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**The Risk Assessment and Mitigation  
Framework for Strategic Materials  
(RAMF-SM)**

Julie C. Kelly  
James S. Thomason

May 2022  
Approved for public release;  
distribution is unlimited.  
IDA Document NS D-33112  
Log: H 22-000224

INSTITUTE FOR DEFENSE ANALYSES  
730 East Glebe Road  
Alexandria, Virginia 22301



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**About This Publication**

This work was conducted by the Institute for Defense Analyses (IDA) under contract HQ0045-14-D-0001, project DE-6-4333, "Comprehensive Assistance to DLA Strategic Materials in preparing Biennial Reports of the DoD to the Congress on National Defense Stockpile Requirements," for the Strategic Materials Office of the Defense Logistics Agency (DLA-Strategic Materials). The views, opinions, and findings should not be construed as representing the official position of either the Department of Defense or the sponsoring organization.

**Acknowledgments**

The authors wish to thank Mr. David Pineault of DLA Strategic Materials, and Daniel Lago and Elly Schwartz of IDA, for their guidance and recommendations.

**For More Information:**

Dr. James S. Thomason, Project Leader  
[jthomaso@ida.org](mailto:jthomaso@ida.org), 703-845-2480  
ADM John C. Harvey, Jr., USN (ret) Director, SFRD  
[jharvey@ida.org](mailto:jharvey@ida.org), 703-575-4530

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730 East Glebe Road  
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## **Executive Summary**

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At the request of the Defense Logistics Agency's Office of Strategic Materials (DLA-SM), IDA prepared a briefing for DoD's National Technology and Industrial Base Working Group Meeting. The meeting included DoD partners in Canada, Australia, and the United Kingdom. DLA-SM presented the briefing, and focused their remarks on their administration of the National Defense Stockpile program. In support of this program, DLA-SM is responsible for estimating potential shortfalls of strategic and critical materials and submitting recommendations to Congress regarding stockpiling and other risk mitigation options. The overarching framework used to inform the report to Congress is the Risk Assessment and Mitigation Framework for Strategic Materials (RAMF-SM). This briefing contains an overview of RAMF-SM, and highlights recent improvements and application of the framework.

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# **The Risk Assessment and Mitigation Framework for Strategic Materials (RAMF-SM)**

Briefing for David Pineault, DLA Strategic Materials for  
Presentation at the National Technology and Industrial Base (NTIB)  
Working Group Meeting

January 24, 2022

**Institute for Defense Analyses**  
730 East Glebe Road • Alexandria, Virginia 22305-3086

## Background (1 of 2)

- DLA Strategic Materials administers the National Defense Stockpile (NDS) for the Secretary of Defense (SecDef), and conducts a variety of related material assessments for the Department of Defense (DOD) and the Congress
- For decades, DOD has had responsibility for estimating potential shortfalls of strategic and critical materials and submitting recommendations to Congress to stockpile materials with significant shortfalls
  - Analyses of defense and civilian needs for such materials, often performed within the context of a national security emergency scenario, as mandated by Congress under the Stock Piling Act
- The overarching analytic framework used for this purpose is called RAMF-SM
  - RAMF-SM = Risk Assessment and Mitigation Eramework for Strategic Materials
  - Accredited by the Defense Logistics Agency (DLA) and DOD, and developed by the Institute for Defense Analyses, RAMF-SM is used to help determine what stockpiling and other risk mitigation efforts are prudent
- RAMF-SM is used to elicit, integrate and analyze the implications of policy judgments from DOD and other departments and agencies as well as to assess the best available data from the government and from relevant industry sources
- Key policy judgments include what civilian and defense demands are deemed essential and what suppliers are judged safe enough to rely upon for a given case

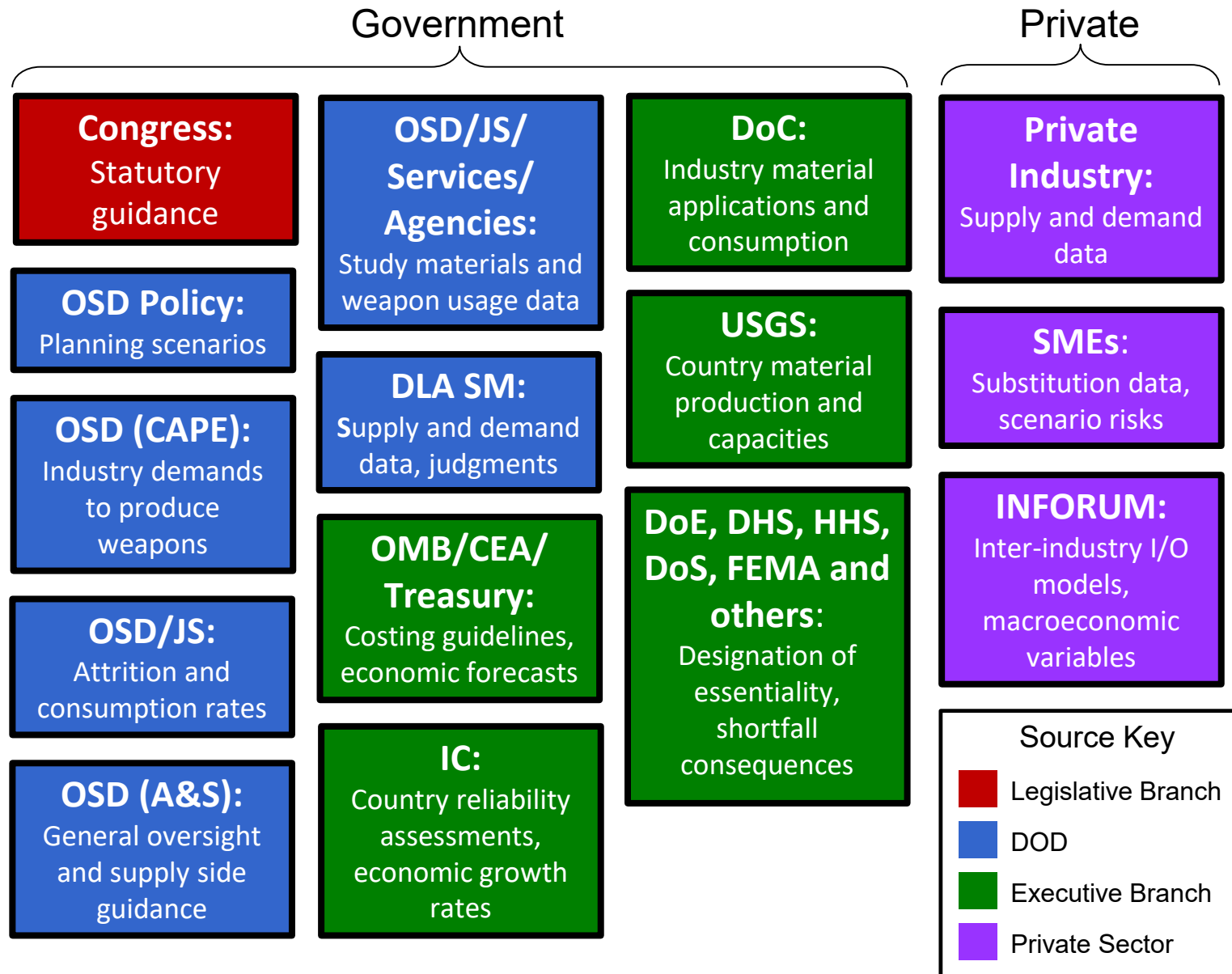


## Background (2 of 2)

- RAMF-SM assessments are conducted at both the “macro” and “micro” levels, on a time-phased basis
  - Macro assessments are conducted at the economy-wide level (several hundred sectors)
  - Micro assessments are conducted at the firm/weapon system level, especially for priority DOD materials
- The RAMF-SM framework is used to elicit and specify consistent policy judgments at both macro and micro levels of analysis
- RAMF-SM enables a variety of sensitivity cases and alternative cases to assess implications of uncertainties with respect to key variables/parameters
- Multidisciplinary teams at DLA Strategic Materials, with key partners, have developed considerable expertise in the materials area, and provide analytic support to DOD as officials determine their future needs
- As part of the RAMF-SM assessment process, DLA Strategic Materials continually seeks better data and analytics
  - Key providers of input data are shown on the next slide

Additional information on RAMF-SM (e.g., briefings, papers) is available upon request.

# RAMF-SM Assessments Draw Upon Many Forms of Input Data and Sources



## RAMF-SM Macro Structure Process Steps

1. Elicit materials to study in a cycle
2. Elicit estimates of **essential civilian demand** categories and levels
3. Elicit assessments of **homeland damage** in the scenario
4. Elicit assessments of **(essential) defense demands** needing to be built, and **schedules**
5. Elicit/develop estimates of materials needed to build these demands on what schedules
6. Elicit estimates of potential supplies of these materials (not counting NDS inventories)
7. Elicit judgments as to which supplies are **safe enough** to depend upon to meet what demands
8. Integrate these demand and supply estimates and estimate any significant **initial shortfalls**
9. Assess feasibility of mitigating or eliminating these initial shortfalls by several types of **market responses** (ready substitution, extra supplies from safe suppliers, “thriftiness” measures)
10. Estimate remaining shortfalls (**net shortfalls**) after “market responses”
11. Estimate whether any net shortfalls exceed existing NDS stockpile inventories
12. If any net shortfalls do exceed NDS inventories, assess those **shortages** as promising candidates for NDS stockpiling (or other prudent mitigation measures)
13. Make recommendations for stockpiling or other mitigation actions
14. Implement approved recommendations as appropriate

An illustration of the RAMF-SM framework appears on the following slide.

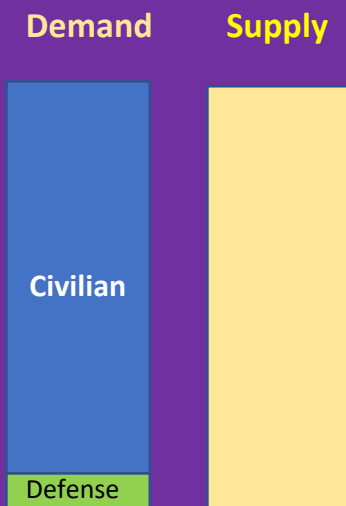
# RAMF-SM Enables Estimates of Shortfalls and Shortages from U.S. Peacetime and National Defense Stockpile National Emergency Demands and Supplies

Start with Peacetime Estimates of Demand and Supply

For Emergency Scenario

- Elicit Estimates of Homeland Damage
- Of Essential Civilian Demands
- Of any additional Defense Demands
- Judgments as to Safe Suppliers

## Peacetime



## National Emergency



If shortfall exceeds any NDS Stockpile Inventory, there is a...

Shortage

Shortages become strong candidates for stockpiling, or for other mitigation options

If Essential Demands exceed Safe Supply, there is a shortfall

Integrated Through DOD's RAMF-SM (Risk Assessment and Mitigation Framework for Strategic Materials)

# RAMF-SM Micro Structure Process Steps

1. Elicit materials (often those critical to defense weapon systems) to study at a **finer level of granularity** than is possible for macro assessments (e.g., at the firm level); these often include single sources of unique and proprietary materials
2. Apply structured policy judgments and assumptions used in RAMF-SM macro assessments to ensure continuity of approach
3. Assess capabilities along the supply chain to **identify node-by-node capabilities** to process and refine upstream materials into semi-finished products (by production node, firm, and production facility)
4. Elicit estimates of **defense demand** for specific material forms/grades required by particular weapon systems or planned replacement systems, and associated **schedules**
5. Elicit/develop estimates of materials needed to build these demands on what schedules
6. Elicit estimates of potential supplies of these materials (often, these materials are not in NDS inventories), including firm-level detail on suppliers (who and where production facilities are located)
7. Identify and evaluate **supply chain “weak links,”** such as a lack of domestic supplier, supply controlled by a foreign market dominator, supply concentrated in a hostile country, etc.
8. Determine which supplies are **safe enough/qualified** to meet what demands, and identify whether domestic supply options exist
9. Integrate these demand and supply estimates and estimate any significant **initial shortfalls**, which are often also **net shortfalls** (because market responses often are unavailable for the types of tailored, high-performance materials required by advanced defense weapon systems)
10. Because these materials are often not yet in NDS inventories, the **shortages** are assessed as promising candidates for NDS stockpiling, developing vendor-managed inventories, or other prudent mitigation measures (including development/qualification of additional sources possibly in conjunction with Defense Priorities & Allocations System and Title III authorities)
11. Make recommendations for stockpiling or other mitigation actions as described above
12. Implement approved recommendations as appropriate

# Notional Example: Supply Chain Fragility for Sintered SmCo Magnets

Every link in the supply chain is important.  
Any weak link puts the entire chain at risk.



Created by Ashim Coquet from Noun Project



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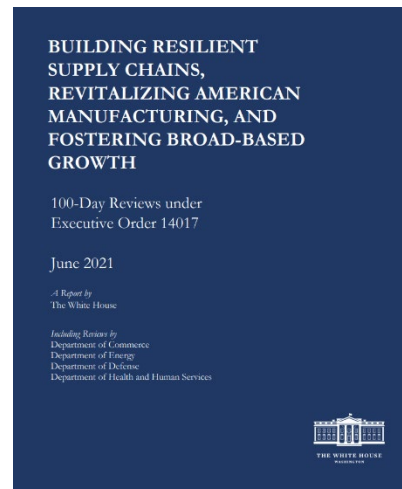
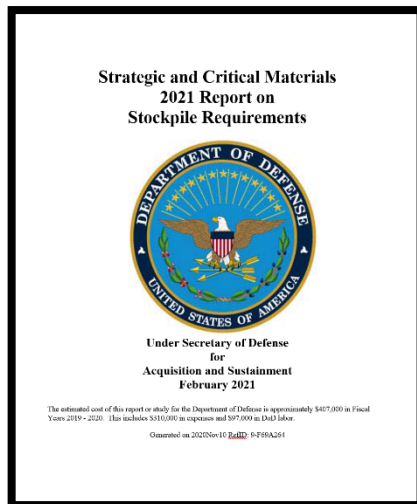
Type of Weak Link	Mining and Production of RE Ores & Concentrates	Production of RE Carbonates	Production of Separated RE Oxides (Sm and Gd)	Production of RE Metals (Sm and Gd)	Production of Sintered SmCo Alloy	Production of Sintered SmCo Magnet
Production capability exists in the U.S.						

**Examples of SmCo Magnet Use**  
 Automobiles  
 Medical Devices  
 Aircraft  
 Satellites

This notional example omits color coding used to indicate supply chain features, such as the following: no production capability in the U.S.; or, limited, untested production capability in the U.S.; or, U.S. production exists.

# RAMF-SM Recent Applications

- RAMF-SM **macro** assessments are a coherent, transparent way of getting a handle on **overall** demands for materials (both for essential civilian and defense needs) and safe supplies of them
- RAMF-SM micro assessments are used to uncover more granular supply disruption risks not detected by the macro studies and to identify more precise risk management approaches
  - Inform government stockpiling
  - Help direct DOD investment in developing material substitutes
  - Facilitate DOD funding to address private sector industrial base gaps, and
  - Build closer collaboration with friendly foreign sources of supply (e.g., NTIB countries)
- RAMF-SM has recently been used for the *Strategic and Critical Materials Report on Stockpile Requirements* for the National Defense Stockpile (NDS), and DOD's response to Executive Order 14017, *Securing America's Supply Chains*



## Recent Improvements to RAMF-SM

- Essential civilian/critical infrastructure (w/ DHS)
  - Shifted from informal survey of civilian departments and agencies regarding the essentiality of sectors in a national emergency “Base Case,” to an approach based on the latest White House guidance (and associated NAICS codes) concerning essential economic sectors
- Country Reliability
  - RAMF-SM process now identifies adversaries and their allies (in the military conflict) as unsafe; the process excludes as unsafe too most “market dominators”; process also elicits judgments about most countries from DIA and CIA using a formal protocol, which decrements chiefly according to their estimated inability to supply materials in the postulated national emergency scenarios
- Climate Change
  - RAMF-SM will incorporate estimates of extreme weather damage (including recovery costs) to key production facilities as part of the forthcoming 2023 Report on Stockpiling Requirements
- Downstream Effects (w/ USGS)
- Market Responses
  - RAMF-SM can be used to model market responses that are likely to occur without government intervention (e.g., thrift, substitution, extra sell)
- Domestic Single Points of Failure (DSPOFs)
  - Subject Matter Experts (at DLA Strategic Materials and elsewhere) review supplier data to identify DSPOFs and determine whether DSPOF supply should be relied upon in the context of the national emergency “Base Case”; these judgments are incorporated into RAMF-SM modeling



## RAMF-SM Next Steps

- Prepare the *Strategic and Critical Materials 2023 Report on Stockpile Requirements*
  - DLA Strategic Materials is in the process of eliciting materials for consideration, determining appropriate policy judgments, collecting demand and supply data, and identifying micro assessment material candidates
  - Please let us know if you have suggestions in these areas (in particular, materials of concern that should be part of 2023 assessments)
- Work with the Department of Homeland Security to see how RAMF-SM can be adapted to help address vulnerabilities and risks in civilian sector
- Conduct assessments and collect information on a priority set of precision-guided munitions, using RAMF-SM techniques and other tools to better understand lower-tier supply chain vulnerabilities

## RAMF-SM References Can Be Made Available\*

- *An Overview of Step 2 of the Risk Assessment and Mitigation Framework for Strategic Materials (RAMF-SM)*, D-5432, March 2015
- *The Material Supply Adjustment Process in RAMF-SM, Step 2*, D-5564, June 2016
- *Computation of Material Demand in the Risk Assessment and Mitigation Framework for Strategic Materials (RAMF-SM) Process*, D-5477, August 2015
- *Verification of the Forces Mobilization Model (FORCEMOB) as Used for the 2015 Defense Stockpile Report to Congress*, D-5557, March 2016
- *Forces Mobilization Model (FORCEMOB): Unclassified Training Tutorial*, D-5433, August 2015
- *Generic Unclassified Stockpile Sizing Module (SSM) Training and Testing for the National Defense Stockpile (NDS) 2015*, D-5270, September 2015
- *Weapon-Specific Strategic Material Estimation Process (WSSMEP)*, D-5364, September 2015
- *RAMF-SM Assesses Risk to Rare Earth Magnet Supply Chain*, D-10860, November 2019
- *Assessing Strategic and Critical Materials National Security Risks*, D-10899, February 2020
- *The RAMF-SM Material Demand Computation Program: Documentation and User's Guide*, P-22689, forthcoming.
- *The RAMF-SM Stockpile Sizing Module: Updated Documentation and User's Guide*, P-22696, forthcoming.

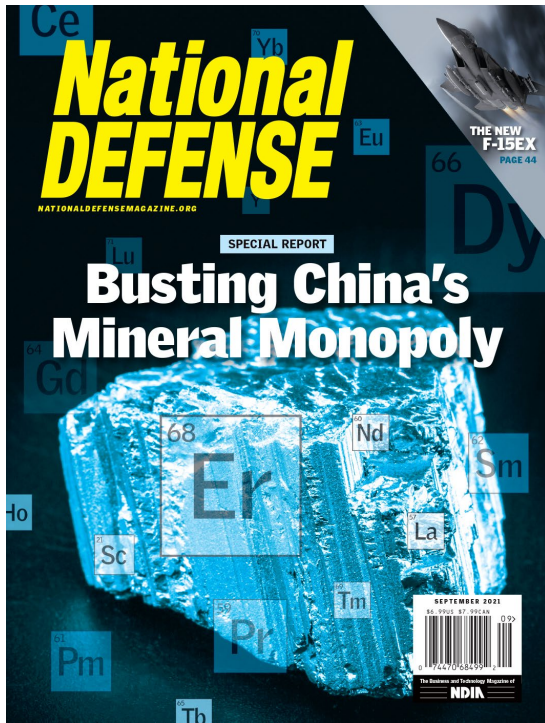
\*Subject to appropriate approval/clearance; some products may be classified and/or proprietary.

# BACK-UP

## Strategic and Critical Material Challenges

- Often the challenge is not in getting the basic material
- It is, rather, dangerous dependence on some others for processing the material for actual use in key parts for key systems
  - Getting rare earth oxides and metals, for example
  - Mt. Pass in CA illustration
- It is also dangerous dependence on some others for the parts themselves (which often contain key materials)
- While there are benefits to globalization, there are security risks to globalization as well
- Finding the right balance is a challenge
- Better determining U.S. vulnerabilities to disruption is a first step

## Rare Earth Mining and Processing is Complex: Mountain Pass Final Step



Bags of partially refined rare earth minerals await shipment to China at the Mountain Pass mine in California.

**Currently, the final step in the REE refinement process (separation) that delivers the purity required is all done in China.**

MP Materials earned a \$10 million Defense Department grant to help it build a \$200 million refinement facility for light REE separation (Nd, Pr). The company broke ground on the building in 2021 and expects it to be operational by 2022. **This facility will still require shipments to China for heavy REE separation (Sm, Eu, Gd).**

**RAMF-SM is used to perform most of the detailed assessments of REEs and other S&CMs for DOD; See DOD's 2021 Requirements Report to Congress. IDA**

- **RAMF-SM Step 2 consists of four primary sub-steps:**
  - Sub-step 2A – Estimate demands for goods and services and the industrial output needed to produce them (by component of demand, industry, and year)
  - Sub-step 2B – Estimate derived demands for the study materials (e.g., SL1 and SL2 materials) to produce the industrial output computed by Sub-step 2A (by component of demand, material, and year)
  - Sub-step 2C –
    - (a) Estimate available supplies of the study materials
    - (b) Estimate any INITIAL shortfalls in the scenario by comparing demands (from Sub-step 2B) with supplies of materials (by component of demand, material, and year)
  - Sub-step 2D – Estimate any NET shortfalls, taking into account important market response (substitution, extra-sell, thriftiness)

Step 2 is a time-phased estimate of material demands, supplies, and shortfalls using Base Case or other data and policy judgments.

## **Additional Supply Chain Assessment Tools May Be Used in Conjunction with RAMF-SM**

- Additional tools help bring in the most realistic information about readiness to meet demands, and risks
- Provides data to stakeholders on capacity constraints, disruption possibilities, and potential mitigation options
- Such a view can be a win-win opportunity for all players
- Analytic platforms can be used by various stakeholders in an integrated manner to
  - Enable efficient collection of inputs,
  - Ensure a common understanding of analytics, and
  - Provide results shareable with all parties, facilitating sound decision-making.

# IDA Contact Info

## **Dr. Jim Thomason**

Deputy Director

Strategy, Forces and Resources Division

Institute for Defense Analyses

571-329-1043 (m) --preferred

703-845-2480 (w)

[jthomaso@ida.org](mailto:jthomaso@ida.org)

[James.Thomason.ffrdc@ida.pentagon.smil.mil](mailto:James.Thomason.ffrdc@ida.pentagon.smil.mil)

## **Ms. Julie Kelly**

Research Staff Member

Strategy, Forces and Resources Division

Institute for Defense Analyses

703-845-6961 (w)

[jkelly@ida.org](mailto:jkelly@ida.org)

[Julie.Kelly.ffrdc@ida.pentagon.smil.mil](mailto:Julie.Kelly.ffrdc@ida.pentagon.smil.mil)



REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188		
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. <b>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</b>					
1. REPORT DATE (DD-MM-YY) XX-05-2022		2. REPORT TYPE Final		3. DATES COVERED (From - To)	
4. TITLE AND SUBTITLE  The Risk Assessment and Mitigation Framework for Strategic Materials (RAMF-SM)			5a. CONTRACT NO. HQ0034-14-D-0001		
			5b. GRANT NO.		
			5c. PROGRAM ELEMENT NO(S).		
6. AUTHOR(S)  Julie C. Kelly James S. Thomason			5d. PROJECT NO.		
			5e. TASK NO. DE-6-4333		
			5f. WORK UNIT NO.		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Institute for Defense Analyses 730 East Glebe Road Alexandria, Virginia 22301			8. PERFORMING ORGANIZATION REPORT NO. IDA Document NS D-33112 IDA Log H 22-000224		
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Defense Logistics Agency, Office of Strategic Materials 8725 John J. Kingman Rd. Ft. Belvoir, VA 22060			10. SPONSOR'S / MONITOR'S ACRONYM(S) DLA-OSM		
			11. SPONSOR'S / MONITOR'S REPORT NO(S).		
12. DISTRIBUTION / AVAILABILITY STATEMENT  Approved for public release; distribution is unlimited.					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT  The United States maintains a National Defense Stockpile of non-fuel strategic and critical materials. The stockpile is managed by the Department of Defense (DOD). Under Section 14 of the Strategic and Critical Materials Stock Piling Act (50 U.S.C. § 98 et seq.), the Secretary of Defense is required to submit biennial reports to the U.S. Congress concerning what materials the stockpile should contain, and in what amounts. The overarching analytic framework used for this purpose is called RAMF-SM (the Risk Assessment and Mitigation Framework for Strategic Materials). Accredited by DLA and DOD, and developed by the Institute for Defense Analyses, RAMF-SM is used to help determine what stockpiling and other risk mitigation efforts are prudent.					
15. SUBJECT TERMS  critical materials; strategic materials; National Defense Stockpile; material requirements					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT  U	18. NO. OF PAGES  26	19a. NAME OF RESPONSIBLE PERSON David Pineault
a. REPORT U	b. ABSTRACT U	c. THIS PAGE U			19b. TELEPHONE NUMBER (Include Area Code) 571-767-5498

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