A-P-T RESEARCH, INC.
AN EMPLOYEE-OWNED COMPANY

IMESAFR UPDATE

CEAEC Spring 2022

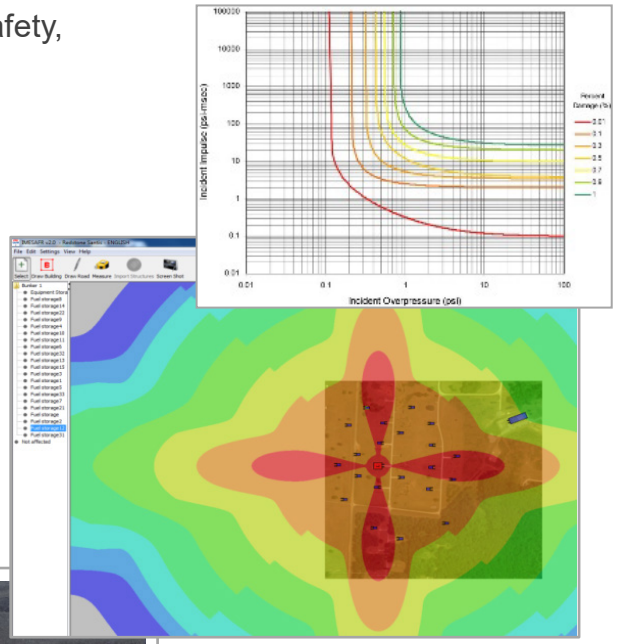
Victoria, BC, Canada

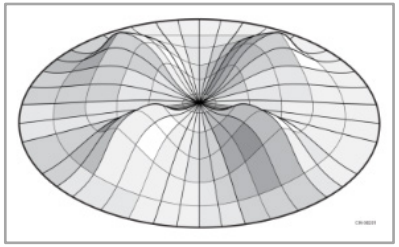
OUTLINE

1) Background
2) General IMESAFR status
    a) Sponsorship
    b) Changes planned for IMESAFR v2.2
    c) Support for Versions
3) New Technical Approach for P_e
4) Regulatory Topics
5) Model Comparison

WHO IS APT?

- A-P-T Research, Inc. (Analysis-Planning-Test Research, Inc. (APT)) is an employee-owned, small business headquartered at the Safety Engineering & Analysis Center (SEAC) in Huntsville, AL, USA.
- APT currently provides professional engineering services, mainly focusing on safety, to approximately 40 US Government agencies in a variety of disciplines.
- APT's Explosives Safety & Testing Division has proven expertise in:
  - Explosives safety site plan development/support
  - Site analyses using the APT-developed software tools
  - Explosives safety quantitative risk assessments
  - Explosives testing (planning, execution, data collection/reduction/analysis, reporting)
  - Explosion effects and consequences modeling and software development
  - Protective construction analysis and design
  - Structural assessments and commercial facility design
  - Regulatory/standards/criteria development





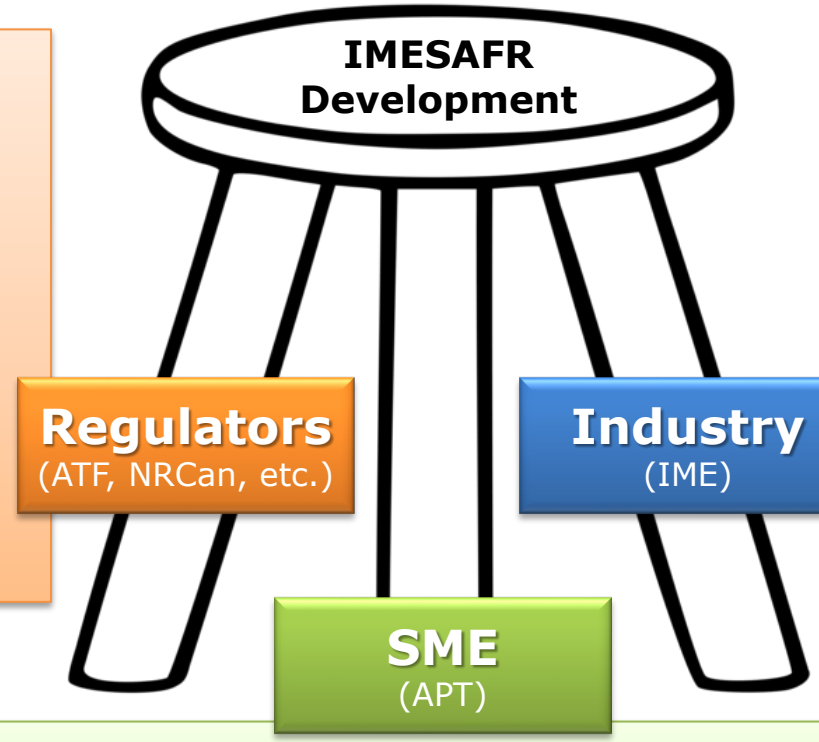
Source: A-P-T Research, Inc.

HOW WAS IMESAFR DEVELOPED?

The "Three-Legged Stool"

Regulators' involvement focused on:

- Buy-in
- Insuring confidence in accuracy (or conservatism) of the models
- Focus on consistency in QRA submissions
- Modernize regulations



Industry's involvement focused on:

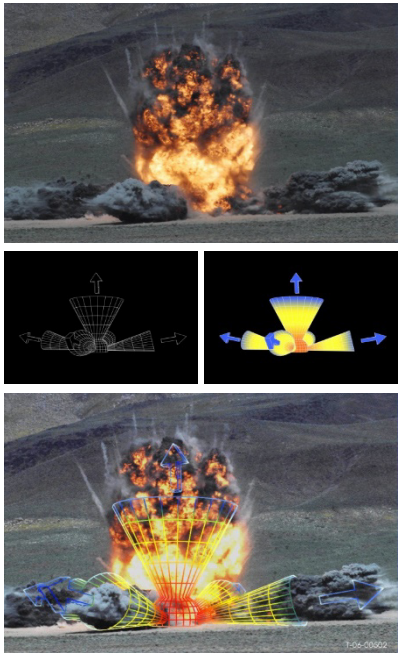
- Buy-in
- Presenting options for regulatory approval not previously available
- Better risk management tools
- Better understanding of operational risk

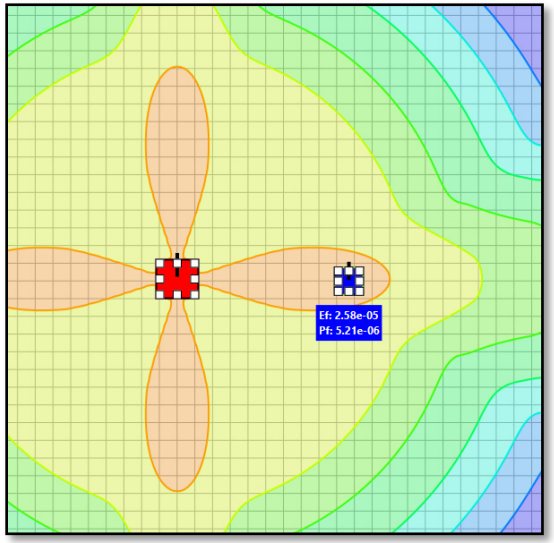
APT's role as the SME included:

- QRA SME
- Connection to other parties (DoD, NATO) solving the same problems
- Honest broker as advocate for QRA/tool without having inherent benefit of industry member
- Software developer

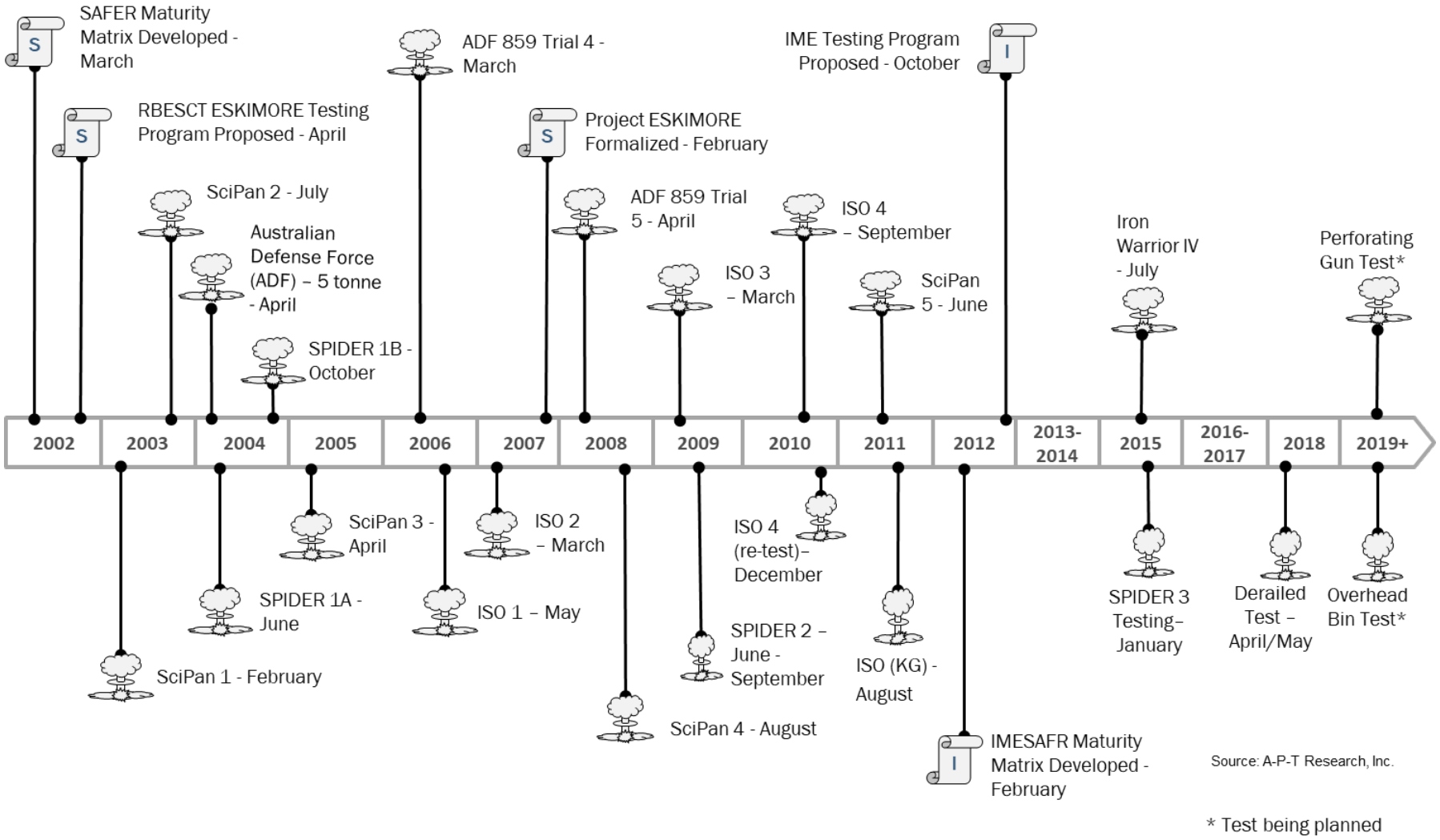
CONSEQUENCES
IMESAFR Algorithms

- APT believes that the consequence algorithms are the strength of the IMESAFR tool.
- IMESAFR's consequence algorithms are applicable to both commercial and military applications and are rooted in explosives effects and consequence modeling science (and therefore are applicable no matter the regulatory jurisdiction). This science is anchored by testing.





CONSEQUENCES
Linking Algorithms to Test Data



Source: A-P-T Research, Inc.

* Test being planned

CONSEQUENCES
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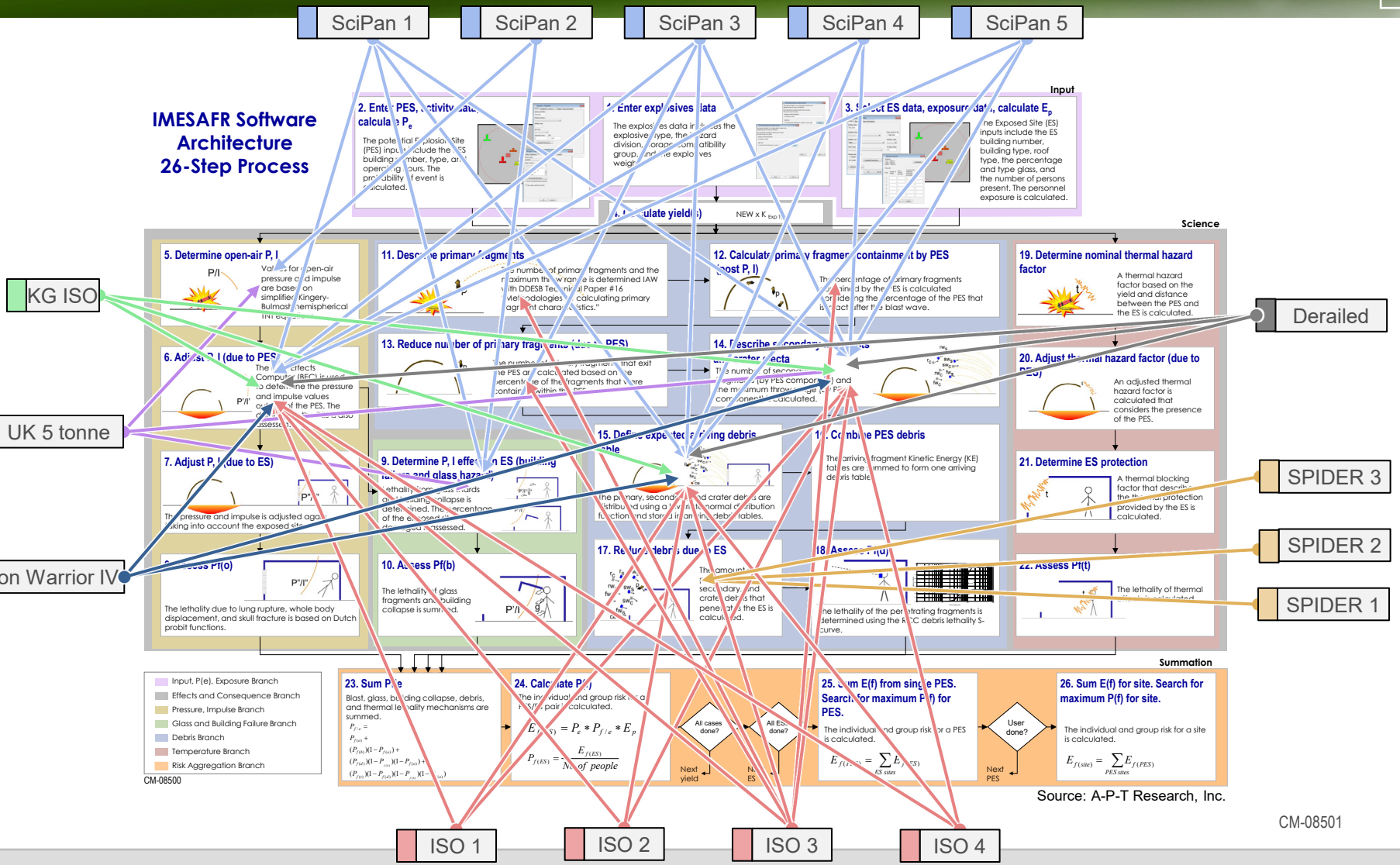


Source: A-P-T Research, Inc.

CM-08501

SPONSORSHIP STATUS

- IME served as the central sponsor for IMESAFR since the project's inception in 2005.
- APT determined that the best funding model going forward was a combination of industry sponsors and individual licensees
  - Individual licenses will not kick in until the release of v 2.2
  - Older versions will continue to be supported by APT (not indefinitely)
  - The majority of the current sponsors' funding will be to develop and issue v 2.2
- As of the end of 2021, IME will stay involved with the software, but will become one of several (currently five) industry sponsors.
- APT owns the software and plans to continue to make it available to the commercial explosives industry and associated regulators.
- Based on agreement between IME and APT, there are no current plans to change the name of the software tool.
- The software will remain available for purchase for those interested who are not sponsors.

NEW V2.2 ITEMS

Task	Description
Ability to Toggle Buildings On/Off in a scenario	Add layering to turn PESs or ESs on/off.
Add/Remove Barricades to All ESs	Feature to add barricades with max coverage to all ESs at the same time. Also, ability to remove all these barricades afterwards.
P_e Updates, TP-14 Rev 5	TP-14 Rev 5 Methodology for P_e
Overall Risk Contours	Risk contours based on the risk from all PESs and not for each PES.
Input Report	Report that shows all input made by the user for all PESs and ESs in a scenario.
Barricade Indicator Screen	Shows barricade on an ES by using a bolded line on the building.
Maintenance Package	Java Runtime update, subscription management, etc.

VERSION STATUS

- v2.0
  - APT will sunset support of v2.0 soon – probably by the end of 2022; this means that replacement licenses will not be issued, and other tech support will not be provided by APT
  - Current license holders have the option to upgrade now at no cost to v2.1 (training required)
  - Since there is no maintenance budget for v2.0, if there is a change to Window or Java (or something else beyond APT's control), use of the software cannot be guaranteed for any specific duration
- v2.1
  - APT will sunset support of v2.1 sometime after the release of v2.2 -- probably by the end of 2023; this means that replacement licenses will not be issued, and other tech support will not be provided by APT
  - Current license holders will be given options for upgrading at a discount (depending on the purchase date of v2.1 license); there will be a training requirement
  - Since there is no maintenance budget for v2.1, if there is a change to Window or Java (or something else beyond APT's control), use of the software cannot be guaranteed for any specific duration
- v2.2
  - Expected release date: summer 2022
  - Annual license plan: expected to be US$2K/yr
  - Sponsors receive a number of free licenses per year
  - Training required – details dependent on previous training (or none)
- v2.3
  - No release date scheduled yet, but plan it to release incremental updates at no cost to annual license holders
  - New users will be able to obtain software on an annual license basis, with a training requirement

PROBABILITY OF EVENT

Current Probability of Event (P_e) Matrix

PES used primarily for:	Applicable Environmental Factors	Probability of Event (PES-year)		
		* I	* II	* III
Commercial long-term storage	A1, A2, A6, B1, B4, D1, E1	2.80E-05	2.80E-05	2.80E-05
Bulk loading and unloading	A1, A3, A4, A6, B2, B3, B4, C1, E2	3.08E-04 (pump) 4.57E-05 (reservoir)	3.08E-04 (pump) 4.57E-05 (reservoir)	3.08E-04 (pump) 4.57E-05 (reservoir)
Perforating gun assembly	A1, A2, A3, A4, A6, B1, B2, B3, B4, C1	1.30E-03	1.30E-03	1.30E-03
Day magazine storage	A1, A2, A6, B4, C1, D1, E1	2.80E-04	2.80E-04	2.80E-04
Manufacturing	A1, A3, A4, A5, A6, B1, B3, B4, C1, D1, E1, E2	4.10E-03	4.10E-03	4.10E-03
AN storage	A1, A6, B1, B4	4.67E-06	4.67E-06	4.67E-06
Commercial loading/unloading	A1, A2, A4, A6, B1, B3, B4, C1, D1, E1	5.71E-04	5.71E-05	1.90E-05
Assembly	A1 , A3, A4, A5, A6, B1, B2, B3, B4, C1	4.74E-03	4.74E-04	1.58E-04
Demilitarization	A1, A2, A3, A4, A5, A6, B1, B2, B3, B4, D1, E1	2.43E-02	2.43E-03	8.11E-04
Disposal	A1, A2, A3, A4, A5, A6, B1, B3, B4, C1, D1, E1	2.43E-02	2.43E-03	8.11E-04
Inspection	A1, A2, A3, A4, A6, B1, B3, B4, C1, D1, E1	8.24E-04	8.24E-05	2.75E-05
Lab	A1, A2, A3, A4, A5, A6, B1, B3, B4, C1, D1, E1, E2	4.25E-03	4.25E-04	1.42E-04
Intransit Storage	A1, A2, A6, B3, B4, D1, E1	8.85E-05	8.85E-05	8.85E-05
Repackaging	A1, A2, A3, A4, A6, B1, B3, B4, C1, D1, E1	8.24E-04	8.24E-05	2.75E-05

- Environmental Factors (defined in training/documentation) used to adjust baseline P_e values by fixed amounts
- Approach based on activity type (rows) and compatibility groups (columns)

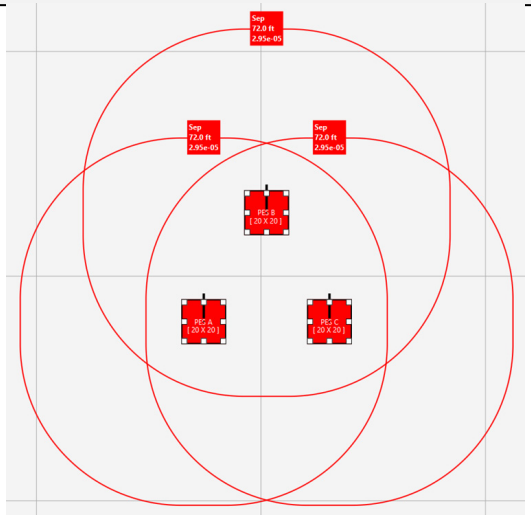
* I. Includes Compatibility Groups: L, A, B, G, H, J, F
* II. Includes Compatibility Group: C
* III. Includes Compatibility Groups: D, E, N

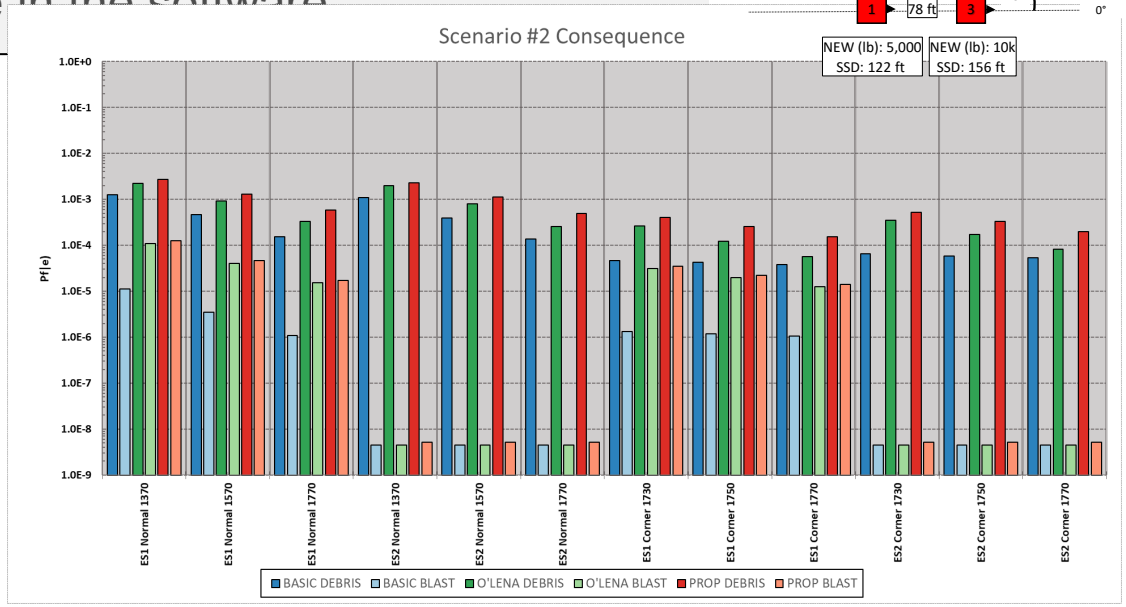
PROBABILITY OF EVENT

- New approach will be a function of activity types and hazard divisions
- Based on US DoD TP-14 Rev 5 approach
  - TP-14 Rev 5 is not yet published
  - New P_e method documented in published 2018 NDIA/DDESB Conference paper by DDESB
  - Has been reviewed by ISP
- Activity types and historical accident rates will remain based on industry accident history
- Some scaling factors and interpolation approaches may be based on new DoD methodology (this remains to be decided – would like to have ISP review)

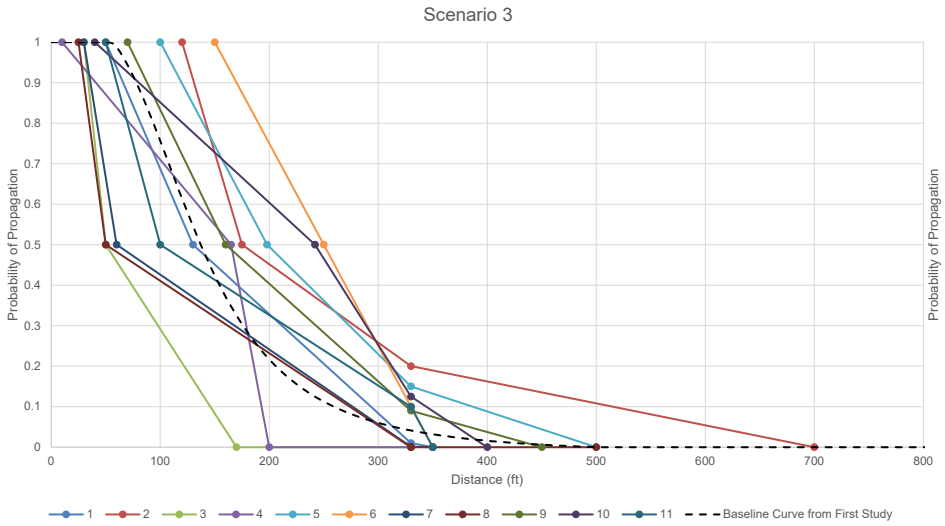
PROPAGATION: CONSEQUENCES

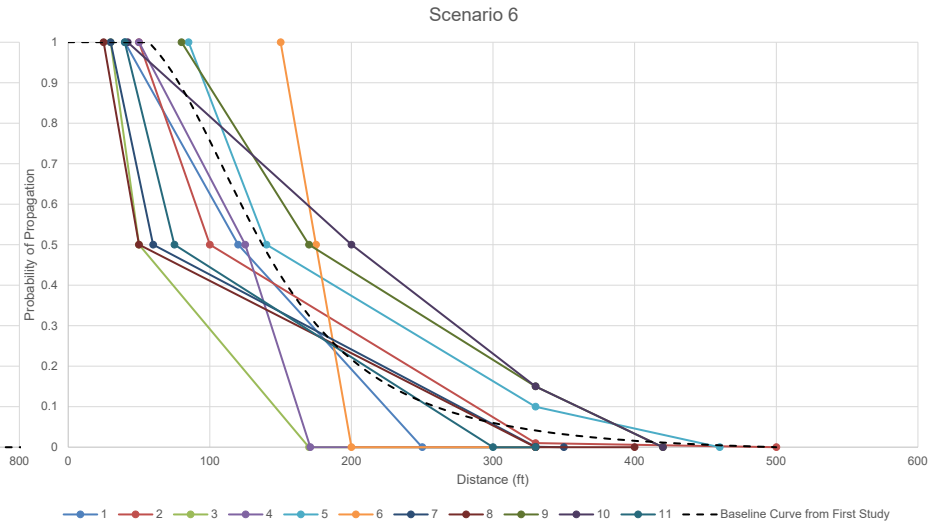
- After coordination with the IMESAFR Science Panel (ISP), ATF commissioned a sensitivity study for the consequence algorithms (both blast and debris) for an IMESAFR propagation model; study comparing three methods using numerous scenarios with thousands of cases to evaluate
- Study completed by APT and reviewed within the ISP
- Logic is ready to introduce in the software



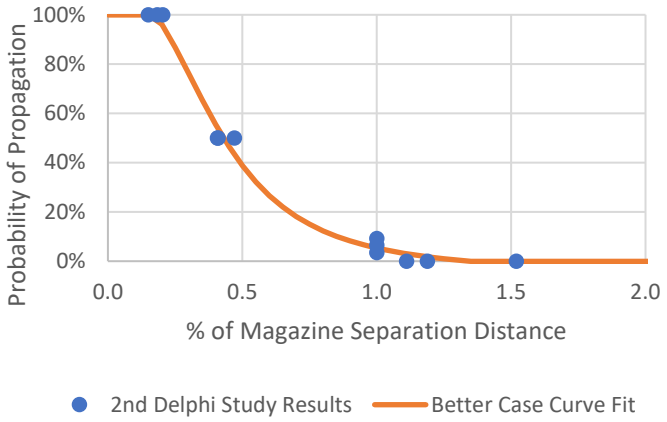


PROPAGATION: PROBABILITY





- The IMESAFR Science Panel conducted two rounds of two-phase Delphi Studies to establish the P(propagation) information required for the model
- Studies are ~95% complete
- Method will then be ready to introduce in the software



CANADA UPDATE:

- Some recent topics of discussion for Canadian regulatory applications:
  - User-defined P_e values
  - Bi-modal P_e for commercial bulk loading/unloading
  - Operations best characterized by an hourly event P_e rather than annual
  - Derogations for fixed/permanent sites
- Also interested in propagation logic implementation

- IMESAFR training class dedicated to NRCan-ERD/CERL in Ottawa
  - Class participants were very enthusiastic, and class was very interactive
  - Course was supported by senior ERD management
  - Recognition that not all regulatory issues can be ‘solved’ by strict adherence to, e.g., Q/D

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QUESTIONS?