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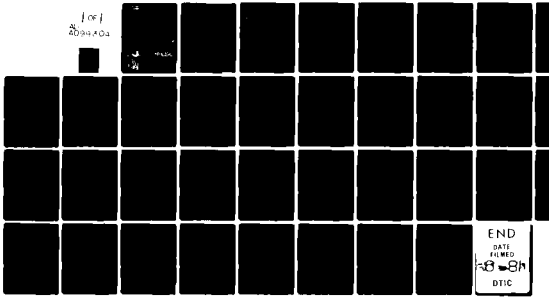

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ACCIDENTAL IMP[illegible] DESCRIPTOR APPLICATION METHODOLOGY

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ENVIRONICS DIVISION
ASSESSMENT TECHNOLOGY BRANCH

AUGUST 1980

FINAL REPORT
31 MAR 1980 – 1 AUGUST 1980

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This report provides the intended user of accidental impact descriptors for Air Force air-to-ground weapon range planning activities a brief summary of their development, the step-by-step procedure for properly applying them, and an example problem. The descriptors are provided in Appendix A. These descriptors show containment contours for significant percentages of impacts resulting from weapon delivery training and weapon tests conducted in the last 12 years. The application methodology is

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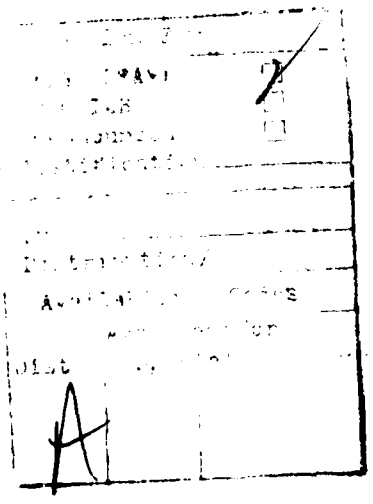
adapted from a previous report and includes qualifications for use of composite descriptors, identification of hazard potential areas, and resolution of land-use conflicts. If the graphical solutions presented in this report do not resolve a particular land-use conflict, further analysis is recommended.



EXECUTIVE SUMMARY

1. OBJECTIVE The objective of this report is to provide a user's guide for properly applying accidental impact descriptors previously developed to identify hazard potential areas on Air Force air-to-ground ranges.

2. APPROACH The descriptor application methodology presented in ESL-TR-79-02, "RACUZ Descriptor Applicator Methodology" is used as the point of departure for defining the procedure to properly apply the Accident Potential Zones previously developed in technical report, ESL-TR-79-41, "Accidental Impact Descriptors for Aircraft Accidents, Incidents, and Inadvertent Ordnance Releases on Air Force Air-To-Ground Ranges." An example problem is presented. Assumptions, limitations, and restrictions on the use of these descriptors are provided.

3. RESULTS Proper application of accidental impact descriptors requires the use of these footprints any time multiple or single passes are comtemplated against any one, or any combination, of the targets listed in this report. These targets include (1) the conventional bombing and rocket target, (2) the practice nuclear weapons delivery target, (3) the strafe target, or (4) the applied tactics (tactical) target on an Air Force air-to-ground gunnery range.

The descriptors presented here represent containment contours oriented with respect to the intended release heading that contain at least the specified percentage of historical impacts resulting from 12 years of previous Air Force air-to-ground accidents, incidents, and inadvertent ordnance releases.

Used singularly, or in any combination of two or more, these descriptors define the hazard potential areas resulting from gross error impacts. These descriptors may be properly combined with previously developed ordnance descriptors that describe the areas subjected to intended ordnance releases. That is, gross error impact descriptors in this report can be combined with intended release impact descriptors to form a combined (composite) descriptor that represents the total hazard potential area subjected to (1) weapons impacts, both intentional and unintentional, (2) inadvertently dropped or jettisoned equipment, aircraft parts and accessories, and finally (3) aircraft crashes on air-to-ground ranges.

These hazard potential areas identify potential land-use conflicts when items of concern are located within the composite descriptor. Resolution of the land-use conflict may be accomplished graphically by:

(1) Orienting descriptors completely within the range boundaries.

(2) Assuring all high value or manned facilities remain outside hazard potential areas.

(3) Relocating items of concern outside hazard potential areas.

(4) Modifying the mission parameters (restricted approach headings, direction of pull-off, etc.).

(5) Moving the target to a more suitable location.

4. CONCLUSIONS If none of the above steps is feasible, then the land-use conflict identified in the appropriate hazard potential area cannot be resolved by this graphical procedure and further analysis is necessary. If the above steps will resolve the land-use conflict, then the area requirements for safety are satisfied.

5. RECOMMENDATIONS Once the resolution of the identified land-use conflict exceeds the graphical solutions presented in this report, other solutions and analysis must be used. Potential for hazardous effects within the composite descriptor should be determined using probability density functions and weapons effects algorithms. Hardening, relocation to less hazardous areas, or other mitigating alternatives should be evaluated and used to reduce the hazards to meet safety requirements.

PREFACE

This report was prepared by the Assessment Technology Group of the Environics Division, Air Force Engineering and Services Laboratory (AFESC/RDVA), Tyndall Air Force Base, Florida 32403, and covers the time period from 31 March 1980 to 1 August 1980.

This report is a follow-on effort to the initial R&D study documented in the technical report, ESL-TR-79-41, "Accident Impact Descriptor for Aircraft Accidents, Incidents and Inadvertent Ordnance Releases on Air Force Air-To-Ground Ranges." The purpose of this report is to provide the intended user of the accidental impact descriptors with: (1) A summary of the development of the accident descriptors, (2) an explanation of how to use the accident descriptors and, finally, (3) a statement of the limitations in their use.

The descriptor application methodology presented here was originally developed by Mr. Donal Myrick of Science Applications, Inc. and published in ESL-TR-79-02, "RACUZ Descriptor Application Methodology," under AF contract F08637-79-M-0114. Modifications or adaptations to the methodology for applying the accidental impact descriptors are included in this report. Full acknowledgement is made of the original authorship, and any modifications presented here merely enhance the methodology or render it more generic in applicability.

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be available to the general public including foreign nationals.

This technical report has been reviewed and is approved for publication.

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SECTION 1

INTRODUCTION

1. BACKGROUND

In the past, the size of Air Force air-to-ground ranges has provided sufficient margin to both meet mission requirement for aircrew training and weapon tests and satisfy public safety considerations. Recent environmental legislation and increased public pressures for access to and shared use of Air Force air-to-ground ranges have demonstrated the inadequacy of current guidance and the need to better define our range area requirements within a certain degree of safety. In addition, the increased sophistication and complexity of today's weapon systems coupled with stand-off, pop-to-delivery tactics have placed increasing demands on the land area requirements for USAF weapon ranges.

To meet these demanding challenges, the Environmental Division, Headquarters Air Force, (HQ USAF/LEEV), established an Air Force program to (1) assess area requirements for air-to-ground ranges, (2) develop policies and procedures to achieve and/or maintain compatible land-uses in the vicinity of ranges and finally, (3) implement the program. Headquarters Air Force Engineering and Services Center (HQ AFESC), Tyndall Air Force Base, Florida was tasked to conduct the research and development portion of the program and to develop implementation plans to achieve the objectives listed.

One of the first tasks was to define the minimum area necessary to conduct air-to-ground weapon delivery events based on aircraft accidents, incidents (dropped objects), and gross error inadvertent ordnance releases. This objective was accomplished by the Assessment Technology Branch, Engineering and Services Laboratory (HQ AFESC/RDVA), and documented in the technical report, ESL-TR-79-41, "Accidental Impact Descriptor for Aircraft Accidents, Incidents and Inadvertent Ordnance Releases on Air Force Air-to-Ground Ranges," September 1979.

This report summarizes the results of that investigation, presents the planning tools developed therein to identify potential land-use conflict areas, and provides a step-by-step procedure with an example problem for applying these descriptors. Finally, specific limitations and assumptions used in the development of these descriptors are presented.

2. REPORT ORGANIZATION

This report is divided into three sections and Appendix A. The three sections address (1) the accidental impact descriptor development, (2) application of the impact descriptor and, finally, (3) assumptions and limitations. Appendix A contains a brief discussion for each of the descriptors and plotted graphs scaled for use on range maps with a scale factor of 1:125,000.

SECTION II

ACCIDENTAL IMPACT DESCRIPTOR DEVELOPMENT

1. DEFINITIONS

Before proceeding with further explanations and example applications, the following definitions are basic to understanding terminology and properly applying the descriptors to identify potential hazards on an air-to-ground range.

Accidental Impact Descriptor - An accidental impact descriptor is a closed contour about a target location with a longitudinal axis aligned with the intended weapon delivery direction. The contour defines the area required to contain at least the specified percentage of historical gross error impacts resulting from unintentional delivery errors or accidents during air-to-ground weapon events.

Gross Error Impact - Gross error impacts are defined as the unintentional or accidental collision or impact of aircraft, weapons, or equipment in the vicinity of an intended target, where such collisions or impacts result from an attempted weapon event. Gross errors generally result from aircrew errors, mechanical failures, release equipment malfunctions, or undertermined causes.

Aircraft Accident - An aircraft accident is defined as the accidental or intentional (controlled bailout) impact of a manned or unmanned aircraft in the vicinity of an air-to-ground target.

Aircraft Incident - An aircraft incident is defined as the accidental release of aircrafts parts, weapon parts or weapon carriage equipment from an aircraft. These incidents result from mechanical failures, air loads, and other physical events; or from the deliberate or acci dental jettisoning of these parts or equipment.

Inadvertent Ordnance Release - An inadvertent ordnance release is defined as the unintentional or accidental release of a weapon from an aircraft because of aircrew errors, weapon release system malfunctions, or aircraft vibrations, mechanical failures, air loads, or other physical events.

Land-Use Conflict - A land-use conflict results from actual, planned, or potential uses for an area which are not compatible for reasons of safety with air-to-ground range operations in the same area.

Conflict Area - A conflict area is defined as an area for which a landuse conflict has been identified within a composite descriptor.

Composite Descriptor - A composite descriptor is the resulting single descriptor defined by tracing the outermost area expected to contain impact data for a combination of target and event descriptors superimposed one on the other using a common origin and attack heading.

Hazard Potential Area - Defined as the area contained within a composite descriptor.

Accident Potential Zone - The area defined within an individual accidental impact descriptor with a specific level of containment.

2. ACCIDENTAL IMPACT DATA

The approach to develop the accidental impact descriptors involved three separate tasks: (1) accumulation of the accidental impact data, (2) analysis of the data, and (3) identification of hazard zones based on the analysis.

a. Data Base. All applicable Air Force air-to-ground range accidents, incidents, and inadvertent ordnance releases recorded at HQ AFISC, Norton AFB, California from January 1966 through September 1978 were reviewed, recorded, and tabulated. The criteria for inclusions in the data base involved three questions: (1) Was the accident the result of an aircraft air-to-ground associated event? (2) Was there an impact somewhere on or near the air-to-ground target? and (3) Was there sufficient information recorded to determine the results? The total data base included encoding 624 entries which listed 184 aircraft accidents, 322 incidents, and 118 inadvertent ordnance releases over the 12 year period. Table 1 shows the number and types of aircraft/objects included in the data base.

TABLE 1. SUMMARY OF ACCIDENTAL IMPACTS ON AIR-TO-GROUND RANGES BY TYPE OF OBJECT

ACCIDENTAL AIRCRAFT IMPACTS			DROPPED OBJECTS OR EQUIPMENT			INADVERTENT RELEASES OR JETTISONED WEAPONS		
Size	Type Aircraft	No.	Size	Type Object	No.	Size	Type Ordnance	No.
M	A7D	10	L	SUU-20, Prac Disp	2	L	BLU-27A/B	2
	B-57B	1		SUU-21, Prac Disp	6		MK82 LGB	2
	F4C/D/E	55		SUU-16, Gun Pod	4		BDU-33B/B	32
	RF4C	2		SUU-23, Gun Pod	6		MK82 SE	2
	F-100C/D/F	49		MER 10N, Wpn Rack	18		CBU-58	1
	F-105B/D/G	16		TER-15, Wpn Rack	17		MK82 GPB	9
	F-111A/D/E/F	9		MER-200, Wpn Rack	1		20 MM Rounds	8
	RB-57A	1		B-37, Wpn Rack	23		MK84 EOGB	1
				BRU-3A, Wpn Rack	25		MK84 GPB	2
S	A1E	4		AN/ARN-101, Laser Designater	1		7.62 MM Rounds	6
	A-37A/B	3						
	A-10A	1		LAU-68/TGM, EO Pod	1	M	2.75" Rx	16
	AU-23A	1		ALQ-101, ECM Pod	1		MK-25 Flare	1
	F5A	4		Fuel Tanks, Wing	26		BDU-12	1
	F-86H	1		Fuel Tanks, CL	21			
	F-84F	3		MAU-12, Wing Pylon	3	S	MK-106	34
	F-104C/G	12					CXU-2/B Spot. Charge	1
	TF-104G	1	M	SUU-25, Flare Pod	13			
	O1E	2		LAU-68, Rx Pod	37			
	O2A	3		LAU-59, Rx Pod	31			
	T-28D	2		SUU-16 RAT	5			
	AT-28D	1		M60 Gun Barrel	2			
	T-33A	1		M-61 Muzzle Clamp	20			
	JT-33A	1		Aircraft Canopy	3			
	AT-33A	1		Wingfold, F4	1			
				Pylon Camera	2			
				Ejection Seat, F4	1			
				CBU-25 Pod	1			
			S	SUU-21 Ejec. Pad	1			
				SUU-16/23 Rear Dome	4			
				SUU-16/23 Gun Door	3			
				MER Breech Gun	1			
				AIM-9 Missile Nose Cone	1			
				F-100 Gun Bay Door	8			
				Formation Light	3			
				Ejection Seat	1			
				Drag Chute	1			
				M-60 Shell Casings	2			
				Panels, Bolts, Doors	26			
	Total	184		Total	322		Total	118

3. DATA ANALYSIS

The investigation phase identified four basic targets on an air-to-ground range, each at a different location for scoring purposes. The four targets are (1) the bomb/rocket target (BRX), (2) the strafe target (STR), (3) the tactical (TAC) target, and (4) the practice nuclear weapons delivery target (NWD). Each of these targets has its own set of patterns and associated delivery maneuvers, weapon release envelopes, and tactics. Each accidental impact in the data base was recorded with respect to the actual target under attack. Since the bomb/rocket target is common to most ranges and is the most frequently used, it was selected as the origin when an impact occurred not involving a specific target (i.e., rejoin, orbit, departure, etc). The distributions were standardized to a left hand pattern and normalized to a 360° final approach heading for documenting the actual impact location with respect to the target.

The cumulative results of breaking out accidents, incidents, and inadvertent ordnance releases against the four different target groups showed that there were three areas of primary interest for the development of hazard zones: (1) the area near the target, (2) the approach run-in line and adjacent recovery area past the target, and (3) the flight pattern.

4. PROCEDURES AND RESULTS OF THE ANALYSIS

The procedures used to analyze accident potential zones were as follows:

a. Use a single reference point as the target.

b. Plot the distribution of accidental impacts from the single reference point using a radial grid pattern and a standardized left-hand pattern. See application for right-hand pattern in Step 1b, (3).

c. Perform a cumulative frequency analysis to determine the length and width of zones which contain the maximum percentage of accidental impacts in the least amount of area expanding from the single reference point.

Results of the analysis for each target and associated pattern showed optimum widths from the centerline and optimum lengths from break points along distance curves. These break points were used to establish optimum areas of containment by minimizing the area necessary to include a significant percentage of accidental impact points. Zone lengths were selected based on the highest cumulative percentage of impact points in the least amount of area. Expanding rectangles were selected from a menu of candidate geometric descriptors for ease of interpretation, drawing, and measuring area requirements.

Sections A-1 through A-4 in Appendix A show the results of the analysis in graphical plots. A brief discussion of each of the accidental impact descriptors is also provided.

SECTION II

APPLICATION OF ACCIDENTAL IMPACT DESCRIPTORS

1. STEP-BY-STEP APPLICATION PROCESS

The step-by-step procedure for applying ordnance descriptors to a range planning or range operations problem is presented in the previous report, ESL-TR-79-02, "RACUZ Descriptor Application Methodology." The procedures outlined in that report, summarized below and outlined in Figure 1, are also applicable for the accidental impact descriptors presented in this report, except for the special conditions or adaptations to the procedures which will be addressed in this report.

Step 1 Problem Definition	Statement of the problem, data collection, and selection of appropiate descriptors.
Step 2 Hazard Area Definition	Application of the descriptors to define the hazard potential area for the targets which comprise the mission definition.
Step 3 Land-Use Conflict Identification	Identification of any land-use conflicts associated with the acutal or planned activities.
Step 4 Alternatives and Decision Actions	Determination of adequate land area for range safety, and/or investigation of alternate solutions.

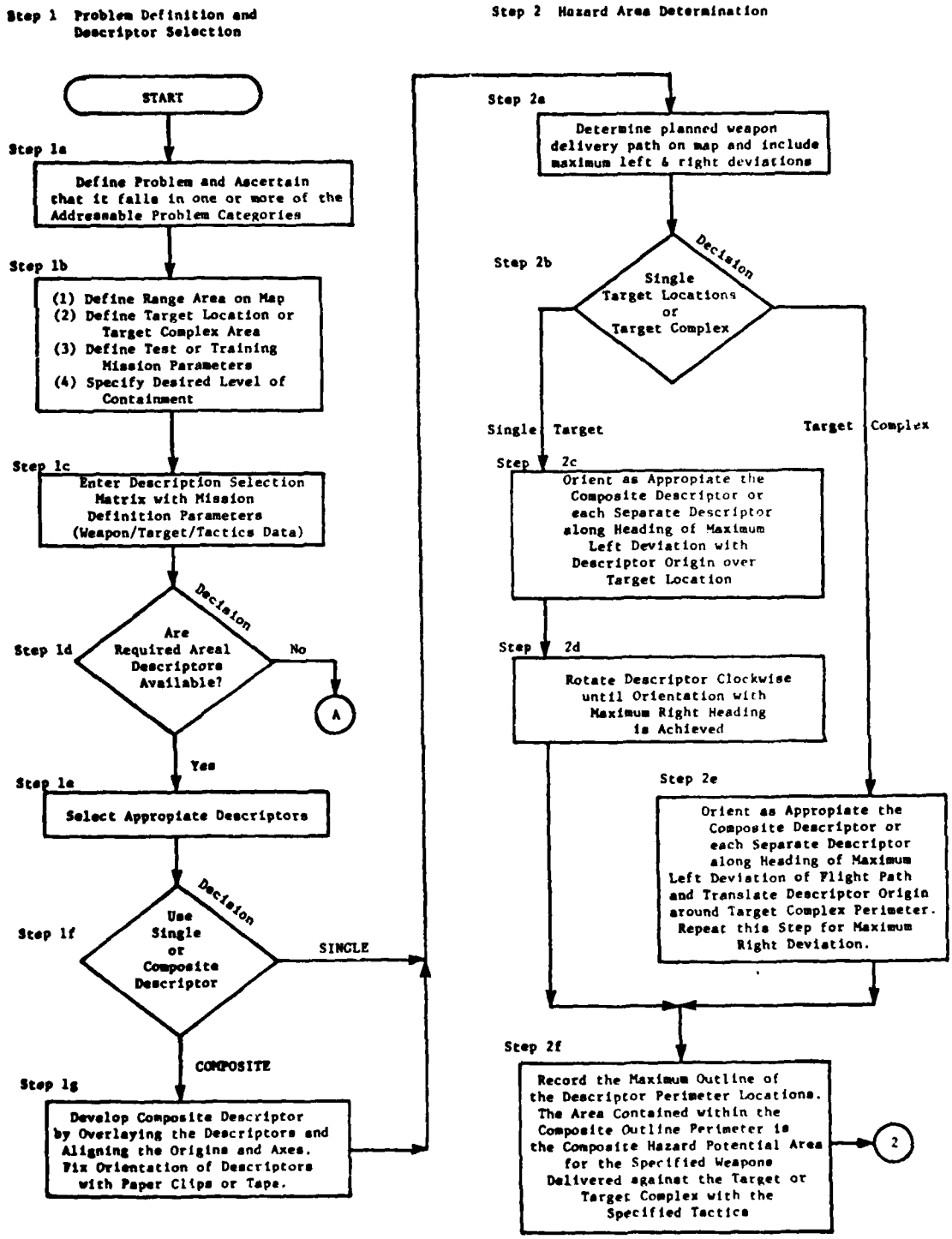

Figure 1. Step-by-Step Procedure for Applying Descriptors.

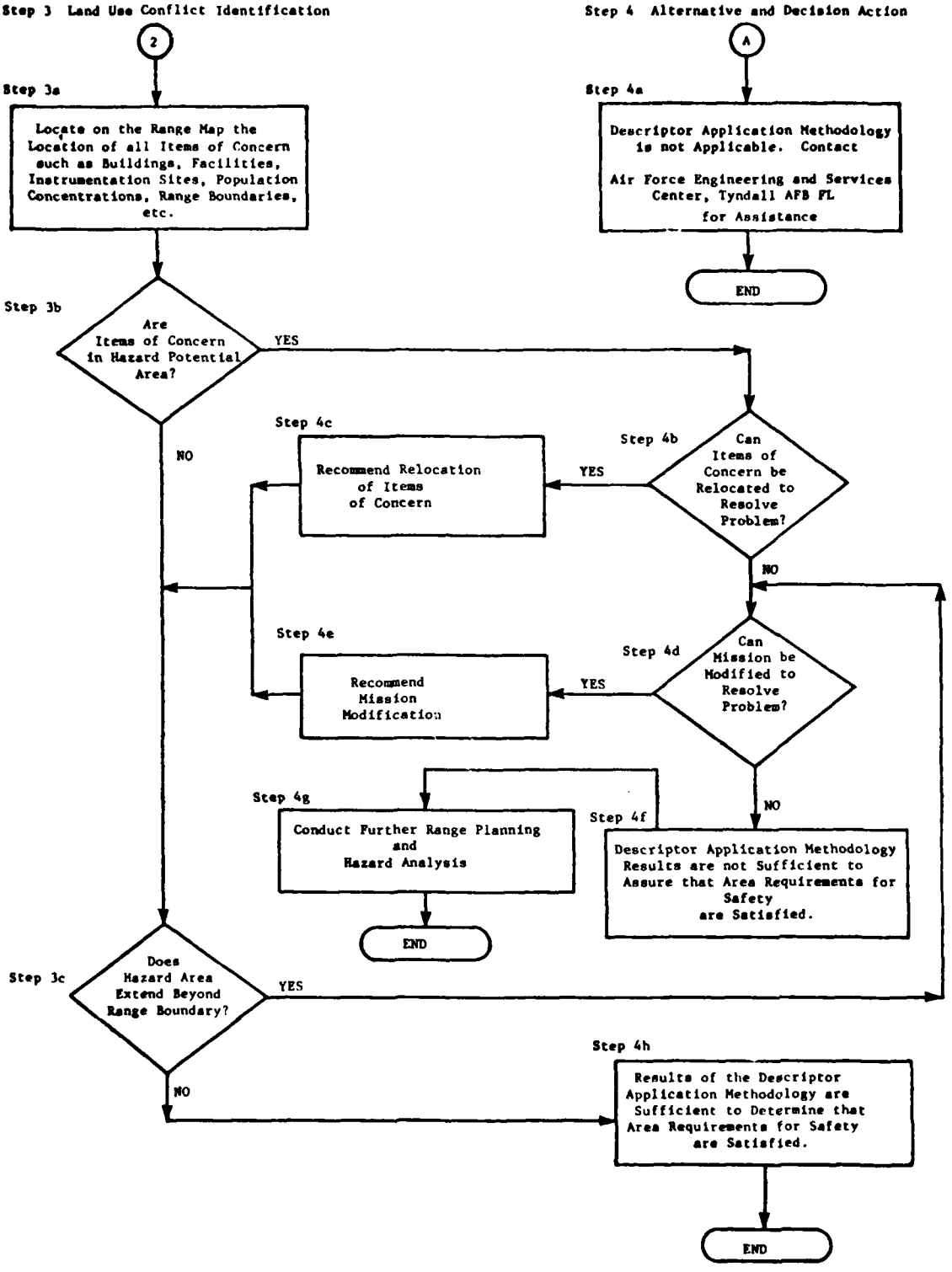

Figure 1. Step-by-Step Procedure for Applying Descriptors. (Concluded)

2. DETAILED EXPLANATION OF STEP-BY-STEP PROCEDURES

Step 1 - Problem Definition and Descriptor Selections

The first step in applying the accidental impact descriptor involves seven substeps.

Step 1a - The procedure must begin by (1) surveying existing target areas for land-use conflicts, or (2) must avoid creating land-use conflicts by identifying suitable locations for proposed targets, range support activities, or range facilities.

Step 1b - Data must be available to provide a clear definition for the following items:

(1) Range Area - The range area must be clearly defined on a map of the same scale as that of the descriptors. The scale factor here is 1:125,000. Other scale factors can be attained by photographic reduction or enlargement. (Caution must be exercised when using certain photo reproduction processes, as descriptors may be distorted when enlarged using some optical lenses.)

(2) Targets - The location of each target or planned target complex must be accurately shown on the range map.

(3) Mission Profile - The specific flight path must be defined in terms of the type of weapon delivery event and final approach heading. Special conditions for random attack

headings should be defined. Merely reverse the descriptor for right-hand patterns.

(4) Containment Level - The prescribed containment levels were based on significant break points in cumulative frequency curves. Accident Potential Zones (APZs) were defined using increasing percentages of accidental impacts contained within each additional zone. If the level of concern is high, the highest percentage of containment should be selected.

Step 1c - Select from Appendix A, Figures A-1 through A-4 the appropiate descriptor that is required for analysis of the given problem.

Step 1d - If the descriptors for the defined target or event are not included in Appendix A, the user should proceed to Step 4a.

Step 1e - If all tne required descriptors are referenced in Appendix A, transparent overlays should be obtained and used on the actual range maps of the same scale.

Step 1f - In some instances (single target range, for example), it is appropiate to overlay the clear transparencies, one on the other, with axes and origins aligned. This simplifies their application; it is not a required step. Overlaying the separate accidental impact descriptors using a common origin is appropriate since each set of target data is independent. Caution

must be exercised, however, in the interpretation of the resulting composite accident descriptor containment level since different containment levels were used. If manipulation of any of the patterns or targets is anticipated in order to arrive at a safety solution, the accidental impact descriptors should be applied one at a time.

Step 1g - Single accidental impact descriptor application is preferred since most targets on scored air-to-ground ranges are not used for multiple events. The ordnance descriptors provided in ESL-TR-79-02 are always appropriate, to combine with accidental impact descriptors for the same target. This combines the data base of intended releases and accidental impacts.

Step 2 - Hazard Area Determination

The second step is to determine the hazard area for the defined problem. Step 2 has six substeps.

Step 2a - Designate the maximum left and right deviation from the intended delivery heading. These lines will be used to properly orient the descriptor. No heading restrictions are necessary if random attack headings are allowed.

Step 2b - If a target complex is evaluated, then define permissible attack azimiths along the boundary of the complex. Again, no heading restrictions are necessary if random attacks are permitted.

Step 2c - For a specific target, place the appropiate descriptor on the range map with the origin over the target and the axis oriented along the direction of maximum left heading deviation.

Step 2d - Rotate the descriptor about the target in a clockwise direction until the descriptor axis is aligned with the maximum right heading deviation. If random attack headings are allowed, merely rotate the descriptor in a full circle about the origin.

Step 2e - If a target complex is being considered, apply the descriptor along the direction of maximum left deviation and translate around the target complex perimeter. Repeat this step with the axis oriented in the direction of maximum right deviation.

Step 2f - Trace the maximum outline described by the descriptor boundaries as they were applied in Steps 2d and 2e. The area contained within the composite outline is the hazard potential area for the specified events and targets selected.

Step 3 - Land-Use Conflict Identification

The third step is to identify possible land-use conflicts once the hazard potential area has been drawn. If manned or high value facilities are within the hazard potential area or if the

range boundary is overlapped, then a land-use conflict may exist. Step 3 consists of three substeps.

Step 3a - During the problem definition step, all population centers, buildings, facilities, and manned instrumentation sites should have been identified. Some of these locations may be for consideration purposes only (for example, alternate building sites).

Step 3b - If any of the items of concern are located in the hazard potential area, they may constitute a possible land-use conflict. A set of alternatives to resolve the conflict must be developed. This is addressed in Step 4b.

Step 3c - If the hazard potential area extends beyond the range boundary, that portion of the hazard potential area outside the range boundary constitutes a possible land-use conflict. This condition is addressed in Step 4d.

Step 4 - List Alternatives and Recommendations

The fourth step is to determine if the range boundary is sufficient to assure a safe operation using the selected target locations and target events as defined. If the descriptors can be oriented within the range boundaries with all high value areas remaining outside the hazard potential area, then the problem is resolved. If the problem cannot be resolved, then additional

analyses are required to determine the potential for hazardous effects. There are eight substeps in Step 4.

Step 4a - If in Step 1d the appropriate descriptor for the type of activity/target could not be found, then a new descriptor needs to be developed. Requirements for the development of a new descriptor can be forwarded to the Air Force Engineering and Services Center (AFESC) at Tyndall Air Force Base, Florida. AFESC has developed an extensive library of descriptors for various weapon/tactics combinations. These descriptors form the weapons data base for a set of computer codes being developed for range planning applications.

Step 4b - If the items of concern that comprise the land-use conflict can be relocated outside of the hazard potential area, then the land-use conflict can be resolved.

Step 4c - If relocation can be accomplished, relocation should be recommended as a solution.

Step 4d - If effective relocation is not possible, modification of mission parameters should be considered. Options include restricting approach headings, moving target locations, or adjusting the flight path for multiple approaches to the target, to avoid the conflict area.

Step 4e - If mission modification can resolve the land-use conflict, then modification should be recommended as a solution.

Step 4f - If neither Step 4c nor Step 4e is feasible, then the land-use conflicts identified in Steps 3b and 3c cannot be resolved by this graphical procedure.

Step 4g - Once the problem exceeds the graphical solution, other analyses and planning efforts must be used. The hazard potential within the containment contour should be determined using probability density functions (pdfs) and weapons effects algorithms. Hardening, relocation to less hazardous areas, or other mitigating alternatives should be evaluated to reduce hazards to meet safety requirements. This methodology is available and outlined in ESL-TR-80-65.

Step 4h - If Steps 3b and 3c do not identify any land-use conflict areas, then the area requirements for safety are satisfied.

3. ILLUSTRATIVE EXAMPLE

The following range planning example problem is given to illustrate the various steps used in the methodology.

Step 1 - Example Problem Definition

Assume the following hypothetical situation: It is desired to locate a tactical target at an existing air-to-ground range. Planned weapons events against this new target include (1) Low-and high-angle dive bombing (both MK-106, BDU-33, and GP bombs, inert), and (2) 30 mm strafe for a wing of A-10A aircraft.

The target is constructed of plywood and 4 x 4 posts (simulating a command post), and the surrounding target area is soft, sandy plowed soil. Because of moderate grazing and recreation vehicle activities near the range boundaries, the Commander wants to know if the range has sufficient area to assure a high level of impact point containment. As a result of his concern, he specifies that planning efforts are to assure maximum available containment levels.

The primary delivery tactics are (1) low altitude [300 to 1500 feet], low speed [300 to 400 knots], and low dive angle [0 to 20 degrees], and (2) high altitude [1500 to 12,000 feet], high speed [300 to 450 knots], and high dive angles [20 to 60 degrees], and finally, (3) 30 mm strafe [10 to 20 degrees] against a soft target. The final attack heading will be from west to east with either a left or right pulloff for multiple passes.

Descriptors for the following events are required:

(1) GP Bombs, MK-106, BDU-33
Low Altitude
Low Speed
Low Dive Angle

(2) GP Bombs, BDU-33
High Altitude
High Speed
High Dive Angle

(3) 30 mm Strafe
10-20 Degrees
Soft Targets

(4) Accidental Impact
Descriptors
Applied Tactics
Target
Strafe Target

Using technical report ESL-TR-79-02 and the accidental impact descriptors provided in Appendix A, Figures A-3 and A-4 of this

report, the required descriptors are available; and hence, the method is applicable. Select description A-2, A-3, A-10; and A-3 and A-4. Descriptors A-2, A-3 and A-10 in ESL-TR-79-02 must be reduced to a scale factor of 1:125,000 for proper application.

Since the same target is used, combining the descriptors for all three events is appropriate. (Note, that only A-2, A-3 and A-10 weapon impact descriptors have the same containment levels.) The resulting composite descriptor is shown in Figure 2.

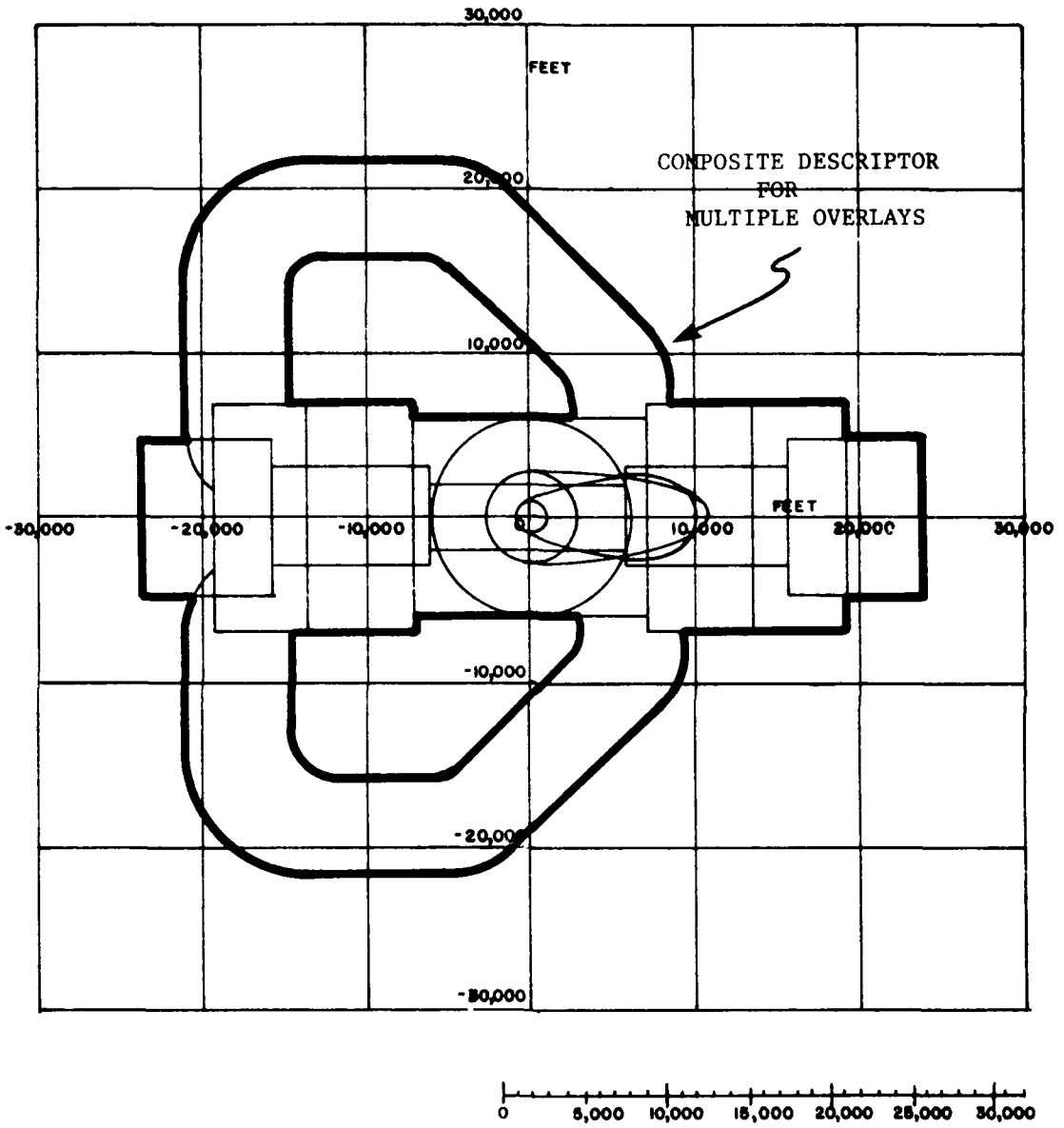

Figure 2. Composite Descriptor for Example Case

Step 2. Hazard Area Determination

The composite descriptor is now applied to the selected target location. The descriptor is oriented to the intended attack heading and rotated 45° left and 45° right. Both the left and right patterns are used. The results of this process are shown in Figure 3.

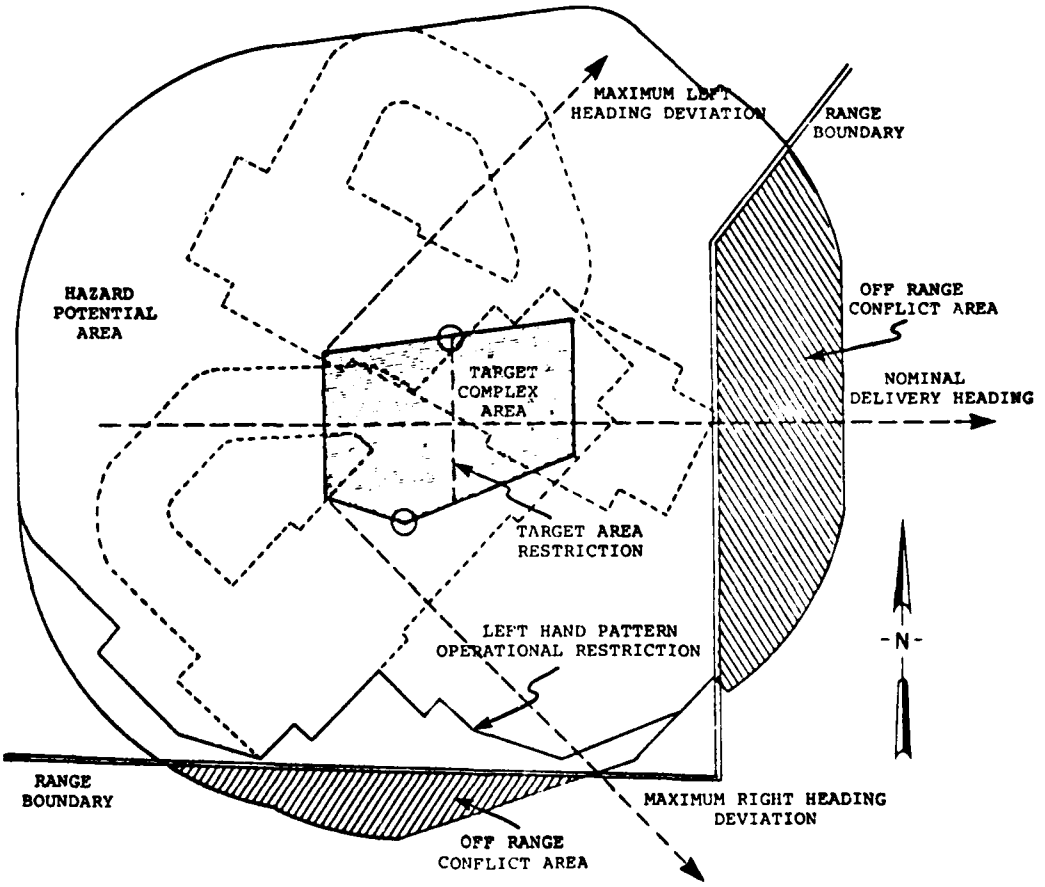

Figure 3. Hazard Area Determination and Conflict Area Identification

Step 3. Conflict Area Identification

In Figure 3, it is seen that a portion of the hazard potential area overlays the range boundary to the east. It is also noted that additional areas under the flight patn of tne aircraft on the re-entry portions of the pattern flown also exceed the range boundary to the south.

Step 4. Identification of Decision Alternatives

The hazard potential area resulting when the flight path exceeds the range boundary to the south is rather straight-forward. By restricting the pull-off direction to a left-hand pattern only, the conflict area is eliminated. (See Left-Hand Pattern Only Operational Restriction in Figure 3.) Attack headings could also be restricted to allow recovery prior to exceeding the range boundaries.

Resolution of the off-range conflict area to the east is more difficult because more decision alternatives exist, and the choice of the most appropiate alternatives cannot be made strictly from the graphical application shown here. Among the alternatives that should be considered are:

(1) Restriction of the target location within the target complex area so that the resulting hazard potential area does not exceed the range. (See Target Area Restriction dashed line in Figure 3.

(2) Restriction of the delivery heading so that the hazard potential area does not exceed the range.

(3) Acquisition of off-range land or effective control of the area to restrict outside access during training missions.

(4) Acceptance of the risk of not controlling the area. A rationale for choosing from among these choices and possibly others requires analysis beyond the scope of graphical solutions. Additional studies should be recommended as appropriate. The capability to perform additional hazard analysis for selecting alternatives in the range planning process has been developed by AFESC/RD.

SECTION IV

ASSUMPTIONS AND LIMITATIONS

1. REQUIREMENTS FOR ASSUMPTIONS

The descriptor application methodology was developed as a graphical technique for applying accidental impact descriptors to identify land area requirements for the safe operation of Air Force air-to-ground ranges. During the development of this methodology, several assumptions were necessary and several limitations become apparent. The accidental impact descriptors presented in this report included the majority of recorded inadvertent accidents and weapon gross errors that occurred on AF air-to-ground ranges during the last 12 years. The data is sparse in some cases; therefore, the descriptors represent conservative estimates of accidental impact zones. High percentages of containment for the sparse number of gross errors are not statistically meaningful. Where assumptions were made, operational considerations were carefully examined to insure integrity and consistency in the interpretation of the results. The accidental impact descriptor application methodology will permit the resolution of most range planning problems, except where land area constraints are severe. A more detailed hazard analysis may be required in these limited special cases.

2. SPECIFIC ASSUMPTIONS

The specific assumptions that were necessary in the development of the accidental impact descriptors and in the application

methodology can be grouped into the following categories: data base adequacy, weapons delivery events, and range independent occurrences.

a. Data Base Adequacy. The data reviewed were limited to recent events. All data was obtained through the Safety Analysis Branch, Air Force Inspection and Safety Center, Norton AFB California (AFISC/SEY), and included data only from January 1966 to the present. (Incidents and inadvertent ordnance release reports were not maintained before January 1972; so earlier data were not available.)

Since the data reviewed for the report includes all the recorded accidents, incidents, and inadvertent ordnance releases with sufficient data to complete an analysis, high statistical confidence levels could not be achieved with some of the small sample sizes. Additional data for the strafe target and the practice nuclear weapons target is recommended.

Additional data from Navy, Marine, and Army air-to-ground range accidents could be added to the Air Force data as an additional data source.

b. Weapons Delivery Events. The distributions of historical accidents used in the development of these accident potential zones are only representative of those accidents that occurred as a result of the tactics, patterns, aircraft and aircrew training,

or weapon tests during the time period of the data base. If there are significant operational changes, mission changes, or deleted tactics and parameters, then the validity of the results may be lessened for future applications.

c. Range Independent Occurrences. The distributions defined by the historical data were the result of summing all the impacts from all Air Force range-related operations and applying these results to one particular example. It is implied that each individual accident is an independent event and not a result of any particular range-specific feature that could preclude that event from happening on any other range.

3. LIMITATIONS

There are several limitations to the use of accidental impact descriptors in the application methodology, and the user must be aware of them in order to avoid improper or invalid applications.

a. Frequency Dependency. The accident potential zones developed in the analysis were derived from the data accumulated for 12 years of accidents, incidents, and inadvertent ordnance releases. The total cumulative number of passes flown against each of four target groupings produced the resulting data base and distribution of impacts. When this distribution is applied against a specific range that has a use-history significantly higher or lower than that of the data base, then application of these descriptors should be qualified.

b. Footprints Identify Safety Conflicts Only. The occurrence of an accident at a specific area is time and frequency dependent. When projecting historical trends, the longer the observed period and the more data, the more qualitative the results will be. Actual hazards or risk must be evaluated on a case-by-case basis, using the best accident and frequency data available and the actual environment on or near the range under investigation. The "footprints" developed in this report may only be used to determine if a safety conflict may be present. This is only the first step in resolving land-use conflicts. The final resolution of a land-use conflict may require additional further analysis to quantify the hazard potential identified by these safety descriptors.

c. Containment Levels. The accidental impact descriptors presented in this report were developed from cumulative frequency curves to minimize the area within each additional containment level. High levels of containment from sparse data are not statistically meaningful. High levels of containment (99.9, 99.95 and 99.99 at a 95 percent confidence level) were achieved for the initial set of ordnance descriptors developed in ESL-TR-79-02, and are valid. Combining the descriptors for intended ordnance releases and gross-error ordnance releases is valid; however, the resulting level of containment for the resulting composite descriptor must be interpreted very carefully. Composite descriptors using different levels of containment should

only be used to identify hazard potential areas and potential land-use conflicts. Meaningful statements about levels of containment cannot be derived from composite descriptors of significantly different levels of containment. Additional analysis using combined origi-nal impact distribution data or probability density functions is recommended when specific levels of containment are required for composite descriptors.

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APPENDIX A

ACCIDENTAL IMPACT DESCRIPTORS

This appendix provides a set of accidental impact descriptors for combined aircraft accidents, incidents, and inadvertent ordnance releases on Air Force air-to-ground ranges. These descriptors are scaled for standard range maps having a scale of 1: 125,000. If copies of these descriptors are made to the same or different scale, caution should be exercised. Some photo copying or reproduction machines can distort the resulting copy from the original.

Instructions for properly applying these descriptors are provided in the methodology outlined in Figure 1. Specific instructions for selecting the appropriate descriptor may be found starting with Step 1e. Limitations on their use are provided in Section IV of this report.

1. ACCIDENT DESCRIPTOR FOR BOMB/ROCKET TARGET

The accident impact descriptor for the bomb/rocket target is provided in Figure A-1. The scale for this figure is 1:125,000. The descriptor describes the contour that contains at least 87.4 percent of the accidental impacts resulting from Air Force air-to-ground operations against the dive bomb and rocket target. Four specific containment areas were identified based on the cumulative percentage of impacts contained.

APZ 1.....66.0 Percent Containment
APZ 2.....70.6 Percent Containment
APZ 3.....74.0 Percent Containment
APZ 4.....87.4 Percent Containment

These hazard zones were determined from a total of 262 plottable accidental impacts associated with the target approach, recovery area, and pattern flown.

Hazard zones 5000 and 6000 feet wide, and 7000, 10,000 and 16,000 feet long formed three accident potential zones containing the cumulative percentages shown above and in Figure A-1. A hazard zone 3000 feet from each side of the flight path formed a fourth zone.

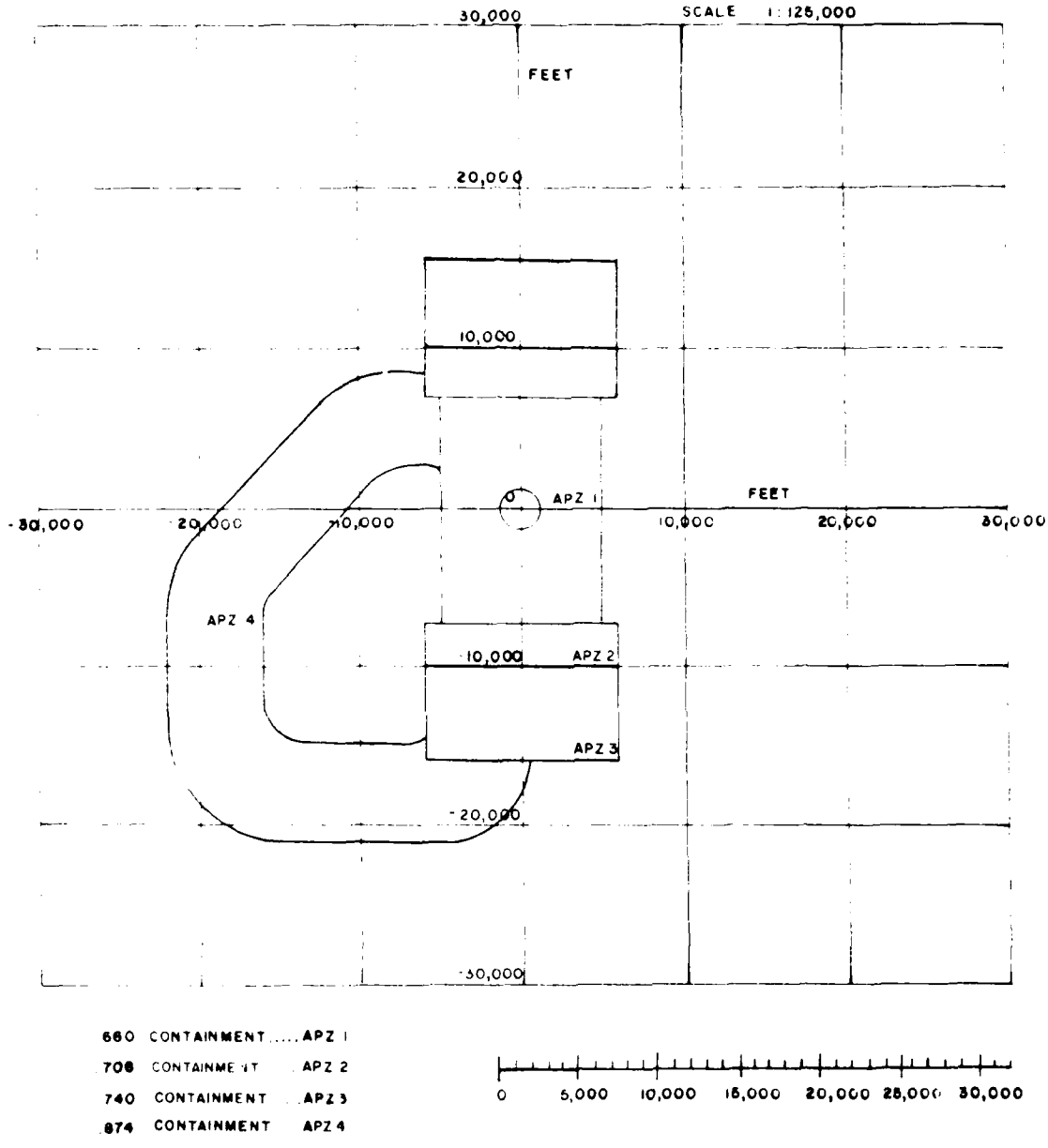

Figure A-1. Accidental Descriptor for Bomb/Rocket Target.

2. ACCIDENT DESCRIPTOR FOR PRACTICE NUCLEAR WEAPONS DELIVERY TARGET

The accident impact descriptor for the practice nuclear weapons delivery target is provided in Figure A-2. The scale for this figure is 1:125,000. The descriptor describes the contour that contains at least 60.5 percent of the accidental impacts resulting from Air Force air-to-ground operations against the practice nuclear weapons target. Four specific containment areas were identified based on the cumulative percentage of impacts contained.

APZ 1.....30.3 percent containment
APZ 2.....35.5 percent containment
APZ 3.....48.7 percent containment
APZ 4.....60.5 percent containment

These hazard zones were determined from a total of 75 plottable accidental impacts associated with the target approach, recovery area, and pattern flown.

Hazard zones 1000, 5000, and 10,000 feet wide and 11,000, 17,000 and 27,000 feet long formed three accident potential zones containing the cumulative percentages shown above and in Figure A-2. A hazard zone 3000 feet wide from each side of the flight path formed a fourth zone.

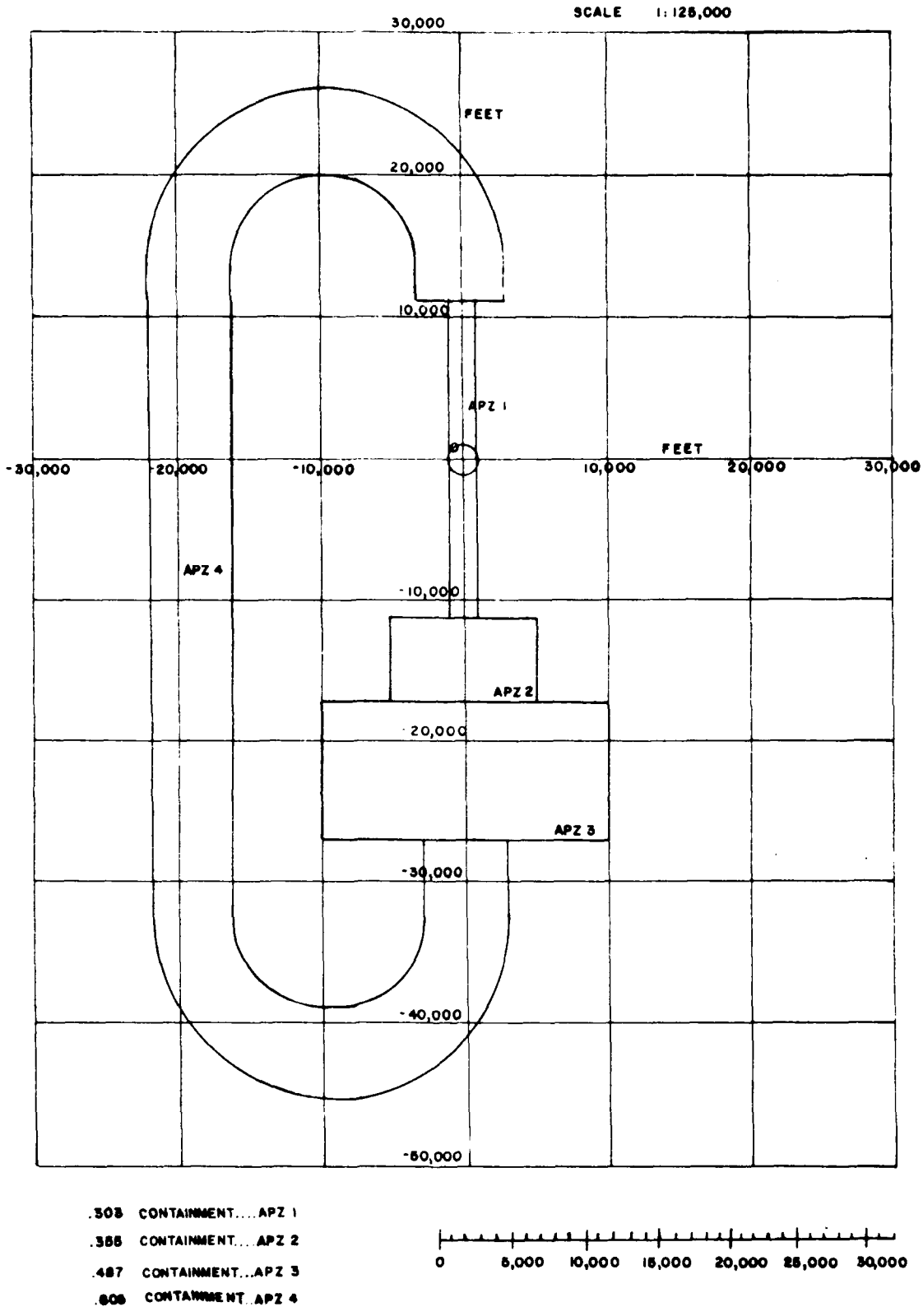

Figure A-2. Accident Descriptor for Practice Nuclear Weapons Delivery Target

3. ACCIDENT DESCRIPTOR FOR STRAFE TARGET

The accident impact descriptor for the strafe target is provided in Figure A-3. The scale for this figure is 1:125,000. The descriptor describes the contour that contains at least 92.7 percent of the accidental impacts resulting from Air Force air-to-ground operations against the strafe target. Four specific containment areas were identified based on the cumulative percentage of impacts contained.

AZP 1.....73.8 percent containment
AZP 2.....78.3 percent containment
AZP 3.....81.3 percent containment
AZP 4.....92.7 percent containment

These hazard zones were determined from a total of 80 plottable accidental impacts associated with the target approach, recovery area, and pattern flown.

Hazard zones 2000, 3000, and 5000 feet wide and 6000, 16,000 and 24,000 feet long formed three accident potential zones containing the cumulative percentages shown above and in Figure A-3. A hazard zone 3000 feet wide from each side of the flight path formed a fourth zone.

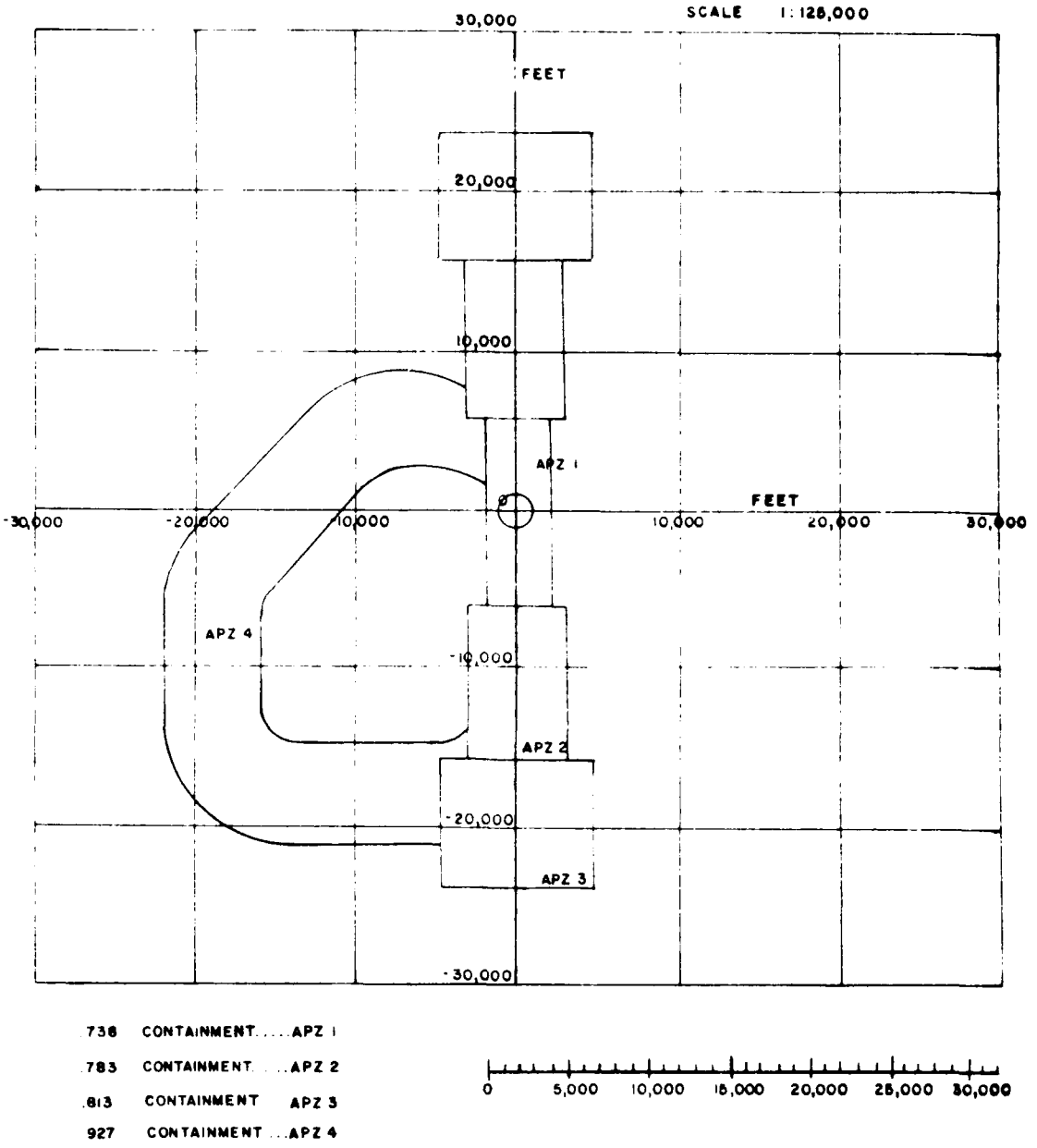

Figure A-3. Accident Descriptor for Strafe Target

4. ACCIDENT DESCRIPTOR FOR THE APPLIED TACTICS TARGET

The accident impact descriptor for the applied tactics target is provided in Figure A-4. The scale for this figure is 1:125,000. The descriptor describes the contour that contains at least 90.2 percent of the accidental impacts resulting from Air Force air-to-ground operations against the applied tactics (tactical) target. Four specific containment areas were identified based on the cumulative percentage of impacts contained.

APZ 1.....73.8 percent containment
APZ 2.....80.9 percent containment
APZ 3.....84.2 percent containment
APZ 4.....90.2 percent containment

These hazard zones were determined from a total of 183 plottable accident impacts associated with the target approach, recovery area, and pattern flown.

Hazard zones 6000 and 7000 feet wide and 7000, 13,500 and 19 [illegible] feet long formed three accident potential zones containing the percentages shown above and in Figure A-4. A hazard zone 3000 feet wide from each side of the flight path formed a fourth zone.

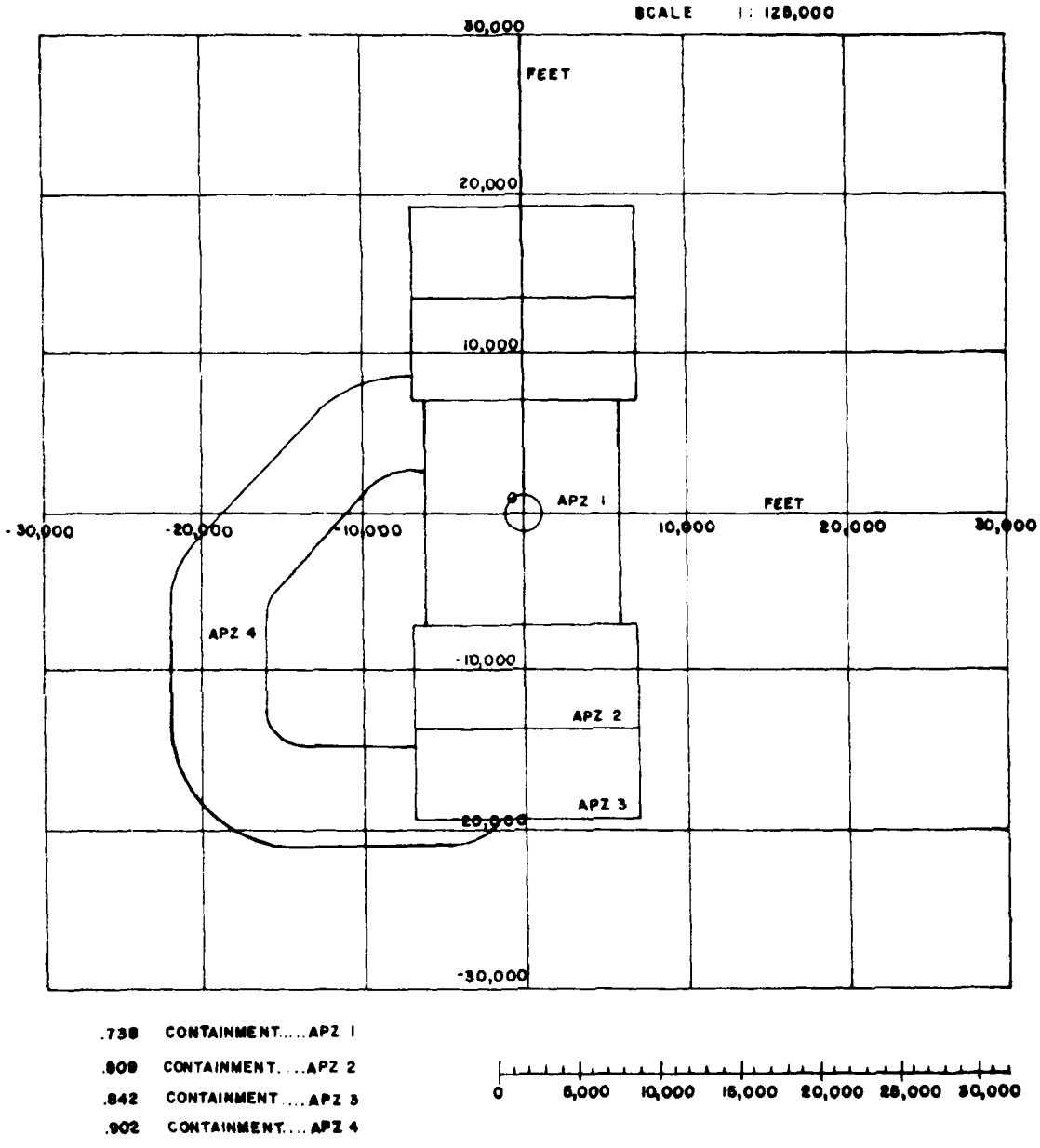

Figure A-4. Accident Descriptor for Applied Tactics Target

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INITIAL DISTRIBUTION

DTIC/DDA	12
HQ AFESC/TST	1
HQ USAF/LEEV	3
HQ AFESC/DEV	15
HQ AFISC/SEP	2
AD/SE	1
AD/TE	1
HQ TAC/DE	1
HQ TAC/DOR	1
HQ TAC/DOO	1
HQ AFSC/DE	1
HQ AFSC/TE	1
HQ USAFE/DOO	1
HQ PACAF/DOO	1
HQ AAC/DOO	1
HQ AFRES/DOOT	1
NGB/XOS	1
HQ USAF/XOORE	3
HQ AFESC/RDVA	15
AFATL/DLODR	1
AUL/LSE 71-249	1

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