DDESB

ASSESSING EXPLOSIVES SAFETY RISKS, DEVIATIONS, AND CONSEQUENCES

Department of Defense Explosives Safety Board

Alexandria, Virginia

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REPORT DOCUMENTATION PAGE		Form approved OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
ASSESSING EXPLOSIVES SAFETY RISKS, DEVIATIONS, AND CONSEQUENCES	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
Department of Defense Explosives Safety Board and Service Representatives	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
Department of Defense Explosives Safety Board, 4800 Mark Center Drive, Suite 16E12, Alexandria, VA 22350-3606	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT Risk assessments for explosives operations are a critical part of the DoD explosives safety program. This technical paper (TP) provides guidance and methodologies in conducting risk assessments outlined in DoD Instruction 6055.16, "Explosives Safety Management Program." This TP also presents tools to standardize the DoD explosives deviation assessment process. It details the information necessary for explosives-related risk decisions to be made by the appropriate decision maker. This TP facilitates implementation of Chairman of the Joint Chiefs of Staff Instruction 4360.01B, "Explosives Safety and Munitions Risk Management for Joint Operations Planning, Training, and Execution," and Allied Logistics Publication 16, "Explosive Safety and Munitions Risk Management (ESMRM) in NATO Planning, Training and Operations." The DoD Components can use these tools to document their deviation processes and communicate the risks associated with these deviations.

15. SUBJECT TERMS
Explosives Safety, Risk Assessment, Risk Management, Deviations, Hazard identification, Risk Decision

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT U	b. ABSTRACT U	c. THIS PAGE U		92	19b. TELEPHONE NUMBER *(include area code)* 571-372-6685

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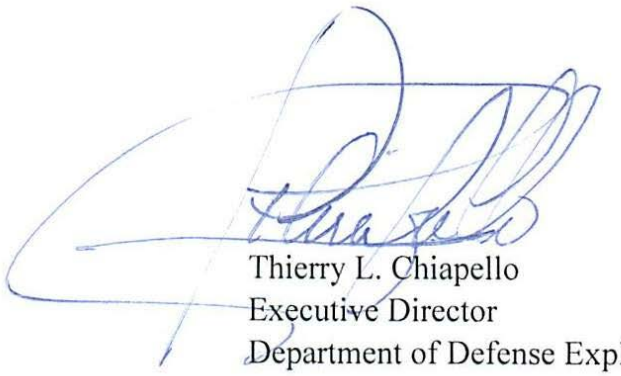
FOREWORD

Technical Paper (TP) 23, Revision 2:

- Supersedes the original TP 23 published on July 31, 2009.
- Outlines explosives safety and munitions risk management (ESMRM) fundamentals.
- Incorporates ESMRM approaches for all ammunition and explosives throughout an entire system's life cycle.
- Provides an overview of applicable Office of Management and Budget and Department of Defense (DoD) risk management policies.
- Supplies DoD Components with explosives safety considerations applicable in each phase of the acquisition life cycle.
- Details a comprehensive explosives safety risk assessment process.
- Summarizes tools available for executing explosives safety risk assessments.
- Provides allied partners with a framework for developing Munition Risk Management Assessments in support of North Atlantic Treaty Organization (NATO) exercises as agreed to in NATO Standardization Agreement 2617, which covers ALP-16 "Allied Logistics Publication for Explosive Safety and Munitions Risk Management (ESMRM) in NATO Planning, Training and Operations."

This TP will be kept current and updated as new information becomes available. The latest version of TP 23 is on the Department of Defense Explosives Safety Board (DDESB) Website at: https://denix.osd.mil/ddes/ddes-technical-papers/

This TP has been reviewed by the DoD Components and the DDESB staff.



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CHAPTER 1: INTRODUCTION

1.1. BACKGROUND.

1.1.1. This technical paper (TP) outlines explosives safety and munitions risk management (ESMRM) fundamentals and:

1.1.1.1. Provides an overview of applicable Office of Management and Budget (OMB) and Department of Defense (DoD) risk management policies.

1.1.1.2. Provides acquisition program managers (PMs) with explosives safety considerations applicable in each phase of the acquisition life cycle.

1.1.1.3. Details a comprehensive explosives safety risk assessment process.

1.1.1.4. Summarizes tools available for executing explosives safety risk assessments.

1.1.1.5. Provides guidelines on how and when to perform an ESMRM.

1.1.2. All DoD Components may use the processes and tools in this TP to evaluate risks when DoD explosives safety criteria cannot be met in accordance with DoD Directive (DoDD) 6055.09E and DoD Instruction (DoDI) 6055.16 or as required for explosives safety siting (ESS) in accordance with Department of Defense Explosives Safety Regulation (DESR) 6055.09. ESMRM:

1.1.2.1. Assists leaders at all organizational levels to better understand explosives hazards, reduce risk to mission, conserve resources, and maximize operational effectiveness.

1.1.2.2. Is a force multiplier when explosives safety and munition risks are evaluated, assessed, and managed as part of the full system life cycle.

1.1.2.3. Enables the DoD Components to effectively execute and often times improve and increase their mission capabilities.

1.1.3. This TP:

1.1.3.1. Provides an overview and linkage between OMB, DoD risk management policies, and ESMRM.

1.1.3.2. Discusses PM acquisition program responsibilities and provides ESMRM considerations applicable in each phase of the acquisition life cycle.

1.1.3.3. Outlines special ESMRM considerations for PMs executing rapid acquisition programs (e.g., urgent operational need (UON)).

1.1.3.4. Provides a comprehensive explosives safety risk assessment process, including general risk assessment fundamentals, circumstances requiring risk assessment, assessment

maintenance and update frequency, a nine-step explosives safety risk assessment process, and an abbreviated process for reviewing and updating an existing risk assessment.

1.1.3.5. Summarizes methodologies and risk assessment tools that analyze munitions-related consequences and associated risks when deviating from the explosives safety standards directed in DoDD 6055.09E and DoDI 6055.16 or as required for siting in accordance with DESR 6055.09.

1.1.3.6. Assists in the development of Munitions Risk Management Assessments (MRMAs) in support of North Atlantic Treaty Organization (NATO) exercises as agreed to in NATO Standardization Agreement 2617, which covers Allied Logistics Publication (ALP)-16, "Explosive Safety and Munitions Risk Management (ESMRM) in NATO Planning, Training and Execution."

1.2. POLICY. It is DoD policy to:

1.2.1. Provide the maximum practicable protection to people and property from the unintentional, potentially damaging effects of DoD military munitions in accordance with DoDD 6055.9E and DESR 6055.09.

1.2.2. Expose the minimum number of people for the minimum time to the minimum amount of DoD military munitions required to safely and effectively execute the mission in accordance with DESR 6055.09.

1.2.3. Make ESMRM risk decisions when compelled by strategic or operational necessity, or as required in support of deviations specified in DoDI 6055.16 and DESR 6055.09. ESMRM risk decisions are based on methodologies and requirements prescribed in related issuances and DoD explosives safety regulations and standards.

1.2.4. Provide standardized information for determining and assessing explosives safety risk in accordance with DoDD 6055.09E.

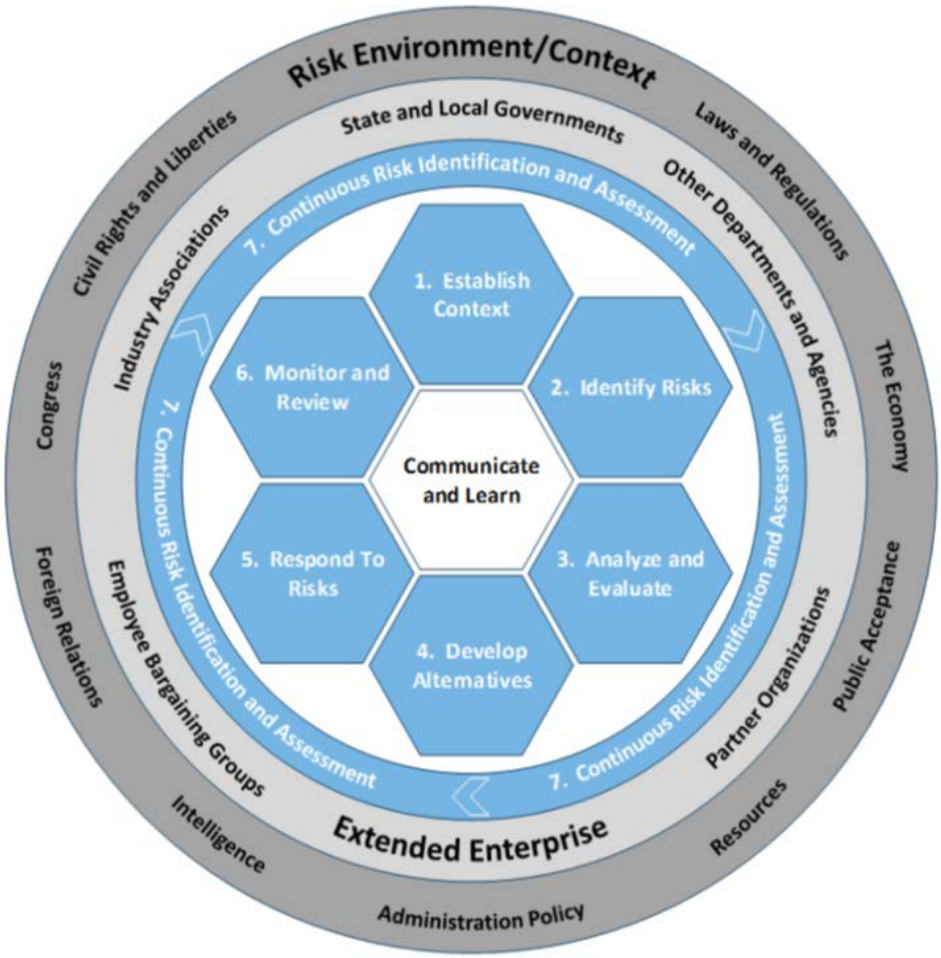
1.3. APPLICABILITY. This TP applies to the Acquisition Program Milestone Decision Authorities (MDAs) and PMs, Joint Staff, Military Services, Defense Agencies, Combatant Commands (CCMDs), Subunified Commands, Joint Task Forces, and their subordinate component commands (referred to collectively in this TP as the "DoD Components").

CHAPTER 2: RISK MANAGEMENT FUNDAMENTALS

2.1. OMB PRINCIPLES OF RISK MANAGEMENT.

2.1.1. OMB identifies enterprise risk management (ERM) as a key discipline necessary for identifying, assessing, and managing risks in accordance with OMB Circular No. A-123. Although there are several approaches to incorporating ERM, the notional model shown as Figure 2.1. includes the most common ERM elements. Adequate and organizationally aligned risk management programs can identify key points of failure and reduce or eliminate potential failures. For expanded and current guidance and associated references, see OMB Circular No. A-123 at https://obamawhitehouse.archives.gov/omb/circulars_a123_rev/.

Figure 2.1. OMB Principles for Risk Assessment



2.1.2. Central to ERM is risk analysis. OMB published overarching risk management principles in OMB Circular M-07-24. The memorandum reinforced generally accepted principles for risk analysis related to environmental, health, and safety risks. Divided into five

parts, the key component applicable to this TP is the OMB principles for risk management. Agencies should:

2.1.2.1. Use the best reasonably obtainable scientific information to assess risks to health, safety, and the environment.

2.1.2.2. Characterize qualitative and quantitative risks, and changes in the nature or magnitude of risks, consistent with available data. The characterizations should be broad enough to inform the range of policies to reduce risks.

2.1.2.3. Explicitly state judgments used in developing a risk assessment (e.g., assumptions, defaults, and uncertainties), and provide the rationale for these judgments and their influence on the risk assessment.

2.1.2.4. Ensure risk assessments encompass all appropriate hazards (e.g., acute and chronic risks, including cancer and non-cancer risks, to human health and the environment). In addition to considering the full population at risk, look at subpopulations that may be particularly susceptible to such risks and/or may be more highly exposed.

2.1.2.5. Perform peer review of risk assessments to ensure that the highest professional standards are maintained. Develop policies to maximize its use.

2.1.2.6. Strive to adopt consistent approaches to evaluating the risks posed by hazardous agents or events.

2.2. DOD RISK MANAGEMENT POLICY.

2.2.1. DoDI 6055.01 outlines risk management principles for the DoD Components. The policy explicitly states, "Commanders, leaders, and personnel will use the risk management process to address safety and occupational health risks across all DoD operations and tasks, both on and off duty." The DoD risk management process is illustrated in Figure 2.2. See DoDI 6055.01 for additional information about each step in the process.

Figure 2.2. DoD Risk Management Process

2.2.2. DoDD 6055.09E enhances the DoDI 6055.01 language regarding ESMRM. ESMRM is a systematic approach that:

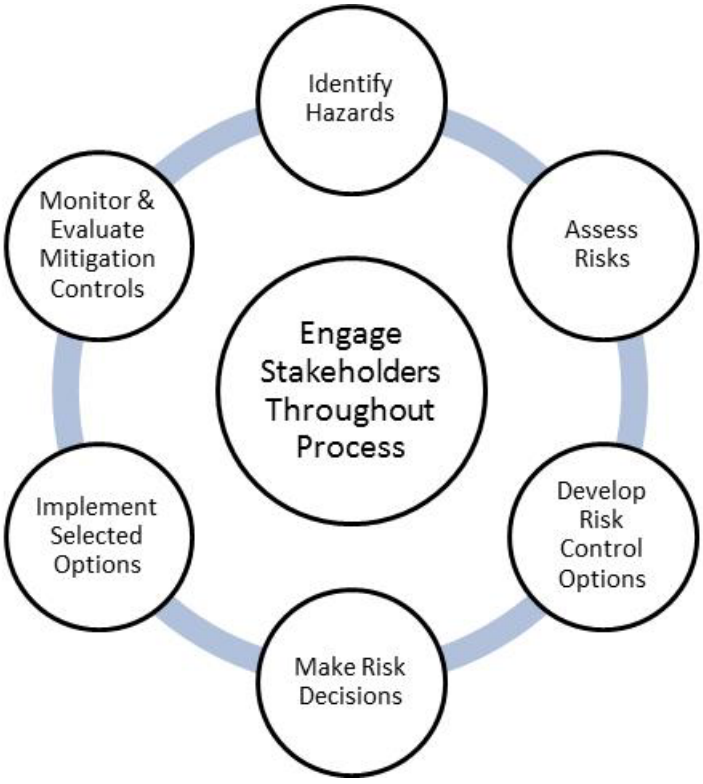
2.2.2.1. Integrates risk analysis into operational planning, military training exercises, and contingency operations.

2.2.2.2. Identifies potentially adverse consequences of munitions operations and risk reduction alternatives.

2.2.2.3. Provides risk acceptance criteria for senior officials to make risk decisions.

2.2.3. ESMRM aligns with OMB and DoD risk management principles and expands their objectives regarding risks to and from explosives and munitions. The cyclical process outlined in DoDD 6055.09E and DoDI 6055.16 is depicted in Figure 2.3. Chapter 4 of this TP further expands on the explosives safety risk management (ESRM) model as a nine-step assessment process containing step-specific guidance and explicit explosives safety and munitions considerations.

Figure 2.3. ESRM Model



CHAPTER 3: EXPLOSIVES SAFETY CONSIDERATIONS IN ACQUISITION

3.1. GENERAL.

3.1.1. ESMRM identifies and communicates to the appropriate level of leadership all risks and consequences to and from explosives and munitions during all phases of a weapon system's life cycle. Issues that negatively affect a program's cost, schedule, or performance may result if ESMRM elements are not considered early in the acquisition life cycle, such as:

3.1.1.1. The need for unplanned infrastructure investments to accommodate weapons and weapon systems.

3.1.1.2. Compatibility constraints that limit combat effectiveness.

3.1.1.3. Unresolvable compliance issues requiring senior leader acceptance of increased risk to personnel, equipment, and infrastructure.

3.1.2. The PM:

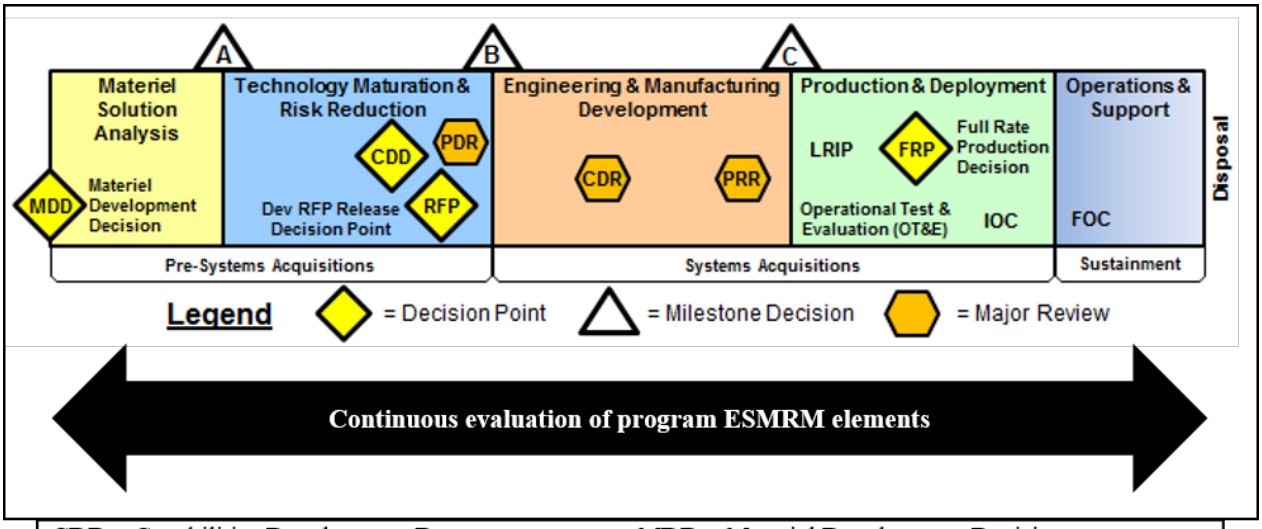
3.1.2.1. Is authorized to, and responsible for, accomplishing program objectives for the entire program life cycle to meet the user's operational needs.

3.1.2.2. Is accountable for credible cost, schedule, and performance reporting to the MDA in accordance with DoDD 5000.01.

3.1.2.3. Must consider ESMRM requirements in all phases of the acquisition life cycle. This is critical to successful program execution and fielding where explosives and munitions are integral to the weapon or weapon system.

3.1.3. The defense acquisition process is illustrated in Figure 3.1. The figure depicts the phases, decision points, milestones, and major reviews that form the cradle-to-grave life cycle from pre-systems acquisition through disposal. Paragraph 3.2. provides ESMRM considerations in each phase. Note that earlier risk considerations should be revisited at each subsequent phase as the program matures, program baselines adjust, and/or program threshold/objectives are changed.

Figure 3.1. Defense Acquisition Process



CDD – Capabilities Development Document	MDD – Materiel Development Decision
CDR – Critical Design Review	OT&E – Operational Test and Evaluation
FOC – Full Operational Capability	PDR – Preliminary Design Review
FRP – Full-Rate Production	PRR – Production Readiness Review
IOC – Initial Operational Capability	RFP – Request for Proposal
LRIP – Low-Rate Initial Production	

3.2. ESMRM CONSIDERATIONS THROUGHOUT THE ACQUISITION LIFE CYCLE.

3.2.1. ESMRM Process. The ESMRM process requires a documented system safety approach as outlined in Military Standard (MIL-STD)-882E for managing hazards as an integral party of the systems engineering process. MIL-STD-882E uses a comprehensive and balanced risk management approach that includes performance, cost, and safety. Part 1910 of Title 29, Code of Federal Regulations (CFR) and the National Fire Protection Association 495 provide additional guidance for situation-specific hazard analyses and risk assessments where energetic materials are involved. The end result is to "achieve acceptable risk within the constraints of operational effectiveness and suitability, time, and cost throughout all phases of the system's life cycle." The only aspect addressed in this TP is ESMRM. Table 3.1. details the ESMRM questions for consideration throughout the acquisition life cycle.

Table 3.1. ESMRM Considerations Throughout the Acquisition Life Cycle

Materiel Solution Analysis (MSA)
1. Will the weapon system be, or have the capability to be, explosive or munitions-laden? 2. Can the explosives or munitions component of the weapon system be minimized or eliminated? 3. Can the manufacturing source of the explosives or munition accommodate program demand? 4. Will increased demand affect other product lines? 5. How does the hazard classification of the proposed weapon system affect storage, transportation, interoperability, and operational employment? 6. Are the explosives and munitions aspects of the proposed materiel solution fully understood and documented in the Capability Development Document? This should include the systems engineering plan, life-cycle sustainment plan, and the life-cycle signature support plan. 7. Does the explosives related materiel solution have adequate infrastructure that meets the current explosives safety standards?
Technology Maturation and Risk Reduction (TMRR). Many of the questions asked during the MSA phase of a system development need to be reevaluated during the TMRR to ensure that no significant changes have occurred and that the explosives safety risks have not changed.
1. How mature are the explosives or munitions components of the program as documented in the technology readiness assessment? 2. Have render-safe procedures for explosives and munitions been developed and documented? 3. Is a live-fire test and evaluation waiver being sought pursuant to Section 2366 of Title 10, United States Code for explosives and munitions weapon systems characterized as a "covered system"? 4. Have programs risk analyses included explosives and munitions components of the proposed weapon system? 5. Have explosives and munitions components of the program been accounted for in the programmatic environmental, safety, and occupational health evaluation? 6. Have sensitive elements of explosives and munitions components been assessed for inclusion in the program protection plan? 7. What manpower requirements will be required to sustain the explosives and munitions components of the weapon system (i.e., servicing, inspecting, and packaging)? 8. What infrastructure requirements will be necessary to support the weapon system (e.g., storage and operations facilities)? If leveraging existing infrastructure, is it sufficient for additional demands? 9. Are there any explosives or munitions components or subcomponents that are reliant on limited or diminishing manufacturing sources? 10. Have the explosives been qualified for materiel release? Have the munitions been hazard classified?

Table 3.1. ESMRM Considerations Throughout the Acquisition Life Cycle, *Continued*

Engineering and Manufacturing Development. Some of the questions asked in MSA and TMRR need to be reevaluated in this phase to ensure that the explosives safety risks have not changed.
1. Have critical supportability aspects for explosives and munitions components been addressed to ensure materiel availability for production and deployment, including sustainment? 2. Have hardware, firmware, and software affecting explosives and munitions program elements been accounted for? 3. Have reliability, availability, maintainability, and sustainability of explosives and munitions elements been demonstrated and incorporated into system design? 4. What type of facility will produce the weapon system (i.e., government-owned/government-operated; government-owned/contractor-operated; contractor-owned/contractor-operated) and what oversight structure, policy, and regulation will be used to oversee explosives safety compliance at the facility? 5. Have transportation and storage requirements been identified? Are they sufficient to support weapon system deployment? 6. Have infrastructure construction requirements required to support explosives and munitions been phased to be completed before weapon system delivery?
Production and Deployment. Some of the questions asked in the previous stages need to be reevaluated in this phase to ensure that the explosives safety risks have not changed.
1. Have product baseline updates been documented, including configuration controls, for explosives and munitions components? 2. Have explosives and munitions test and evaluation requirements been documented and accounted for across the acquisition life cycle? 3. Have explosives and munitions elements been adequately addressed in the life-cycle sustainment plan? 4. Have explosives and munitions component requirements been appropriately documented in the systems engineering plan, as applicable?
Operations and Support. Some of the questions asked in the previous stages need to be reevaluated in this phase to ensure that the explosives safety risks have not changed.
1. Are reporting procedures in place for capturing explosives and munitions component performance, reliability, and safety issues? 2. Is a process in place to advantageously apply reported data to improve the product support package, process improvements, modifications, upgrades, and future increments of the weapon system, specifically explosives and munitions components?
Disposition/Demilitarization.
1. Has disposition/demilitarization of manufacturing explosives residue been accounted for in the contract vehicle? 2. Have the disposition/demilitarization plans addressed all explosives safety considerations? Can the system be safely dispositioned/demilitarized? 3. If the system requires novel disposition/demilitarization technology, has it been identified and evaluated for effectiveness?

3.2.2. Comprehensive ESMRM.

3.2.2.1. The ESMRM needs to be current, updated periodically, and relevant for all aspects of the program. This is an iterative process to ensure that critical explosives safety requirements are not missed.

3.2.2.2. At any junction, the explosives safety and munitions risks need to be properly communicated and understood.

3.2.2.3. The risk acceptance needs to be made at the appropriate level commensurate to the level of risk. This risk acceptance needs to be reviewed and accepted whenever there are any changes, including changes in leadership.

3.3. ESMRM CONSIDERATIONS IN SUPPORT OF UONs AND JOINT URGENT OPERATIONAL NEEDS.

3.3.1. UONs are capability requirements identified by a DoD Component that support an ongoing or anticipated contingency operation. If left unfulfilled, UONs result in capability gaps that have the potential to result in loss of life or critical mission failure. DoD Component UONs apply to only one DoD Component. UONs affecting two or more DoD Components are joint urgent operational needs.

3.3.2. The primary concerns facing capabilities fielded through the UON process are related to long-term maintenance and sustainment of weapon systems. ESMRM considerations regarding maintenance and sustainment are especially problematic given the explosives safety guidance that directly affects storage, transportation, and disposition of explosives and munitions. PMs should ensure explosives and munitions-laden weapon systems acquired through the UON process account for the potential long-term issues that such systems present. In addition to the guidance provided in Paragraph 3.2., PMs should consider the following UON-specific ESMRM concerns:

3.3.2.1. Is the planned production supporting a limited requirement that does not require sustainment? Small lot specialized production may not require long-term sustainment and may not be planned for a program of record (e.g., a munition for special operation with modified fuze for shorter or longer initiation).

3.3.2.2. Is there a potential for the capability to be retained and sustained beyond near term (i.e., is the UON expected to transition into a formal program of record)?

3.3.2.3. Is this a transitional capability being fielded with the intent to terminate once an alternative formal program becomes operationally viable?

3.3.2.4. Are the explosives and munitions components of a proposed capability mature, or have they been tested and meet explosives safety requirements? Do the existing test results meet current explosives safety requirements?

3.3.2.5. Are the explosives and munitions component requirements of the proposed capability stable? This includes transportation, storage, maintenance, sustainment, intended operational environment, and demilitarization.

3.4. ACQUISITION PROGRAMS THAT CONTAIN AMMUNITION AND EXPLOSIVES.

3.4.1. ESMRMs should be conducted for all acquisition systems that contain ammunition and explosives regardless of the type of program. This includes rapid acquisition, rapid prototyping, rapid fielding, agile, integrated, adaptive, programs listed in Section 804 of the National Defense Authorization Act for Fiscal Year 2018, or any other part of the government investments. This ESMRM effort should not be seen as a hindrance to these programs but as a capability that, when added to the overall program, significantly increases the combat potential and safety of the warfighter.

3.4.2. These acquisition programs should be notified that tailoring of the safety ESMRM requirements will be considered. The explosives safety community will work with the programs to ensure that explosives safety requirements are addressed and the programs' schedules are not adversely affected.

3.4.3. In many instances acquisition programs may contain hazards other than explosives. These risk assessments are not within the scope of this TP and are not discussed. The specific guidance may be found in other DoD issuances regarding specific system hazards (e.g., lasers, radiation).

3.5. ADDITIONAL EXPLOSIVES SAFETY CONSIDERATIONS.

3.5.1. When developing new systems, or improvements of existing systems, the PM will conduct explosives safety risk assessments in accordance with the guidelines in MIL-STD-882E and this TP. Special explosives safety considerations that may be applicable include:

3.5.1.1. Chemical hazards, environmental, and toxicological studies.

3.5.1.2. Scale-up parameters.

3.5.1.3. Storage requirements and hazard classification for transport.

3.5.1.4. Critical chemicals, ingredients requalification, and materials reliability.

3.5.1.5. Interoperability/Joint Service usage.

3.5.2. Challenges faced when explosives safety risk assessments are not considered include:

3.5.2.1. New energetic ingredients not considering toxicology or commercial supplier getting fielded.

3.5.2.2. Insensitive munitions rounds having head-space and timing tolerance issues during use.

3.5.2.3. New weapon systems not having adequate infrastructure when fielded.

3.5.3. ESMRM challenges become significant when not addressed properly. It is only during the system life-cycle explosives safety risk assessments that programs can identify and mitigate these types of hazards. The development of these safety strategies ensure the ease of fielding and the well-being of the warfighter.

3.6. ESRM AND RISK ACCEPTANCE DURING MUNITION LIFE CYCLE.

3.6.1. Management of ESMRM-related risks may become necessary at any phase of the munition life cycle. Weapon systems that have elements inconsistent with applicable guidance will warrant an assessment of the nonconforming ESMRM portion of the Acquisition Program. Documented acceptance of explosives safety risk will be accomplished by an authority commensurate with the level of risk being accepted and the applicable life-cycle phase as determined by the Component-level guidance. Depending on the life-cycle phase, this may be the Acquisition Program MDAs and PMs, Military Services, CCMD, Subunified Commands, Joint Task Forces, or their subordinate component commands.

3.6.2. The ESMRM assessment process documented in Chapter 4 of this TP, in combination with the resources and tools described in Chapters 5 and 6, provide an approach to assessing explosives safety risks. The process and tools in these chapters may be used in isolation or in combination with existing programmatic tools used in the acquisition community (e.g., active risk manager).

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CHAPTER 4: EXPLOSIVES SAFETY RISK ASSESSMENT PROCESS

4.1. BACKGROUND.

4.1.1. There are a number of locations where explosives and munitions are developed, handled, assembled, tested, stored, used, and demilitarized that cannot meet the requirements of DESR 6055.09. These locations range in levels of complexity and available data. The type and level of risk assessment required may depend on what is known about the location of the risks involved, and how much of an investment may be required to mitigate the risks. The risk assessment tools used may vary depending on the level of complexity. The DDESB and Services' Explosives Safety Organizations can assist with these assessments.

4.1.2. MRMAs will inform leaders of the risk associated with explosives and munitions based on the potential consequence associated with an explosives incident. The DoD Component risk management processes can be used to quantify hazard severity and mishap probability. This will determine the decision level that can approve a deviation from the explosives safety requirements of DESR 6055.09 or related regulatory guidance.

4.1.3. MRMAs will analyze the potential consequences of an explosives or munitions-related incident at an operating location, including an estimate of:

4.1.3.1. The number of personnel exposed, potential fatalities, and potential injuries involved as defined in the risk assessment scope.

4.1.3.2. The infrastructure and physical assets (e.g., military equipment, manufacturing equipment) exposed as defined in the risk assessment scope.

4.1.3.3. The operational impact and cost of lost assets and potential infrastructure damage as defined in the risk assessment scope.

4.1.4. MRMAs will analyze risks to and from explosives and munitions and their related operations. Site-specific risk reduction recommendations to mitigate identified risks should be considered in the analysis. MRMA decision authority will be determined by, and delegated no lower than, the prescribed levels agreed to in the MRMA methodology used (i.e., DoD Component-specific risk management policy or MIL-STD-882E). At no time will the risk decision authority be delegated below general/flag officer, or civilian equivalent, for a risk determined to be high or greater.

4.1.5. Geographic combatant commands will follow the guidance in Chairman of the Joint Chiefs of Staff Instructions (CJCSIs) 4360.01B and 3150.25G for overseas operating locations.

4.1.6. In each case, the MRMA and the derived qualitative measure used to identify the hazard severity will be coordinated for approval as a single package. This will ensure that potential consequences and mitigating strategies are effectively communicated throughout the organization/chain of command.

4.2. CIRCUMSTANCES REQUIRING ESMRM ASSESSMENT. An ESMRM assessment is required:

4.2.1. When explosives safety requirements of DESR 6055.09 cannot be met and deviations from standards as specified in DoDI 6055.16 are required.

4.2.2. In support of the nonconforming portion of a hybrid safety submission as defined in DoDI 6055.16.

4.2.3. When explosives safety elements of an acquisition program are noncompliant with DoD or regulatory guidance (e.g., nonstandard ammunitions).

4.2.4. When there is nonstandard, foreign, or acquired ammunitions.

4.2.5. In support of civilian locations where DoD military munitions will be, or are forecasted to be, supporting operational requirements.

4.3. MRMA MAINTENANCE AND UPDATE FREQUENCY.

4.3.1. Strategic, operational, and tactical operational environments, in addition to acquisition life cycles, may be dynamic and fluid. MRMAs should be maintained and updated to reflect changes that can occur within acquisition programs, operating environments, and mission scope. Munitions-related risks will be reevaluated as specified. MRMAs that support:

4.3.1.1. Explosives safety deviations as defined in the DESR 6055.09 and DoDI 6055.16 will be updated in accordance with the timelines specified.

4.3.1.2. Strategic, enduring, contingency, or exercise locations not under DoD control (e.g., commercial ports, airfields) require validation every 24 months.

4.3.1.3. Strategic, enduring, contingency, and exercise locations under DoD control (e.g., Military ports, airfields) require validation every 24 months when the deviation is a waiver required to support either temporary operational requirements or the completion of corrective actions to eliminate a deviation.

4.3.1.4. Acquisition programs will be updated in accordance with the MDA.

4.3.2. MRMAs are subject to review or updating when (as applicable):

4.3.2.1. The geographic combatant commander (GCC) has undergone a change of command. The combatant commander will be informed of approved MRMAs affecting the GCC on taking command.

4.3.2.2. The functional combatant command (FCC) has undergone a change of command. The combatant commander will be informed of approved MRMAs affecting the United States Transportation Command distribution network.

4.3.2.3. MDA has undergone a change of authority. The Director, MDA, will be informed of approved MRMAs affecting acquisition programs on being appointed director.

4.3.2.4. Changes have occurred to acquisition program baselines, operation plans, or concept plans that significantly affect weapon system development, manufacturing, deployment, sustainment, operations, and disposition.

4.3.2.5. The risk associated with DoD military explosives and munitions at a specific location that affect personnel, equipment, or infrastructure have increased.

4.3.3. GCCs, FCCs, MDAs, and the Services may elect to require more frequent MRMA reevaluations based on administrative or operational considerations. It is also recommended that more frequent evaluations occur based on higher levels of risk.

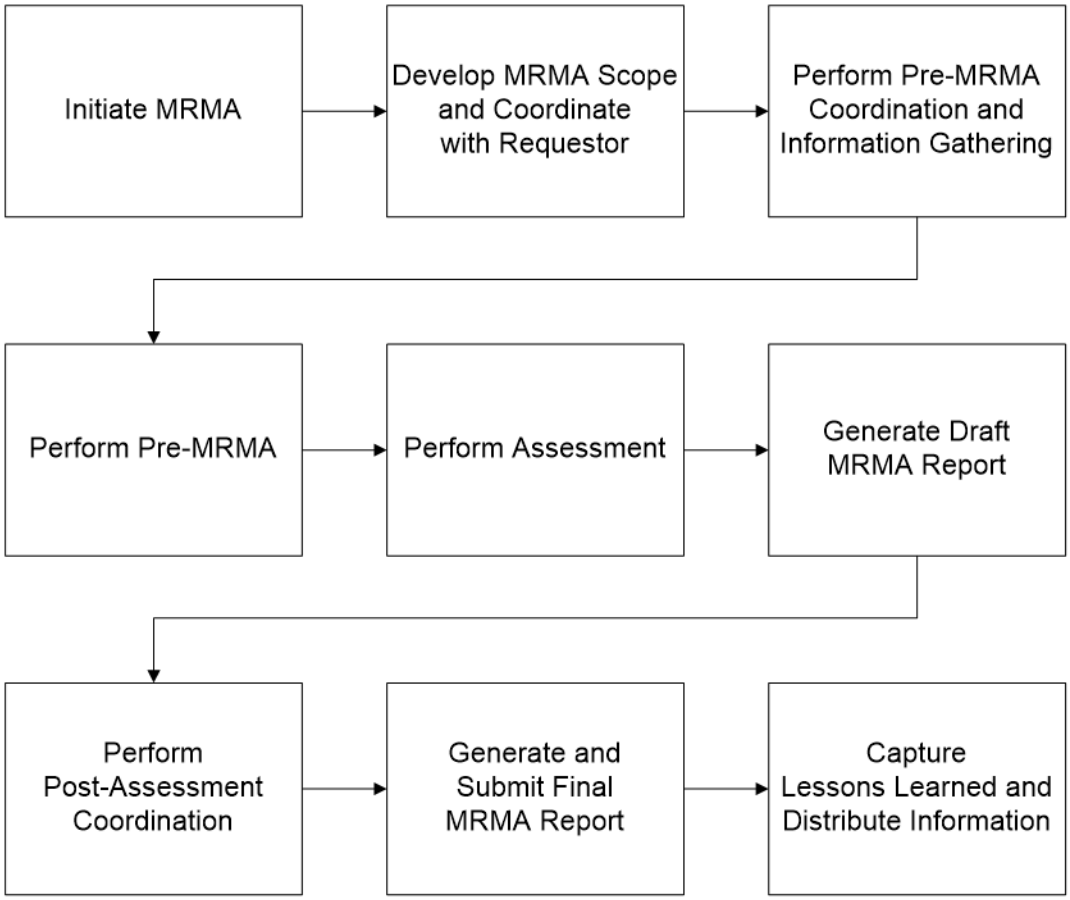
4.4. TOOLS AND FACTORS FOR ASSESSING EXPLOSIVES SAFETY RISK.

4.4.1. The ESMRM risk assessment process is based on a variety of tools that includes quantity distance (QD) and risk-based tools, observations, interviews, information gathered before and during the assessment, and analysis and application of DoD and DoD Component issuances. The methodologies used in each risk assessment will be identified in both the draft and final assessment reports. Chapter 5 provides a framework for assessing the likelihood and subsequent consequence of an explosives mishap. Chapter 6 provides an overview of the common risk assessment tools and their applicability.

4.4.2. In each risk assessment, the assessment and the derived qualitative measure used to identify the hazard severity will be identified and coordinated as a single package. This will ensure that potential consequences and mitigating strategies are effectively communicated to all affected parties. Additional guidance for conducting situation-specific hazard analyses and risk assessments where energetic materials are involved can be found in MIL-STD-882E; Part 1910 of Title 29, CFR; and the National Fire Protection Association 495. The DoD Components can use these methods to evaluate risks, document processes and findings, and inform leadership. Aspects of these methodologies can be included in operating procedures, technical orders, site plans, or other specific safety documentation where risk identification, quantification, and communication are needed.

4.5. ESMRM ASSESSMENT PROCESS. Figure 4.1. shows the specific steps that should be followed when conducting an ESMRM. Paragraphs 4.5.1. through 4.5.6. describe how to proceed in each step.

Figure 4.1. MRMA Process



4.5.1. Step 1: Initiate MRMA. The requesting organization will initiate a request for an MRMA through the PM or Service component with the lead equity in the program or weapon system. MDA, GCC, FCC, and DoD Component commanders or subordinate commanders can initiate requests for MRMAs at non-DoD controlled facilities or locations not assigned a lead Service.

4.5.1.1. The DoD Components can conduct MRMAs using the resources of their organizations/installations in accordance with Paragraph 4.1.1.

4.5.1.2. MRMAs accomplished organically may tailor the MRMA process to meet assessment objectives. A completed MRMA must be distributed to all parties with equities in the MRMA (i.e., report, briefs, and U.S. Army Deviation and Risk Acceptance Document (DARAD), if used).

4.5.2. Step 2: Develop MRMA Scope and Coordinate with Requestor. The minimum content of the MRMA scope, possible modifications to assess and develop a comprehensive final report, and assessment team composition are shown in Table 4.1. The assessment team lead will assemble a team based on the type of assessment requested, scope, and the location. Team representation should be determined based on the type and intended use of the assessment.

Table 4.1. Step 2: Develop MRMA Scope and Coordinate with Requestor

Minimum Content	Modifications	Assessment Team Composition
1. All areas to be included in the assessment addressed in the content agreement. A signature page with both the requestor and the assessment team lead signatures is required ensuring process and output expectations are understood. 2. Assessment location and, as required, associated lines of communications (LOCs) and distribution channels. 3. Assessment approach and methodology. 4. Assessment team composition. 5. Timelines (i.e., assessment execution window and delivery expectations). 6. Deliverables (i.e., report, briefs, and U.S. Army Deviation and Risk Acceptance Document (DARAD), if used) and their distribution. 7. Any required follow-on actions.	1. Modifications to the scope will be documented for complete understanding and become part of the report. 2. The requestor and assessment team lead will agree to each modification; either party can initiate a modification. 3. Final modifications will be distributed to all parties with equity in the respective MRMA.	1. DDESB. 2. Acquisition Program Office. 3. PM. 4. Lead Service acquisition program element manager. 5. Defense Contract Management Agency. 6. Commercial industry partners. 7. Commercial port operators. 8. Service Explosives Safety Center. 9. Surface Deployment and Distribution Command. 10. Supporting engineering command (e.g., Naval Facilities Engineering Command, throughput assessors and engineers, Army Corps of Engineers). 11. Service expeditionary support team. 12. U.S. Defense Attaché Office. 13. Air Mobility Command. 14. Military Sealift Command. 15. Requesting Service Component. 16. Applicable MDA, GCC, or FCC Joint Munitions Officer or equivalent representative. 17. Host-nation (HN) representatives. 18. Location Support Organizations (e.g., Explosives Safety Specialist, Occupational Safety, Logistics Management Specialist, Planning Elements, Defense Contract Management Agency, Quality Assurance Specialist-Ammunition Surveillance).

4.5.3. Step 3: Perform Pre-MRMA Coordination and Information Gathering. The assessment team must acquire relevant MRMA information necessary for advance arrangements for effective MRMA execution, including logistics requirements as shown in Table 4.2.

Table 4.2. Step 3: Perform Pre-MRMA Coordination and Information Gathering

Assessment Team Logistics	Acquisition and Site-Specific Technical Information	Coordination with External Organizations
1. Pre-site survey travel to the assessment location. 2. Medical (e.g., vaccinations, certificates). 3. Country clearance. 4. Personal protective equipment. 5. Transportation and billeting. 6. Advance notifications to affected parties/organizations. 7. Applicable restrictions and limiting factors. 8. HN coordination and local requirements. 9. Political conditions (country brief). 10. Training (e.g., antiterrorism/force protection and combatant command-specific). 11. Equipment critical to mission success (e.g., Global Positioning System, camera, laptop computer, range finder, communications equipment). 12. Personal security clearance information, as required. 13. Passport. 14. Government Card. 15. HN coordination and site access approval.	1. Acquisition program documents. 2. Commercial manufacturing explosives safety requirements. 3. Explosives and munitions transportation, storage, maintenance, and demilitarization requirements. 4. Commercial output/throughput capability. 5. Existing site plans, where applicable. 6. Existing deviations, prior MRMAs, and explosives safety-related risk decision documents based on prior MRMAs. 7. Operation plan/concept plan details and supporting information, including concept of operations for exercise or other military operations. 8. Maps and overhead imagery of manufacturing, distribution, and operating locations. 9. Supporting infrastructure integral to explosives and military munitions manufacturing and processes. 10. Status of forces agreements. 11. International agreements. 12. HN munitions and munitions process information. 13. Local HN logistic node laws and regulations. 14. Allied Ammunition Storage and Transport Publication. 15. HN explosives safety laws, limitations, and regulations. 16. Exposures (e.g., population density, vehicles, infrastructure).	1. Commercial Partners, prime contractors, and associated sub-contractors. 2. CCMDs. 3. DoD Components. 4. FCC (including appropriate components). 5. Joint Staff J-2/-3/-4/-5/-7. 6. DDESB. 7. DoD Component explosives safety centers (e.g., U.S. Army Technical Center for Explosives Safety, Naval Ordnance Safety and Security Activity, Air Force Safety Center, Marine Corps Systems Command). 8. Supporting engineering activity (e.g., Naval Facilities Engineering Command, Army Corps of Engineers, Military Surface Deployment and Distribution Command). 9. Department of State. 10. Military attaché. 11. Defense Intelligence Agency. 12. National Geospatial-Intelligence Agency. 13. Service Component expeditionary support team. 14. HN equities as prescribed by Department of State.

4.5.4. Step 4: Perform Pre-MRMA Analysis.

4.5.4.1. Accomplish initial analysis of data and materials compiled in Step 3.

4.5.4.2. Reconcile documents in relation to assessment scope.

4.5.4.3. Assess explosives, munitions, and their related process risks in the context of manufacturing, transportation, storage, operation, and demilitarization to be executed at the MRMA site.

4.5.4.4. Identify information gaps that require resolution before on-site assessment.

4.5.4.5. Ensure all assessment team member requirements are fulfilled for on-site assessment, as required.

4.5.5. Step 5: Perform MRMA Assessment. MRMAs may be accomplished on-site or virtually. In either instance, the MRMA team assesses all phases of explosives and munitions acquisition, manufacturing, and operations as a single system with respect to the acquisition program, mission, vulnerabilities, and hazards to and from explosives and munitions operations. Table 4.3. provides details of the assessment, which will be performed in accordance with Paragraph 4.5.2.

Table 4.3. Step 5: Perform MRMA Assessment

Assess manufacturing, storage, and operating locations, LOCs, and supporting infrastructure to identify the consequences and risks to and from explosives and munitions and their related processes in relation to operations, environment, and surrounding community. Consider the following, as applicable:
1. Explosives and munitions manufacturing infrastructure need to be evaluated. The assessment needs to take into account the different product lines that may be affected by a partial or total loss of the facility. 2. Reception, staging, onward movement, and integration elements and associated support equipment requirements. 3. Supporting LOCs at no less than inhabited building distance (IBD). 4. Surface transportation routes of ingress/egress (i.e.., rail or road) used for explosives and munitions transport. Road assessment should include width assessment based on the type of vehicles used. 5. Clear zones around loading and unloading points. 6. Ability to access the loading and unloading points. 7. Containerized munitions on/off-load support equipment (e.g., cranes, handling equipment). 8. Supporting munitions-enabling infrastructure (e.g., operating facilities, storage pads/facilities, in-transit holding areas). 9. Ability to throughput multiple missions at a single location. 10. Tactical assembly areas and large gun siting/checkout areas. 11. Emergency response capabilities, equipment, and timelines. 12. Location and information on potential exposed sites (ES), such as shopping centers, hospitals, schools, apartment complexes, and houses. 13. Location of hazardous materials producers and storage (e.g., liquefied natural gas or bulk fuels facilities). 14. Utilities location (e.g., gas pipes, power stations, electrical lines, critical communication nodes). 15. Encumbered commercial operations independent of explosives and munitions operations. 16. Lightning protection systems.
Assess risk in accordance with the agreed upon scope in Step 2. Develop risk management measures that may mitigate or eliminate identified risks for MRMA risk decision authority consideration.
1. Develop risk control measures to address remaining risks, as appropriate. Controls may include protective construction, protective or specialized equipment, remote operations, and limitations on personnel exposures and operating timeframes. 2. Controls may reduce risk by reducing the hazard or reducing the probability of the event. Effective measures must address who, what, where, when, why, and how the control will affect the risk and associated operation. 3. Residual risk and hazard (what remains after the controls are introduced) should be reevaluated to ensure no new hazards are introduced and the overall risk levels are reduced.
Generate and deliver preliminary on-site out-brief to the appropriate leader. Emphasis must be placed on the preliminary nature of information pending draft report coordination and finalization.

4.5.6. Steps 6, 7, 8, and 9: Creation of Final MRMA Documentation and Archive. The final four steps in the MRMA process are the generation of a draft report, post-assessment coordination, generation and submittal of a final report, and the capture and distribution of lessons learned. Table 4.4. provides details of each of these steps.

Table 4.4. Steps 6, 7, 8, and 9: Creation of Final MRMA Documentation and Archive

Step 6: Generate Draft MRMA Report. The report will include:
1. Executive summary will contain the recommended decision and risk-reducing actions detailed in the report. 2. MRMA purpose or objective. 3. Scope of assessment (with signatures and modifications). 4. MRMA methodology. 5. Explosives safety technical information (e.g., site plans, deviations, and exposures). 6. Identification and explanation of explosives and munitions operations and their related processes. 7. Infrastructure analysis based on risk to and from explosives and munitions and their related processes. 8. Overall risks to and from explosives and munitions and their related processes. 9. Recommendations for mitigating or eliminating explosives safety risks. 10. Proposed organizations/units responsible for implementing or supporting risk-reduction actions and timeline for implementation. 11. Process for executing oversight of risk reduction implementation measures and associated MRMA authority decisions.
Step 7: Post-Assessment Report Coordination. The MRMA team lead is responsible for ensuring coordination execution and report accuracy.
1. Coordination will be accomplished using the Document Comment Resolution Matrix in Figure 4.2. Critical inputs require adjudication or clarification with input source. 2. Coordination timeline and finalization of MRMA deliverables will vary based on the number of locations and number of potential explosion site (PES) and ES relationships. MRMA report completion generally takes up to 6 months.
Step 8: Generate and Submit Final MRMA Report
1. The MRMA team will develop and coordinate the final brief in conjunction with developing the report. Final briefs will be provided by the MRMA team lead and members as agreed to in Paragraph 4.5.2. 2. The MRMA team lead will provide the final report to the requestor during the final brief and subsequently distribute the report to the DDESB and parties as agreed to in Step 2. 3. Additional follow-on actions as required by MRMA decision authority.
Step 9: Lessons Learned and Information Management
1. The MRMA team lead will capture lessons learned from the assessment team and requesting organization in accordance with CJCSIs 3150.25G and 4360.01B. Inputs should focus on improving MRMA processes (i.e., coordination, scoping, logistics, data gathering, and information management). 2. The requesting organization will distribute MRMA information and associated risk management decisions as agreed to in Step 2.

Figure 4.2. Document Comment Resolution Matrix

Name:								
Organization:							**Phone:**	
#	**Staff**	**Type**	**Page**	**Para**	**Line**	**Comments**	**Rationale**	**Adjudication Decision**

Type

- Critical – Comments are such that you will recommend nonconcurrence on the final if not incorporated. You must provide convincing support for such nonconcurrence in the Rationale section.
- Substantive – Comments will not necessarily justify a nonoccurrence if not incorporated.
- Administrative – Comments are those that require consideration.

Page. Page numbers are expressed in decimal form using this format, Page I-2 = 1.02, enabling proper sorting of consolidated comments.

Paragraph. Paragraph number that pertains to the comment expressed (e.g., 4a, 6g).

Line. Line number on the designated page that pertains to the comment, expressed in decimal form (e.g., line 1=1, line 4-5 = 4.5, line 45-67 = 45.67).

- For figures where there is no line number, use "F" with the figure number expressed in decimal form (i.e., figure II-2 as line number F2.02).
- For appendices, use the "F" and the appendix letter with the figure number (e.g., Appendix D, Figure 13 as line number FD.13; Appendix C, Annex A, Figure 7 as line number FCA.07)

Comment. Provide comments using line-in-line-out format. To facilitate adjudication of comments, copy and insert complete sentences into the matrix. This makes it unnecessary to refer back to the publication to understand the rationale for the change. **Do not use Tools/Track Changes mode to edit the comments in the matrix.** Include deleted material in the comment in the strikethrough mode. Add material in the comment with underlining. Do not combine separate comments into one long comment in the matrix, (i.e., five comments rolled up into one).

Rationale. Provide concise, objective explanation of the rationale for the comment.

Adjudication Decision

- A – Accept
- R – Reject (Rationale required for rejection)
- M – Accept with modification (Rationale required for modification)

4.6. REVIEW AND UPDATING EXISTING MRMA. An MRMA is only effective if maintained and updated periodically. As conditions change, missions evolve, operational scope matures or changes a new or update to the assessment is required.

4.6.1. Perform the following actions to review and update MRMAs:

4.6.1.1. Identify changes to PES, ES, and explosives and munitions-related infrastructure.

4.6.1.2. Determine how changes impact potential fatalities, facilities, and infrastructure damage estimates.

4.6.1.3. Assess impact of changes on previously identified risk management processes.

4.6.1.4. Update any changes to explosives safety technical information and issuances.

4.6.1.5. Reassess risk to and from explosives and munitions and their related processes.

4.6.1.6. Update recommendations and risk mitigation measures.

4.6.2. Execute MRMA Steps 6-9 to complete the MRMA update.

CHAPTER 5: CONSEQUENCE AND PROBABILITY MATRIX

5.1. RISK. Assess explosives risk associated with all identified hazards. Risk is comprised of both probability and severity and both components can be evaluated either qualitatively or quantitatively. This chapter provides an expanded framework for assessing explosives safety risks. The content may be used to inform or expand on the existing risk management approaches in MIL-STD-882E and CJCSI 4360.01B.

5.2. PROBABILITY. The probability portion of a risk assessment involves determining the likelihood of a hazard occurring. Assessor experience and knowledge of the mission and operations being conducted are significant considerations as they will inform estimates of an occurrence. Mishap probability categories as presented in MIL-STD-882E are shown in Table 5.1. Consult MIL-STD-882E for expanded and current guidance.

Table 5.1. MIL-STD-882E Defined Probability Levels

Description	Level	Specific Individual Item	Fleet or Inventory
Frequent	**A**	Likely to occur often in the life of an item.	Continuously experienced.
Probable	**B**	Will occur several times in the life of an item.	Will occur frequently.
Occasional	**C**	Likely to occur sometime in the life of an item.	Will occur several times.
Remote	**D**	Unlikely, but possible to occur in the life of an item.	Unlikely, but can reasonably be expected to occur.
Improbable	**E**	So unlikely, it can be assumed occurrence may not be experienced in the life of an item.	Unlikely to occur, but possible.
Eliminated	**F**	Incapable of occurrence. This level is used when potential hazards are identified and later eliminated.	Incapable of occurrence. This level is used when potential hazards are identified and later eliminated.

5.3. MUNITIONS-RELATED PROBABILITIES. A matrix similar to the MIL-STD-882E matrix for explosives safety purposes is shown in Table 5.2. The probability levels specific for munitions-related mishaps were agreed on by the Service representatives and are commonly used by all Services when reporting deviations. Detailed examples of Service-specific operations and probabilities are documented in MIL-STD-882E and Part 1910 of Title 29, CFR. Table 5.3. lists

conditions that may increase the likelihood of an event occurring more often than the probabilities listed in Table 5.2.

5.3.1. Explosives safety requirements, operational procedures, and engineering controls reduce the probability of an explosives mishap. Therefore, explosives operations that comply with established guidance will rarely have a "Frequent" or "Probable" likelihood of an explosives mishap.

5.3.2. The probability and severity model discussed in this TP does not apply to intentional detonations. The ESS requirements of DESR 6055.09 apply in such circumstances.

Table 5.2. Probability Levels for Munitions-Related Mishaps

PES Used Primarily for:	Probability*
Burning Ground/Demilitarization/Demolition/Disposal/ Explosive Ordnance Disposal	OCCASIONAL
Assembly/Disassembly/Land Acquisition Plan/ Maintenance/Renovation	REMOTE
Lab/Test/Research, Development, and Test Evaluation	REMOTE
Training	REMOTE
Missile System in Static Mode	IMPROBABLE
Manufacturing/Production	IMPROBABLE
Inspection/Painting/Packing	IMPROBABLE
Loading/Unloading/Handling (Ships, Aircraft, Vehicles, Container Stuffing/Unstuffing)	REMOTE
Short-Term Storage (hours - few days)	IMPROBABLE
Temporary Storage (1 day - 1 month)	IMPROBABLE
Deep Storage (1 month - year)	IMPROBABLE

*Default probability is continental United States day-to-day home station activities.

Table 5.3. Conditions that Affect the Probability of an Event

Conditions that Affect the Probability of an Event ***Check all that apply.***
☐ Outside the continental United States operations in support of wartime actions.
☐ Operations involving dangerously unserviceable items awaiting destruction.
☐ Operations involving exposed explosives.
☐ Captured enemy ammunition.
☐ Break bulk operations.
☐ Nonstandard ammunition.
☐ Combat configured loads, Z compatibility.
☐ Outdoor storage/operations normally done indoors.
☐ Home station activities during exercises/contingencies/alert.
☐ Unserviceable ammunition.
☐ Initial tests of new systems.
☐ Operations occurring in hazardous environments with gases, fibers, etc.
☐ Required remote operations.
☐ Concurrent servicing operations, forward arming and refueling, hot arming and refueling, or integrated combat turn operations.
☐ Considerations of monetary losses in the absence of injuries or fatalities. This can be equipment or unique capabilities.
☐ Consideration of mishaps occurring outside of QD criteria.
☐ Consideration of damage occurring to the public.
☐ System is noncompliant with DoD regulatory guidance.

5.3.3. In many instances, the team conducting the assessment defines and justifies probabilities depending on their level of understanding of the situation. When establishing these probabilities, consider the guidance provided along with factors such as unique capabilities, monetary considerations in the absence of injury or fatality, mission, or other programmatic aspects. This ESMRM only addresses the probabilities that are driven by DoDD 6055.09E, DoDI 6055.16, and DESR 6055.09.

5.4. SEVERITY. The severity portion of a risk assessment involves determining the negative impact on personnel, facilities, equipment, operations, the public, and the environment. Many of the questions asked in the hazard identification step will assist in determining the severity of the event and magnitude of the risk. The DoD Component conducting the assessment must determine how the event severity will be classified. Severity categories are identified and defined in Table 5.4. When determining the severity category, additional considerations include unique capabilities, replacement costs, time lost, political impact, impact to local populations, and other considerations deemed important by the team conducting the assessment.

Table 5.4. Severity Categories

Description	Category	Definition
Catastrophic	**1**	Mission Failure One or more deaths or serious injuries to individuals not meeting QD criteria.
Critical	**2**	Mission Interrupted Multiple serious injuries to individuals not meeting QD criteria.
Marginal	**3**	Mission Degraded Minor injuries to individuals not meeting QD criteria.
Negligible	**4**	Mission Unaffected No anticipated injuries or other effects to individuals not meeting QD criteria.

5.5. RISK LEVEL. The combination of hazard severity and probability of event is expressed as a level of risk (high, serious, medium, or low) based on the risk assessment matrix in Table 5.5., as specified in MIL-STD-882E.

Table 5.5. Risk Assessment Matrix in Accordance with MIL-STD-882E

Probability/ Severity	Catastrophic (1)	Critical (2)	Marginal (3)	Negligible (4)
Frequent (A)	High	High	Serious	Medium
Probable (B)	High	High	Serious	Medium
Occasional (C)	High	Serious	Medium	Low
Remote (D)	Serious	Medium	Medium	Low
Improbable (E)	Medium	Medium	Medium	Low
Eliminated* (F)	Eliminated*			

*Since explosives are inherently reactive and hazardous, total elimination of the risk is not likely. In the case of ESMRM, "Eliminated" as a probability category should be well justified and substantiated with data.

5.5.1. The matrix in Table 5.5. was modified to account for ESMRM-specific practices, which is shown in Table 5.6.

Table 5.6. Risk Assessment Matrix as Adopted by the Components for Explosives Risk

Severity	**A - Frequent**	**B - Likely**	**C - Occasional**	**D - Seldom**	**E - Unlikely**
I - Catastrophic	EH(1)	EH(1)	H(2)	H(2)	M(3)
II - Critical	EH(1)	H(2)	H(2)	M(3)	L(4)
III - Moderate	H(2)	M(3)	M(3)	L(4)	L(4)
IV - Negligible	M(3)	L(4)	L(4)	L(4)	L(4)
Legend					
Description	**Symbol**	**Risk Assessment Code (RAC)**	**Color**		
Extremely High	EH	1			
High	H	2			
Moderate	M	3			
Low	L	4			

5.5.2. The DoD Components have agreed to the common methodology outlined in this chapter when documenting and communicating their Component's deviations. These deviations should also be made available to the DDESB.

5.6. DEVIATIONS. Hazards that result in violations of the explosives safety standards require a deviation in accordance with DESR 6055.09. The explosives safety risk assessment process

provided in Chapter 4, in combination with the risk assessment tools described in Chapter 6 and the risk assessment matrix in this chapter, will help the DoD Components assess the explosives safety risk. The DoD Components may use, or augment, the process and tools described in this TP with other DDESB or DoD Component developed tools. The Services have additional explosives safety risk assessment regulations:

5.6.1. Army – DA Pamphlet 385-30.

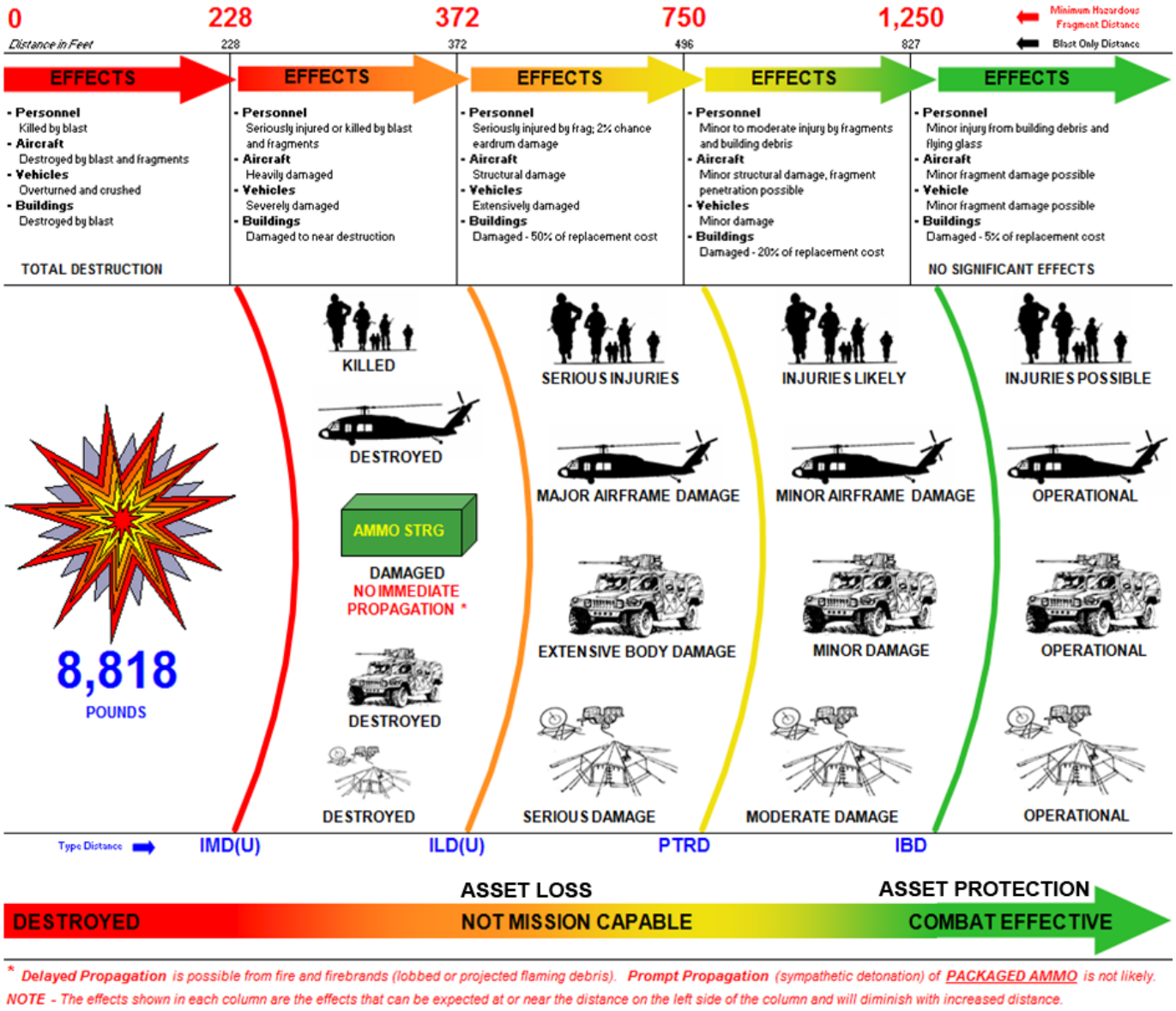
5.6.2. Navy – Department of the Navy Instruction 3500.39C.

5.6.3. Air Force – Air Force Instruction 90-802.

5.6.4. Marine Corps – Order 3500.27C.

5.7. RISK COMMUNICATION AND RISK ACCEPTANCE. Two critical components of an ESMRM are risk communication and risk acceptance. Figure 5.1. illustrates the possible damage caused by an explosion as a function of distance. It can be used as a communication tool to illustrate the different explosion effects, personnel injury and fatalities, asset loss, and mission impairment as a function of distance. This information, along with the risk level, can be a useful communication tool and be included in the risk acceptance documentation. The DoD Components have agreed to follow the procedures outlined in this TP when documenting and reporting explosives safety-related deviations.

Figure 5.1. Illustration of Blast/Fragment Effects as a Function of Distance



* ***Delayed Propagation*** *is possible from fire and firebrands (lobbed or projected flaming debris).* ***Prompt Propagation*** *(sympathetic detonation) of* ***PACKAGED AMMO*** *is not likely.*

NOTE - The effects shown in each column are the effects that can be expected at or near the distance on the left side of the column and will diminish with increased distance.

CHAPTER 6: RISK ASSESSMENT TOOLS

6.1. TOOLS FOR ASSESSING THE EXPLOSIVES SAFETY RISKS. The DDESB has given the DoD Components latitude on how the explosives safety risks are assessed and documented for the risk acceptance process. Various software tools are available for performing explosion hazard, consequence, and risk assessments to assist the DoD Components in their overall ESMRM process. These tools range in complexity and accuracy. It is important that the right tool is used for the appropriate risk assessment. This chapter provides a short description of each available tool. If a DoD Component needs a different ESMRM tool, the DoD Component may develop its own based on specific requirements.

6.1.1. ESMRM tools include:

6.1.1.1. Nomograph or Nomagram - A graphical representation detailing the parameters that drive the explosives safety deviation versus an assessment of what may happen given an inadvertent event. This should also be accompanied by a documented risk acceptance.

6.1.1.2. ESS - The DDESB-approved automated site planning tool. This software is used to perform explosives safety site planning. For Service personnel, contact your Service explosives safety office (U.S. Army Technical Center for Explosives Safety, Naval Ordnance Safety and Security Activity, Air Force Safety Center, Marine Corps Systems Command) to obtain this software. For all other U.S. Government personnel, contact the DDESB regarding this software.

6.1.1.3. Automated Safety Assessment Protocol - Explosives (ASAP-X).

6.1.1.4. Consequence and Risk Identification Assessment Tool.

6.1.1.5. Safety Assessment for Explosives Risk (SAFER) Hazard and Explosion Effects.

6.1.1.6. Field Assessment Spreadsheet Tool for Operational Munitions Risk Management in Explosive Safety Site Planning (FAST-Site).

6.1.2. Some of the tools are described in detail in this chapter. The DoD Component conducting the risk assessment for a deviation need only accept a risk above and beyond what is already accepted by meeting the ESQD. The risk associated with meeting the ESQD requirements of DESR 6055.09 is understood and accepted by the DoD.

6.2. ESMRM TOOLS. Table 6.1. lists the currently available explosion assessment tools. The table is a summary of all the available explosion assessment tools capable of estimating the hazards, consequences, and risks of a PES on ESs in terms of percent damage/dollar loss (%_damage/$_loss), percent/number of injuries (%/#_injuries), percent/number of fatalities (%/#_fatalities). The tools are divided into three categories called tiers.

Table 6.1. Explosion Assessment Tools

Analysis	Tool	Application Type	Resp. Org.	Documentation	Analysis Results
Tier 1					
Consequences based on DESR 6055.09 damage descriptions	ASAP-X/C&RI	Spreadsheet	DDESB	TP 23	$loss, #injuries/fatalities
	HAZX/ASAP-X	GUI/GIS	ACTA	User's Guide w/ tech info	%damage, $loss, %/# minor/major injuries/fatalities, DARAD, various GIS displays/reports
	RBESS/ASAP-X	GUI/GIS	EXWC	RBESS User's Guide	%damage, $loss, %/# minor/major injuries/fatalities, DARAD, various GIS displays/reports
	RBESS/MRAS/ ASAP-X	GUI/GIS	EXWC	RBESS User's Guide	%damage, $loss, %/# minor/major injuries/fatalities, DARAD, various GIS displays/reports
Tier 2a					
Consequences based on DDESB TP 14, Rev. 4	HAZX/TP 14	GUI/GIS	ACTA	User's Guide w/ tech info	%damage, $loss, %/# minor/major Injuries/fatalities, DARAD, risk Matrix/RAC, various GIS displays/reports
	RBESS/TP 14	GUI/GIS	EXWC	RBESS User's Guide	%damage, $loss, %/# minor/major Injuries/fatalities, DARAD, risk Matrix/RAC, various GIS displays/reports
	FAST-Site	Spreadsheet	APT	User's Guide w/ tech info	%damage, $loss, %/# minor/major injuries/fatalities, other graphic displays/reports
	SAFER	GUI/GIS	APT	TP 19	%damage, $loss, %/# minor/major injuries/fatalities, other graphic displays/reports
Tier 2b					
Consequences based on DDESB TP 14, Rev. 4	SAFER	GUI/GIS	APT	TP 19	%damage, $loss, %/# minor/major injuries/fatalities, other graphic displays/reports
	HAZX	GUI/GIS	ACTA	User's Guide w/ tech info	%damage, $loss, %/# minor/major injuries/fatalities, other graphic displays/reports
Tier 3					
Consequences based on PES/weapon-specific data	HAZX	GUI/GIS	ACTA	User's Guide w/ tech info	%damage, $loss, %/# minor/major injuries/fatalities, other graphic displays/reports

ACTA	Advanced Core Concepts, LLC	EXWC	Expeditionary Warfare Center	PES	potential explosion site
APT	analysis, planning, test research	GIS	geographical information system	RAC	risk assessment code
ASAP-X	Automated Safety Assessment Protocol – Explosives	GUI	graphical user interface	RBESS	risk-based explosives safety siting
		HAZX	hazard and explosions effects	SAFER	safety assessment for explosives risk
C&RI	consequence and risk identification	MRAS	Munitions Risk Management Assessment	TP	technical paper
DARAD	Deviation Approval and Risk Acceptance Document				

6.2.1. **Tier 1:** Hazards/consequences/risks (given an explosion occurs at a PES) are based on the location of an ES within six hazard zones and the damage definitions in DESR 6055.9:

6.2.1.1. Inter-magazine distance (IMD)-barricaded: K6.

6.2.1.2. Intra-line distance (ILD)-barricaded: K9.

6.2.1.3. IMD-unbarricaded: K11.

6.2.1.4. ILD-unbarricaded: K18.

6.2.1.5. Public traffic route distance: K24.

6.2.1.6. IBD: K40/K50.

6.2.2. **Tier 2:** Hazards/consequences/risks are based on the PES-ES distance and the physics-based air blast, fragment/debris, and thermal consequence models documented in DDESB TP 14.

6.2.2.1. **Tier 2a** (Qualitative Risk): The explosion at a selected PES is assumed to occur and the qualitative accident probability (unlikely, seldom, occasional, likely, frequent) and consequence severity (catastrophic, critical, moderate, negligible) are used to generate a risk matrix and a DARAD, if used.

6.2.2.2. **Tier 2b** (Quantitative Risk): The quantitative accident probability (e.g., 1.5E-5/year) and fatality consequences are used to compute:

6.2.2.2.1. Maximum probability of an individual fatality, P_f, and

6.2.2.2.2. Expected number of fatalities, E_f, which are compared to DDESB risk acceptance criteria for unrelated and related personnel.

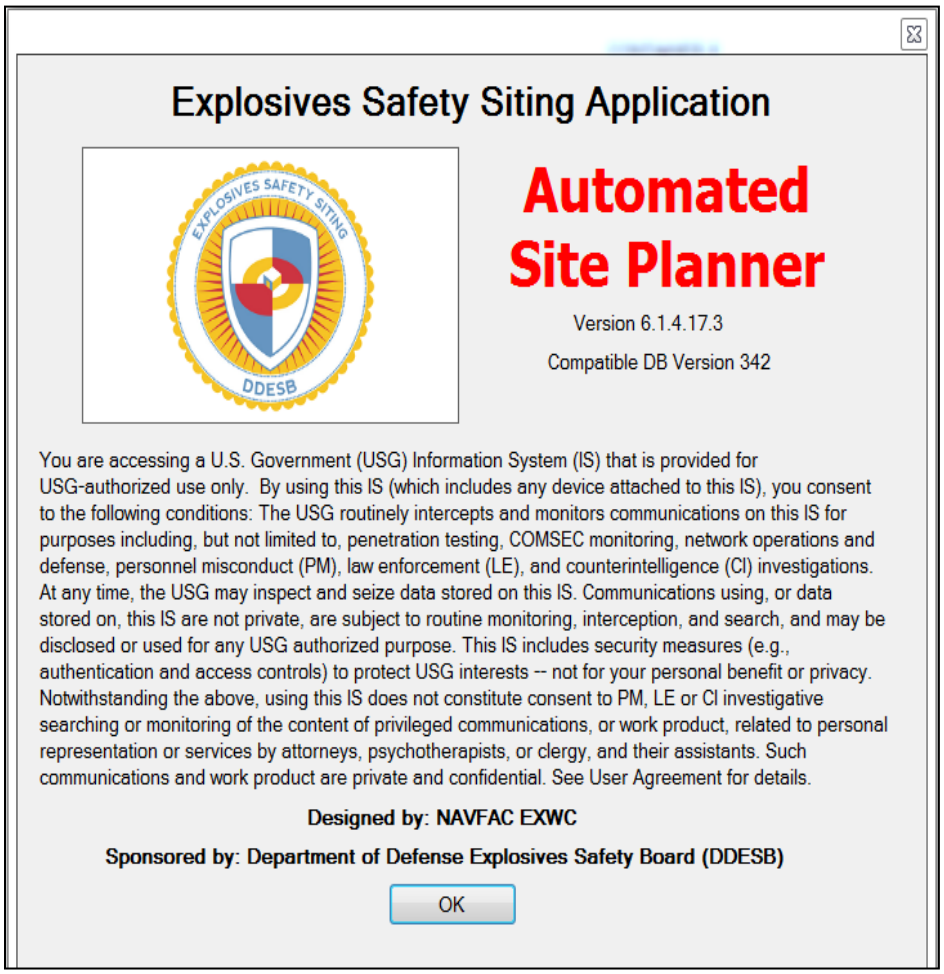
6.2.3. **Tier 3:** Hazards/consequences/risks (given an explosion occurs at a PES) are based on the PES-ES distance using more complex PES and weapon-specific air blast and fragmentation/debris models (these tools are beyond the scope of this TP).

6.3. ASAP-X AND RISK-BASED EXPLOSIVES SAFETY SITING (RBESS). The various tools can be obtained from the "Responsible Organization" as defined in Table 6.1. This TP focuses on ASAP-X and RBESS (Tier 1, Tier 2a, and the munition risk assessment spreadsheet). Figure 6.1. illustrates the splash screen for the explosives safety siting (ESS) tool. RBESS is a module in ESS.

6.3.1. ASAP-X is a Microsoft Excel spreadsheet (for versions 2003 or later) designed to assist DoD Component personnel in assessing hazards associated with ESQD consequences. Modifications of the spreadsheets (for use by U.S. DoD (ASAP-X (US)), NATO (ASAP-X (N)), or the Defense Threat Reduction Agency (ASAP-X(D)) can be provided. The ASAP-X tool can be obtained from the DDESB staff on request.

6.3.2. RBESS is a new module incorporated into ESS that allows the DoD Components to use an existing ESS facility database to perform simple ASAP-X like (Tier 1) or TP 14 physics-based (Tier 2a) explosion assessments. Request the latest version of ESS that includes the RBESS capabilities through the Service Safety Center. The information provided in Paragraph 6.4. is not meant to be used as a training package in the use of risk assessment tools, but provides examples of the capabilities.

Figure 6.1. ESS Splash Screen



6.4. ASAP-X AND RBESS EXAMPLE.

6.4.1. The initial splash screen for the ESS tool is illustrated in Figure 6.1. The Alameda Naval Air Station example demonstrates how to set up, run, and use the results to aid in the risk management process. The example problem is an accidental explosion inside an aboveground magazine (AGM) located at the Alameda Naval Air Station in central California (currently closed). Figure 6.2. shows a Google Earth aerial view of a portion of the Alameda Naval Air Station and an enlargement of an area adjacent to the airfield. An explosion accident at AGM 1041 demonstrates an explosion assessment using three of the selected tools: RBESS Tier 1, ASAP-X, and RBESS Tier 2a.

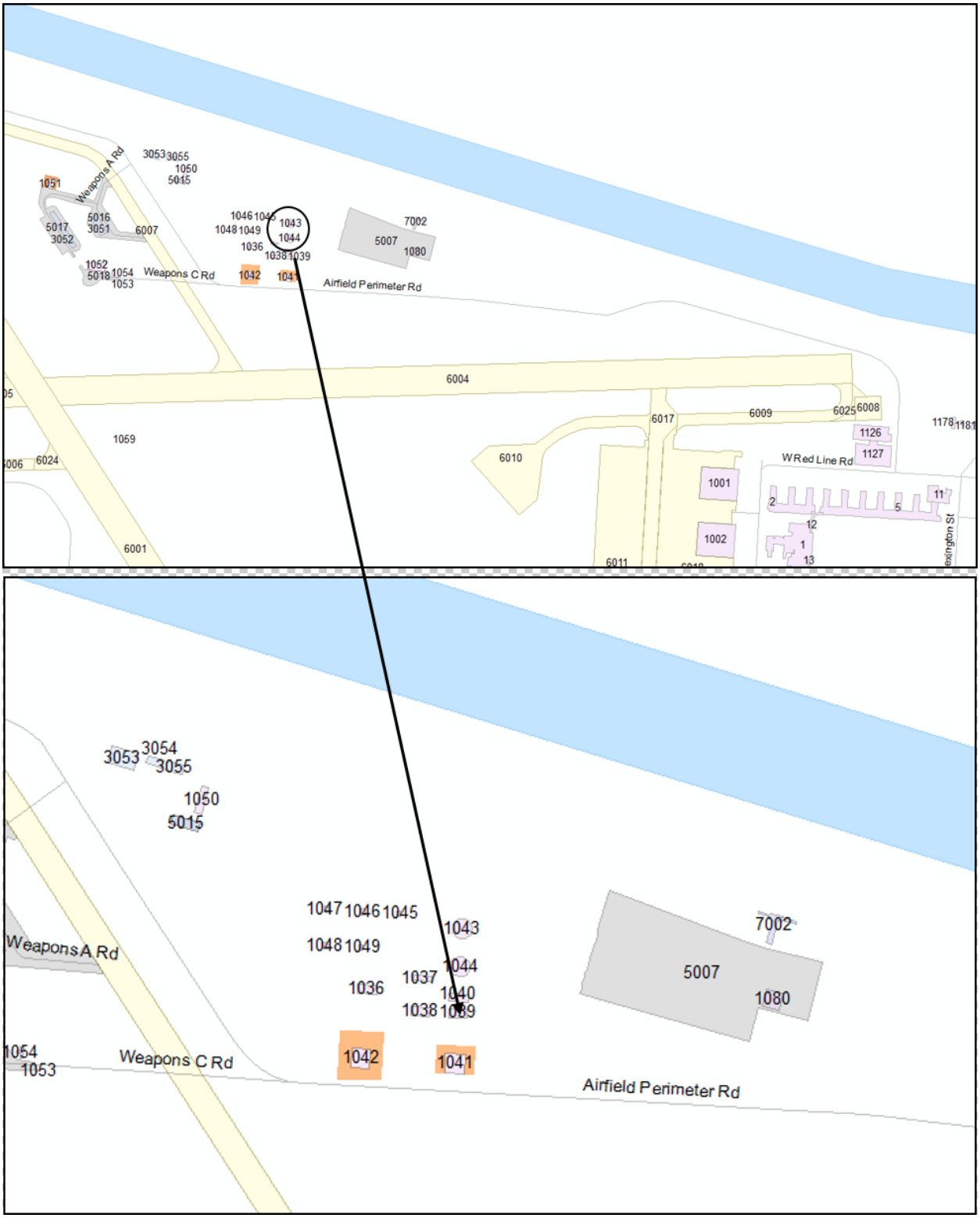
6.4.2. For the RBESS example, it is assumed that all ESS PES and ES facility data necessary to perform a facility QD siting analysis have been previously entered by the analyst. The examples then demonstrate how to use the ESS data to perform an RBESS analysis.

6.4.3. RBESS Tier 1 will be demonstrated first since it uses a geographical information system (GIS) to perform spatial analyses and measure PES-ES distances. ASAP-X requires the analyst to manually input PES-ES distances.

6.4.4. Both RBESS Tier 1 and Tier 2a use ESS and an ESS facility database to perform a risk-based siting analysis. Figure 6.2. shows the initial entry image to ESS. For the example, ESS is open and the facility database prepared and loaded for Alameda Naval Air Station. Figure 6.3. shows the ESS GIS display of the area adjacent to AGM 1041, including the facility numbers.

Figure 6.2. Naval Air Station Alameda Aerial View and AGM 1041

Figure 6.3. ESS Display of Area Adjacent to AGM 1041



6.4.5. Figure 6.4. illustrates how to start an RBESS Tier 1 analysis. Click on the ESS menu bar "Analysis" option, then on "Risk-Based Analysis," "Tier 1: Run New Analysis." From here, the PES Selection Screen (Figure 6.5.) is now available and configurable. Select "PES 1041" and click "OK" to view the Scenario Selector Screen (Figure 6.6.). A new scenario can be defined; however, this example uses an existing scenario accessed by clicking on the scenario and then "Select." This is illustrated in Figure 6.7.

Figure 6.4. Starting RBESS Tier 1 Analysis

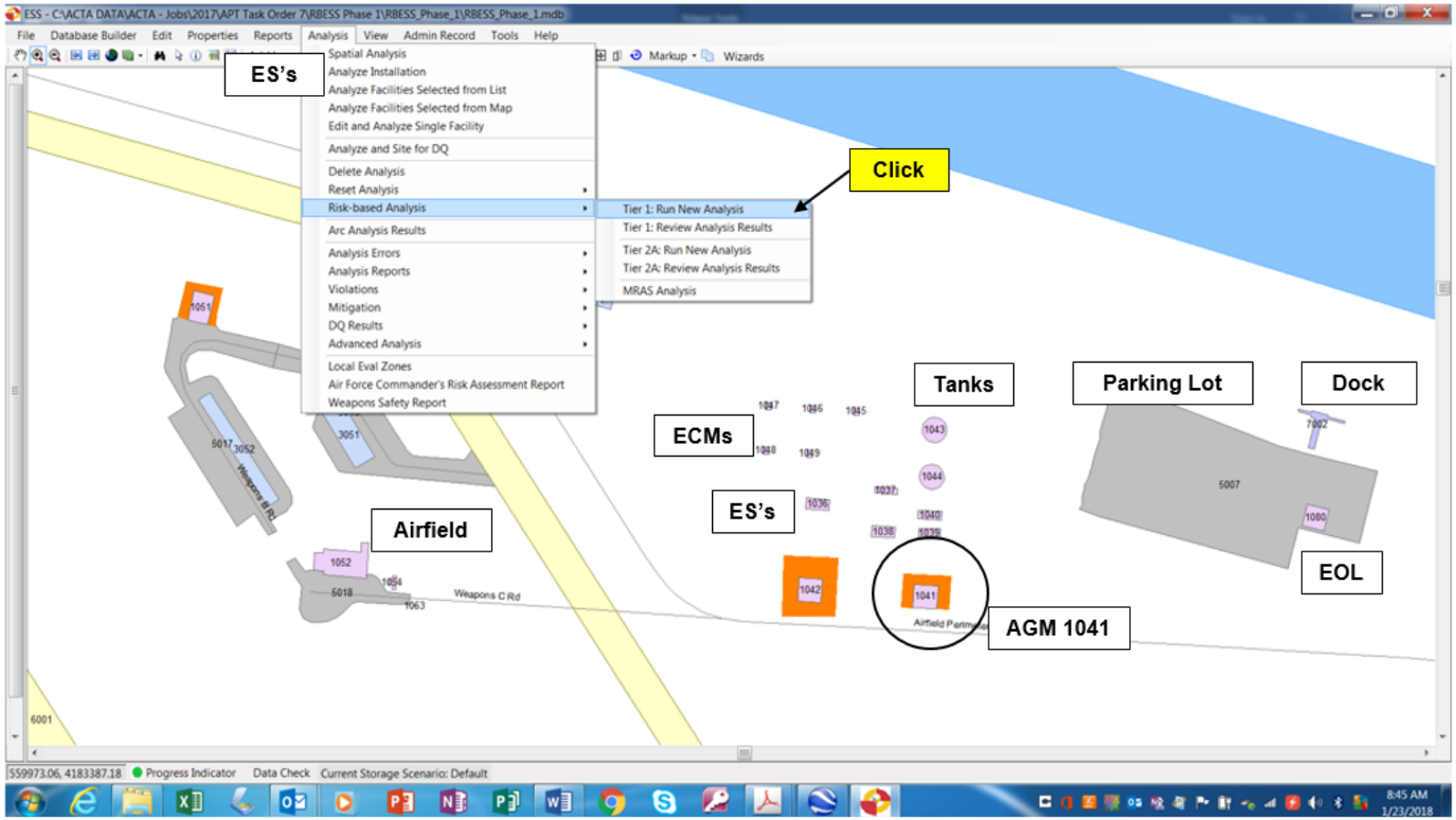


Figure 6.5. PES Selection Screen

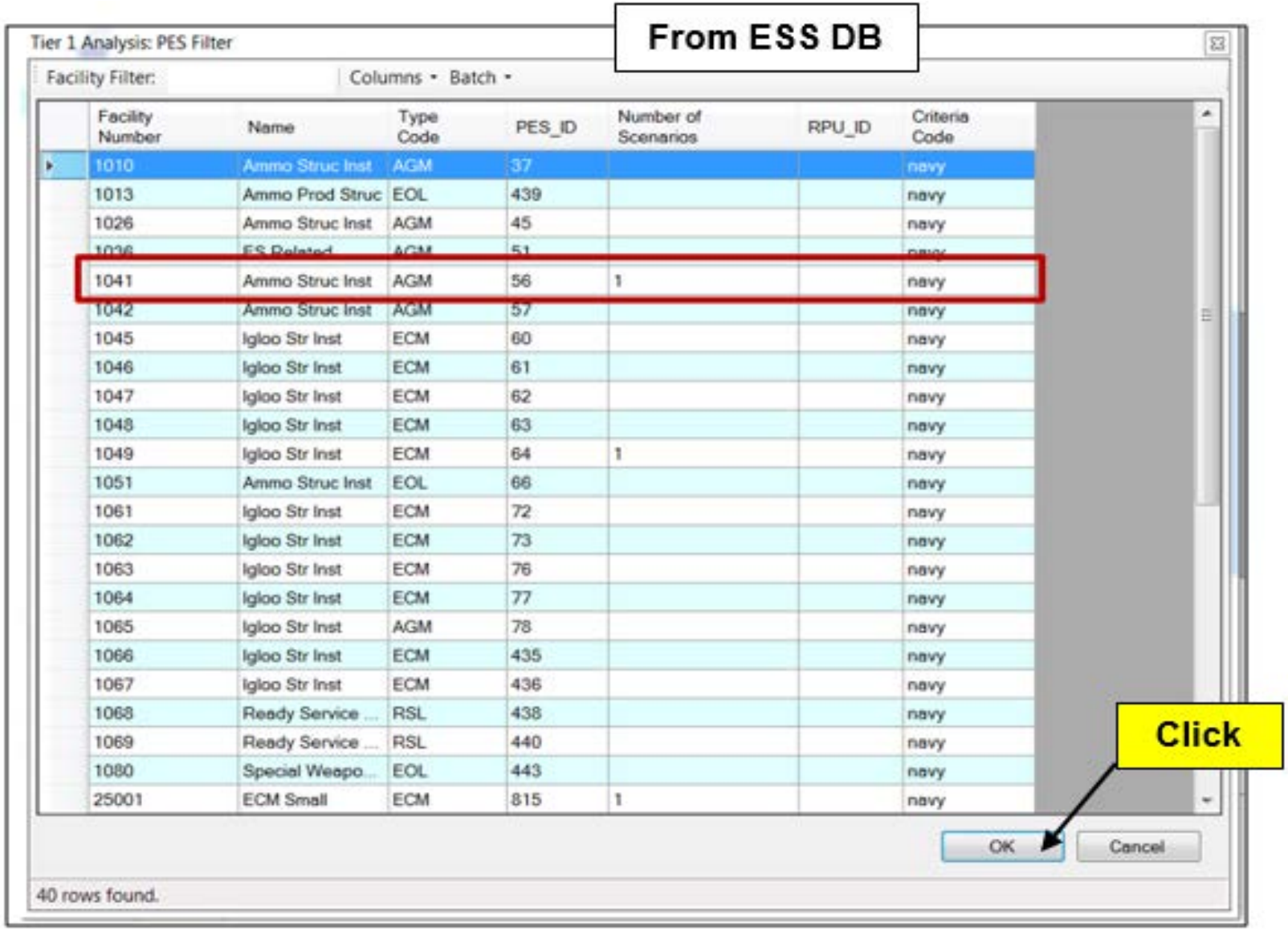


Figure 6.6. Scenario Selector Screen

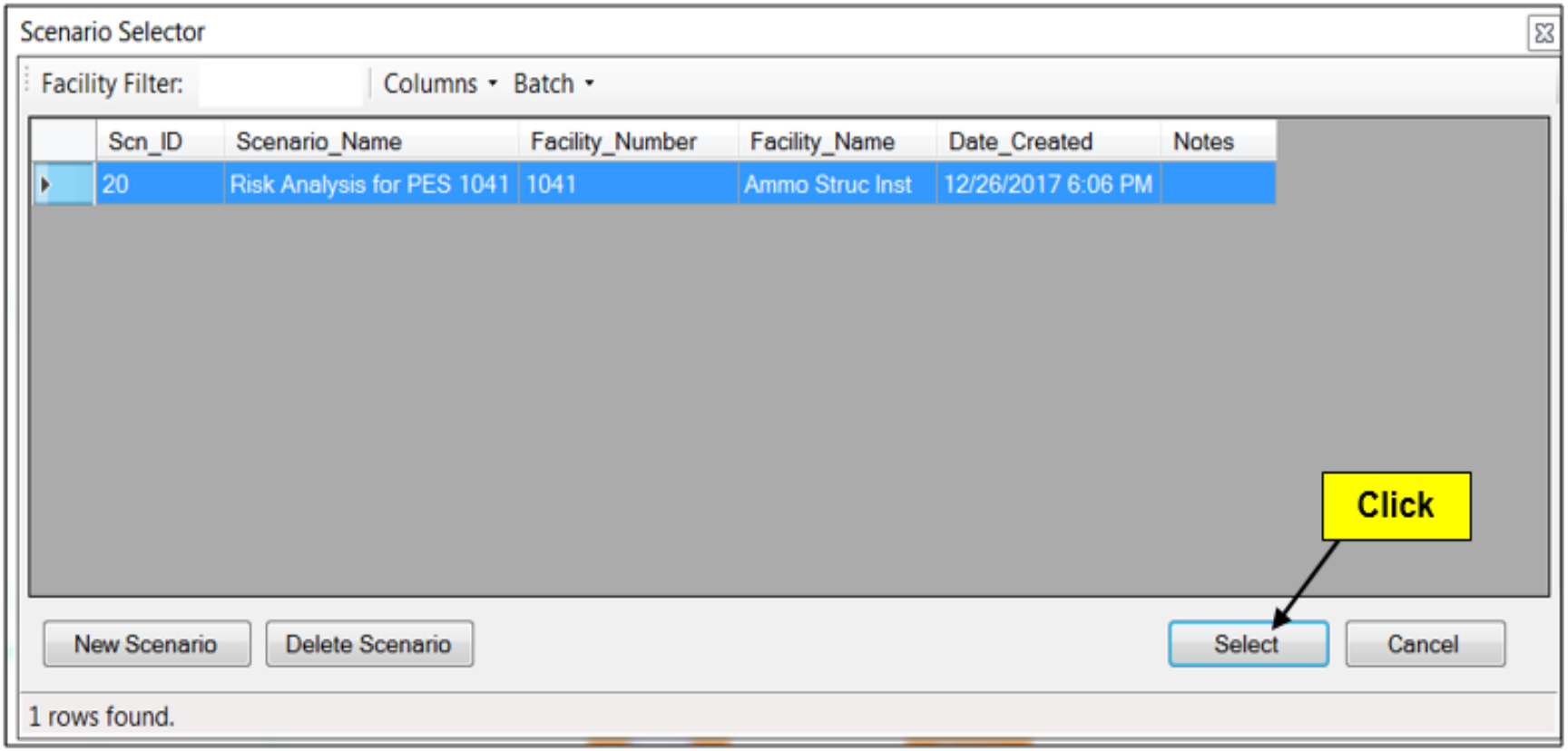
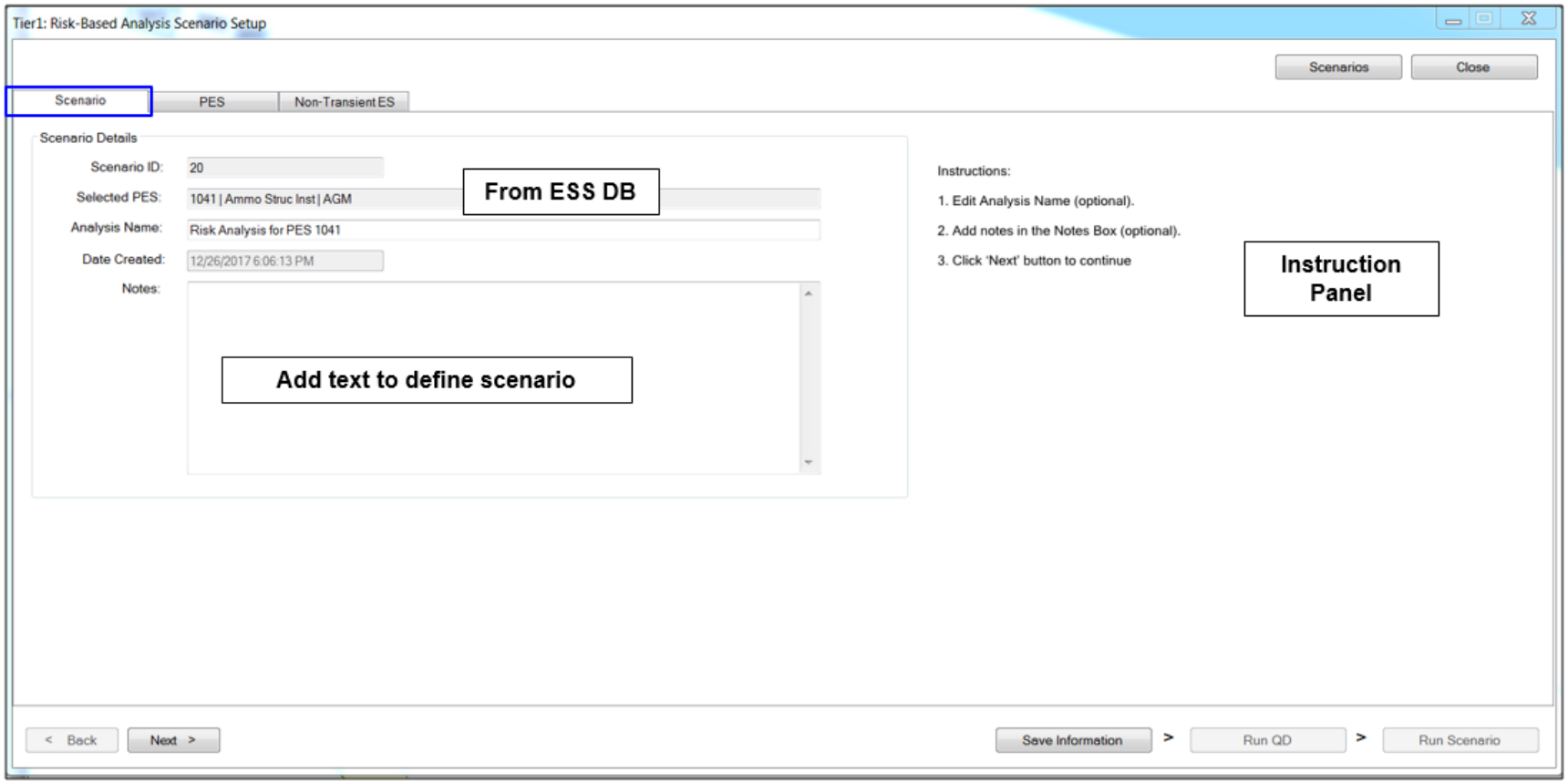
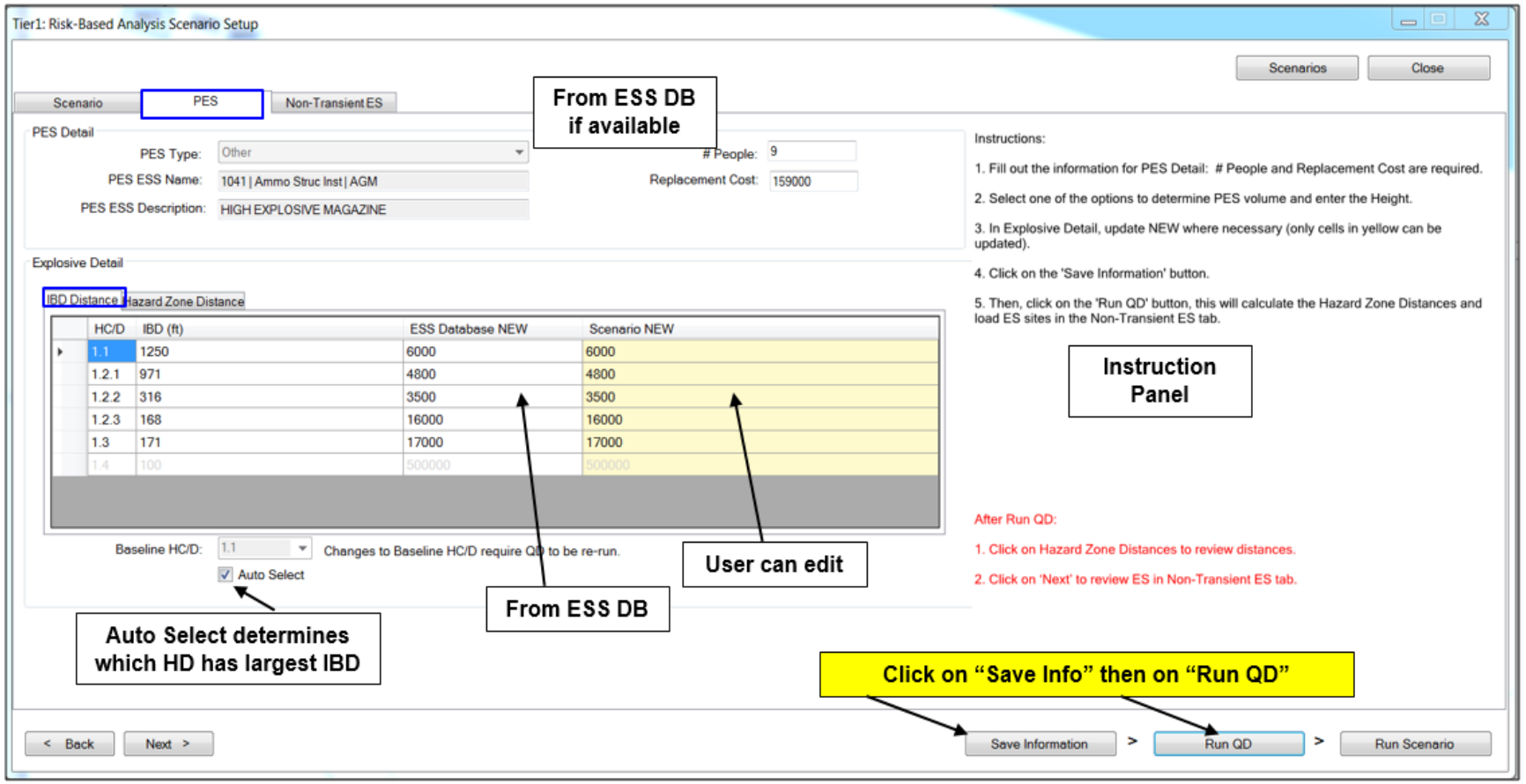


Figure 6.7. Scenario Setup Screen – Scenario Tab



6.4.5.1. The "Scenario" Tab displays ESS PES description data. The analyst can add additional information to help define the scenario in the "Notes" text box. When complete, click on "Save Information" and then on the "PES" Tab shown in Figure 6.8.

Figure 6.8. Scenario Setup Screen – PES Tab



6.4.5.2. Additional ESS PES data are displayed in the "PES Detail" frame. Items in gray cannot be modified, but the "# People" and "Replacement Cost" parameters can be modified by the analyst. The "ESS Database NEWs" column in the "Explosive Detail" frame lists the net explosive weight (NEW) stored in the ESS database by hazard division (HD). For the AGM 1041 example, ESS reports that there are potentially five HDs stored at the facility. This example uses the ESS database NEWs with no changes. The analyst, if desired, can change the NEWs that are stored in the ESS database to perform a what-if analysis; however, only one HD can be selected for analysis at a time. Below the HD data frame, the analyst can:

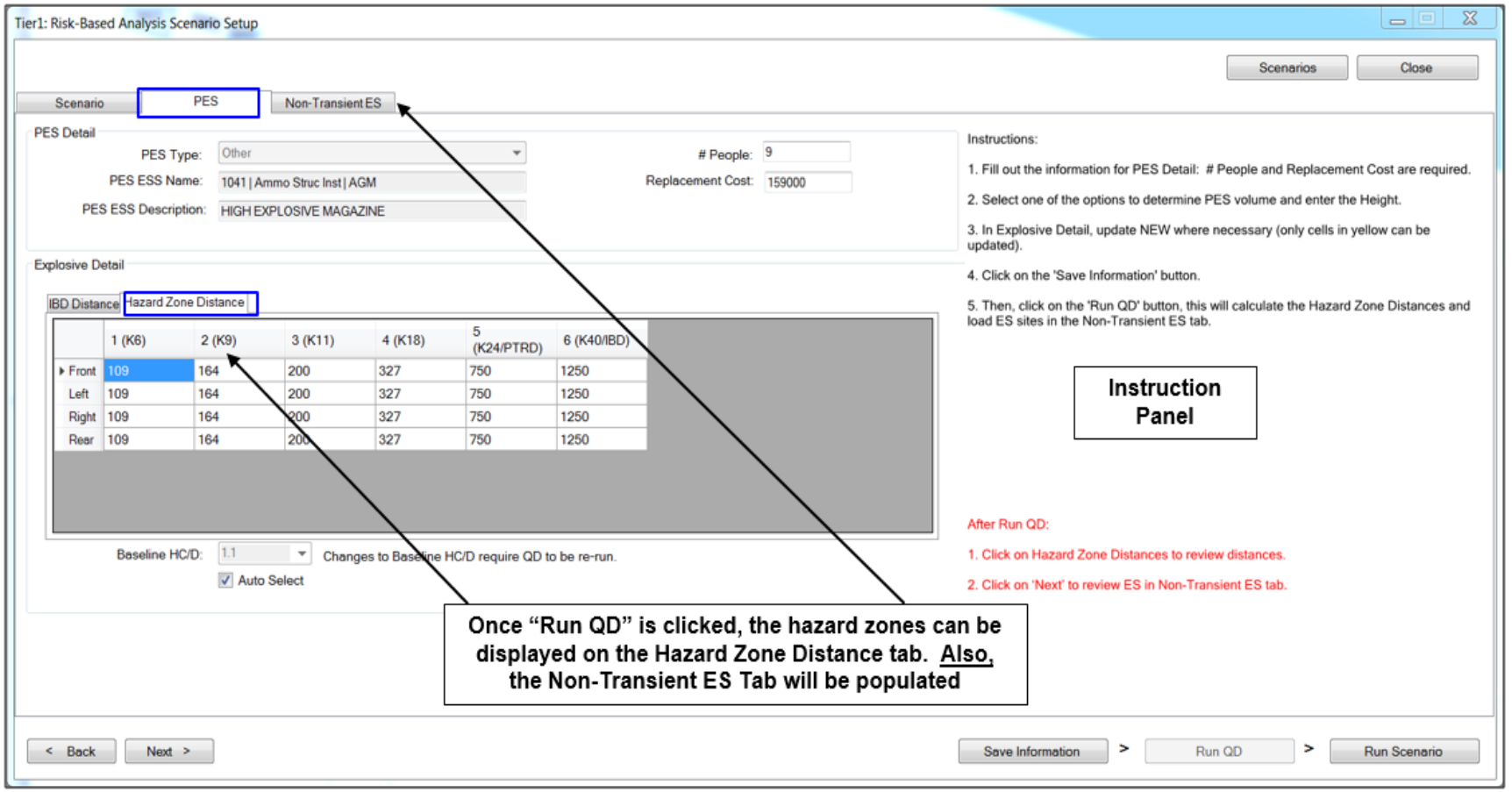
6.4.5.2.1. Check the "auto select" box and RBESS will use the HD that generates the largest IBD, or,

6.4.5.2.2. Click on the drop-down list to select the desired HD, and

6.4.5.2.3. Enter any HD in the "Scenario NEW" column. For example, if mixing rules are applied, the analyst would sum up the appropriate HDs and enter it under the proper HD (e.g., HD 1.1). Once the data have been entered, click on the "Save Information" button and then on the "Run QD" button.

6.4.5.3. RBESS will run the DDESB QD engine to get the hazard distances for six zones: IMD-barricaded, ILD-barricaded, IMD-unbarricaded, ILD-unbarricaded, public traffic route distance, and IBD. To view the hazard zone distances, click on the "Hazard Zone Distance" tab as illustrated in Figure 6.9. RBESS computes distances for the PES Front, Left Side, Right Side, and Rear. The distances will differ for PES, as appropriate, to account for different structures. In this example, all distances are the same.

Figure 6.9. PES Tab – Hazard Zone Distance Sub-Tab



6.4.5.4. At the same time the hazard zone distances are computed, RBESS populates the "Non-Transient" tab as shown in Figure 6.10. Non-Transient refers to stationary ESs, such as buildings.

6.4.5.5. RBESS loads the ES data from the ESS facility database using the "RBESS Eval Zone" factor with a default of 1.2 times the computed IBD. The analyst can edit this data as desired.

6.4.5.6. The drop-down list under "Additional Options" allows the analyst to also filter which ESs are to be included in the analysis.

6.4.5.7. The QD analysis will need to be re-run once either data has been modified and saved. The RBESS defaults were used for the AGM example.

6.4.5.8. In Figure 6.10., the ESs included within the evaluation zone and the attributes required to perform a Tier 1 analysis are listed.

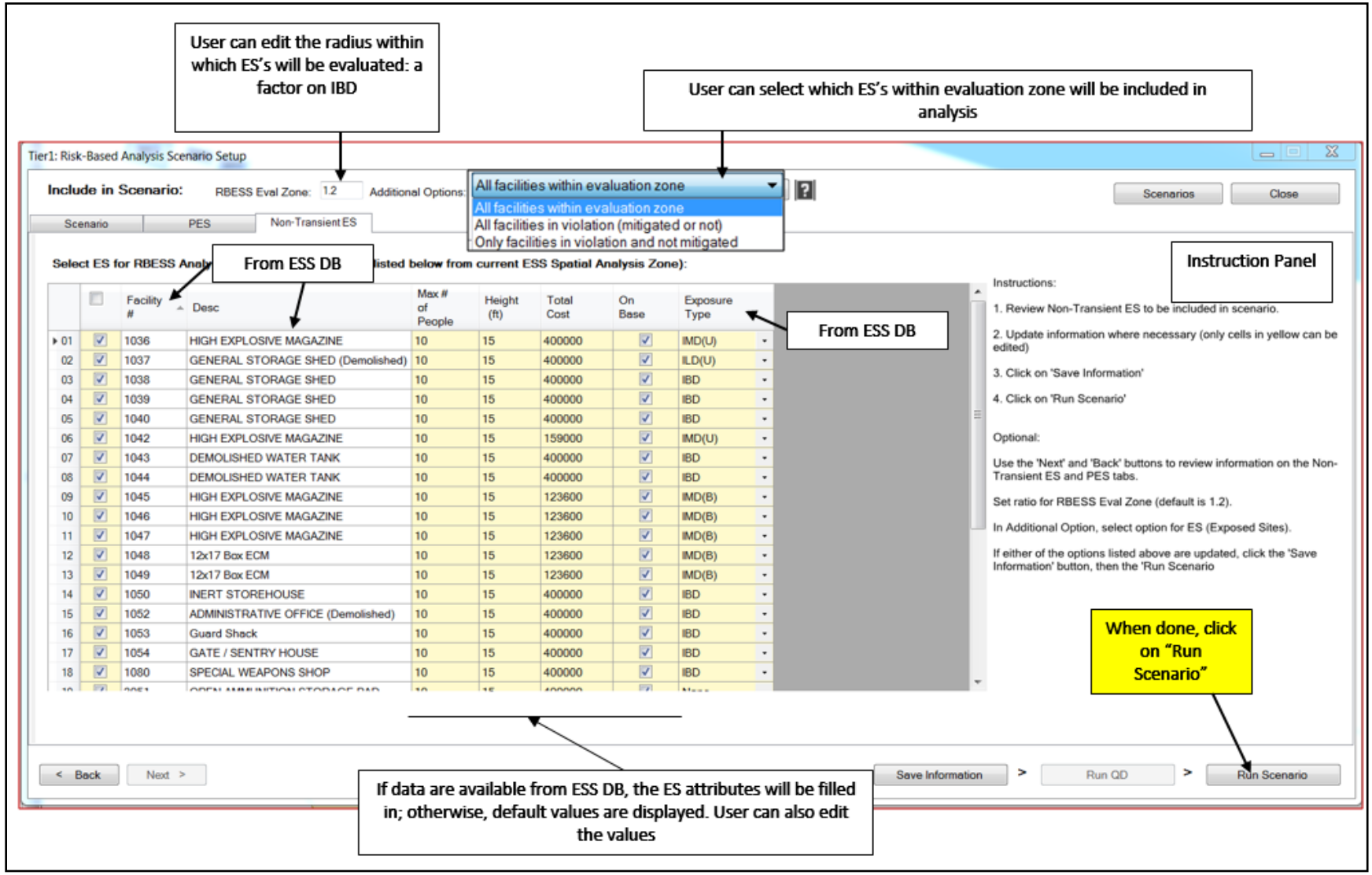
6.4.5.9. RBESS will use all ESS facility data available, but will insert default values for attributes not stored in the ESS database. Missing Tier 1 attributes are typically the number of people and the replacement cost values.

6.4.5.10. The analyst should check the ES attributes carefully and edit them if better data are available.

6.4.5.11. The analyst can check or uncheck ESs on a case-by-case basis for inclusion in the consequence analysis.

6.4.5.12. When done, click on the "Run Scenario" button" to perform the Tier 1 analysis.

Figure 6.10. Setup Screen – Non-Transient ES Tab



6.4.5.13. The GIS screen will be refreshed and various display and report options will be shown in the right-hand panel when the Tier 1 analysis is complete as illustrated in Figure 6.11.

6.4.5.13.1. The analyst can display the six hazard zones or color-code the ESs included in the evaluation by clicking on the "Percent Fatality" button rendering a display like Figure 6.12.

6.4.5.13.2. Figure 6.13. provides a summary of the ES consequences and is derived by clicking on the "Results by ES" button. The results can be printed or exported to Excel for inclusion in other documents.

6.4.5.13.3. Finally, clicking the "View DARAD Form" button will insert the Tier 1 consequence analysis results into the U.S. Army's DARAD, if used. Figure 6.14. shows the information that RBESS will automatically fill in, including computing residual risk due to QD violations.

Figure 6.11. RBESS Tier 1 Analysis Results – Hazard Zone Display

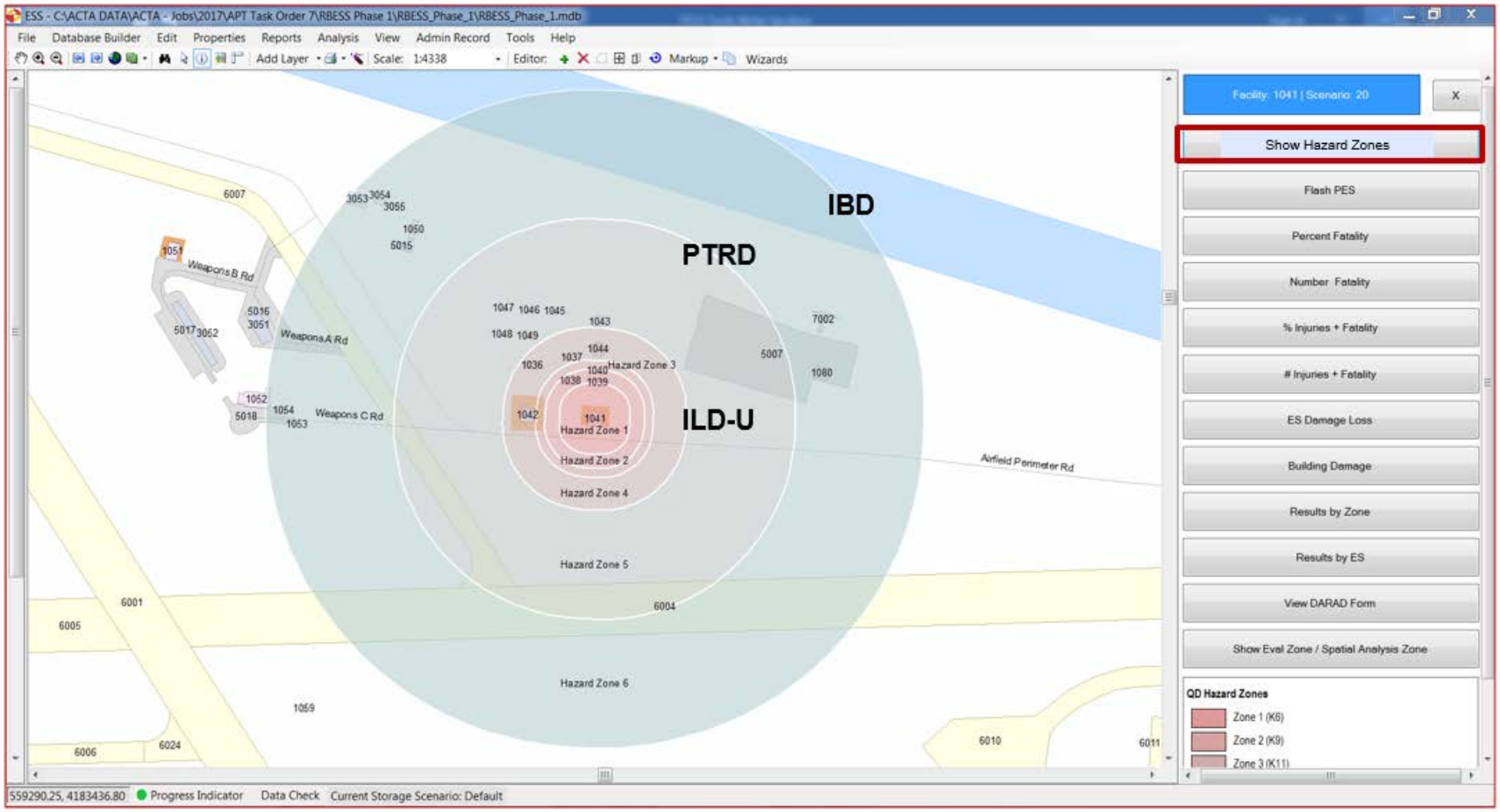


Figure 6.12. RBESS Tier 1 Analysis Results – Percent Fatality Display

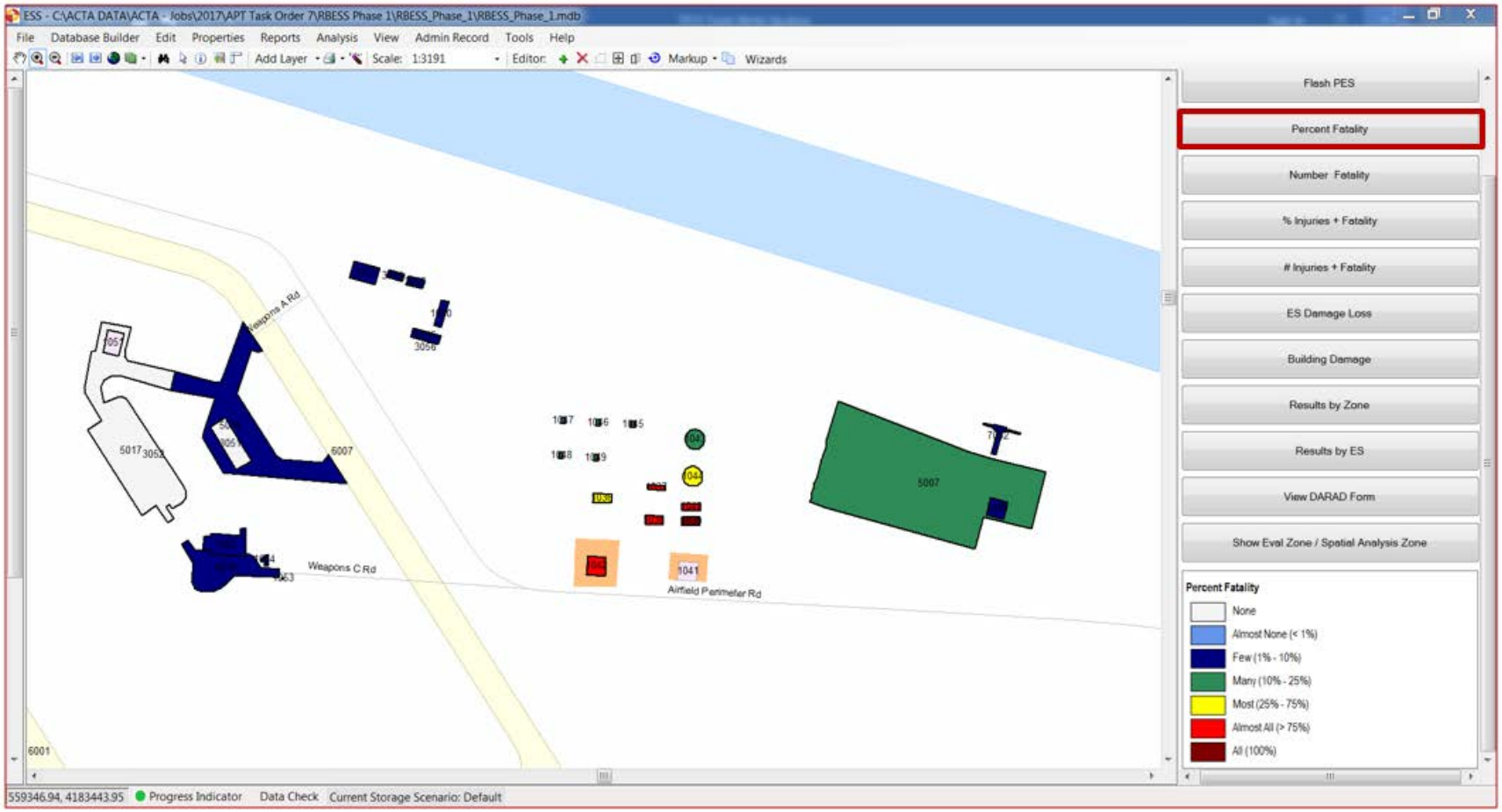


Figure 6.13. RBESS Tier 1 Analysis Results – ES Consequence Summary Report

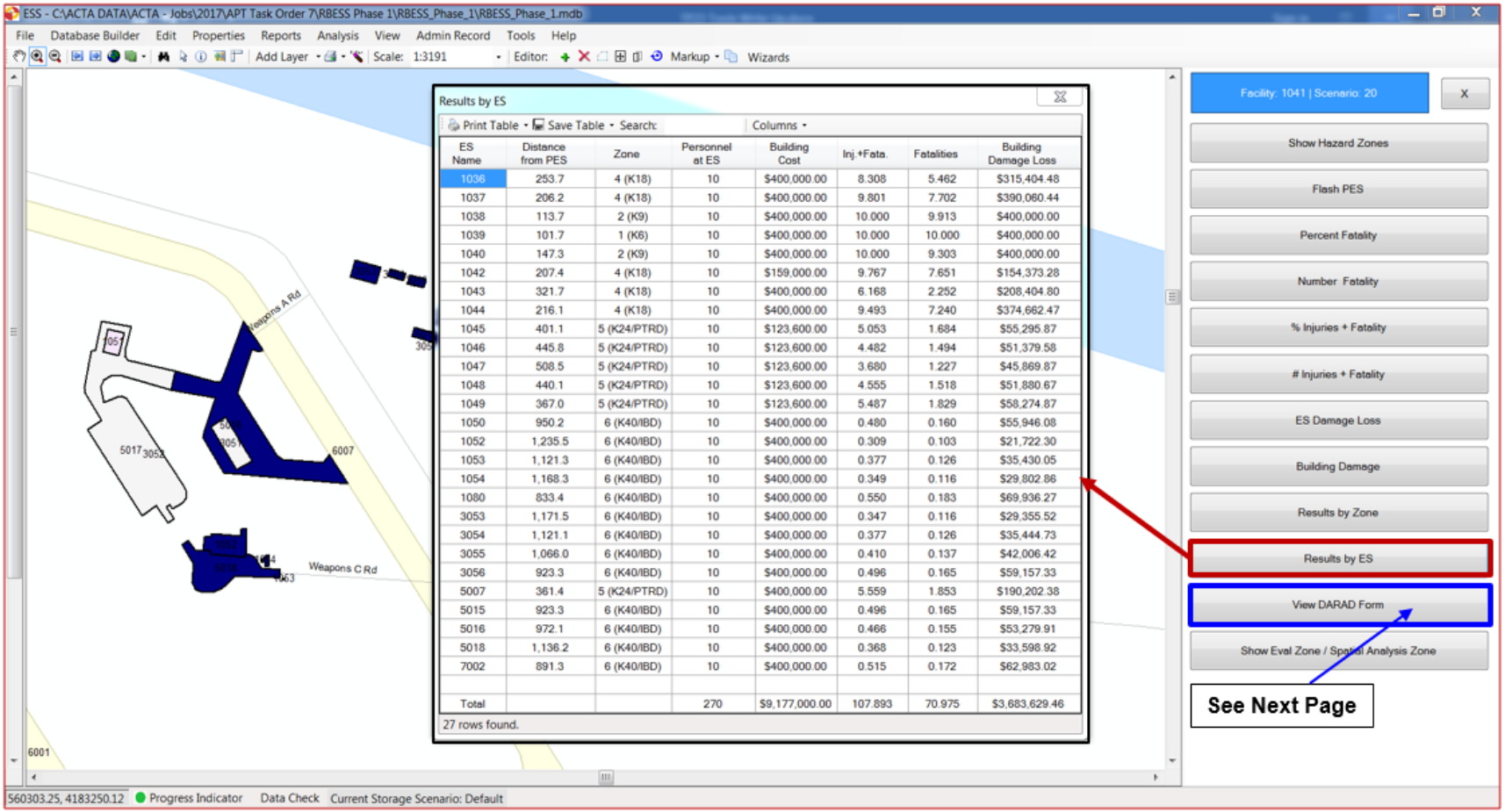
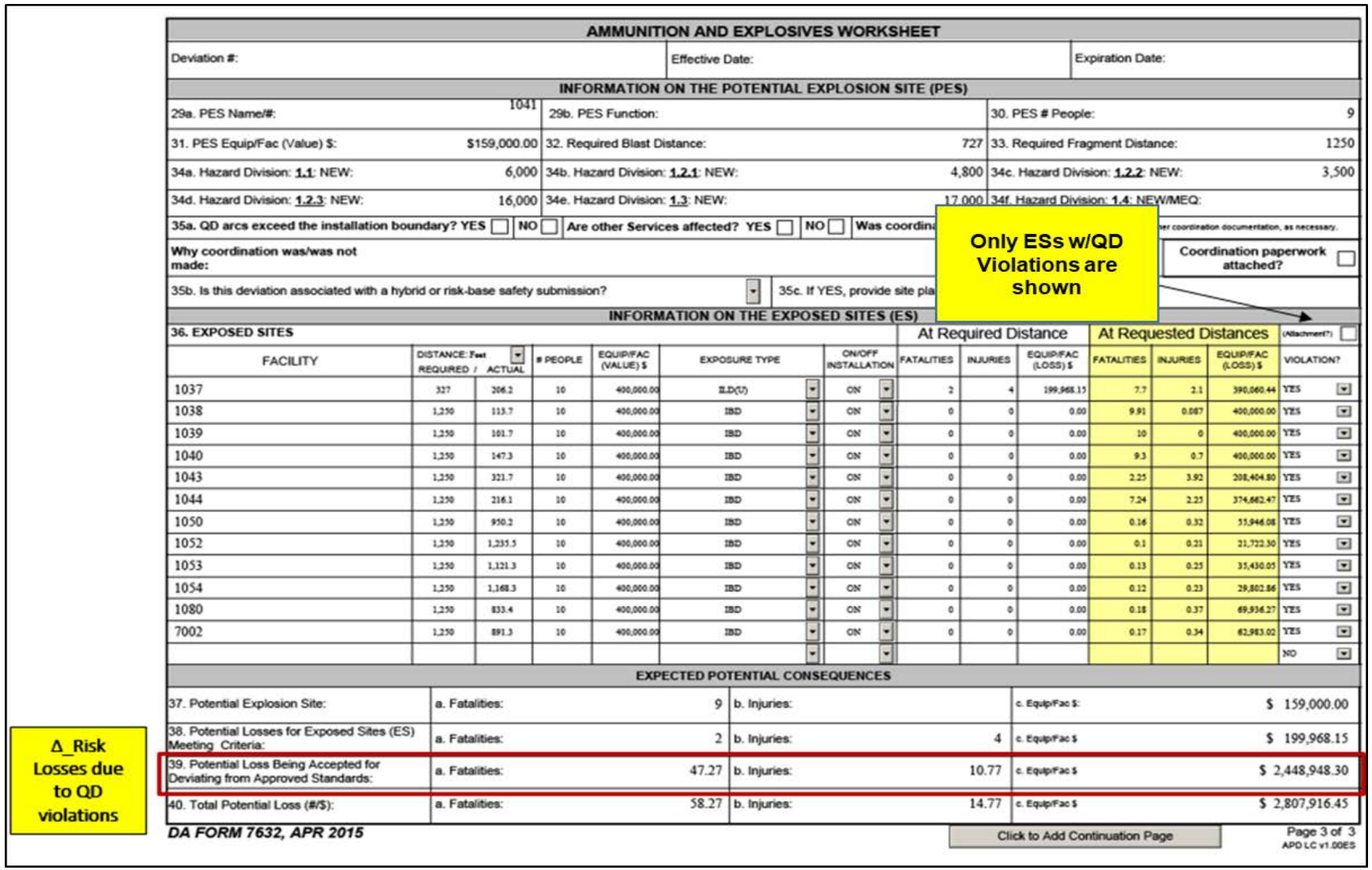


Figure 6.14. RBESS Tier 1 Analysis Results – Army DARAD – Page 3



AMMUNITION AND EXPLOSIVES WORKSHEET

Deviation #:	Effective Date:	Expiration Date:

INFORMATION ON THE POTENTIAL EXPLOSION SITE (PES)

29a. PES Name/#:	1041	29b. PES Function:		30. PES # People:	9
31. PES Equip/Fac (Value) $:	$159,000.00	32. Required Blast Distance:	727	33. Required Fragment Distance:	1250
34a. Hazard Division: 1.1: NEW:	6,000	34b. Hazard Division: 1.2.1: NEW:	4,800	34c. Hazard Division: 1.2.2: NEW:	3,500
34d. Hazard Division: 1.2.3: NEW:	16,000	34e. Hazard Division: 1.3: NEW:	17,000	34f. Hazard Division: 1.4: NEW/MEQ:	

35a. QD arcs exceed the installation boundary? YES ☐ NO ☐ Are other Services affected? YES ☐ NO ☐ Was coordina… …er coordination documentation, as necessary.

Why coordination was/was not made:

Coordination paperwork attached? ☐

35b. Is this deviation associated with a hybrid or risk-base safety submission?

35c. If YES, provide site pla…

Only ESs w/QD Violations are shown

INFORMATION ON THE EXPOSED SITES (ES)

36. EXPOSED SITES

FACILITY	DISTANCE: Feet REQUIRED	DISTANCE: Feet ACTUAL	# PEOPLE	EQUIP/FAC (VALUE) $	EXPOSURE TYPE	ON/OFF INSTALLATION	At Required Distance FATALITIES	At Required Distance INJURIES	At Required Distance EQUIP/FAC (LOSS) $	At Requested Distances FATALITIES	At Requested Distances INJURIES	At Requested Distances EQUIP/FAC (LOSS) $	(Attachment?) ☐ VIOLATION?
1037	327	206.2	10	400,000.00	ILD(U)	ON	2	4	199,968.15	7.7	2.1	390,060.44	YES
1038	1,250	113.7	10	400,000.00	IBD	ON	0	0	0.00	9.91	0.087	400,000.00	YES
1039	1,250	101.7	10	400,000.00	IBD	ON	0	0	0.00	10	0	400,000.00	YES
1040	1,250	147.3	10	400,000.00	IBD	ON	0	0	0.00	9.3	0.7	400,000.00	YES
1043	1,250	321.7	10	400,000.00	IBD	ON	0	0	0.00	2.25	3.92	208,404.80	YES
1044	1,250	216.1	10	400,000.00	IBD	ON	0	0	0.00	7.24	2.25	374,662.47	YES
1050	1,250	950.2	10	400,000.00	IBD	ON	0	0	0.00	0.16	0.32	55,946.08	YES
1052	1,250	1,235.5	10	400,000.00	IBD	ON	0	0	0.00	0.1	0.21	21,722.30	YES
1053	1,250	1,121.3	10	400,000.00	IBD	ON	0	0	0.00	0.13	0.25	35,430.05	YES
1054	1,250	1,168.3	10	400,000.00	IBD	ON	0	0	0.00	0.12	0.23	29,802.86	YES
1080	1,250	833.4	10	400,000.00	IBD	ON	0	0	0.00	0.18	0.37	69,936.27	YES
7002	1,250	891.3	10	400,000.00	IBD	ON	0	0	0.00	0.17	0.34	62,983.02	YES
													NO

EXPECTED POTENTIAL CONSEQUENCES

37. Potential Explosion Site:	a. Fatalities:	9	b. Injuries:		c. Equip/Fac $:	$ 159,000.00
38. Potential Losses for Exposed Sites (ES) Meeting Criteria:	a. Fatalities:	2	b. Injuries:	4	c. Equip/Fac $	$ 199,968.15
39. Potential Loss Being Accepted for Deviating from Approved Standards:	a. Fatalities:	47.27	b. Injuries:	10.77	c. Equip/Fac $	$ 2,448,948.30
40. Total Potential Loss (#/$):	a. Fatalities:	58.27	b. Injuries:	14.77	c. Equip/Fac $	$ 2,807,916.45

Δ_Risk Losses due to QD violations

DA FORM 7632, APR 2015

Click to Add Continuation Page

Page 3 of 3

APD LC v1.00ES

6.4.5.6. Figure 6.15. shows the logic used to calculate the consequences (building damage, fatalities, and injuries) based on an ES location within each of the six hazard zones. If an ES lies between two zones, the consequences are determined by linear interpolation based on distance.

Figure 6.15. Tier 1 Consequence Logic

Building Damage:

Zones 1, 2 and 3 = 100%
Zone 4 = 50% - (0.5(K18-ES distance)/(K18-K11)+0.5)
Zone 5 = 20% - (0.3(PTRD-ES distance)/PTRD-K18)+0.2)
Zone 6 = 5% - (0.15(IBD-ES distance)/(IBD-PTRD)+0.05)

Fatalities:

Zone 1 = 100%
Zone 2 = 90% - (0.1(K9-ES distance)/(K9-K6)+.90)
Zone 3 = 80% - (0.1(K11-ES distance)/(K11-K9)+. 80)
Zone 4 = 20% - (0.6(K18-ES distance)/(K18-K11)+.20)
Zone 5 = 2% - (0.18(PTRD-ES distance)/PTRD-K18)+.02)
Zone 6 = 1% -(0.01(IBD-ES distance)/(IBD-PTRD)+.01)

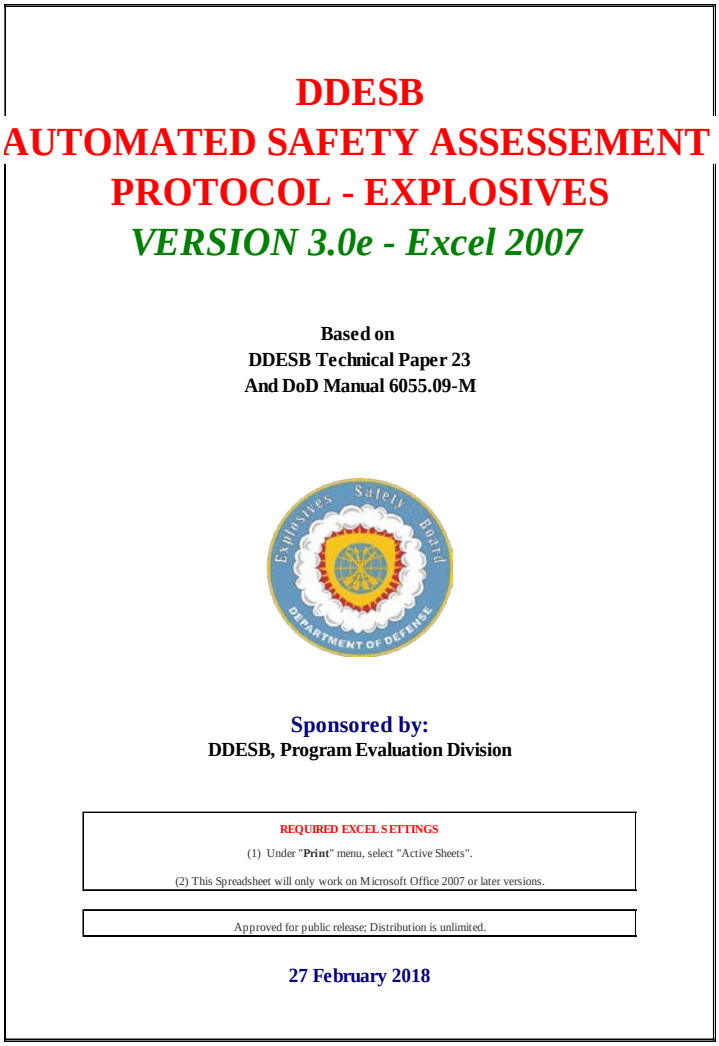
Injuries:

Zone 1 = All non-fatal are injuries
Zone 2 = All non-fatal are injuries
Zone 3 = All non-fatal are injuries
Zone 4 = Sliding scale from "all non-fatal" to 2 x fatalities
Zone 5 = Twice the # of fatalities
Zone 6 = Twice the # of fatalities

6.4.6. ASAP-X is a simple Excel spreadsheet application. ASAP-X calculates the explosion consequences based on the location of an ES within the six hazard zones like the RBESS Tier 1 tool. It does not, however, use a geographic information system/graphical user interface and does not link to ESS. All spatial-related input data must be entered manually and cannot be displayed on a map for verification.

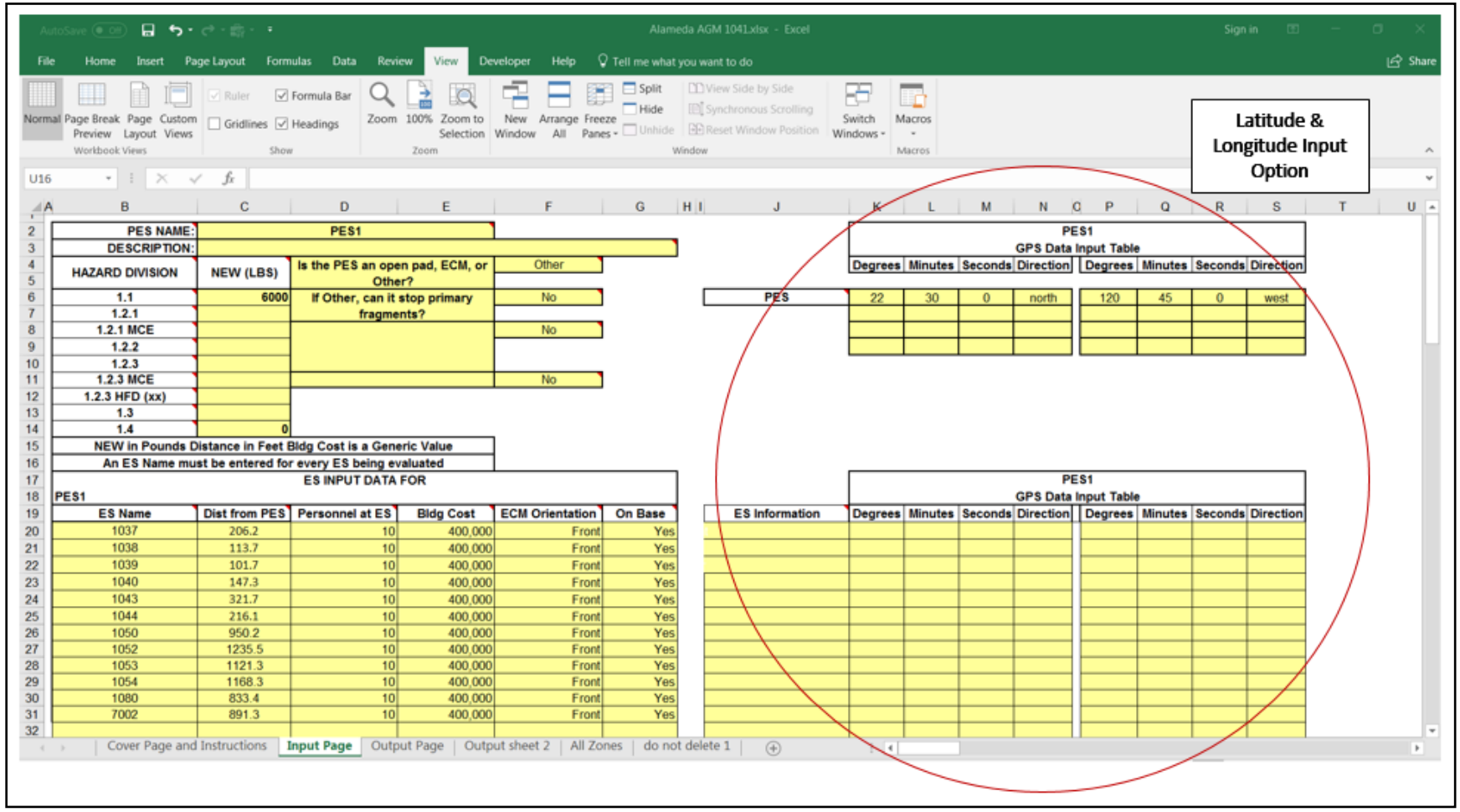
6.4.6.1. The ASAP-X tool consists of three key worksheets: Cover Page (Figure 6.16.), Input Page (Figure 6.17.), and Output Page (Figure 6.18.). Other internal worksheets may appear and should be ignored or hidden for normal use.

Figure 6.16. ASAP-X Cover Page



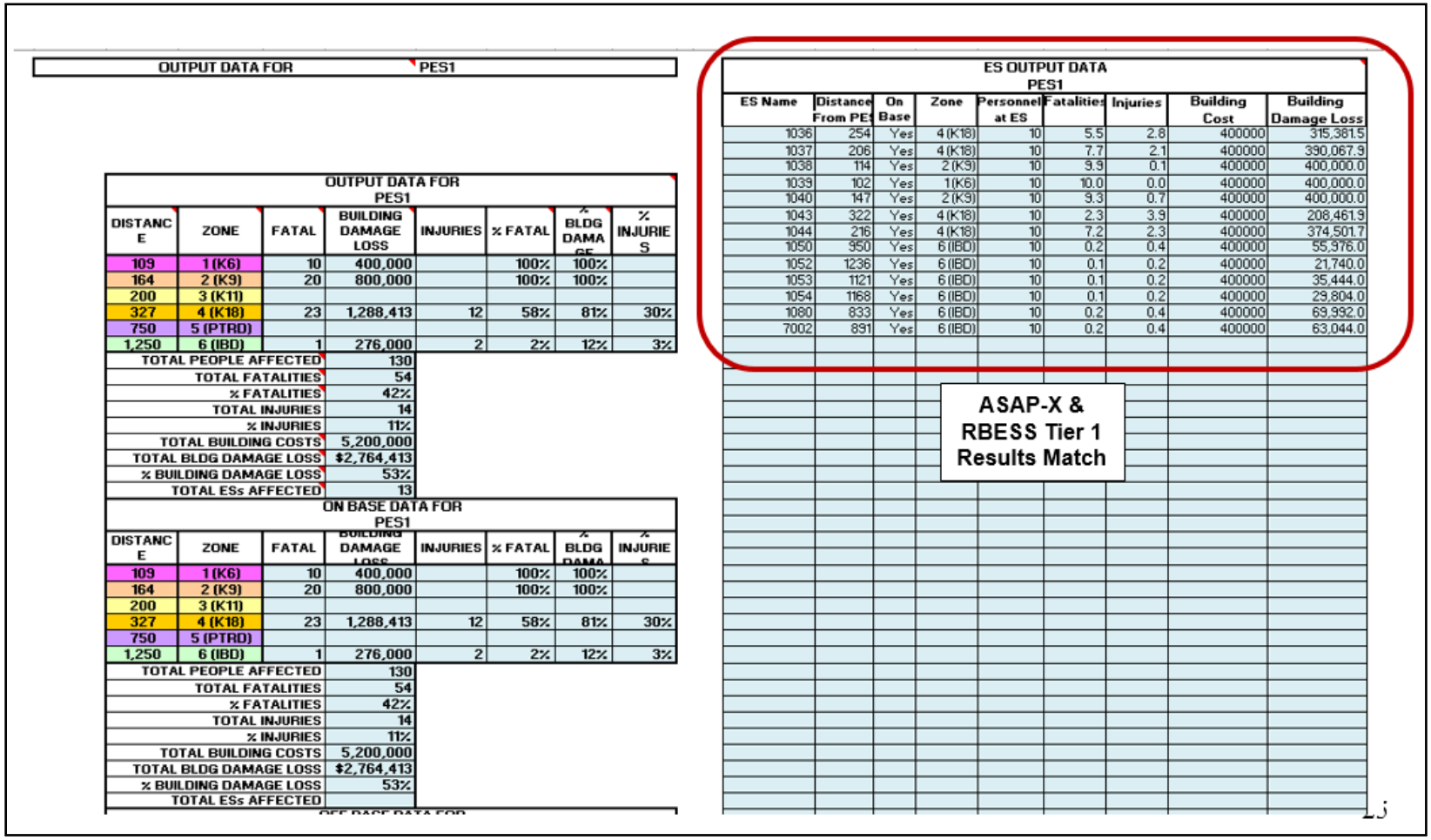
6.4.6.2. The Input Page worksheet is shown in Figure 6.17. for the AGM 1041 example. The analyst must enter all required data manually. For the AGM example, the PES types available are Open Pad, Earth-Covered Magazine (ECM), or Other. "Other" was entered for the AGM as it cannot stop primary fragments. In the HD section, the analyst can enter the NEWs. "6,000 pounds trinitrotoluene HD 1.1" was entered to be consistent with the RBESS Tier 1 QD analysis where HD 1.1 was selected as the controlling HD.

Figure 6.17. ASAP-X: Input Tab



6.4.6.3. Once the input data have been entered, click on the "Output Page." The consequence results will be displayed by individual ES and summed across the six hazard zones as illustrated in Figure 6.18. For the AGM 1041 example, the RBESS Tier 1 and ASAP-X results are identical.

Figure 6.18. ASAP-X: Output Tab



OUTPUT DATA FOR PES1

DISTANCE	ZONE	FATAL	BUILDING DAMAGE LOSS	INJURIES	% FATAL	% BLDG DAMAGE	% INJURIES
109	1 (K6)	10	400,000		100%	100%	
164	2 (K9)	20	800,000		100%	100%	
200	3 (K11)						
327	4 (K18)	23	1,288,413	12	58%	81%	30%
750	5 (PTRD)						
1,250	6 (IBD)	1	276,000	2	2%	12%	3%

TOTAL PEOPLE AFFECTED	130
TOTAL FATALITIES	54
% FATALITIES	42%
TOTAL INJURIES	14
% INJURIES	11%
TOTAL BUILDING COSTS	5,200,000
TOTAL BLDG DAMAGE LOSS	$2,764,413
% BUILDING DAMAGE LOSS	53%
TOTAL ESs AFFECTED	13

ON BASE DATA FOR PES1

DISTANCE	ZONE	FATAL	BUILDING DAMAGE LOSS	INJURIES	% FATAL	% BLDG DAMAGE	% INJURIES
109	1 (K6)	10	400,000		100%	100%	
164	2 (K9)	20	800,000		100%	100%	
200	3 (K11)						
327	4 (K18)	23	1,288,413	12	58%	81%	30%
750	5 (PTRD)						
1,250	6 (IBD)	1	276,000	2	2%	12%	3%

TOTAL PEOPLE AFFECTED	130
TOTAL FATALITIES	54
% FATALITIES	42%
TOTAL INJURIES	14
% INJURIES	11%
TOTAL BUILDING COSTS	5,200,000
TOTAL BLDG DAMAGE LOSS	$2,764,413
% BUILDING DAMAGE LOSS	53%
TOTAL ESs AFFECTED	

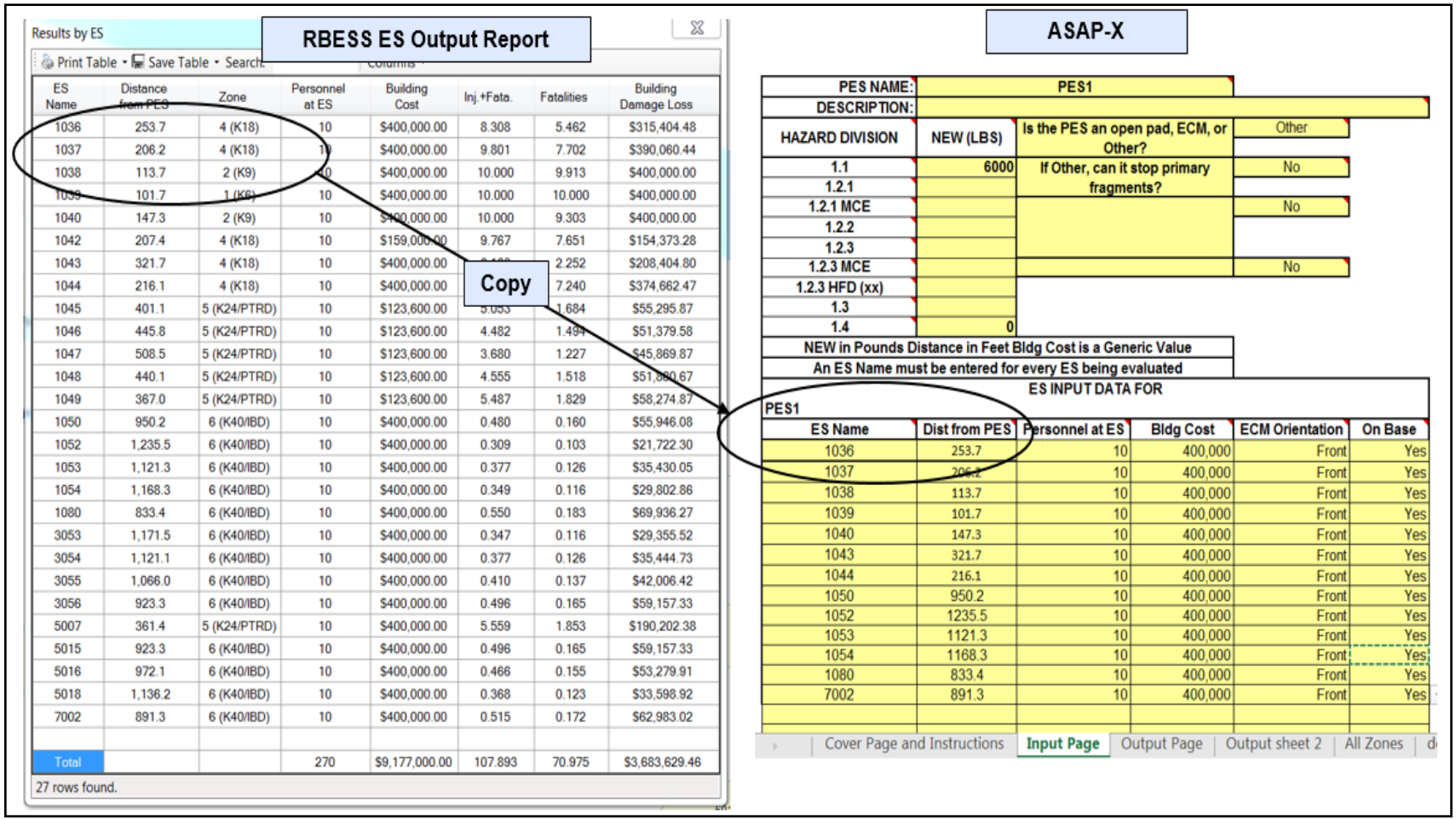
ES OUTPUT DATA PES1

ES Name	Distance From PES	On Base	Zone	Personnel at ES	Fatalities	Injuries	Building Cost	Building Damage Loss
1036	254	Yes	4 (K18)	10	5.5	2.8	400000	315,381.5
1037	206	Yes	4 (K18)	10	7.7	2.1	400000	390,067.9
1038	114	Yes	2 (K9)	10	9.9	0.1	400000	400,000.0
1039	102	Yes	1 (K6)	10	10.0	0.0	400000	400,000.0
1040	147	Yes	2 (K9)	10	9.3	0.7	400000	400,000.0
1043	322	Yes	4 (K18)	10	2.3	3.9	400000	208,461.9
1044	216	Yes	4 (K18)	10	7.2	2.3	400000	374,501.7
1050	950	Yes	6 (IBD)	10	0.2	0.4	400000	55,976.0
1052	1236	Yes	6 (IBD)	10	0.1	0.2	400000	21,740.0
1053	1121	Yes	6 (IBD)	10	0.1	0.2	400000	35,444.0
1054	1168	Yes	6 (IBD)	10	0.1	0.2	400000	29,804.0
1080	833	Yes	6 (IBD)	10	0.2	0.4	400000	69,992.0
7002	891	Yes	6 (IBD)	10	0.2	0.4	400000	63,044.0

ASAP-X & RBESS Tier 1 Results Match

6.4.6.4. The analyst must also input the PES and ES location data manually. This is accomplished by entering either their latitudes and longitudes or the PES-ES distances. This example was simplified by using the PES-ES distances reported from the RBESS Tier 1 results for AGM 1041 as shown in Figure 6.19.

Figure 6.19. ASAP-X: PES and ES Attributes



ES Name	Distance from PES	Zone	Personnel at ES	Building Cost	Inj.+Fata.	Fatalities	Building Damage Loss
1036	253.7	4 (K18)	10	$400,000.00	8.308	5.462	$315,404.48
1037	206.2	4 (K18)	10	$400,000.00	9.801	7.702	$390,060.44
1038	113.7	2 (K9)	10	$400,000.00	10.000	9.913	$400,000.00
1039	101.7	1 (K6)	10	$400,000.00	10.000	10.000	$400,000.00
1040	147.3	2 (K9)	10	$400,000.00	10.000	9.303	$400,000.00
1042	207.4	4 (K18)	10	$159,000.00	9.767	7.651	$154,373.28
1043	321.7	4 (K18)	10	$400,000.00		2.252	$208,404.80
1044	216.1	4 (K18)	10	$400,000.00		7.240	$374,662.47
1045	401.1	5 (K24/PTRD)	10	$123,600.00		1.684	$55,295.87
1046	445.8	5 (K24/PTRD)	10	$123,600.00	4.482	1.494	$51,379.58
1047	508.5	5 (K24/PTRD)	10	$123,600.00	3.680	1.227	$45,869.87
1048	440.1	5 (K24/PTRD)	10	$123,600.00	4.555	1.518	$51,880.67
1049	367.0	5 (K24/PTRD)	10	$123,600.00	5.487	1.829	$58,274.87
1050	950.2	6 (K40/IBD)	10	$400,000.00	0.480	0.160	$55,946.08
1052	1,235.5	6 (K40/IBD)	10	$400,000.00	0.309	0.103	$21,722.30
1053	1,121.3	6 (K40/IBD)	10	$400,000.00	0.377	0.126	$35,430.05
1054	1,168.3	6 (K40/IBD)	10	$400,000.00	0.349	0.116	$29,802.86
1080	833.4	6 (K40/IBD)	10	$400,000.00	0.550	0.183	$69,936.27
3053	1,171.5	6 (K40/IBD)	10	$400,000.00	0.347	0.116	$29,355.52
3054	1,121.1	6 (K40/IBD)	10	$400,000.00	0.377	0.126	$35,444.73
3055	1,066.0	6 (K40/IBD)	10	$400,000.00	0.410	0.137	$42,006.42
3056	923.3	6 (K40/IBD)	10	$400,000.00	0.496	0.165	$59,157.33
5007	361.4	5 (K24/PTRD)	10	$400,000.00	5.559	1.853	$190,202.38
5015	923.3	6 (K40/IBD)	10	$400,000.00	0.496	0.165	$59,157.33
5016	972.1	6 (K40/IBD)	10	$400,000.00	0.466	0.155	$53,279.91
5018	1,136.2	6 (K40/IBD)	10	$400,000.00	0.368	0.123	$33,598.92
7002	891.3	6 (K40/IBD)	10	$400,000.00	0.515	0.172	$62,983.02
Total			270	$9,177,000.00	107.893	70.975	$3,683,629.46

27 rows found.

HAZARD DIVISION	NEW (LBS)
1.1	6000
1.2.1	
1.2.1 MCE	
1.2.2	
1.2.3	
1.2.3 MCE	
1.2.3 HFD (xx)	
1.3	
1.4	0

ES Name	Dist from PES	Personnel at ES	Bldg Cost	ECM Orientation	On Base
1036	253.7	10	400,000	Front	Yes
1037	206.2	10	400,000	Front	Yes
1038	113.7	10	400,000	Front	Yes
1039	101.7	10	400,000	Front	Yes
1040	147.3	10	400,000	Front	Yes
1043	321.7	10	400,000	Front	Yes
1044	216.1	10	400,000	Front	Yes
1050	950.2	10	400,000	Front	Yes
1052	1235.5	10	400,000	Front	Yes
1053	1121.3	10	400,000	Front	Yes
1054	1168.3	10	400,000	Front	Yes
1080	833.4	10	400,000	Front	Yes
7002	891.3	10	400,000	Front	Yes

6.4.7. An RBESS Tier 2a analysis uses physics-based air blast and debris models to calculate the potential for damage, injury, and fatality. This differs from an RBESS Tier 1 consequence analysis where consequences are based only on the location of an ES within six hazard zones. A Tier 2a analysis requires this additional PES and ES input data:

6.4.7.1. Tier 2a Inputs:

6.4.7.1.1. NEW (air blast) - lb, trinitrotoluene: HD 1.1, 1.2, 1.3, etc.

6.4.7.1.2. PES Type (to consider secondary debris): various size/types of ECMs, aboveground brick structures, operation buildings, ships, etc.

6.4.7.1.3. Weapon types (to consider primary frags): MK bombs, bulk/light case, missile, projectiles.

6.4.7.1.4. ESs: construction (wall/roof) type, window type/size/amount, population, replacement cost.

6.4.7.2. Tier 2a Outputs:

6.4.7.2.1. %/$ damage, injuries, fatalities are calculated due to probability of primary/secondary debris impact, air blast, and thermal hazards.

6.4.7.2.2. Fragment/debris impact damage, fatality and injury based on probability of impact, ES penetration, and blunt trauma.

6.4.7.2.3. Air blast damage, fatality, and injury based on overpressure and impulse.

6.4.7.2.4. Various ES hazard/risk displays and reports, including overpressure contours.

6.4.7.2.5. Risk matrix and DARAD form, if used.

6.4.7.3. The same RBESS project developed for Tier 1 can be used to run a Tier 2a analysis after the additional PES and ES data are input. To start an RBESS Tier 2a analysis, click on the ESS menu bar “Analysis” option, then “Risk-Based Analysis,” “Tier 2a: Run New Analysis” as illustrated in Figure 6.20. Following the same process as for Tier 1, select “AGM 1041” and the default scenario. Figure 6.21. will be displayed.

Figure 6.20. Tier 2a RBESS Project for AGM 1041

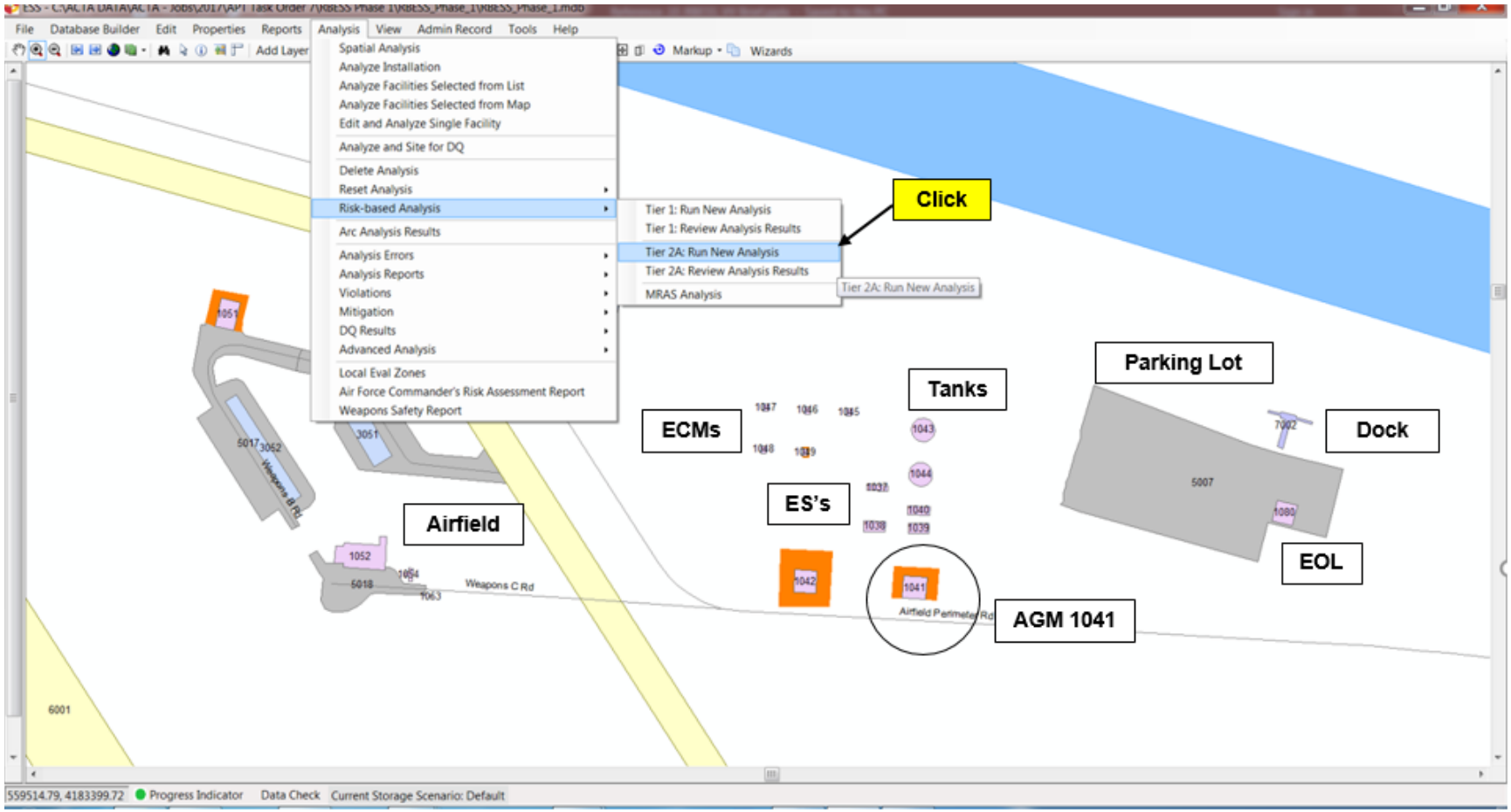
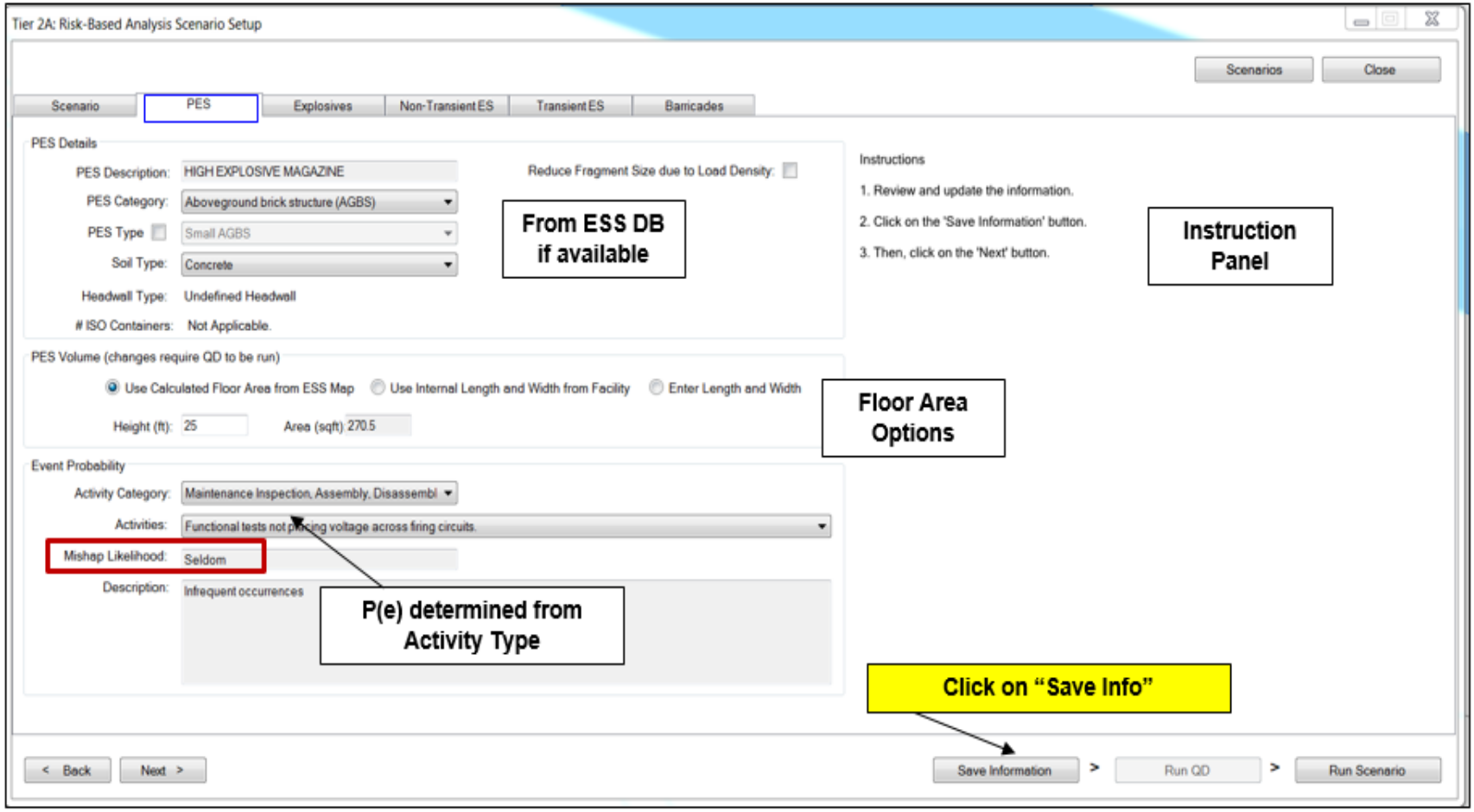


Figure 6.21. Tier 2a Scenario Setup Screen



6.4.7.4. The "PES" tab has options for floor area and event probability. To set the probability, select an "Activity Category" and "Activity Type" and an internal table will assign one of the five likelihood levels (frequent, likely, occasional, seldom, or unlikely) as shown in Table 6.2. Click on "Save Info."

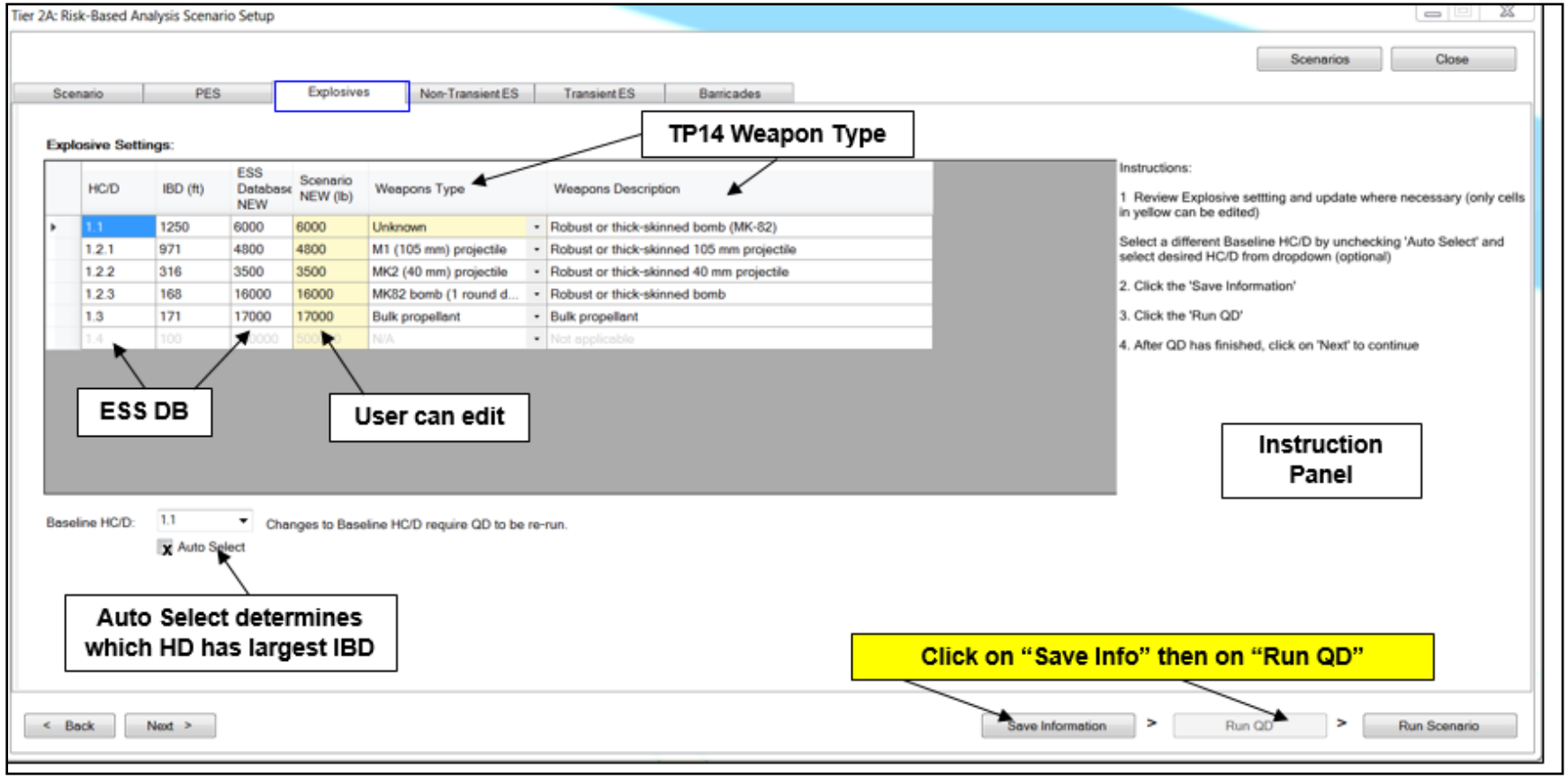
Table 7. Event Probability/Likelihood Versus Hazardous Activity*

Category / Probability	Storage	Maintenance Inspection, Assembly, Disassembly	Operations	Transportation	Destruction	Testing
Frequent (A). Over a typical career, a mishap can be expected to occur on an intermittent basis.		Dangerously unserviceable items awaiting destruction				Initial tests of new systems
Likely (B). Over a typical career, a mishap can be expected to occur randomly.	Any operating stocks in an area subject to hostile action, such as rockets, missiles, air attacks, or terrorists	Any operating location in an area subject to hostile actions, such as rockets, missiles, air attacks, or terrorists	Any explosives operations in an area subject to hostile actions, such as rockets, missile, air attacks, or terrorists			
	Dangerously unserviceable items awaiting destruction	Hazardous environments with gases, fibers, etc.				
Occasional (C). Over a typical career, a mishap can be expected to occur infrequently		Unserviceable (but not dangerous) items.	TDY operations during exercises, Contingencies, or alert		Burning, detonation, and static firing areas	
		Circuit checks	Hot Cargo Missions of unserviceable or unpackaged material			
		TDY during contingencies or exercises				
Seldom (D). Over a typical career, a mishap will rarely occur	Operating stocks in storage requiring handling more than once each month	Home station during contingencies or exercises	Home station activities during exercises, contingencies or alerts	Railheads requiring application of QD		Testing operational systems
	Unserviceable (but not dangerous) items in storage	Pyrotechnics	TDY operations during peacetime	Material Handling Equipment movements and shipments on and off station		
		Functional tests not placing voltage across firing circuits	Flight-line holding areas/ready service storage locations outside munitions storage areas			
		Outdoor operations during inclement weather	Deployed ground-based missile meant to be employed in a non-mobile mission for offensive or defensive purposes			
Unlikely (E). So rare, a mishap is not expected to occur during a typical career	Serviceable items in extended storage requiring handling less than once each month	Paint and packing	Home station flight-line explosive activities during peacetime			
		Operations involving no exposed explosives	ICBM Launch Facilities			
			Hot Cargo Missions of serviceable packaged material			

* This table is a slight modification of the Event Probability used in Air Force Manual 91-201 and DA Pamphlet 385-30.

6.4.7.5. Select the "Explosives" tab as illustrated in Figure 6.22. For a Tier 2a analysis, the NEWs by HD stored in the ESS facility database will be displayed. The analyst can modify them to perform a sensitivity analysis, if desired. Because Tier 2a uses physics-based models to predict fragment and debris effects, the analyst must also select a weapon type and description from drop-down lists for each HD.

Figure 6.22. Tier 2a Explosives Tab



NOTE: Tier 1 analysis can check the "Auto Select" box and let RBESS determine the controlling HD (based on the largest IBD).

6.4.7.6. Click on “Save Information” when data entry is complete and then click on “Run QD.” RBESS will perform the QD calculations in the background and inform the analyst that data for the “Non-Transient ES,” “Transient ES,” and “Barricade” tabs were loaded. Figure 6.23. shows the Non-Transient Tab. Users can set the evaluation zone for Tier 1 analysis, but require additional ES attributes for Tier 2 analysis as shown by the red ellipses in Figure 6.23. RBESS will fill in the attributes if they are stored in the ESS facility database. RBESS will enter these default values for attributes not stored in the database:

6.4.7.6.1. Height = 15 feet.

6.4.7.6.2. Glass (percentage of glass covering the wall elevations) = 10%.

6.4.7.6.3. Replacement Cost = $400,000.

6.4.7.6.4. Window Cost (% of replacement cost) = 2.5%.

6.4.7.6.5. Structure Category = Steel pre-engineered metal building.

6.4.7.6.6. Structure Type = Medium-size.

6.4.7.6.7. Roof Type = Light steel panel.

6.4.7.6.8. Window Type = Annealed (single pane).

6.4.7.6.9. Personnel at ES as described in Figure 6.24.: 10 people, 8 hours/day, 5 days/week, 50 weeks/year (note that the current version of RBESS only allows for the analysis of one group).

Figure 6.23. Tier 2a Non-Transient ES Tab

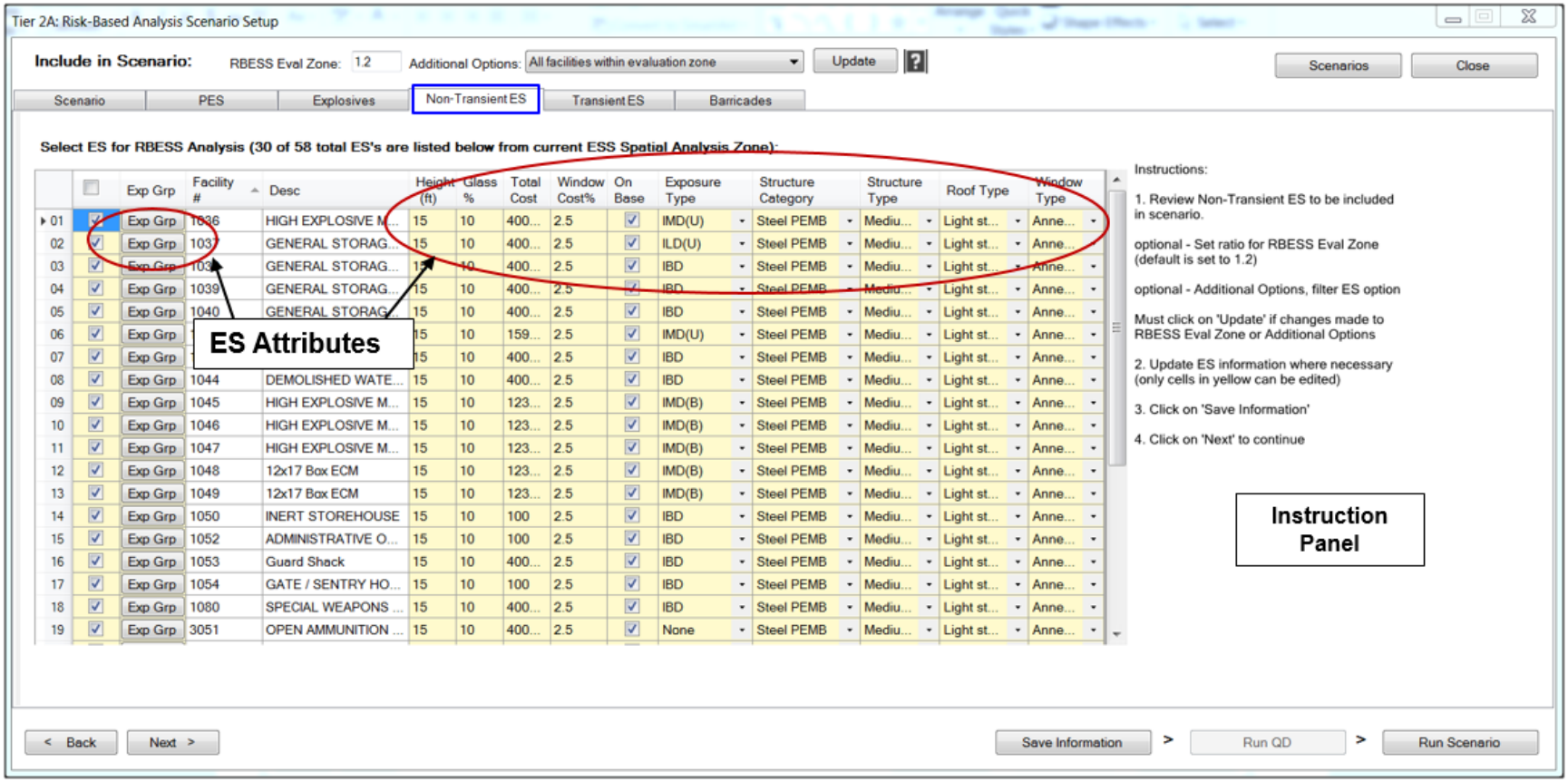
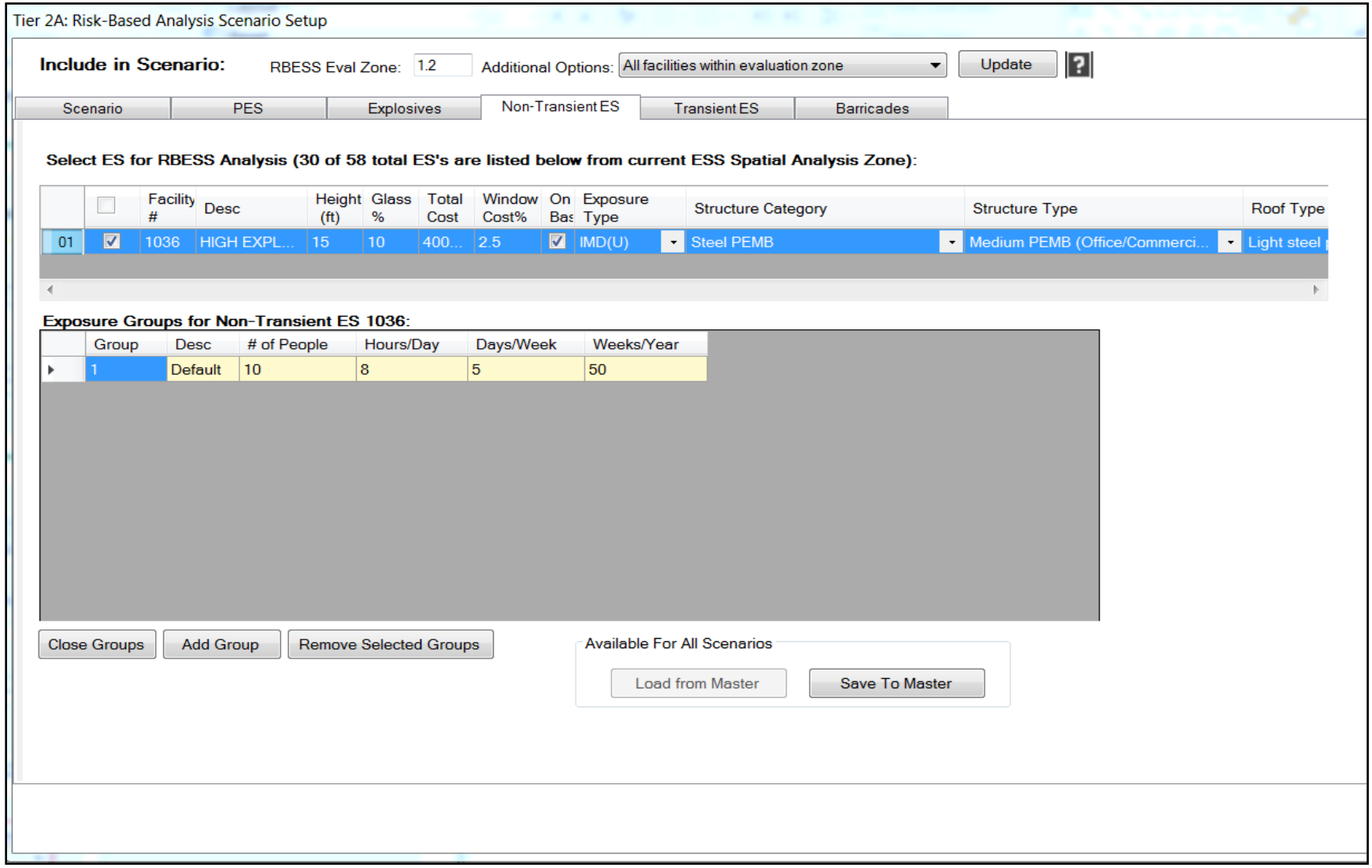


Figure 6.24. Tier 2a ES Exposure Group Screen



6.4.7.7. Transient ES can be evaluated (e.g., roads, runways, shipping lanes). Figure 6.25. shows elements associated with the ESS facility database located in the ESS evaluation zone. The attributes shown in the "red" ellipses are required to perform a transient analysis. RBESS uses the attributes to place vehicles at the specified interval along the road segment and determine the average number of people exposed if an explosion occurs. The default values are:

6.4.7.7.1. Vehicle Interval = 500 feet (distance between ESs placed along the road).

6.4.7.7.2. Vehicle Length, Width, Height = 12 feet, 5 feet, 4.5 feet.

6.4.7.7.3. Vehicle Replacement Cost = $20,000.

6.4.7.7.4. Window Cost = 2.5% of replacement cost.

6.4.7.7.5. Glass Percentage = 25%.

6.4.7.7.6. Window Type = Tempered.

6.4.7.7.7. Vehicle Exposure (Figure 6.26.): average people in vehicle = 1.5, average speed = 50 mph, # cars per hour = 2000, hour/day = 20, days/week = 5, weeks/year = 50 (note that the current version of RBESS only allows for the analysis of one group).

Figure 6.25. Tier 2a Transient ES Tab

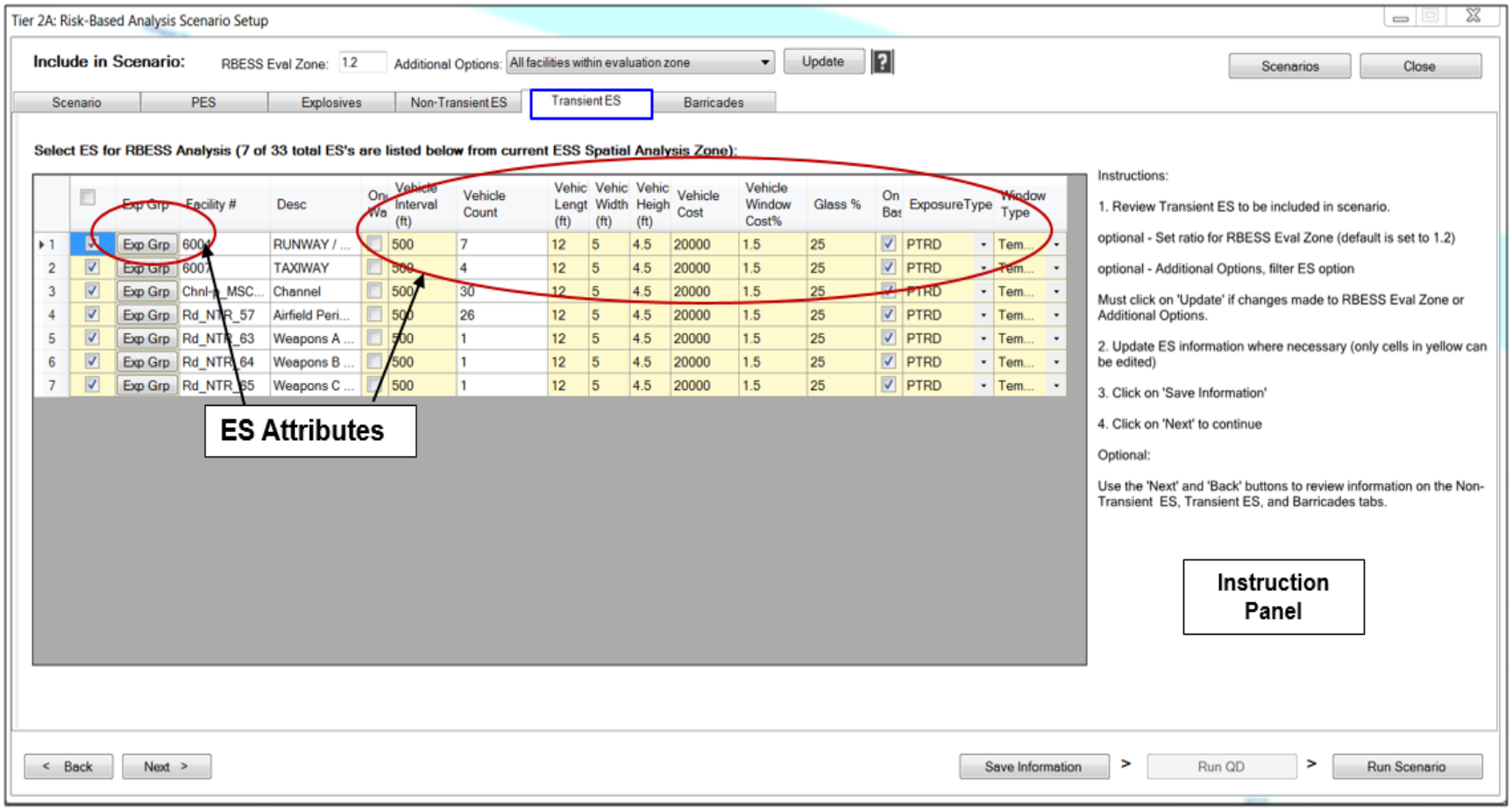
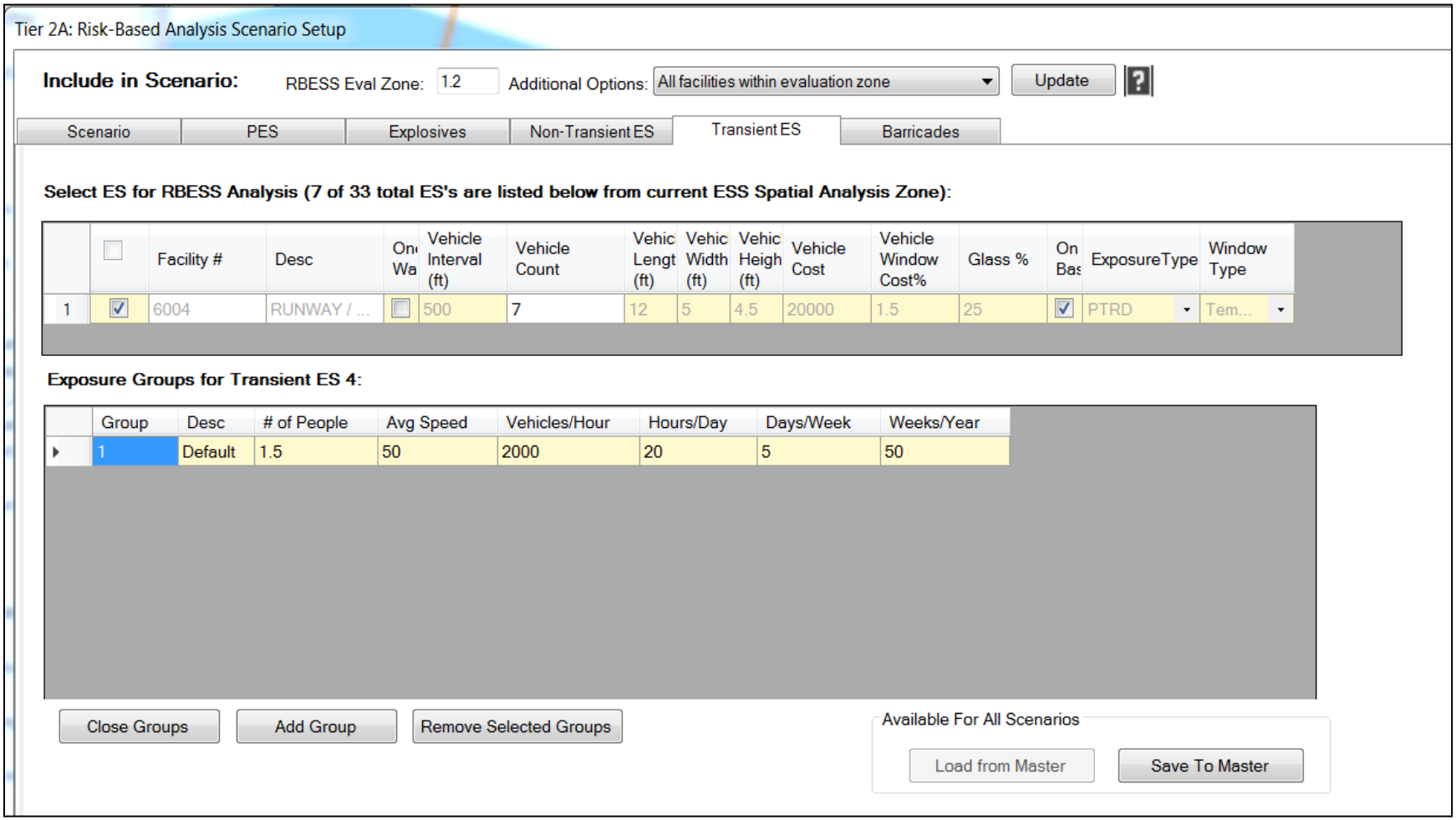
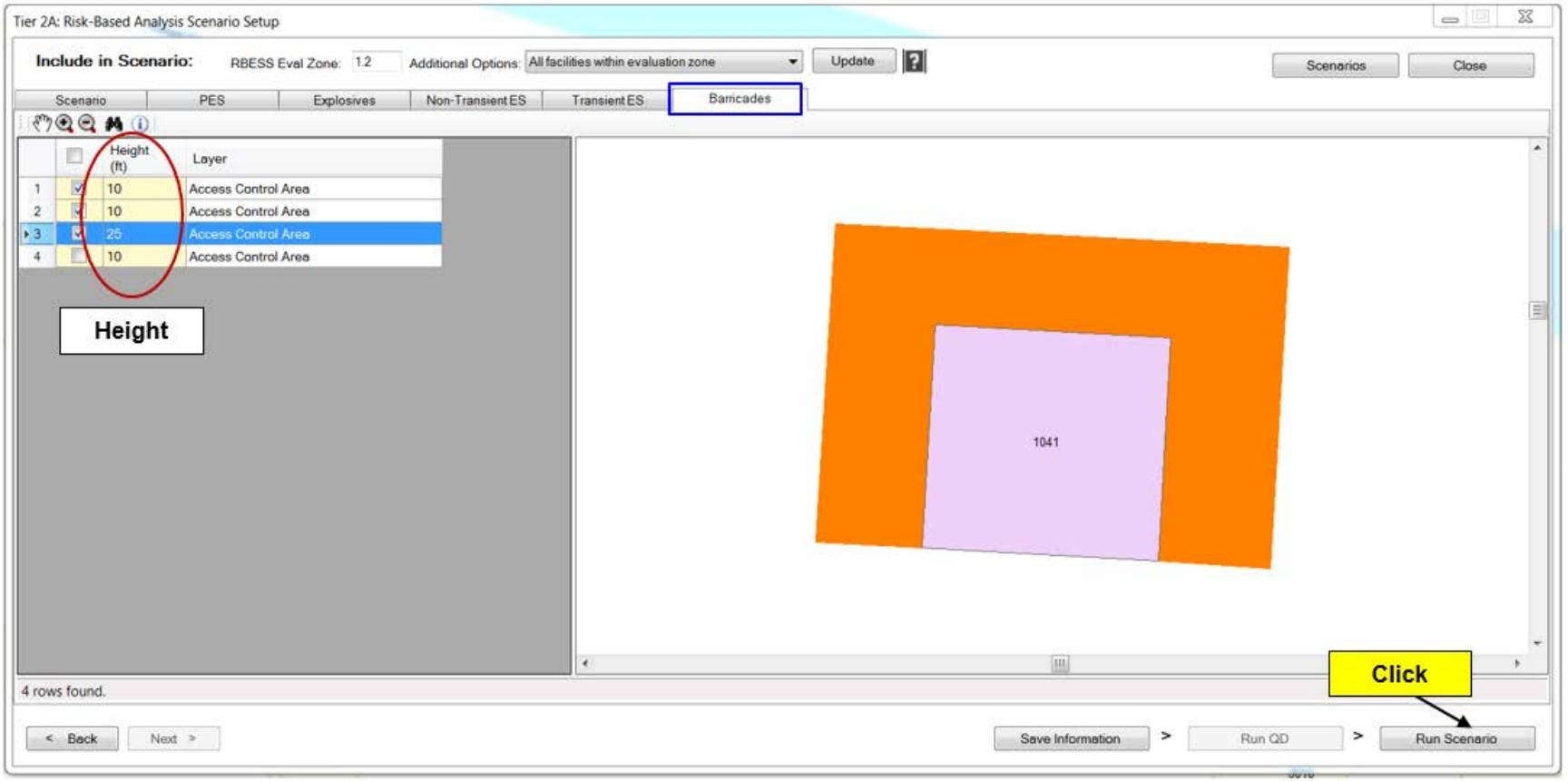


Figure 6.26. Tier 2a Transient Vehicle Exposure Group Screen



6.4.7.8. RBESS Tier 2a can consider the presence of barricades that potentially block fragments and debris thrown from the PES as shown in Figure 6.27. For this example, a barricade has been placed around the sides and rear of AGM 1041. The only attribute for a barricade is its height, which the analyst can edit. When all of the data has been entered, the analyst clicks on the "Run Scenario" button to start the Tier 2a analysis.

Figure 6.27. Tier 2a Barricade Tab



6.4.7.9. When the analysis is complete, the ESS screen will be updated including a panel on the right-hand side to show various analysis results. Figure 6.28. illustrates the "Show Overpressure" button data. The analyst can view a host of intermediate results including structural damage, percentage of fatalities, and risk as shown in Figures 6.29., 6.30., and 6.31.

Figure 6.28. Tier 2a Analysis Results – Overpressure Contours

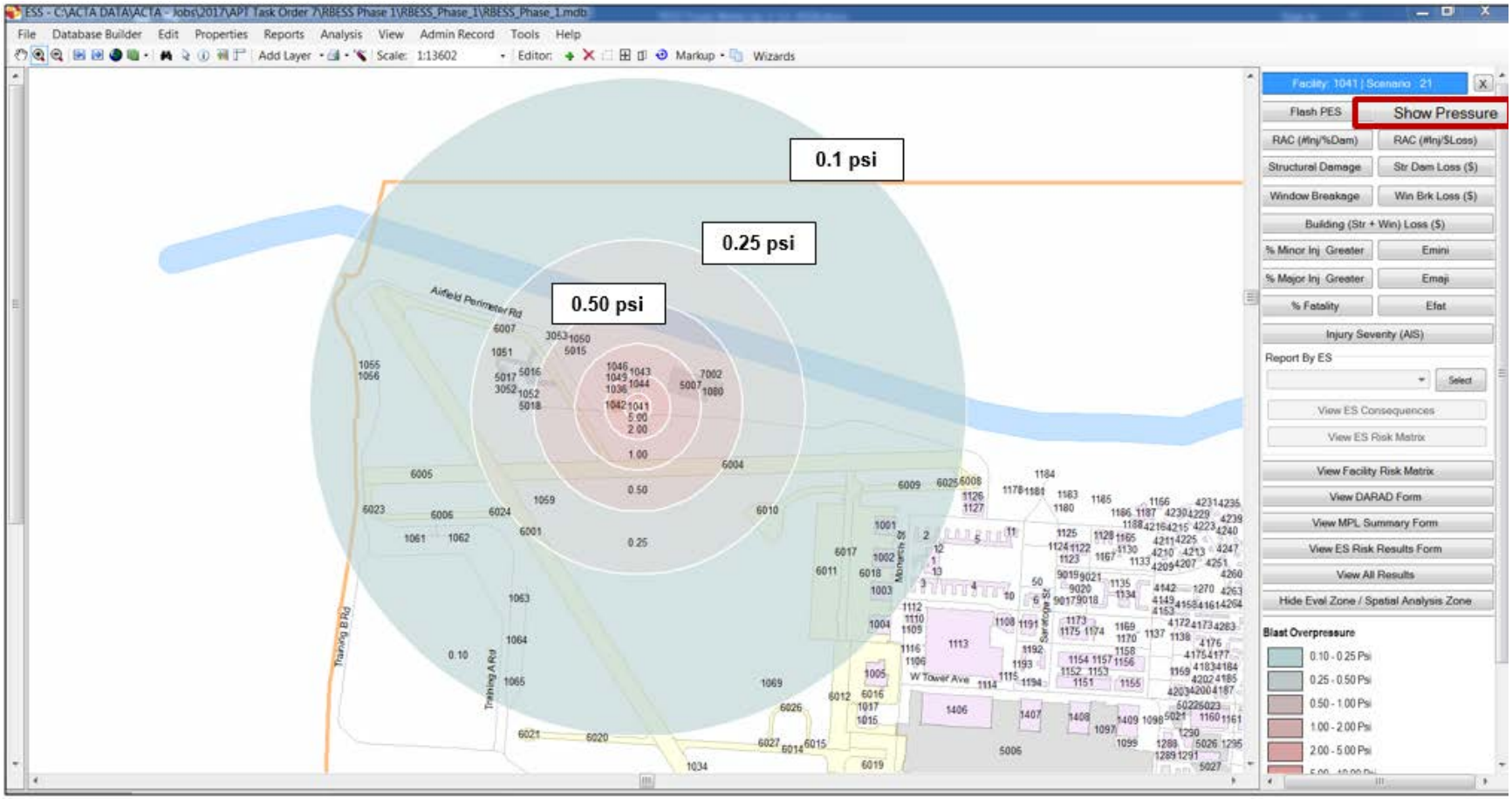


Figure 6.29. Tier 2a Analysis Results – Structural Damage

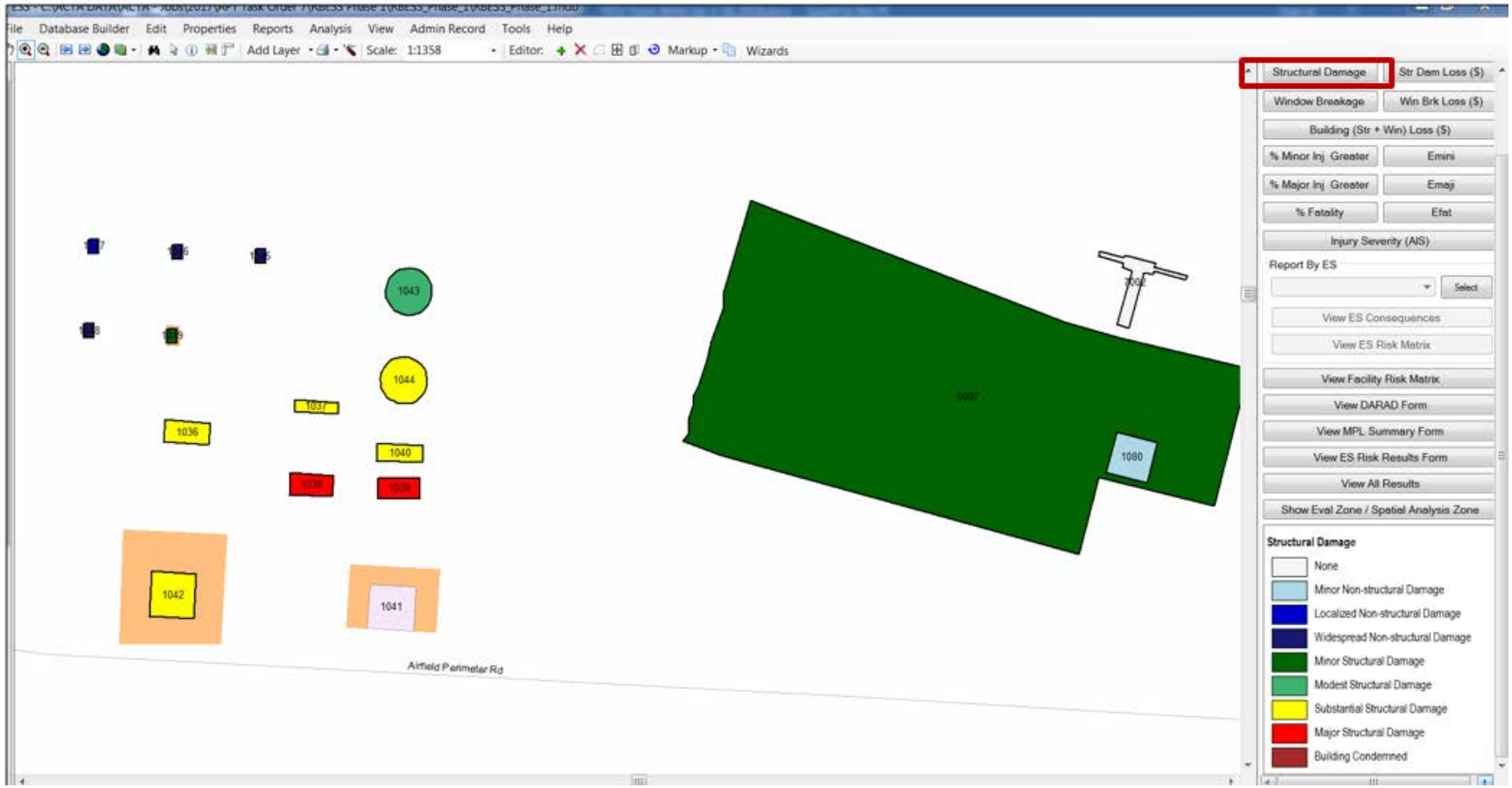


Figure 6.30. Tier 2a Analysis Results – Percentage of Fatalities

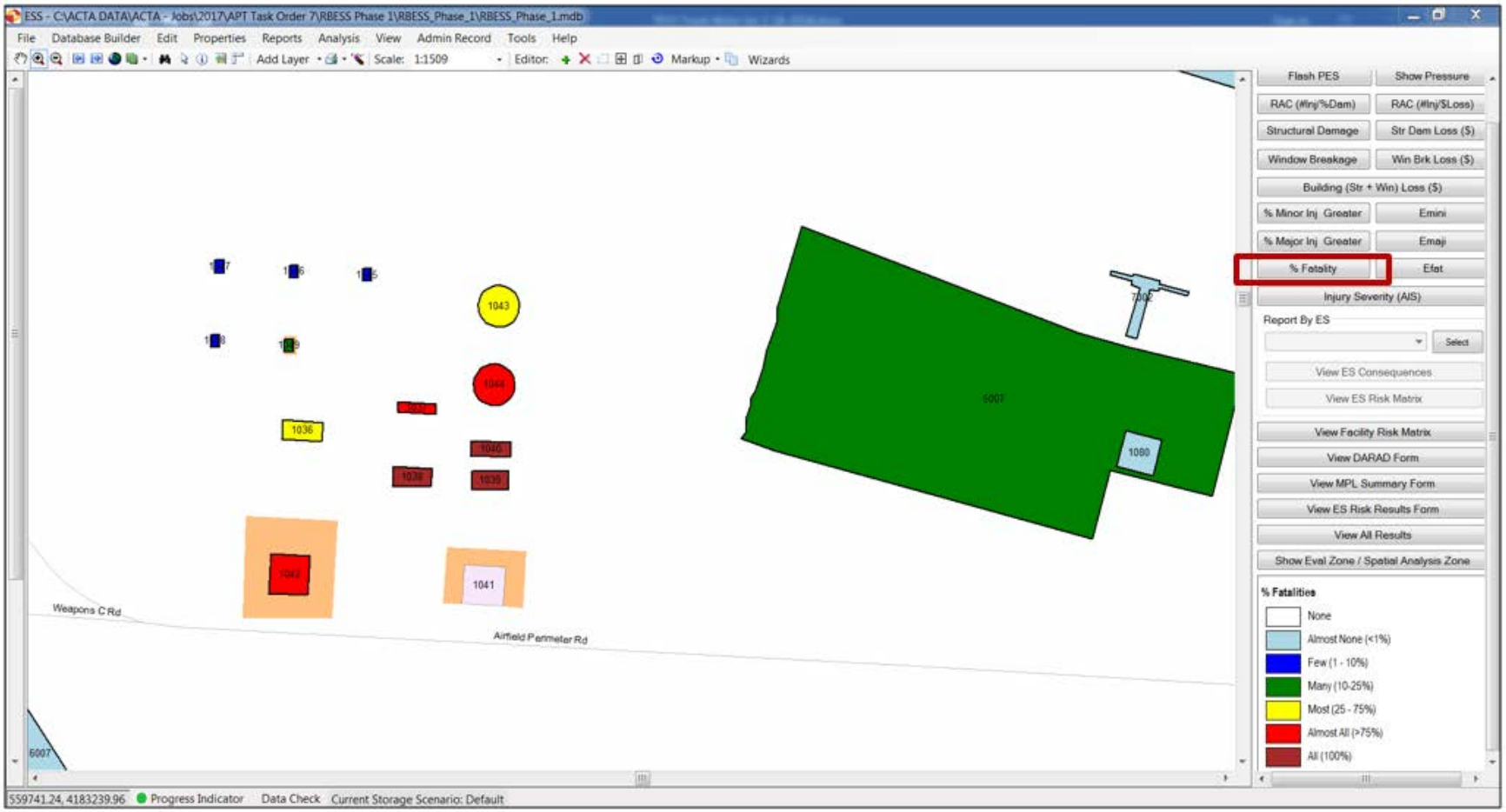
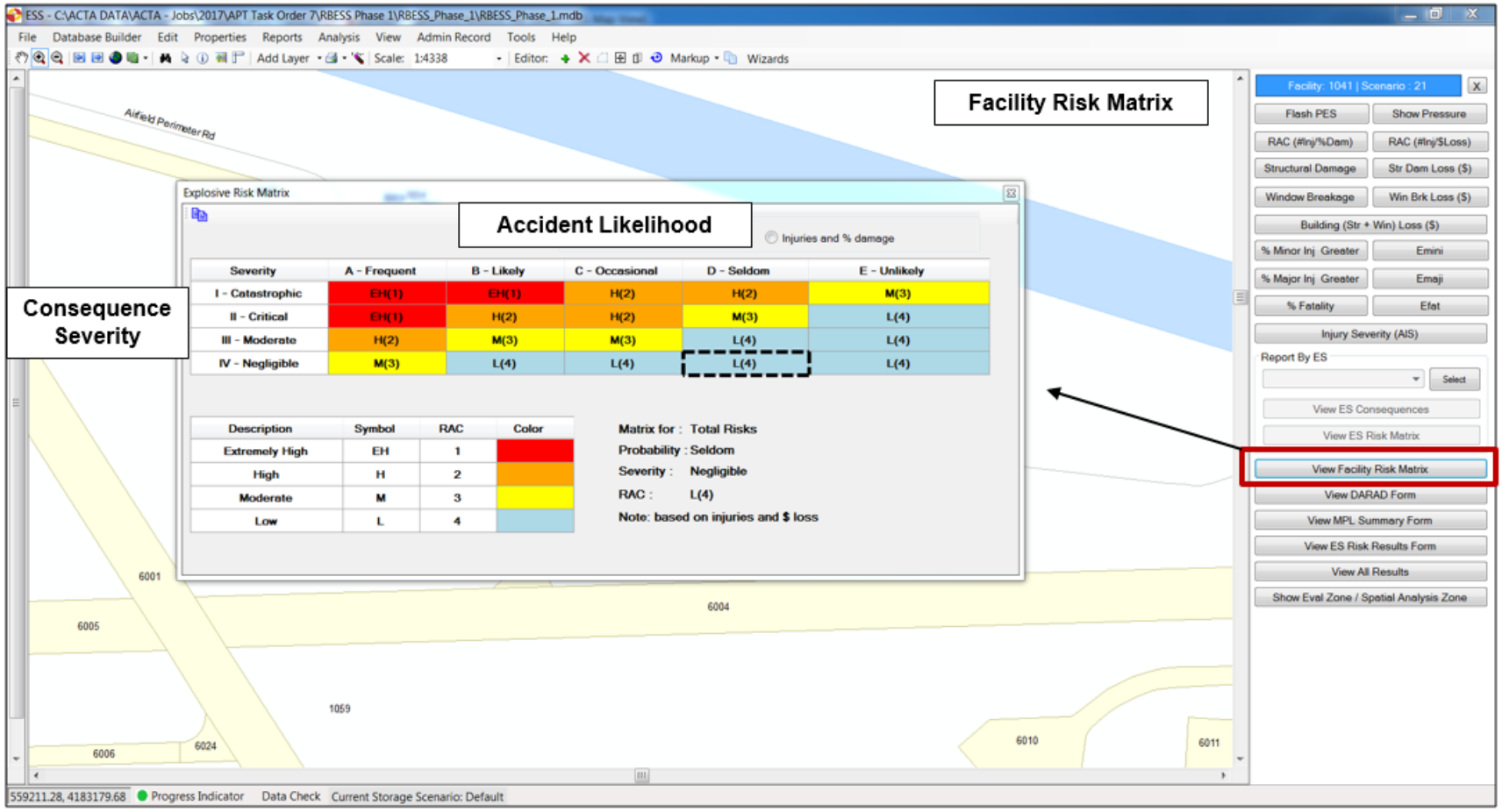


Figure 6.31. Tier 2a Analysis Results – Risk Matrix



6.4.7.10. The consequences in terms of number of fatalities, number of injuries, and monetary loss will be converted into a Severity Category (Catastrophic, Critical, Moderate, Negligible) as shown in Table 6.3. Table 6.4. shows the consequences summarized by non-transient, transient, and people in the open. Table 6.5. shows the consequences tabulated for all ESs. Finally, Table 6.6. shows how the analysis is populated in the DARAD form, if used.

Table 6.3. Conversion of Computed Consequences to Severity Level

Severity Level	Severity Description	Expected # Fatalities	Expected # Major Injuries	Expected # Minor Injuries	Expected % Damage
I	Catastrophic	≥ 1	≥ 10	≥ 200	> 75
II	Critical	0.1 - 1	5 – 10-	50 - 200	40 - 75
III	Moderate	10^{-6} – 0.1	1 - 5	5 -50	15 - 40
IV	Negligible	< 10^{-6}	< 1	< 5	< 15

Table 84. Tier 2a Analysis Results (View Maximum Probable Loss Summary Form)

Maximum Probable Loss (MPL)

Print Table | Save Table | Search: | Columns

Receptor Type	No. of People	Equip/Fac Value ($)	Fatalities	Major Inj.+Fata.	Any Inj.+Fata.	Equip/Fac Loss ($)
Buildings	300	$7,977,600	70.12	92.25	115.52	$1,378,010
Moving Vehicles	327	$4,356,543	2.08	3.17	4.25	$5,686
Open Areas						
Total	627	$12,334,143	72.2	95.42	119.77	$1,383,696

5 rows found.

Table 6.5. Tier 2a Analysis Results (View ES Risk Results Form)

FacilityNumber	Distance from PES	No. of People	Equip/Fac Value ($)	Fatality	Major Inj. Fata.	Any Inj. Fata.	Equip/Fac Loss ($)
1036	291.6	10	$400,000	5.65	9.96	10	$124,500
1037	239.2	10	$400,000	9.28	10	10	$152,000
1038	150.1	10	$400,000	10	10	10	$207,300
1039	129.1	10	$400,000	10	10	10	$220,400
1040	173.7	10	$400,000	10	10	10	$192,200
1042	235.2	10	$159,000	9.44	10	10	$62,480
1043	347.9	10	$400,000	2.77	7.89	10	$94,730
1044	242.3	10	$400,000	9.15	10	10	$150,800
1045	435.9	10	$123,600	0.83	3.13	7.81	$18,760
1046	483.0	10	$123,600	0.22	0.9	3.59	$14,530
1047	546.5	10	$123,600	0.15	0.55	2.07	$9,491
1048	478.1	10	$123,600	0.23	0.94	3.72	$14,940
1049	405.1	10	$123,600	1.15	4.27	8.99	$21,970
1050	988.4	10	$100	0.0011	0.0043	0.013	$1
1052	1,263.4	10	$100	0.00017	0.00067	0.0021	$1
1053	1,150.8	10	$400,000	0.00034	0.0013	0.004	$83
1054	1,196.3	10	$100	0.00026	0.00099	0.0031	$1
1080	866.4	10	$400,000	0.0019	0.0075	0.024	$4,059
3051	1,284.4	10	$400,000	0.00012	0.00048	0.0015	$1,191
3052	1,478.1	10	$400,000	3.9E-05	0.00015	0.00047	$1,006
3053	1,209.6	10	$400,000	0.00025	0.00096	0.003	$922
3054	1,159.2	10	$400,000	0.00034	0.0013	0.004	$500
3055	1,104.2	10	$400,000	0.00047	0.0018	0.0055	$623
3056	961.4	10	$400,000	0.0013	0.0051	0.016	$2,326
5007	398.8	10	$400,000	1.23	4.57	9.23	$78,340
5015	961.4	10	$100	0.0013	0.0051	0.016	$1
5016	1,004.2	10	$100	0.00088	0.0034	0.01	$1
5017	1,446.6	10	$100	4.7E-05	0.00018	0.00058	$1
5018	1,165.1	10	$400,000	0.00031	0.0012	0.0037	$2,176
7002	927.4	10	$400,000	0.0012	0.0049	0.016	$2,678
6004	648.3	40	$530,480	0.072	0.26	0.74	$0
6007	604.5	27	$359,910	0.034	0.13	0.37	$0
Chnl-p_MSC_8002	961.4	172	$2,296,480	0.00084	0.0032	0.0099	$0
Rd_NTR_57	117.0	79	$1,048,208	1.97	2.77	3.12	$5,686
Rd_NTR_63	1,056.6	2.9	$39,080	5.2E-05	0.0002	0.00062	$0
Rd_NTR_64	1,451.4	2.9	$39,249	6.8E-06	2.7E-05	8.5E-05	$0
Rd_NTR_65	587.5	3.2	$43,136	0.00099	0.0038	0.012	$0

Table 6.6. Tier 2a Analysis Results (DARAD Form)

AMMUNITION AND EXPLOSIVES WORKSHEET

Deviation #:	Effective Date:	Expiration Date:

INFORMATION ON THE POTENTIAL EXPLOSION SITE (PES)

29a. PES Name/#: 1041	29b. PES Function:	30. PES # People: 9
31. PES Equip/Fac (Value) $: $159,000.00	32. Required Blast Distance: 0	33. Required Fragment Distance: 0
34a. Hazard Division: 1.1: NEW: 6,000	34b. Hazard Division: 1.2.1: NEW: 4,800	34c. Hazard Division: 1.2.2: NEW: 3,500
34d. Hazard Division: 1.2.3: NEW: 16,000	34e. Hazard Division: 1.3: NEW: 17,000	34f. Hazard Division: 1.4: NEW/MEQ: 500000

35a. QD arcs exceed the installation boundary? YES ☐ NO ☐ | Are other Services affected? YES ☐ NO ☐ | Was coordination made? YES ☐ NO ☐ | Provide other coordination documentation, as necessary.

Why coordination was/was not made: | Coordination paperwork attached? ☐

35b. Is this deviation associated with a hybrid or risk-base safety submission? | 35c. If YES, provide site plan #:

INFORMATION ON THE EXPOSED SITES (ES)

36. EXPOSED SITES — At Required Distance | At Requested Distances | (Attachment?) ☐

FACILITY	DISTANCE: Feet REQUIRED	DISTANCE: Feet ACTUAL	# PEOPLE	EQUIP/FAC (VALUE) $	EXPOSURE TYPE	ON/OFF INSTALLATION	FATALITIES	INJURIES	EQUIP/FAC (LOSS) $	FATALITIES	INJURIES	EQUIP/FAC (LOSS) $	VIOLATION?
1037	436	206.2	10	400,000.00	ILD(U)	ON	0.82	2.3	59,980.00	9.28	0.72	152,000.00	YES
1038	1,250	113.7	10	400,000.00	IBD	ON	0.00019	0.00056	526.40	10	0	207,300.00	YES
1039	1,250	101.7	10	400,000.00	IBD	ON	0.00019	0.00056	515.30	10	0	220,400.00	YES
1040	1,250	147.3	10	400,000.00	IBD	ON	0.00019	0.00056	478.50	10	0	192,200.00	YES
1043	1,250	321.7	10	400,000.00	IBD	ON	0.00019	0.00056	720.30	2.77	5.11	94,730.00	YES
1044	1,250	216.1	10	400,000.00	IBD	ON	0.00019	0.00056	720.50	9.13	0.83	150,800.00	YES
1052	1,250	1,235.5	10	100.00	IBD	ON	0.00017	0.00049	0.69	0.00017	0.00049	0.69	YES
1053	1,250	1,121.3	10	400,000.00	IBD	ON	0.00019	0.00053	73.22	0.00034	0.00096	83.14	YES
1054	1,250	1,168.3	10	100.00	IBD	ON	0.00019	0.00053	0.70	0.00026	0.00074	0.74	YES
1080	1,250	833.4	10	400,000.00	IBD	ON	0.00019	0.00056	728.80	0.0019	0.0056	4,059.00	YES
3051	1,284.4	1,252.4	10	400,000.00		ON	0.00012	0.00035	1,191.00	0.00012	0.00035	1,191.00	YES
3052	1,478.1	1,448.3	10	400,000.00		ON	0.000039	0.00011	1,006.00	0.000039	0.00011	1,006.00	YES
5007	398.8	361.4	10	400,000.00		ON	1.23	3.34	78,340.00	1.23	3.34	78,340.00	YES

EXPECTED POTENTIAL CONSEQUENCES

37. Potential Explosion Site:	a. Fatalities:	9	b. Injuries:	c. Equip/Fac $:	$ 159,000.00
38. Potential Losses for Exposed Sites (ES) Meeting Criteria:	a. Fatalities:	2.12	b. Injuries: 5.83	c. Equip/Fac $	$ 147,095.84
39. Potential Loss Being Accepted for Deviating from Approved Standards:	a. Fatalities:	54.53	b. Injuries: 11.13	c. Equip/Fac $	$ 1,112,653.41
40. Total Potential Loss (#/$):	a. Fatalities:	65.65	b. Injuries: 16.96	c. Equip/Fac $	$ 1,418,749.25

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Table 6.6. Tier 2a Analysis Results (DARAD Form), continued

Deviation #: _____

INFORMATION ON THE EXPOSED SITES (ES) CONTINUATION WORKSHEET

Exposed Sites (continued from block 36)							At Required Distance			At Requested Distances			
FACILITY	DISTANCE: Feet REQUIRED / ACTUAL		# PEOPLE	EQUIP/FAC (VALUE) $	EXPOSURE TYPE	ON/OFF INSTALLATION	FATALITIES	INJURIES	EQUIP/FAC (LOSS) $	FATALITIES	INJURIES	EQUIP/FAC (LOSS) $	VIOLATION?
5015	961.4	923.3	10	100.00		ON	0.0013	0.0038	1.38	0.0013	0.0038	1.38	YES
5016	1,004.2	972.1	10	100.00		ON	0.00088	0.0025	1.22	0.00088	0.0025	1.22	YES
5017	1,446.6	1,416.8	10	100.00		ON	0.000047	0.00014	0.55	0.000047	0.00014	0.55	YES
5018	1,165.1	1,136.2	10	400,000.00		ON	0.00031	0.00088	2,176.00	0.00031	0.00088	2,176.00	YES
7002	1,250	891.3	10	400,000.00	IBD	ON	0.00019	0.00056	635.30	0.0012	0.0036	2,678.00	YES
6004	750	615.8	40	530,480.00	PTRD	ON	0.037	0.1	0.00	0.072	0.19	0.00	YES
6007	750	566.4	27	359,910.00	PTRD	ON	0.016	0.046	0.00	0.034	0.093	0.00	YES
Rd_NTR_57	750	78.9	79	1,048,208.00	PTRD	ON	0.0096	0.027	0.00	1.97	0.8	5,685.70	YES
Rd_NTR_65	750	557.1	3.2	43,136.00	PTRD	ON	0.0009	0.0026	0.00	0.00099	0.0028	0.00	YES

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LIST OF ACRONYMS

ACTA	Advanced Core Concepts, LLC
AGM	aboveground magazine
APT	analysis, planning, test research
ASAP-X	Automated Safety Assessment Protocol - Explosives
CCMD	combatant command
CFR	Code of Federal Regulations
CJCSI	Chairman of the Joint Chiefs of Staff Instruction
C&RI	consequence and risk identification
DARAD	Deviation Approval and Risk Acceptance Document
DDESB	Department of Defense Explosives Safety Board
DESR	Department of Defense Explosives Safety Regulation
DoDD	Department of Defense directive
DoDI	Department of Defense instruction
ECM	earth-covered magazine
ERM	enterprise risk management
ES	exposed site
ESMRM	explosives safety and munitions risk management
ESQD	explosives safety quantity distance
ESRM	explosives safety risk management
ESS	explosives safety siting
EXWC	Expeditionary Warfare Center
FCC	functional combatant commander
GCC	geographic combatant commander
HD	hazard division
HN	host nation
IBD	inhabited building distance
ICBM	intercontinental ballistic missile
ILD	intra-line distance
IMD	inter-magazine distance
LOC	line of communications

MDA	Milestone Decision Authority
MIL-STD	military standard
MRMA	Munitions Risk Management Assessment
MSA	materiel solution analysis
NATO	North Atlantic Treaty Organization
NEW	net explosive weight
OMB	Office of Management and Budget
PES	potential explosion site
PM	program manager
QD	quantity distance
RAC	risk assessment code
RBESS	risk-based explosives safety siting
SAFER	safety assessment for explosives risk
TDY	temporary duty
TMRR	technology maturation and risk reduction
TP	technical paper
UON	urgent operational need

REFERENCES

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Office of Management and Budget, Circular No. A-123, "Management's Responsibility for Enterprise Risk Management and Internal Control," July 15, 2016

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[1] Available at https://nso.nato.int/nso/zPublic/ap/ALP-16%20EDA%20V1%20E.pdf