Sea Launched Cruise Missile System Flight Termination System Report page 2-13. The length of the missile impact area (along flight path) is roughly 2.7 times greater than the total width; thus the Tomahawk missile can be expected to fall within 0.4 nm laterally of the flight path. Tomahawk Flight Test Operations on the West Coast of the United States, Final Environmental Assessment (Oct. 1998) page 2-19.

Figure 16A: Downrange Distance Graph After FTS Termination
(From Boeing Tech Order Data)

THE BOEING COMPANY

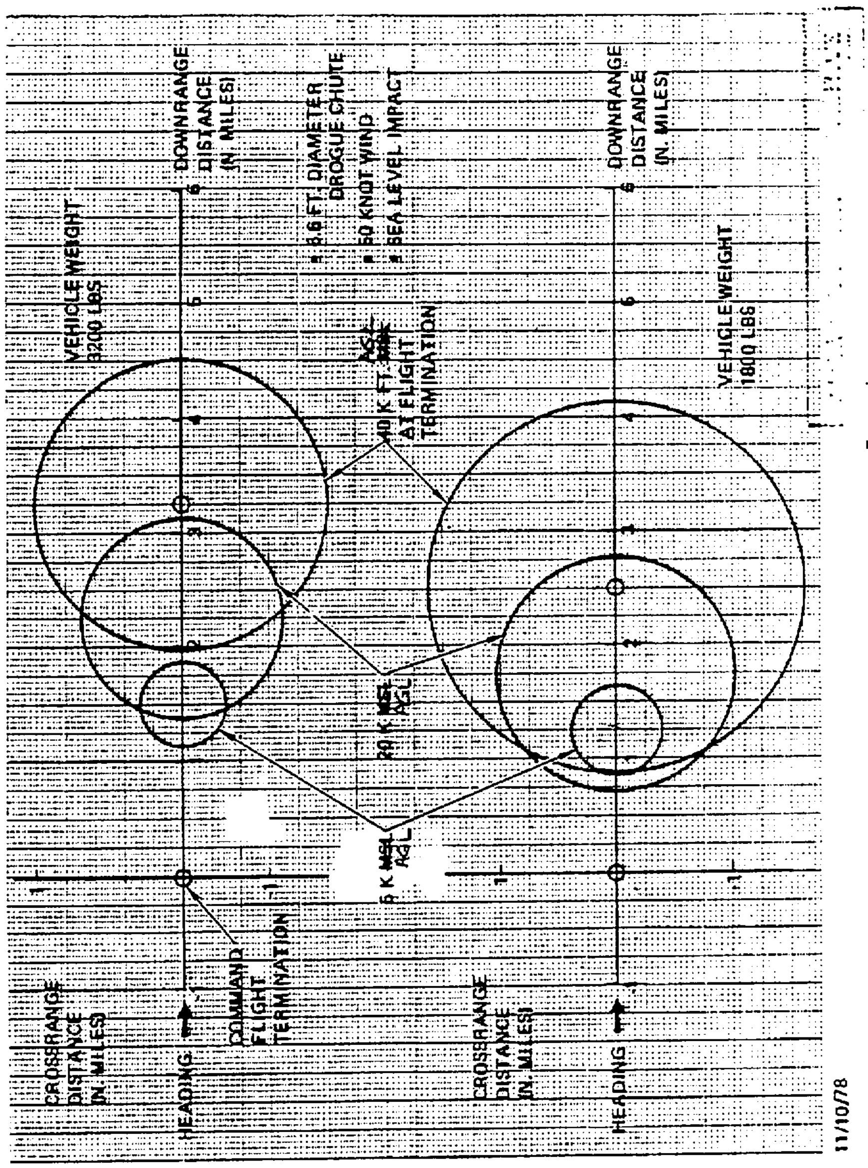

Figure 3.1-4. Air Vehicle Missile Impact Footprints

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Figure 16B: ALCM Cruise Missile Trajectory After Flight Termination

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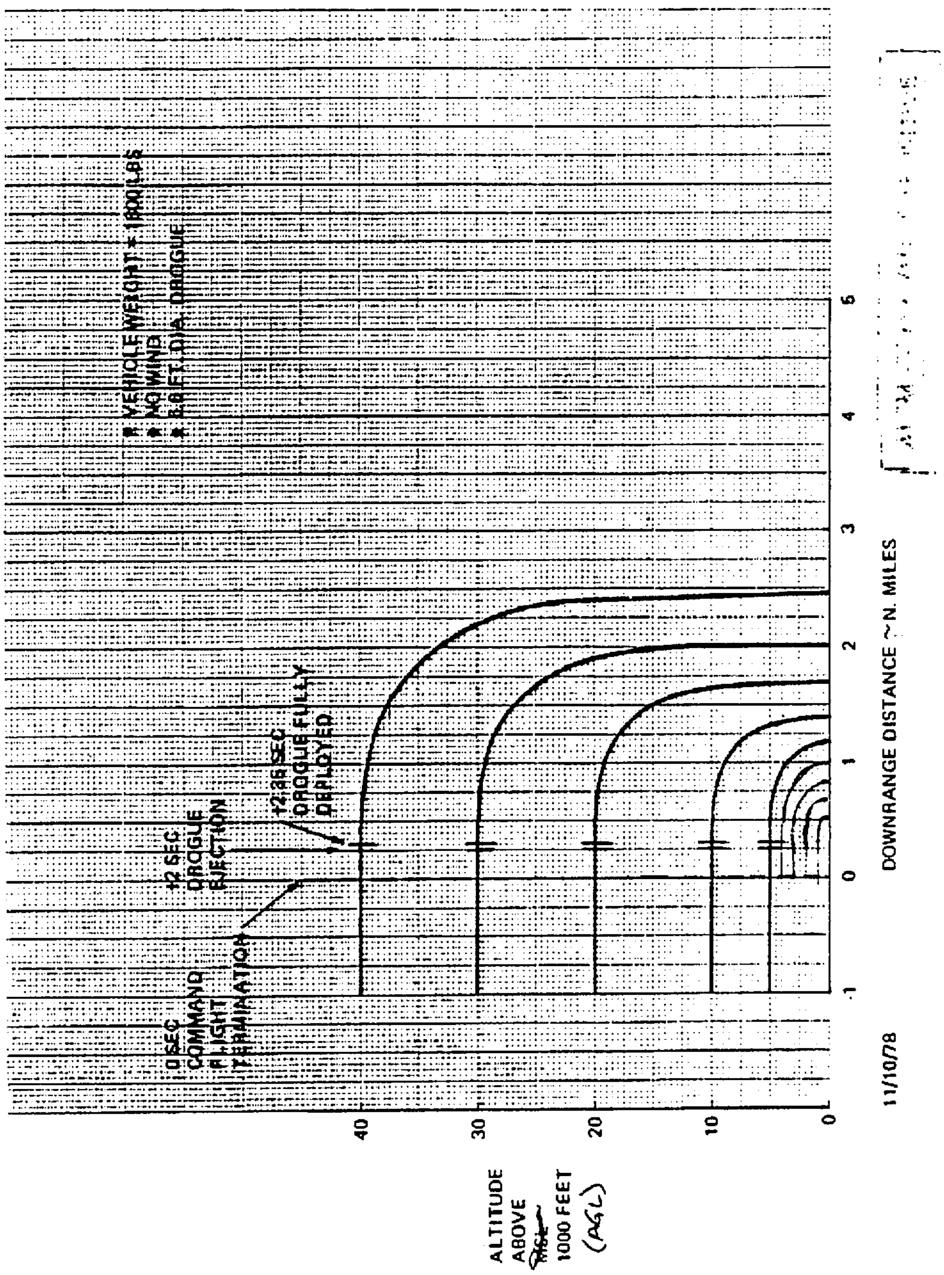

Figure 3.1-3. Flight Termination Trajectory Profiles at Empty Weight

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SUMMARY and CONCLUSION

As described in the preceding sections of this report, there is a comprehensive and controlled process in place the governs testing of cruise missiles on the Utah Test and Training Range, all of which are to ensure tests are safe and avoid potential damage to people, facilities or structures. In summary:

(1) Cruise Missile Tests are methodically planned events with safety as a primary consideration throughout the process.
(2) Formal approval reviews are conducted prior to the execution of each test to ensure thoroughness of all mission and contingency plans.
(3) All test cruise missiles are fitted with a Flight Termination System (FTS) capable of being used to take manual control of a missile when needed to redirect it, or to immediately terminate its flight should that be required. No FTS failure has ever occurred.
(4) All cruise missile test flights are conducted with a number of supporting aircraft in company with the cruise missile to observe its flight (eyeball contact). In addition, telemetry is continuously monitored by airborne and ground control stations to observe all operating parameters of the test missile. With the ability to detect incipient problems, these monitoring stations are able to take preventive actions should such be warranted.
(5) Cruise missiles fly pre-programmed routes with high navigation accuracy. In instances where cruise missiles have failed in flight, impact has been within ¼ mile of the planned flight path,
(6) In the UTTR, cruise missile flight paths are required to remain clear of manned facilities (e.g. the PFSF) by 3 miles.
(7) At their closest point of approach to the PFSF, cruise missile flight trajectories are tangential (as opposed to radial) to the PFSF, coming no closer than 10 nm from the facility.

Conclusion

The processes and procedure in place ensure that any flight failure of a cruise missile under test on the UTTR is highly unlikely to encroach on the ISFSI site. The separation geometry and FTS activation parameters will ensure that any failed missile lands within the UTTR controlled airspace boundaries, clear of known manned sites.

ASSESSMENT: Extremely low risk to the ISFSI from a cruise missile test on UTTR.

DEFINITIONS

Captive Carry:

- Captive Carry refers to the time that a missile is attached to an aircraft, and can be for an entire flight or for a partial flight in preparation for launch. A total captive carry mission is one in which the missile is purposely held on the launch aircraft pylon for the entire test mission. This is typically done to verify the mission profile sequence interface hardware and software. Additionally, the missile mission computer can be coupled to the mother ship's autopilot to allow the missile navigation set to fly the mission profile while still attached to and directing the maneuvers of the launch aircraft. In this scenario no launch is ever attempted. A second definition of captive carry refers to that portion of the test mission in which the missile is attached to the launch platform. In this scenario, a missile launch is planned and as such captive carry refers to only that portion of the test mission during which the missile is actually mated to and communicating with the launch aircraft. The captive carry portion of the mission ends when the missile departs the pylon

Restricted Areas:

- An area (land, sea, or air) in which there are special restrictive measures employed to prevent or minimize interference between friendly forces or an area under military jurisdiction in which special security measures are employed to prevent unauthorized entry.
- Airspace within which the flight of aircraft, while not wholly prohibited, is subject to restriction. IFR of VFR operations in the area may be authorized by the controlling air traffic control facility when it is not activated by the using agency.
- An area that must contain all "Hazardous Activity" as defined by branch of service for specific type of aircraft using the range.

Military Operating Areas (MOAs):

- Special use airspace allocated to the military to separate/segregate certain military activities from Instrument Flight Rules (IFR) traffic and to identify for Visual Flight Rules (VFR) traffic where these activities are conducted.

Special Use Airspace:

- Airspace of defined dimension wherein activities must be confined because of their nature, and/or wherein limitations may be imposed upon aircraft operation that are not part of those activities.