



## PREVENTION MEASURES

TRND is a major step toward identifying potential risks from environmental regulations, and their impact on the supply chain, to achieve long-term risk mitigation. (Photo by Arthur Ogleznev, Pexels)

# PREVENTION IS THE *BEST* DEFENSE

A new regulatory database for assured supply chains aims to prevent the deployment of suspect harmful chemicals into the environment.

*by Cheryl Marino*

**W**e're all for products that are stain resistant, waterproof, anti-corrosive and made to last. But the not-so-charming side of these wonders lies in the "forever chemicals" that make them tick. It's a tale of innovation and unintended consequences, where the very features we cherish in our products are casting a shadow on the delicate balance of the Earth's ecosystems.

Munitions, whether used for training, stockpiles for wartime needs or provided in support of our friends and allies, play a vital role in the military's mission to defend the nation. They contain various chemicals that enhance performance and ensure Soldier safety. However, there is evidence suggesting that some of these materials may pose environmental risks, despite their benefits to our military forces.

We may be years away from revamping munitions manufacturing to remove these harmful chemicals, but taking some preventative steps now will reduce pollution, safeguard groundwater, ensure compliance with environmental regulations and enhance public health and safety in the future.

Environmental oversight of these chemicals is increasing, so program managers and technology researchers must strike a delicate balance to deliver capability for the warfighter while exercising proper environmental stewardship.

A new database tool called TRND, which developers pronounce as "Trend," aims to achieve that balance by providing the munitions community with a tool for rapid assessment of the current munitions supply chain and analysis of novel emerging energetics.

Identifying potential risks from environmental regulations and their impact on the supply chain—early, and more easily—to achieve both near- and long-term risk mitigation. Meaning reduced supply chain issues and less harmful chemicals polluting the environment.

The U.S. Army Combat Capabilities Development Command Armaments Center (DEVCOM AC) Life Cycle Readiness Branch is developing the TRND database tool in support of the U.S. Army Joint Program Executive Office for Armaments and Ammunition's (JPEO A&A) Assured Munitions effort.

The application of TRND is more simplistic than its acronym, which stands for the first four datasets used with the tool:

**T** – Toxic Substances Control Act.

**R** – Registration, Evaluation, Authorization and Restriction of Chemicals (REACH).

**N** – National Aerospace Standards.

**D** – Department of Defense Emergent Chemicals.

“This is a powerful resource that can be used to quickly identify where and how emerging chemicals of regulatory concern are present in JPEO A&A end items and or supply chain,” said Brian Hubbard, JPEO A&A's Environmental, Safety and Occupational Health (ESOH) officer. “The tool can be used by stakeholders supporting materiel developers and project management offices to identify how changing laws, regulations and policies could impact the ability to field armaments and ammunition items.”

According to Hubbard, the intent of TRND is to serve as a solution, where the TRND team can rapidly identify the environmental regulatory risks of a chemical or material, communicate impacts to acquisition stakeholders across their chain of command and, if necessary, begin research into [less hazardous material] substitution or replacements that still achieve performance requirements and enable Soldier readiness.

### THE LATEST TRND

To grasp the necessity for TRND, it's important to comprehend the impact that global environmental regulations have on DOD operations. Things like insufficient material supply; logistical complications; schedule delays; changes to hazard management; demilitarization; manufacturing; and raw material mining may collectively hinder task execution, raise costs, affect performance

and necessitate adaptations requiring effective navigation to maintain operational efficiency and readiness.

The TRND tool is capable of monitoring environmental regulatory agencies and their watch lists containing emerging environmentally concerning chemicals and can be used to steer research in a direction to prevent some of these challenges going forward.

It also simplifies the task for engineers by eliminating the need to manually search for the presence of listed chemicals in the munitions supply chains. Before TRND, engineers had to extract data from multiple sources to determine whether the chemical components in their catalog items were on some of the regulatory lists.

“I thought, there's a much better way to do this,” said Veronica Copp, environmental program specialist in the Life Cycle Readiness Branch at the Armaments Center, who developed the TRND worksheet tool. Copp said what started out as a phone call from Hubbard about the current process, sparked the development of a greatly needed tool that cross walks 8,379 catalog end items, subcomponents and chemicals in the JPEO A&A portfolio against multiple regulatory requirement databases like the DOD watch list, industry standards, Environmental Protection Agency (EPA) regulations and the 27-member European Union. “It was like seeing a niche need, and then responding to that with a 20-year-old technology niche.”

TRND streamlines the process into a single database tool that analyzes catalog items, breaks them down into their chemical components and compares them against the regulatory lists. “We look to see how those are regulated right now and how we think that they will be regulated in the future,” she said.

The next iterative step, she said, will be to expand the database to include chemical synthetization route alternatives, which will map end items down to a manufacturing level. This can be used to add functionality of health and safety and byproducts in the manufacturing process and provide a more comprehensive look at the supply chain.

According to Copp, enhanced search criteria, chemical mapping integration, weapon system detail and user interface can be further developed in a more refined product to close identified gaps in data reporting. As well as improvements for a more user-friendly report interface and integration of additional data sources.

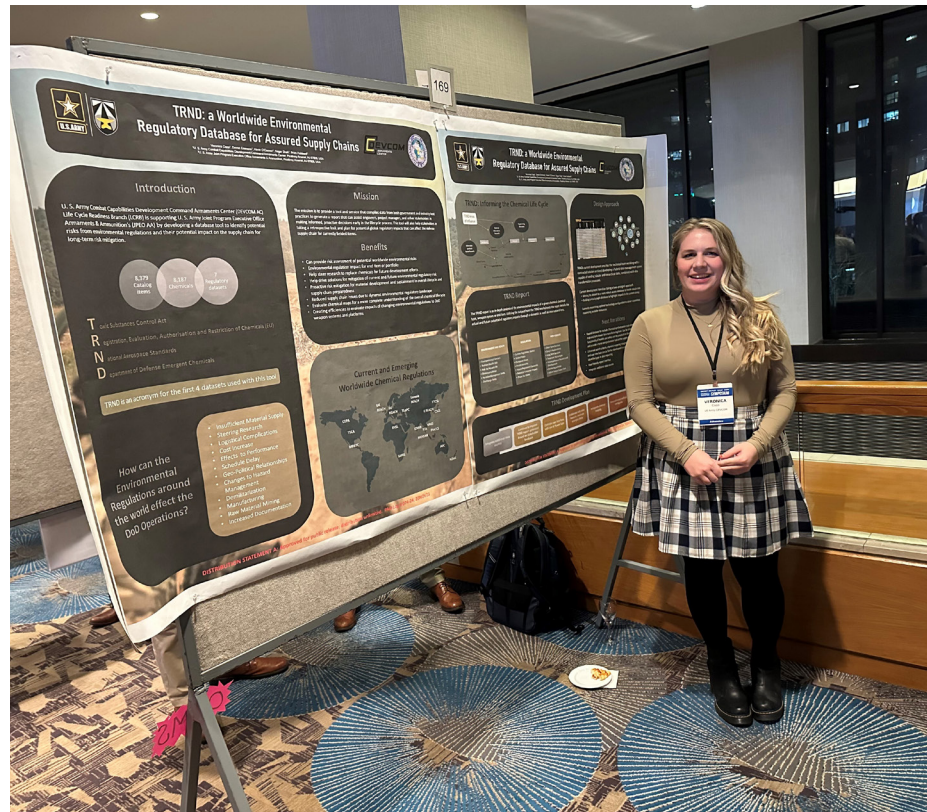
## THE GREEN SCHEME

“I think COVID brought forth a lot of supply chain enlightenment,” Copp said. “We’re seeing there’s other risks to the supply chain besides a global pandemic and there’s things that we could be foreseeing and modeling that we haven’t been tracking specifically.”

One hot button item, she said, is per- and polyfluorinated substances (PFAS), a group of chemicals used to make fluoropolymer coatings and products that resist heat, oil, stains, grease and water, which has drawn public scrutiny and driven TRND database development. PFAS have become the poster child for the threat of environmental contaminants that can cause anything from an altered immune system to kidney and liver disease to cancer. A primary manufacturer of PFAS is 3M Co., who announced in December 2022 that they will exit the market by 2025 in order to avoid further liability. The Army uses PFAS in munitions parts and formulations, but it will take years and millions of dollars to try to find a replacement and requalify items.

“We want to get rid of our forever chemicals [in general],” Copp said. But certain PFAS are mission critical, ensuring materiel performs as intended. “With 3M leaving the PFAS market ... they are a supplier and now we’re going to have only a few smaller companies left,” which could affect supply. So, she said, with political pressure to get out of the PFAS market, “What are our other options? What would lead us to another solution that we won’t regret in the future?”

The TRND database tool generates an in-depth analysis report of the environmental impacts of a given chemical, chemical type, weapon system or end item, and details the actual and future potential of regulatory impacts through



## TRND-ING AT THE SYMPOSIUM

Veronica Copp stands with her poster outlining TRND capabilities and objectives at the Department of Defense Energy and Environment Innovation Symposium, held Nov. 28 through Dec. 1, 2023, at the Crystal Gateway Marriott in Arlington, Virginia. (Photo courtesy of Veronica Copp, DEVCOM AC)

a domestic, as well as international, lens. Using the output from the TRND worksheets, assessments can be made about the environment and health (human health risk, bioaccumulation, permissible exposure limits); regulation (United States, EU, private industry); and path forward (short- and long-term solutions, drop-in chemical replacements and onshoring potential).

Before TRND, according to Copp, there wasn't a central location or database where data could be analyzed both “retrospectively” (with consideration of how past events or situations might affect future outcomes) and “prospectively” (accessing

current data sets with consideration of or in preparation for future events). Engineers and program managers would be able to access the impact of emerging regulation and provide data and courses of action for a fact-based decision on mitigation by leadership. The response to emerging regulation could range from improved environmental practices to redesign of the item to eliminate the material of concern. In instances where no alternatives exist, the database will provide information to support a permitted, continued use request for specific applications of regulated materials in support of national security needs. One of the ultimate goals is for TRND

to be used as a tool early in the life cycle to help identify and access potential environmental regulatory risks during the development of new materials.

The TRND tool would compile data from both government and industry best practices to generate a report that can assist engineers, project managers and other stakeholders in making informed, proactive decisions early in the life cycle process—allowing for potential improvements to be identified and implemented—leading to reduction in a product’s overall environmental impact.

Another big issue, Copp said, is hexavalent chromium, an industrially produced forever chemical used to protect Army vehicles, equipment and missile systems from corrosion; also known to cause cancer and other long-term health effects.

The Army is pursuing a number of heavy metal mitigation and replacement projects beyond hexavalent chromium (see “Heavy Metal—Banned” in the Fall 2021 issue of AL&T). A European Union hexavalent chromium elimination (memo) in March 2022 was another major driver of TRND development. “We’re trying to get ahead of this,” she said. “TRND will be useful in two ways, since it’s retrospective, which is the easy part right now. But my team is also looking prospectively, and TRND has the ability to look at the current catalog.”

The TRND workbook is broken down into two main interactive smart reports: The TRND “end item” is a retrospective search used to identify what current items and sub-components are regulated. And the TRND “chemical” is a sheet that can be prospectively used as a forecasting tool in the design and product development

process. Currently, the tool is limited to chemical forecasting, but will expand to end items in the coming months.

“When you’re talking to the public or people who don’t have a chemistry background, I feel like being able to link carcinogenic items, or something along those lines, with real world examples is really impactful,” she said. “So, I’ve been bringing in some data from the EPA as well.” This data includes information about chemical compositions, toxicity and the effects on drinking water, waste and wastewater.

Copp said with TRND, she’s ultimately trying to get in the ear of research engineers and say: “Hey, I want you to start thinking about environmental regulations and how they’re going to impact the material choices you make.” By linking up with Army materiel engineers, she is hoping to bridge gaps and provide them with a tool where they might consider alternate choices and might say “maybe I don’t want to use the next hexavalent chromium and replace it. Maybe there’s a green alternative,” said Copp. “We want to steer the research hoping that we can use TRND to influence research for greener alternatives.”

**AVOIDING REGRETTABLE SOLUTIONS**

Copp is taking a holistic approach from the “ground to the round,” she said, meaning from material in the ground to the end item, because everything that comes out of a gun is going to end up somewhere. So, she wants to build in a demilitarization thought process now, to avoid regrettable solutions later.

“We’re trying to go about the development of these new energetic materials in a much more measured way that balances the safety of our warfighter mission goals but is also environmentally responsible.” And

CAS Number	Chemical Name	REACH SVHC	REACH AL	NAS 411	TSCA High Priority	IAEG LIST	Higher # = more regulated
306-80-9	1,1,2,2-Tetrabromo-1-fluoroethane (HBFC-121 B4)			Prohibited			1
26545-49-3	(Neodecanoato-O)phenylmercury			Prohibited		R1,R2,D1	2
69011-06-9	(Phthalato-2)glycoldiethylad	SVHC		Restricted		R1,D1	3
71411-66-0	(R)-1,2-dihydroxyethane, barium cadmium salt			Restricted			3
64681-08-9	(S)-dichloro-2-[[[2,3-dihydroxypropoxy]hydroxyphosph			Restricted			1
43136-18-1	(Z)-1,1,3,3-tetramethyl-1,3-bis[(1-oxooctadec-9-enyl			Restricted		R2	2
29977-13-7	[[N,N'-ethylenebis(glycinato)](2-N,N,N',O')cadmium			Tracked			1
51594-55-9	1 chloro 2,3 isopropylene			Tracked			1
872-50-4	1 methyl 2 pyrrolidone	SVHC		Restricted	High Priority	R1,R2,D1	5
75-34-3	1,1 dichloroethane			Restricted	High Priority		3
75-35-4	1,1 dichloroethane			Restricted		R2	3
57-14-7	1,1 dimethylhydrazine			Restricted			2
630-20-6	1,1,1,2-tetrachloroethane			Tracked		R1,R2	2
375-17-7	1,1,1,2,2,3,3,4,4-Nonafluorobutane (HFC-329p)			Tracked			1
422-78-6	1,1,1,2,2,3,3-Heptachloro-3-fluoropropane (CFC-211a)			Prohibited		R1,R2,D1	2
135401-87-5	1,1,1,2,2,3,3-Heptachloro-3-fluoropropane (CFC-217a)			Prohibited			1
2929-86-8	1,1,1,2,2,3,3-Heptafluoropropane (HFC-227ca)			Tracked			3
138495-42-8	1,1,1,2,2,3,4,5,5-Decafluoropentane (HFC-43-10) (HFC			Tracked		R1,R2,D1	3
677-56-5	1,1,1,2,2,3-Hexafluoropropane (HFC-236cb)			Tracked		R1,R2,D1	2
354-33-6	1,1,1,2,2-Pentafluoroethane (HFC-125)			Tracked		R1,R2,D1	3
1814-88-6	1,1,1,2,2-Pentafluoropropane (HFC-245cb)			Tracked			1
431-89-0	1,1,1,2,3,3,3-Heptafluoropropane (HFC-227ea)			Tracked		R1,R2,D1	3
631-83-0	1,1,1,2,3,3,3-Hexafluoropropane (HFC-236fa)			Tracked		R1,R2,D1	3
421-94-3	1,1,1,2,3-Pentachloro-2-fluoroethane (HFC-231bb)			Prohibited			1
76-11-9	1,1,1,2-Tetrachloro-2,2-difluoroethane (CFC-112a)			Prohibited		R1,R2,D1	2
354-11-0	1,1,1,2-Tetrachloro-2-fluoroethane (HFC-121a)			Prohibited			1
811-97-2	1,1,1,2-Tetrafluoroethane (HFC-134a)			Tracked		R1,R2,D1	3
460-79-1	1,1,1,3,3-pentafluoropropane (HFC-245fa)			Tracked		R1,R2,D1	3
3182-26-1	1,1,1,3,3,3-Hexachloro-2,2-difluoropropane (CFC-212)			Prohibited		R1,R2,D1	2
690-39-1	1,1,1,3,3,3-Hexafluoropropane (HFC-236fa)			Tracked		R1,R2,D1	3
2954-06-5	1,1,1,3,3-Pentachloro-2,2,2-trifluoropropane (CFC-213)			Prohibited		R1,R2,D1	2
422-49-1	1,1,1,3,3-Pentachloro-2,2-difluoropropane (HFC-222c)			Prohibited			1
406-58-6	1,1,1,3,3-Pentafluorobutane (HFC-358mf)			Tracked		R1,R2,D1	3
148875-98-3	1,1,1,3-Tetrabromo-3,3-difluoropropane (HBFC-232 B4)			Prohibited			1
148875-95-0	1,1,1,3-Tetrabromo-3-fluoropropane (HBFC-241 B4)			Prohibited			1
2268-46-4	1,1,1,3-Tetrachloro-2,3,3-tetrafluoropropane (CFC-21			Prohibited			1
622-82-4	1,1,1,3-Tetrachloro-2,3,3-trifluoropropane (HFC-223ca)			Prohibited			1
166-89-6	1,1,1,3-Tetrachloro-2,2,2-trifluoropropane (HFC-223ca)			Prohibited			1

**EXAMPLE WORKSHEET**

A TRND worksheet mockup showing environmental regulations by chemical. (Graphic by Veronica Copp, DEVCOM AC)

currently, she said, there is a lot of basic and advanced research being conducted regarding hexavalent chromium and corrosive coatings, especially in guns.

“When you think about acquisition, you’ve got a current problem right now, but any reflection on the catalog we’re looking at in the best scenario five years, and that’s very lofty—very, very lofty,” she said. “I would say we’re looking at a 10-to-15-year lag, so any heads up on research that we could get [is going to help]. If we are looking at trends maybe in Europe from the REACH, if we could get on that kind of schedule, we might be a little bit more competitive in a green way.” REACH is a European Union regulation that affects the supply and use of substances and aims to ensure a high level of protection of human health and environment against harmful materials.

### BUILT TO SERVE

While built to serve the munitions community, the preventative features of TRND hold promising potential for adaptation to serve other customers (government agencies, departments, industry) in the future.

In the short term, Hubbard said, “TRND provides the capability to rapidly search the JPEO A&A portfolio for critical chemicals and materials that are contained in fielded end items. And it enables JPEO A&A to respond to quick-turn information requests asking if certain chemicals are used in Army materiel.” In the long term, TRND may evolve to include developmental items, and enable material developers to identify impacts from the rapidly changing environmental regulatory landscape—before a technology or end item transitions to a program management office and or program of record. “This could allow material developers to pivot to less hazardous, alternate chemicals/materials and mitigate risks before transition,” he said.

Copp said 6.1 Environmental Basic Research funding was secured for TRND a year ago but will run out in June. She also applied for a grant from the DOD Strategic Environmental Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ESTCP)—the gatekeepers of environmental research, who steer the DOD’s environmental research funding lines.

Each year the SERDP/ESTCP hold a symposium for all grant applicants, and at last year’s Department of Defense Energy and Environment Innovation Symposium—held Nov. 28 through Dec. 1, 2023 in Arlington, Virginia—other project management offices and program executive offices outside of JPEO A&A were

briefed on TRND and its benefits for potential use with their product or commodity areas.

“Our biggest goal going forward is to chemically map our items down to such an elemental level, so we can have the greatest impact and also avoid those supply chain issues from regulations,” Copp said. “And we’re also trying to see where we can make headway with onshoring the chemical production.”

Copp and her team at the Armaments Center say they are working with chemists on building chemical mapping functionality into TRND to assess potential environmental regulatory impacts during the development of alternate synthesis of some energetic polymers and plasticizers, with cohorts across the Army, on better alternatives to synthesize these into working energetics to determine the “greenest route.”

### CONCLUSION

The goal of TRND is to identify potential threats to acquisition from increased regulatory scrutiny or perceived liability which may result in supply chain deficiencies and an inability of the Army and DOD to produce and field munitions.

Copp said TRND, which is still in the testing phase, is currently limited to Army partners, while efforts on design and enhancements continue. “Right now, it consists of taking current environmental policies and comparing those to chemicals, not Army or DOD catalog items yet,” she said. “But in the next year, we’re hoping to have a prototype out and available, on a wider scale.”

“Is it going to be a perfect solution? Absolutely not,” Copp said. “But I think it could help steer research away from those regrettable solutions.”

*For more information, go to the JPEO A&A website at <https://jpeoaa.army.mil>.*

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*CHERYL MARINO provides contract support to the U.S. Army Acquisition Support Center (USAASC) at Fort Belvoir, Virginia, as a writer and editor for Army AL&T magazine and Network Runners Inc. Prior to USAASC, she served as a technical report editor at the DEVCOM Armaments Center at Picatinny Arsenal for five years. She holds a B.A. in communications from Seton Hall University and has more than 20 years of writing and editing experience in both the government and private sectors.*