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Supply Chain Resiliency Study for New Nuclear Deployment

Executive Summary

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Revision Table

Revision	Description of Changes	Date Modified	Responsible Person

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Executive Summary

Supply Chain Readiness Is a Deployment Risk

The United States has set an ambitious objective to expand U.S. nuclear generating capacity from approximately 100 GWe today to 400 GWe by 2050, while strengthening the nation's industrial base and securing critical supply chains. Achieving this goal will require rapid ramp-up to large-scale deployment of a diverse fleet of large light-water reactors (LLWRs) and emerging reactor technologies, including reactors of multiple designs, sizes, and coolant technologies.

This report finds that nuclear supply chain readiness could become a significant constraint on achieving large-scale nuclear deployment unless manufacturing capacity, supplier capabilities, and supporting infrastructure expand sufficiently in advance of need and in parallel with reactor deployment. Across all deployment scenarios evaluated, demand for essential components, balance-of-plant equipment, critical materials, specialized services, logistics infrastructure, qualification programs, and skilled labor increases substantially.

Across a range of deployment scenarios, supply chain readiness will be critical to achieving national deployment goals and completing projects at scale. Success will depend not only on reactor design readiness, licensing, financing, and project management, but also on the ability to deliver qualified components, materials, manufacturing capacity, and specialized services at the required volume, pace, and reliability across multiple concurrent projects while continuing to support the operating reactor fleet.

Key Findings

The central conclusion of this report is that while the existing industrial base presents manageable risks for near-term early deployments, supply chain readiness is a core risk for new nuclear generation to achieve large-scale deployment rates. Specifically, the following systemic challenges will shape the ability of the nuclear supply chain to support the ramp up to deployment at scale:

- **Significant industrial expansion will be required under all modeled new nuclear deployment pathways.** While different reactor technology choices change the mix and quantity of components, materials, and suppliers that most stress the supply chain, no pathway to 400 GW succeeds without expanding manufacturing capacity, supplier capability, qualification infrastructure, logistics readiness, and skilled labor well in advance of deployment at scale.

- **Primary constraints are systemic rather than isolated.** Supply vulnerabilities exist across multiple essential items, supplier tiers, reactor technologies, and shared industrial markets. Potential constraints include long lead times, limited qualified manufacturing capacity, supplier financial resilience, certification and qualification barriers, transportation and logistics constraints, and limited visibility into upstream suppliers. Several critical components and materials remain heavily dependent on or geographically concentrated in foreign suppliers, creating exposure to export restrictions, trade disruptions, logistics constraints, and geopolitical risks.

- **Suppliers are unlikely to expand capacity based on deployment aspirations alone.** For long-lead components and specialized manufacturing capabilities, credible demand signals, such as

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multi-unit procurement visibility, framework agreements, capacity reservations, or other capital-backed commitments and guarantees, will be needed to support supplier investment.

- **Proactive action is needed to expand industrial capacity before demand fully materializes**. Near-term projects can manage long-lead requirements through early procurement, qualification, supplier engagement, and logistics planning. However, waiting until projects reach the final procurement stage will be too late for long-lead components, nuclear qualification, manufacturing expansion, and logistics planning. Proactive capacity planning and incentives that support supply-side readiness are therefore needed to justify new supplier investment.

- **Technology diversity creates both resilience and complexity.** A diverse nuclear fleet of LLWRs and small modular reactors (SMRs) of various technologies can reduce dependence on a single design pathway, but it also requires suppliers to support multiple specifications, materials, manufacturing processes, and qualification regimes. Design-specific requirements can fragment demand across multiple suppliers and qualification pathways, limiting the ability of the industrial base to scale efficiently. Expanded deployment of smaller reactors also increases the number of components required to reach the same overall generating capacity. Smaller component sizes may also broaden the potential supplier base, but that advantage may be offset by technology-specific designs, advanced materials, operating conditions, and qualification requirements.

- **Balance-of-plant and specialized input materials can also become critical-path constraints.** Deployment risk is not limited to reactor-specific components. Shared industrial equipment (e.g., power transformers, turbine generator sets) faces competing demand from grid, power-generation, and industrial markets. In parallel, specialized input materials may create technology-specific constraints where they depend on limited production routes, specialized purification or handling, qualification requirements, concentrated foreign supply, or limited upstream visibility. The severity of these constraints will depend in part on the mix of reactor technologies deployed.

- **Competition with other industries will intensify pressure on shared capacity but may present opportunities to expand the supply base.** Many bottlenecks will be shared with supply chains for grid expansion, data centers, electrification, aerospace, defense, liquefied natural gas (LNG), petrochemicals, and semiconductor supply chains. Though future nuclear deployment will compete with these other sectors, the cross-sector demand can help justify and drive a greater expansion of shared industrial capacity.

- **Adjacent-industry suppliers represent a major opportunity to broaden and strengthen the nuclear supplier base.** A larger population of potential suppliers outside the current nuclear supply base exists in adjacent sectors that may be capable of supporting increased capacity in one or more essential items. Realizing this opportunity will require targeted supplier outreach, qualification program support, credible demand signals, and incentives for expansion and investment.

- **Qualification and certification requirements can constrain entry by new suppliers.** Nuclear quality and certification programs can require significant investments of time, capital, specialized personnel, documentation systems, and regulatory oversight. These requirements

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can discourage otherwise capable manufacturers in adjacent industries from entering the nuclear market while not negatively impacting safety or quality.

- **Compliance risk warrants continued supplier oversight and due diligence.** Reported compliance issues were identified among many evaluated Tier 1 suppliers (suppliers of the delivered product), including environmental, antitrust, and self-reported NRC findings. These findings do not necessarily indicate that a supplier is unsuitable for nuclear work, but they do signal where enhanced due diligence, contractual controls, corrective-action review, or ongoing monitoring may be warranted.

- **Limited upstream supplier visibility can mask hidden risks.** Risks may emerge below the Tier 1 level, particularly among suppliers of specialized materials, subcomponents, equipment, and services. Limited visibility into Tier 2 and Tier 3 suppliers (suppliers that produce components or subcomponents that go into the delivered product) can make it difficult to identify hidden bottlenecks, financial or compliance concerns, geopolitical exposure, or quality risks before they affect procurement or construction. This risk is particularly important for input materials where upstream suppliers may include mining, refining, processing, equipment, and chemical suppliers that are not visible from Tier 1 supplier relationships alone, as well as where alternative suppliers are limited.

Mitigation Framework

The Key Findings above describe how the identified supply chain risks could affect deployment at scale. The vulnerabilities and risks identified in this report are addressable, but they require early, sustained, and coordinated action by industry, government, and regulators. Because risks across the individual essential items are interconnected and can compound one another, the analysis synthesizes them into seven overarching supply chain risk themes, as shown in Figure E.1, rather than addressing each vulnerability in isolation. The report then organizes potential responses to these risk themes into four cross-cutting mitigation pillars, each of which addresses multiple risk themes. Together, these pillars should guide efforts to strengthen nuclear supply chain readiness:

1. **Expand and diversify the supplier ecosystem**. Strengthen domestic and trusted global supplier options by developing upstream and adjacent industry suppliers, building long-term supplier relationships, and qualifying alternative sources.

2. **Scale manufacturing capacity**. Evaluate constrained essential items by investing in U.S. manufacturing infrastructure, improving long-lead procurement planning, and providing credible demand signals capable of supporting private investment.

3. **Reduce barriers for supplier entry**. Reduce the time, cost, and complexity for capable suppliers to enter the nuclear market by enabling appropriate use of commercial quality standards, commercial grade dedication, and risk-informed qualification pathways while maintaining nuclear safety and quality requirements.

4. **Strengthen supply chain intelligence**. Improve Tier 2 and Tier 3 supplier mapping, supplier risk monitoring, financial and compliance screening, and ongoing due diligence.

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Workforce availability is a cross-cutting enabler of these mitigation actions, particularly for machining, welding, forging, nondestructive examination (NDE), quality assurance, digital manufacturing, and project logistics. A detailed workforce assessment is outside the scope of this report, but workforce limitations without early action may constrain the pace at which supply chain capacity can expand.

Any industry collaborations contemplated by these mitigation strategies should be structured to comply with applicable antitrust and competition laws. Shared forecasting, supplier mapping, or risk-intelligence efforts should use appropriate safeguards, such as aggregation, anonymization, independent third-party administration, and exclusion of competitively sensitive pricing, bid, cost, supplier-selection, or customer-allocation information.

Figure E.1 shows primary alignment between the seven risk themes and four mitigation priorities; however, it is not intended to rank the relative importance of each action. Each priority addresses one or more risk themes, and several risks require action across multiple priorities.

Implementing the four mitigation priorities will require actions by industry, government, and regulators, with each playing a distinct but complementary role. Industry can strengthen supplier relationships, invest in manufacturing capacity, and improve visibility into upstream supply chains. Government can support these efforts through targeted financial incentives, manufacturing development programs, and policies that facilitate access to domestic and trusted global suppliers. Regulators can help reduce unnecessary barriers to supplier participation by streamlining qualification approaches, advancing commercial quality standards, and encouraging legally appropriate knowledge and data sharing frameworks.

Figure E.2 summarizes the primary role of each stakeholder group across the four mitigation pillars. It is intended as an organizing framework rather than an exhaustive list of actions or an assignment of exclusive responsibility.

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Figure E.1: Impact of Mitigation Actions on Identified Risk Themes

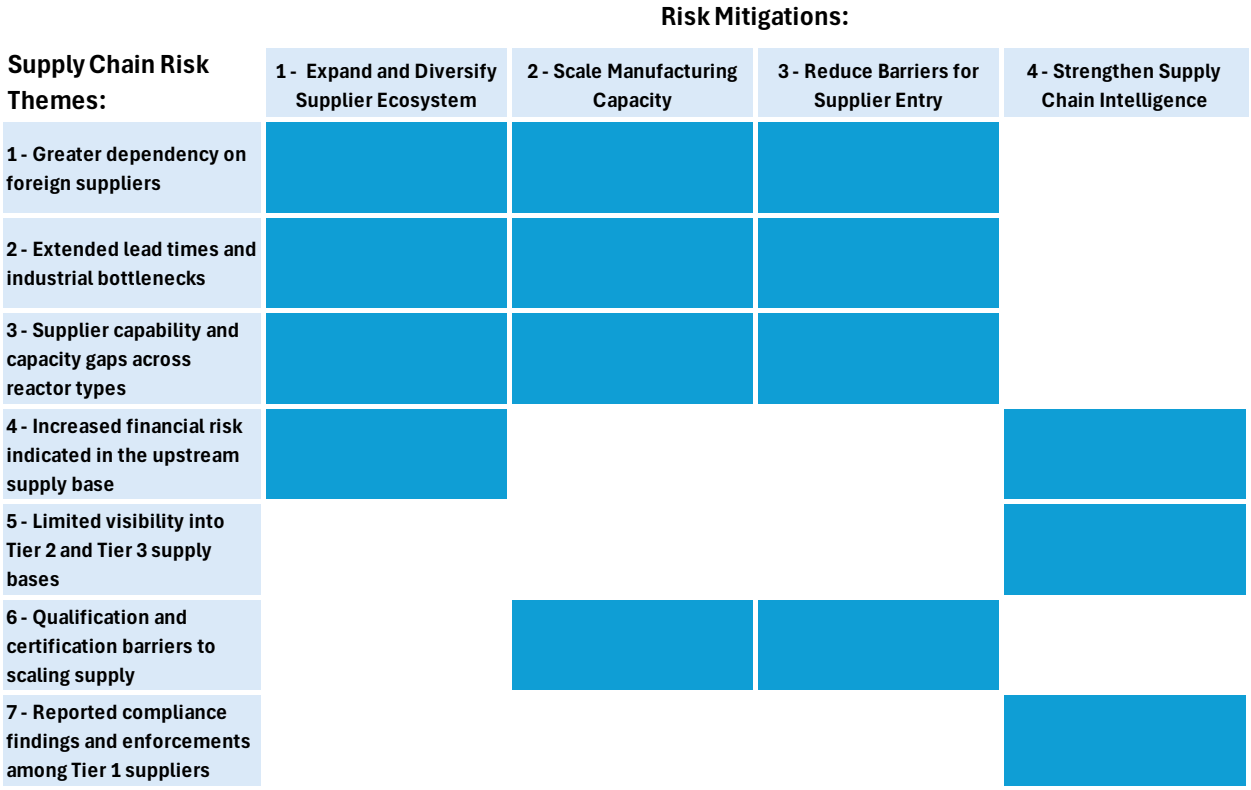


Figure E.2: Roles for Key Nuclear Stakeholders Across Mitigation Pillars

	1 - Expand and Diversify Supplier Ecosystem	2 - Scale Manufacturing Capacity	3 - Reduce Barriers for Supplier Entry	4 - Strengthen Supply Chain Intelligence
Industry Role	Diversify and develop the supplier base, strengthen supplier relationships, and qualify scalable manufacturing methods.	Invest in demand and supply planning capabilities, assess supplier capacity, provide project-specific demand signals, and use early-procurement and inventory strategies	Structure procurement and supplier outreach to broaden participation by capable suppliers	Assess and monitor supplier risks, improve Tier 2/Tier 3 visibility, and strengthen supplier-risk management tools
Government Role	Shape policy, incentives, and enabling capabilities to support domestic and trusted-allied supplier development	Support manufacturing investment, workforce development, critical industrial capabilities, and enabling trade and cost-relief tools	Reduce financial and market-entry barriers through targeted federal, state, and local programs	Improve visibility into future demand and encourage project-level mechanisms that provide suppliers with credible investment signals
Regulator Role	Enable portability and continuity of supplier certifications and qualifications across projects	Modernize codes, standards, and procurement frameworks to support timely manufacturing investment and long-lead procurement	Enable efficient commercial-quality and risk-informed supplier qualification pathways	Clarify consistent, risk-informed qualification, documentation, digital-qualification, and supplier-oversight expectations

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Conclusion

Nuclear supply chain readiness could become a limiting factor on the rate of large-scale deployment of nuclear power generation if capacity expansion and supply chain development do not occur in advance of clear order book demand and in parallel with reactor deployment plans. Achieving 400 GWe of nuclear generating capacity by 2050 will require a nuclear supplier base capable of producing, qualifying, transporting, and sustaining essential components, materials, and services at scale.

Without early action to expand qualified supplier capacity, improve supply chain visibility, reduce unnecessary entry barriers, strengthen logistics and workforce capabilities, and provide credible demand signals, deployment demand will outpace the ability of the supply chain to deliver. Addressing these challenges would do more than support nuclear deployment. It would strengthen U.S. industrial capacity, enhance energy security and economic competitiveness, broaden opportunities for domestic manufacturers, and position the United States to sustain a new era of nuclear energy growth.

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