IDA | Research Summary

RAMF-SM Assesses Risk to Rare Earth Magnet Supply Chain

The Defense Logistics Agency's Office of Strategic Materials asked IDA to conduct a comprehensive rare earth permanent magnet (REPM) supply chain assessment in support of the National Defense Stockpile Program's 2017 Biennial Report to Congress on Stockpiling Requirements. IDA's assessment—which includes a study of REPM technologies, an investigation of the REPM global supply chain, an analysis of current and predicted REPM demands and supplies, and an in-depth study of Department of Defense (DoD) usage of REPMs in critical defense systems—builds upon decades of analytical assessments of rare earths and other strategic and critical materials, and provides a comprehensive qualitative and quantitative analysis of the macroeconomic, military, and strategic dependence of the United States on the REPM global industry.

The assessment leveraged IDA's Risk Assessment and Mitigation Framework for Strategic Materials (RAMF-SM)—a comprehensive analytical framework DoD uses to identify strategic and critical materials, assess strategic U.S. vulnerabilities related to those materials, and determine optimal mitigation approaches—inclusive of stockpiling—to address those vulnerabilities. The RAMF-SM process, which includes extensive use of modeling and simulation tools, rigorously combines heterogeneous information on economics, policy, uncertainty, intelligence, defense planning scenarios, military operations, and technology to generate quantitative assessments of risk to guide decisions by the U.S. Government on strategic and critical materials stockpiling. RAMF-SM comprises both macro-scale and detailed case study methodologies, which were exercised in the assessment's two-part approach.

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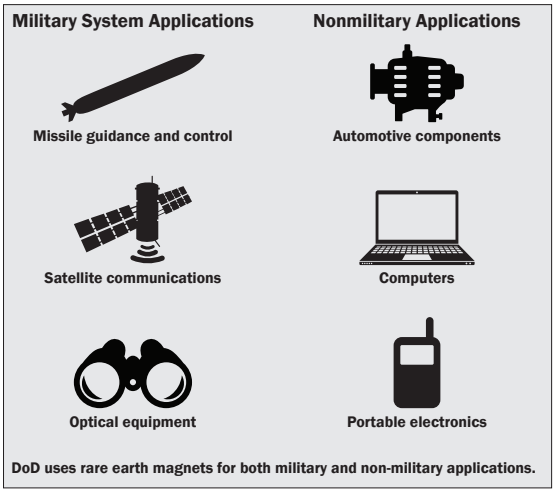
REPMs are a type of permanent magnet with exceptional performance characteristics that are dependent on rare earth content. Two main types of REPMs exist: neodymium-iron-boron (NdFeB) and samarium-cobalt (SmCo). The assessment includes estimates of projected REPM shortfalls under emergency scenario conditions; the first time that the NDS Program has conducted these analyses using both (1) a macro-assessment approach, and (2) a deep-dive approach. These approaches contribute to a comprehensive understanding of REPM supply chain vulnerabilities and have assisted DoD with identifying effective mitigation options to reduce these risks.



IDA's assessment found that DoD is highly dependent on REPMs in military systems. NdFeB and SmCo magnets are used extensively in U.S. military systems, including for missile guidance and control, laser detection, optical equipment, disk drive motors, and satellite communications. In addition, REPMs are used in many non-military applications by DoD, including computers, portable electronics, industrial motors, and automotive components. A shortage of REPMs would cause significant delays in replacing DoD military systems, as well as significant loss of system performance. It would also negatively affect the broader U.S. industrial base upon which DoD depends.

Furthermore, significant risk exists at multiple steps in the REPM manufacturing supply chain. The United States has limited capabilities with respect to critical production inputs (i.e., upstream and intermediate materials, including separated compounds, metals, and alloys) required for the production of sintered NdFeB or SmCo magnets used in DoD systems. The United States is highly reliant on foreign suppliers for finished magnets. For SmCo magnets, the U.S. relies on foreign countries for critical upstream steps of production—and while it has domestic capabilities for the later SmCo magnet production stages—it has limited capacity compared to foreign producers. For NdFeB magnets, analyses found that the U.S. has no commercial scale production of these magnets for defense systems, and it is heavily reliant on foreign sources of upstream materials. Significant supply chain risk for REPMs exists primarily at upstream production steps, including production of the required rare earth concentrates and compounds. Particular risk exists at the stage of rare earth element sepraration (production of concentrates and compounds) because few suppliers outside of China possess the required capability, and these suppliers are often limited by their ability to make feedstock changes.

Using RAMF-SM, IDA updated assessments of REPMs in support of the National Defense Stockpile Program's 2019 and 2021 Biennial Report to Congress on Stockpiling Requirements. In addition, RAMF-SM capabilities and research results have been applied to numerous other U.S. Government initiatives. These include assessments for the Office of the Secretary of Defense, reports to Congress, and contributions to three White House Executive Orders (Executive Order 13806, *Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States*; Executive Order 13817, *A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals*; and Executive Order 14017, *America's Supply Chains*).

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