Sandia National Laboratories

FACILITIES

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Asset Management: Beyond 2020

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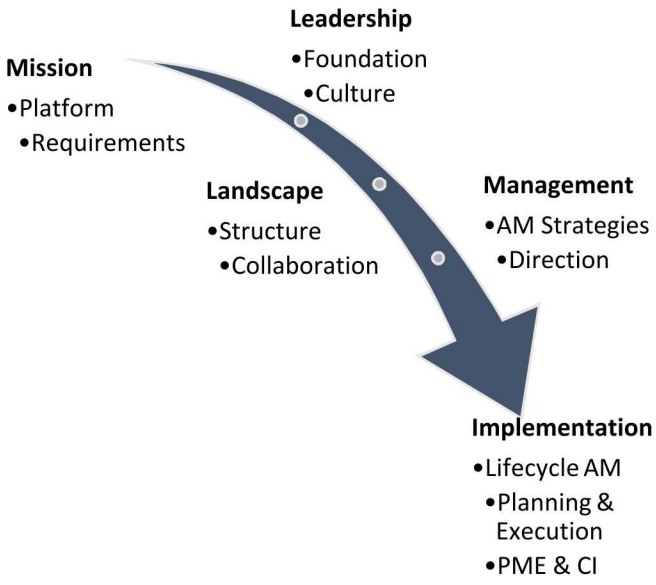

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1.0 Asset Management: Beyond 2020

1.1 Executive Summary

This Asset Management Beyond 2020 document provides: (1) an introduction to asset management (AM) and an asset management system (AMS), along with insights to next steps, (2) an overview of the International Standards Organization (ISO) 55000 series documents, (3) an overview of the ISO 55001 gap analysis of Center 4700/4800 ("Facilities") organizations at Sandia National Laboratories, hereafter referred to as Sandia, with observations, gaps, and gap closure recommendations, and (4) an asset management architecture (AMA) recommendation aligned with the ISO 55001.

The AMS and the AM are different but related. ISO 55000 cites AMS as "a management system for AM" to "direct, coordinate, and control AM activities." ISO 55000 cites AM as translating "the organizational objectives into technical and financial decisions, plans and activities."[1] Essentially, the AMS begins with all levels of leadership to enable a structured and consistent approach to AM culminating in lifecycle asset management excellence.

Why is AM important at Sandia? Sandia is entrusted with the stewardship of nearly 700,000 real property-related assets (i.e., building components like air handling units, transformers, carpeting, etc.), with a replacement value of more than $22.5 billion. This is exclusive of nearly all programmatic-related real and personal property assets. Assuring our partners and taxpayers that the value of these assets is maximized to ensure the success of Sandia's mission is a requisite that is both resource-intensive and challenging. The importance of AM and the mandates related to it are embedded in federal executive orders, Department of Energy (DOE) and National Nuclear Security Administration (NNSA) agency directives, supplemental directives, guidance, and planning documents. Subsequently, the requirement for AM is rightfully embedded in the Sandia Prime Contract.

Is AM being performed today? Yes, but there is growing interest in developing a structured and disciplined approach to AM that promotes cross-functional collaboration and that can be implemented consistently to arrive at the same common corporate AM goals and objectives. AM implies a formalized structured approach implemented to manage assets through their entire lifecycle. Today, assets are being managed. However, a documented approach that integrates AM functions within Facilities that are involved in the entire asset lifecycle does not exist. In addition to this interest, the fact that AM executive sponsorship is necessary and essential to ensure a successful common approach to AM is being increasingly recognized. AM executive sponsorship will demonstrate that AM is an important cornerstone in providing a stable and secure platform to accomplish its national security mission. Moreover, executive sponsorship will signify the importance of AM and begins a path to a sustainable AM culture of excellence.

Does an AMS exist at Sandia? Although the term itself is not common vocabulary within Sandia, an AMS does exist and continues to be developed. However, challenges remain relative to a structured and consistent approach to the implementation of AM activities. An example is the manner in which asset information is monitored and reported. The monitoring and reporting structures are not consistent. Information is managed with varying degrees of maturity and through various reporting structures. Moreover, institutional knowledge of asset information resides with the subject matter experts (SME) and is not readily available, much less captured in any asset management information system.

What is the status of AM and the AMS at Sandia? Although there are AM working groups internal to Sandia to promote knowledge sharing related to AM activities—along with an AM joint working group

[1] International Standards Organization ISO 55000:2014 (E) Section 2.4 – Overview of an Asset Management, 2.4.2(b)

promoting AM collaboration across NNSA sites—there are no efforts comparing Sandia's AMS to industry best practices. Therefore, while knowledge sharing and collaboration are essential from a lessons-learned perspective, improving AM is difficult without knowing the AMS current state or having a vision for AM.

With all these considerations taken into account, where should Sandia begin in implementing a successful AMS program? A gap analysis provides an understanding of an organization's AMS current state and identifies opportunities for improvement in developing an AMS end state. With AM planning for physical real property assets being performed in Center 4800, Group 4850 conducted a gap analysis to ascertain the alignment of the current state of Facilities' AMS to the AMS requirements outlined in the ISO 55001 Asset Management. The results of the gap analysis are reflected Table 1: ISO 55001 Alignment Ratings and Results Summary and is discussed in detail in Section 5. Alignment rating definitions can be found in Table 5: ISO 55001 Alignment Ratings and Definitions. The alignment ratings in Table 1 are not meant to demonstrate that Sandia does not have an AMS or that AM is not being performed. Rather, the understanding should be that AMS improvements are necessary to continue aligning with ISO 55001.

Table 1: ISO 55001 Alignment Ratings and Results Summary

ISO 55001 Description	Alignment
ISO 55001 (overall)	Lagging
ISO 55001 Section 4 – Context	*Lagging – immediate attention **NOT** required
ISO 55001 Section 5 – Leadership	**Lagging – immediate attention is required
ISO 55001 Section 6 – Planning	Lagging – immediate attention is required
ISO 55001 Section 7 – Support	Lagging – immediate attention is required
ISO 55001 Section 8 – Operation	Lagging – immediate attention is required
ISO 55001 Section 9 – Performance Evaluation	Lagging – immediate attention is required
ISO 55001 Section 10 – Improvement	Lagging – immediate attention **NOT** required

* Immediate attention "**NOT**" required is intended to convey that there was evidence of partial alignment with ISO 55001.
** Immediate attention required is intended to convey that that there is very little evidence of alignment with ISO 55001.

2.0 Asset Management System and Asset Management

2.1 Asset Management System and Asset Management– Maximizing the Asset's Value to Meet Business Objectives

The concepts of AMS and AM are simple. Yet, their breadth of cross-cutting functional integration and required resources—coupled with the timeframe to implement and realize value—are the primary implementation challenges. There are many AMS frameworks founded on philosophies suited specifically for the organizational business need. ISO 55002 guidance indicates that the application of ISO 55001 requirements, as it relates to the AMS, "should be scalable."[2] This provides flexibility in applying the AMS requirements of ISO 55001 to be commensurate with business needs. Ultimately, no "right" framework exists to meet every organizational business need, and the only "wrong" framework is one that does not exist. Regardless of the AMS framework chosen and level of implementation, ***the purpose for an AMS is to provide a structured, disciplined, and consistent approach to AM, giving assurance that the asset's value is maximized and enabling the fulfillment of business objectives and, ultimately, mission success.***

The terms AMS and AM, along with the framework relative to these terms, are related and thus are often used interchangeably. However, as previously mentioned, AMS and AM are different. ISO 55000 cites

[2] International Standard ISO 55002:2014 (E), Subsection 4.1.1.3

AMS as "used to refer to a management system for AM."[3] "An AMS is used to direct, coordinate, and control AM activities."[4] Adding some context, ISO 55000 cites an AMS "as a set of tools, including policies, plans, business processes and information systems, which are integrated to give assurance that expected outcomes of AM activities will be delivered."[5] Therefore, think of the AMS as toolbox with all the "right" tools needed to enable AM, a process, to yield a desired output. ISO 55000 cites AM as translating "the organizational objectives into technical and financial decisions, plans and activities."[6] Think of AM as the overarching process where AM subprocesses are working cohesively to realize the desired output (maximizing the asset's value). Therefore, an AMS whose role is defined in a Strategic Asset Management Plan (SAMP), coupled with AM, provides reasonable assurance that assets will fulfill their intended purpose to meet AM objectives. The SAMP should include "structures, roles and responsibilities necessary to establish the AMS and to operate it effectively."[7] Hence, the AMS enables AM to yield asset value and collectively enable mission success. Figure 1: AMS and AM in Perspective provides a visual representation of how the AMS enables the AM process to yield asset value.

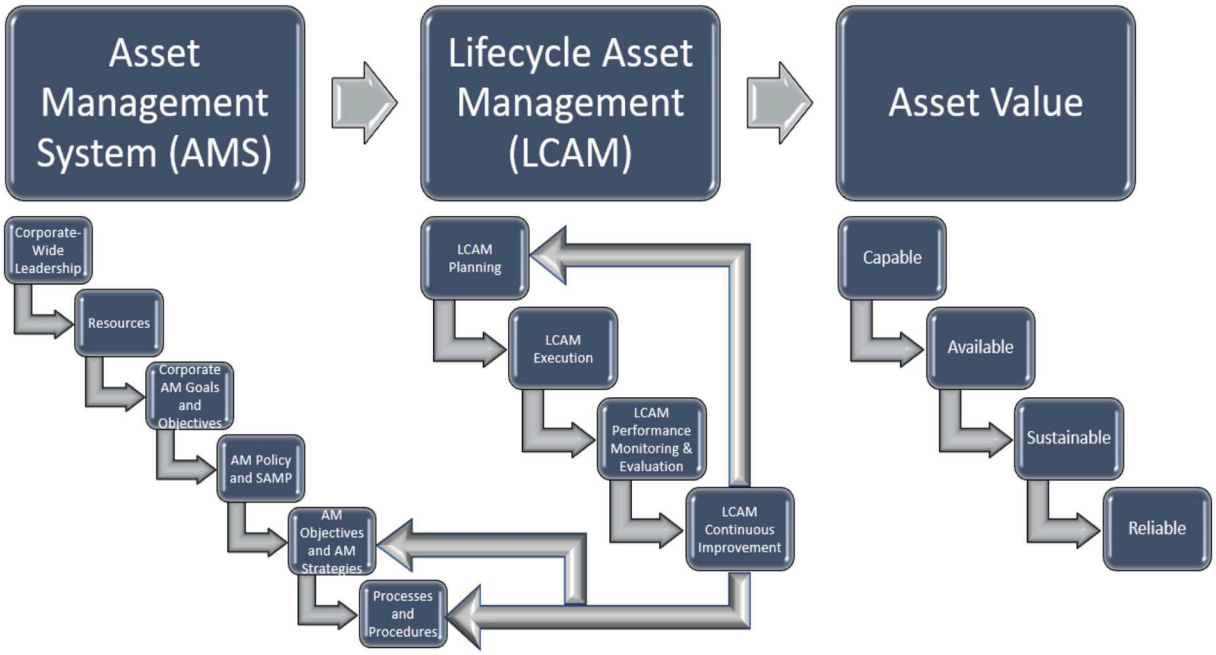

Figure 1: AMS and AM in Perspective

[3] International Standard ISO 55000:2014 (E), Asset Management – Overview, principles and terminology, Section 1, Note 3
[4] International Standards Organization ISO 55000:2014 (E) Section 2.4 – Overview of an Asset Management, 2.4.3
[5] International Standards Organization ISO 55000:2014 (E) Asset Management – Overview, principles and terminology, Section 2.5.1
[6] International Standards Organization ISO 55000:2014 (E) Section 2.4 – Overview of an Asset Management, 2.4.2(b)
[7] International Standards Organization ISO 55000:2014 (E) Section 2.5 – Overview of the Asset Management System 2.5.3.4

2.2 Asset Management System and Asset Management Benefits

ISO 55001 cites the following AM benefits: improved financial performance, informed asset investment decisions, managed risk, improved services and outputs, demonstrated social responsibility, demonstrated compliance, enhanced reputation, improved organization sustainability, and improved efficiency and effectiveness.[8] To place some context to these benefits, AMS and AM collectively provide reasonable assurance that assets are planned and acquired to meet mission requirements, sustained in an effective and efficient manner to meet mission requirements, and eventually dispositioned. Assets that perform to design specifications, perform reliably, are capable and available, are sustainable (maintained, rebuilt, and/or recapitalized), and are dispositioned in a timely manner are indicators of AM success. The intangible benefits are building credibility through customer satisfaction, asset stewardship excellence, fiscal and environmental responsibility, and justifiable data-driven risk-based decisions.

3.0 International Standards Organization Overview

3.1 ISO 55000 – Asset Management Overview, Principles, and Terminology[9]

The ISO 55000 international standard provides an overview of AM and the AMS. It discusses the benefits of AM, outlines AM fundamentals (asset value, alignment with organizational objectives, leadership, and assurance), describes the purpose and elements of an AMS, emphasizes the importance of an integrated approach to AM, and provides definitions to AM terms to form a common language that drives a consistent understanding of AM. ISO 55000 "provides the context for ISO 55001 and ISO 55002."[10]

3.2 ISO 55001 – Asset Management: Management Systems Requirements[11]

ISO 55001 outlines the overarching requirements for the development of an AMS framework. It provides the "what" to be included in the framework, and the requirements are delineated in seven sections as follows: Context, Leadership, Planning, Support, Operation, Performance Evaluation, and Improvement. ISO 55001 neither provides the specifics of how to develop an AMS framework nor does it provide specific direction on AM activities.

3.3 ISO 55002 – Asset Management: Management Systems – Guidelines for the Application of ISO 55001[12]

ISO 55002, as the standard's title implies, provides guidance and considerations to implement each of the seven sections of ISO 55001. It provides context and meaning to the requirements of ISO 55001 that reasonable assurance can be provided, demonstrating that the intent of the requirements is fulfilled. Given

[8] International Standards Organization ISO 55000:2014 (E) Subsection 2.2 – Benefits of Asset Management, 2.2(a) thru (i).
[9] International Standard ISO 55000:2014(E) Standard Title
[10] International Standard ISO 55000:2014(E), Subsection 0.1 – Purpose
[11] International Standard ISO 55001:2014 (E) Standard Title
[12] International Standard ISO 55002:2104(E) – Standard Title

that ISO 55002 provides guidance, it should not be interpreted as being a minimum nor exhaustive set of factors to be considered when implementing ISO 55001.

4.0 Asset Management Architecture Team – Overview

An ISO 55001 gap analysis is the initial step in reviewing the AMS to continually improve and sustain a long-term, structured, disciplined, and consistent approach to AM. To begin the gap analysis effort, an AMA team was formed consisting of managers, strategic planners, an engineer, and operations and engineering leads, each with varying levels of Sandia experience.

4.1 Asset Management Architecture Team

The AMA team was composed of representatives from Sandia National Laboratories-New Mexico (SNL-NM) (Depts. 4700 & 4800) and Sandia National Laboratories-California (SNL-CA) (Dept. 8547). Table 2: Asset Management Architecture Team, identifies the team members and the represented organizations.

Table 2: Asset Management ArchitectureTeam

Site/Department	Name	Title
SNL-NM/4744 – Facilities Mechanical Services	Chris Evans	Manager, Mechanical Services
SNL-NM/4851 – Systems Engineering	Gabriel Martinez	Mechanical Engineer
SNL-NM/4852 – Infrastructure Engineering	Jeremy Michaels	Manager, Infrastructure Engineering
SNL-NM/4853 – Asset Management	Birgitta Foster	Strategic Planner
SNL-NM/4853 – Asset Management	John Zavadil	Strategic Planner
SNL-NM/4853 – Asset Management	Pete Otero	Manager, Asset Management
SNL-NM/4853 – Asset Management	Waylon Clark	Operations & Engineering Lead
SNL-NM/4854 – Strategic Planning	Diane Sholtis	Strategic Planner
SNL-CA/8547 – Partnership & Planning	Jennifer Herrington (ad hoc)	Operations & Engineering Lead

4.2 Asset Management Architecture Team Goals

The AMA team gap analysis goals are to: (1) determine the ISO 55001 alignment rating with the current state of Facilities' AMS, and (2) recommend an AMA that promotes cross-functional AM collaboration with emphasis on a data-driven risk-based approach to AM decision making.[13]

4.3 Asset Management Architecture Team Objectives

The AMA team gap analysis objectives are: (1) to crosswalk ISO 55001 AMS requirements to the current state of Facilities' AMS, as well as identify gaps and gap closure recommendations; and (2) to develop an AMA based on an AMS framework as outlined in the ISO 55000 AM series documents.

[13] NNSA Supplement Directive (SD) 430.1 as incorporated into the SNL Prime Contract requires SNL to implement real property asset management in accordance with industry best practices. ISO 55000 Asset Management – Overview, principles and terminology (2.4.2)(b)(1) re-emphasizes the importance of a data-driven risk-based approach to asset management.

4.4 Asset Management Architecture Team Responsibilities

AMA team members were assigned ISO 55001 sections to lead the gap analysis and provide gap analysis guidance. Table 3: Asset Management Architecture Team ISO 55001 Section Leads, identifies the ISO 55001 section and the respective AMA team member section lead.

Table 3: Asset Management Architecture Team ISO 55001 Section Leads

ISO 55001 Section Description	Team Member Section Lead(s)
Section 4 – Context	Pete Otero
Section 5 – Leadership	Chris
Section 6 – Planning	Diane Sholtis/Gabe Martinez
Section 7 – Support	Jeremy Michales
Section 8 – Operation	John Zavadil
Section 9 – Performance Evaluation	Waylon Clark
Section 10 – Improvement	Birgitta Foster

Within each ISO 55001 section, there are subsections with many cross-cutting-related factors, which made the gap analysis cumbersome. To provide clarity on the approach to the gap analysis, elements were created that best represented the overlapping factors. These elements are listed in Table 4: Asset Management Architecture ISO 55001 Element Leads.

Table 4: Asset Management Architecture (AMA) Team ISO 55001 Element Leads

ISO 55001 Element Description	Team Member Element Lead
Culture	Pete Otero
Continuous Improvement	Birgitta Foster
Integrated Asset Management	Birgitta Foster
Leadership & Commitment	Chris
AMP/LCAMP/SAMP/Org Plan	Diane/Gabe
Risk Management	Diane Sholits/Gabe Martinez
Resources/Roles & Responsibilities	Jeremy Michaels
Data/Process Documentation	John Zavadil
Asset Management Context	John Zavadil
AM & Org Objectives/AM Policy	Pete Otero
AM Performance Monitoring & Evaluation	Waylon Clark
Asset Scope/Portfolio Requirements	Waylon Clark

5.0 Asset Management: Beyond 2020 - Closing the ISO 55001 Gap

5.1 ISO 55001 Gap Analysis

The ISO 55001 gap analysis leveraged the Institute of Asset Management (IAM) assessment methodology to determine gaps between and alignment with the current state of Facilities' AMS relative to ISO 55001. The IAM maturity ratings guidance was used in determining an alignment rating. Because the IAM maturity rating guidance differed for many of the assessment questions, gap analysis alignment

ratings of Lagging, Aligning, and Leading were developed and are derivatives of the IAM[14] maturity ratings. These alignment ratings versus the IAM maturity ratings provide a common intuitive alignment definition along with a qualitative description of the alignment of the current state of AM relative to ISO 55001. The alignment ratings are shown in Table 5: ISO 55001 Alignment Ratings and Definitions.

Table 5: ISO 55001 Alignment Ratings and Definitions

ISO 55001 Alignment Rating	Alignment Rating Definition
Lagging	At least 50% of the IAM questions evaluated suggested that the current state of the AMS alignment with ISO 55001 is lagging.
*Lagging – immediate attention **NOT** required	Greater than 50% but less than 80% of the IAM questions evaluated suggested that the current state of the AMS alignment with ISO 55001 is lagging.
**Lagging – immediate attention required	At least 80% of the IAM questions evaluated suggested that the current state of the AMS alignment with ISO 55001 is lagging.

* Immediate attention "NOT" required is intended to convey that there was evidence of partial alignment with ISO 55001.
** Immediate attention required is intended to convey that that there is very little evidence of alignment with ISO 55001.

5.2 ISO 55001 Gap Analysis Scope

While the FY20 D4K Facilities Balanced Scorecard Objective P&P-02 limited the scope of the ISO gap analysis to Group 4850, the scope of the ISO 55001 gap analysis was extended to perform the following:

1. Identify gaps between deployed AMS elements in Facilities Centers 4700/4800 and the ISO 55001 AMS requirements.
2. Provide gap closure recommendations to eliminate the identified gaps. ***It is important to note that the gap analysis neither reviewed the effectiveness and efficiency of existing AM activities nor identified what activities should be performed. Rather, the gap analysis focused on the existence of the ISO 55001 requirements for an AMS to effectuate AM.***
3. Develop an AMA proposal that could lay the groundwork for a structured, disciplined, and consistent approach to AM.

5.3 ISO 55001 Gap Analysis Approach

The approach to the gap analysis proceeded as follows:

1. Review the ISO 55000 AM documents.
2. Crosswalk the ISO AMS requirements to the current state of Facilities' AMS.
3. Use questions from the IAM assessment tool and ISO 55001/55002 as guidance:
    a. Determine and document the ISO 55001 AMS gaps;
    b. Provide an alignment rating for each of the seven ISO 55001 sections; and,
    c. Provide gap closure recommendations to further align the current state of the AMS with ISO 55001 AMS system requirements.
4. Recommend an AMA.

[14] IAM – Institute of Asset Management is a registered trademark.

5.4 ISO 55001 Gap Analysis Summary

The ISO 55001 gap analysis focused on the current state of the AMS and its alignment with the ISO 55001 AMS requirements as outlined in the following sections: Context, Leadership, Planning, Support, Operation, Performance Evaluation, and Improvement.[15]

The AMA team's common observation throughout the gap analysis is the absence of a structured, disciplined, and consistent approach to AM. The underlying causal factors for this observation are the absence of an executive leadership sponsor for AM, an AM policy, a SAMP, an AM-specific vision and mission, organizational and tactical level AM objectives, and an AM communication plan. Moreover, the AMA team concluded that their absence creates unclear AM roles and responsibilities, competing AM objectives, different AM direction and/or implementation approaches, and AM activities that do not support common AM goals and objectives, as well as hinders an AM culture where everyone understands how their contributions affect AM and ultimately the mission. As a result, the overall ISO 55001 alignment rating was lagging. The lagging rating indicates that the alignment of the current state of the AMS relative to ISO 55001 is in development as compared to an organization that is either ISO 55001 certified or is seeking certification. The lagging rating does not indicate that an AMS does not exist or that AM is not being performed to some degree. Table 6: ISO 55001 Gap Analysis Results provides the overall ISO 55001 alignment rating along with qualified alignment ratings for each ISO 55001 section.

Table 6: ISO 55001 Gap Analysis Results

ISO 55001 Overall Alignment Rating	*86% Lagging	Lagging
ISO 55001 Section Alignment Rating with Qualification		
4 Organization Context	65% Lagging	**Lagging – immediate attention **NOT** required
5 Leadership	95% Lagging	***Lagging – immediate attention required
6 Planning	100% Lagging	Lagging – immediate attention required
7 Support	82% Lagging	Lagging – immediate attention required
8 Operation	86% Lagging	Lagging – immediate attention required
9 Performance Evaluation	100% Lagging	Lagging – immediate attention required
10 Improvement	70% Lagging	Lagging – immediate attention **NOT** required

- % Lagging is an indication of lagging rating given as compared to other alignment ratings given.

** Immediate attention "NOT" required is intended to convey that there was evidence of partial alignment with ISO 55001.

*** Immediate attention required is intended to convey that that there is very little evidence of alignment with ISO 55001.

[15] International Standard ISO 55001:2014(E)

5.4.1 ISO 55001 Section 4 – Context of the Organization: Purpose, Gap Analysis Summary, and Gap Closure Recommendations

Purpose: ISO 55001 Section 4 identifies the requirements that would demonstrate an organization's understanding of the AMS coupled with the overall strategic approach to AM and the factors that "affect its ability to achieve intended outcomes."[16] These factors include the organization's purpose (vision, mission, and core values), asset requirements, risk-based decision making criteria, asset portfolio, the AMS scope, and the application of integrated environment, safety, security, and health (ESS&H), quality, and risk management systems.

Gap Analysis Summary: While the term AMS is not used within Sandia, an AMS exists within Division 4000 (D4K). D4K centers have AM planning and execution functions for managing physical assets. However, executive asset management sponsorship, corporate-specific AM objectives, an AM strategic vision, AM mission expectations, an AM policy, a SAMP, AM objectives, asset management plans (AMPs), and AM strategies were the noted gaps. While AMPs—specifically area plans and lifecycle asset management plans (LCAMPs)—are in the development stages, these planning documents must be aligned with each other and with the AM policy, SAMP, AM objectives, and AM strategies. The absence of these ISO 55001 requirements hinders a common approach to AM, thus preventing cross-cutting AM functions from collaborating and working cohesively to meet AM objectives. To install a culture of AM excellence, corporate-wide AM awareness, and a clear understanding of the AM vision, policy, SAMP, corporate and organizational AM objectives, and AM strategies is essential. As a result of the noted gaps, the alignment rating for Section 4 was "Lagging."

Gap Closure Recommendations:

1. Obtain corporate-level AM sponsorship and include AM expectations, goals, and objectives in the Corporate Strategic Plan.
2. At the Associate Laboratory Director (ALD) Division Leadership level, champion AM and develop an AM policy, SAMP, and a strategic AM vision aligned with corporate-specific AM strategic goals and objectives.
3. At the Center Leadership level, develop AM objectives and mission aligned with the SAMP and ALD strategic AM vision.
4. At the Group and Department Leadership levels, define AM strategies to be aligned with the Sandia Corporate Strategic Plan, the ALD strategic AM vision, the AM policy, the SAMP, and AM objectives.
5. At the Group and Department Leadership levels, develop an AM communication plan that aligns with the communication strategy.

5.4.2 ISO 55001 Section 5 – Leadership: Purpose, Gap Analysis Summary, and Gap Closure Recommendations

Purpose: ISO 55001 Section 5 identifies the requirements that would demonstrate at all leadership/management levels the willingness, commitment, and support of an AMS and subsequent AM that fosters a culture of lifecycle AM excellence. The focus of the requirements is embedded in the development and sustainment of an AM policy, a SAMP, and AM objectives.

Gap Analysis Summary: The AM principles and overarching guidance to achieve AM objectives are not explicitly defined in any existing Sandia planning or procedural document. In the absence of an AM

[16] International Standard ISO 55001: 2014(E) Asset Management Section 4.1 – Understanding the organization and its context.

policy, SAMP, and AM objectives, the underlying message is that AM is not as important as other business needs. In turn a culture of lifecycle AM excellence is difficult to promote and sustain. Lifecyle AM will be mediocre at best, and resulting asset failures will eventually have adverse effects on the ability to meet mission deliverables. As a result of the noted gaps, the alignment rating for Section 5 was "Lagging."

Gap Closure Recommendations:

1. Currently, ISO 55001 is not supported at the corporate, D4K, or all subsequent D4K levels at Sandia. Many elements of ISO 55001 exist and are being practiced in various forms, but they exist in stand-alone AM documents. Sandia D4K leadership should develop a SAMP document that will tie current AM documents together. Being that facilities is divided into two Centers, the SAMP needs to be developed at the division level and then allowed to flow down to the center levels.
2. AM planning activities are heavily centered around Center 4800 with minimal input/representation from Center 4700. Collaboration between AM planning and execution is a requisite and therefore must be communicated and driven at the Division level. In addition, AM should be included as a part of the corporate strategic objectives.

5.4.3 ISO 55001 Section 6 – Planning: Purpose, Gap Analysis Summary and Gap Closure Recommendations

Purpose: ISO 55001 Section 6 identifies the requirements that would demonstrate how asset management objectives are developed from and aligned with corporate objectives, communicated and implemented through asset management plans, monitored, and have risk management provisions put in place to assure the success of the mission.

Gap Analysis Summary: As it pertains to planning, AM organizational objectives need to be established and further developed through the AM objectives. While there are internal planning documents and work improvement plans, they are at the system level and do not address criteria outlined in ISO 55001, nor are they consistent across the systems. LCAMPs exist to some degree, but they are inconsistent at best. They lack both support from SMEs and a structured system of reporting and are therefore inconsistent. There is an additional lack of consistent alignment of NNSA capabilities and asset data management and reporting. Area plans will be driven by NNSA capabilities, but assets do not necessarily align with those capabilities. An AM policy and AM objectives are nonexistent, and therefore the items that follow, such as planning, documentation, information management, and risk management, are disjointed and lacking integration. Furthermore, no AM documents exist to convey AM objectives at relevant functions and levels. As a result of the noted gaps, the alignment rating for Section 6 was "Lagging."

Gap Closure Recommendations:

1. Create an AM architecture complete with policies, objectives, resources (RACI), and systematic approaches to planning and reporting. Future lifecycle area and lifecycle AMPs should strictly follow this new framework and apply all principles that lie within to better align with ISO 55001. Planning activities should include information identified by the risk management process through structured data monitoring and evaluation, incorporate recommendations and evaluations from the LCAMPs, and align with corporate objectives, NNSA capabilities, and the newly established AM policies and objectives. The synthesis that would occur from the alignment of NNSA capabilities and assets would be reflected in the area plans and LCAMPs. A SAMP would further align the recommendation. These policies, plans, and objectives should be communicated from upper management to all lower levels and disseminated across the organization for consistent implementation.

2. Information and data should be consistently managed and reported by all stakeholders and administered to be effectively synthesized for reporting to NNSA. Furthermore, some alignment with NNSA capabilities will be necessary.

5.4.4 ISO 55001 Section 7 – Support: Purpose, Gap Analysis Summary, and Gap Closure Recommendations

Purpose: ISO 55001 Section 7 identifies the requirements that would demonstrate that adequate and competent resources exist and asset information requirements are known, documented, and available to support the necessary processes that enable asset management. In addition, communication requirements to promote asset management awareness is also outlined.

Gap Analysis Summary: The team considered existing Facilities' processes and resources in the ISO Support section of the analysis. The analysis considered the following questions and statements: How does the organization ensure that resources required to establish, implement, maintain, and improve the asset management system are determined and provided? How does the organization ensure that persons performing work under the organization's control are aware of the how they impact the achievement of asset management objectives? How does the organization determine internal and external communication requirements related to assets and asset management systems? Finally, what has the organization done to determine what asset management information is required to support its management of assets, the AM system, and organizational objectives.

Facilities has committed resources to AM and retains key staff that are knowledgeable and competent in their subject areas of influence. They understand their influence on the operations of systems, role in planning projects and identifying risks, and routinely make strong contributions to manage our assets. One of the shortcomings is that our organization still needs to define the AM strategy, the AM objectives, and the expectations for the AMPs. The concept of AM is not currently connected or integrated across the Facilities organizations. The roles and responsibilities for AM are not developed across 4700/4800; however, many individuals know they have a role in AM.

The organization has made a commitment to the development of LCAMPs. It should be noted that the development of these LCAMPs are not always the priority for the assigned resources and that it has been difficult to gather related asset information. The current state within the organization is that we have many elements of the AMS. The organization could improve AM and realize efficiencies through improved integration of AM elements.

Facilities has several processes and deliverables through which asset information is communicated and reported. Information is communicated through tier boards, planning documents, and in focused efforts. The exchange of information with external stakeholders typically consists of planning efforts, presentations, and documents. Strategic planning activities with line customers gather customer requirements through facilities and infrastructure planning activities and similar efforts. This exchange of information is typically at a higher level and may not always consider detailed asset information. Our organization could benefit from improving how and when asset information is collected, analyzed, and evaluated.

We began our journey to improve AM, and the LCAMP templates are identifying information and process gaps as we work to develop LCAMPs. The organization has not determined information requirements to support its AMS, AM, assets, and the achievement of its organizational objectives beyond contract deliverables. There are several processes and asset information systems in place that can be leveraged to form our AMS such as Facilities Information Management System (FIMS), BUILDER, Maximo, and ProjectWise. Each of these asset information systems play a role in information requirements and the management of information in support of an AM program. The information has not been integrated into a program.

The gaps that were identified include:

- Specifically looking at ISO 15001 Section 7.2. The organization has not completed a SAMP that would help determine the resource needs of the program.
- There are activities within the organization that can add value to the AM program; however, these activities are not integrated. Observations and results from work activities completed by maintenance and Facilities Area Management teams may not roll up into the AMS
- The integration of maintenance data, test reports, and related condition information could drive efficiency in the AM program.
- Preventive maintenance plans, condition assessments and other components of an AMS are siloed. Results of are not integrated into AM.
- Our FCS and Building Automation System could be utilized to better inform our AMS. Look for opportunities to improve integration.
- The staff awareness within the organization and the understanding of how their role affects AM is not consistent. Staff members in pockets of the organization may lack awareness of how their job role can support and impact AM.
- The organization does not consistently communicate the significance of the identified risks through an AM structure. We do effectively communicate risks through our tier board structure.

As a result of the noted gaps, the alignment rating for Section 7 was "Lagging."

Gap Closure Recommendations:

1. Facilities should consider developing the AM objectives, an AM policy, and documenting them in a SAMP. The SAMP would help communicate our asset management strategy to our organization and be beneficial in the evaluation of the resource needs to support AM. The development of LCAMP documents will define in detail the type of information that is required to support AM. We also have BUILDER and other systems that provide information. The first action may be to simply perform a self-assessment of asset information and identify gaps. It is recommended that the organization would complete a self-assessment of required asset information and data to determine where gaps exist supporting the development of the SAMP.
2. Create an AM culture and ensure that our AMS clearly communicates roles and responsibilities. Ideally, support for AM would be incorporated into our culture so that each person understands how their efforts are related to AM.
3. Our organization should develop a process to oversee and communicate the effectiveness and value of the AM program. The effort should include financial analysis and cost avoidance to help justify the resources supporting AM.
4. Develop an AM communication strategy at the corporate level that communicates AM progress, risks, financials, and related information. The communication strategy could be integrated into the laboratory operating system, or flow down from divisions, to centers and to departments, to allow for information to be integrated and communicated efficiently.

5.4.5 ISO 55001 Section 8 – Operation: Purpose, Gap Analysis Summary, and Gap Closure Recommendations

Purpose: ISO 55001 Section 8 identifies the requirements that would demonstrate that change management systems exist to control and manage risks associated with changes to AM roles and responsibilities, policies, plans, and objectives.

Gap Analysis Summary: The team looked at Facilities' processes for controlling the implementation of AMPs, how well they are being implemented, and how effective they are, for both in-house and outsourced activities. This includes risk assessment and management before and during implementation of changes, as well as mitigation of any negative effects.

Facilities does have a Quality Management System (QMS) in place for controlling and implementing some AM activities. The QMS is managed by Department 4801, Strategic and Technical Operations. However, because Facilities does not have comprehensive AMPs, the team could not assess the effectiveness of the QMS to control and manage changes to AM activities. For the most part, QMS is used to plan for business needs, support major initiatives, and provide centralized resources for requirements management, risk management, publications, process design, training, measures and metrics, audits and assessments, corrective actions, lessons learned, communications, information technology, records, and continual improvement. Once an AMP has been developed, Facilities will use QMS to track and manage its objectives. Specific observations include:

- Facilities does not have a comprehensive SAMP or AMPs, and formal objectives related to AM are minimal.
- Sandia does have methods in place to identify internal and external issues at the corporate level, but these mainly deal with high-level missions and flowdown to AM is inconsistent.
- Facilities has not developed a systematic approach to address or mitigate the risk of changes that affect the entire AMS. Risk management is dealt with on a case-by-case basis.
- Metrics are kept estimating the overall condition of assets (deferred maintenance, Facility Condition Index, etc.), but these are mainly lagging and not proactive.
- Facilities outsources some AM activities, such as condition assessment survey inspection, but the drivers behind these decisions are resource capability and availability driven. Risk is not considered when making outsourcing decisions.
- Performance monitoring is not consistent across contracts. Sandia-Delegated Representatives must assess the contractor in Oracle after approving each invoice, but Facilities has not developed guidelines for doing these assessments, nor are any of the assessment questions specifically related to AM.
- Many of Facilities' contracts are one deep. If the contractor shuts down or decides to stop supporting Sandia, it would take several months to find a replacement and put a contract in place.

As a result of the noted gaps, the alignment rating for Section 8 was "Lagging."

Gap Closure Recommendations:

Facilities should formalize the AMS and develop a SAMP whose inputs are aligned with Error! Reference source not found.**.** Department 4801 should help develop and implement this plan using QMS, and then use existing processes once the system is in place to determine whether objectives are met, processes are implemented, risks of planned changes are properly assessed and managed, and outsourced activities are properly identified, managed, and controlled.

5.4.6 ISO 55001 Section 9 – Performance Evaluation: Purpose, Gap Analysis Summary, and Gap Closure Recommendations

Purpose: ISO 55001 Section 9 identifies the requirements that would demonstrate asset performance monitoring, and evaluation processes exist to assure asset performance and asset management objectives are being fulfilled. Note that while the performance evaluation requirements apply to the AMS, including the assets themselves, the focus of the gap analysis was on performance of assets.

Gap Analysis Summary: As it pertains to the performance of assets, it was noted that there are programs in place that could be leveraged to help meet the intent of ISO 55001 (Reliability-Centered Maintenance and the Predictive Maintenance teams within 4700), none of which are currently geared toward the most noted gaps. The two gaps are the lack of formal documented processes that answer the following:

- How has the organization determined what assets need to be monitored and measured?
- How has the organization determined what information generated via its monitoring and measurement processes need to be analyzed, evaluated, and reported?

As a result of the noted gaps, the alignment rating for Section 9 was "Lagging."

Gap Closure Recommendations:

1. Provide structure within the AMS that dictates the flow of information from assets that are monitored (i.e., identify who analyzes the data [Center, Group, Department], how it is evaluated, and to whom the determinations made from the evaluations are reported [Center, Group, Department]).
2. Leverage the creation of the SAMP and AMPs to provide a clear rationale as to which assets require monitoring and measurement with concurrence and participation from all affected entities within Facilities.
3. Leverage audits from top management to ensure that they are both a champion for asset data-driven decision making and championing an overall effort toward asset health monitoring/condition-based monitoring methods for Facilities assets.

5.4.7 ISO 55001 Section 10 – Improvement: Purpose, Gap Analysis Summary and Gap Closure Recommendations

Purpose: ISO 55001 Section 10 identifies the requirements that would demonstrate a process for continuous improvement exists for the AMS and AM. The focus on improvement affect asset anomalies and process failures.

Gap Analysis Summary: Even within its corporate behaviors, Sandia advocates a Continuous Improvement (CI) culture. There are existing CI processes embedded in corporate programs for DOE/NNSA reportable activities such as ES&H accidents and Physical Security incidents. These programs have staffed, robust processes for recording, resolving, and reporting incidents/deficiencies/process failures, developing preventative/corrective actions plans, and performing follow up assessments. Currently, there are no similar formal CI programs for an AMS and AM within Facilities. The primary gap for the development of a valued AM CI program was conclusively identified as a lack of established D4K AM Policy, SAMP and AM objectives that align with Sandia's annual Corporate Goals and Objectives.

Although credit was considered for the existing Corporate CI programs, the alignment rating as a result of the noted gaps for Section 10, is "Lagging."

Gap Closure Recommendations:

The critical initial step is for D4K top management to commit to Facilities' AMS and AM program structured around ISO 55001 framework, followed by the establishment of an AM Policy, SAMP and Facilities' AM objectives that is aligned with Sandia's Corporate goals and objectives. Once those are launched, AMPs can be developed providing the required components for a robust CI program for the AMS. These components must include:

1. Corrective action processes for nonconformities, failures, and incidents on assets and AMS with defined roles, responsibilities, and fundamental criteria for identifying and investigating nonconformities and incidents.
2. Preventative action processes for assets utilizing proactive monitoring procedures of asset performance and evaluation processes for determining an asset's need for preventative actions. Roles, responsibilities and monitoring criteria must also be defined.
3. Follow up procedures for asset nonconformities, failures, or incidents that require corrective and preventative actions, processes established to document the identified actions on the asset or changes to AMS. The recording of results should have a review process to assess their effectiveness.
4. Processes established on how to control nonconformities and their consequences and to minimize any adverse effects.

The SAMP should consider an AM configuration management process for reporting, tracking, monitoring, and documenting changes in AM activities including CI processes. Additionally, the SAMP should address staff support needs to maintain and sustain a robust CI Program.

Review of existing Corporate ES&H and Security CI Program processes and staffing for nonconformity and/or incidents reporting/investigating/recording should be performed to evaluate how to adapt for the AMS and AM needs.

5.5 ISO 55001 Gap Closure Recommendations Summary

Below is the compilation of gap closure recommendations from each ISO 55001 section:

1. Obtain Executive Leadership sponsorship for AM.
2. Develop Corporate AM specific objectives.
3. Develop an AM Policy, SAMP and AM Vision at the Division leadership level
4. Develop AM objectives at the Center Leadership level aligned with the Corporate AM objectives, AM Policy, SAMP and D4K Vision.
5. Develop an AM communication plan at the Group and Department Leadership levels.
6. Develop AM strategies at the Group and Department Leadership levels.
7. Align Area-Plans with LCAMPs and further align with the AM Policy, SAMP and AM Objectives.
8. Develop an Asset Health Monitoring Program aligned with the performance monitoring and evaluation requirements of ISO 55001.
9. Apply QMS to ensure the AMS is enabling AM and to validate AM objectives are being fulfilled.
10. Develop an AM configuration management process.

6.0 Asset Management: Beyond 2020 - Asset Management Architecture Recommendation

6.1 AM Architecture (AMA) Overview

As previously introduced in Section 2.1, the AMS coupled with AM is the framework, hereinafter referred to as the AM framework, for providing a structured, disciplined, and consistent approach to AM. The AM framework's purpose is to maximize the asset's value in support of mission requirements. The AM framework consists of the mission, which is the platform that establishes an understanding of asset requirements; leadership, which develops the foundation setting the AM culture of excellence; the landscape, which is a roadmap identifying AM principles and expectations that promote collaboration across the organization; management, which defines AM strategies that provide direction on AM implementation; and implementation of lifecycle AM. Figure 2: Asset Management Framework shows the basic concept of an AM framework. The components of the AM framework (Platform, Foundation, Structure, Strategies, Lifecycle AM) and the Asset Scope are interrelated, and Figure 3: Asset Management Framework – Interrelated Components shows these interrelationships

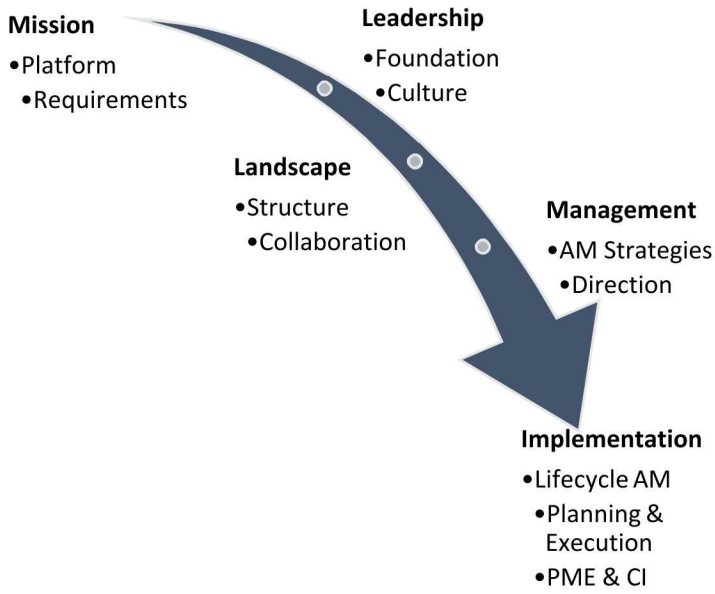

Figure 2: Asset Management Framework

Figure 3: Asset Management Framework – Interrelated Components

An AMA is the systematic layered construct of components and elements forming the AM framework that drives a structured, discipline,d and consistent approach necessary to sustain lifecycle AM excellence. The sequence of the AMA construct is as follows:

1. AM Platform: The AMA begins with a platform, which is the premise of an organization's existence. In Sandia's case it is national security (the mission) and the core values of ESS&H. The AM platform is about understanding the asset requirements needed to meet stakeholder/partner expectations and ultimately mission goals and objectives.
2. AM Foundation: The AM foundation is then built on this platform with emphasis placed on all levels of leadership and management being committed to an AM vision, mission, corporate AM plan, goals, and objectives. The foundation is a roadmap providing direction and expectations that foster a culture of lifecycle AM excellence.
3. AM Structure: The AM structure consists of the development and sustainment of AM-specific policies, guiding principles, roles, and responsibilities that are engrained in the AM culture. It's a continued leadership commitment to establish and support an AM policy, a SAMP, and AM objectives that are aligned with corporate AM goals. The AM structure builds a culture of collaboration across the organization and promotes the importance of AM.
4. AM Strategies: The AM strategies are then developed and define approaches to enable lifecycle AM (LCAM). AM strategies include resource and LCAM strategies. A resource-planning strategy focuses on the right-sized skilled workforce, funding, tools, asset information and related information systems, and integrated management systems inclusive of ESS&H core values, quality (continuous improvement), and risk management. The LCAM strategy focuses on LCAM planning and execution guiding principles that are aligned with the AM policy, the SAMP, and AM objectives.
5. Lifecycle AM: LCAM focuses on the AM planning, execution, performance monitoring and evaluation (PME), and continuous improvement (CI) during the asset lifecycle phases of

planning, sustainment, and disposition. The AM strategies are then deployed to: (1) implement LCAM planning, which culminates in the creation of area and lifecycle asset management plans (referenced herein as Area AMPs and LCAMPs), and (2) to execute the identified plan activities to meet AM objectives.

6. AM Scope/Portfolio: Finally, the AM scope/portfolio is the inventory of assets to which AMS and the AM will be applied.

Figure 4: Asset Management Framework – Hierarchy of Component Elements shows the AMS and AM elements and flow of inputs.

Figure 4: Asset Management Framework – Hierarchy of Component Elements

Figure 5: Asset Management Architecture (AMA) Model shows a "bottom-up" construct to an AM framework approach.

Figure 5: Asset Management Architecture (AMA) Model

Figure 6: Asset Management Framework – Organizational Line of Sight provides a "top-down" organizational perspective of the flowdown of the AMS components and the expected AM outcomes.

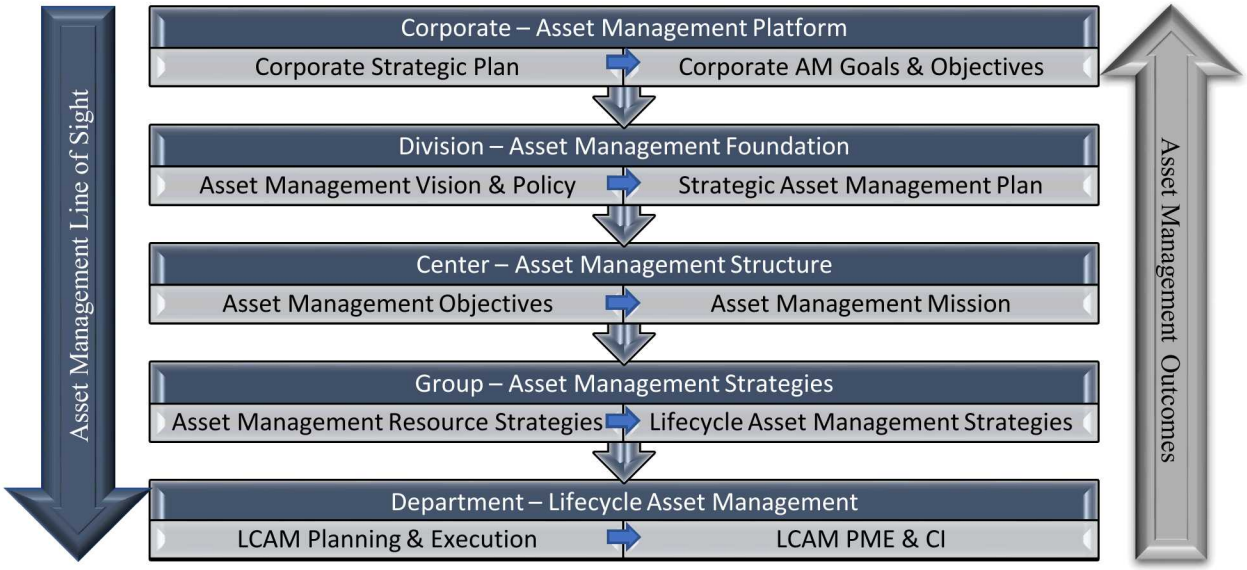

Figure 6: Asset Management Framework – Organizational Line of Sight

6.2 Navigating through the Asset Management Framework of Elements

Navigating through the AM framework of elements provides an understanding of the composition of the elements. As referenced in Section 5.2, the gap analysis did not focus on AM activities. Therefore, the focus on navigating through the AM framework of elements is on the "what," not the "how." The "how" is equally if not more important than the "what" and should be developed by the SMEs who are engaged daily with AM activities.

6.2.1 Asset Management Policy

ISO 55000 places the responsibility for developing the AM policy on leadership and emphasizes that the policy should be driven by an AM vision and mission also created by leadership. The AM policy should list the principles for meeting organizational and subsequently AM objectives.[17]

ISO 55001 identifies the minimum AM policy requirements, offers flexibility for the AM policy to be developed in a manner that is commensurate for the organization, and identifies the AM policy as the "framework for developing the AM objectives." The general requirements are that the AM policy shall be consistent with the corporate plan and relevant corporate policies. Additionally, the AM policy shall be documented, communicated, made readily available, and periodically reviewed.[18]

ISO 55002 guidance on the AM policy is that the policy should contain statements that convey the AM principles, commitment, and expectations for decisions and activities and culture relative to AM.[19]

To provide assurance that the AM policy communicates the importance of AM and begins developing the path to a consistent approach to AM, Figure 7: Asset Management Policy Framework identifies inputs that should be considered when developing the AM policy framework.

[17] International Standards Organization ISO 55000:2014 (E) Asset Management – Overview, principles and terminology, subsection 2.5.3.3

[18] International Standard ISO 55001: 2014(E) Asset Management-Management Systems – Requirements, subsection 5.2

[19] International Standard ISO 55002:2104(E) – Asset Management-Management Systems – Guidelines for the application of ISO 55001, subsection 5.2

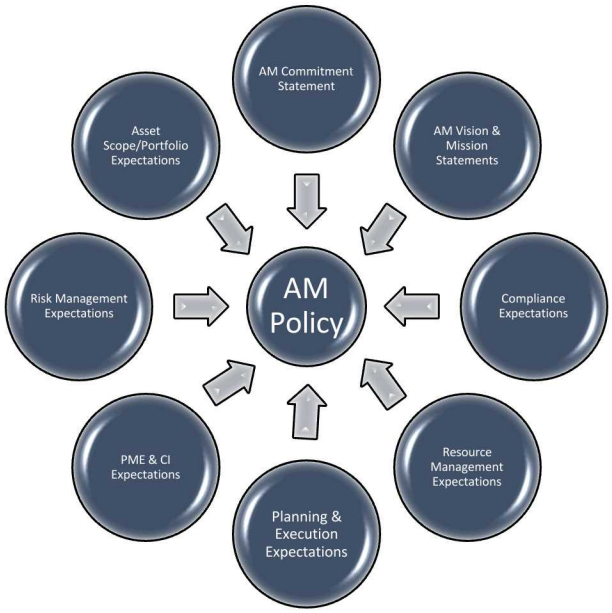

Figure 7: Asset Management Policy Framework

6.2.2 Strategic AM Plan

ISO 55000 indicates that the SAMP should convey how the AM principles will be implemented to meet organizational and subsequently AM objectives. Additionally, the "SAMP should be used to guide the setting of its AM objectives, and describe the role of the AMS in meeting these objectives." So as not to confuse the roles of the AM policy and SAMP relative to the development of the AM objectives, the AM policy defines the considerations for "what AM objectives to develop" and the SAMP defines "how to fulfill" the AM objectives. The SAMP is also used "to guide its AMS in the development of its asset management plans (AMPs)."[20]

ISO 55001 places responsibility with leadership for assuring that a SAMP is established and aligned with the AM policy, AM objectives, and AMPs.[21]

ISO 55002 guidance on the SAMP is that they should explain the relationship between organizational and AM objectives and reiterate that these objectives should be aligned. The SAMP should document the AM objectives and define the framework for achieving the objectives to include the organizational structure, roles and responsibilities, and resources. The SAMP should incorporate stakeholder's expectations and requirements, document the decision-making criteria, and be used for the development of AMPs.[22] Figure 8: SAMP Framework identifies inputs that should be considered when developing the SAMP framework.

[20] International Standards Organization ISO 55000:2014 (E) Asset Management – Overview, principles and terminology, subsection 2.5.3.4
[21] International Standard ISO 55001: 2014(E) Asset Management – Management Systems – Requirements, subsection 5.1 and subsection 6.2.2
[22] International Standard ISO 55002:2104(E) – Asset Management – Management Systems – Guidelines for the application of ISO 55001, subsections 4.1.1.1 and 4.1.1.2

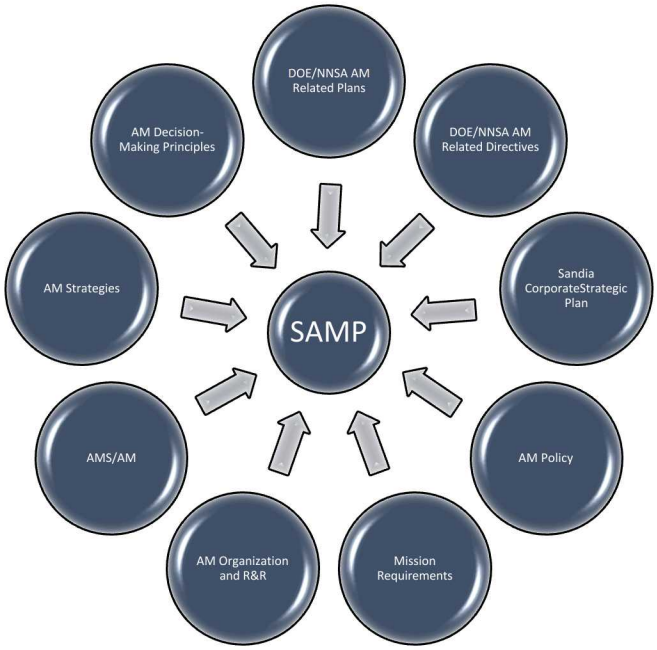

Figure 8: SAMP Framework

6.2.3 AM Objectives

ISO 55000 says very little on AM objectives other than that they are needed to articulate a particular outcome or "result to be achieved" and that the AM objectives should be aligned with AM policy and the SAMP.[23]

ISO 55001 provides prescriptive requirements to manage the objectives but does not delineate the make-up of the AM objectives. The requirement to align the AM objectives with organization objectives AM policy and SAMP is reiterated. ISO 55001 also indicates that AM objectives' performance shall be measurable, monitored, reviewed, and communicated.[24]

ISO 55002 guidance on AM objectives is that they be SMART (specific, measurable, achievable, realistic, and time-bound) and that the objectives should be linked with the AMPs. Additional guidance is that the AM objectives should consider asset risks and "importance of assets related to their intended outcomes" (i.e., asset criticality).[25]

[23] International Standards Organization ISO 55000:2014 (E) Asset Management - Overview, principles and terminology, Section 3-Terms and definitions, subsection 3.1.12
[24] International Standard ISO 55001: 2014(E) Asset Management-Management Systems-Requirements, subsection 6.2.1
[25] International Standard ISO 55002:2104(E) – Asset Management-Management Systems-Guidelines for the application of ISO 55001, subsections 6.2.1.1 and 6.2.1.2

To assure that the AM objectives are aligned with Sandia's Corporate Strategic Plan & Objectives, Figure 9: Asset Management Objectives Framework, identifies inputs that should be considered when developing the AM objectives.

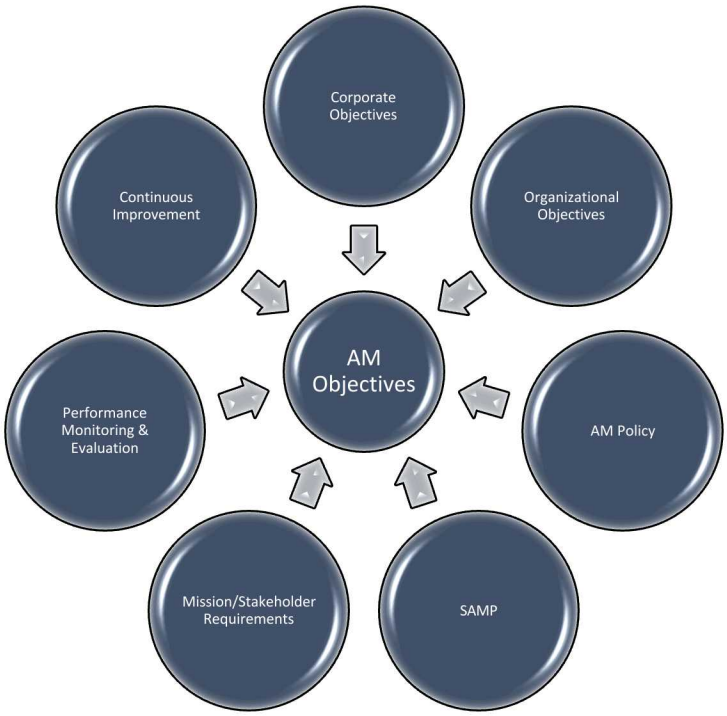

Figure 9: Asset Management Objectives Framework

6.2.4 AM Strategies

ISO 55000, 55001, and 55002 are all but silent on the requirement for or the development of AM strategies. However, AM strategies provide guidance on how to achieve the AM objectives and are necessary to drive a common approach to AM. The AM strategies provide approaches to drive what AM activities (i.e., planning and execution) are necessary to successfully achieve the AM objectives and ultimately the corporate AM objectives. To assure a common approach to AM, Figure 10: Asset Management Strategies Framework identifies strategies that promulgate a structured approach to AM.

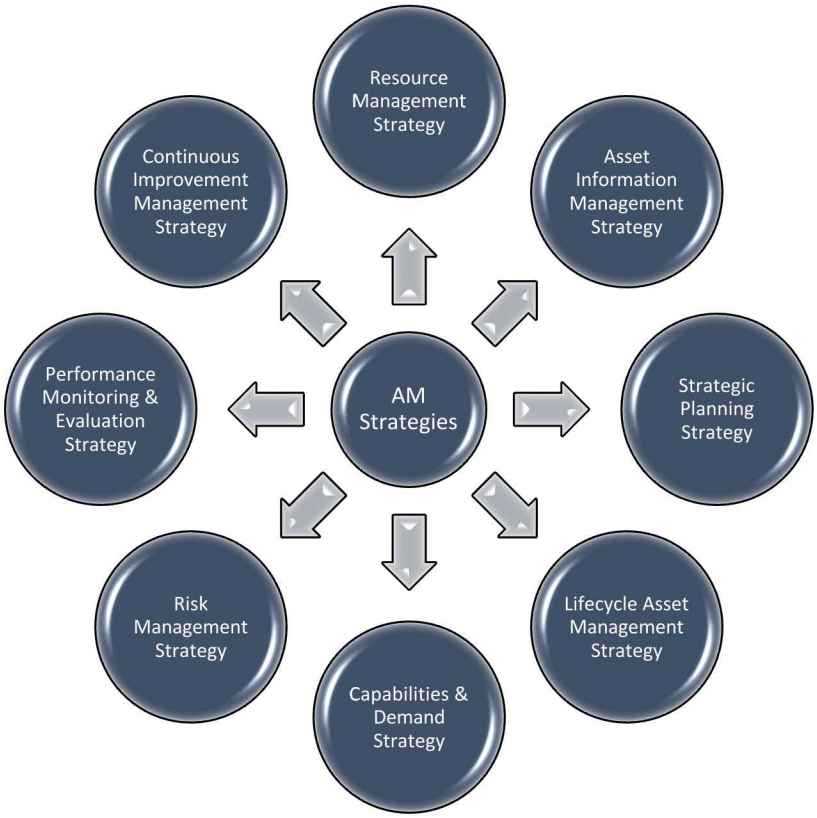

Figure 10: Asset Management Strategies Framework

6.2.5 Lifecycle Asset Management

ISO 55000, 55001, and 55002 are silent on the framework for LCAM. However, throughout these documents, there are many references indicating that managing assets throughout their lifecycle phases is required. The most common description for the lifecycle phases of physical assets are planning, acquisition, sustainment, and disposition. The planning and acquisition phases are often combined into the planning phase. The acquisition phase is often separated into construction and commissioning phases. Additionally, the sustainment phase is often separated into operations and maintenance phases.

DOE 430.1C identifies asset lifecycle phases as planning a ndbudgeting, acquisition, sustainment, and disposition. The Contracts Requirements Document in the NNSA 430.1 Supplemental Directive lists the asset lifecycle phases as planning, maintenance and modernization, and disposition. Additionally, the NNSA Real Property Asset Management (RPAM) Guide identifies the asset lifecycle phases as acquisition, sustainment, and disposition. Regardless of the definition chosen for asset lifecycle phases, managing an asset using the cradle to grave concept is inclusive of all the lifecycle phases. For the purpose of the AM architecture, asset lifecycle phases will consist of the planning (cradle), sustainment (maturity), and disposition (grave).

The overarching LCAM activities inherent in the asset lifecycle phases include planning and execution, performance monitoring and evaluation, and continuous improvement. Figure 11: Lifecycle Asset Management Framework shows the relationship between asset lifecycle phases and LCAM.

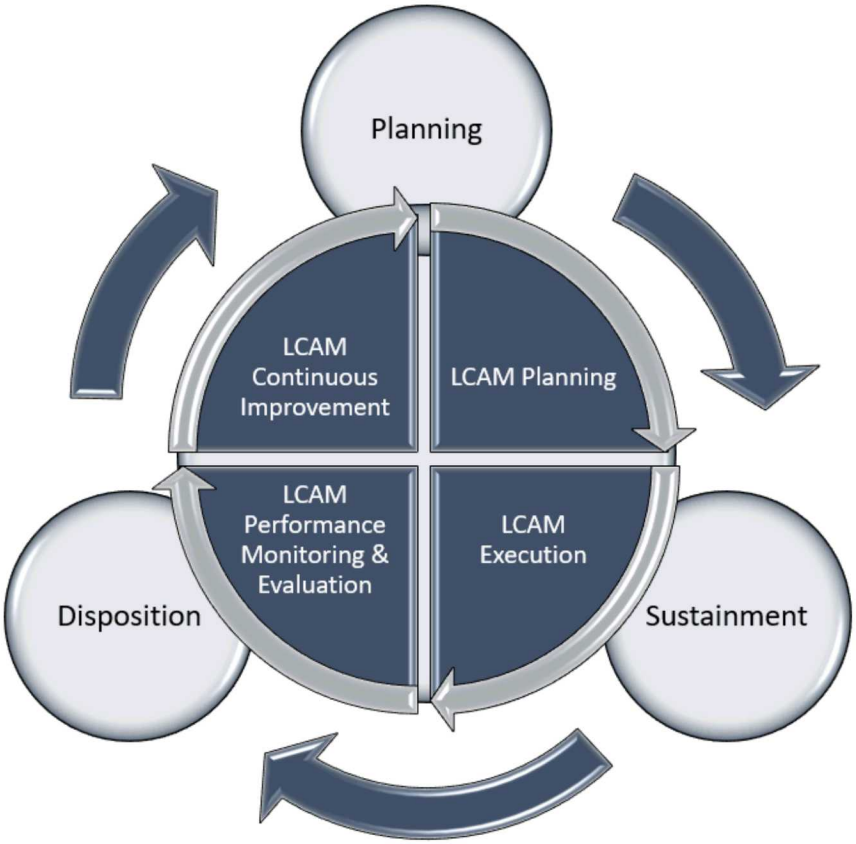

Figure 11: Lifecycle Asset Management Framework

6.2.5.1 LCAM Planning

LCAM planning is an AM activity necessary to ensure new assets are acquired to meet mission requirements, existing assets are managed to minimize lifecycle cost while maximizing the asset's value, and assets are properly dispositioned in a timely manner. LCAM planning focuses on the requirements for the assets, the assets' purpose, the timeframe the assets are needed, the assets' abilities, condition of existing assets, sustaining the assets, and disposition of the assets. The outputs from the LCAM planning efforts are executable AMPs specifically Area AMPs (Area Plans) and Lifecycle AMPs or LCAMPs. The Area Plans and LCAMPs are integrated (linked) working documents.

The Area Plans are considered strategic plans that focus on infrastructure capabilities needed to meet mission requirements. Area Plans define the "what needs to be done and when it needs to be done" for acquiring new and disposing of existing major assets, and modernizing, recapitalizing, and rebuilding major assets. Area Plans are coordinated with NA-50. LCAMPs are generally considered tactical and operational plans but can have a strategic component as well. As with Area Plans, the primary focus of LCAMPs is to address the "what needs to be done and when it needs to be done" of sustainment efforts. LCAMPs also have a role with the planning and disposition asset lifecycle phases but are more to ensure that the existing assets' purposes are sustained for a time horizon aligned with the mission need. The LCAMP's scope is the LCAM of existing infrastructure and building system assets with the goal of

sustaining the assets' capability, availability, and reliability throughout their useful lives. Figure 12: LCAM Planning Framework shows the LCAM planning activities necessary for the development and execution of the Area Plans as well as LCAMPs.

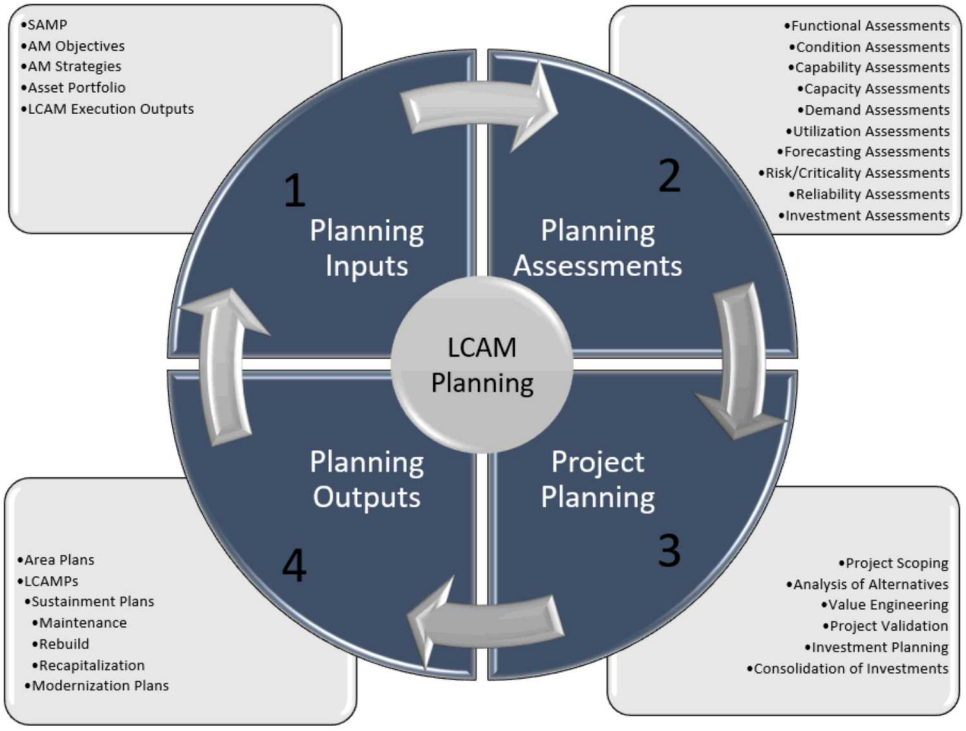

Figure 12: LCAM Planning Framework

6.2.5.2 LCAM Execution

LCAM execution responsibility resides within several departments within Center 4700, most predominately the Maintenance Services Departments (electrical, mechanical, and structural) and the Project & Construction Management Services Departments. The success of LCAM requires crosscutting integration between Facilities on multiple levels. The interrelationship and interdependencies are worth noting.

Sustainment and modernization plans from Center 4850 Site Planning & Engineering efforts are inputs to Center 4700's Project & Construction Management Departments, which then execute the projects. Group 4850's Reliability-Centered Maintenance and LCAMP efforts directly affect the Maintenance Services Departments for modification and execution of maintenance activities. An aspect of LCAM execution is implementing the inputs from several different entities within the LCAM planning activity. Outputs from the LCAM execution provide feedback into the LCAM planning activity. However, feedback rarely occurs prior to execution completion. The feedback loop should explicitly exist in the LCAMP at all phases of execution back to Center 4800 entities for LCAM to be successful.

Since the outputs of the LCAM planning activity only specify "what needs to be done" and "when it needs to be done," the "how it needs to be done" relative to implementing Center 4800 planning inputs rests with Center 4700. Although project managers and maintenance personnel have a certain depth of

knowledge concerning Sandia's assets, a formalized asset ownership (a predominately missing link) model needs to exist within Facilities. The "how it needs to be done" of sustainment is as, if not more, important than planning the "what."

LCAM planning and execution must be a collaborative and integrated effort within Facilities to ensure that the effectiveness and efficiency of LCAM is optimized. LCAM planning and execution must work in concert with the LCAM performance monitoring and evaluation to provide assurance that the AM objectives are achieved. Moreover, if AM objectives are not being achieved, LCAM planning and execution must work collectively to determine the underlying causal factor(s) and identify LCAM planning and/or execution improvement opportunities. Therefore, LCAM planning and execution are overlapping activities and must be performed in coordination with rather than in isolation from one another. Figure 13: LCAM Execution Framework shows the LCAM execution activities necessary to achieve the AM objectives and to contribute to the continual improvement of the LCAM planning activities.

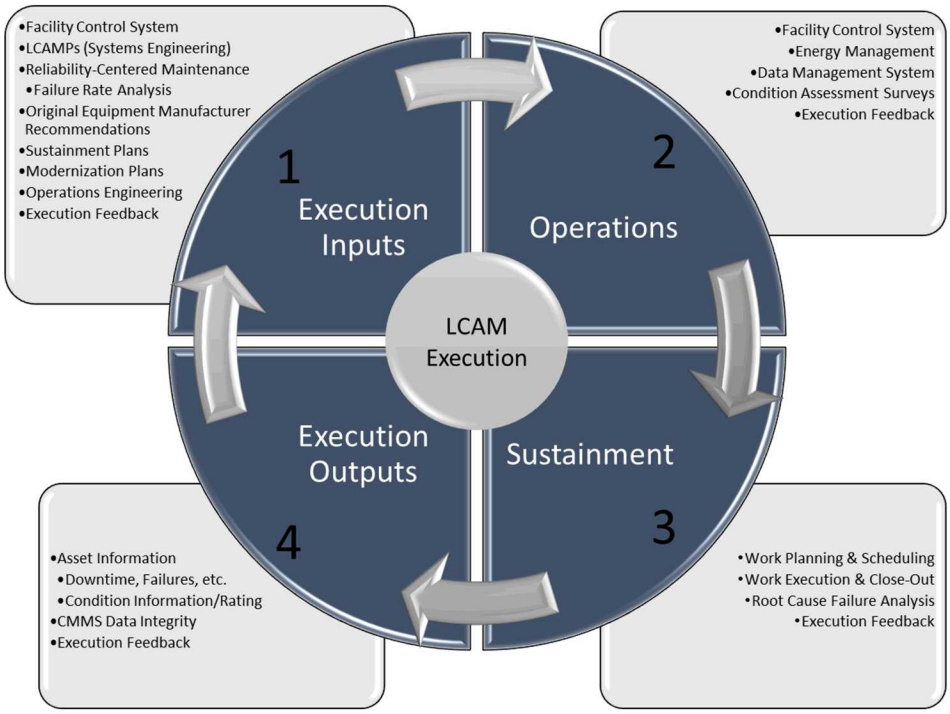

Figure 13: LCAM Execution Framework

6.2.5.3 LCAM Performance Monitoring & Evaluation

ISO 55000 indicates that assets and the AMS should be continuously evaluated to determine if AM objectives are being fulfilled in an effective and efficient manner.[26]

[26] International Standards Organization ISO 55000:2014 (E) Asset Management – Overview, principles and terminology, subsection 2.5.3.7

ISO 55001 requires a method be developed to determine what to monitor, how to monitor, when to monitor, and that monitoring data be evaluated to manage risk and identify opportunities for improvement.[27]

ISO 55002 guidance recommends that a process be developed to regularly conduct performance monitoring and evaluation to ascertain the performance of the AMS, AM, and assets. The results of the analysis should be used to manage risk and continually improve the performance of the AMS, AM, and assets.[28] Figure 14: LCAM Performance Monitoring and Evaluation Framework identifies the inputs to PME.

Figure 14: LCAM Performance Monitoring and Evaluation Framework

6.2.5.4 LCAM Continuous Improvement

ISO 55000 provides little information on CI other than to indicate that it applies to assets, AM, and the AMS, and that improvements can be identified through the PME process and evaluation of non-conformities.[29]

ISO 55001 requires that corrective and preventive action processes be in place to mitigate the consequences of non-conformities and to prevent the recurrence. These processes should evaluate the non-conformity to determine its cause and identify improvement opportunities to prevent recurrence. Additionally, established processes shall "proactively identify potential failures in asset performance…"[30]

[27] International Standard ISO 55001: 2014(E) Asset Management – Management Systems – Requirements, subsection 9.1
[28] International Standard ISO 55002:2104(E) – Asset Management – Management Systems – Guidelines for the application of ISO 55001, subsections 9.1.1 and 9.1.2
[29] International Standards Organization ISO 55000:2014 (E) Asset Management – Overview, principles and terminology, subsection 2.5.3.8
[30] International Standard ISO 55001: 2014(E) Asset Management-Management Systems – Requirements, subsections 10.1 and 10.2

ISO 55002 indicates that continuous improvement should be included in AM objectives and be a top-down and/or bottom-up iterative process aimed at assuring that objectives will be achieved.[31]

Figure 15: LCAM Continuous Improvement (CI) Framework identifies the inputs to CI.

Figure 15: LCAM Continuous Improvement Framework

7.0 Asset Management: Beyond 2020 - Asset Management Recommendations

Efforts up to this point have focused on bridging the ISO 55001 AMS gaps. Equally important to the AMS are AM activities that are essential to achieve the AM objectives. Below are four recommendations supporting AM activities that should be developed and implemented. AM policy, SAMP, AM objectives, and AM strategies shall serve as guidance in developing these recommendations to assure AM objectives are achieved and to continue with the journey to LCAM excellence. Facilities' Group and Department leadership should prioritize the importance and need of these AM activities and identify resources to implement the recommendations. These recommendations and their purpose include:

1. Collaborate with Sandia line organizations to develop a corporate-wide AM approach.
2. Develop and implement an Asset Data Quality Assurance Program to ensure asset data fidelity.
3. Develop and implement an Asset Criticality Identification Program to promulgate a risk-based AM approach.

[31] International Standard ISO 55002:2104(E) – Asset Management-Management Systems – Guidelines for the application of ISO 55001, subsections 9.3.1, 10.3.1 and 10.3.2

4. Develop and implement an Asset Health Monitoring (AHM) strategy centered around integrated technologies and data analytics to support data-driven decision making.

Appendix A: Abreviations/Acronyms and Definitions

Abbreviation/Acronyms	Definition
AHM	Asset Health Monitoring
ALD	Associate Laboratory Director
AM	Asset Management
AMA	Asset Management Architecture
AMO	Asset Management Objectives
AMP	Asset Management Plan
AMS	Asset Management System
Area AMP = Area Plan	Area Asset Management Plan
BUILDER	BUILDER Sustainment Management System
CI	Continuous Improvement
D4K	Division 4000
DM	Deferred Maintenance
DOE	Department of Energy
ES&H	Environment, Safety, and Health
ESS&H	Environment, Safety, Security and Health
FCI	Facility Condition Index
FCS	Facilities Control System
FIMS	Facilities Information Management System
IAM	Institute of Asset Management
ISO	International Standards Organization
KPI	Key Performance Indicator
LCAM	Lifecycle Asset Management
LCAMP	Lifecycle Asset Management Plan
NNSA	National Nuclear Security Administration
P&P	Partnership & Planning
PM	Preventive Maintenance
PME	Performance Monitoring and Evaluation
QMS	Quality Management System
RCM	Reliability-Centered Maintenance
RAMP	Real Property Asset Management
SAMP	Strategic Asset Management Plan
SD	Supplemental Directive
SIPOC	Suppliers, Inputs, Process, Outputs, Customers
SMART	Specific, Measurable, Achievable, Realistic, and Time-bound
SME	Subject Matter Expert
SNL-CA	Sandia National Laboratories-California
SNL-NM	Sandia National Laboratories-New Mexico