Explosives Safety Siting Software Overview and Status

Authors:

David Bianchi, GISP; NAVFAC EXWC; Port Hueneme, California, USA.

Michael Oesterle PhD, PE; NAVFAC EXWC; Port Hueneme, California, USA.

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Abstract:

The Explosives Safety Siting (ESS) software is a Geographic Information System (GIS) application that automates the calculation and display of Explosives Safety Quantify Distance (ESQD) arcs for explosives storage and handling sites. The ESS software contains planning and analytical tools for assisting with the development of site plan packages. The Department of Defense Explosives Safety Board (DDESB) works with the Naval Facilities Engineering Command - Engineering and Expeditionary Warfare Center (NAVFAC EXWC) to develop and deploy the ESS software for Department of Defense (DoD) use. This paper will provide an overview of the software and a status on development, deployment, training, and support.

Introduction

Explosives safety site plans are developed and submitted for DoD approval when planned construction or explosives operations change. The Services have long recognized that planning and siting for explosives ordnance storage and handling is a complex, high-risk, time-intensive, and error-prone activity that too often results in inefficient use of facilities and non-compliance with explosives safety criteria.

Efforts to automate the explosives safety siting process have been underway prior to the 1980s. Around 1990, a Tri-Service committee was formed to develop functional requirements and a technical approach to automate the Quantity Distance (QD) analysis process and assist planners in the preparation of explosives safety site plans. In 1993, a Technical Plan and Statement of Work was published and Deputy Under Secretary of Defense, Installations and Environment (DUSD I&E), subsequently set up the Defense Environmental Corporate Information Management (DECIM) Program Office to (1) determine the state-of-the-art software requirement and (2) fund the migration of the best software applications into a DoD standard system. The goal was to automate up to 80% of the functional site analyses tasks associated with site planning and administrative decisions supporting waivers, exemptions, and special certifications.

In 1996, the DESCIM Program Management Office (PMO) embarked on an effort to automate the explosives safety planning and site approval request process. This effort has resulted in the development of the ESS software.

In March 1998, the NAVFAC Engineering Service Center (now called NAVFAC EXWC) was tasked to become the Central Design Authority (CDA) for ESS and is currently providing technical and program guidance to this program. In 2002, program management of DESMS transferred from DESCIM to the Environmental Information Technology Management (EITM) Program. In 2006, program management of DESMS transferred from EITM to the Department of Defense Explosives Safety Board (DDESB).

In 2008, three explosives safety planning software applications were in significant use in the DoD: ASHS, ESS and MSS. These software applications were developed by the Air Force, DoD and Army, respectively, to meet specific needs of their target customers. All three software programs were developed in response to urgent, specific explosives safety siting requirements that differed from one Service to another. Even though each meets those needs very well, evolving DoD needs and requirements for the future brought explosives safety approval authorities together to develop plans to bring the best features of each of these software applications together into one "Best-of-Breed" system that is designed to meet the needs of explosives safety planners throughout all of the DoD. A unanimous agreement was reached among members of the Joint Service Automated Site Planning Working

Committee to merge the best features of the MSS and ASHS software into the ESS software to create the hybrid software system that resulted in ESS Version 6.1.

The Automated Site Planning (ASP) Configuration Control Board (CCB) developed the Explosives Safety Automated Site Planning Requirements Document (ASPRD) that defines the current and future required software functionality for this "Best of Breed" hybrid system. Additional software functionality is called for in the near future which will include merging the functionality of risk-based explosives safety site planning (Published in DDESB Technical Paper 14) into ESS, and adding the ability to evaluate the explosives safety siting regulations published by North Atlantic Treaty Organization (NATO) (NATO Allied Ammunition Storage and Transport Publication AASTP-1, Edition, Version 1 and AASTP-5, Edition 1, Version 3). Minor enhancements to software functionality called out in the ASPRD will also be added via annual software updates throughout the life of the project.

The Department of Defense has tasked the DDESB with evaluation and approval of all explosives storage, handling and maintenance functions that occur worldwide within the Military Services. DDESB requirements and regulations are published in DoD 6055.09-M, "Ammunition and Explosives Safety Standards". All DoD organizations that deal with explosive items must comply with these regulations. The approval process requires installation planners to prepare individual formal Site Approval Request (SAR) packages for a potential explosion site (PES) that are routed through a review and approval process, ultimately receiving final approval from the DDESB. This approval process is supported by Component explosives safety approval authorities, who have the authority to impose additional requirements over-and-above the DoD requirements. Historically, planners have prepared SAR packages using manually-generated tables, forms and maps (typically using AutoCAD-type software). The manual creation of the SAR packages has proven to be time consuming and error prone, primarily due to the inexperience of users, misapplication/misunderstanding of the regulations, inaccurate maps, and incomplete facility information.

The automated tool, called ESS software, has been developed as previously described and fielded for use. ESS is used to identify violations of the regulations when they are found to exist, and it provides tools to automate the creation of site approval request package documentation that includes tabular and graphical information that is required by Approval Authorities. ESS Version 6.1.3 is the currently approved software for DoD use. A web-based version of ESS is currently under development and is planned to be deployed in 2019.

ESS Software Overview

The ESS software is a GIS software application that automates the calculation and display of Explosives Safety Quantity Distance (ESQD) arcs for explosives storage or handling sites. ESS software tools are used to assist with the development of site plan packages.

The concept behind the ESS software is to use existing installation GIS map data combined with Real Property Inventory (RPI) data and Potential Explosives Sites (PES) data to calculate, analyze, and generate ESQD arcs. The GIS data is used for the map display and spatial analysis. RPI data used by ESS includes building numbers and descriptions as well as facility category codes which describe the use of each facility. The PES data consists of a listing of explosive sites that identifies the sited net explosive weight for all hazard divisions, building number, and a listing of the types of buildings (operating location, earth-covered magazine, above-ground magazine, etc.). The GIS, RPI, and PES data are linked together in a database accessed by the ESS software interface (Figure 1).
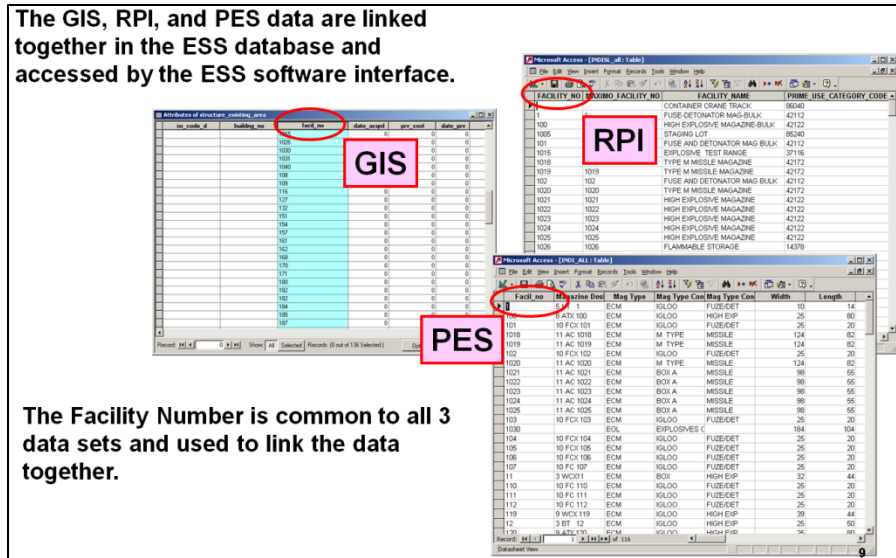
Figure 1: The GIS, Real Property Inventory, and Potential Explosives Sites data are linked together in the ESS database. (All displayed maps and data do not represent existing explosives sites)

When the ESS software performs an ESQD analysis, it calculates the Inhabited Building Distance (IBD) of a PES. This is called the Inclusion Zone. A GIS spatial analysis is performed on all GIS features (Exposed Sites) within the IBD Inclusion Zone calculating distances between the PES and all ES. If the PES is an Earth Covered Magazine (ECM) or other site with specific orientation criteria, the IBD Zone is divided into four sectors (front, left, right, and rear) (Figure 2). The software identifies the ES facilities in each sector and determines the required safety distance. ES facilities that do not meet the required safety distance are flagged as a possible violation. If desired, the Inclusion Zone can be increased to be larger than IBD. Software tools exist for applying and documenting mitigations.
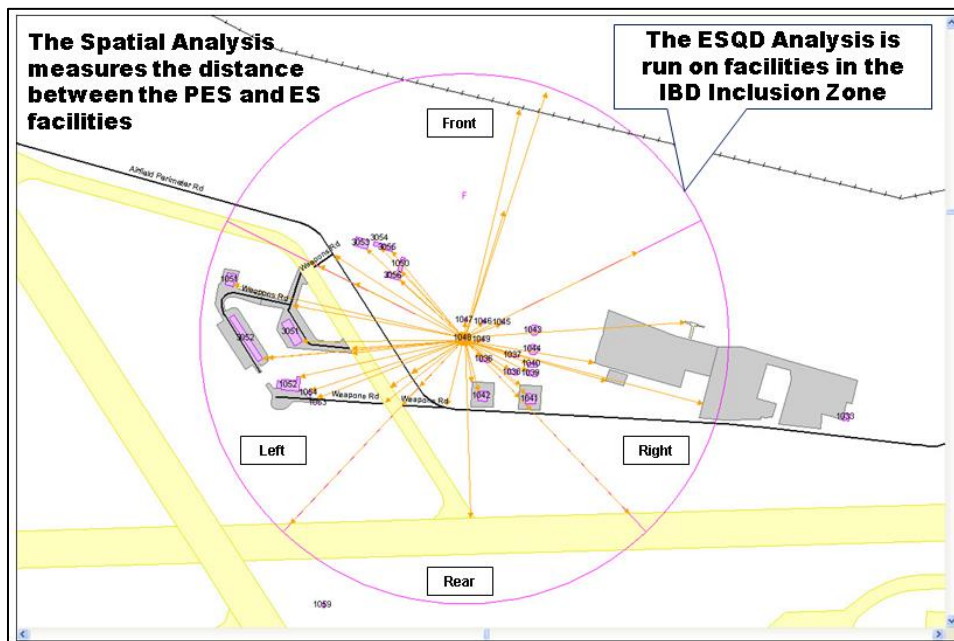

Figure 2: IBD Inclusion Zone and sectors.
(Displayed maps and data do not represent existing explosives sites)

ESS users have the ability to set the ESQD analysis to use either DoD 6055.9, NAVSEA OP5, or AF Man 91-201 criteria. When the software analysis is performed, ESQD arcs are generated for all PES. This includes arcs for each PES-ES pair, hazard class, exposure, and orientation. Two sets of explosives safety arcs are generated. The first set of arcs are called Analysis Arcs. These arcs are generated for each PES-ES pair, including separate arcs for each hazard class (1.1, 1.2, 1.3, etc.), exposure (Inhabited Building (IB), Transportation Route (TR), Intraline (IL), Inter-magazine (IM)), and each sector (Front, Left, Rear, Right). The second set of arcs are called ESQD Arcs. These arcs do not take into account ES facilities. They only represent the Net Explosive Weight (NEW), hazard class, and QD properties associated with the PES facility. Distance Quantity (DQ) values are also calculated providing the maximum NEW that can be stored for a PES for each hazard class.

Once the ESQD analysis is complete, arcs can be displayed in the map interface consisting of Inhabited Building Distance arcs, Public Transportation Route arcs, Intraline Distance arcs, and Inter-Magazine Distance arcs. The arcs can be displayed for one or more PES facilities and unioned (Figure 3). All arcs and GIS data displayed on the map interface can be exported to standard GIS formats that contain attribute data. Tabular (non-graphic) data can also be displayed for all arcs associated with a PES. This includes Hazard Class, Orientation, NEW, Actual/Required Distance, Exposure, and other PES properties.
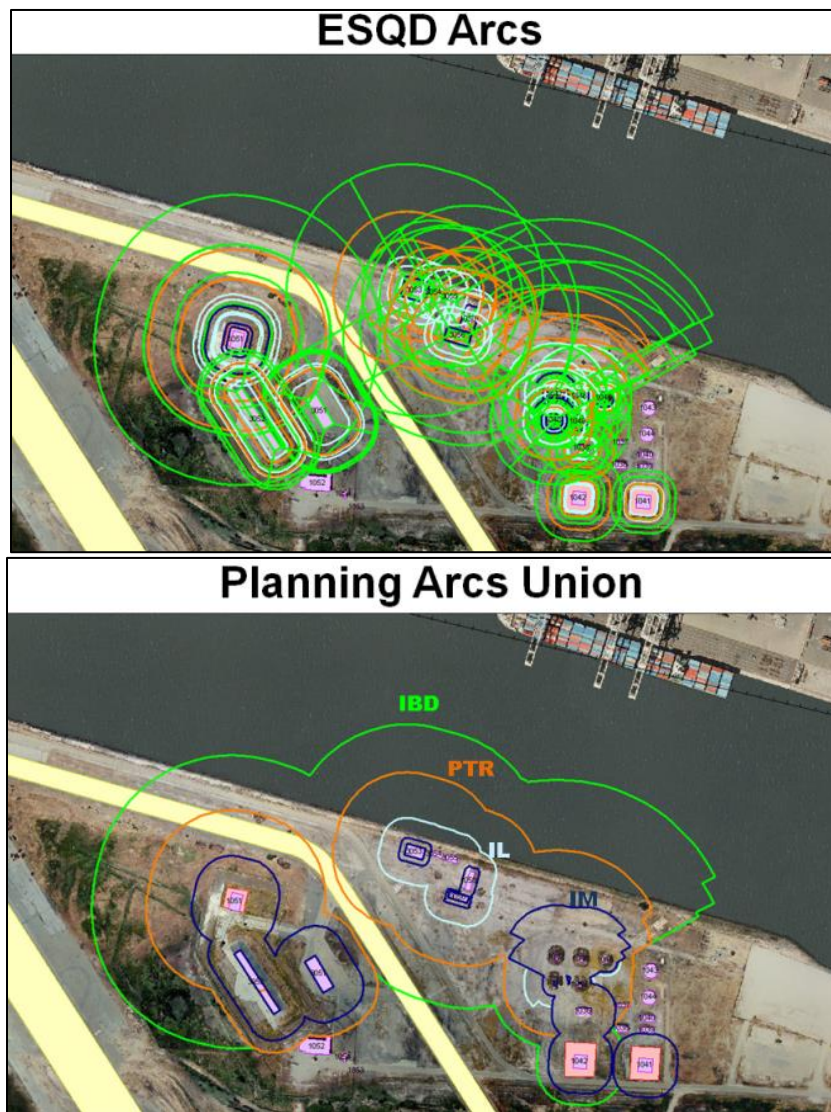

Figure 3: ESQD and Planning arcs can be displayed for one or more PES facilities and unioned.
(Displayed maps and data do not represent existing explosives sites)

The ESS software automates the creation of documents required in an explosives safety site submittal package. This includes the generation of a submittal form listing all PES-ES paired relationships with facilities being sited within IBD along with detailed information consisting of PES and ES Required IBD and PTR Distances, PES Hazard Classes and NEW, ES Orientation, Relation, Headwall, Barricade, Look-back reverse calculations from ES facilities as a PES, and Criteria reference information (Figure 4).

EXPLOSIVES SAFETY SITE PLAN									
SECTION I - GENERAL INFORMATION									
INSTALLATION: Alameda	LOCATION:			DATE: 04 Jul 2018			QD Engine: NAVY2016JUN02 ESS: 6.1.3.19.8		
SECTION II - DATA ON FACILITY TO BE SITED									
FAC # & OWNER	FACILITY DESC	RQD IBD	RQD PTR	1.1 (xx)	1.2.1 MCE	1.2.2	1.2.3 MCE (xx)	1.3	1.4
1063 Alameda	ECM Undefined HW HIGH EXPLOSIVE MAGAZINE	Front: 702 ft Side: 300 ft Rear: 300 ft	Front: 421 ft Side: 300 ft Rear: 300 ft	150 lbs >= 26' X 60'	1000 lbs 100 lbs	225000 lbs	225000 lbs	0 lbs	240000 lbs
SECTION III - PES/ES QD PAIRED RELATIONSHIPS WITH FACILITIES BEING SITED									
FAC # & OWNER	FACILITY DESC	ACT & RQD DIST	ORIEN-TATION	1.1 (xx)	1.2.1 MCE	1.2.2	1.2.3 MCE (xx)	1.3	1.4
1064 Alameda IM	ECM Undefined HW HIGH EXPLOSIVE MAGAZINE	Actual: 446.28 ft Required: 15 ft	As PES (reverse) PES Front ES Rear	400 lbs 15 ft T7-13 ECM(FU) :ECM-U(R)	20000 lbs 400 lbs 0 ft T7-18 ECM(F) :ECM-U(R)	200000 lbs 0 ft T7-18 ECM(F) :ECM-U(R)	200000 lbs 0 ft T7-18 ECM(F) :ECM-U(R)	70000 lbs 9 ft T7-20 FN4 T7-20	200000 lbs 0 ft T7-22 AGS-H:IMD
1065 Alameda IM	AGM HIGH EXPLOSIVE MAGAZINE	Actual: 947.04 ft Required: 185 ft	As PES (reverse) ES Rear	4000 lbs 95 ft T7-13 AGM(UB) :ECM-U(R)		170000 lbs 0 ft T7-18 AGS-L :ECM-U(R)	170000 lbs 0 ft T7-18 AGS-L :ECM-U(R)	75000 lbs 185 ft T7-20 IMD	170000 lbs 0 ft T7-22 AGS-H:IMD
6001 Alameda TR	AMR RUNWAY / FIXED WING	Actual: 430.17 ft Required: 421 ft	As ES PES Front	300 ft 7-6.2.1.2	421 ft T7-15 PTR	415 ft T7-17 PTR	242 ft T7-20 IBD	0 ft T7-20 PTR	100 ft T7-22 IBD>3000

Figure 4: Explosives Safety Site Plan Submittal Form.
(Displayed maps and data do not represent existing explosives sites)

Submittal maps can be generated for one or more PES. The user tells the software which arcs to display, dimension lines, drawing extents, and scale. The submittal map is automatically created with a title block, scale bar, and north arrow (Figure 5).
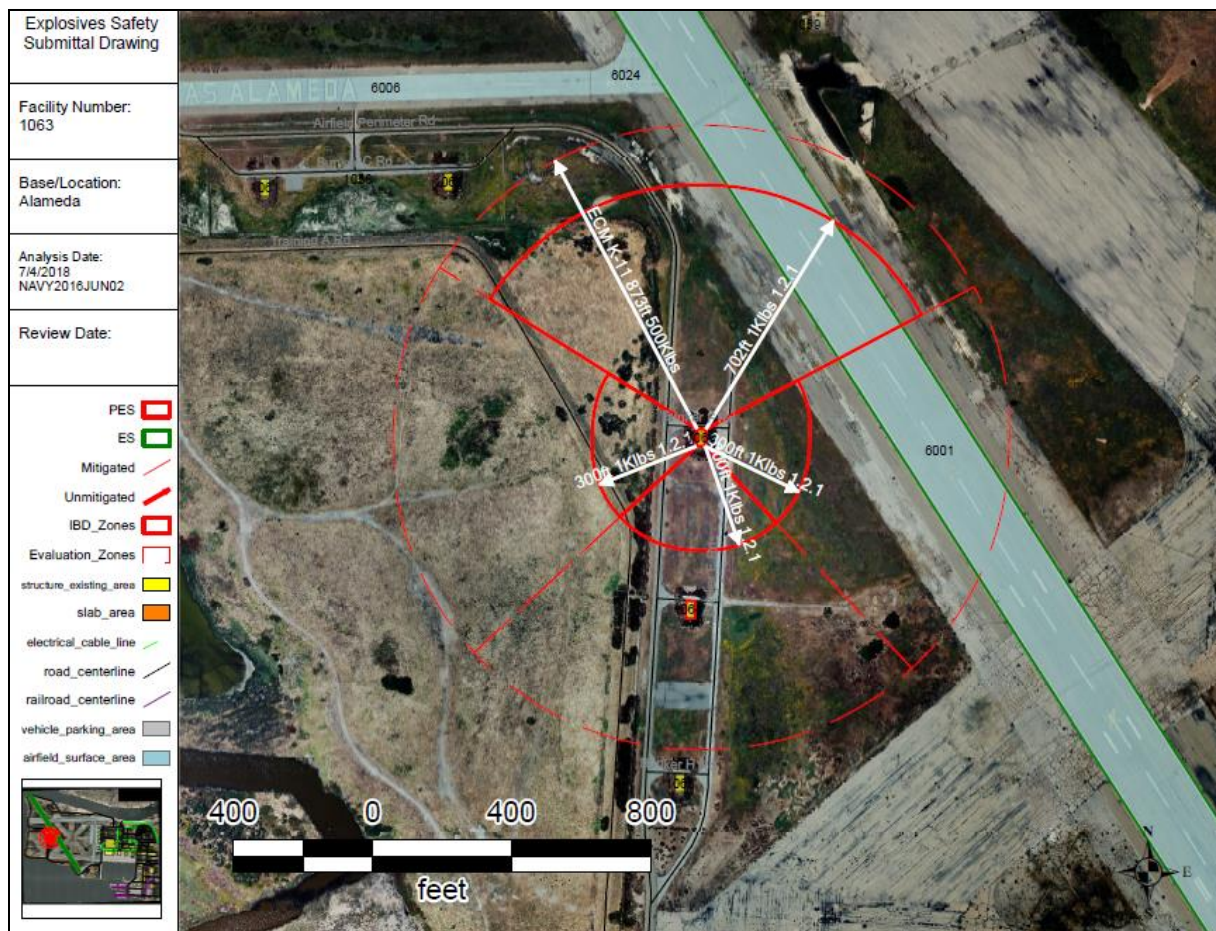

Figure 5: Explosives Safety Site Plan Submittal Drawing.
(Displayed maps and data do not represent existing explosives sites)

ESS Software Status

The latest version of the ESS v6.1.3 software is currently in use at Army, Navy, USMC, and Air Force installations and has approximately 600 users at 200 installations. Users of the ESS software include Facility Planners, Explosives Safety Officers, and GIS managers. The ESS software written in Visual Basic .Net is compatible with Windows 7 and 10 desktop computers running ArcGIS software versions 10.1 to 10.5. System requirements are minimal, consisting of 4GB RAM or more, 2GHz processor or better, and running on a 32 or 64 bit operating system. The Navy is also running the ESS 6.1.3 software on a server using Citrix at the NAVFAC Information Technology Center (NITC). This allows Navy users to access the ESS software through an Internet browser.

ESS v6.1.4 is currently under development and includes new capabilities of Risk Based Explosives Safety Siting for Tier 1 (hazard zone-based model equivalent to ASAP-X) and Tier 2a (TP14 hazard-consequence models), Munitions Risk Assessment System, and the Navy Enterprise Explosives Safety database (Figure 6). The ESS v6.1.4 software is scheduled to be completed in the second half of 2018.
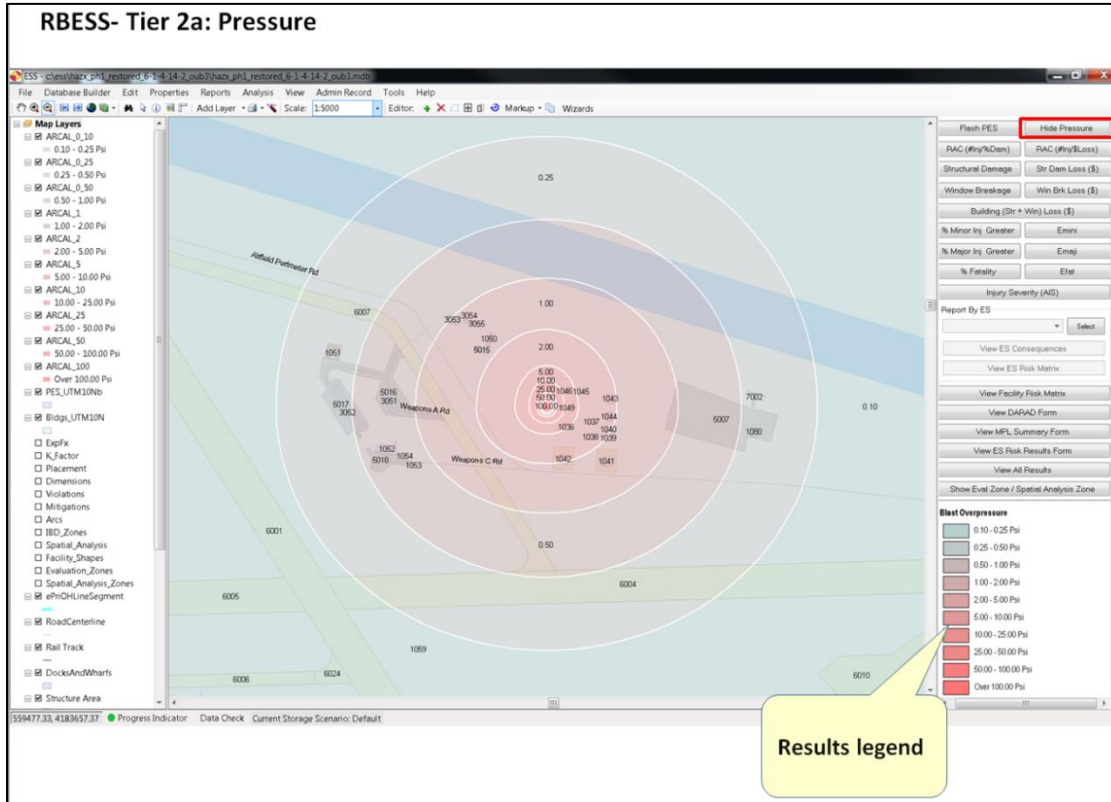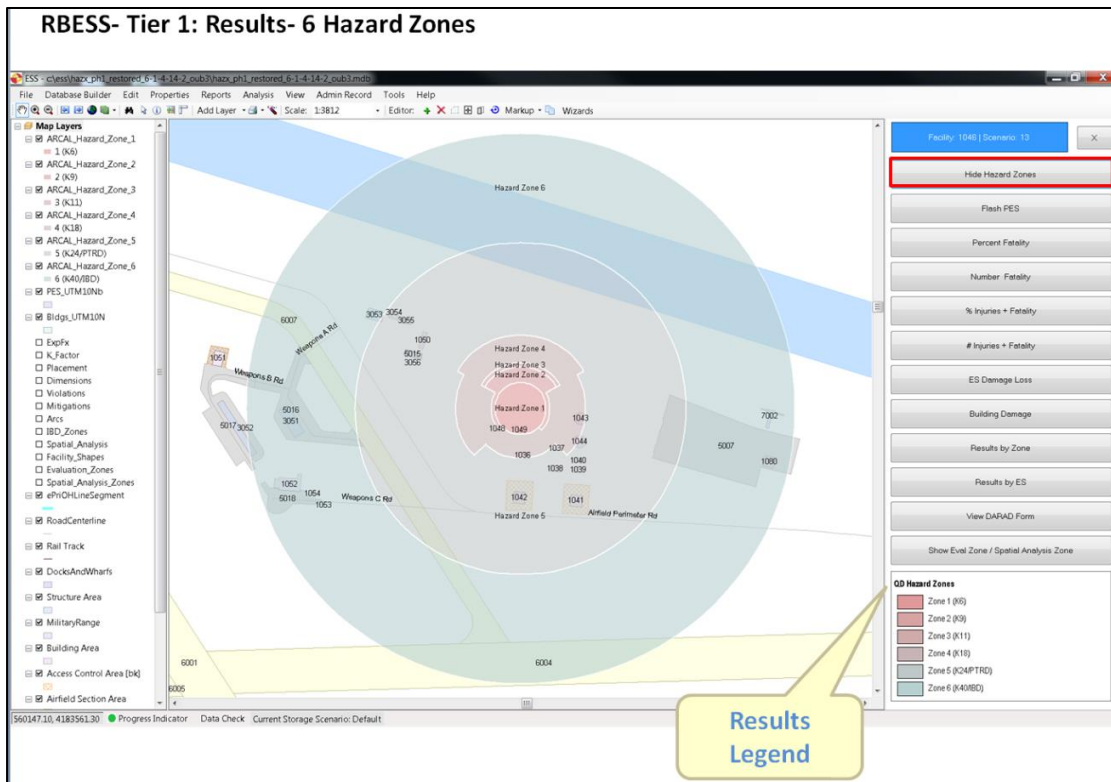
Figure 6: Examples of ESS Software RBESS results for Tier 1 and Tier 2a.
(Displayed maps and data do not represent existing explosives sites)

ESS v6.1.5 is planned for development and release in 2019. This version of the software will include several updates to correct known issues and bugs and to improve the usability of the software. ESS v6.1.5 will also include the newest version of the ESS quantity-distance engine (QDE). Currently, the QDE is three separate pieces of software code that calculate required distances based on explosives safety regulations for Air Force, Navy, and DoD (Army QD analysis uses the code for DoD). An effort was undertaken in 2016 to 2017 to merge the three different service specific code bases into one merged QDE. This effort included an extensive review of QD siting criteria in the DoD and Service level regulations, the development of a single set of QDE flowcharts, and eventually a single QDE. Currently, NAVFAC EXWC near completion of the source code re-write and will commence a validation and verification study of the QDE.

Development has also begun and a web-based version of the ESS software written in C# and Java Script utilizing ArcGIS Server technology rather than the currently used Citrix technology. This will be hosted in Amazon Web Services (AWS) allowing users to access the software through an Internet browser and provide centralized storage of ESS datasets. The web platform will allow the ability to submit, review, and approve explosives safety site plans all in the same online database environment. Information assurance compliance will be simplified across multiple Services and eliminate the need for ESS and ArcGIS software to be installed on individual desktop computers. Multiple users will be able to access and collaborate on ESS data simultaneously (Figure 7 and Figure 8). The initial version of the ESS web-based software is scheduled to be completed in 2019.

Figure 7: The current version of ESS is a stand-alone desktop application. Each desktop contains an instance of GIS maps, Potential Explosives Sites, and Real Property Inventory data in a database for each installation. Maintenance and data management occurs at the installation level.
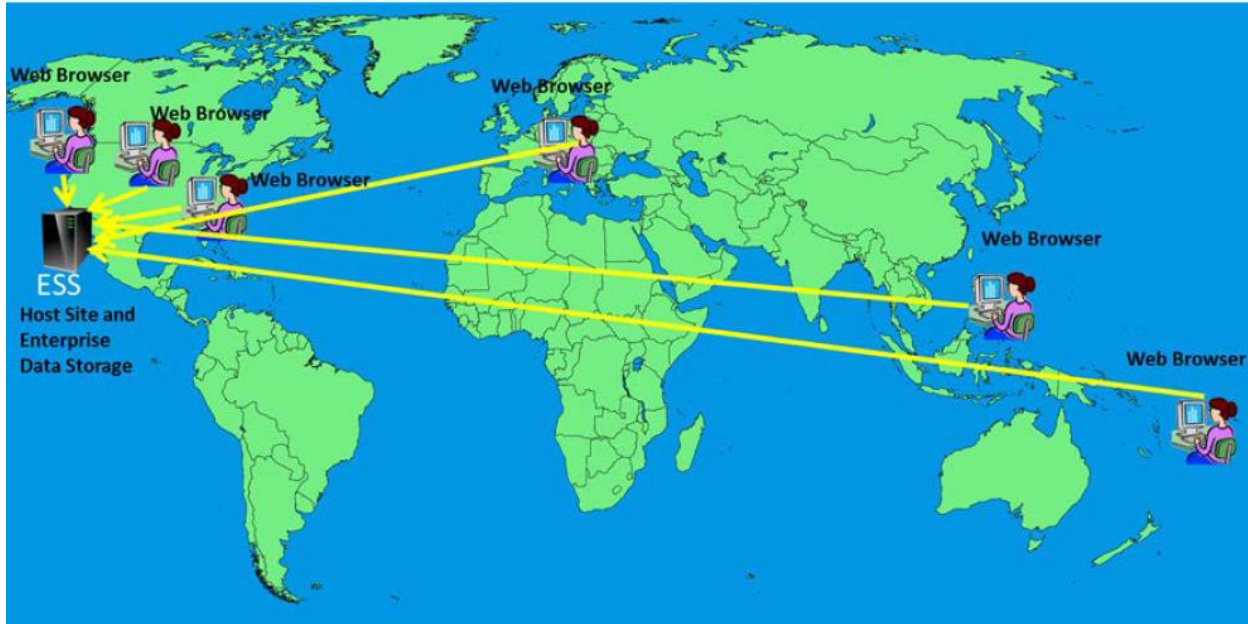
Figure 8: The ESS Web application will contain one instance of GIS maps, PES, and RPI data that is available to all ESS users. Maintenance and data management will be centralized.

The NAVFAC Engineering and Expeditionary Warfare Center (EXWC), Army Technical Center for Explosives Safety (USATCES), and Air Force Safety Center provide ESS software help desk support and training to new users. Classes are offered through EXWC and the Air Force Safety Center who have trained over 1000 students.ESS training documentation is available from the NAVFAC Portal or upon request from EXWC. There are ESS training guides for building new ESS database and working with an existing ESS database. Workbook exercises contain over 250 pages for working through specific capabilities within the ESS software. An ESS Reference Guide is available providing a detailed explanation of each menu option. The Data Configuration Guide helps users with data settings. Training videos are currently being developed and will be available on the NAVFAC Portal in 2019.

<center>**Conclusion**</center>

The deployment and use of the ESS software has been underway throughout DoD since early 2000. Over time, the use of the ESS software has shown several improvements in the explosives safety site planning process. There are fewer errors interpreting and implementing complex explosives safety criteria. Automating the spatial and ESQD analysis has eliminated errors in measurements and calculations. Once all data has been entered into an ESS database, it takes significantly less time to create site plan submittal packages. Standardized submittal maps, data, and reports have made the review and approval of submittal packages faster and easier. Previously unknown violations are easily identified. The use of the ESS software has allowed Planners and Explosives Safety Officers to rapidly view existing conditions and perform what-if scenarios to help optimize safety and explosives storage capacity for base planning operations.