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IN REPLY REFER TO:

5100
Ser 521300E/ A-2883
30 SEP 1998

From: Commander, Naval Air Warfare Center Weapons Division, Point Mugu
To: Commanding Officer, Pacific Missile Range Facility, Barking Sands, Hawaii

Subj: RANGE SAFETY OPERATIONAL PLAN 3-98 FOR THE NAVY THEATER WIDE THEATER BALLISTIC MISSILE DEFENSE TARGET

Ref: (a) NAWCWPNSINST 5100.2

Encl: (1) Range Safety Operational Plan 3-98

1. In accordance with reference (a), enclosure (1) is forwarded for action and retention. It defines the basic Range Safety criteria common to all Navy Theater Wide Theater Ballistic Missile Defense target operations conducted at the Pacific Missile Range Facility.

2. Point of contact is Mr. John Morris, Code 521300E, DSN 351-5680 or (805) 989-5680.

Michael V. Wechsler

MICHAEL V. WECHSLER
By direction

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RANGE SAFETY OPERATIONAL PLAN 3-98
FOR
NAVY THEATER WIDE (NTW) THEATER BALLISTIC MISSILE DEFENSE (TBMD) TARGET
AT
THE PACIFIC MISSILE RANGE FACILITY (PMRF), BARKING SANDS, KAUAI, HAWAII

30 SEPTEMBER 1998

Prepared by: _____
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Reviewed by: _____
NAWCWPNS Sea Range Safety Office

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K. J. PRINDLE
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Enclosure (1)

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RECORD OF CHANGES AND CORRECTIONS

NO.	CHANGE DATE	DATE ENTERED	ENTERED BY

ACRONYMS AND SPECIAL NOMENCLATURE

Word/Acronym	Definition
A&F	Arm and Fire
AMFSO	Assistant Missile Flight Safety Officer
BETA	Ballistic Coefficient, W/C_DA; lb/ft^2
CCT	Command Control Transmitter (Command Destruct Transmitter)
CDR	Command Destruct Receiver
CRT	Cathode Ray Tube
ECEF	Earth Centered Earth Fixed
ECI	Earth Centered Inertial
EIS	Environmental Impact Statement
FAA	Federal Aviation Administration
FCDC	Flexible Confined Detonating Cord
FS	Front Section
FTR	Flight Termination Receiver
FTS	Flight Termination System
G&C	Guidance and Control
GHA	Ground Hazard Area
GSP	Ground Safety Panel
IIP	Instantaneous Impact Point
IRIG	Inter-Range Instrumentation Group
Khz	Kilohertz
KTF	Kauai Test Facility
KW	Kilowatt
LOB	Launch Operations Building
LSC	Linear Shaped Charge
MDF	Mild Detonating Fuse
MFSO	Missile Flight Safety Officer
Mhz	Megahertz
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MRT	Mission Readiness Test
NAWCWPNS	Naval Air Warfare Center Weapons Division
NAWCWPNSINST	Naval Air Warfare Center Weapons Division Instruction
NOTAM	Notice to Airmen
NOTMAR	Notice to Mariners
NTDS	Naval Tactical Data System
OC	Operations Conductor
OSC	Orbital Science Corporation
PC	Personal Computer (IBM)
PCM/FM	Pulse Code Modulation/Frequency Modulation
PMB	Payload Module Bus
PMRF	Pacific Missile Range Facility
PTS	Power Transfer Switches
RCC	Range Control Center
RF	Radio Frequency
RFCO	Range Facilities Control Officer
RSM	Range Safety Monitor
RSOP	Range Safety Operational Plan
SDC	Serial Data Controller
SID	Sensor IDentification
SNL	Sandia National Laboratories
SRDS	Sounding Rocket Destruct System
TD	Test Director
T&C	Tracking and Control (control spaces at PMRF)
TM	Telemetry
UHF	Ultra High Frequency
VO	Visual Observer

REFERENCES

a. Sea Range Safety NAWCWPNSINST 5100.2 of 9 July 1993.

b. Memorandum of Understanding between Commander, Naval Air Warfare Center, Weapons Division and Commanding Officer, Pacific Missile Range Facility.

c. Range Commanders Council Standard 319-92, Flight Termination Systems Commonality Standard.

d. Navy Theater Wide (NTW) Aegis LEAP Interceptor (ALI) Target Test Vehicle (TTV) Flight Termination System Report (FTSR) of 8 Sep 1998.

e. Pacific Missile Range Facility Enhanced Capability Environmental Impact Statement.

f. Range Commanders Council Standard 3321-97, Common Risk Criteria for National Test Ranges.

g. Navy Theater Wide (NTW) - ALI Target Test Vehicle (TTV) Program Flight Safety Data Report of 27 July 1998.

5100
521300E
30 Sep 98

RANGE SAFETY OPERATIONAL PLAN 3-98
FOR
NAVY THEATER WIDE (NTW) THEATER BALLISTIC MISSILE DEFENSE (TBMD) TARGET
AT
THE PACIFIC MISSILE RANGE FACILITY, BARKING SANDS, KAUAI, HAWAII

1. Introduction

This Range Safety Operational Plan (RSOP) has been developed in compliance with the policy of the Commander, Naval Air Warfare Center Weapons Division (NAWCWPNS) as stated in NAWCWPNSINST 5100.2 (reference (a)) regarding missile flight safety. Consistent with that policy, this RSOP establishes the operational requirements and procedures to ensure, within reasonable risk, against personal injury or damage to property resulting from missions involving the NTW TBMD target vehicle at the Pacific Missile Range Facility (PMRF), Barking Sands, Kauai, Hawaii.

a. Purpose and Scope: NAWCWPNS Range Safety (acting on behalf of PMRF per reference (b)) has issued this RSOP to define the general in-flight procedures and the minimum range instrumentation requirements for operations involving the NTW TBMD target vehicle launched from the Kauai Test Facility (KTF) at PMRF. This RSOP is to be used in conjunction with its scenario specific annex.

b. Definitions:

(1) Range Facility Control Officer (RFCO): The PMRF Range Operations representative responsible for ensuring compliance with this RSOP as well as all applicable PMRF procedures and policies governing missile launch operations.

(2) Missile Flight Safety Officer (MFSO): The MFSO is the designated representative of the NAWCWPNS Range Safety Officer and is responsible for executing in-flight safety in accordance with the flight termination criteria (described in paragraph 10).

(3) Instantaneous Impact Point (IIP): The drag corrected predicted point of impact of a vehicle based on its zero-lift, zero-thrust, ballistic trajectory. Using radar and/or telemetry generated state vectors, this point is continuously updated and displayed on a geographic presentation throughout missile powered flight. Note: For the NTW TBMD target, all realtime IIP plots will be computed using a fixed ballistic coefficient (W/C_DA) of 150 lb/ft^2 unless specified otherwise in the scenario specific annex to this RSOP.

(4) Notice to Airmen (NOTAM): A notification to civil and military aircraft through appropriate FAA facilities of a possible hazard to aircraft because of missile launch operations.

(5) Notice to Mariners (NOTMAR): A notification to civil and military navigation through appropriate Maritime facilities of a possible hazard to vessels because of missile launch operations.

c. Vehicle Description: The single-stage NTW TBMD target vehicle consists of a M56A1 solid rocket motor (Minuteman I second stage) and a non-separating Front Section (FS)--which houses the Flight Termination System (FTS) module

and Payload Module Bus (PMB). Stability and guidance are maintained with four fixed 7.6 ft^2 fins and four gimbaled nozzles. The body diameter narrows from 44 inches (M56A1) to 38 inches (PMB) within the span of the FTS module (see figure 1). Overall vehicle length and weight are approximately 360 inches and 13,800 lbs.

d. Flight Termination System (FTS) description: The FTS, designed in compliance with references (a) and (c), consists of two linearly polarized quadraloop blade antennas linked to two UHF Flight Termination Receiver/Decoders (L3/Conic FTR-915A1) through a 90° hybrid coupler (via interconnecting coaxial cables). There are two FTS battery packs (each comprised of 25 high-temperature, rechargeable Nickel-Cadmium cells) supplying power to the Flight Termination Receivers (FTR) via a redundant pair of Power Transfer Switches (PTS). Output from the FTR's is connected directly to the dual-channel Safe and Arm (S/A) device (armed prior to launch from the Ground Safety Panel (GSP) via the umbilical link). The output ports of the S/A interface with the Flexible Confined Detonating Cord (FCDC) for transfer of the ordnance train to the Sounding Rocket Destruct System (SRDS)--a 100 grain/foot Linear Shaped Charge (LSC) installed in the raceway running the length of the rocket motor case.

The NTW TBMD target vehicle FTS is described in detail in reference (d). Any departures from the specifications outlined in that document must be detailed and submitted to NAWCWPNS Range Safety for approval in accordance with paragraph 12 of this RSOP.

2. **Communications**

a. Two-way voice communication links are required between the MFSO in the Tracking and Control room (T&C) at PMRF and the

(1) Back-Azimuth Visual Observer,

(2) Cross-Range Visual Observer,

(3) Guidance and Control (G&C) personnel in the Launch Operations Building (LOB) at KTF,

(4) Missile Flight Safety Analyst (telemetry analyst) at Makaha Ridge,

(5) Range Safety Monitor (RSM) located near the GSP (in the LOB),

(6) Range Facility Control Officer (RFCO),

(7) PMRF Operations Conductor (OC) and KTF Test Conductor.

b. The MFSO must have available the following two-way communication links to monitor:

(1) Command Control Transmitter (CCT) circuit (between the Site Controller and the transmitter sites),

(2) Radar Control Coordinator (RCC) circuit (between the RCC at PMRF and radar sites assigned to track the NTW TBMD target vehicle).

3. **Range Safety Support Instrumentation Requirements**

The following range instrumentation requirements provide the MFSO with necessary realtime in-flight missile status data and flight termination capability to ensure that the safety criteria for the operation is met with minimal risk to the program. Specific instrumentation details and support assignments are delineated in the scenario specific annex to this RSOP.

a. Flight Termination: CCT (UHF) systems at Kokee and KTF will be controlled remotely from the MFSO console located in the T&C spaces at PMRF. The CCT panel at the MFSO console has the capability to control and automatically cycle between the multiple CCT systems. Each CCT system consists of a dual 1 KW transmitter pair with automatic failover. The following standard command tones (modulated on a carrier of 407 Mhz (typically), with +/- 30 Khz deviation) are used for the NTW TBMD target:

Command	IRIG Tones	Frequency	Purpose
Monitor	5	12.14 Khz	FTR check (pre-launch)
Optional	2 & 5	8.46 & 12.14 Khz	FTR check (pre-launch)
Arm	1 & 5	7.50 & 12.14 Khz	1st step in FTS sequence (also used in FTR check)
Terminate	1 & 2	7.50 & 8.46 Khz	Following the removal of tone 5, applying tone 2 initiates flight termination.

Note: Flight termination can only be commanded via the UHF link; there is no automatic flight termination feature.

b. Displays: Geographic displays providing present position and IIP track of the NTW TBMD target vehicle as well as NTDS/radar track of all participants and non-participants operating near the NTW TBMD target hazard area during the operation must be available at the MFSO console. The hazard areas and flight termination lines (defined in the scenario specific annex) must be incorporated into these geographic displays.

c. Telemetry: Realtime telemetry data will be processed and made available to Range Safety as follows:

(1) FTS and missile performance data displayed on strip charts for the Missile Flight Safety Analyst (MFSA) at Makaha Ridge,

(2) FTS and missile health data displayed either on CRT or strip charts at KTF for the Range Safety Monitor during pre-launch checks,

(3) FTS and missile performance data displayed on CRT's at the MFSO console in the T&C spaces at PMRF,

(4) IIP and present position track (generated by TM state vector data) displayed on a geographic presentation at the MFSO console.

d. Radar: C-band (transponder) and skin track is required throughout the operation. This track data as well as derived IIP track will be displayed on a geographic presentation at the MFSO console.

e. Skyscreens: Skyscreens are devices used to provide a frame of reference for the Range Safety Visual Observers--who visually track the vehicle, providing commentary to the MFSO. On the vertical, transparent plane of the skyscreen are traces of the nominal trajectory (approximately 20 seconds) and flight limit lines. The two visual observers will be set up at surveyed positions backrange (Back-Azimuth) and crossrange of the missile's flyout azimuth.

f. Launch Pad Video: Video coverage of the launch pad (consistent with RFCO policy) must be displayed in the T&C spaces.

4. **Range Safety Personnel**

a. Missile Flight Safety Officer: A Missile Flight Safety Officer is required in the T&C room for each operation to direct and coordinate all aspects of missile flight safety, which includes enforcing the flight termination criteria defined in paragraph 10.

b. Assistant Missile Flight Safety Officer (AMFSO): The AMFSO will assist the MFSO at the MFSO console, primarily monitoring FTS and vehicle performance via telemetry CRT displays.

c. Missile Flight Safety Analyst (MFSA): The MFSA, located at Makaha Ridge, will monitor realtime telemetry via strip charts, reporting pre-launch FTS checks and system status, as well as providing continuous verbal reports to the MFSO on vehicle performance throughout flight.

d. Range Safety Monitor (RSM): The RSM will be present at the launch complex at KTF to witness any pre-mission FTS tests as well as during the final countdown, reporting to the MFSO results of pre-launch FTS checks and status of the S/A.

e. Visual Observers: Two Visual Observers located backrange and crossrange of the flight profile, will provide commentary to the MFSO on missile performance. The skyscreens provide a reference for such evaluation.

5. **Hazard Area**

The surface hazard areas and associated hazardous airspaces are defined as those regions within which the risk to personnel resulting from NTW TBMD target operations exceed those maximum levels mandated in reference (e) or exceed those specified in reference (f). These areas are trajectory dependent and therefore defined in the scenario specific annex to this RSOP.

a. Launch Hazard Area: The launch hazard area is that area within which the risk from a malfunctioning missile in early flight is unacceptable.

b. Ground Hazard Area: The ground hazard area (consistent with the definition in reference (e)) is that area overlying land in the vicinity of the launch pad within which all potentially hazardous debris resulting from a missile malfunction or flight termination action will be contained (regardless of casualty expectation analysis). This potentially hazardous debris includes inert debris impacting the earth with a kinetic energy equal to or greater than 11 ft-lbs. The GHA is defined graphically in the scenario specific annex and must be contained within or defined by the Restrictive Easement Area as specified in reference (e).

c. Terminal Hazard Area: The terminal hazard area is a composite of the 3-sigma dispersion of a nominally performing vehicle and the fragment impact probability density contours resulting from flight termination action of a malfunctioning vehicle.

d. Hazardous Airspaces: The hazardous airspaces are those volumes above the surface hazard areas, extending to unlimited altitude.

6. **Range Clearance**

The hazard area and hazardous airspaces (as defined in paragraph 5) must remain clear of all contacts from launch until it has been determined that the NTW TBMD target and any associated hazardous debris has impacted or, in the case of the launch area, no longer poses a threat. Only the RFCO has the authority to release clearance.

7. **Range Safety System Tests**

Throughout missile build up and mission preparation, system tests of the NTW TBMD target vehicle and of the range instrumentation systems are conducted. The following are those in which Range Safety must witness or participate:

a. FTR certification: The flight termination receivers will be certified by NAWCWPNS (or authorized agency) prior to installation in the NTW TBMD target vehicle. Certification is valid for 1 year.

b. FTS Systems Test: an end-to-end test of the FTS performed before final missile assembly.

c. Pre-launch FTS checks: Prior to launch, the Optional and Arm commands will be sent from the MFSO console and the receipt of these commands verified via telemetry (and FTS umbilical at the GSP).

d. Mission Readiness Test (MRT): The MRT is essentially a mission dress rehearsal in which PMRF, KTF and all support agencies will participate. It will follow the mission launch countdown script, where all range instrumentation systems, including those in paragraphs 2 and 3, will be thoroughly tested.

8. **Restrictions**

a. Weather

(1) Wind: Wind data up to 100 kft will be collected at various times prior to launch to accurately measure winds aloft. This data will be analyzed to determine if any potentially hazardous debris will impact beyond the established ground hazard area in the event of missile breakup or flight termination action. If the potential of such a violation of the GHA exists, the launch will be held until acceptable wind conditions prevail. The final wind data must be taken no more than 2 hours before intended launch.

(2) Visibility: The Visual Observers must have clear visual sight of the missile from launch until at least 20 seconds of flight. This equates to a 2 nm visibility, with a 10 kft ceiling.

b. Flight: The approved nominal trajectory, on which the Range Safety analysis is based, will be provided by Orbital Science Corporation (OSC) or authorized agency and referenced in the scenario specific annex to this RSOP.

9. **Emergency Procedures**

a. Pre-launch: A "HOLD" will be issued if any of the Range Safety requirements or provisions set forth in this RSOP or the governing annex are not met. It is the responsibility of any participant who observes an unsafe condition, inoperative system or questionable item to call a HOLD. The following items constitute HOLD conditions:

(1) There are unauthorized persons within the ground hazard area.

(2) An unauthorized ship or aircraft will violate a hazard area or hazardous airspace (as defined in paragraph 5) during the operation.

(3) It is determined that whales or other sensitive species will be exposed to an unacceptable risk (i.e. within the launch hazard area in close proximity to the launch pad, or within the terminal hazard area and in close proximity to the predicted impact point). This determination is made by the RFCO and/or PMRF Environmental personnel.

(4) There is reason to believe that critical range instrumentation may not be functioning properly. This includes all CCT, Radar and TM systems and related subsystems.

(5) There is reason to believe that critical missile components may not be functioning properly. This includes, but is not limited to, the radar transponder (C-band beacon), guidance and control system, and the telemetry and flight termination systems.

(6) FTS battery voltage (of either battery) falls below the 28 volt nominal.

(7) Severe weather conditions exist that may adversely affect critical range instrumentation.

(8) Weather criteria specified in paragraph 8 are not met.

b. In-flight: The following are emergency procedures to be followed in the event failures or anomalies develop in critical instrumentation during missile flight.

(1) Command destruct panel fails:

(a) Initiate manual (non-sequencing) operation mode,

(b) Designate the secondary computer as primary (in the control/sequencing PC system),

(c) Transfer control to the secondary PC system (or to the Serial Data Controller (SDC) System, if still in operation),

(d) Site Controller (SC) verbally direct action to Site Operator.

(2) Track display fails:

(a) Have appropriate personnel check the systems (Site IDs (SID), Vehicle IDs (VID), etc.),

(b) if confidence in TM has been established, rely on the telemetry strip chart monitor (MFSA) and G&C personnel in the LOB to provide verbal commentary,

(c) if track data cannot be restored within 5 seconds, flight termination will be commanded in accordance with paragraph 10.c.

10. **Flight Termination Criteria**

Flight termination will be initiated at the discretion of the MFSO under the following conditions (all parameters and track limits defined in the scenario specific annex to this RSOP):

a. The missile IIP track violates the defined limits.

b. The Visual Observers report a radical departure from the anticipated flight path or, in the absence of tracking data at the MFSO console, a violation of the flight limit lines.

c. 5 second loss of all tracking and telemetry data after approximately 20 seconds of flight (i.e. beyond the range of the VOs).

d. Telemetered data indicates the flight termination battery voltage of both systems has reached the minimum operational level (24 volts).

e. Circumstances indicate missile flight may not be safely continued.

11. **Additional Requirements**

a. Approval for each NTW TBMD target scenario will be issued under separate cover as an annex to RSOP 3-98. At least 30 days prior to the scheduled operation, the mission parameters must be submitted to NAWCWPNS Range Safety Office as well as other designated support agencies so that the necessary analysis can be completed and the scenario specific annex generated and disseminated. These mission parameters include nominal and expected off nominal trajectory data (as presented in reference (g)), as well as any system modifications, etc. The following is a list of parameters required by Range Safety:

(1) Nominal trajectory data (with clearly defined coordinate system).

(2) Predicted 3-sigma dispersion about the nominal trajectory (presented as trajectory data in the same format as the nominal).

(3) Maximum turn analysis: Maximum excursions from the nominal trajectory presented as state vectors starting at times 0, 2, 4...12, 15, 20...60 seconds, applied for 10 seconds or until the alpha-q limit of 100,000 psf-deg is reached (the point at which vehicle breakup is expected). The direction the turns are applied must cover the up, down, up-right/left, right/left, and down-right/left pitch/yaw cases. If the data provided in

reference (g) is deemed sufficient, submittal of this data is not required.

(4) Failure mode analysis: Trajectories off the nominal resulting from identified failure modes, applied every 2 seconds (along the nominal) for a duration 10 seconds or until the 100,000 psf-deg is reached.

(5) Fragment impact probability density functions and casualty expectation contours resulting from flight termination. If insignificantly different from a previous analysis, submit a statement to that effect or resubmit the previous analysis.

b. PMRF must dedicate at least three hand-held radios (walkie-talkies) for use by the VO's throughout the operation.

c. PMRF must coordinate all NTW TBMD target activities within the restrictive easement area or applicable areas adjacent to it with the Kekaha Sugar Co. and other organizations with rights over these lands.

12. **Review**

Authority to waive any portion of the Safety Criteria presented in this RSOP rests solely with the Range Safety Officer, the Range Commander or designated representative. In no case will such waivers involve the compromising or relaxing of the basic tenants of Missile Flight Safety as stated in paragraph 1 (they may however introduce greater risk to the success of mission). If a request for waiver of specific criteria is anticipated, such request should be submitted at least five working days prior to the scheduled operation to ensure sufficient time for complete review.

13. **Environmental Restrictions**

Additional conditions or constraints may be required by the PMRF Environmental Division (Code 7031-5), to ensure that tests are in compliance with environmental regulations. All projects and programs must have environmental documentation. It is the responsibility of the program manager to ensure that the Environmental Division has been provided copies of the applicable program documentation. The program manager is also responsible for ensuring that any special requirements have been identified, provisions for compliance have been established and the OC has been adequately briefed before a scheduled operation.

Unless otherwise stated, NTW NTBD target operations will be conducted in compliance with all applicable stipulations and mitigation measures required by reference (e).

14. **Disclaimer**

The safety and operational environments in an on-range, controlled scenario are quite different than those of a lesser controlled situation. PMRF uses specialized instrumentation and a trained, experienced and independent organization to provide operational safety, command and control. This RSOP should only be used as intended at this designated location.

15. **Automatic Suspension**

As a result of NTW TBMD target operations, should hazardous debris (as defined in paragraph 5.b) impact land outside of the GHA or any other provisions of this RSOP be violated, this RSOP is automatically suspended with reinstatement contingent on a thorough investigation.

NTW TBMD Target Vehicle Design Overview
(taken from reference (b))

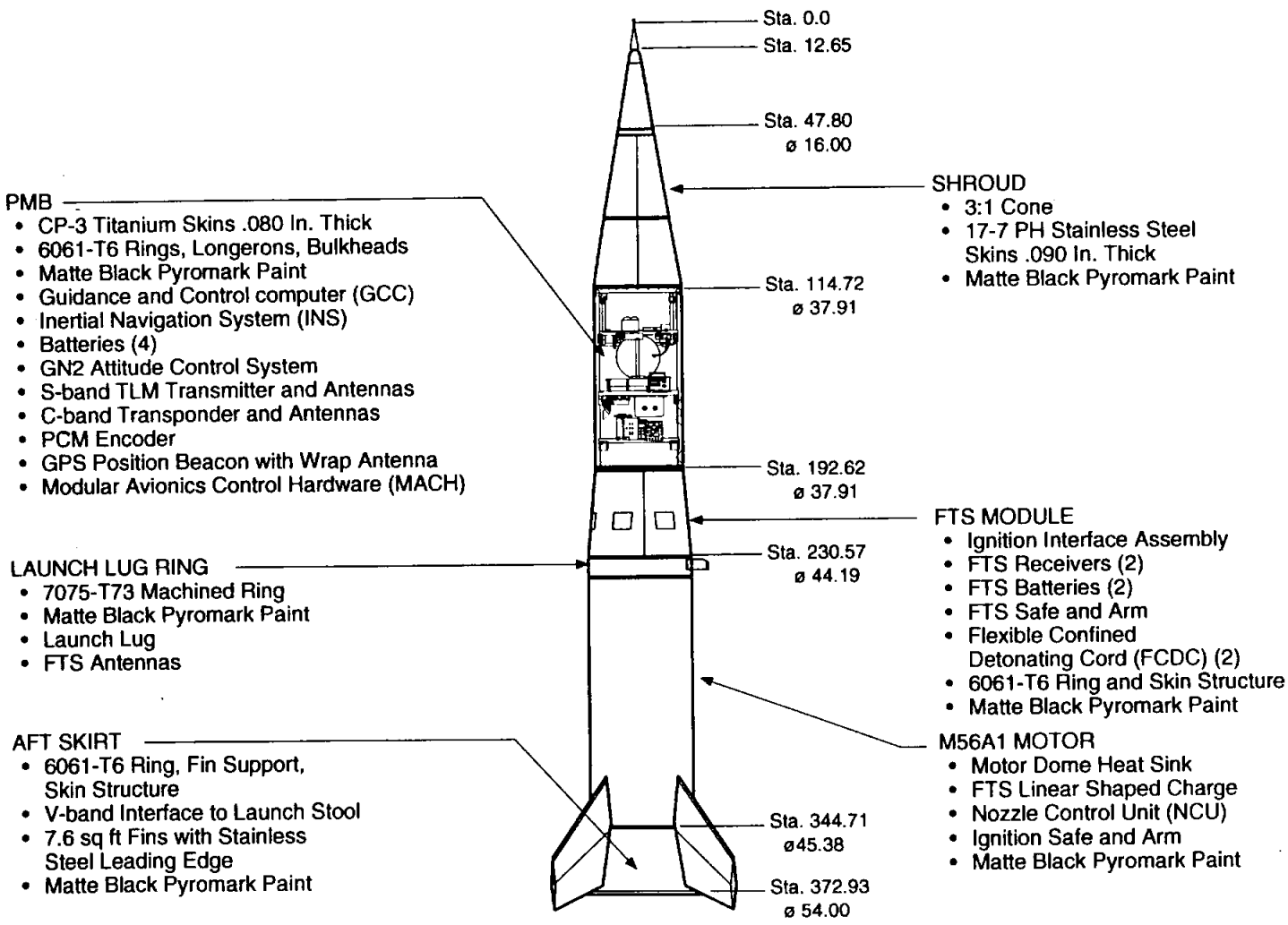

Figure 1
RSOP 3-98

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IN REPLY REFER TO:

5100
Ser 521300E/A-3081
27 OCT 1998

From: Commander, Naval Air Warfare Center Weapons Division, Point Mugu
To: Commanding Officer, Pacific Missile Range Facility

Subj: ANNEX A TO RANGE SAFETY OPERATIONAL PLAN 3-98

Ref: (a) NAWCWPNS ltr 5100 Ser 521300E/A-2883 of 30 Sep 98

Encl: (1) Annex A to RSOP 3-98 for Navy Theater Wide (NTW) Theater Ballistic Missile Defense (TBMD) Target Test Vehicle Operation TTV-1

1. Enclosure (1) is forwarded in accordance with reference (a) and provides the mission specific range safety requirements, procedures, and criteria for the TTV-1 operation.

W. L. BRUTON
By direction

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Sandia National Laboratories (Dept. 9115 (2), 2419 (2))
USASMDC (LTC J. Matthewson, R. Gonzales)

ANNEX A

TO RSOP 3-98

FOR

NAVY THEATER WIDE (NTW) THEATER BALLISTIC MISSILE DEFENSE (TBMD)
TARGET TEST VEHILE OPERATION TTV-1

23 October 1998

Prepared by: _____
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Approved by: _____ for
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ACRONYMS AND SPECIAL NOMENCLATURE

Word/Acronym	Definition
AGC	Automatic Gain Control
AMFSO	Assistant Missile Flight Safety Officer
BETA	Ballistic Coefficient, W/C_DA; lb/ft^2
CCT	Command Control Transmitter (Command Destruct Transmitter)
CDR	Command Destruct Receiver
CRT	Cathode Ray Tube
FTR	Flight Termination Receiver
FTS	Flight Termination System
GHA	Ground Hazard Area
IIP	Instantaneous Impact Point
Khz	Kilohertz
KW	Kilowatt
MFSO	Missile Flight Safety Officer
Mhz	Megahertz
NAWCWPNS	Naval Air Warfare Center Weapons Division
OC	Operations Conductor
PMRF	Pacific Missile Range Facility
ROCC	Range Operations Control Center
RSOP	Range Safety Operational Plan
SDC	Serial Data Controller
SID	Sensor IDentification
SPARS	Sensor Position And Readback System
T&C	Tracking and Control (control spaces at PMRF)
TM	Telemetry
UHF	Ultra High Frequency
VO	Visual Observer

REFERENCES

a. Range Safety Operational Plan 3-98 for the Navy Theater Wide (NTW) Theater Ballistic Missile Defense (TBMD) Target at the Pacific Missile Range Facility (PMRF) of 30 Sep 1998.

b. NTW-ALI TTV Program Flight Safety Data Report, Orbital Sciences Corporation of 12 Aug 1998.

c. Trajectory Release 5 of 7 Oct 98.

d. Hazard Assessment for Navy Theater Wide Target Test Vehicle, Sandia national Laboratories of November 1998.

e. Final Environmental Impact Statement for the Restrictive Easement Kauai, Hawaii of Oct 93.

f. Navy Theater Wide (NTW)-ALI Target Test Vehicle (TTV) Program PCM Telemetry Format, TM-14245 Rev A, Orbital Sciences Corporation of 17 Sep 98.

5100
521300E
23 Oct 98

ANNEX A
TO RSOP 3-98
FOR
NTW TBMD Target Test Vehicle Operation TTV-1

1. **Introduction** This Annex is supplied as a supplement to the basic RSOP 3-98 covering TBMD NTW vehicles launched at PMRF Kauai, Hawaii (reference (a)). It details the Range Safety requirements and procedures specific to the TTV-1 mission as defined in reference (b).

2. **Mission Parameters**

a. TTV-1 Launcher (Pad 1): 22° 03' 33.33" N, 159° 46' 54.80" W (22.059259 N, 159.781892 W) and 87.438 ft geodetic altitude (WGS-84).

b. Flight Azimuth: 330° T

c. Nominal Apogee: 1,056,502 ft (322.006 km) altitude, 133.3 nm downrange (23.938965° N, 161.076865° W) at t+309 sec.

d. Nominal Impact Point: 25° 50' 13" N, 162° 24' 23" W (25.83707, 162.406303), 268.0 NM downrange at t+612.72 sec.

e. Trajectory designator: Release 5 (reference (c)).

3. **Hazard Areas**

a. Hazard Area: Defined in Table 1 and depicted in Figure 1. The dimensions of this area reflect the risk analysis of reference (d).

b. Hazardous Airspace: Bounded by the points defined in Table 2 and depicted in Figure 2, extending to unlimited altitude.

c. Ground Hazard Area: This exclusion zone for all non-essential personnel is defined by the Restrictive Easement Area (reference (f)). The coordinates are presented in Table 4 and depicted geographically in Figure 3.

4. **Range Safety Hold Fire Criteria** The following supplements but does not replace paragraphs 8.a and 9.a of reference (a):

a. Wind: Debris impact analysis (based on winds measure up to 100 kft) indicates a potential violation of the ground hazard area. In this analysis six classes of fragments are considered: aft dome, forward dome (1/4), PMB and shroud, Cylindrical Section (case fragments with propellants), bolt and rivet fragments, and fins.

b. Visibility: A minimum 2 nm visibility with a 10,000 ft ceiling is required for the visual observers,

c. FTS battery voltage of either battery falls below 28 volts,

d. loss of C-band radar beacon,

e. failure of the S/A device,

f. loss of telemetry,

g. anomalies in range instrumentation adversely affecting Range Safety,

h. unauthorized personnel in the GHA,

i. unauthorized ship or aircraft in the hazard area or hazardous airspace.

5. **Flight Termination Criteria** The following supplements but does not replace paragraph 10 of reference (a):

a. Radar or telemetry generated Instantaneous Impact Prediction (IIP) track violates the IIP Destruct Boundary as defined in Table 3 and depicted in Figure 2. The IIP is computed using a fixed ballistic coefficient (beta) of 150 lb/ft^2.

b. During powered flight, a 5 second loss of all tracking data.

c. Both FTS battery voltages drop to 24 volts.

d. Visual Observer(s) report a radical departure from the anticipated flight path or, in the absence of tracking data at the MFSO console, a violation of the flight limit lines depicted in Appendix C.

6. **Data Displays**

a. NTADS: Geographic display of radar and telemetry generated present position and IIP track (beta = 150 lb/ft^2).

b. Strip Charts: Two 8-pen analog strip chart banks will display telemetry (TM) data realtime at Makaha Ridge. See Appendix B.

c. System 90: The System 90 (dual EMR/Loral System 90 Telemetry Processing System) will process incoming telemetry data from Makaha Ridge and display the realtime information on CRTs at the MFSO console in ROCCS Alpha. Appendix A defines parameters to be displayed.

7. **Review** This annex was based on data provided in references (b), (c), and (e); any changes to the trajectory or other aspects of the mission may invalidate this annex or RSOP 1-98. Modifications that could impact the Range Safety aspect of the mission must be submitted in writing to the NAWCWPNS Range Safety Office.

TABLE 1: Points that define the TTV-1 Hazard Area

1.	26.25415° N, 162.72202° W	26° 15′ 15″ N, 162° 43′ 19″ W
2.	26.25916° N, 162.44352° W	26° 15′ 33″ N, 162° 26′ 37″ W
3.	25.42625° N, 161.54669° W	25° 25′ 35″ N, 161° 32′ 48″ W
4.	26.05546° N, 161.22294° W	25° 03′ 20″ N, 161° 13′ 23″ W
5.	23.59248° N, 160.25527° W	23° 35′ 33″ N, 160° 15′ 19″ W
6.	22.79381° N, 159.95476° W	22° 47′ 38″ N, 159° 57′ 17″ W
7.	22.31660° N, 159.73749° W	22° 19′ 00″ N, 159° 44′ 15″ W
8.	22.17660° N, 159.73529° W	22° 10′ 36″ N, 159° 44′ 07″ W
9.	22.07377° N, 159.91520° W	22° 04′ 26″ N, 159° 54′ 55″ W
10.	22.14212° N, 160.04707° W	22° 08′ 32″ N, 160° 02′ 49″ W
11.	22.53252° N, 160.40981° W	22° 31′ 57″ N, 160° 24′ 35″ W
12.	23.12304° N, 161.06150° W	23° 07′ 23″ N, 161° 03′ 41″ W
13.	24.51248° N, 162.13499° W	24° 30′ 45″ N, 162° 08′ 06″ W
14.	24.93187° N, 162.37634° W	24° 55′ 55″ N, 162° 22′ 35″ W
15.	26.02545° N, 162.83731° W	26° 01′ 32″ N, 162° 50′ 14″ W

TABLE 2: Points that define the TTV-1 Hazardous Airspace

1.	26.25415° N, 162.72202° W	26° 15′ 15″ N, 162° 43′ 19″ W
2.	26.25916° N, 162.44352° W	26° 15′ 33″ N, 162° 26′ 37″ W
3.	26.09007° N, 162.10693° W	26° 05′ 24″ N, 162° 06′ 25″ W
4.	25.47098° N, 161.38953° W	25° 28′ 16″ N, 161° 23′ 12″ W
5.	24.72259° N, 160.75832° W	24° 43′ 21″ N, 160° 45′ 30″ W
6.	23.42480° N, 160.02711° W	23° 25′ 29″ N, 160° 01′ 38″ W
7.	22.93390° N, 159.80361° W	22° 56′ 02″ N, 159° 48′ 13″ W
8.	22.59040° N, 159.68810° W	22° 35′ 25″ N, 159° 41′ 17″ W
9.	22.21009° N, 160.33658° W	22° 12′ 36″ N, 160° 20′ 12″ W
10.	22.45449° N, 160.62048° W	22° 27′ 16″ N, 160° 37′ 14″ W
11.	22.85078° N, 161.00388° W	22° 51′ 03″ N, 161° 00′ 14″ W
12.	24.00446° N, 161.97568° W	24° 00′ 16″ N, 161° 58′ 32″ W
13.	24.83576° N, 162.46379° W	24° 50′ 09″ N, 162° 27′ 50″ W
14.	25.67955° N, 162.79930° W	25° 40′ 46″ N, 162° 47′ 57″ W
15.	26.02545° N, 162.83731° W	26° 01′ 32″ N, 162° 50′ 14″ W

TABLE 3: Points that define the TTV-1 IIP Destruct Boundary

1.	25.80206° N, 162.24732° W	25° 48′ 07″ N, 162° 14′ 50″ W
2.	25.58475° N, 161.92796° W	25° 35′ 05″ N, 161° 55′ 41″ W
3.	24.56254° N, 160.98995° W	24° 33′ 45″ N, 160° 59′ 24″ W
4.	22.07911° N, 159.77471° W	22° 04′ 45″ N, 159° 46′ 29″ W
5.	22.05970° N, 159.77580° W	22° 03′ 35″ N, 159° 46′ 33″ W
6.	22.05673° N, 159.78023° W	22° 03′ 24″ N, 159° 46′ 49″ W
7.	22.05448° N, 159.78513° W	22° 03′ 16″ N, 159° 47′ 06″ W
8.	22.06269° N, 159.80402° W	22° 03′ 46″ N, 159° 48′ 14″ W
9.	24.16549° N, 161.67792° W	24° 09′ 56″ N, 161° 40′ 41″ W
10.	25.30766° N, 162.39151° W	25° 18′ 28″ N, 162° 23′ 29″ W
11.	25.70406° N, 162.42081° W	25° 42′ 15″ N, 162° 25′ 15″ W

TABLE 4: Points that define the TTV-1 Ground Hazard Area

1.	22.803° N, 159.762° W	22° 48′ 11″ N, 159° 45′ 43″ W
2.	22.071° N, 159.753° W	22° 04′ 16″ N, 159° 45′ 11″ W
3.	22.049° N, 159.754° W	22° 02′ 56″ N, 159° 45′ 14″ W
4.	22.038° N, 159.765° W	22° 02′ 17″ N, 159° 45′ 54″ W
5.	22.036° N, 159.773° W	22° 02′ 10″ N, 159° 46′ 23″ W
6.	22.038° N, 159.786° W	22° 02′ 17″ N, 159° 47′ 10″ W

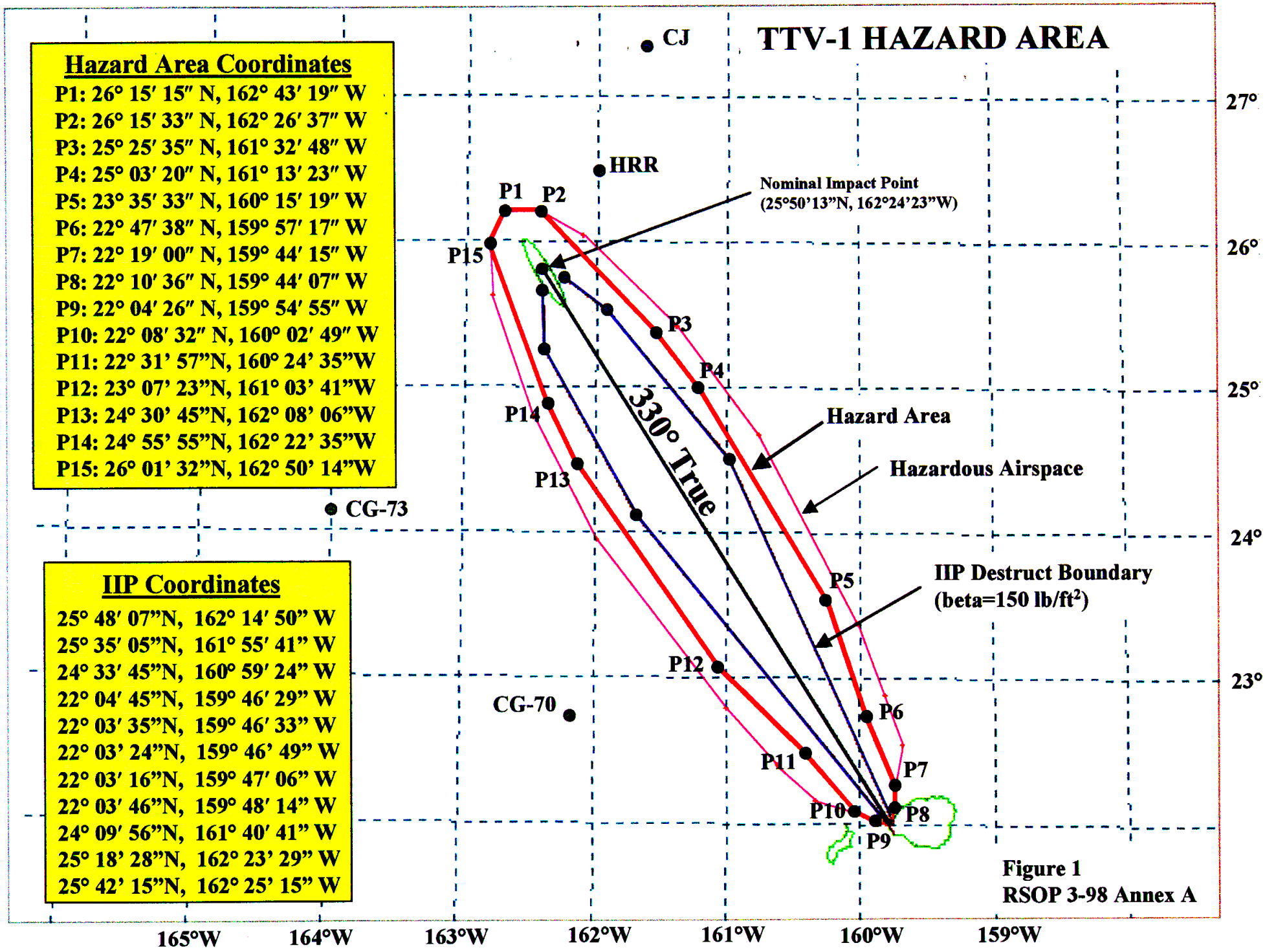


Figure 1
RSOP 3-98 Annex A

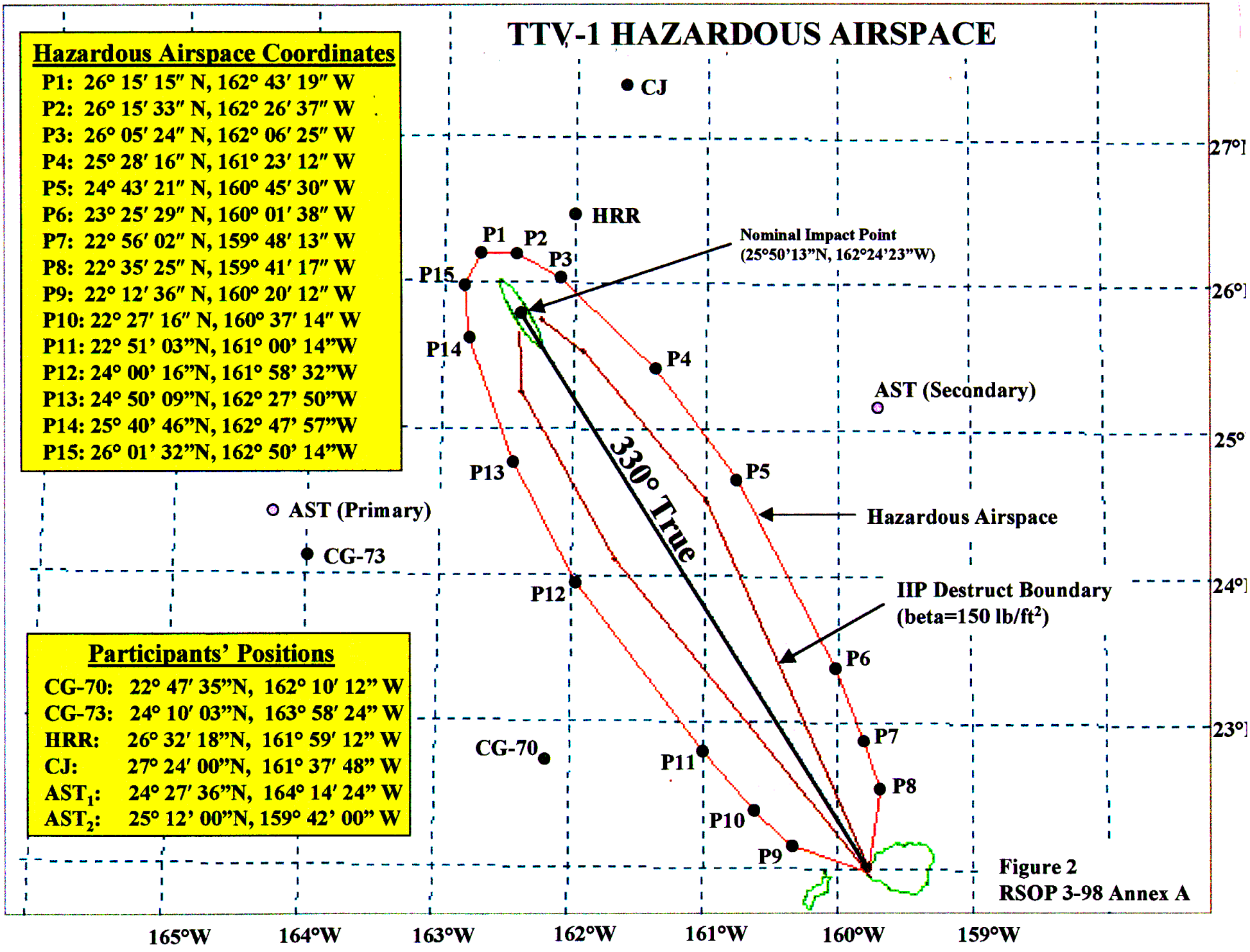


Figure 2
RSOP 3-98 Annex A

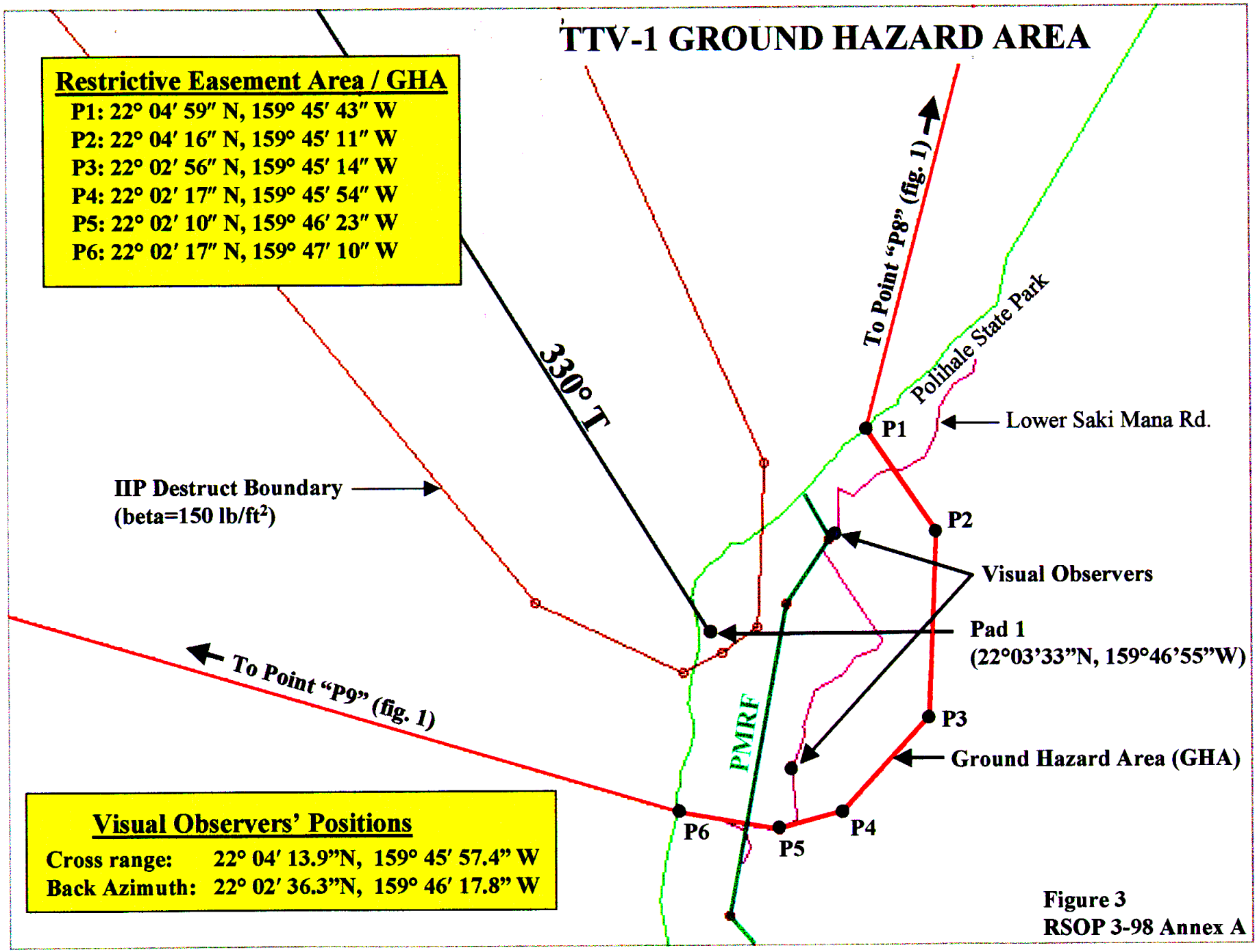


Figure 3
RSOP 3-98 Annex A

Appendix A. Makaha Ridge Strip-Chart Display Requirements

Table A-1 lists the TTV-1 telemetry functions that are to be monitored at two reserved strip-chart banks at Makaha Ridge. A detailed description of the frame format as well as word location and data ranges is referenced in the TTV PCM Telemetry Format (TM-14245 REV-A) of September 17, 1998.

Table A-1. Makaha Ridge Strip-Chart Setups for 'ait'

Bank	Pen	ID	Parameter	Range 0%	Range 100%	Units	Notes
1	1	FT001	FTS Batt A Voltage	0	40	Volts	
1	2	FT003	FTS Batt B Voltage	0	40	Volts	
1	3	FT013_0	FTS S/A Arm Mon	1	0	Logical	0=ARM; 1=SAFE
1	4	FT007	Tone 1 Combined	0	20	Volts	Sum both parameters
		FT010					
1	5	FT008	Tone 2 Combined	0	20	Volts	Sum both parameters
		FT011					
1	6	FT009	Tone 5 Combined	0	20	Volts	Sum both parameters
		FT012					
1	7	FT005	FTS RCVR A AGC	0	5	Volts	
1	8	FT006	FTS RCVR B AGC	0	5	Volts	
2	1	GC107_5	Umbilical Pull	0	1	Logical	1=UMB PULL
2	2	BD006	Motor Pressure	0	500	psi	
2	3	LI2	Hybrid Pitch	-90	90	Degrees	
2	4	LI3	Hybrid Roll	-180	180	Degrees	
2	5	LI12	Hybrid Heading	-180	180	Degrees	
2	6	LI44	Hybrid Altitude (fine)	0	100	Kft	See Note 1
2	7	GS005	Mission Time (coarse)	0	500	Kft	See Note 2
2	8	GS005	Mission Time	0	60	Sec	See Note 3

Note 1. Altitudes greater than 100kft shall wrap-around to the 0% level. For example: 5k, 105k, 205k, 305k, etc will be indicated by a pen level of 5%.

Note 2. Altitudes greater than 500kft shall wrap-around to the 0% level. For example: 100k, 600k, 1100k, etc will be indicated by a pen level of 20%.

Note 3. Mission time will be negative prior to launch. In order to display it as a positive value, the absolute value of Mission Time (ABS(GS005)) shall be used for display at this strip-chart location.

Appendix B. MFSO Console Display Requirements

The Missile Flight Safety Officer (MFSO) shall be provided with computer generated displays that use telemetry input to continuously update the status and health of the TTV vehicle. The MFSO shall have two CRT monitors: one for displaying telemetry in the graphical format described below as the TM Page and the other for displaying track locations on a geographical background described below as the Map Page(s).

The telemetry source is a single PCM link from the TTV missile. Descriptions of the frame formats and available measurements from TM are contained in the TTV PCM Telemetry Format (TM-14245 REV-A of 30 Nov 1998 by Orbital Sciences Corporation) reference document.

TM Page. The TM page shall be laid out in a configuration similar to that of Figure B-1. The animation of individual objects and range of values for the measurements are described in Table B-1.

Map Page. The general Map page shall include provisions for two Instantaneous Impact Prediction (IIP) tracks and two missile telemetry tracks. These tracks will be provided to NTADS in a Geodetic Latitude (°N), Longitude (°E) and Altitude (ft) format for position. Missile velocity will be provided to NTADS in a East, North, Up Earth tangent plane coordinate frame referenced to the current position in units of feet per second. IIP tracks will not have an associated velocity.

The general Map page background shall include PMRF and the surrounding Hawaiian Islands. It shall also include a nominal TTV vehicle trajectory as well as the associated Hazard Areas and IIP limit lines described in Paragraph 5 of this Annex.

Table B-1. MFSO TM Page Parameters (Use with Figure B-1)

Page Area	Parameter	Display Type	Value	Display Function
FTR A TONES				
	FT009	Toggle light	>5	Green fill
			<5	Grey fill
	FT008	Toggle light	>5	Green fill
			<5	Grey fill
	FT007	Toggle light	>5	Green fill
			<5	Grey fill
AGC	FT005	Float	f4.2	Updated continuously
		Bar graph	>1.5V	Upper bar is green
			<1.5	Upper bar turns red
VOLTAGE	FT001	Float	f4.1	Updated continuously
		Bar graph	>28	Upper bar-green fill
			<28 AND >24	Upper bar-yellow fill
			<24	Upper bar-red fill
FTR B TONES				
	FT012	Toggle light	>5	Green fill
			<5	Grey fill
	FT011	Toggle light	>5	Green fill
			<5	Grey fill
	FT010	Toggle light	>5	Green fill
			<5	Grey fill
AGC	FT006	Float	f4.2	Updated continuously
		Bar graph	>1.5V	Lower bar is green
			<1.5	Lower bar turns red
VOLTAGE	FT003	Float	f4.1	Updated continuously
		Bar graph	>28	Lower bar-green fill
			<28 AND >24	Lower bar-yellow fill
			<24	Lower bar-red fill
S/A STATUS				
INT POWER A	FT013-3	Alpha	0	Display ON
		Alpha	1	Display OFF
INT POWER B	FT013-2	Alpha	0	Display ON
		Alpha	1	Display OFF
FTS S/A	FT013-0	Alpha	0	Display ARM
ALTITUDE				
TTV BCN	RADAR data	Float	f7.0	Updated continuously
TTV LN100	LI44	Float	f7.0	Updated continuously
ITTV GCC	GC131	Float	f7.0	Updated continuously

IGN CMD	GC075-4	Toggle light	0	Green fill
			1	Grey fill
IGNITION	GC073-4	Toggle light	0	Green fill
			1	Grey fill
UMB PULL	GC107-5	Toggle light	0	Grey fill
			1	Green fill
MTR PRESS	BD006	Float	f5.1	Updated continuously
		Bar graph		Cyan fill
Compass Area				
PITCH	90 – LI2	Float	f5.1	updated continuously
		Horizontal bar		moves up and down
ROLL	LI3	Float	f6.1	updated continuously
		Cross		rotates
HDG CMD	GC109	float	f6.1	updated continuously
HDG INS	LI12	float	f6.1	updated continuously
Timing				
IRIG	Zulu Time	date	HH:MM:SS.S	updated continuously
MISSION	GS005	float	f7.1	updated continuously
EVENT	GS008	float	f7.1	updated continuously
Nozzle Pos'ns				
1	BD001	Horizontal bar	>3 OR <-3	Red fill
			<3 AND >-3	Green fill
2	BD002	Horizontal bar		Same as 1
3	BD003	Horizontal bar		Same as 1
4	BD004	Horizontal bar		Same as 1

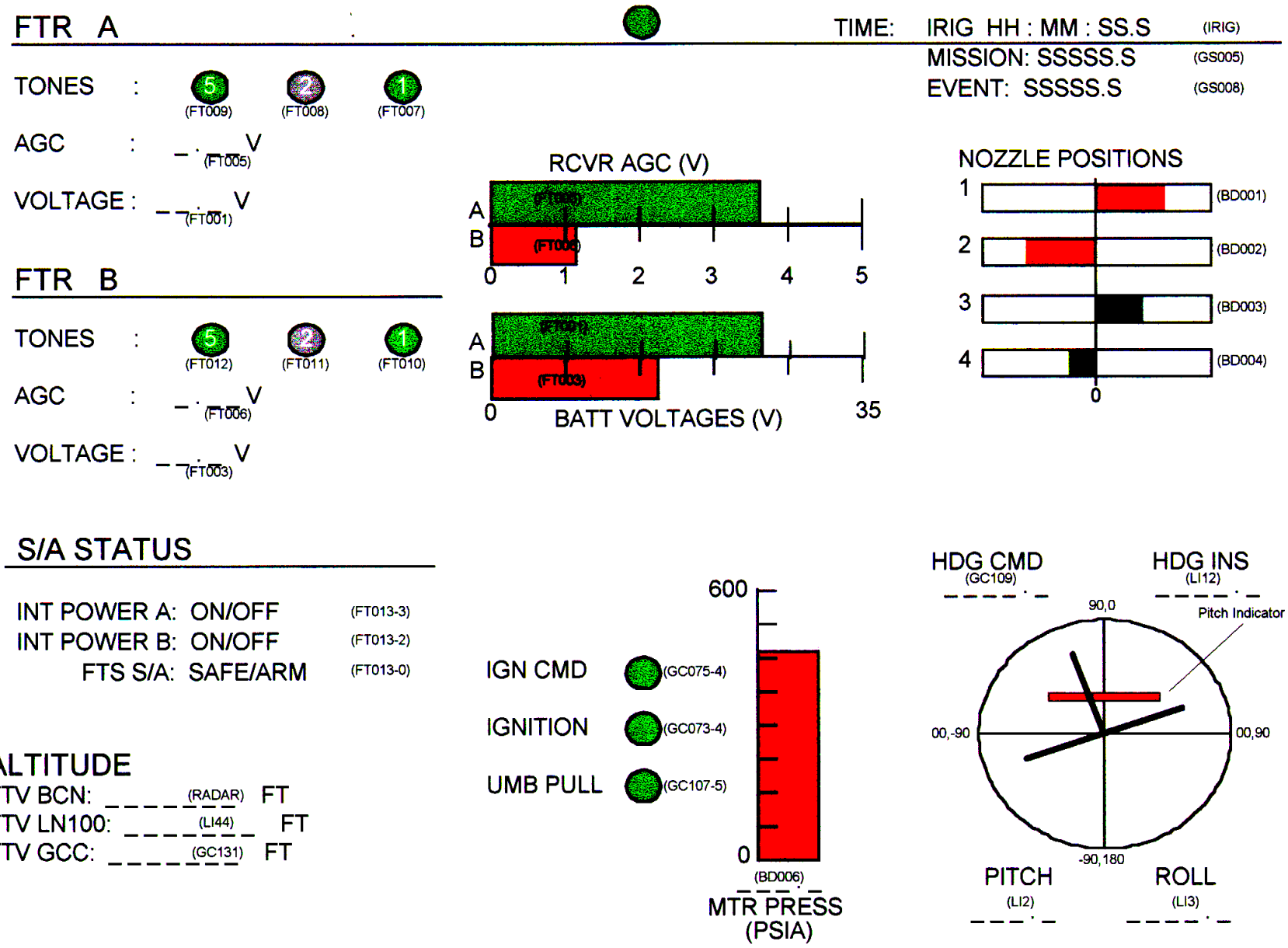
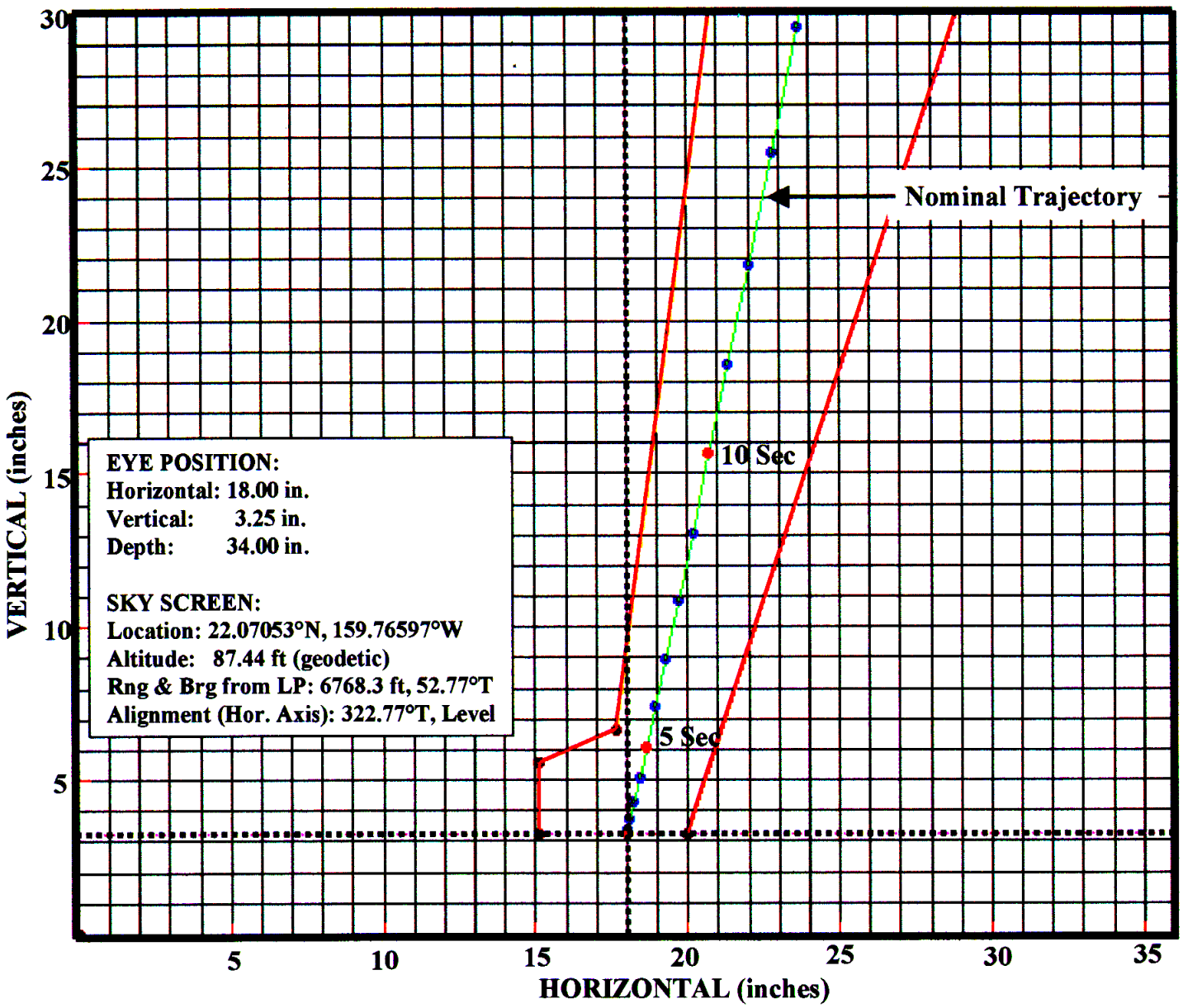


FIGURE B-1. MFSO Telemetry Page Configuration

Appendix C. Sky Screen Requirements

1. Site Location: The back-azimuth and cross-range sky screens are situated (relative to Pad 1) directly back range and perpendicular to the nominal trajectory. Their locations are defined in Figures C-1 and C-1, and depicted geographically in Fig 3.

2. Equipment: The sky screen consists of a 30' X 36" sheet of plexiglass (mounted on a tripod assembly) with an eyepiece located 34" from the screen, providing a view of the vehicle for the first 15 seconds of flight. The sky screens are marked with the nominal trajectory and flight limit lines. See figures C-1 and C-2.



NOMINAL TRAJECTORY

Time (s)	Hor (in)	Ver (in)
0.0	18.00	3.25
1.0	18.03	3.41
2.0	18.10	3.74
3.0	18.23	4.28
4.0	18.42	5.07
5.0	18.65	6.10
6.0	18.94	7.39
7.0	19.29	8.98
8.0	19.70	10.88
9.0	20.18	13.08
10.0	20.72	15.64
11.0	21.33	18.54
12.0	22.02	21.83
13.0	22.78	25.49
14.0	23.64	29.56
15.0	24.61	34.05

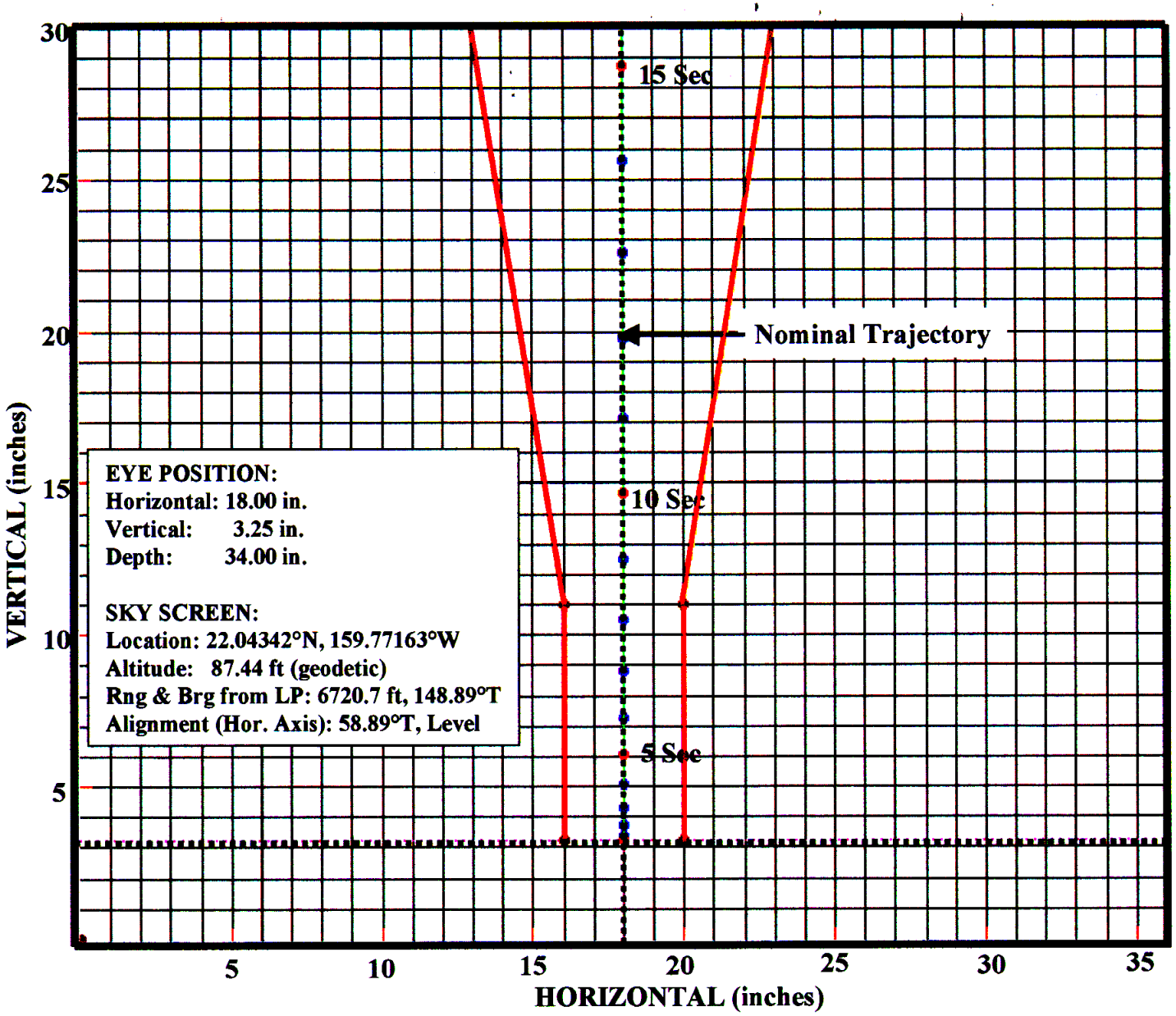
LOWER FLIGHT LIMIT LINE

Point	Hor (in)	Ver (in)
1	20.00	3.25
2	30.00	30.00

UPPER FLIGHT LIMIT LINE

Point	Hor (in)	Ver (in)
1	15.08	3.25
2	15.08	5.58
3	17.64	6.67
4	20.72	30.10

Figure C-1 Sky Screen as Seen by Cross-Range Observer



NOMINAL TRAJECTORY

Time (s)	Hor (in)	Ver (in)
0.0	18.00	3.25
1.0	18.00	3.41
2.0	18.00	3.74
3.0	18.00	4.28
4.0	18.00	5.06
5.0	18.00	6.06
6.0	18.00	7.29
7.0	18.00	8.79
8.0	18.01	10.53
9.0	18.01	12.49
10.0	18.01	14.70
11.0	18.01	17.13
12.0	18.01	19.77
13.0	18.01	22.59
14.0	18.01	25.59
15.0	18.01	28.71
16.0	18.01	31.92

LEFT FLIGHT LIMIT LINE

Point	Hor (in)	Ver (in)
1	16.00	3.25
2	16.00	11.00
3	13.00	30.00

RIGHT FLIGHT LIMIT LINE

Point	Hor (in)	Ver (in)
1	20.00	3.25
2	20.00	11.00
3	23.00	30.00

Figure C-2 Sky Screen as Seen by Back Azimuth Observer