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

Julie C. Kelly
James S. Thomason

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Executive Summary

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.
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
• 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 Framework 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
• 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

Government

- **Congress:** Statutory guidance
- **OSD Policy:** Planning scenarios
- **OSD (CAPE):** Industry demands to produce weapons
- **OSD (A&S):** General oversight and supply side guidance
- **OSD/JS/Services/Agencies:** Study materials and weapon usage data
- **DLA SM:** Supply and demand data, judgments
- **OMB/CEA/Treasury:** Costing guidelines, economic forecasts
- **IC:** Country reliability assessments, economic growth rates
- **DoC:** Industry material applications and consumption
- **USGS:** Country material production and capacities
- **DoE, DHS, HHS, DoS, FEMA and others:** Designation of essentiality, shortfall consequences

Private

- **Private Industry:** Supply and demand data
- **SMEs:** Substitution data, scenario risks
- **INFORUM:** Inter-industry I/O models, macroeconomic variables

Source Key
- Red: Legislative Branch
- Blue: DOD
- Green: Executive Branch
- Purple: Private Sector
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
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

If Essential Demands exceed Safe Supply, there is a shortfall

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

Peacetime

Demand

Supply

Essential Demands

Safe Supplies

National Emergency

Fix Homeland Damage

Shortfall

Minus NDS Inventory

Shortage

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

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

<table>
<thead>
<tr>
<th>Type of Weak Link</th>
<th>Mining and Production of RE Ores &amp; Concentrates</th>
<th>Production of RE Carbonates</th>
<th>Production of Separated RE Oxides (Sm and Gd)</th>
<th>Production of RE Metals (Sm and Gd)</th>
<th>Production of Sintered SmCo Alloy</th>
<th>Production of Sintered SmCo Magnet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production capability exists in the U.S.</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

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*

- 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
- 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

*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.
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** –
  1. (a) Estimate available supplies of the study materials
  2. (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
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
Julie.Kelly.ffrdc@ida.pentagon.smil.mil
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.
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