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QRA FOR REGULATORY APPLICATIONS USING IMESAFR©

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Presented by: John Tatom

OUTLINE

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- RBESCT History
- IMESAFR History
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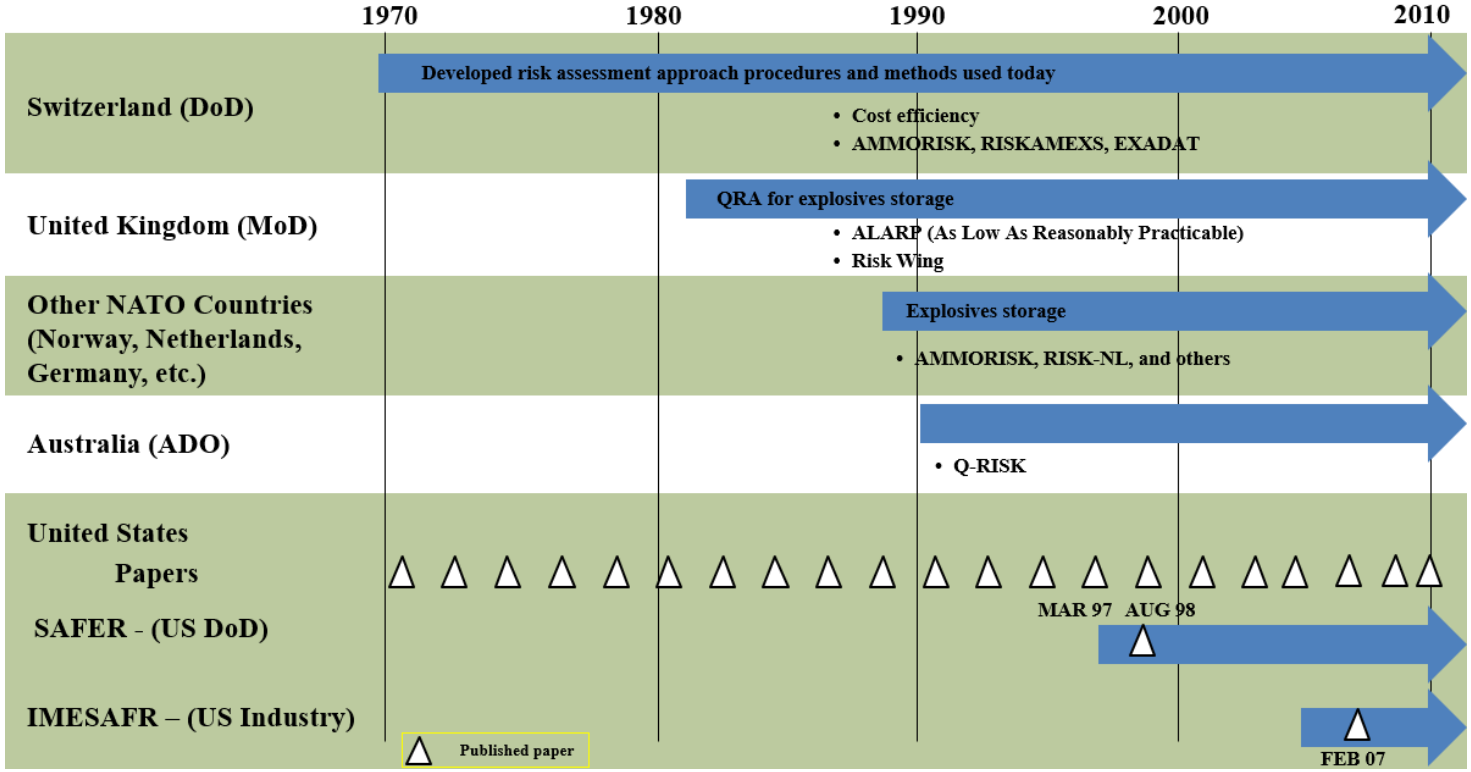
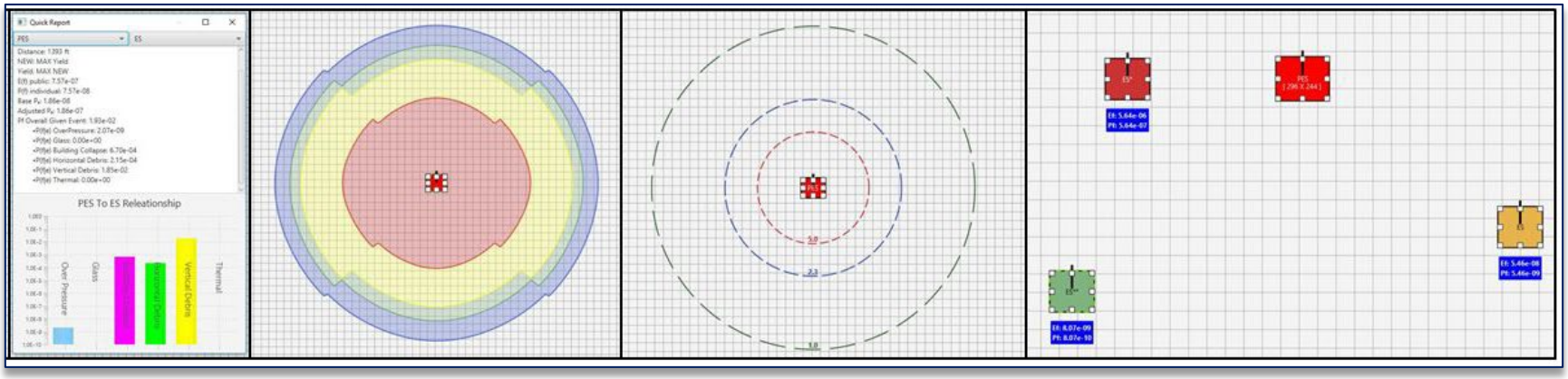
QUANTITATIVE RISK ASSESSMENT (QRA)

- QRA is an approach to safety based on evaluating risk as a numerical value
- Considers factors such as facility construction, number of exposed individuals, amount of time individuals are present, probability of an event occurring, type of explosives present, and more



INSTITUTE OF MAKERS OF EXPLOSIVES SAFETY ASSESSMENT FOR RISK (IMESAFR)

- IME Safety Analysis for Risk (IMESAFR©) is a probabilistic risk assessment software tool that was developed by APT, in a collaborative effort with industry and regulators, with the IME as the original central sponsor.
- IMESAFR is designed calculate risk to personnel from explosives facilities. It also calculates Quantity Distances based on the American Table of Distances (ATD) and a NATO-Based system.
- IMESAFR uses information about the donor structure and activity, the structure of the exposed sites, and duration of exposed personnel to calculate risk. The program provides users with the option of working with metric or Imperial measures, and it allows users to import maps or drawings of their site for optimal visualization of facility layouts and calculated risk results.



RISK BASED EXPLOSIVES SAFETY CRITERIA TEAM (RBESCT)

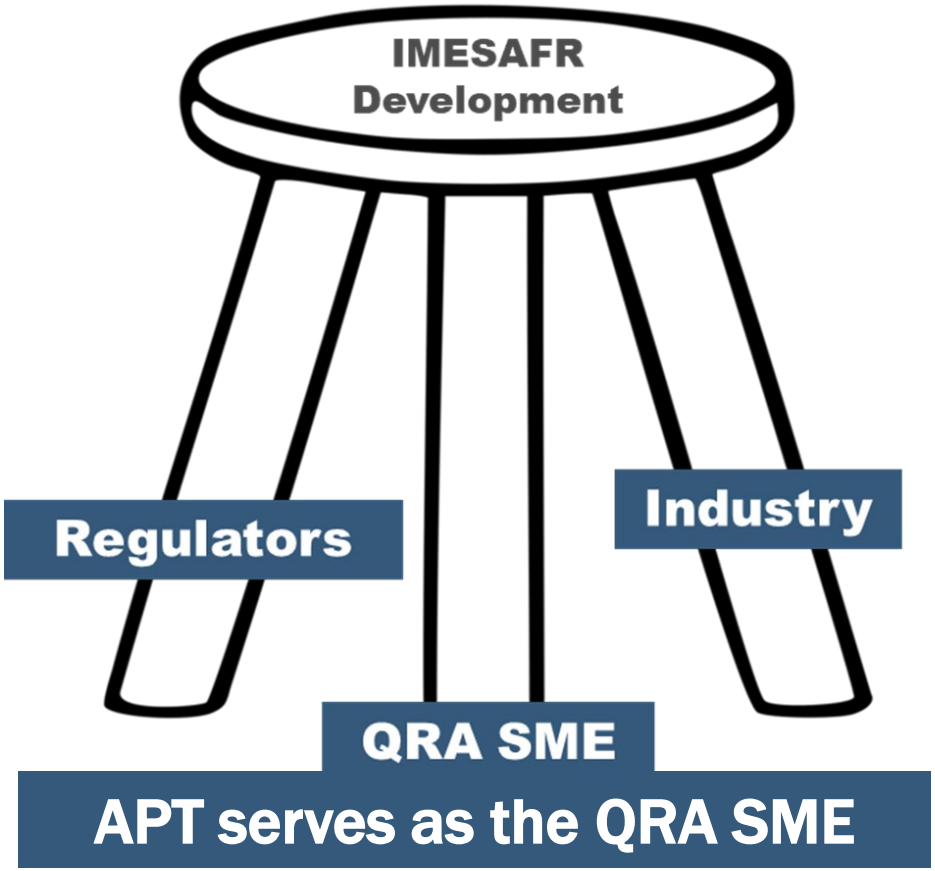
- The Department of Defense (DoD) began developing its own approach to implementing QRA for explosives safety in 1997
- This led to the creation of the RBESCT, which developed the Technical Paper 14 (TP-14) model/methodologies that were used to build the Safety Assessment for Explosives Risk (SAFER) tool
- The RBESCT comprised representatives from the Department of Defense Explosives Safety Board (DDESB) and Services (Army, Navy, Air Force, Marines, and Coast Guard), with participation at times from other government entities such as the Defense Contract Management Agency (DCMA)
- APT supported the RBESCT from its inception in 1997 by providing subject matter experts (SMEs) on QRA and explosives effects/consequences modeling, in addition to serving as the team secretariat and software developer for the SAFER tool

IMESAFR HISTORY

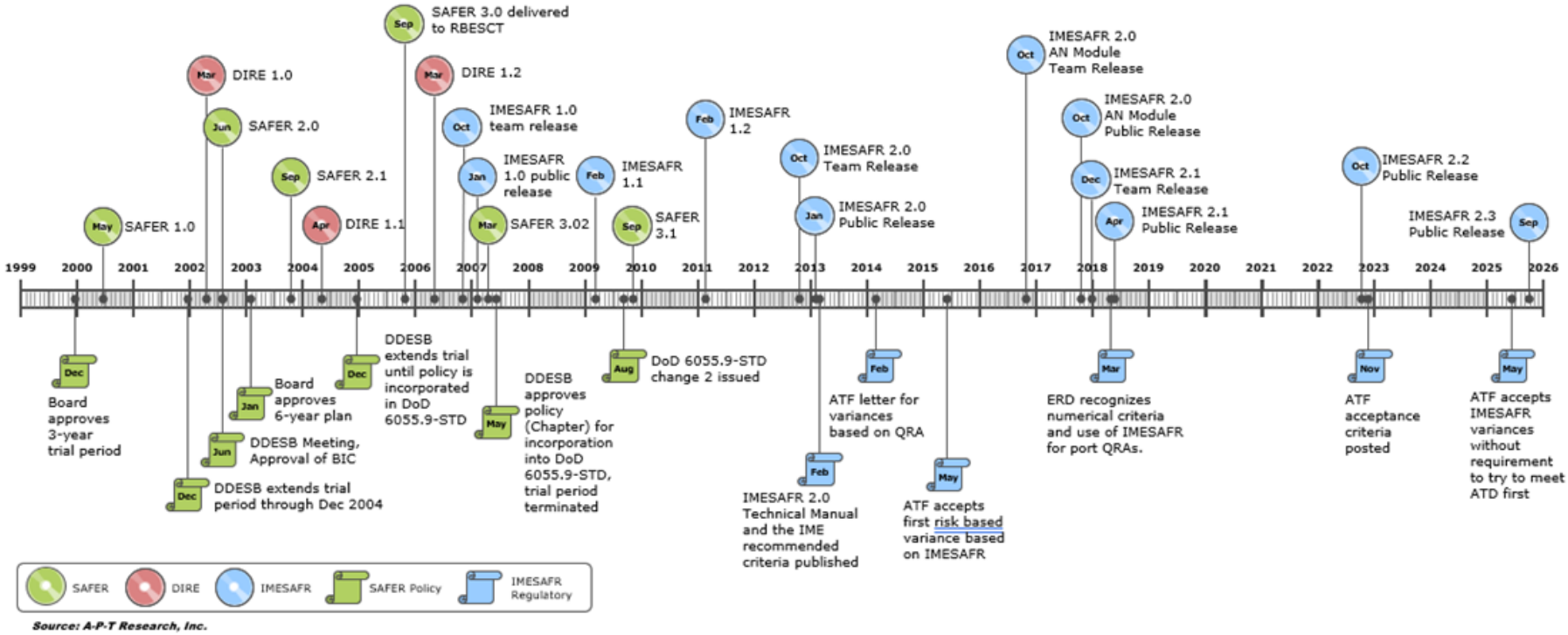
- After the creation of the SAFER tool for use by the DoD, the Institute of Makers of Explosives (IME) felt it would be beneficial to have a similar tool for use in the commercial explosives community
- APT was hired by IME to create the IMESAFR tool, given the role APT played in developing the SAFER tool and TP-14

IMESAFR PROJECT HISTORY

IMESAFR was developed with a “Three-Legged Stool” model in mind

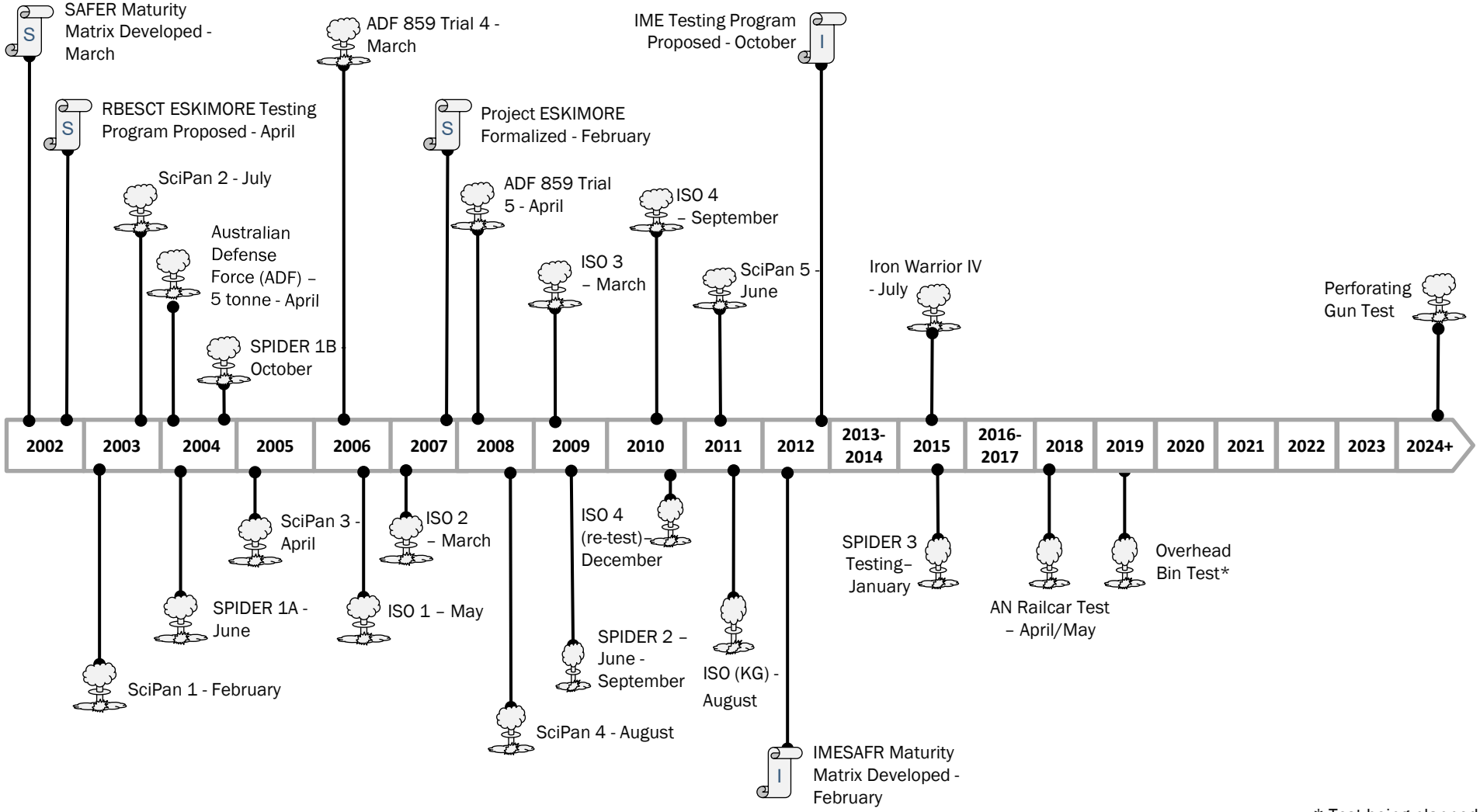


IMESAFR SOFTWARE DEVELOPMENT HISTORY



Source: A-P-T Research, Inc.

TESTING HISTORY

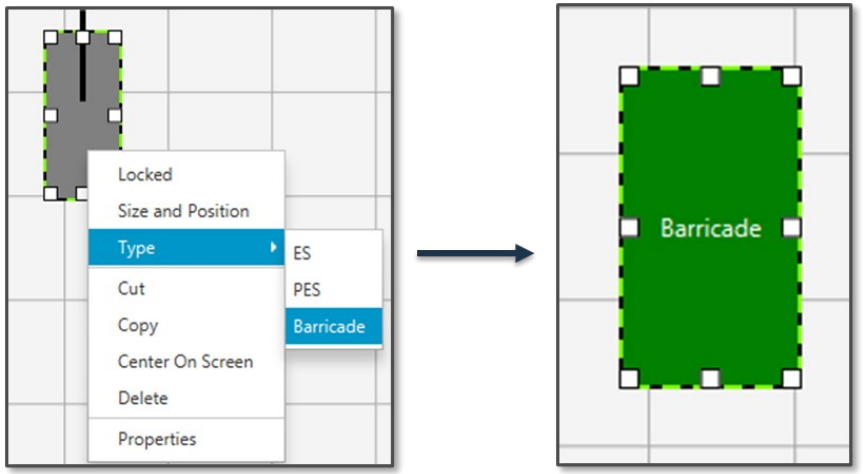


* Test being planned

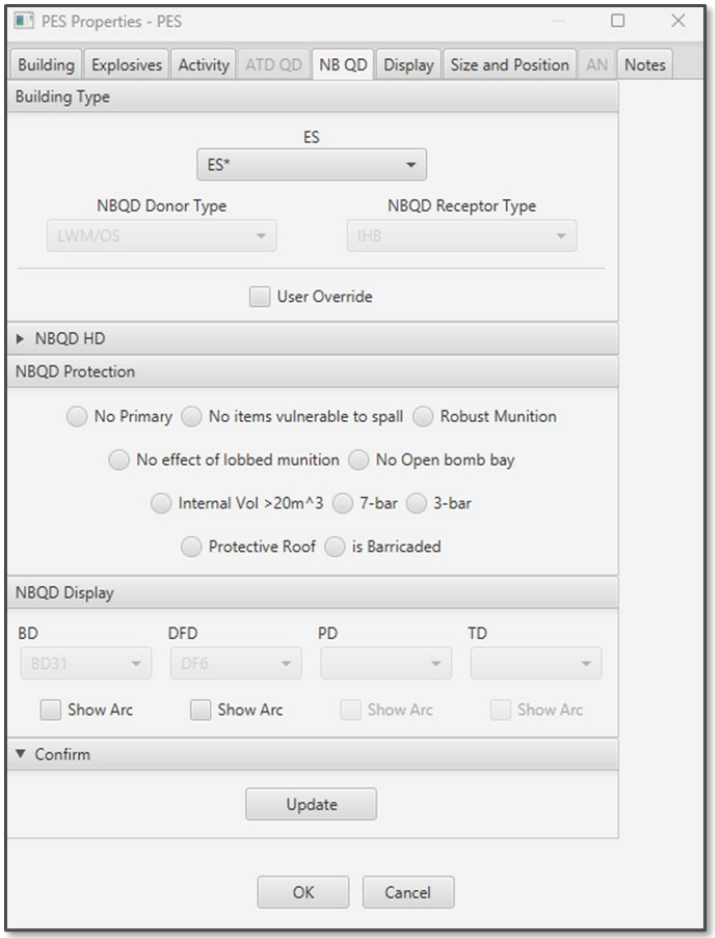
NEW FEATURES IN IMESAFR V2.3

Undo and Redo Buttons

Barricade Structure

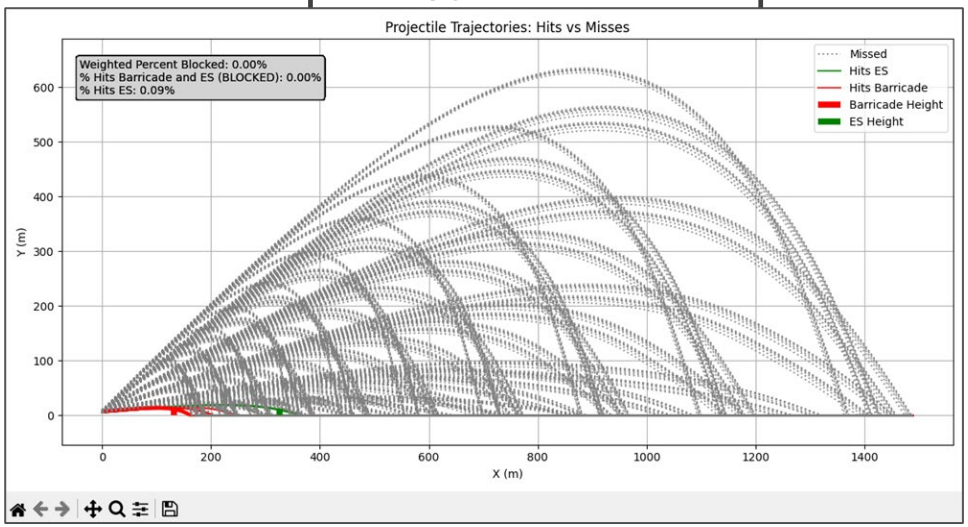


NATO-Based QD

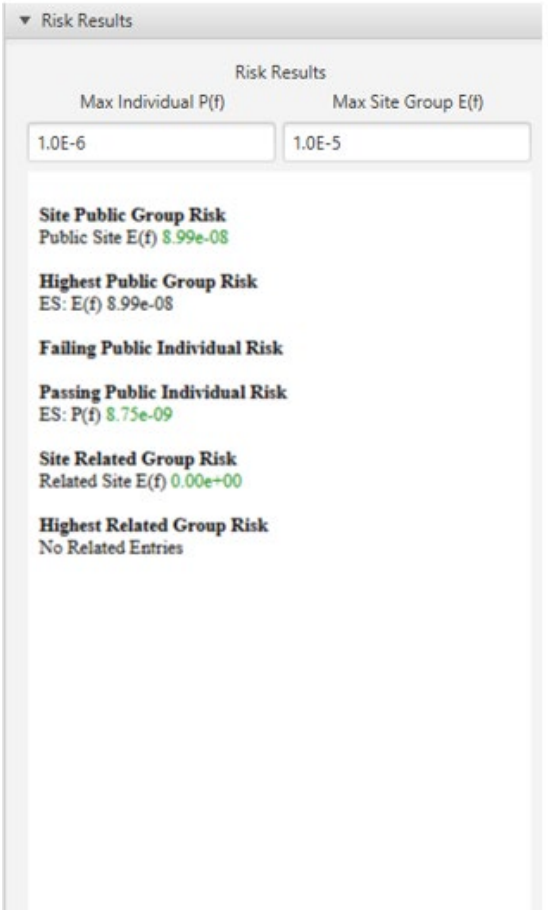


NEW FEATURES IN IMESAFR V2.3

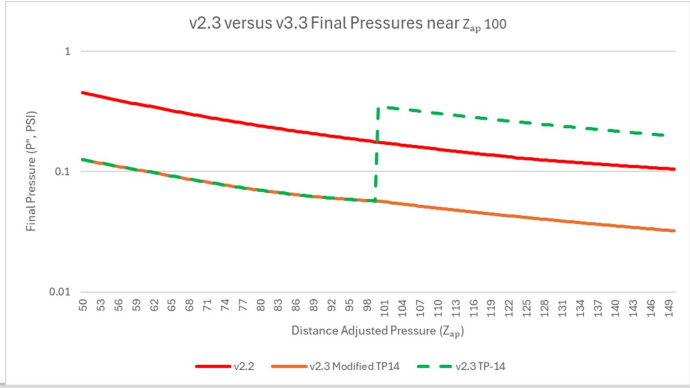
Side-Impact % Blocked Report



Risk Results Panel



P” and I” Calculation Updates

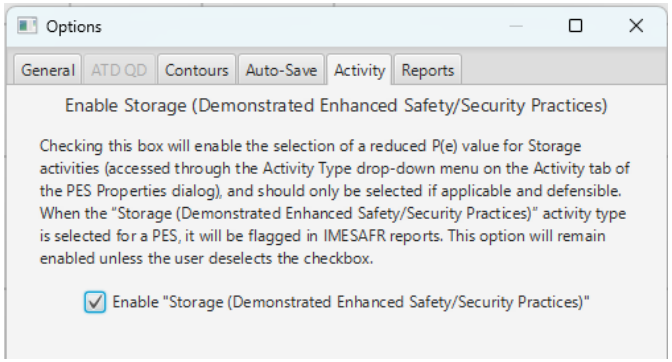


NEW FEATURES IN IMESAFR V2.3

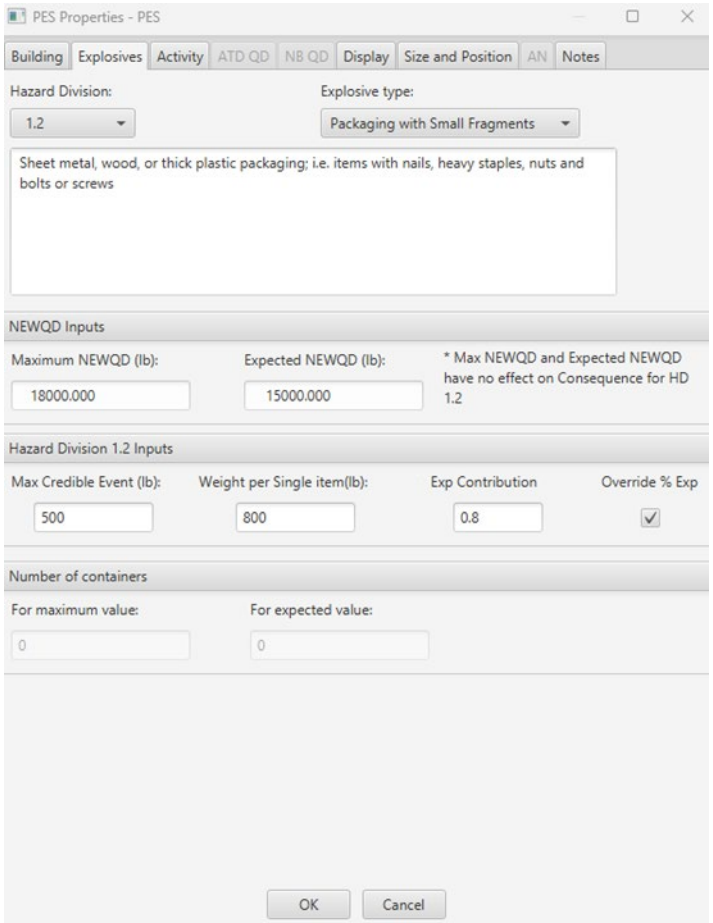
P(e) Matrix and Storage Updates

Activity	Probability of Event & Applicable Environmental Factors				
	HD 1.1	HD 1.2	HD 1.3	HD 1.5	HD 5.1
Storage	2.62E-05 D	2.62E-05 D	7.86E-05	2.62E-06 D	2.62E-07
Storage (Demonstrated Safety Record)	1.86E-05 D	1.86E-05 D	5.58E-05	1.86E-06 D	1.86E-07
Bulk loading and unloading - Pump	3.08E-04 I			3.08E-05 I	3.08E-06 I
Bulk loading and unloading - Reservoir	9.74E-05 I			3.08E-06 I	9.74E-08 I
Perforating gun assembly	1.30E-03				
Manufacturing	4.10E-03 D I	4.10E-03 D I	4.10E-03 I	4.10E-04 D I	4.10E-05 I
Storage - AN					4.67E-06
Loading and Unloading	3.15E-06	3.15E-06	2.84E-05	3.15E-07	3.15E-08
Assembly	5.37E-05	5.37E-05	4.83E-04		
Demilitarization	7.78E-04	7.78E-04	2.33E-03		
Disposal	7.78E-04	7.78E-04	2.33E-03	7.78E-05	7.78E-06
Inspection	2.05E-05	2.05E-05	1.85E-04		
Laboratory	9.75E-05 I	9.75E-05 I	2.93E-04 I		
Repackaging	2.05E-05	2.05E-05	1.85E-04		

Universally Applicable Factors:

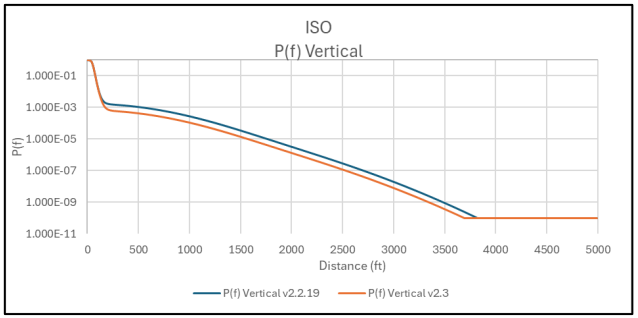


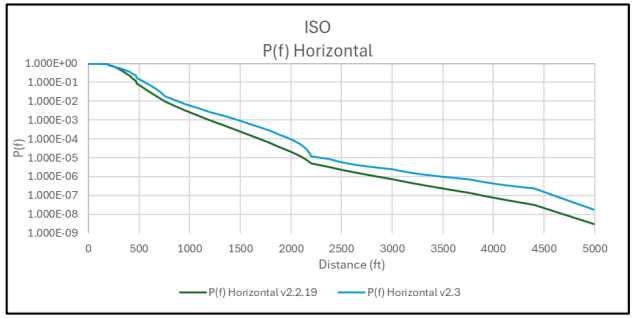
HD 1.2 Inclusion

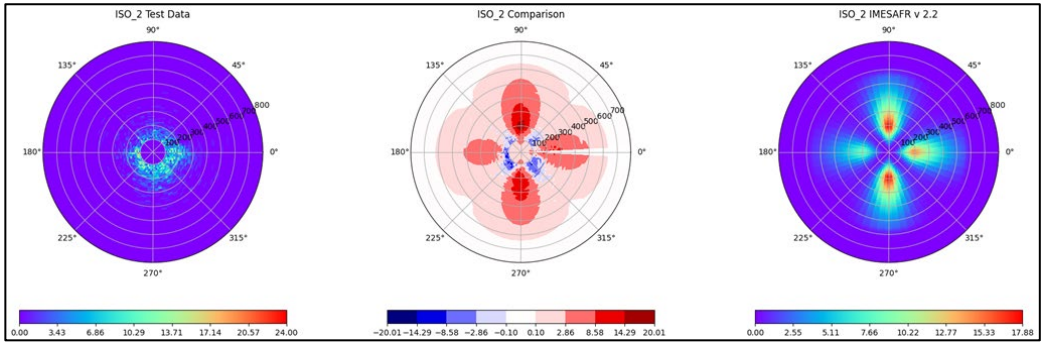


NEW FEATURES IN IMESAFR V2.3

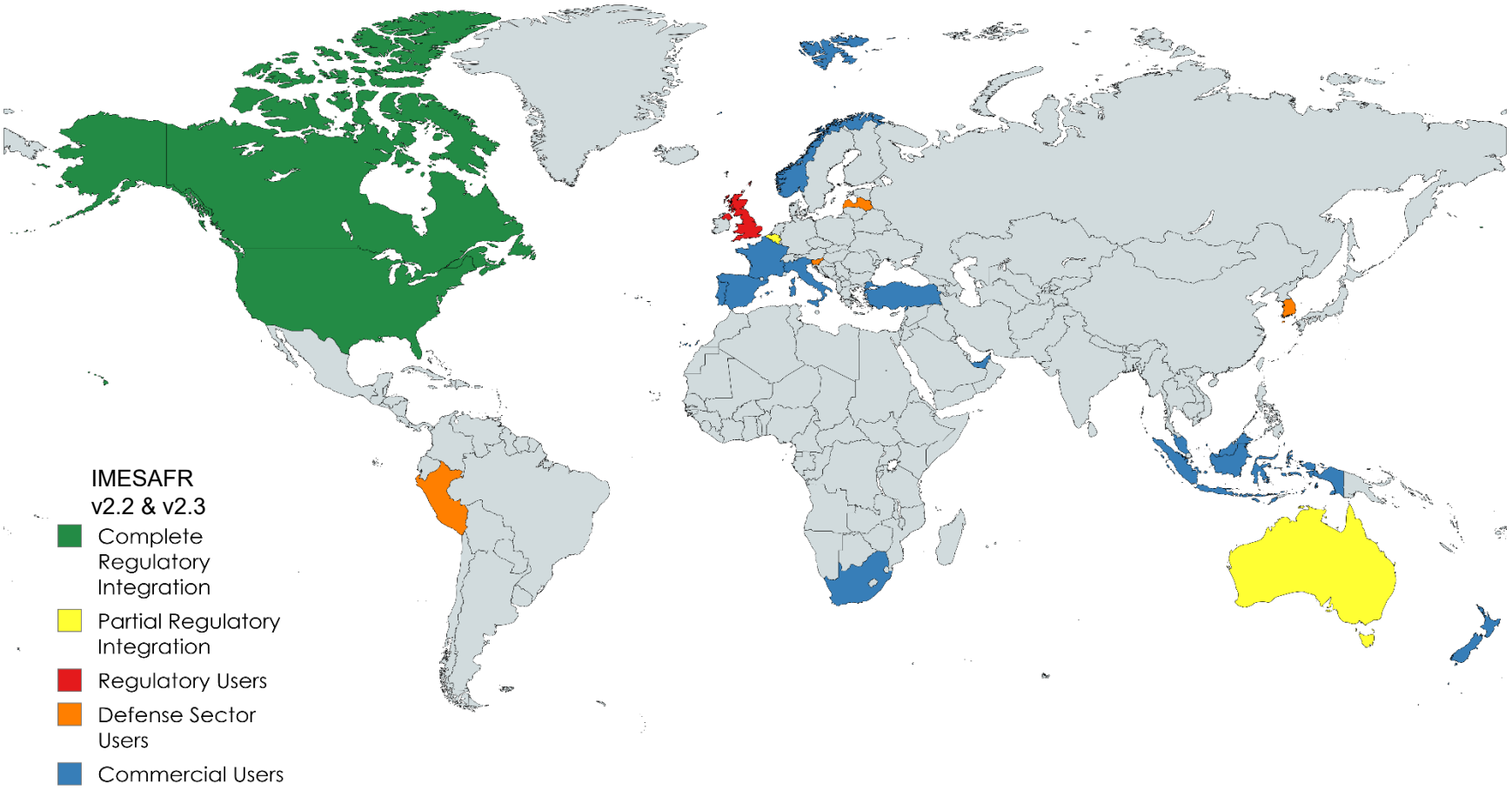
- Debris Logic Updates
  - Updated parameters used in debris probability density functions
  - Updated Mass Bin distribution for Steel and Standard Concrete models
  - Updated the mass per component (roof, side walls, front wall, and rear wall) for ISO containers
  - Added a “new” Large Concrete PES type
- Example comparison plots: Consequence values for an ISO Container at nominal loading density





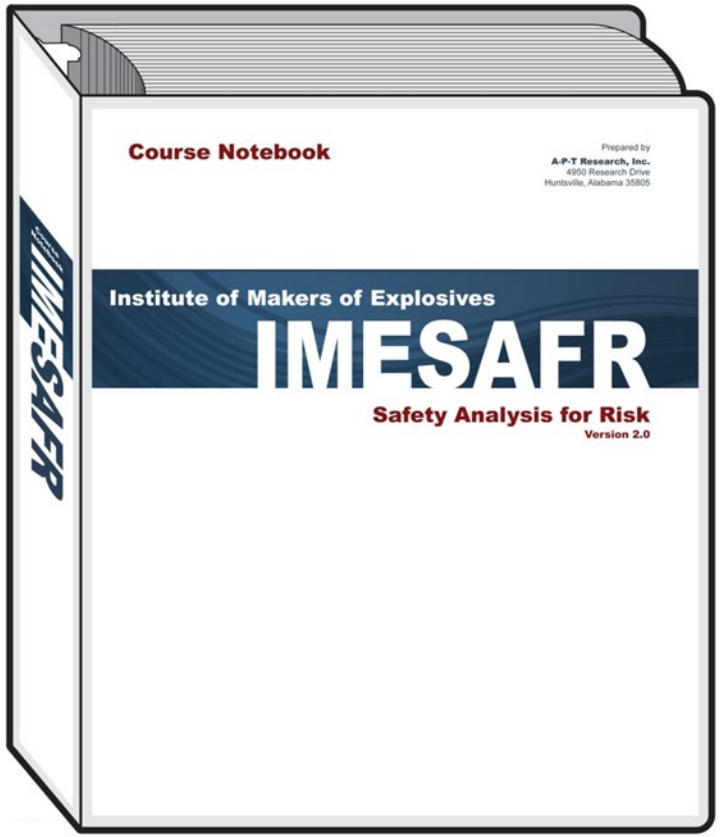


CURRENT STATUS OF REGULATORY USE

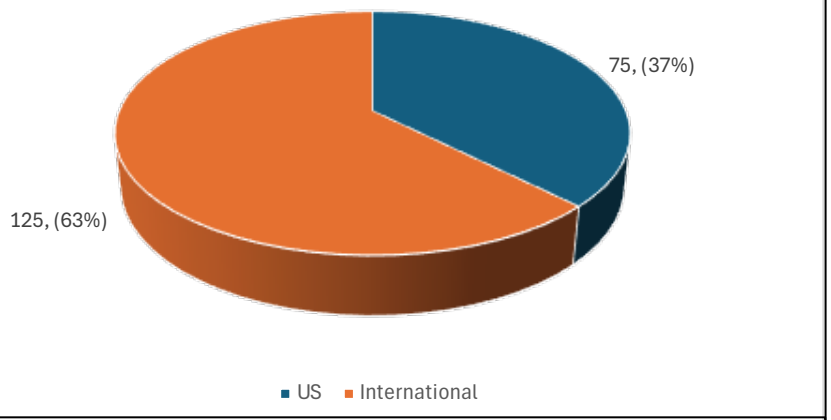


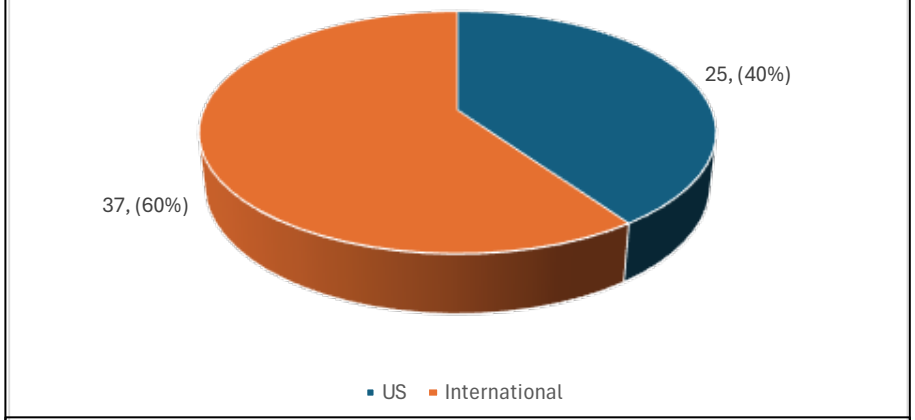
HOW TO GET TRAINED

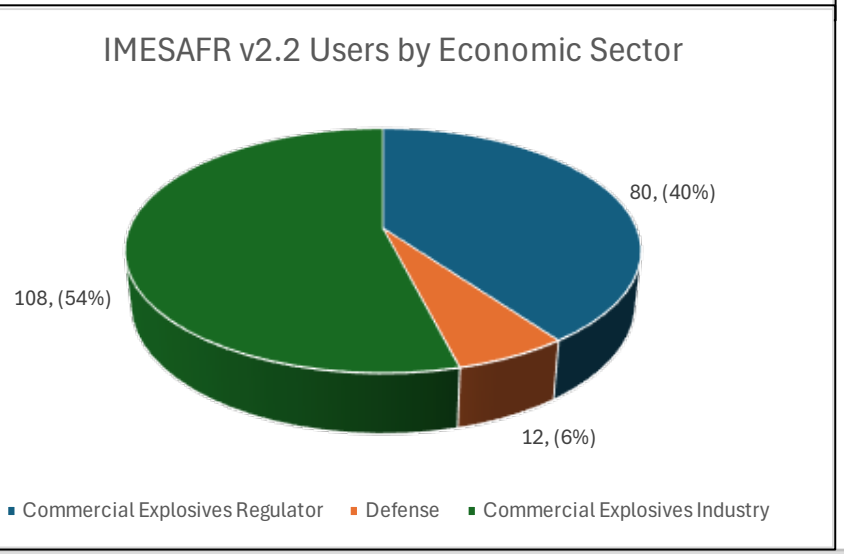
- The IMESAFR training class is held several times a year at the APT Safety Engineering and Analysis Center (SEAC) headquarters in Huntsville, AL.
- Classes are also offered in Canada, Australia, and Europe at least once per year
- Additional training options are available as need/demand warrants, including virtual upgrade trainings when new versions of IMESAFR are released

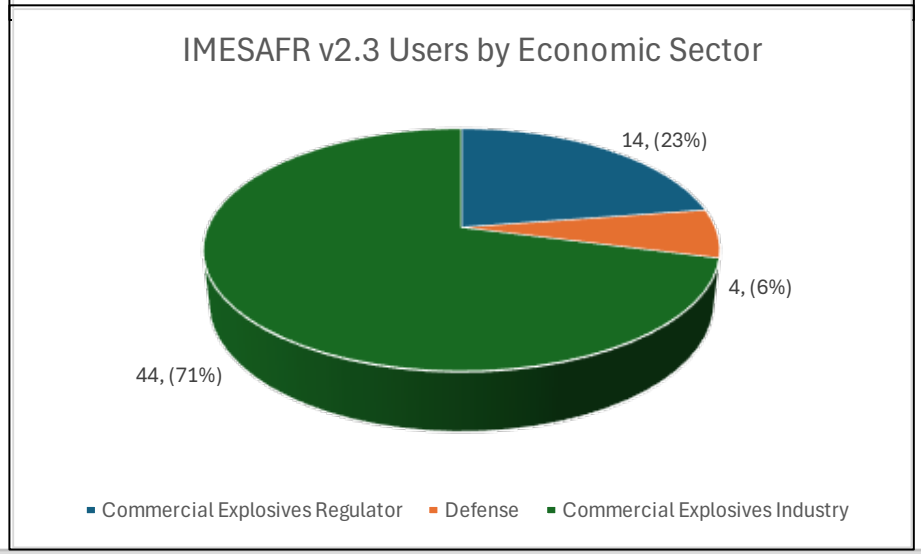


CURRENT USER BASE



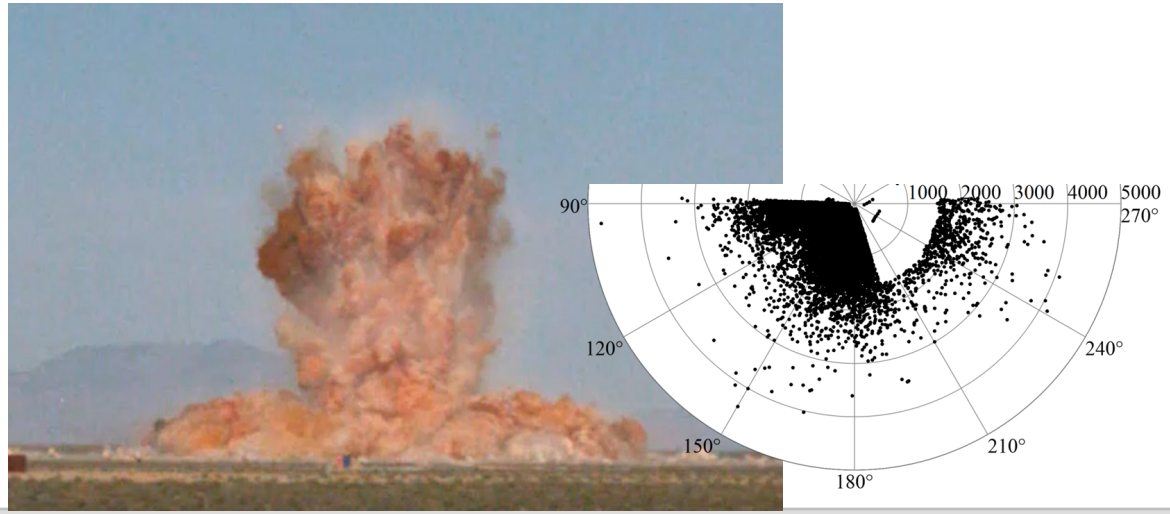


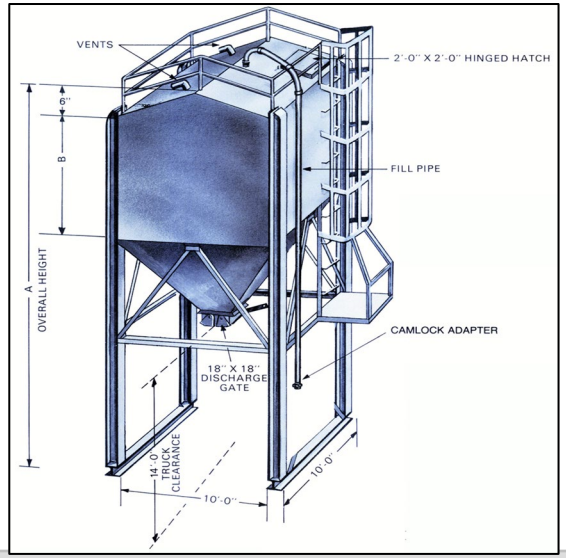




FUTURE PLANS - TESTING

- More empirical data will be required to implement new models and capabilities into IMESAFR
- To support the acquisition of this additional data, APT, IME, and ATF hope to jointly conduct tests on ammonium nitrate in overhead bins and small quantities in small ATF magazines
- Further testing of JPGs will be necessary considering that some parameters/variables were not able to be tested in the first test series; more details on this test series are covered in *2024 ATF Perforating Gun Test Series to Support Quantitative Risk Assessment*
- ATF has expressed interest in a testing program on pyrotechnics in order to build a unique pyrotechnics model/engine in the future





FUTURE PLANS - RESEARCH

- Some of the new features and capabilities planned for future version of IMESAFR require additional research before they can be fully implemented into the program
  - Pyrotechnics engine/models
  - Underground Storage engine/models
- Other features have already been researched extensively and are pending implementation, such as the prompt propagation logic; which is covered in detail in *Implementation of Prompt Propagation Logic in a QRA Tool*

FUTURE PLANS - SOFTWARE

- There are numerous potential new features and capabilities that could be added to future versions of IMESAFR
- APT has confirmed some of the potential new features will be implemented in future version, while other new features remain on a wishlist for tracking purposes
- Some of the confirmed new features coming to future versions of IMESAFR include the prompt propagation logic mentioned previously, an updated JPG model, adding in a live, cloud-based GIS interface, a 3D user interface, and further optimizing the software runtime

FUTURE PLANS - SOFTWARE

SUMMARY

- QRA is gaining in acceptance for explosives safety regulatory applications and provides a more comprehensive evaluation of risk than QD
- IMESAFR is a QRA tool developed by APT for use by the commercial explosives industry, but is also used in the international defense sector
- The tool uses methodologies originally based on DDESB TP-14
- Since its initial release in 2007, IMESAFR has undergone numerous updates based on empirical test results, regulator engagement, and scientific review
- New features in the latest version (IMESAFR 2.3) include NATO-based QD logic, updated debris logic, HD 1.2 addition, and updated pressure and impulse ingress calculations
- IMESAFR is used internationally by both regulators and the commercial explosives community, as well as the defense sector to a limited extent
- On-going development efforts are focused on improving models, further testing, and implementing new capabilities such prompt propagation

Questions?