

# INTEGRATED SUTAINMENT STRATEGY THROUGH A UNIFIED ACCELERATOR SYSTEMS DEFINITON\*

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## *Abstract*

The sustained reliability and availability of the LANSCE accelerator depend on a clearly defined and integrated “systems” framework. This foundation links five core sustainment strategies: Asset Management, Risk Management, Conduct of Engineering, Training & Qualification, and Data Collection & Analysis. Unifying these under a common structure enables consistent decision-making, coordinated resource use, prioritized maintenance, and system-level performance tracking. It breaks down silos, improves efficiency, and supports targeted workforce development while reinforcing clarity in roles, responsibilities, authority, and accountability. Realizing this vision requires deliberate planning, early stakeholder engagement, and a robust change management strategy to navigate organizational and cultural shifts. This unified framework bridges short-term needs with long-term goals, positioning LANSCE to sustain mission-critical operations through 2050 and beyond. The paper explores this integrated approach as a scalable model for other aging accelerator facilities seeking sustainment without compromising mission continuity.

## INTRODUCTION

The Los Alamos Neutron Science Center (LANSCE) is a national user facility supporting materials science, nuclear science, isotope production, and national security missions. Commissioned over 50 years ago, it now operates as a mature accelerator facility where aging infrastructure, evolving mission needs, and constrained resources create growing sustainment challenges [1, 2].

Historically LANSCE has implemented accelerator sustainment through partially independent efforts. Equipment assessments, risk management, workforce qualification, and engineering governance often evolved in response to specific institutional, operational, or funding drivers. While effective within their respective domains, these programs have become organizationally siloed, limiting system-level optimization and obscuring interdependencies between equipment condition, operational risk, engineering rigor, configuration management, and workforce capability, among other things [3].

To address these challenges, LANSCE has initiated the development of a Unified Accelerator Systems Definition

(UASD) that was born out of an asset management program initiative. The UASD establishes a structured, accelerator-wide (asset) hierarchy that clearly defines how the accelerator is organized by systems and subsystems. It allows the identification of systems required within each geographic area and therefore clarifies how they collectively support overall accelerator function for an area (e.g. H-Minus Injector). The current level of detail represents a foundational framework, intended to evolve into a more comprehensive and refined structure over time.

At present, the UASD is primarily accelerator (programmatic) centric. However, long-term plans strive ideally for the integration of conventional facility systems—such as facility power, facility chilled water, and other infrastructure, to ensure a fully unified sustainment model.

In plain terms, the UASD shall serve as a common blueprint for understanding the accelerator—not as a collection of individual equipment records, but as an interconnected, mission-driven system.

As for now the UASD:

- Defines the accelerator by systems and subsystems down to the component level
- Clarifies boundaries between systems
- Provides a consistent structure for asset management, risk assessment, engineering standards, training, and data analysis
- Establishes clear roles, responsibilities, authority, and accountability aligned to that structure

Instead of having asset databases, risk models, maintenance plans, and training programs operating in parallel, a UASD creates a single structural backbone that all sustainment functions reference.

The result is:

- Better system-level decision-making
- Risk-informed prioritization
- Consistent engineering rigor
- Clearer workforce alignment
- Improved long-term reliability and availability

For a mature facility like LANSCE, a UASD shifts the focus from managing equipment to managing mission-critical systems over decades, enabling sustainment through 2050 and beyond.

## MOTIVATION FOR UNIFIED SYSTEM FRAMEWORK

### *Aging Infrastructure and Mission Expansion*

LANSCE’s infrastructure includes legacy systems operating alongside modern upgrades. Components may exceed their original design lifetimes, replacement parts may

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be scarce, and in the best-case documentation may reflect decades of incremental modification. At the same time, user demands and mission complexity continue to increase.

In this environment, reactive maintenance and fragmented upgrades are no longer sufficient. Sustainment must be proactive, risk-informed, and strategically aligned across multiple time horizons, ranging from near-term operational demands to multi-year investment planning.

### *Fragmented Sustainment Mechanisms*

Common challenges in mature facilities include:

- Asset data distributed across multiple, unintegrated systems
- Risk assessments that are not directly tied to maintenance prioritization or investment planning
- Inconsistent application of engineering rigor across subsystems of comparable mission importance
- Training and qualification programs not aligned with mission-critical systems or not yet established.
- Limited feedback loops connecting operational performance, maintenance efforts & needs, and long-term strategic planning

Without a unified systems definition, decisions tend to focus on local subsystem issues instead of overall accelerator performance, reliability, and mission goals.

The UASD resolves this gap by establishing a common structural backbone to which all sustainment functions are anchored. This shared framework enables alignment across disciplines, promotes system-level visibility, and ensures that operational, engineering, and strategic decisions reinforce overall accelerator performance rather than compete for localized gains.

## **UNIFIED ACCELERATOR SYSTEMS DEFINITION**

### *System Architecture as the Foundation*

The UASD begins with a formalized, hierarchical decomposition of the accelerator into systems, subsystems, and components aligned with functional boundaries. This structure:

- Defines clear ownership at each system level
- Establishes standardized naming conventions
- Maps assets, documentation, and performance metrics to system elements
- Serves as the reference architecture for sustainment processes

This system definition becomes the authoritative framework connecting technical configuration to operational accountability.

### *Integration of Core Sustainment Strategies*

#### **Asset Management**

All physical assets are mapped directly to the system architecture. This enables:

- Lifecycle tracking by functional system
- Maintenance prioritization based on system criticality
- Consolidated condition monitoring
- Budget planning aligned with system-level performance goals

Rather than viewing equipment as isolated records, the UASD connects each component to the function it serves in keeping the accelerator running.

#### **Risk Management**

Risk identification and mitigation are structured according to the same system hierarchy. This alignment provides:

- Transparent linkage between component condition and mission impact
- Risk roll-up from component to system level
- Prioritization of mitigation actions based on functional criticality

By integrating risk and asset data, leadership can make informed trade-offs between near-term repairs, mid-term replacements, and long-term modernization efforts.

#### **Conduct of Engineering**

Engineering governance including configuration control, design standards, and modification approval is mapped to defined system ownership. This ensures:

- Clear authority for technical decisions
- Clear responsibility for system reporting
- Improved configuration management across legacy and upgraded systems

The unified structure reinforces accountability and reduces ambiguity in engineering responsibility.

#### **Training and Qualification**

Workforce capability is directly tied to system ownership and functional responsibility. This ensures:

- Qualification requirements are derived from system documentation and criticality
- Training programs are aligned with technical risk profiles
- Succession planning reflects system sustainment priorities

This approach supports targeted workforce development rather than generalized training models.

#### **Data Collection and Analysis**

Operational data, maintenance history, failure trends, and performance metrics are aggregated and analyzed within the system framework. Benefits include:

- System-level performance dashboards
- Predictive maintenance analytics
- Data-informed labor and material need planning
- Early identification of reliability degradation

Data integration transforms sustainment from reactive response to predictive strategy.

## IMPLEMENTATION STRATEGY

### *Phased Deployment*

Recognizing the complexity of organizational change, implementation follows a phased approach:

1. **System Definition and Validation** – Establish authoritative system boundaries and ownership.
2. **Data Alignment** – Map existing asset, risk, and maintenance data to the unified framework.
3. **Process Integration** – Develop/update procedures/system documentation and governance models to reference system structure.
4. **Performance Metrics Development** – Define system-level reliability and availability indicators and means to collect the necessary data.
5. **Continuous Improvement** – Refine structure and processes based on operational feedback.

Recognizing the scope and time required for these changes, an incremental approach minimizes disruption to ongoing mission operations.

### *Stakeholder Engagement*

Successful integration requires early and sustained involvement from:

- Engineering and maintenance organizations
- Operations personnel
- Experimental end station users
- Funding agencies

On the engineering, maintenance, and operations side, workshops should be used to refine the UASD, define system boundaries, and clarify roles, responsibilities, authority, and accountability.

### *Change Management*

In a mature facility like LANSCE, cultural adaptation is as critical as technical implementation. Key elements include:

- Communication of long-term sustainment goals
- Engagement of those affected by the change
- Transparent definition of decision rights
- Leadership alignment across organizations
- Training on new processes and tools

The objective is not just structural change, but lasting behavioral alignment supported by consistent reinforcement and accountability.

## PERFORMANCE IMPACT AND STRATEGIC BENEFITS

### *Improved Decision-Making*

With unified system mapping, leadership can:

- Quantify trade-offs between capital investment and operational risk
- Prioritize maintenance based on mission impact
- Align annual work planning with long-term sustainment strategy

This consistency reduces competing priorities and increases transparency.

### *Resource Optimization*

Integrated visibility across systems enables:

- Coordinated accelerator outage planning
- Efficient allocation of engineering resources
- Reduced duplication of effort
- Improved inventory management

Breaking down organizational silos and taking a holistic view improves overall sustainment efficiency.

### *Enhanced Reliability and Availability*

By aligning asset condition, risk assessment, and workforce qualification, the accelerator facility moves toward:

- Reduced unplanned downtime
- Improved mean time between failures
- Better predictability of system performance

Over time, this strengthens mission assurance and user confidence through reliable delivery of required capabilities and beam availability.

### *Long-Term Strategic Alignment*

Perhaps most importantly, the UASD bridges daily operational execution with decade planning horizons. It provides a structured mechanism to:

- Support modernization roadmaps
- Justify capital investment with data
- Sustain institutional knowledge
- Prepare for generational workforce transitions

The framework positions LANSCE for reliable operations through 2050 and beyond.

## SCALABILITY TO OTHER FACILITIES

Many accelerator facilities worldwide face similar challenges: aging infrastructure, constrained funding, and expanding mission requirements. The Unified Accelerator Systems Definition offers a scalable model because it:

- Does not require organizational restructuring
- Builds upon existing sustainment programs
- Emphasizes integration rather than replacement
- Is adaptable to varying facility sizes and governance models

By anchoring sustainment strategies to a common systems backbone, facilities can enhance reliability without interrupting mission continuity.

## CONCLUSION

Sustaining a mature accelerator facility demands more than incremental maintenance improvements; it requires structural integration of technical, organizational, and strategic functions. The Unified Accelerator Systems Definition at LANSCE establishes a common framework linking Asset Management, Risk Management, Conduct of Engineering, Training and Qualification, and Data Collection and Analysis.

This integration enhances decision-making, clarifies accountability, optimizes resource use, and strengthens beam availability and reliability. Equally important, it bridges near-term operational demands with long-term mission

objectives. As accelerator facilities worldwide confront aging infrastructure and evolving missions, a unified systems-based sustainment model provides a practical and scalable pathway to ensure continued scientific and national mission success.

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