Appendix C

Maintenance Standards for Generators with Suggested Implementation and Enforcement Model

Approved by

The California Electricity Generation Facilities Standards Committee

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SECTION 1

MAINTENANCE STANDARDS FOR GENERATORS

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INTRODUCTION

Fundamental standards must be met by a generation maintenance organization if it is to be successful over time in maintaining the performance of the generating assets. This document highlights these important performance standards and provides a set of assessment guidelines to facilitate evaluation of the performance of the organization with respect to each standard. . The standards were developed in conjunction with Appendix A, Maintenance Guidelines for Electric Generating Facilities, which will provide additional insight in to how to meet a standard.

The purpose of this document is to define the standards for generating asset owners to use in the self-assessments and certification of their maintenance program. CPUC auditors will also use this document during the audit of a facility to determine the adequacy of its maintenance program. The standards address both line organization and functional performance areas. The line organization performance areas focus on the traditional departmental performance, primarily for the maintenance organization. The functional performance areas focus on processes and behaviors that cross-organizational boundaries and that address maintenance department organizational integration and interfaces. Operations, engineering, and chemistry have been included at the functional levels, to the extent that those activities are integral to the larger concept of maintenance. There clearly is some redundancy in the assessment guidelines between the performance standards as a result of addressing both organizational and functional requirements. The functional categories interwoven into the performance standards include:

- Safety
- Problem Resolution and Continuing Improvement
- Equipment Performance and Monitoring
- Work Management
- Plant Status and Configuration
- Training

For each performance standard there is a set of assessment guidelines intended to provide a sense of the breadth and depth of the standard. These represent of a collection of “Best Practices”, and not an exclusive set of criteria to demonstrate that a standard is being met. Those performing audits and assessments must keep in mind that the assessment guidelines may not be all inclusive of activities associated with the performance standard. It may be beneficial to the user of this document to refer to Appendix A, Maintenance Guidelines for Electric Generating Facilities, to gain additional insight regarding how to satisfy a particular performance standard. Generating asset owners may use different approaches to meet the standards. Given that the assessment guidelines represent only a means to an end, the certification process emphasizes achievement of the performance standards.

Generating asset owners are to use this document in performing the self-assessments required for initial certification and periodic re-certification that their programs meet the intent of the Generation Maintenance Standards and Assessment Guidelines. During the certification process, each asset owner must document in summary format how each standard is being met. In cases where a standard is not being satisfied, the asset owner must provide an action plan and time line for achieving the standard, or adequately justify its alternative to the standard.

PERFORMANCE STANDARDS - EXECUTIVE SUMMARY

The following is a summary of the eighteen (18) performance standards, grouped into nine (9) functional/organizational categories, which represent fundamental organizational and functional standards required to effectively maintain a generating asset. They are not meant to be all-inclusive, nor are they meant to be mutually exclusive. They were developed for a large population of generating assets, of diverse technologies, diverse geographic locations and owned and operated by a diverse universe of corporate structures. It is recognized that there may be some unique circumstances where a generating asset owner may perceive that a particular performance standard does not apply to their situation. It is also likely, if not a certainty, that a wide variety of methods are applied toward achieving applicable performance standards. That not withstanding, this is the set of performance standards against which each generating asset owner is required to assess the maintenance program(s) applied to their generating assets. In this section, the detailed performance standards and a set of assessment guidelines are provided. The assessment guidelines should be useful when assessing of the degree compliance necessary to meet each performance standard.

I. MAINTENANCE ORGANIZATION MANAGEMENT AND LEADERSHIP

A. Safety Performance - The protection of life and limb for the work force is the paramount performance standard.

B. Organizational Structure and Responsibilities - A line organization with responsibility and accountability for establishing and implementing a maintenance strategy to support company objectives for reliable station operation is clearly defined, communicated, understood and is effectively implemented.

C. Maintenance Management and Leadership - Maintenance managers establish high standards of performance and align the maintenance organization to effectively implement and control maintenance activities.

D. Problem Resolution and Continuing Improvement - The company values and fosters an environment of continuous improvement and timely and effective problem resolution.

II. MAINTENANANCE PERSONNEL RESOURCES

A. Maintenance Personnel Knowledge and Skills Performance - Maintenance personnel are trained and qualified to possess and apply the knowledge and skills needed to perform maintenance activities that support safe and reliable plant operation.

B. Training Support - A systematic approach to training is used to achieve, improve, and maintain a high level of personnel knowledge, skill, and performance.

III. MAINTENANCE STRATEGY

A. Balance Of Maintenance Approach - The maintenance program includes the proper balance of the various approaches to maintenance, e.g., preventive, predictive, or corrective.

IV. MAINTENANCE PROCEDURES USE

A. Maintenance Procedures and Documentation - Maintenance procedures and documents are clear and technically accurate, provide appropriate direction, and are used to support

safe and reliable plant operation. Maintenance procedures and documents should include the generation equipment and all those components owned by the generation owner directly connected to the plant that are an integral part of delivering power to the grid including fuel supply systems, electrical switchyards, transmissions lines, penstocks, flumes, exhaust system, etc.

B. Conduct of Maintenance - Maintenance is conducted in an effective and efficient manner so equipment performance and materiel condition effectively support reliable plant operation.

V. WORK MANAGEMENT PROCESS

A. Work Management - Work is planned, scheduled, coordinated, controlled, and supported with resources for safe, timely, and effective completion.

B. Plant Status and Configuration - Station activities are effectively managed so plant status and configuration is maintained to support reliable and efficient operation.

VI PROCUREMENT OF PARTS, MATERIALS AND SERVICES

A. Spare Parts, Material and Services - Correct parts and materials in good condition, are available for maintenance activities to support both forced and planned outages.

VII EQUIPMENT PERFORMANCE AND MONITORING

A. Equipment Performance and Materiel Condition - Equipment performance and materiel condition support reliable plant operation.

B. Engineering and Technical Support - Engineering activities are conducted such that equipment performance supports reliable plant operation.

C. Chemistry Control - Chemistry controls optimize chemistry conditions during all phases of plant operation and system non-operational periods.

D. Regulatory Requirements - Regulatory compliance is paramount in the operation of the generating asset.

VIII MAINTENANCE HISTORY

A. Equipment History - Maintenance standards or procedures clearly define requirements for equipment history for the systems and equipment, including, what information or data to collect, how to record data, and how the data is to be used.

IX MAINTENANCE FACILITIES, TOOLS, AND EQUIPMENT

A. Maintenance Facilities and Equipment - Facilities and equipment are adequate to effectively support maintenance activities.

PERFORMANCE STANDARDS AND ASSESSMENT GUIDELINES

I. MAINTENANCE ORGANIZATION MANAGEMENT AND LEADERSHIP

A. Safety

1. Performance Standard

The protection of life and limb for the work force is paramount. The company behavior ensures that individuals at all levels of the organization consider safety as the overriding priority. This is manifested in decisions and actions based on this priority. The work environment, and the policies and procedures foster such a safety culture, and the attitudes and behaviors of individuals are consistent with the policies and procedures.

2. Assessment Guidelines

A. Individuals at all levels in the organization contribute to the safety culture of the work environment through:
   1. Demonstrating a great respect for safety in all actions and decisions.
   2. Demonstrating a questioning attitude by challenging existing conditions, considering the potential adverse consequences prior to proceeding, and willingness to stop work in the face of uncertainty.
   3. Demonstrating a willingness to identify problems and ensure they are corrected.
   4. Accepting accountability for their own performance, including recognizing shortfalls and acting to improve.
   5. Holding their co-workers accountable for their performance.
   6. Using peer checking as a means of protecting themselves and others.

B. Managers in the organization contribute to the safety culture of the work environment through:
   1. Establishing standards and clearly communicating expectations that safety is the highest priority.
   2. Maintaining an environment that welcomes identification and communication of problems.
   3. Reinforcing individual behaviors that promptly and forthrightly identify problems.

C. Work practice norms in the organization promote the safety culture through:
   1. Appropriate defenses, such as technical accuracy, precautions, cautions and notes, are explicitly embedded in procedures, processes, and

equipment configuration to minimize the occurrences and consequences of inappropriate actions.

2. Clearly defined responsibility and authority for implementing a conservative approach with respect to stopping activities and seeking assistance or guidance when faced with uncertain conditions are communicated to all personnel. This expectation is reinforced frequently.
3. Ensuring safety concerns are promptly identified and resolved.
4. Training which reinforces safety practices and expected behaviors.

B. Organizational Structure and Responsibilities

1. Performance Standard

The organization with responsibility and accountability for establishing and implementing a maintenance strategy to support company objectives for reliable station operation is clearly defined, communicated, understood and is effectively implemented. Reporting relationships, control of resources, and individual authorities support and are clearly defined and commensurate with responsibilities.

2. Assessment Guidelines

A. The organizational structure and the responsibilities and authorities of each organizational position are clearly defined and communicated to maintenance and other station personnel, including contractors and temporary employees.

B. The line organization is established as the principal focus of management, the principal source of information, and the only source of management direction.

C. Interfaces with supporting organizations, including company work groups such as transmission and distribution, fuel suppliers, contractors, and temporary workers, are clearly defined and understood.

D. Decisions are made at the appropriate level within the organization, considering:
   1. The understanding of the effect on personnel safety, and equipment reliability
   2. The value added to, and the potential adverse effects on, plant operations under all conditions
   3. The effects on other work groups

E. Technical and managerial support is readily available to the maintenance manager.

F. Administrative controls such as policies, procedures, and schedules are implemented for activities affecting safe and reliable plant operation and maintenance. Such policies, procedures should address things such as:
   1. infrequently performed tests and evolutions
   2. procedure use and adherence
   3. training and qualification of maintenance personnel
   4. communications
   5. fitness for duty

G. Key processes that contribute to safe and reliable plant operation are designed, managed, and improved. Each process has a sponsor who is responsible for its effectiveness.

H. Contract and other non-plant personnel use and are held accountable for using the same (or equivalent) station-approved policies, procedures, and controls and the same quality standards as station personnel.

I. Station and utility personnel are adequately trained and equipped to mitigate the consequences of normal or emergent conditions and to manage emergency situations.

C. Maintenance Management and Leadership

1. Performance Standard

Maintenance managers establish high standards of performance and align the maintenance organization to effectively implement and control maintenance activities.

2. Assessment Guidelines

A. Leadership and Accountability
   1. High standards of performance are established and reinforced for maintenance activities. Personnel are held accountable for implementing these standards. Shortfalls in meeting expectations are evaluated, understood, and addressed promptly.
   2. Maintenance managers demonstrate a broad knowledge of their areas of responsibility and effectively integrate maintenance organization actions with the functions and activities of other appropriate station and company organizations.
   3. Maintenance managers motivate personnel to improve performance by taking initiative and eliminating inappropriate barriers.
   4. Personnel throughout the organization are aligned to achieve common goals.
   5. By example, managers consistently demonstrate their commitment to improve station performance and to achieve station goals and objectives.
   6. Maintenance management is accountable for the training, qualification, and performance of maintenance personnel.

7. Managers are trained on and effectively implement human interaction skills that result in improved teamwork, collaboration, and motivation.
8. Personnel are actively encouraged to admit errors, seek help when they are faced with uncertainty, and assume responsibility for their decisions.

B. Management Direction and Expectations
   1. Maintenance management directions, such as goals, initiatives, expectations, and priorities, are effectively used to enable personnel to make decisions, take actions, and implement changes that contribute to safe and reliable plant operation.
   2. Goals are established to challenge the organization to continually improve. Results are measurable and are periodically evaluated to determine effectiveness.
   3. Strategic direction for improving performance is established and clearly communicates the priorities for long-term and near-term performance to maintenance personnel.
   4. Priorities for daily activities are clearly communicated to affected personnel.
   5. Maintenance managers reinforce individual ownership through delegation of authority. Personnel are actively encouraged to admit errors, seek help when needed, assume responsibility for their decisions and actions, and develop methods to improve safety, reliability, quality, and productivity.
   6. Administrative controls are implemented for activities that affect safe and reliable plant operations. Examples of activities that should be controlled include job turnovers, use of procedures, use of special tools and lifting equipment, and use and traceability of measuring and test equipment.
   7. Contract and other non-plant personnel working in the maintenance area use the same (or equivalent) station-approved policies, procedures, and controls and the same quality standards as station maintenance personnel.

C. Planning and Implementing
   1. Maintenance managers ascertain that plant staffing and resources are sufficient, including that maintenance personnel have requisite knowledge, skill, proficiency, and familiarity with the operations of the plant(s) where they perform maintenance to accomplish tasks to achieve safe and reliable plant operation.
   2. The maintenance organizational structure is clearly defined. Responsibilities and authorities of each position are understood.
   3. Tasks, responsibilities, authorities, expectations for performance, and interfaces for non-plant personnel are clearly defined and understood.
   4. Interfaces with support groups are clearly defined and understood.
   5. Future resource needs, such as personnel, capital, equipment and parts, and information, are identified and integrated into business plans.
   6. Changes to plant equipment, procedures, and processes are planned and implemented systematically to improve safe and reliable station operation. Change objectives, responsibilities, and implementation

schedules are clearly communicated to affected personnel, and appropriate training is provided.

7. Change initiatives are managed and coordinated.

D. Monitoring and Assessing

Managers continuously and effectively monitor and assess the performance of maintenance activities, with particular attention to:

1. Adherence to maintenance standards, policies and procedures, especially worker safety.
2. Work practices and worker skills and knowledge.
3. Performance of services provided by outside organizations or contractors.
4. Work management implementation, including use of schedules, work packages, documentation of work for work history, and providing work status updates.
5. Equipment performance and material condition.
6. General area housekeeping.
7. Developing and using performance measures to monitor organization performance. Typical measures might include, but not be limited to:
   a. Maintenance work backlogs.
   b. Amount of rework.
   c. Work Management Indicators
8. Managers effectively follow-up on issues identified or problems noted and provide feedback to affected parties. Reinforcement of desired behaviors is also provided.
9. Managers frequently interact with maintenance and station personnel to coach and mentor desired behaviors.

E. Follow-up, Reinforcement, and Feedback

1. Maintenance managers initiate changes and corrective actions to improve the performance effectiveness of personnel, processes, and equipment.
2. Maintenance managers acknowledge the accomplishments of others and the importance of individual contributions to overall performance. Maintenance managers reinforce behaviors that improve performance.
3. Maintenance managers coordinate resources to accomplish goals and objectives safely and reliably. Adjustments are made and corrective actions are taken to accomplish goals. Timely corrective actions are taken when adverse conditions or trends are identified.
4. Maintenance problems, including events and materiel deficiencies that affect plant operations and maintenance effectiveness, are tracked, investigated, and reviewed periodically for timely resolution.

D. Problem Resolution and Continuing Improvement

1. Performance Standard

The company values and fosters an environment of continuous improvement and timely and effective problem resolution.

2. Assessment Guidelines

A. Self-Assessment

Self-Assessment activities are used to compare actual performance to management's expectations, and to identify and correct areas needing improvement. While self-assessments, by definition, are driven from within, they may be used to measure internal performance to external criteria, such as ISO, EPA or OSHA. Self-assessment is both a discreet activity and a continuous process that includes such activities as:

1. Dedicated teams, with a specific chartered objective to assess certain program(s) or element(s).
2. Management monitoring of on-going performance through performance metrics or problem resolution process monitoring.
3. Discreet event investigations

B. Problem Reporting, Root-Cause Analysis, and Corrective Actions

A systematic approach and process is used to identify and report problems, determine the cause(s) and establish corrective actions to prevent recurrence. Attributes of successful programs include:

1. Encouraging employees to report problems at low thresholds of significance.
2. Using a graded approach to significance, and performing more extensive root cause determination to those problems having high significance, and trend and track those with low significance.
3. Trending capability on information such as "cause code" or equipment or process involved.
4. Tracking of corrective actions to closure.

C. Operating Experience

Management processes exist to capture, evaluate, and initiate, required actions to incorporate lessons learned from other departments, stations or organizations. (Some successful stations incorporate this into their Problem Reporting/Corrective Action process.)

D. Benchmarking and Emulation

Managers seek improvement by benchmarking performance or processes against better performers.

E. Human Performance

Behaviors that contribute to excellence in human performance are reinforced to continuously strive for event free operations as evidenced by:

1. Individuals taking responsibility for their own actions and are committed to improve maintenance performance.

2. Individuals making conservative decisions when faced with uncertain or unexpected conditions.
3. Searching out and eliminating conditions that lead to poor human performance, such as poor labeling, poor lighting, hard to read prints, etc.
4. Focusing attention on the task at hand to reduce likelihood of error, including self-checking and peer checking.
5. Coaching and mentoring on human performance techniques and practices

II. MAINTENANCE PERSONNEL RESOURCES

A. Maintenance Personnel Knowledge and Skills

1. Performance Standard

Maintenance personnel are trained and qualified to possess and apply the knowledge and skills needed to perform maintenance activities that support safe and reliable plant operation.

2. Assessment Guidelines

A. Maintenance personnel capabilities and aptitude meet established entry criteria for their assigned positions.

B. Maintenance personnel possess job-related knowledge and skills

C. On-the-job training and evaluation criteria are identified, completed, and documented before personnel are assigned to perform tasks independently.

D. Continuing training is implemented to maintain and enhance knowledge and skills and to address areas such as plant equipment and procedure changes, infrequently used and difficult skills and lessons learned from operating experience.

E. Training and evaluation methods and standards are sufficient to verify trainee and contractor competence for assigned functions.

F. Initial and continuing training, including programs to develop and maintain managerial skills, are effectively implemented.

G. Contract maintenance technicians and other non-plant maintenance personnel possess knowledge and skills equivalent to those of station maintenance personnel for their assigned functions and are task-qualified prior to independent work assignment.

H. Facilities, equipment, and tools are provided and maintained to effectively support training activities.

B. Training Support

1. Performance Standard

A systematic approach to training is used to achieve, improve, and maintain a high level of personnel knowledge, skill, and performance.

2. Assessment Guidelines

A. Managers are responsible and accountable for the training and qualification of personnel assigned to their work groups.

B. Training administrative controls address the following requirements, as appropriate:
   1. Training program content
   2. Management of training
   3. Qualification of training staff
   4. Analysis, design, and development of training
   5. Classroom training
   6. In-plant and laboratory training
   7. Simulator training
   8. Evaluation of training effectiveness

C. Training is used to improve personnel performance.

D. Management expectations and standards are reinforced during training.

E. A systematic process is used to develop needed training.

F. Training management supports the line organization by maintaining an awareness of current industry training issues, identifying similar precursor conditions, and initiating proactive corrective actions.

G. Periodic reviews of applied fundamentals are integrated into continuing training.

H. A systematic assessment process is used to determine training needs for managers, including leadership, management, technical, administrative, and decision-making skills.

I. Workers from off site, such as contractors or workers from other facilities are appropriately trained and task-qualified before they work independently.

J. General employee training provides plant personnel, contractors, and visitors with a basic understanding of employee responsibilities and safe work practices and with the knowledge and practical abilities necessary to effectively implement their work.

III. MAINTENANCE STRATEGY

A. Balance of Maintenance Approach

1. Performance Standard

The maintenance program includes the proper balance of the various approaches to maintenance, e.g., preventive, predictive, or corrective. The approach is adequately documented with consideration of economics and reliability of equipment or components, and their affect on reliable operation of the unit. Operating experience is factored into the program. Maintenance procedures and documents should include the generation equipment and all those components owned by the generation owner directly connected to the plant that are an integral part of delivering power to the grid including fuel supply systems, electrical switchyards, transmissions lines, penstocks, flumes, exhaust system, etc.

2. Assessment Guidelines

A. Preventive maintenance is proper for the equipment whose failure adversely impacts safety or reliable operation or results in forced outages, or significant derates.

B. Preventive maintenance is appropriately balanced between time based and condition based, as appropriate for the equipment.

C. The preventive maintenance program is supported by a master equipment database.

D. Preventive maintenance tasks are technically based, including vendor input and industry experience.

E. Preventive maintenance tasks are properly documented in procedures, and receive appropriate planning prior to scheduling.

F. Qualified personnel perform preventive maintenance tasks.

G. Preventive maintenance is effectively coordinated into operational and outage planning to prevent unnecessary repetitive removal of equipment from service for maintenance.

H. Predictive maintenance data receives appropriate technical review and is trended to predict when maintenance should be done to prevent failure.

I. Predictive maintenance data is captured in equipment history in a manner to support maintenance analysis and equipment performance problem analysis.

J. Performance of predictive maintenance is monitored through effective performance measures.

K. The effectiveness of predictive maintenance tasks is periodically reviewed for effectiveness.

L. Equipment or components that are degraded or not performing their intended function are restored in a timely manner, consistent with their respective importance to personnel safety and efficient, reliable operation of the unit.

M. Perform activities that can affect personnel safety or plant reliability only after safety and operational assessments, detailed planning and scheduling, job briefings, and coordination with all necessary personnel have been completed.

N. Personnel should be knowledgeable of maintenance work activities that may result in changes in plant configuration, e.g., unauthorized part substitutions, repairs that do not comply with design specifications or code requirements.

O. Schedule work to maximize critical system availability and to ensure maintenance can be performed within committed time limits.

P. Post maintenance testing, sufficient to verify that functionality has been restored, is performed prior to restoring equipment to service.

IV. MAINTENANCE PROCEDURES USE

A. Maintenance Procedures and Documentation

1. Performance Standard

Maintenance procedures and documents are clear and technically accurate, provide appropriate direction, and are used to support safe and reliable plant operation. Procedures must be current to the actual methods being employed to accomplish the task and are comprehensive to ensure reliable energy delivery to the transmission grid

2. Assessment Guidelines

A. The preparation, review, approval, and revision of procedures and documents are properly controlled and timely.

B. Documents used in lieu of procedures, such as excerpts from vendor manuals, receive sufficient review and approval to verify accuracy needed to support the intended use.

C. New and revised procedures are reviewed for technical accuracy prior to initial use and are verified and validated for correctness and usability prior to/or during initial use.

D. Procedures are clear and concise and contain sufficient information for users to understand and perform activities effectively. Necessary elements include the following:

1. Technical details such as setpoints, tolerences, control logic, and equipment numbers are correct and consistent among procedures, drawings, valve lineup sheets, and system descriptions.
2. Procedures specify portions or steps of other documents that are to be referenced or used when a procedure is performed.
3. Human factor considerations, such as the sequence of procedure steps and the placement of notes and caution statements, are incorporated into procedures to reduce the likelihood of error.
4. The level of detail in procedures is consistent with the training and qualification of the users.
5. Maintenance procedures and documents should include the generation equipment and all those components owned by the generation owner directly connected to the plant that are an integral part of delivering power to the grid including fuel supply systems, electrical switchyards, transmissions lines, penstocks, flumes, exhaust system, etc.

E. Hold points, such as quality checks, are included in procedures as needed.

F. A policy governing the use of procedures is implemented. The policy includes the following:

1. Directions for when procedures are to be used as general guidance, followed step-by-step, or signed off for each step
2. Directions for when a procedure must be physically at the job site
3. Actions to be taken when procedures conflict or are inadequate for the intended task or when unexpected results occur
4. Actions to be taken when a procedure activity is interrupted

G. Temporary changes to procedures, if used, are controlled, including the following:
   1. Appropriate review and authorization prior to use
   2. User awareness of applicable temporary changes
   3. Timely incorporation into permanent revisions, when appropriate

H. Procedures, documents, drawings, and other work-related references are readily accessible, authorized, clearly identified, controlled, technically accurate, and up to date.

I. Maintenance instructional aids reflect procedure guidance.

J. Procedures are periodically reviewed for technical accuracy, human factors, considerations, and inclusion of lessons learned from operating experience.

K. Procedure users are encouraged to provide feedback to procedure writers to identify such items as inaccuracies, difficulties in use, and suggestions for improvement.

B. Conduct of Maintenance

1. Performance Standard

Maintenance is conducted in an effective and efficient manner so equipment performance and materiel condition effectively support reliable plant operation.

2. Assessment Guidelines

A. Personnel exhibit professionalism and competence in performing assigned tasks that consistently result in quality workmanship.

B. Maintenance is performed by or under the direct supervision of personnel who have completed applicable qualification for the tasks to be performed.

C. Personnel seek appropriate guidance before proceeding when uncertainties or unexpected conditions arise.

D. Maintenance personnel accurately transfer pertinent information during turnovers.

E. Personnel identify and pursue corrective action for human performance and plant deficiencies with a goal of maintaining equipment performance and materiel condition to support safe and reliable plant operation.

F. Maintenance work is properly authorized, controlled, and documented. Documentation includes sufficient details of as-found and as-left conditions of the equipment and work performed.

G. Work activities are performed in accordance with controlled procedures, instructions, and drawings. These documents provide appropriate instruction and details, are technically accurate, and are consistently used to perform maintenance in a safe, correct, and efficient manner. Craft and other maintenance personnel identify and provide timely feedback to correct procedure problems.

H. Effective maintenance practices are followed.

I. Post-maintenance testing and post-modification testing are performed, results are reviewed, and corrective actions are taken as necessary before equipment is released for service.

J. Maintenance rework is identified, documented, and trended. Actions to determine causes and corrective actions to prevent recurrence, including periodic reviews for generic implications and trends, are taken to reduce rework.

V. WORK MANAGEMENT PROCESS

A. Work Management

1. Performance Standard

Work is identified and selected based on value to maintaining reliable plant operation. Work is planned, scheduled, coordinated, controlled, and supported with resources for safe, timely, and effective completion.

2. Assessment Guidelines

A. Work Identification and Selection

1. Equipment deficiencies and work activities are identified using a simple, efficient method. Necessary elements include the following:
   a. Operating personnel are notified of deficiencies and work activities that potentially affect equipment performance or operability.
   b. Equipment deficiencies are identified early to avoid further degradation and to support resolution using routine or simple corrective actions. Affected personnel are informed of the equipment condition.
   c. Requested work activities and equipment deficiencies are clearly described so the work scope, significance, and need are evaluated.
2. Criteria are established and used to identify, categorize and evaluate work activities based on the extent of detailed reviews, approvals, documentation, planning, or scheduling required to safely execute the work. These criteria provide a means to enhance efficiency without compromising plant reliability and personnel safety.
3. Knowledgeable personnel using approved criteria and guidelines evaluate work activities. This evaluation addresses priority, category, and plant conditions required to do the work.
4. Requested and approved work activities are tracked until dispositioned. The status of incomplete and pending work activities is maintained and readily accessible.
5. Pending work activities are periodically reviewed for continued need.
6. Work requests are screened and approved based on value to the station and alignment with station and company business plans and long-term performance goals.
7. Modifications and major maintenance activities are integrated into a long-range plan that identifies appropriate staffing and budget resources.
8. Identification and selection of work activities incorporate applicable lessons learned from operating experience.

B. Work Planning

Not all work will require rigorous planning. But all work will require at least an assessment, at some designated level, to determine what level of planning, if any, beyond assignment to craft will be required.

1. Knowledgeable personnel using approved criteria and guidelines that include factors such as the following perform work planning:
    a. Operational configuration constraints
    b. Materials, tools, work duration, and manpower needs
    c. Intra and interdepartmental coordination
    d. Special skills
    e. Equipment testing for functionality and operability following maintenance or modifications
    f. Industrial safety considerations for worker and equipment protection and environmental protection
    g. Special engineering features (such as fire or flood barriers, temporary staging, and shielding)
    h. Previous work history
    i. Quality control considerations
    j. Industry experience
2. Work planning for in-service and outage maintenance, modification, and testing activities incorporates the above factors and the following:
    a. Contingency plans to the extent practical to restore equipment to service if emergent problems occur during maintenance
    b. Actions to reduce event initiators or augment mitigation systems when removal of a system or component from service would result in a significant increase in risk
3. Emergent work activities are evaluated for impact on operational plans and scheduled activities and resources.
4. The level of work planning detail and instructions is based on the complexity and operational significance of the activity and takes into consideration the training, experience, and skills of the workers.
5. Tools, equipment, materials, and parts are identified sufficiently early in the planning process to support the schedule.
6. Clearly defined post maintenance and post modification testing criteria are identified that include the following:
    a. Written and approved test instructions or procedures, including prerequisites
    b. Sufficient test scope to verify that work has corrected the deficiency
    c. Quantitative test acceptance criteria, where appropriate
7. Troubleshooting activities are planned using a systematic method to identify the causes of equipment problems. Where appropriate, such activities are controlled by work documents or instructions that have appropriate approvals, limitations, and precautions on the scope and boundaries of the activities and control over configuration changes.

C. Scheduling and Coordination

1. Work activities are analyzed and scheduled to minimize operational limitations and manage risk.
2. Integrated scheduling is used to coordinate work activities, minimize the impact on operations, manage risk, and align priorities. Milestones and schedule freeze dates are established and used to monitor schedule adherence.

3. Work activities are scheduled to allow preparation and coordination among participating organizations.
4. Related and similar work activities are scheduled concurrently or sequentially, as appropriate, to optimize use of resources and minimize impact on plant status and status changes.
5. Emergent work activities are evaluated for inclusion in the work schedule considering inoperable and out-of-service equipment, the impact on operations, status of work planning, and the disruption of scheduled activities and resources.
6. Long-range plans are implemented to optimize availability, reliability, and capability of important plant equipment.
7. Work is scheduled to allow personnel to perform pre-job activities such as work package familiarization walkdowns and to interact with cognizant personnel so that timely changes can be made.
8. The integrated schedule is periodically assessed and adjusted to resolve conflicts and reduce risk. Schedule changes are evaluated against predefined criteria with management approval.
9. Work schedule reports are tailored to the users and provide information necessary to effectively coordinate the work.
10. Scheduling and coordination incorporate applicable lessons learned from operating experience and plant risk analyses.

D. Resource Availability
   1. Sufficient plant personnel, with the appropriate training , qualification, and plant specific experience, including specialty expertise, are available to support scheduled and other work activities.
   2. Materials and parts meet quality and design specifications and are available to support scheduled and other work activities. Necessary elements include the following:
      a. Procurement sources and services are selected and approved based on vendor qualifications and performance.
      b. Nonconforming and damaged materials and parts are controlled to prevent unauthorized use.
      c. Methods are established to acquire replacement materials and parts not available from the original supplier. Engineering support is provided to qualify substitutions that affect plant configuration.
      d. Traceability of materials and parts is maintained, as required.
      e. The quality of stored equipment, materials, and parts is maintained by means such as environmental and shelf-life controls and preventive maintenance.
      f. Issued materials and parts are controlled and are returned to storage if not used.
      g. Equipment, materials, and parts brought in by non-plant personnel are subject to inspection, storage, and issue controls equivalent to items received through normal processes.
      h. Flammable and hazardous materials are identified, segregated, and controlled during receipt inspection, storage, issue, and disposal or return to storage.

3. Facilities and equipment such as lifting equipment, scaffolding, and tools are available to support the integrated schedule and other work activities safely and effectively.

E. Implementation and Control of Work
   1. Work is implemented and controlled consistent with the planning and schedule such that personnel qualifications, procedure guidance, and supervision are commensurate with the complexity of the activity.
   2. Prior to implementing work activities, involved personnel are aware of applicable lessons learned from prior experience and plant risk and have planned countermeasures to minimize the potential for repetitive problems.
   3. Pre-job and post-job briefings are used to promote effective work performance.
   4. Equipment configuration changes to protect people, equipment, and the environment during work activities such as safety tagging are effectively controlled, implemented, and verified.
   5. Equipment removal from service for maintenance, modification, or testing is authorized by operations personnel based, in part, on plant/system conditions and configuration in conjunction with the work schedule. Operations personnel maintain cognizance of maintenance, modification, and testing activities.
   6. Work backlogs are maintained at a manageable level that supports safe and reliable station operation.
   7. Good housekeeping in work areas are maintained and industrial safety work controls are used to achieve a high degree of personnel safety.
   8. Field changes to maintenance, modification, or testing activities receive technical reviews and approvals similar to the original.
   9. Infrequently performed tests or evolutions are conducted using established controls that address the criteria for and guidance covering the development, review, and preparation of these activities.
   10. Controls are established to prevent foreign material intrusion from affecting equipment performance.
   11. Post-maintenance and post-modification tests are conducted to verify that work was performed correctly and that equipment functional and operational criteria were met.
   12. Once equipment is removed from service it is repaired and returned to service in a timely manner.
   13. Maintenance, modification, and testing activities are adequately documented.
   14. Work status is accurate and accessible for review and follow-up.
   15. Work completed is compared to work planned and scheduled to identify improvement opportunities.

B. Plant Status and Configuration

1. Performance Standard

Station activities are effectively managed so plant status and configuration are maintained to support reliable and efficient operation.

2. Assessment Guidelines

A. Plant Status Control

1. Operations personnel are cognizant of the status of plant systems and equipment under their control and of the nature of work being performed.
2. Operations personnel authorize activities that affect the status of installed systems and equipment.
3. Operators maintain a focus on important plant parameters during maintenance situations and identify and address conditions that may be affecting plant parameters as a result of the work activities.
4. Operations personnel are responsible for assessing the operability of important equipment. Information about equipment deficiencies, existing plant configuration, and the design bases for the equipment is used in the assessment. Other personnel, such as in engineering, maintenance, or chemistry, provide technical support for the assessment.
5. Policies and procedures for controlling plant status are effectively implemented. Provisions for special situations, such as extended outages, and post trip recovery, are included.
6. Controls for infrequently performed tests and evolutions maintain the plant within the design basis. Procedures used to control infrequently performed tests and evolutions are reviewed for operational impacts and safety concerns before each test or evolution. Prior training and walkthrough of procedures by the affected personnel verify the controls and identify appropriate contingency actions. Pre-evolution briefings are conducted.
7. The position of valves important to operation are known and accurately recorded. Administrative controls for clearance tagouts or locked valves prevent unauthorized and inadvertent operation while allowing access for off-normal operation.
8. Independent (or concurrent, if appropriate) verification of component position is performed for equipment important to safety and/or critical to reliable plant operation.
9. Checklists or other comparable means are used to verify that proper conditions are established for each mode of plant operation and for mode changes.
10. Procedures are implemented to control the placement of caution, warning, information, and other similar tags on plant equipment and operator aids in the plant.
11. Procedures are implemented to control the placement, removal, and periodic review of temporary modifications for equipment, such as

electrical jumpers, lifted leads, mechanical jumpers, hoses, pipe blanks, and spool pieces.

B. Configuration Control
   1. The design authority is clearly defined, including organizational responsibilities and scope of application. Interfaces are controlled to coordinate design change activities.
   2. The design control process is defined and communicated and is understood by affected personnel.
   3. Operational specifications and restrictions imposed by the plant design, are appropriately communicated and incorporated into station programs, procedures, practices, and training.
   4. Plant design and status documents are accurate and accessible to station personnel.
   5. Lessons learned from user feedback, maintenance history, and operating experience are used to improve configuration control processes.
   6. Modification designs undergo interdisciplinary technical reviews, and the results are incorporated into the plant design basis.
   7. Each modification is planned, scheduled, and tracked throughout design, installation, testing, turnover to operations, training of affected personnel, and completion of document revisions.
   8. Temporary modifications are controlled and periodically reviewed for continued need. The number of temporary modifications is minimized. Those needed on a permanent basis are converted in a timely manner.
   9. Designs and supporting information, including computer software and special or unique calculations are verified and approved prior to use.
   10. Design field changes receive technical reviews and approvals similar to the original.
   11. Documents affected by plant modifications such as drawings, procedures, and equipment indexes commonly used for system operation, tagouts, and maintenance, are updated before the modifications are turned over to operations.
   12. The as-built configuration of modified systems is verified.
   13. Personnel are trained on changes prior to operating or maintaining modified equipment. Affected procedures, operational drawings, and work documents are revised before modified equipment is operated or maintained.
   14. Modifications of station simulators and training materials should coincide with or precede the modification of the station.

VI. PROCUREMENT OF PARTS, MATERIALS AND SERVICES

A. Spare Parts, Material and Services

1. Performance Standard

Correct parts and materials in good condition, are available for maintenance activities to support both forced and planned outages. Procurement of services and materials for outages are performed in time to ensure materials will be available without impact to the schedule. Storage of parts and materials support maintaining quality and shelf life of parts and materials.

2. Assessment Guidelines

A. Policies and procedures are in place for early identification and timely procurement of parts, material, and services. These procedures specifically describe the responsibilities of the company and station personnel involved in the procurement function.

B. These policies are understood by materials management, materials engineering, systems engineering, design engineering, procurement engineering, purchasing personnel, and other plant personnel who interface with the procurement process, such as maintenance managers, planning and scheduling personnel.

C. As part of the design change process, spare parts needs are updated and outdated and obsolete materials are removed from the stock system.

D. Long lead parts and materials are available in advance of planned outages, and verified to be correct prior to being needed in the field.

E. Minimum/maximum stock levels are periodically reconciled to actual usage.

F. Adequate engineering and technical review is done to ensure purchased materials meet design specifications.

G. Materials are receipt inspected to verify procurement specifications are met. Non-conforming materials are controlled to prevent inadvertent use.

H. Adequate records are maintained to ensure material traceability, if required.

I. Special handling requirements are specified in procurement documents.

J. Preventive maintenance requirements for spare components are properly specified and performed to specifications.

K. Proper precautions are taken for storage of hazardous materials and chemicals, including separation and labeling requirements.

L. Inventory levels will be verified to actual count on a periodic basis.

VII. EQUIPMENT PERFORMANCE AND MONITORING

A. Equipment Performance and Materiel Condition

1. Performance Standard

Equipment performance and materiel condition support reliable plant operation. This is achieved using a strategy that includes methods to anticipate, prevent, identify, and promptly resolve equipment performance problems and degradation.

2. Assessment Guidelines

A. Plant equipment operates on demand.

B. Personnel exhibit a low tolerance for equipment and materiel condition problems by identifying deficiencies and advocating resolution.

C. Equipment performance monitoring is used to detect problems and degrading performance. Performance monitoring activities include the following:
   1. In-service testing and in-service inspections
   2. Collection and analysis of performance data and predictive monitoring information, such as thermal, hydraulic, chemical, electrical, acoustical, vibration, and mechanical parameters
   3. Routine inspections and walkdowns
   4. Analysis of performance history and trends
   5. Aggregate reviews and analyses of performance data to determine equipment operability and availability

D. Performance criteria are established for equipment based on the importance to safety and plant reliability. These criteria address items such as the following:
   1. System performance, including reliability and availability
   2. Shutdowns, generation losses, and outage extensions
   3. Integrity of barriers to the release of hazardous materials
   4. Equipment problems that challenge the ability of operations personnel to control the plant and respond to transients
   5. Thermal performance
   6. Visible equipment condition

E. Equipment performance and plant materiel condition are measured and compared to established performance criteria.

F. Predictive maintenance and preventive maintenance are performed on equipment and spare parts to improve equipment performance. The frequency and type of predictive and preventive maintenance are adjusted

based on operating experience, results of reliability analyses, changes in operating conditions and environment, and vendor recommendations.

G. In-service testing, predictive, and preventive maintenance activities have a technical basis to support equipment performance analysis and changes to the activities.

H. Deferrals of scheduled predictive and preventive maintenance are infrequent and are justified and authorized by designated management.

I. Instruments and controls are operational and calibrated within established criteria.

J. Equipment is protected against the effects of environmental conditions, such as humidity, temperature, dust, and seismic shock.

K. Chemistry controls are established and implemented to preserve equipment. Specific response actions are established for out-of-specification chemistry conditions.

L. Temporary repairs receive adequate engineering review, are controlled, and tracked. The use of temporary repairs is minimized, and permanent repairs are made at the earliest reasonable opportunity.

M. Causes of equipment problems are determined, and corrective actions are implemented and verified for effectiveness. In-depth analysis of equipment failures is commensurate with the importance to plant performance, cost of repairs and the likelihood for recurrence.

N. Equipment problems receive appropriate attention and timely resolution, based on priorities established through the work management process. Technical support is available to resolve equipment problems.

O. Repetitive equipment failures are promptly identified and aggressively pursued to resolution.

P. Component-based operating experience information is shared with the industry, as appropriate.

B. Engineering and Technical Support

1. Performance Standard

Engineering activities are conducted such that equipment performance supports reliable plant operation. Engineering provides the technical information necessary for the plant to be operated and maintained within the operating parameters defined by plant design.

2. Assessment Guidelines

A. Engineering personnel are actively involved in plant operational activities, such as identifying, analyzing, and resolving conditions that can impact the plant design bases.

B. Personnel demonstrate and reinforce in others expected culture behaviors, such as a questioning attitude, and personal integrity.

C. Engineering activities are performed by or under the direct supervision of personnel who have completed applicable educational and qualification guidance for the tasks to be performed.

D. Engineering personnel use technical information, such as design analyses, operating experience information, and fundamental engineering principles, to provide recommendations on plant operations.

E. Engineering personnel support station outage goals for scope, efficient use of resources, maintenance support, risk management, configuration control, and duration. Long-range planning is effectively used for engineering activities, such as performance of major modifications and the implementation of engineering changes.

F. Engineering personnel monitor and evaluate equipment and system performance by examining and trending the results of condition-monitoring activities, reviewing equipment failure history, analyzing availability/reliability information, and performing system walkdowns. Follow-up actions, based on identified problems, trends, and root cause determinations, are timely and effective.

G. Comprehensive in-service and post modification/maintenance testing is conducted so that equipment necessary for safe and reliable plant operation will perform within established limits. The testing program includes a description of scope and responsibilities, scheduling mechanisms, test procedures, and methods for program updates.

H. Engineering personnel support the effective maintenance of the plant. Engineering is aware of and proactively pursues maintenance issues.

I. Processes are in place to communicate technical information and recommendations to the operations and maintenance staffs.

J. Engineering personnel are familiar with operating experience concerning their areas of expertise and use this experience to prevent and resolve equipment problems and improve plant performance.

K. Engineering personnel use outside experts, such as vendor representatives or other utility expertise, as necessary, to resolve station problems. Appropriate

controls are implemented to confirm the quality of the support and products supplied by non-plant organizations.

L. Engineering personnel incorporate industry advances in technology and practices into station activities to improve overall performance.

M. Engineering personnel are cognizant of generic industry issues. These issues are reviewed for applicability at the station, and appropriate actions are initiated.

N. Engineering personnel maintain a long-term view of station performance, anticipate issues that could impact long-term plant performance, and develop strategies to address these issues.

O. Engineering programs, such as those for monitoring flow-accelerated corrosion, in-service testing and inspections, and leak rate testing, are clearly defined and effectively implemented.

C. Chemistry Control

1. Performance Standard

Chemistry controls optimize chemistry conditions during all phases of plant operation and system non-operational periods.

2. Assessment Guidelines

A. Chemistry specifications and methods of control are clearly established for systems requiring corrosion control. Chemical and biological contaminants are kept to a practical and achievable minimum level.

B. Sufficient parameters are measured to detect abnormal conditions or changes to conditions. Limits for key parameters are established based on industry technical guidance, where applicable.

C. Action levels are established and emergency actions are planned and implemented for key chemistry parameters. Out-of-specification conditions and abnormal chemistry are corrected in a timely manner.

D. Chemistry parameters are maintained within specified bands. Sampling frequency provides timely detection of chemistry trends.

E. Corrective actions are taken before chemistry specifications are exceeded.

F. Bulk chemicals, laboratory chemicals, corrosive agents, organic chemicals, and cleaning agents are controlled to prevent improper use or inadvertent introduction into plant systems.

G. Chemicals and media such as resins are maintained and controlled to preserve their physical and chemical properties.

H. System leaks that affect chemistry conditions are promptly investigated, and actions are taken to preserve materiel condition.

I. System chemistry controls are evaluated and adjusted, as necessary, to improve plant materiel condition.

J. The effectiveness of water processing equipment is routinely evaluated, and adjustments are made to improve performance.

K. Chemistry specifications and methods of control are clearly established for systems requiring corrosion control during non-operational periods, including system startup and shutdown.

L. Equipment is soaked and flushed, as needed, to remove contaminants prior to corrosion control measures being established, after system cleaning, and prior to startup.

M. Schedules for plant startup and shutdown contain hold points to verify that system chemistry is within control limits.

N. Chemistry data is routinely reviewed and trended to identify chemistry control problems and analytical errors.

O. On-line monitor results are routinely compared with laboratory results. Analytical data is compared to calculated or theoretical data. Investigations are performed when the data does not correlate.

P. The effectiveness of system chemistry control is determined by measures such as component inspections or corrosion monitoring of selected plant systems.

Q. On-line chemistry monitors accurately measure, record, and provide alarms for key parameters, where needed. On-line monitors are properly maintained and calibrated.

D. Regulatory Requirements

1. Performance Standard

Regulatory compliance is paramount in the operation of the generating asset. Each regulatory event is properly identified, reported and appropriate action taken to prevent recurrence.

2. Assessment Guidelines

A. Plant activities are managed to minimize the generation of effluents and emissions.

B. Liquid waste tank levels are monitored periodically to detect unexpected changes.

C. Liquid waste are identified and segregated during collection according to the treatment specified for each waste stream.

D. Processed waste is sampled and analyzed for impurities prior to release or reuse in plant systems.

E. Established criteria are used to routinely evaluate effluent and emission processing equipment, such as stack gas treatment systems, or filters, demineralizers.

F. Effluent and emission monitors accurately measure, record, and provide alarms for key parameters, as needed. Effluent monitors are properly maintained and calibrated.

VIII. MAINTENANCE HISTORY

A. Equipment History

1. Performance Standard

Maintenance standards or procedures clearly define requirements for equipment history for the systems and equipment, including, what information or data to collect, how to record data, and how the data is to be used.

2. Assessment Guidelines

A. Procedures specify requirements for maintenance history, and clearly:
   1. Define the method and manner of equipment identification
   2. Define the engineering data base or other method for retaining the maintenance history
   3. Define the systems and equipment that require documentation and retention of historical data
   4. Define the minimum set of information to be included in the data base for each component

B. Procedures clearly define the type of data to be collected and recorded. Accountabilities for data entry are also clearly specified. Some examples of data to include or cross-reference in equipment history are as follows:
   1. Corrective maintenance records with failure modes and causes included
   2. Appropriate preventive and predictive maintenance records and design modification packages
   3. As-found condition during corrective and preventive maintenance
   4. Vendor repair information (for example, correspondence on component repairs and modification bulletins)
   5. Startup tests and other baseline data
   6. Appropriate surveillance test data
   7. Calibration data
   8. Spare parts information
   9. Applicable industry experience information

C. Maintenance history is periodically and systematically reviewed and problems trended. Problems are investigated and corrective actions taken.

D. Maintenance History Database is updated when modifications occur.

IX. MAINTENANCE FACILITIES, TOOLS AND EQUIPMENT

A. Maintenance Facilities and Equipment

1. Performance Standard

Facilities and equipment are adequate to effectively support maintenance activities.

2. Assessment Guidelines

A. Maintenance facility size and arrangement promote safe and effective work and training activities. Appropriate facilities are provided for work on equipment involving hazardous materials.

B. Work area lighting and other environmental conditions promote safe and effective working conditions.

C. Work areas are maintained in a clean and orderly condition.

D. Tools, equipment, and consumable supplies are available to support work. Appropriate equipment is available for loading, lifting, and transporting equipment.

E. Suitable storage is provided for tools, supplies, and equipment. Special tools, jigs, and fixtures are identified and stored to permit ready retrieval.

F. Rigging equipment and scaffolding are identified, tested, and properly stored.

G. Facilities, equipment, and tools are maintained in good repair.

H. Measuring and test equipment is calibrated and controlled to provide accuracy and traceability. Out of tolerance test equipment is removed from service. Plant equipment maintained with out of tolerance test equipment is evaluated in a timely manner for operability, and deficiencies are corrected as necessary.

I. Equipment is accessible for maintenance activities. Fixed local area hoists and work platforms are provided, as needed, to facilitate maintenance access to plant equipment.

J. Communications equipment is provided and is available to support maintenance activities.

SUGGESTED IMPLEMENTATION AND ENFORCEMENT MODEL

Revised May 2, 2003

SECTION 2

GENERATING UNIT PERFORMANCE METRICS

INTRODUCTION

This section describes those methods and measures used to monitor and confirm the ultimate effectiveness of the maintenance program, or alternatively, alert CPUC management of the potential need to perform audits of generating asset owner compliance to the Generation Maintenance Performance Standards and Assessment Guidelines, as certified.

The ultimate objective of the Generation Maintenance Program is to improve generating capability within the State of California. This will lead to improved grid reliability. Therefore measurement of maintenance program effect on generation capability is an essential metric. For this purpose, the Capacity Unavailability Factor (CUF) was chosen as the primary performance metric.

The CUF is equal to the sum of all of the hours of lost generation in a period divided by the period hours, and expressed as a percentage. In essence, it is the percentage of Net Dependable Capacity generation that was not available to the grid over the reporting period due to maintenance, fuel limitations (hydro), or regulatory restrictions. It does not address whether or not the generating asset was bid into the system, nor does it recognize significant changes in generator operation (e.g., starts and stops, total generation, and operating hours) that could influence future availability or capability.

$$CUF = \frac{\text{Planned Outage Hour} + \text{Maintenance Outage Hours} + \text{Scheduled Outage Extension Hours} + \text{Unplanned (Forced) Outage Hours} + \text{Equivalent Unplanned Derate Hours} + \text{Equivalent Planned Derate Hours}}{\text{Period Hours}} \times 100\%$$

CUF is numerically equal to NERC GADS EUF (North American Electric Reliability Council's Generation Availability Data System Services Equivalent Unavailability Factor). CPUC chose to modify the name and expand the terms in the numerator to make the equation clear as to the factors that are being utilized.

This factor was chosen as the primary metric because each factor in the numerator is believed to be sensitive to the effect of a change to the applied maintenance program. However, there is no single performance metric that can suffice to evaluate the effectiveness of a maintenance program, especially during periods when generator operational characteristics change significantly. Therefore, other operating parameters will be monitored along with CUF to assure that conclusions regarding plant operation are not drawn from an incomplete set of measurements.

It should also be recognized that this performance measure, despite its close relationship to the adequacy or effectiveness of the maintenance program, is still a historical or lagging indicator. Therefore, generating asset owners and the CPUC t should use additional information or measures to provide early warnings that some element of a maintenance program may have deteriorated. This can sometimes be better accomplished by ad hoc review of the raw data used to derive this upper tier performance measure.

For these reasons, the CPUC has adopted the North American Electric Reliability Council's (NERC) Generation Availability Data System (GADS) practice of generating asset owners reporting data in a raw format, and then storing the data in such a manner that CUF can be calculated from the raw data. This approach provides the added benefits of enabling other more detailed analyses of performance trends, with consideration of recent changes in operating practices and external factors such as evaluating CUF with the effects of fuel limitation and regulatory limitation filtered out. It also facilitates storage of information for reprocessing in the event that better higher-tier performance measures are developed in the future. This data can also then be used to assess past performance for benchmarking purposes.

I. Data Collection and Reporting

Data must be collected and analyzed to measure the effectiveness of maintenance programs and to assess the effect of generating asset performance on grid reliability. All reported change of unit state event data, as required by this program, shall have detailed log entries at the respective generating facilities describing the event.
The majority of generation owners in the Western Electricity Coordinating Council (WECC) providing energy to California currently participate in the North American Electric Reliability Council's (NERC) Generating Availability Data System Services (GADS). For the sake of consistency, the CPUC has selected a subset of NERC GADS data that is to be reported by participants, and the NERC GADS protocol for applying definitions of unit state, and unit state changes, as the standard for data to be reported directly to the CPUC on a real time basis as changes of unit states occur. The generation asset owners shall have the option of reporting directly to the CPUC or reporting to NERC GADS and authorize the CPUC access to the NERC GADS data on a unit specific basis. In addition, NERC GADS Performance Definitions and Equations were adopted for use. These definitions are based on the Institute of Electrical and Electronic Engineers (IEEE) Standard 762, "Definitions for Use in Reporting Electric Generating Unit Reliability, Availability, and Productivity."

A. Required Data Sets

The data set chosen for monthly reporting to the CPUC includes the information required to derive each factor in the CUF calculation:

1. Cause Code (if applicable) to the time and date for each change of unit state (Event)
2. The unit state code for unit state prior to the change
3. The unit state code for unit state after the change
4. Net Available Capacity in the new state
5. Net Dependable Capacity at the time of year

1. Unit States

Outage

An outage starts when the unit is either desynchronized from the grid or when it moves from one Unit State to another. The outage ends when the unit is synchronized to the grid or moves to another unit state. In the case of moving from one Unit State to another, the exact date and time that one outage ends will be the same as the next outage starts. The Unit State can only be changed if the first outage ends.

Planned Outage (PO) - An outage that is scheduled well in advance and is of a predetermined duration, lasts for several weeks, and occurs only once or twice a year. Turbine and boiler overhauls or inspections, testing, and nuclear refueling are typical Planned Outages

Maintenance Outage (MO) - An outage that can be deferred beyond the end of the next weekend, but requires that the unit be removed from service, another outage state, or Reserve Shutdown state before the next Planned Outage (PO).

Characteristically, a MO can occur any time during the year, has a flexible start date, may or may not have a predetermined duration, and is usually much shorter than a PO. Note that IEEE standard 762 considers this an unplanned outage.

Scheduled Outage Extension (SE) - An extension of a Planned Outage (PO) or a Maintenance Outage (MO) beyond its estimated completion date. Use SE only in instances where the original scope of work requires more time to complete than originally scheduled. Do not use SE in those instances where unexpected problems or delays outside the scope of work are encountered which render the unit out of service beyond the estimated end date of the PO or MO. Report these delays as Unplanned (Forced) Outage-Immediate (U1). SE or U1 must start at the same time (month/day/hour/minute) that the PO or MO ended.

Startup Failure (SF) - An outage that results when a unit is unable to synchronize within a specified startup time following an outage or Reserve Shutdown. The startup period for each unit is determined by the operating utility. It is unique for each unit, and depends on the condition of the unit at the time of startup (hot, cold, standby, etc.). A startup period begins with the command to start and ends when the unit is synchronized. SF begins when the problem preventing the unit from synchronizing occurs. The SF ends when the unit is synchronized, another SF occurs, or the unit enters another permissible state.

Unplanned (Forced) Outage (U1) - An outage that requires removal of a unit from service, another Outage State, or a Reserve Shutdown state anytime prior to the end of the next weekend. [This is inclusive of NERC GADS Unplanned (Forced) Outage Codes U1, U2, and U3]

Derates

A derating exists whenever a unit is limited to some power level less than the unit's Net Maximum Capacity. Similar to outages, the general derating event classification is divided into distinct event types. A derating starts when the unit is not capable of reaching 100% capacity. The available capacity is based on the output capability of the unit and not on dispatch requirements. The derating ends when the equipment that caused the derating is returned to service, whether the operators use it at that time or not. More than one derate can occur at one time. Report all deratings that are greater than 2% of the unit's Net Maximum Capacity and longer than 30 minutes in duration.

Planned Derating (PD) - A derating that is scheduled well in advance and is of a predetermined duration. Periodic deratings for tests, such as weekly turbine valve tests, should not be reported as PD's. Report deratings of these types as Maintenance Deratings (D4).

Maintenance Derating (D4) - A derating that can be deferred beyond the end of the next weekend but requires a reduction in capacity before the next Planned Outage (PO). A D4 can have a flexible start date and may or may not have a predetermined duration.

Derating Extension (DE) - An extension of a Planned Derating (PD) or a Maintenance Derating (D4) beyond its estimated completion date. Use a DE only in instances where the original scope of work requires more time to complete than originally scheduled. Do not use a DE in those instances where unexpected problems or delays outside the scope of work are encountered which render the unit incapable of full load beyond the estimated end date of the PD or D4. The DE must start at the same time (month/day/hour/minute) that the PD or D4 ended.

Unplanned (Forced) Derating (D1) - Immediate - A derating that requires a derating that cannot be delayed beyond the end of the next weekend. [This is inclusive of NERC GADS Unplanned (Forced) Derate Codes D1, D2, and D3]

Service

In-Service (IS) - When the unit is synchronized to the system.

Reserve Shutdown (RS) - The unit is available to the system but not synchronized for economy reasons.

Pumping Service (PS) - The unit is available to system, with or without, derates, but used in pumping capacity.

Available (A) - The unit is in a condition that allows it to be started up and synchronized to the grid (Reserve Shutdown), be used as a pump, or is actually synchronized to the system as generator or be used as a synchronous condenser (In-service).

Figure 1 illustrates the logical relationship between the defined Unit States possible for an active or inactive Generating Asset.

It should be noted that this protocol does not differentiate between a unit Available in the Reserve Shutdown status that is bid into the market or a unit in Available in the Reserve Shutdown status that is not bid into the market. Likewise, it doesn't differentiate between in-service with a bid less than full capacity. This was done deliberately, since bid status of a unit is not related to the effectiveness of the maintenance program, but a business or contractual decision.

2. Cause Codes

Outage and derate causes will be reported at the major system/sub-system level using NERC GADS cause codes. The NERC GADS Data Reporting Instructions contain a listing of cause codes.

When reporting an event, select the code, which best describes the cause or component responsible for the event. The following guidance should be used in selecting the cause code:

Assign the cause of the event to the major component or system that was responsible for the event, not to an auxiliary component or operation that triggered the failure of a major component or system. For instance, on a fossil steam boiler, failure of an air line to one feedwater regulating valve may cause closure of that valve, resulting in a boiler trip on low level. In this case, the cause code for the feedwater system would be chosen as the primary cause, not the code for the service air system. Conversely, if the feedwater regulating valve had failed as the result of a complete loss of service air system, the cause code would be assigned to service air (Balance of Plant Auxiliary Systems).

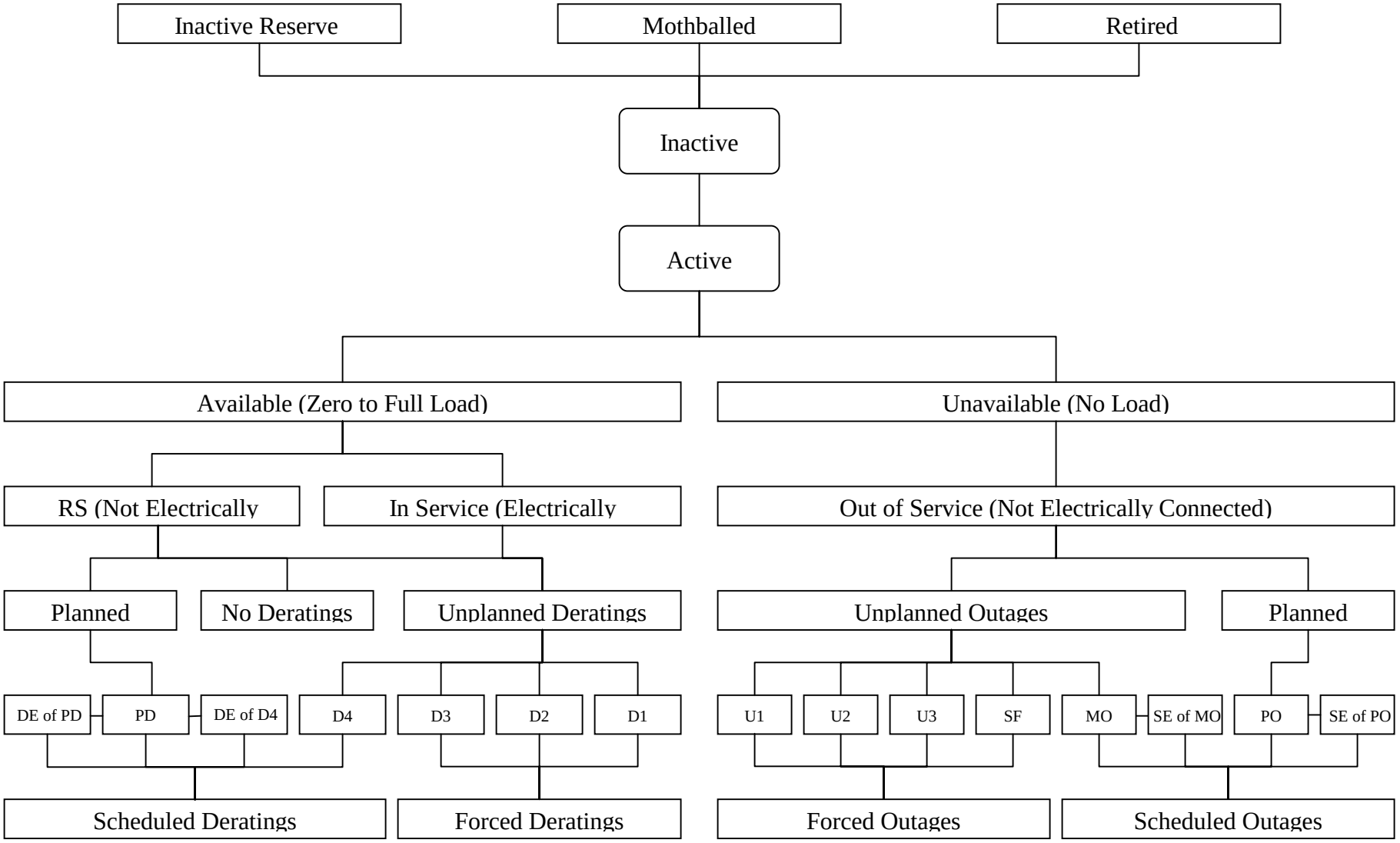
Report power supplies (motor control centers, breakers, etc.) which serve a particular component or system in the same manner, e.g. if a breaker for the boiler feedwater pump fails, the cause code would be assigned to the Feedwater System. Likewise, if the loss of power to the feedwater pump was due to a failure in the AC Distribution system that caused a loss of power to a number of systems or components, the cause code would be assigned to the Electrical System.

Report instruments or controls for a component (such as pressure switch, pressure regulator, position indicator, etc.), which are a part of a fan, pump, or valve as the system for the component. The exception is for instruments or controls that are components in a designated system, such as Boiler Control. Report all instruments, transmitters, logic modules, etc. for these systems using the System Code for that control system.

Use the codes for “External” and “Safety, Regulatory, and Environmental” only when no other system/component cause code applies. For instance, if stack emission limits are exceeded because of a fault in the flue gas scrubber, use a scrubber code. However, if a new limit on emissions is imposed and is exceeded even though the scrubber is functioning properly, then use an environmental code.

The Primary Cause of event is required for all outages, startup failures and derates. Cause codes are not required for a change of Unit State related to Service, e.g., Reserve Shutdown, In Service, Pumping, or Synchronous Condensing.

FIGURE 1


Inactive Reserve
Mothballed
Retired
Inactive
Active
Available (Zero to Full Load)
Unavailable (No Load)
RS (Not Electrically
In Service (Electrically
Out of Service (Not Electrically Connected)
Planned
No Deratings
Unplanned Deratings
Unplanned Outages
Planned
DE of PD
PD
DE of D4
D4
D3
D2
D1
U1
U2
U3
SF
MO
SE of MO
PO
SE of PO
Scheduled Deratings
Forced Deratings
Forced Outages
Scheduled Outages

B. Data Reporting

The data to be provided is divided into three different categories, design, event, and performance. This section is subdivided by data type, and provides explanation of how each type of data is to be reported. Section (1) describes the design data to be reported and required transmittal specifications. Section (2) details the event and performance reporting requirements.

1. Design Data

Design data is fundamental data necessary for NERC GADS to classify the generating asset and develop the appropriate data base code tables for that asset. Generating asset owners shall either report design data to NERC GADS, and authorize the CPUC access to such data on a unit specific basis, or provide such design data, in identical format, directly to the CPUC upon request. Normally, design data must be reported to NERC GADS when the unit first enters the active state. This is termed the "service date" and occurs when the unit is first declared available for the dispatch of power at some level of its capability. If, at the issuance of this document, the design data for a generating asset has not previously been reported to NERC GADS by the present, or prior owner, the design data will be reported to NERC GADS or to the CPUC within 30 days following the announcement of the Generation Maintenance Program implementation. While a discussion of the design data is presented here, see GADS Data Reporting Instructions for specific instructions and complete description of data. The minimum design data includes:

Unit Type

- Nuclear (steam) units - those units consisting of a single reactor and a single turbine-generator. In cases where multiple reactors or multiple turbine-generators are headered together, the entire ensemble is considered a single unit.
- Fossil (steam) units - those units consisting of a single boiler and a single turbine-generator. In cases where multiple boilers and/or multiple turbine-generators are headered together, the entire ensemble is considered a single unit.
- Hydro, pumped storage, gas turbine, jet engine, and diesel units - those units consisting of the unique prime mover and a single generator. In cases where multiple combinations of turbines/engines and generators exist, either physically or because of operating philosophy, the entire ensemble may be considered as a single unit or as individual units.
- Combined cycle units - those units consisting of one or more gas turbines/jet engines and one or more heat recovery boilers. The steam from the heat recovery boiler is sent to a steam turbine for generating electricity. Units where the gas turbines/jet engines can generate

independent of the heat recovery boilers and steam turbine are also combined cycle units. The entire ensemble is considered a single unit.

- Cogeneration units - those units consisting of one or more gas turbines/jet engines and one or more heat recovery boilers. The steam from the heat recovery boiler is used for other purposes (process steam), not generating electricity. The entire ensemble is considered a single unit.
- Fluidized bed combustion units - those units consist of one or more bubbling, circulating or pressurized bed boilers or steam turbines. Consider the entire group as a single unit.

Unit Capacity - Gross: Gross Maximum Capacity (GMC) - The maximum capacity the unit can sustain over a specified period of time when not restricted by ambient conditions or deratings. To establish this capacity, formal demonstration is required. No standard demonstration test method or test duration exists at this time. The GMC of a unit should change only as a result of a new performance test or permanent unit modification. GMC is never changed due to equipment problems, even if they persist for a lengthy period of time **unless** the unit is permanently modified as a result.

Unit Capacity - Net: Net Maximum Capacity (NMC) - NMC is the unit's GMC less any capacity (MW) utilized for that unit's station service or auxiliary load.

Gross Dependable Capacity (GDC) - The gross power level that the unit can sustain during a given period if there are no equipment, operating, or regulatory restrictions. By definition, therefore, the GDC is the GMC modified for ambient limitations. The GDC is the same in intent and purpose as the historically reported Maximum Dependable Capacity (MDC).

2. Event and Performance Data

An "event" occurs any time a generating unit changes Unit State as defined in Data Set above. This typically includes a change in operating status or changes in capability. Reporting event data and performance data, provides all the information needed to evaluate generating unit availability and capability performance.

Event data (changes in unit state) will be reported to the CPUC andmonthly performance summaries reported to NERC GADS or the CPUC quarterly. Figure 2 depicts the general requirement of data. Monthly reports shall include all Unit State changes, which have occurred since the end of the last reporting period. The quarterly report to NERC GADS or the CPUC is a summarization of operations for the reporting period.

Performance Data associated with the event reporting to the CPUC is limited to:

Net Dependable Capacity (NDC) - Is the Net Maximum Capacity less the Seasonal Derate due to environmental impact, if any.

Net Available Capacity (NAC) - Is the current limit on Net Capacity, regardless of whether it is bid in, or demanded.

Figure 2 – Example Event Report

Generating Facility ID							
Report Period	From:			To:			
Change of Unit State (Examples)	Date (mm/dd)	Time (24 hour clock)	From Code	To Code	Cause Code	Net Available Capacity	Net Dependable Capacity
Planned Derate - Feedwater System from full power (350 MW to 75% of full power) occurring at 1230 am, July 28 and lasting till 2330 on July 29.	7/28	0:30	IS	PD	3400*	262.5	350
Return to full capacity	7/29	23:30	PD	IS	NA**	350	350

* Hypothetical cause code.
** No cause code required when changing into the In-Service, Reserve Shutdown or Pumping Service states.

II. Data Analysis

A. Capacity Unavailability Factor (CUF)

As a minimum the CUF shall be calculated once per calendar month for each generating asset. Once per quarter, the mean value of the monthly CUF shall be calculated and plotted for trends. The trend will be compared with the benchmark data for each generating asset (see paragraph III-A of this section). A suitable means shall be developed for generating asset owners to quality check the calculations. Declining trends, or performance outside the benchmark control values as set forth in performance analysis thresholds, below, will be further analyzed by the CPUC using information from additional data analysis.

B. Additional Data Analysis

1. Internal CPUC information will be examined, including such outage coordination information as planned, approved, deferred, cancelled or forced outages. Review of "Restricted Generation Maintenance Periods" and other information that might have bearing on unit performance will be included.

2. The CPUC also will have at its disposal, either through authorized access to NERC GADS Unit Specific Data, or directly supplied data from the GAO, sufficient data to analyze, track, trend and query as required to test the apparent results of CUF calculations and the implications on generating asset owner's maintenance program effectiveness. Particular interest will be applied to those performance metrics that reflect recent changes in operating practice that may impact CUF other than the maintenance program. As a minimum these shall include:

   a. Net Actual Generation for the period compared to historical
   b. Actual starts for the period compared to historical
   c. Service hours for the period compared to historical
   d. Outage hours for period compared to historical

C. Evaluation of Data Anomalies

If, following this analysis, additional information is needed to understand the generating asset's performance; the CPUC will initiate queries with the generating asset owner. These queries may be conducted via telephone conference or site visits, as the CPUC deems necessary.

D. Audit

If, following analysis and preliminary investigation, performance remains questionable; it will be further evaluated by the CPUC performing a "triggered site audit". The purpose of the audit is to assure that the cause of the decline or

performance issue has been identified. The generating asset owner can then develop actions to remedy the situation. Such audits shall be conducted in accordance with guidance in Section 3 of the Generation Maintenance Program, Verification and Audit Process.

E. Confidentiality

The CPUC recognizes the proprietary nature of the data and information provided (directly and via NERC GADS) by the generating asset owners, and agrees to treat the information in a manner that protects the proprietary interest of the generating asset owners from other parties.

III. Benchmarking Performance

A. Existing Generating Assets

Existing generating assets shall be benchmarked against their own historical performance. To facilitate this process, the generating asset owner shall, within 60 days of the announcement of the Generation Maintenance Program implementation, submit to the CPUC the necessary data to calculate the monthly Capacity Unavailability Factor (CUF) for at least the past 5 years (60 months). In the event that a unit owner does not have reliable, continuously-recorded CUF data for the 60-month minimum, the CPUC may determine the control chart limits using data for a shorter period or utilize an alternative means for establishing the limits until such time as sufficient CUF data is available for the unit. The CPUC shall periodically review the control chart limits and appropriately modify them when necessary.

New benchmarks shall be calculated each year, by adding in the past 12 months of data to the historical data originally used to calculate the benchmarks.

If the asset owner is a participant in the NERC GADS system, they have the alternative of authorizing NERC GADS to release the data to the CPUC.

B. New Generating Assets

Prior to the commercial date of operation, the generating asset owner shall submit to the CPUC its proposed, pro-forma benchmark for CUF, including a summary description of how the proposed value was derived. If the derivation did not include, as a minimum, comparison with industry class data, the CPUC will make such a comparison with like type units before accepting the proposed benchmark. Once accepted, the pro-forma benchmark becomes the starting point for performance monitoring, until such time as sufficient historical data is available for the unit.

C. Benchmark Calculations

Using the monthly-calculated values for CUF, the Quarterly Mean Value of CUF will be calculated for the historical period. The overall average across all quarters will be the unit specific Centerline for the Control Chart. The monthly-calculated values would also be used to establish the Upper Warning Limit and Upper Control Limit as required for the performance analysis thresholds described below. The Upper Warning Limits and Upper Control Limits are calculated from the historical data using a statistical technique called “bootstrap resampling”. This technique is used when data doesn’t fit a normal distribution, and is intended to establish an Upper Control Limit such that only .25% of the quarterly CUF values are likely to fall above the Upper Control Limit value, and only about 2.5% of the quarterly CUF values are likely to fall above the Upper Warning Limit

value, assuming nothing unusual occurred. New Upper Control Limits, Upper Warning Limits and Centerline Values (benchmarks) will be calculated each year. This information will be provided to the generating asset owner.

The CPUC will use a set of performance analysis thresholds to monitor the actual performance of each generating asset. Activation of any one of the performance analysis thresholds would result in the CPUC initiating additional performance analysis using other data.

D. Performance Analysis Thresholds

The following thresholds shall be used by the CPUC to prompt a more thorough analysis of the generating asset's performance.

1. Current Quarter CUF Value exceeding Upper Control Limit.
2. Two out of the last three Quarterly CUF values exceeding the Upper Warning Limit
3. An adverse trend of CUF as defined by 6 Quarterly CUF Values in a row with increasing values.
4. At least v1 consecutive Quarterly CUF Values above the Benchmark Value.

NOTE: v1 is a derived value obtained during the calculation of the Upper Warning Limits and Upper Control Limits using a statistical technique called "bootstrap resampling".

In addition such performance evaluations could also result from other sources such as:

- CPUC Site Visit Feedback
- Forced outage rates
- Excessive outage extensions

SECTION 3

VERIFICATION AND AUDIT PROCESS

INTRODUCTION

As a means to improving grid reliability, Generator Maintenance Performance Standards, Assessment Guidelines and a Verification and Audit Process were developed to verify that adequate maintenance programs are being employed by generation asset owners. While it is recognized that unit performance metrics are the truest indicator of the effectiveness of a maintenance program, the metrics are lagging indicators, with a fairly long time constant. Therefore a more timely verification process is needed to provide assurance that such maintenance programs are being employed by generation asset owners. This section describes the methods employed to provide the assurance that maintenance programs, which meet the performance standards approved by the CPUC, are being carried out by generation asset owners. The methods described reflect the principle that the generation asset owners can best assess the manner and effectiveness in satisfying the performance standards, and will improve their maintenance programs and practices through the performance of such assessments. The methods adopted include an initial certification process, periodic re-certifications, or notification of interim significant changes to programs, and a process of both random and triggered audits by CPUC.

I. Initial Certification

A. Purpose

The purpose of the initial certification process is to provide assurance to both the generating asset owner and the CPUC that the maintenance program(s) being employed are adequate to maintain or improve their current generating capability.

B. Requirement

Within 90 days of the announcement of the Generation Maintenance Program implementation, or prior to commencement of operations for any generating asset not in an active status at the time of issue, the generating asset owner shall provide a certification to the CPUC. This certification is to be signed by an officer of the company under oath and affirmation, that the generating asset owner has in place, and is effectively implementing, a maintenance program for each of its generating assets that meets the intent of the Generation Maintenance Performance Standards & Assessment Guidelines. Any exceptions should be noted and accompanied by a corrective action plan and timeline or adequate justification for the exception. The basis for the certification shall be a documented self-assessment conducted by the generating asset owner. The self-assessment shall be against the generation maintenance performance standards and should use the associated assessment guidelines as a measurement tool to understand the intent of a particular standard.

1. The initial certification shall include, as a minimum:
    1. The identity of the generating asset owner
    2. The identity of the generating asset(s)
    3. A summary description of its maintenance program. Where generating asset owners elect to use a single or common program for multiple generating assets, they shall clearly identify the assets to which the certification applies.
    4. A list of deficiencies noted during the performance of the initial self-assessment, and a summary remedial action plan including timeline for each deficient area. If a performance standard is not applicable to the generation assets or the owner chooses not to meet the standard, adequate justification must be provided. As used in this context, a deficiency is failure to satisfy a maintenance performance standard as described in the generation maintenance performance standards. Where generating asset owners elect to use a single or common program for multiple generating assets, deficiencies shall be identified as either a generic deficiency or a deficiency specific to a particular asset within the grouping included in the certification.
    5. The location of the records of the initial self-assessment.

6. The name and contact information of the asset owner representative that the CPUC should contact related to the initial self-assessment or the certification. If applicable, for each generating asset.

2. The summary description for each program included in the certification report shall include, as a minimum:
   a) For each performance standard in the generation maintenance performance standards, provide a brief statement describing how the generating asset owner meets the intent for each asset included in the certification.
   b) Where appropriate, a listing of applicable document(s) that govern the activity, including title, revision and revision date.
   c) If exceptions are taken to any performance standard, provide adequate justification.

> NOTE: The CPUC may, at its discretion, seek additional information or justification in cases where a generating asset owner has taken exception to a performance standard.

3. The minimum record requirements for the initial self-assessment include, but are not limited to:
   a) Identification of self-assessment team members
   b) Procedure or charter used to guide conduct of the self-assessment
   c) List of persons contacted/interviewed during the self-assessment
   d) List of documents reviewed as part of self-assessment
   e) Dates and times of major events of the self-assessment
   f) Reports which document the findings for each Performance Standard
   g) If the self-assessment is applicable to a grouping of Assets, the identity of all Assets included in the self-assessment.

4. Exceptions or modifications to requirements
   a) If a generating asset is purchased from an existing generating asset owner, the acquiring generation asset owner shall submit initial certification prior to close of the sale.
   b) The owner of any new generating asset must submit an initial certification prior to commercial operation of the generating asset or specify an existing self-assessment under which the asset is to be certified.

5. Notice of Receipt of Certification
   The CPUC shall, within 15 working days of receipt of certification, acknowledge receipt of the certification by providing written notice. Such notice shall be addressed to the certifying officer.

6. Notice of Request for Additional Information
   The CPUC shall, within 60 days of receipt of certification, provide written notice to the certifying officer of any additional request for information regarding exceptions taken to the performance standards, if any.

II. Periodic Re-Certification

A. Purpose

The purpose of the periodic re-certification process is to provide continuing assurance to both the generating asset owner and the CPUC that the maintenance program(s) being employed to sustain their generating assets continue to be adequate to maintain or improve their current generating capability.

B. Requirement

By the last business day in the month of June, following the first full year of operation since the original certification, and every 2 years thereafter, the generating asset owner shall provide to the CPUC a certification, signed by an officer of the company under oath and affirmation, that the generating asset owner continues to have in place, and effectively implements, a maintenance program(s) for each of its generating assets that meets the intent of the generation maintenance performance standards, with exceptions noted. For exceptions, a corrective action plan and timeline will be included. If there is no intent to meet the performance standard, adequate justification must be provided. The basis for the certification shall be a documented self-assessment conducted by the generating asset owner completed within 60 days of the date of re-certification.

1. The re-certification report shall include, as a minimum:
   a) The identity of the generating asset owner
   b) The identity of the generating asset(s)
   c) A list of deficiencies noted during the performance of the re-certification self-assessment, and a summary remedial action plan and timeline for each deficient area. If there is no intent to meet the performance standard, adequate justification must be provided. As used in this context, a deficiency is failure to satisfy a maintenance performance standard as described in the generation maintenance performance standards. Where generating asset owners elect to use a single or common program for multiple generating assets deficiencies shall be identified as either a generic deficiency or a deficiency specific to a particular asset within the grouping included in the certification.
   d) The location of the record(s) of the periodic self-assessment(s).
   e) The name(s) and contact information of the asset owner representative(s) that the CPUC should contact related to the periodic self-assessment(s) or the certification.

2. The minimum record requirements for the periodic self-assessment include, but are not limited to:
   a) Identification of self-assessment team members
   b) Procedure or charter used to guide conduct of the self-assessment
   c) List of persons contacted/interviewed during the self-assessment
   d) List of documents reviewed as part of self-assessment
   e) Dates and times of major events of the self-assessment
   f) Reports which document the findings for each performance standard
   g) If the self-assessment is applicable to a grouping of assets, the identity of all assets included in the self-assessment.

3. Notice of receipt of certification
   The CPUC shall, within 15 working days of receipt of certification, acknowledge receipt of the certification by providing written notice. Such Notice shall be addressed to the certifying officer.

4. Notice of request for additional information
   The CPUC shall, within 60 days of receipt of certification, provide written notice to the certifying officer of any additional request for information regarding exceptions taken to performance standards, if any.

III. Notice of Significant Changes

A. Purpose

The purpose of the Notice of Significant Change process is to provide continuing assurance to the CPUC that the maintenance program(s) previously certified as sufficient to sustain the generating assets will continue to be adequate to maintain or improve their current generating capability following the change.

B. Requirement

1. Within 30 days of the implementation of a change to a maintenance program previously certified for any generating asset, the generating asset owner shall determine if the change materially affected the certification previously provided to the CPUC. If so, the generating asset owner shall, within the next 30 days, provide to the CPUC a written summary of the change to the certified program, along with certification, signed by an officer of the company under oath and affirmation, that the change will not materially degrade its ability to satisfy the intent of the Generation Maintenance Performance Standards and Assessment Guidelines, with exceptions noted as previously certified. The basis for the certification shall be a documented in the Notice of Significant Change.

2. For each performance standard in the generation maintenance performance standards and Assessment Guidelines document, provide an updated summary describing how the performance standard is affected by the change and describe how the intent will still be met with the change in effect. Where appropriate, provide a listing of applicable document(s), which govern the activity, including title, revision and revision date.

3. Notice of Receipt of Certification
   The CPUC shall, within 15 working days of receipt of certification, acknowledge receipt of the certification by providing written. Such Notice shall be addressed to the certifying officer.

4. Notice of Request for Additional Information
   The CPUC shall, within 60 days of receipt of certification, provide written notice to the certifying officer of any additional request for information regarding exceptions taken to performance standards, if any.

IV. Initial Audit Program

A. Purpose

The purpose of the Initial Audit Program is to provide the CPUC assurance that maintenance programs are in effect as certified. This is essentially the same process as the Random Audit Process defined in Section V, below, with the exception that the sample size will be increased for both full and partial audits during the 6-month period following the initial certification.

B. Requirement

1. At the completion of the deadline for the initial certification process, the CPUC shall designate any generating assets for which a certification has not been received for an audit within the next 60 days.

2. For those generating asset owners who have certified their maintenance program(s), a random sample of the Generating Assets shall be audited during the first calendar year following the deadline for the initial certification. The random sample size shall be up to 10 percent of the maintenance programs being applied to generating assets. Based on the initial audit results, the CPUC may increase the sample population.

3. If during the audit of the initial random sample population, deviations are identified that result in the determination that one or more of the certifications were erroneous, the following action will be taken. If the determination of erroneous certification occurs during the audit of a specific generating asset within a portfolio of generating assets to which a common program applies, additional audits may be conducted within the portfolio to achieve the required confidence that the certification was fundamentally flawed or the deviation was a unique exception. If the deviation was a unique exception, the deviation may, or may not, result in a determination of erroneous certification. The decision will be left to the discretion of the CPUC.

4. Based on the initial audit results, the CPUC may adjust either of the following:
    1. The frequency of random sample audits; or
    2. The time interval between certification and re-certification.

V. Random Audit Program

A. Purpose

The purpose of the random audit program is to provide continuing assurance, over time, without total reliance on lagging indicators, that the maintenance programs are being maintained in such a manner as to sustain the generating capability of the Generating Assets.

B. Requirements

1. Following completion of the Initial Audit Program described in Section IV above, the CPUC shall prepare a schedule of audits to be performed annually, during the period beginning on the last day of the month of June, following the completion of the initial audit program. This schedule shall schedule a random selection of the defined audit population, such that up to 10 percent of the population is audited annually.

2. The audit program will be conducted in accordance with audit procedures approved by the CPUC. Audit program procedures shall be developed using guidance contained in American National Standards Institute (ANSI) Guidelines for Auditing Quality Systems, including ANSI/ASQC Q10011-1-1994, Q10011-2-1994, and Q10011-3-1994. The audit procedures shall as a minimum address the following topics:
    1. Selection and qualification of audit teams
    2. Training of auditors
    3. Notification of audits
    4. Audit planning
    5. Conduct of audits
    6. Audit reporting and comment resolution or disposition
    7. Corrective action follow-up
    8. Confidentiality and code of ethics
    9. Audit program improvement

3. Combined audits and use of third party audit/inspection reports may be used as a means to limit impact on the generating asset owners. Examples of these types of activities may include, but necessarily be limited to:
    a) Results of regulatory agency audits or inspections, e.g. OSHA, EPA as they may apply to maintenance performance objectives.
    b) Authorized inspectors
    c) Insurance inspections

It should be noted that the CPUC audit program is intended to be performance based, and results of third party audits may not be sufficient, by themselves, to demonstrate that an objective is being met.

VI. Triggered Audits

A. Purpose

The purpose of a triggered audit, or one that is prompted by anomalies in generating asset performance, is simply to determine if the anomaly is an early indication that the maintenance program is not achieving the desired objectives. Triggered audits will result from a clearly discernable declining trend in performance as indicated by examination of performance metrics and analysis of performance data for the generating asset that are not satisfactorily explained by investigation.

B. Requirements

1. Triggered audits will normally occur after appropriate interrogatory steps have been taken by the CPUC to determine the rationale behind performance issues. Typical interrogatory actions that might be applied would include:
   a) Documented telephone or e-mail contact with the generating asset owner with questions regarding apparent anomalies noted in data.
   b) Performing additional analysis of other data.
   c) Formal request for information that might explain the anomaly, or, in some cases, to document the cause investigation and corrective action planned to prevent recurrence.
   d) Site visit if issues are too complex to understand via telephone or written correspondence.

2. Once it has been determined that an audit is the appropriate response to the questionable performance issue, the CPUC shall appoint an Audit Team Leader, and define the scope of the audit. The scope of the audit may be assessed by review of the generation maintenance performance standards, the questionable performance issue, and prior communication with generating asset owner.

3. Once the scope has been determined, the audit shall be conducted in accordance with the audit procedures discussed in V.B.2 above.

4. The generating asset owner designee shall be provided at least one calendar week notice of the audit. The notice shall be provided in accordance with the audit procedures discussed in Section V.B.2 above.

VII. Example Initial Certification Report

The following is an example of an Initial Certification Report to the CPUC for a hypothetical Power Generation Plant. All of the document references, discussion and dates are purely fictional, but do represent the level of detail envisioned for the Certification Report.

Generating Asset Owner: *Legal Name of Owner*
Owners Address

Generating Asset: *Name of Station or Unit*
Address of Station or Unit

Certification:

I, (*name of officer*), being duly sworn, do hereby certify that I am an officer in (*Legal Name of Owner*), and have sufficient knowledge of the maintenance programs being employed at the (*Name of Station or Unit*), and also certify, that with exceptions noted in Enclosure 1, that the maintenance program currently being employed at the (*Name of Station or Unit*), meets the intent of each Generation Maintenance Performance Standard promulgated by the Generation Maintenance Program, Revision 0, dated _____.

All records of the initial self-assessment providing a basis for this certification are maintained at the (Location of records).

(*Legal Name of Owner*)'s designated contact for information regarding the self-assessment or other information providing a basis for this certification is:

Name of Individual
Title of Individual
Address of Individual
Telephone number of Individual

Attested to this (date).

_____(Signature of Officer_____
(Typed *Name of officer* and Title)
Legal Name of Owner

Encl: 1

Notarized by:

Enclosure 1, Certification Report for (*Legal Name of Owner*).

The following report summarizes the methods employed by (*Legal Name of Owner*) to achieve each Generation Maintenance Performance Standard promulgated in the Generation Maintenance Program, Revision 0, Dated _____.

(Note – Fictional documentation and dates are used to show level of detail desired)

Performance Standard: I. A

No exceptions noted in the Self-Assessment dated July 29, 2001. Applicable documents include:

Legal Name of Owner Safety Manual, Revision 4, 2000
Legal Name of Owner Safety Performance Report, YTD, June 2001

Performance Standard: I. B

One exception noted. Assessment Guideline I.B.2.F.1, suggests administrative controls for infrequently performed test and evolutions. At the current time, (*Legal Name of Owner*) does not have such an administrative control approved. A procedure is currently being developed and will be approved prior to November 30, 2001. Applicable documents include:

Name of Station or Unit Organization and Accountabilities, Rev. 14, June 2001
Name of Station or Unit, Conduct of Maintenance, Rev. 03, November 2000
Name of Station or Unit, Development and Control of Procedures, Rev. 2, April 1999

Performance Standard: I. C

No exceptions noted in the Self-Assessment Dated July 29, 2001. Applicable documents include:

Name of Station or Unit Organization and Accountabilities, Rev. 14, June 2001
Name of Station or Unit, Conduct of Maintenance, Rev. 03, November 2000
Name of Station or Unit Monthly Performance Report, YTD, June 2001
Name of Station or Unit, Corrective Action Process, Rev. 0, January 2001

Performance Standard: I. D

One exception noted. Although Assessment Guideline I.D.2.A does not explicitly require an administrative procedure for conducting self-assessments, we feel such a procedure is necessary. It will be developed and fully implemented by April 2002. Applicable documents include:

Name of Station or Unit, Corrective Action Process, Rev. 0, January 2001
Name of Station or Unit Monthly Performance Report, YTD, June 2001

Performance Standard: II. A

No exceptions noted in the Self-Assessment Dated July 29, 2001. Applicable documents include:

Name of Station or Unit Organization and Accountabilities, Rev. 14, June 2001
Legal Name of Owner Performance Evaluation Process, Revision 2, 1999

Performance Standard: II. B

One exception noted. At the time of the self-assessment, no means or method was available or being used to assess the qualification of contractor personnel as recommended by Assessment Guideline II.B.2.I. A method will be developed, documented in Station Administrative Procedures and be fully implemented by April 2002. Applicable documents include:

Name of Station or Unit Training Manual, Rev. 4, July 2001

Performance Standard: III. A

No exceptions noted in the Self-Assessment Dated July 29, 2001. Applicable documents include:

Name of Station or Unit Organization and Accountabilities, Rev. 14, June 2001
Name of Station or Unit, Conduct of Maintenance, Rev. 03, November 2000
Name of Station or Unit, Work Management, Rev. 02, October 2000
Name of Station or Unit, Post Maintenance Testing Manual, Rev. 01, June 1998
Name of Station or Unit, PM Program Manual, Rev. 04, June 1998

Performance Standard: IV. A

One exception noted. At the time of the self-assessment, no written policy existed governing the use of procedures. We feel such a procedure is necessary. It will be developed and fully implemented by April 2002. Applicable documents include:

Name of Station or Unit, Conduct of Maintenance, Rev. 03, November 2000
Name of Station or Unit, Development and Control of Procedures, Rev. 2, April 1999
Name of Station or Unit, Corrective Action Process, Rev. 0, January 2001

Performance Standard: V. A

Two exceptions noted. At the time of the self-assessment, the extent of planning and scheduling to support corrective maintenance for work performed in-service or during outages definitely did not meet the intent of this standard. In addition, the material support for maintenance as suggested by Assessment Guideline V.A.2.D.2 is not being satisfied. Station management is developing an action plan to resolve these issues prior to the commencement of our planned major overhaul in the fall of 2002. Specifics are not available at this time.

Name of Station or Unit, Conduct of Maintenance, Rev. 03, November 2000
Name of Station or Unit, Work Management, Rev. 02, October 2000
Name of Station or Unit, Procurement of Parts and Supplies, Rev. 08, November 2000
Name of Station or Unit, Post Maintenance Testing Manual, Rev. 01, June 1998

Performance Standard: V. B

One exception noted. Station Management does not subscribe to the concept of independent verification. Our monitoring of the number of problems created by mis-positioned components supports the management position.

Name of Station or Unit, Conduct of Operations, Rev. 06, April 1998
Name of Station or Unit, Conduct of Maintenance, Rev. 03, November 2000
Name of Station or Unit, Work Management, Rev. 02, October 2000

Performance Standard: VI. A

This performance standard is clearly not being met at this time. As noted in the response to Performance Standard V.A, the material support for maintenance as suggested by Assessment Guideline V.A.2.D.2 and this Standard are not being satisfied. Station management is developing an action plan to resolve these issues prior to the commencement of our planned major overhaul in the fall of 2002. Specifics are not available at this time.

Name of Station or Unit, Procurement of Parts and Supplies, Rev. 08, November 2000
Name of Station or Unit, Conduct of Maintenance, Rev. 03, November 2000
Name of Station or Unit, Work Management, Rev. 02, October 2000

Performance Standard: VII. A

One specific exception was noted, and there is general area for improvement in the overall technical support of station maintenance. As noted in response to Performance Standard III.B, at the time of the self-assessment, no systematic approach was being used to assess the effectiveness of the PM Task. Station management is considering development of such a process, but has no definite plans at this time. Improvements in the technical support for maintenance are addressed in Performance Standard VII.C. Applicable documents include:

Name of Station or Unit, Conduct of Maintenance, Rev. 03, November 2000
Name of Station or Unit, Work Management, Rev. 02, October 2000
Name of Station or Unit, Post Maintenance Testing Manual, Rev. 01, June 1998
Name of Station or Unit, PM Program Manual, Rev. 04, June 1998

Performance Standard: VII. B

As noted in response to Performance Standard VII.A there is general area for improvement in the overall technical support of station maintenance. These areas of improvement are performance related, not insufficient program documents. At the time (*Legal Name of Owner*) acquired (*Name of Station or Unit*), many of the engineers in the Technical Support Department opted to take an early retirement option from the previous owner. Recruitment efforts for experienced degreed engineers have not yielded the desired results. As an alternative, Station Management, with full support of (*Legal Name of Owner*), is developing job descriptions for Technical Specialist who will be experienced operators or maintenance personnel, and perform many of the non-design functions of technical support. Such tasks would include, but not be limited to, monitoring equipment performance and trends, conducting in-service test program, and review of equipment history for potential areas of improvement in maintenance approach or required design changes. We expect to have this performance weakness corrected by the time of our first re-certification.

Applicable documents include:

Name of Station or Unit, Conduct of Maintenance, Rev. 03, November 2000
Name of Station or Unit, Work Management, Rev. 02, October 2000
Name of Station or Unit Organization and Accountabilities, Rev. 14, June 2001
Name of Station or Unit, Conduct of Engineering Services, Rev. 03, July 1999

Performance Standard: VII. C

At the time of the self-assessment, Station Management had instituted a significant improvement program for chemistry. We were not meeting the requirements of Performance Standard VII.C. The improvement program is an integrated program, with scheduled completion for September 2002. Applicable documents include:

Name of Station or Unit Organization and Accountabilities, Rev. 14, June 2001
Name of Station or Unit, Conduct of Operations, Rev. 06, April 1998
Name of Station or Unit, Conduct of Engineering Services, Rev. 03, July 1999

Performance Standard: VII. D

While there are many improvements to be made in the chemistry support for station operations, no exceptions were note to regulatory compliance. Applicable documents include:

Name of Station or Unit Organization and Accountabilities, Rev. 14, June 2001
Name of Station or Unit, Conduct of Operations, Rev. 06, April 1998

Performance Standard: VIII. A

One exception noted. At the time of the self-assessment, technical support required for performing the reviews of equipment history as recommended by Assessment Guideline VIII.A.2.C is insufficient. See the response to VII.B above. Applicable documents include:

Name of Station or Unit, Conduct of Maintenance, Rev. 03, November 2000
Name of Station or Unit, Work Management, Rev. 02, October 2000
Name of Station or Unit, Conduct of Engineering Services, Rev. 03, July 1999

Performance Standard: IX. A

No exception noted. Applicable documents include:

Name of Station or Unit, Conduct of Maintenance, Rev. 03, November 2000
Name of Station or Unit, Work Management, Rev. 02, October 2000

Prepared by:

_____
(Name and Title of Individual Performing Assessment for Certification)
This may be the individual who lead the self-assessment, or someone using the output of the self-assessment to prepare the certification summary.

SECTION 4

PENALTIES

INTRODUCTION

The most probable outcome of the Generation Maintenance Program monitoring will be acceptable resolution of any questionable performance, or appropriate corrective actions agreed to by the generating asset owner. This is based on the fact that both parties have goals that are, to a large degree, mutually beneficial. However, this may not always be the outcome. This section outlines the process the CPUC will use in those cases where the CPUC identifies questionable practices and the outcome remains contentious.

Monitoring Process

As outlined in Section 2 of the Generation Maintenance Program, Generating Unit Performance Metrics, the CPUC will primarily monitor the effectiveness of maintenance programs by monitoring the performance of the generating unit itself. When questionable performance is noted in the Unit's CUF or other operational data, the CPUC will implement an interrogatory process to determine the cause for questionable performance. This process will include, as a minimum, the following steps:

1. Review of CUF data against pre-defined performance analysis thresholds.
2. Review of other NERC GADS operating data for adverse trends. As a minimum this would include review of the following for impact of changes in operating practices:
    a. Net Actual Generation for the period compared to historical
    b. Actual starts for the period compared to historical
    c. Service hours for the period compared to historical
    d. Outage hours for period compared to historical
3. Review Outage information for the affected unit.
    a. Deferrals of scheduled outages
    b. Denials of requested outages
    c. Forced Outage and Derate History.
4. Examine unexplained questionable performance with the Generating Asset Owner by any, or all of the following:
    a. Review prior communication with Generating Asset Owner (if any).
        i) Discussion of prior performance questions
        ii) Notification of prior equipment problems
    b. Direct telephone conversations.
    c. Conduct an on-site visit.

If this investigation does not identify mitigating circumstances explaining the change in performance, the CPUC shall conduct a "Triggered Audit" in accordance with the guidance in the Verification and Audit section. In preparation for this audit, additional information will be reviewed, as applicable:

1. Review reports from prior audits (if any)
2. Review of information from prior site visits (if any)

Actions

Findings include, but are not absolutely limited to:

1. A material discrepancy in the generating asset owner's certification report
    a. No evidence to substantiate a claim made
    b. Justified alternative not achieving results
2. Performance not meeting standards
    a. Poor unit performance without mitigating factors
    b. Not performing to something that was accurately stated in certification
    c. Clearly not meeting one or more performance standards
    d. Failure to meet a prior commitment to take action
3. Inaccurate or untimely performance metric reporting

SECTION 5

GLOSSARY OF TERMS

ISO Generation Maintenance Program Glossary of Terms

Capacity Unavailability Factor CUF The percentage of lost capability due to planned outages, maintenance outages, scheduled outage extensions, forced outages, and planned or unplanned restrictions on capability (Derate).

Derate – Placing a temporary restriction on the capability of a Generating Asset to allow continued Availability of the Generating Asset. Derated Capability may be the result of equipment failures or degradation, approaching limits, such as emission control limits, or any other reason deemed necessary by the generating asset owner to ensure continued safe and legal operation of the generating asset.

Generator – The seller of Energy or Ancillary Services produced by a generating unit.

Generating Asset) – A generating device that has a metered output, or an administratively defined group of generating devices, that may or may not have individual metered outputs, but are aggregated for performance measurement.

Generating Asset Class– An administrative grouping of generating assets based on certain attributes, typically for the purpose of defining applicable maintenance practices or performance standards.

NERC ----The North American Electric Reliability Council or any successor thereto.

Acronym Listing

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
CUF	Capability Unavailability Factor
CAISO	California Independent System Operator
EEI	Edison Electric Institute
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
GADS	Generating Availability Data System
IEEE	Institute of Electrical and Electronic Engineers
INPO	Institute of Nuclear Power Operations
NERC	North American Electric Reliability Council
OSHA	Occupational Safety and Health Administration
MR	Maintenance Request
WECC	Western Electricity Coordinating Council

APPENDIX A

MAINTENANCE GUIDELINES FOR ELECTRIC GENERATING FACILITIES

("[Committee] Staff shall perform further edits to Appendix A, and resubmit Appendix A to the Committee for consideration as additional standards for generators." – Committee Resolution 2, ordering paragraph 4, adopted May 2, 2003)

General Introduction

Each section described herein is an essential element of an effective maintenance program. The manner and extent to which it is applied, can vary significantly from one Generating Asset Owner's Maintenance Program to that of another.

It should be noted that "Maintenance" includes those actions that prevent structures, systems, and components from degrading or failing, and to restore intended functionality following failures. Therefore, maintenance includes not only the activities traditionally associated with identifying and correcting actual or potential degraded conditions (that is, repair, surveillance, and other preventive and predictive measures), but also extends to supporting functions for the conduct of these activities. Examples of these functions include operator identification of equipment performance and material condition deficiencies, engineering support of maintenance, some aspects of chemistry control, record keeping, document control, and training. These guidelines are directed at those actions performed primarily by mechanical, electrical, instrument, planning, scheduling and materials management functions. Generating Asset Owners should ensure that similar program guidance is developed and implemented by those functional organizations that support the larger concept of "Maintenance".

These guidelines have been provided to support Section 1, the Generation Maintenance Performance Standards & Assessment Guidelines and assist Generating Asset Owners in meeting the objectives of that section. It is intended they be used to review existing programs and make revisions as required, or to develop and implement new programs. The program guidelines reflect generally accepted methods for effectively conducting maintenance activities. Differences between practices described in the guidelines and those of the Generating Asset Owner should be assessed to determine if change is warranted. A change to practices would be appropriate if performance weaknesses exist.

These guidelines support Section 1, the Generation Maintenance Performance Standards & Assessment Guidelines. That document along with these guidelines should be useful to company managers and staff members responsible for maintenance. The CPUC will use the guidance contained herein when conducting audits of Generating Asset Owner programs.

I. Maintenance Organization Management and Leadership

A. INTRODUCTION

Establishing and communicating high standards, monitoring personnel and equipment performance, assessing the effectiveness of the maintenance program, and implementing improvements with an emphasis an individual accountability is an essential step towards strengthening the management of maintenance activities. To that end:

- Company and station managers should establish safety as the highest goal in all company endeavors. Individuals at all levels should include respect for safety in decision-making, and foster an environment that supports questioning attitudes. Policies, standards and procedures should be developed around the principle of safety first.
- Company and/or station managers should establish and reinforce maintenance standards that provide clear direction to maintenance personnel. Standards should clearly define maintenance objectives, expected performance levels, and responsibilities and accountabilities for maintenance activities. Standards for maintenance activities should be integrated into maintenance department policies and procedures. Maintenance standards should be reinforced in training.
- Department goals and objectives should be derived from company goals and objectives, and provide direction, establish standards, and foster continuing improvements.
- Company and maintenance management should effectively monitor and assess maintenance activities. Managers should motivate maintenance managers to observe the activities of workers in the field and initiate coaching or corrective action.
- Managers should continually assess the effectiveness of maintenance programs through a variety of techniques such as collecting and analyzing selected data, observing work practices in the field, and identifying root causes of maintenance-related problems. This assessment should address personnel and equipment performance and the effectiveness of processes. Maintenance department staffs should be trained to perform these types of assessment activities.
- Maintenance personnel should be held accountable for their performance. Effective feedback mechanisms for personnel performance, such as managerial coaching, performance appraisals, recognition and rewards, and disciplinary measures should be established. Feedback should be actively solicited from all members of the maintenance organization.
- Maintenance managers should effectively manage change within the organization. Maintenance performance should be closely monitored to

ensure changes have the intended effect and to make additional modifications, as necessary.

B. GUIDELINES

Managers should establish mechanisms to provide direction to personnel conducting maintenance activities. These mechanisms should employ both written and oral means and address the following aspects of management.

1. Maintenance Department Standards

Maintenance managers should establish and maintain high standards of performance and ensure implementation of company and department policies that affect the achievement of these standards. Clearly define responsibilities for implementing these standards and policies, including the responsibility of maintenance personnel. Although management sets the standards, it is important that workers are given an opportunity to help define them. Maintenance personnel must understand their authority, responsibility, and interfaces with other groups. Industry and station operating experience should be used to develop performance standards. Industry technical standards such as IEEE, ASME or ANSI documents that normally provide scientifically developed and industry-accepted parameters for fulfilling technical performance criteria may also provide a basis for some maintenance standards.

Department standards should also provide guidance for the development of other more definitive documents that govern maintenance activities such as policies and procedures. Methods should be specified for the controls necessary to develop, revise and implement department standards.

2. Lines of Communication

Clear lines of communication should be developed among departments and external groups that contribute to and support the maintenance function (for example, operations, construction or modifications, materials management, engineering, and training). The maintenance program should clearly depict the relationships among these supporting groups, as related to overall generation/station maintenance, by defining responsibility and authority and addressing organization and process interfaces. Communications protocols should be defined to ensure information across interfaces is transmitted accurately and efficiently. The

degree of control should be sufficient to ensure accuracy, but informal enough to prevent stifling teamwork.

3. Long Range Planning

Long range planning of maintenance programs is required to achieve high levels of equipment availability and reliability over the life of the plant. Resources can be managed to support ongoing maintenance and continuous improvement of equipment performance and reliability. Activities that should be included in maintenance program long-range planning includes, but are not limited to:

- company business planning
- coordination with California ISO
- recurring major maintenance items such as turbine overhaul, boiler inspections, transformer testing and major pump rebuilds
- planned maintenance outages
- major projects and modifications requiring maintenance organization involvement
- future organizational and staffing changes
- life cycle management, e.g., replacement of components that are projected to reach the end of their service life or become obsolete
- coordination of common resources used for outages with other plants
- contingency plans for system operations, environmental or industry issues and events that may impact the maintenance program
- contractor and company support
- personnel development needs
- audits and self-assessments to determine effectiveness of maintenance activities

4. Goals and Objectives

Maintenance goals should be consistent with, and supportive of, company goals and serve to focus management and worker direction. Maintenance goals should be used as a management tool to in improve generating asset performance. Examples of general goals related to maintenance include the following:

- personnel safety goals
- reduction in the number of unit trips caused by maintenance activities or maintenance preventable failures
- reduction in the number of start failures caused by maintenance activities or maintenance preventable failures
- reduction in the number of derates or ramp rate restrictions attributable to maintenance program deficiencies
- reduction in equipment deficiencies that adversely impact the operators' ability to effectively operate the plant
- decrease the number and duration of unplanned outages

- optimize timeliness of scheduled preventive maintenance activities, and predictive maintenance activities
- optimize corrective and preventive maintenance backlog
- work delays by cause

Goals should be challenging but achievable. Actions to support the goals are determined with input from personnel involved in conducting maintenance activities. Additionally, the status of meeting goals is given frequent and wide dissemination.

5. Monitoring

Maintenance performance is monitored through observations of work activities, inspection and monitoring of equipment performance, and follow-up of corrective actions.

a. Manager Field Observations

Managers should routinely monitor work in progress to determine ways to improve maintenance and verify maintenance activities are conducted in accordance with policies and procedures.

Good work practices are recognized and encouraged; improper work practices are corrected on the spot. Self-checking is reinforced. Causes of improper work practices are identified and corrected, and generic corrective actions are initiated as needed. Corrective actions to consider include clarifying expectations, holding workers accountable for their actions, and revising training programs. Examples of practices or conditions to be checked include the following:

- proper use of pre-job and post-job briefings (tailboards)
- industrial safety protection practices
- worker awareness and knowledge of the impact of maintenance on system/plant performance
- quality of workmanship, material, and parts
- use of and adherence to procedures and policies
- practices for foreign material exclusion
- use of correct tools for the job
- maintenance of clean and orderly work sites
- work progress and time required to perform the job, especially if time-critical maintenance is involved for equipment vital to plant operation
- work being performed on the correct component, system, and unit
- adequacy of turnover for work spanning multiple shifts

- adequacy of post-maintenance tests
- techniques for quality verification
- effectiveness and timeliness of communication of problems and delays encountered in critical activities
- worker knowledge and proficiency on maintenance being performed

b. Performance Indicators

Selected maintenance data is monitored and trended to identify performance barriers toward achieving maintenance goals and objectives. Periodic reports to management include trends, a brief explanation for trends that appear to be unusual (positively or negatively), and corrective measures where warranted. The number and nature of data to be monitored may be affected by the maintenance information management system. The following are examples of quantitative and qualitative measures that should be considered when developing a performance-monitoring program.

1. Preventive Maintenance (PM) Effectiveness

- number of equipment failures
- mean time between failures
- preventive maintenance tasks overdue
- number of overdue preventive maintenance tasks deferred with technical justification
- components and systems requiring corrective maintenance more than a designated number of times within a given interval
- components and systems with high unavailability or low reliability
- analysis reports of component performance that indicate failure rates greater than industry wide averages
- historical equipment data that indicates high maintenance cost

2. Availability of Spare Parts

- items not in stock on demand (percent of stock items not available on request)
- scheduled work requests delayed because of parts
- work requests in progress with material restraints
- quantity of discontinued and infrequently used inventory

3. Planned and Unplanned Outage Effectiveness

- actual length of outage compared to scheduled duration
- amount of scheduled work not performed
- amount of unscheduled work added to outage
- evaluation of plant performance following the outage

4. Rework

- Rework monitoring data is collected on a clear definition of rework.
- corrective maintenance recurring within a specific period
- additional maintenance required during or following completion of maintenance activities, possibly involving the following:
  - incorrect re-assembly
  - damage to other components during maintenance
  - post-maintenance test failure

5. Work Productivity

- trending of man-hours expended per work item, particularly repetitive tasks
- summaries of items scheduled versus items completed
- direct observation of work and identification of barriers to work productivity
- benchmarking to compare with similar size/age units

6. Management Effectiveness

- analysis of trends in program strengths or weaknesses, communication skills, procedure adherence, and safe work practices, as indicated by personnel errors and their causes
- performance in reinforcing management expectations, as indicated by overall department performance or by maintenance program monitoring data and self-assessments
- monitoring of manager during conduct of assigned tasks
- performance of workers assigned to an individual manager, as indicated by injury rate, personnel errors, rework, and productivity
- manager observations of maintenance and training activities and associated reports to management

6. Self-Evaluation

Self-evaluation activities, including inspections, audits, reviews, and investigations, are necessary for an effective maintenance program. Self-

evaluation activities should be balanced to provide the management team with a comprehensive view of past performance and identification of improvements needed to meet projected performance goals. The following four approaches should be considered when self-evaluations are conducted:

- reactive - conducted in response to a performance shortfall, such as root cause analyses of a critical component failure or an adverse trend in rework
- continuous - conducted on a routine basis to identify performance strengths and shortfalls; for example, manager in-field observations, post-job critiques, and accident prevention
- periodic - conducted on an event-dependent or periodic basis, such as a post-outage critique and scheduled program assessments
- proactive - conducted to identify improvements needed to move performance to levels that are above current expectations or to prepare for performance of an evolution; for example, benchmarking and infrequently performed tests

The following are proven successful assessment methods.

II. a. Comprehensive Self-Evaluation

Assesses the overall effectiveness of the maintenance program. Key attributes of successful comprehensive self-evaluations include the following:

- The self-assessment is a performance-based review of maintenance field activities that evaluates program implementation, rather than a programmatic review of maintenance procedures and policies for compliance with governing documentation.
- Sufficient resources, both personnel and time, are allocated for self-assessment activities. An unbiased input can be achieved by involving personnel from external organizations.
- An agenda is developed for the self-assessment with specific areas to examine and a clear definition of standards that are expected to be met in each area.
- Ownership is established for resolving issues developed in the self-assessment, with a specific time frame for resolution.

III. b. Program Reviews

Specific elements of the maintenance program are evaluated to identify and correct program strengths and deficiencies. Such reviews, which may be performed by personnel outside the maintenance organization, and include input from maintenance managers as well as from groups such as operations, technical staff, and appropriate company departments. The evaluations address the overall effectiveness of program elements and inter- and intradepartmental coordination. Areas needing improvement are assigned for corrective action and follow-up. In addition, other work groups evaluate strengths for possible emulation. Examples of topics to be considered include the following:

- training and qualification of maintenance staff
- maintenance facilities and equipment
- planning of maintenance work
- scheduling of maintenance work
- post-maintenance testing
- conduct of on-line maintenance
- procurement of parts, materials, and services
- maintenance history
- trends in maintenance-related industry events
- results from inspections of maintenance activities at other facilities
- maintenance best practices as identified by industry support organizations such as Institute of Nuclear Power Operations and the Electric Power Research Institute.

7. Maintenance Problem Analysis

Systematic analysis methods are used to determine causes of equipment and personnel performance problems or maintenance-related incidents. A threshold for selecting incidents that warrant root cause analysis is established. The initiation of root cause analysis may result from a management request, an adverse trend, or a desire for assistance in solving a specific problem. Analysis of human performance errors to address the organizational and environmental factors influencing individual behavior could help identify contributing factors to human performance errors. Incident reports, post-outage reviews, and other similar operating experience review methods supplement the maintenance history program and provide data, including human error data, to be reviewed by the analysis program.

Maintenance Problem Analysis include the following elements:

IV. a. Root Cause Analysis Initiation Criteria

Incidents that require root cause analysis are identified based on incident type and performance trends. Maintenance department management establishes the required threshold for conducting root cause analyses of maintenance incidents. Considerations in making this selection include the following:

- actual or potential consequence of the incident in relation to plant or equipment reliability, and personnel safety
- sequence of occurrences or multiple failures during the incident
- recurring maintenance and human performance problems or equipment failures
- unexpected conditions encountered during the incident
- previous corrective action taken for similar incidents

Some factors that contribute to the success of a root cause analysis include the following:

- providing adequate time to investigate
- quarantining the area after an incident to prevent inadvertent loss of as-found information
- interviewing involved personnel as soon as possible after the incident while circumstances are still clear and perceptions have not formed that may rationalize away clues to the root cause

V. b. Information Collection, Analysis and Cause Determination

All relevant maintenance performance information is collected, analyzed, and actual or probable causes of a problem are evaluated as appropriate. Events or conditions not identified as warranting specific investigation for cause are trended to identify adverse performance trends. Adverse trends can then be investigated to identify apparent or root causes. Some proven techniques available for analyzing information to determine causes of problems. Examples of these include the following:

- event and causal factor charting
- barrier analysis
- walk-through task analysis managers
- interviewing
- change analysis and fault-tree analysis

Regardless of the technique used, direct involvement by maintenance line managers, and workers in this process is essential to achieve desired continuous improvements and buy-in by maintenance personnel.

To be validated, potential root and contributing causes meet the following criteria in relationship to the problem:

- The problem would not have occurred had the causes not been present.
- The problem will not recur because of the same causal factors if the causes are corrected or eliminated.

Care should be taken not to limit analysis to merely addressing the symptoms of a problem. Symptoms may be causes in themselves, but more often they are only indications that need to be pursued to find the underlying causes.

VI.

VII. c. Corrective Action

Once causes have been identified, additional action is taken to verify that correction of these causes will prevent recurrence. Viable

corrective actions should be identified for each cause. The following criteria can be used to determine viability:

- Will these corrective actions prevent recurrence of the condition?
- Is the corrective action within the capability of the organization to implement?
- Have assumed risks been stated clearly and evaluated appropriately?

Planned corrective actions should be assessed on the impact they will have on the causes and whether they meet the above criteria. They must also be assessed in terms of the impact they will have on other plant systems/components or organizations. Root causes of incidents frequently involve management issues. Therefore, management should be involved and willing to take responsibility for corrective actions related to management issues. Once corrective actions have been defined and received management concurrence, they should be prioritized, scheduled, and tracked to timely completion. Interim compensatory actions may be required for those cases involving corrective actions, which will require a long time to implement.

VIII. d. Reporting Results

The results of the problem analysis should be presented to appropriate management in sufficient detail to allow an understanding of the incident, its significance, the causes, and the recommended corrective actions. The same information should also be conveyed to appropriate personnel in a timely, manner to help prevent recurrence, e.g., at tailboard sessions, shift relief or in training sessions. Lessons learned that might be of interest to other station departments should be identified, and an effective method of communicating them employed.

IX. e. Effectiveness Review and Extent of Condition

If a maintenance-related event recurs, the original condition or event, in addition to the new condition or event, should be reevaluated. Methods are developed for tracking and trending corrective action and cause information. The program should address the extent of condition or common causes among different organizations, processes or systems/components. The self-evaluation process should be used to determine causes that contribute to recurrence of the performance weakness. In the case of an equipment problem, post-maintenance testing and performance monitoring may be required to determine if additional maintenance work or diagnostics should be performed. Extended monitoring of equipment during various modes of operation may be necessary to provide assurance that the cause(s) have been properly corrected. Long-term follow-up as a part of Self-Evaluation is appropriate to determine if the desired results are obtained from

corrective actions such as retraining, procedure changes, and preventive maintenance changes.

8. Accountability

Accountability for the effectiveness of the maintenance program should be clearly established. This includes ensuring clear understanding of performance expectations. This should include the expectations of managers, engineers, planners, craftsmen, warehouse personnel, and other personnel who support maintenance. A key element of personnel accountability is an environment in which feedback and communication are continuously encouraged. This environment supports the recognition of strengths and weaknesses and encourages participation in improvements.

Use feedback through such tools as performance appraisals to improve maintenance personnel performance. Accountability must include recognition of superior performance. Counseling, remedial training or disciplinary measures should be used to encourage personnel not meeting expectations, as appropriate.

II. Maintenance Personnel Resources

A. INTRODUCTION

The size, organization and required skill sets of the maintenance organization should be adjusted to the specific mission of the organization. The organization should be described in terms of reporting structure, e.g., Organizations Charts, which depict reporting relationships and communication structures, and responsibilities and accountabilities of each position or category of worker. Knowledge and skills required by an individual to perform each of the defined jobs should be assessed, and methods developed to ensure that individuals possess the requisite knowledge and skills prior to being assigned to perform in an un-supervised manner.

Methods to develop the requisite skills and knowledge for new employees or newly promoted individuals may include:

- classroom training
- on-the-job training
- self-study
- apprenticeships

Methods used to assess the level of skills and knowledge includes, but is not limited to:

- written examinations
- oral examinations
- observations of simulated performance
- observation of actual performance under supervised conditions

Maintenance tasks may vary from very simple tasks performed routinely to those, which are very complex or are performed at very infrequent intervals. Personnel continuing training and re-qualification programs should be considered to sustain requisite performance competency, especially for complex, infrequently performed tasks. Management and personnel have unique knowledge and skills requirements. These should also be addressed for initial training and qualification process as well as on-going training.

In cases where the maintenance of requisite numbers or specific skills within the in-house organization is not economically practical, or unexpected demands on in-house resources are beyond their capability, use of contracted resources is often used. Appropriate methods should be employed to ensure that adequate controls are applied to the contractor(s) personnel and performance to ensure the desired outcome without personnel safety events or damage to systems, structures or components.

B. GUIDELINES

1. Organization, Responsibilities and Accountabilities

The maintenance organization should be developed around the defined mission. The mission should address such factors as:

- the number and type of assets to be maintained
- the geographical location of the assets to maintained
- the operational criticality of the assets to be maintained
- the company strategies for maintenance
- availability of supplemental resources
- availability of spare parts and replacement equipment
- capabilities of support services such as original equipment manufacturers or specialty service contractors

Task analysis should form the basis for initial resource requirements, and should account for:

- span of control for managers
- industry experience with operating and maintaining the equipment within the maintenance mission
- labor agreements
- geographical location of assets within the maintenance mission
- criticality of maintenance to the company mission

Performance measures should be established to provide feedback on organization size and structure.

2. Responsibilities and Accountabilities

Management expectations for the maintenance organization should be clearly communicated. Some methods available for this include:

- job or position descriptions
- annual performance contracts

Such documents should not only establish objective performance goals, but also define freedom to act in terms of decision-making and execution authorities, and expected communication thresholds when the incumbent should seek additional guidance.

Job and/or Position Descriptions should be used as a source document when performing job/task analysis for knowledge and skill requirements for training and qualification programs.

3. Maintenance Training Programs

The training and qualification program provides a foundation for the basic skills and knowledge (skill of the worker) that a worker (contractor and permanent staff) must possess to perform the job. This refers to any tasks that may be performed as part of a procedure or work order but are not described in detail. This could include such things as the ability to perform administrative duties, use of basic hand tools or proper use of basic measurement and test equipment. The level of detail included in the procedures and extent of management oversight will dictate knowledge and skill proficiency needs for workers.

Management, with assistance from training, establishes and maintains training and qualification programs that meet Maintenance Department needs. Management establishes qualification standards and evaluation methods to verify maintenance personnel (employee and contractor) competence for assigned functions. Specific accountabilities include but are not limited to the following:

- Design, develop, implement, evaluate, and modify training and qualification programs to meet the needs of maintenance personnel.
- Train managers, planners, schedulers, engineers, storekeepers, and craft and contractor personnel, as well as personnel in other positions deemed necessary by the company.

In the training and qualification program, include initial training to provide personnel with the knowledge and skills necessary to perform work and continuing training to maintain and enhance worker knowledge and skills.

4. Maintenance Personnel Initial Training and Qualification

Initial training and qualification verify that maintenance personnel possess the knowledge and skills necessary to perform job functions competently before independent job assignments. Topics in this training should include, as appropriate, the following:

- orientation training that acquaints the trainee with maintenance and site facilities, interdepartmental responsibilities, communications, and department philosophy
- industrial safety training to increase trainee awareness of industrial hazards at the station and adherence to safety precautions in the performance of daily activities
- regulatory limitations imposed on the types of activities to be performed, e.g., hazardous waste handling, OSHA, fire protection, asbestos abatement, ASME or IEEE codes, local or state building codes.

- fundamentals training in mathematics, physics, electrical science, and properties of materials to provide the trainee with the knowledge of technical concepts that are applied during daily maintenance activities
- tools and equipment skills training to provide the trainee with the knowledge and skills needed to select, inspect, use, and care for tools and equipment used in maintenance
- plant systems training to provide the trainee with an understanding of plant systems, including the purpose, major component functions, principles of operation, interface with other plant systems, and alarms and indications affected by maintenance
- specific system component training to provide the trainee with in-depth knowledge and skills required to maintain the equipment
- configuration control training to sensitize maintenance personnel to maintenance activities that could change the design configuration of the plant
- on-the-job training and task performance evaluation to teach and evaluate job-related knowledge and skills within the job environment and develop an understanding of management standards and expectations
- basic planning and scheduling skills used by maintenance to include familiarity with the content of work packages, scheduling tools, and computer-based information management systems
- cross-discipline/multiple task training to develop worker knowledge and improve productivity

5. Maintenance Personnel Continuing Training and Re-qualification

Continuing training verifies that workers' knowledge and skills needed to successfully perform assigned maintenance tasks are maintained and enhanced. This training includes changes in generating unit configurations and procedures, regulatory requirements, and applicable lessons learned from industry and in-house operating experiences. In addition, improvement in maintenance personnel job performance and development of broader scope and depth of job-related knowledge and skills also are goals of a comprehensive, continuing training program.

Continuing training topics address maintenance personnel needs identified through ongoing reviews of personnel job performance. Continuing training topics could include the following:

- observed problems or job performance weaknesses
- changes to processes, procedures, and equipment; industry and in-house operating experience
- lessons learned from outage critiques
- generating unit systems and component training for infrequently performed or difficult tasks
- fundamentals refresher training to maintain and improve maintenance personnel knowledge and skills of academic principles

- cross-discipline/multiple task training to enhance worker knowledge and improve productivity
- training to reinforce management standards and expectations, such as self-checking, procedure adherence, and tool use

Certain jobs, particularly those involving special processes, may require periodic re-qualification, or demonstration of skill at an acceptable level. Jobs that typically require re-qualification or re-certification would include, but not be limited to:

- welders
- quality control inspectors
- asbestos workers
- confined space entry watch

6. Training Program Records

Records of each individual's performance in the training and qualification program are maintained in an auditable manner. Typically these records document:

- the results of final written, oral, and practical demonstration examinations
- on-the-job training and task performance evaluations

In addition, records of program content and training effectiveness evaluations are maintained. Maintenance managers have access to qualification records as necessary to support the assignment of work to qualified individuals.

7. Training Program Approval, Effectiveness, and Feedback

Managers should monitor the performance of maintenance personnel to identify initial and continuing training program enhancements and emphasis. Results of self-evaluations should also be used as input to training program changes. Trainee's feedback on his or her perception of and suggestions for improving the training program, is a critical element in maintaining effective training programs.

When reviewing maintenance-training programs, consider any performance trends as a result of monitoring activities that indicate maintenance knowledge or skills need improvement.

Identify generic weaknesses that should have been prevented by effective initial training, perform appropriate cause analysis and take corrective actions to eliminate the training program deficiency.

8. Management Training

A structured program should provide the training needed to develop and maintain management skills. This training should:

- Address needs of new first-line managers to aid them in managing maintenance activities
- Accommodate plant staff serving as temporary managers or coordinators of maintenance projects to determine if management skills' training is needed.
- Use career progression planning to help customize the training program for personnel being considered for specific managerial positions.

9. Control of Contractor Personnel

Non-department and contract personnel should perform maintenance under the same controls as, and to the same high work standards expected of, maintenance personnel. Maintenance managers should hold non-department and contract managers accountable for the work of their personnel. Consideration should be given to training and qualifying non-department and contractor personnel who perform planning, scheduling, maintenance, or modifications independently on generating unit systems to the appropriate level on maintenance organization administration, safety, chemical control, quality control, and regulatory limitations.

Exemptions to these training requirements may be considered and allowed for:

- Experienced personnel through examination and demonstration of skill level.
- Those individuals for whom management reviews, of the individual's training records, and job history, provides acceptable confidence that the individual can perform competently.
- For those contractors or vendors with recognized specialized knowledge and skills beyond department expertise, the process may be limited to a review of work history and contact with prior customers.

When practical assign non-department and contract personnel who are not fully trained and qualified for the job to work with qualified personnel until training is available or until competency is obtained through on-the-job training.

III. Maintenance Categories or Types

A. INTRODUCTION

Maintenance programs typically include two basic types of maintenance: corrective maintenance and preventive maintenance (time-based and condition-based). A number of maintenance programs further divide these basic types. For example corrective maintenance may be sub-categorized based on complexity into minor, and planned work. Sub categorizing of preventive maintenance programs is becoming more prevalent. PM programs are typically subdivided into preventive maintenance (time-based) and predictive maintenance (condition-based) as a separate category of maintenance. However, these criteria treat predictive maintenance as a part of preventive maintenance. A proper balance of these types of maintenance provides a high degree of confidence that equipment degradation is identified and corrected, a high level of unit and system availability and reliability is maintained, equipment life is optimized, and the maintenance program resources efficiently used.

This section provides guidelines for establishing the proper relationship of the types of maintenance in the maintenance program. It does not specifically address maintenance activities integrated into operating requirements; however, consider operator surveillance's, ASME inspections and in-service testing requirements when establishing the scope of the preventive maintenance program.

Many factors must be considered when establishing an effective and efficient balance of the different types of maintenance. On important systems and equipment (for example, emission treatment systems or systems important to unit reliability or personnel safety), a thorough technical analysis may be needed to refine this balance. On less important systems, the amount of preventive maintenance may be determined using experience and engineering judgment.

A proper balance of the types of maintenance may include no preventive maintenance for equipment that is allowed to run until failure, provided the failure would not adversely impact operations and is more cost-effective than preventive maintenance. Conversely, for equipment whose failure can adversely impact safety or reliable operation or result in forced outages, or significant derates, extensive preventive maintenance may be required. The purpose of preventive maintenance is to significantly reduce the frequency of equipment failure. Increased preventive maintenance results in improved safety, reliability, and availability, as well as reduced corrective maintenance. However, if performed unnecessarily or excessively, preventive maintenance can consume valuable and limited resources that could otherwise be used to extend the scope of the preventive maintenance program. Additionally, excessive preventive

maintenance may unnecessarily increase the potential for operational or maintenance errors, unavailability, rework, and increased costs.

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The elements needed to successfully implement the maintenance program discussed above include the following:

- a comprehensive master equipment list or equivalent to help in selecting and scheduling maintenance activities
- a methodology for determining the correct type and frequency for preventive (time-based) maintenance and predictive (condition-based) maintenance technology for each system and component
- coordination of maintenance actions that allows other related maintenance to be performed concurrently
- review and approval of preventive maintenance actions deferred past a grace period (normally a predetermined percent of the established interval) or postponed until the next scheduled date -- This review should include documented engineering evaluations, as required, to determine the acceptability of the equipment based on a lack of preventive maintenance.
- continuing enhancement of the maintenance program through periodic review of preventive and corrective maintenance effectiveness

B. GUIDELINES

10. Master Equipment List

A detailed master list of equipment, components, and structures to be included in the maintenance program is essential to help in selecting and scheduling preventive maintenance and to evaluate the effectiveness of the maintenance program. The list normally is developed and controlled by or with assistance from the engineering support organization and can be used for other purposes, such as determining the code classification of components, procurement specifications for parts and materials, and creating consistent nomenclature for equipment labeling. Special tools and equipment should also be included in the master list. This list also could be used effectively to help establish the maintenance history program and to determine the necessary parts required to maintain equipment.

2. Types of Maintenance

X. a. Corrective Maintenance

Corrective maintenance is restoration of equipment or components that are degraded or not performing their intended functions. As a rule, if the specific component (for example, packing or bearing) requiring maintenance has degraded or failed, the action required to

repair it is classified as corrective maintenance. Corrective maintenance can be minor, or planned (more significant activities that require planning to correct). Non-urgent preparation and planning normally precede much of this work.

Ideally, the majority of these repairs will be to equipment previously selected to run until failure because its loss does not appreciably affect safety and reliability, and it is more cost-effective to run to failure. Only a small fraction of the corrective maintenance effort should be needed to restore equipment that limits safe and reliable operation or results in a forced power reduction.

Corrective maintenance can be performed with the unit in or out of service. In-service maintenance activities are selected based on operational impact and contribution to safety and reliability. Perform activities that can affect plant safety or reliability only after safety and operational assessments, detailed planning and scheduling, job briefings, and coordination with all necessary personnel have been completed. Have contingency plans, resources, tools, materials, and equipment in place in the event of a problem that could result during the corrective maintenance. Schedule work to maximize critical system availability and to ensure maintenance can be performed within committed time limits.

The impact of corrective maintenance activities on the design and configuration of equipment and systems should be evaluated to identify where configuration control processes should be applied. Personnel should be knowledgeable of corrective maintenance work activities that may result in changes in plant configuration, e.g., unauthorized part substitutions, repairs that do not comply with design specifications or code requirements.

XI. b. Preventive Maintenance

Preventive maintenance includes predictive (condition-based) and periodic (time-based) actions taken to maintain a piece of equipment within design operating conditions and to extend its life. It is normally performed before equipment failure in order to reduce the likelihood of equipment failure. The distinction between predictive and periodic maintenance is presented below.

1. Predictive maintenance monitors conditions and the results are used to trend and monitor equipment performance so that needed corrective or preventive maintenance can be performed before equipment failure. Predictive maintenance actions are determined by the data required to monitor equipment condition. Examples are as follows:

- Vibration analysis (includes spectral analysis and bearing temperature monitoring) and lube oil and grease analysis are used to monitor rotating equipment.
- Check valves are tested and analyzed, and a program exists for maintaining a history of test results. Non-intrusive testing techniques, such as acoustic monitoring, may be used for this purpose.
- Infrared surveys (thermography) are performed on heat-producing equipment such as motors, circuit breakers, batteries, load centers, bus ducts, transformers, and insulated areas to monitor for high resistance or insulation breakdown.
- Oil analyses (tribology) are performed on lubrication for rotating equipment to identify degrading equipment and chemical breakdown of lubricants.
- Motor-operated valves are diagnostically tested and analyzed. Tests determine parameters such as run current, valve stem thrust, and torque switch and limit switch actuation points.
- Air-operated valve testing is performed. Test parameters for air-operated valves include operating pressure, stem thrust, and stroke time.

Selected process data is identified; normal values and acceptance criteria for the operating condition of the equipment are established; and readings, such as differential temperatures, pressures, and motor running currents, are monitored and trended for the operating condition of the equipment to detect degradation.

When predictive maintenance requires in-process monitoring of the equipment, such action specifies the proper conditions, system configuration, and operating parameters to establish reliable and trendable data. Equipment-monitoring locations are identified and marked to obtain consistent readings each time the predictive maintenance data is recorded. Knowledgeable individuals gather, review, and analyze this data for the predictive maintenance program. Include an analysis of the equipment history of failed components to help validate the correlation between predictive maintenance data and field conditions and to determine shortcomings in the program.

(2) Periodic maintenance is time-based action taken on equipment to prevent breakdown and involves servicing such as lubrication, filter changes, cleaning, testing, adjustments, calibration, and inspection. Periodicity and required actions should be derived from Original Equipment Manufacturers recommendations, and modified based on actual application and industry experience with the equipment. Periodic maintenance can also be initiated because of the results of predictive maintenance, or experience. Examples are as follows:

- scheduled valve repacking because of anticipated leakage based on previous experience

- replacement of bearings or pump realignment as indicated from vibration analysis and/or lubricating oil analysis
- major or minor overhauls based on experience factors or vendor recommendations

3. Maintenance Action and Frequency Selection

Using the master equipment list, analyze preventive maintenance actions and their frequencies to identify periodic actions to improve equipment performance. Determine the actions selected and their frequencies based on considerations such as the following:

- reliability-centered maintenance analysis techniques, such as problem component or system analysis
- regulatory and code requirements
- vendor recommendations (technical or service information)
- industry and station experience
- maintenance history
- equipment or system availability during operating conditions
- operating history
- engineering judgment
- operator insight/feedback
- cost/benefit evaluations
- function, ease of replacement, and demonstrated reliability of equipment or system

Include in preventive maintenance efforts the analysis of failure modes and frequencies, the determination of failure causes, and the identification of preventive maintenance actions that could improve safety or reliability or reduce operating costs.

Document the justification for the preventive maintenance program. Maintenance and accountable engineering managers approve the program, including new or revised preventive maintenance actions and their frequencies. Effective monitoring and diagnostic methods (predictive maintenance) often are preferred to periodic internal inspection or equipment overhauls.

Although vendor recommendations are an important factor in developing the preventive maintenance program, it is important to establish or validate the basis for the vendor recommendations. Blanket acceptance of vendor recommendations may result in a program that does not reflect the service conditions of the equipment and may cause unnecessary or insufficient preventive maintenance. For example, the environment or operating demands on the equipment may differ from the vendor's assumptions when the preventive maintenance recommendations were established.

When a balance is being established between corrective and preventive maintenance as they pertain to the various systems and equipment, the overriding consideration is safe and reliable operations.

11. Scheduling

Schedule each preventive maintenance action at appropriate intervals. When possible, combine with corrective maintenance activities on the same equipment/system and with other related maintenance based on equipment similarity or proximity. However, when various maintenance activities are combined, activities should be sequenced to obtain accurate as-found data and conditions prior to any repairs or adjustments.

12. Preventive Maintenance Deferral

Preventive maintenance programs should establish not only frequencies or intervals for performance, but should establish a grace period (normally some percent of the established interval) beyond which the PM action is considered overdue. Management controls should be established to manage deferrals of PM activities beyond the grace period, and limit overdue PM tasks. Deferrals should receive review and approval at a level appropriate to the importance of the equipment. Identify the level of review for different types of equipment in the procedures or database used to implement the preventive maintenance program. Reviews for safety or operationally important equipment should have sufficient technical input to ensure any potential consequences are recognized and addressed. Maintenance management should review statistics on overdue and deferred preventive maintenance actions periodically.

13. Preventive Maintenance Program Effectiveness

The preventive maintenance program should be continually reviewed for effectiveness, with subsequent changes based on changes in unit design, operating conditions, regulatory requirements, and as-found conditions. Critical to this continuing assessment is obtaining accurate feedback on preventive maintenance tasks, particularly the as-found conditions and actual work performed. In addition, unexpected equipment failures should trigger a critical self-assessment as to why the previous maintenance activities were insufficient to sustain equipment reliability. The primary objectives of the program are to reduce future component failures, optimize preventive maintenance tasks and use of resources, identify program scope, and satisfy regulatory requirements.

IV. Maintenance Procedures

A. INTRODUCTION

One of the key elements needed to consistently perform maintenance in a safe, efficient, and effective manner is the proper use of written procedures. A balanced combination of this written guidance, the worker's skills, and supervision help achieve quality workmanship essential to safe and reliable operation. This chapter describes the important concepts for preparation, verification, validation, approval, control, use, and periodic review and revision of maintenance procedures.

Maintenance procedures provide technical and administrative guidance to workers to help ensure work is accomplished in a correct and systematic manner. This guidance must be technically accurate, complete, and up to date and be presented in a clear, concise, and consistent manner to minimize human error. Industry experience has shown that deficient procedures and failure to follow procedures are often major contributors to significant events. The probability of worker error increases considerably with the use of procedures that are not well written. Maintenance policies or standards should provide guidance for the development and issuance of maintenance procedures that includes development and writing, review, approval, control, periodic review, use, and revision and changes. Administrative procedures, policies or standards should also guide control of reference material, procedure identification, accessibility and storage, and the requirement to maintain accurate procedures.

B. GUIDELINES

14. Procedure Development and Writing

Procedures should be written for and used in all work that could result in a personnel or equipment hazard, transient, degraded reliability, or significant economic risk. Vendor, contractor, or company procedures may be used provided they meet the intent of these guidelines and receive the same approvals as similar maintenance department procedures. The complexity of the work is also a good indicator of the need for a procedure.

Procedures should be written for preventive maintenance actions and written generically for similar preventive maintenance actions. Procedures should also be written for repetitive tasks of a complex nature that require consistent performance. Since these types of procedures are used repeatedly, include information such as resources and skill levels required; time to accomplish the action; special tools, required measurement and test equipment, parts, and materials needed; unit or system conditions required; other industrial safety

requirements and precautions; and the actual steps required to perform the preventive maintenance or repetitive task. They then form an excellent planning and scheduling tool.

Maintenance procedures should be developed in accordance with an approved writer's guide. In addition, review procedures related to new equipment, tooling, or maintenance techniques to identify potential impact to initial or continuing training. Sufficient resources should exist to implement an effective procedure development and review program. Maintenance procedures should be written at a level commensurate with the knowledge and skills of those intended to use them. Provide the information clearly and concisely to minimize the need for interpretation. Consider the following in procedure writing guidance:

- procedure identification and status (titling and numbering, page and revision identification, and originator)
- procedure purpose, scope, applicability, impact on other systems, and operational impact of activity
- consistent format (for organization, instructional step format, instructional step designation, caution and note format, and page format)
- clearly understood text, using standard grammar and punctuation; appropriate level of detail; concise instructional steps in logical sequence; proper arrangement of multiple verb objects; specific nomenclature; quantitative and compatible values; referencing and branching methods; coordination of multiple actions; warning and caution location; effective formatting; and clear table, graph, and data sheet layout
- consistent use of illustrations (for example, preparation, compatibility, views, level of detail, legibility when reproduced)
- clear indication of steps that could initiate a unit upset or derate
- certain systems or equipment (for example, boilerfeed, steam, lube oil systems and electrical switchgear) should have specific instructions for foreign material exclusion
- clear indication of holdpoints, independent verification requirements, or data to be recorded
- systematic unit and system prerequisites, precautions, and limitations
- required special tools and materials, and estimated resources
- clear indication of acceptance criteria, follow-on steps, and restoration instructions
- steps that inform control room operators of expected alarms or equipment operations
- guidance to workers to expeditiously notify control room operators of maintenance that cannot be completed as originally planned or will be delayed and extended past the anticipated schedule
- applicable operating experience information
- procedure development and preparation using personal computer desktop publishing and computer-aided writing programs -- This also aids in providing easy-to-read text and clear illustrations.

- other administrative requirements for successful task completion

15. Procedure Verification

Procedure review should verify the proper format and technical accuracy of a new or revised procedure. Ensure human factors principles and other appropriate administrative guidance is appropriate. Review the procedure against the design requirements for that system or component. This may be accomplished by comparing such sources as the vendor manual, design specifications, and design drawings. One or more reviewers who were not involved in writing the procedure, but who are representative of the intended user audience do verification. Other disciplines such as quality control, engineering, chemistry, and operations should be considered for the review process.

16. Procedure Validation

Validation ensures the new or revised procedure is usable. This validates that the procedure provides sufficient and understandable guidance and direction to the worker and that it is compatible with the equipment or system being maintained. Validation may be done in a shop, in a training environment, on a mockup or simulator, or by the worker and manager during the first use of the procedure.

17. Procedure Approval

Approval is consistent with maintenance department's administrative procedures. As a minimum, the maintenance manager or designee approves maintenance procedures.

18. Procedure Use and Adherence

Procedures should be readily available and clearly identified to ensure the user can determine the purpose, applicability, and physical completeness. Use identification markings sufficient for the user to compare a procedure to some centralized controlling record that verifies the procedure is the most current revision. A means should be provided to check procedures before use to ensure the correct revision is being used. The extent of procedure use may vary considerably depending on factors such as task complexity, consequences of improper performance, or extent of management involvement. Address the following levels of procedure use in maintenance policies or standards:

- continuous use of procedures for activities having direct impact on safety and reliability or difficult, complex tasks independent of the frequency performed

- reference use for tasks easily accomplished from memory or for tasks for which improper actions pose no immediate consequences to workers or equipment
- information use for tasks that can be performed without referring to the procedure

The intent and direction provided in procedures should be followed during the course of activities, regardless of the level of use. If flexibility is given within the procedure that allows the individual to alter the steps or segments of an activity, then the procedure is being adhered to so long as the user stays within the flexibility specified. Maintenance standards should not permit variances from the guidance contained within the procedure without an approved procedure change. Maintenance and, if appropriate, operations managers are notified immediately when a procedure cannot be followed as written or when unexpected results occur. In these instances, work should be stopped with the equipment or system restored to a safe condition. Procedures may need to be changed or revised as described below before restarting.

19. Procedure Control, Periodic Review, and Revision

Maintenance policies or standards should clearly define responsibilities for procedure program administration. Control procedures in accordance with administrative requirements. Review all procedures periodically (for example, every two years or before use for infrequently used procedures) for changes affecting content, such as reference material revisions, permanent incorporation of changes, incorporation of industry and in-house experience, format enhancements, and human factors considerations. Use of checklists for the review ensures the scope and depth of the review is consistent and adequate. Organizational review includes necessary inputs such as an engineering review.

Procedure revisions should receive an equivalent review and approval as new procedures. Review significant procedure revisions to determine potential impact to initial and continuing training programs. This review also evaluates qualifications of personnel presently performing these tasks. Also, include procedure revisions that affect task performance in training, as appropriate.

Administrative controls are needed to support procedure changes (temporary alterations of procedures so that work can be safely continued) and revisions (permanent alterations of procedures that incorporate outstanding temporary changes and other needed updates). Changes and revisions are necessary to correct errors and to ensure procedures reflect current maintenance practices and requirements. As a minimum, technically competent managers review and approve all changes, even those that may not become permanent later. For example, a typical procedure change may require a review by an engineer for technical content, by a maintenance manager for good maintenance practice and human factor principles, and by an operations manager for operational impact and approval. Changes that have to remain in effect beyond their original intent receive the same review and approval as a revision as soon as feasible (normally within two weeks). Insert change information neatly in the body of the procedure to preclude the user's missing the changes when the procedure is used.

A procedure revision is initiated when a change, deemed to be a permanent change, is approved. Control copies of each procedure so that only the currently approved revision with any applicable changes is available for use by workers.

Vendor manuals, or the portions of a vendor manual and other reference materials used in support of maintenance, must be technically accurate, up to date, and controlled. Reference material used in lieu of maintenance procedures (for example, an instruction section of a vendor manual, vendor or contractor drawings) should receive the appropriate review and approval. When vendor recommendations conflict with maintenance experience, a documented engineering evaluation may be required

V. Work Management Process

A. INTRODUCTION

A work management process is a method by which maintenance activities are identified, selected, planned, scheduled, and coordinated. The work management process supports the completion of tasks in a safe, timely, and effective manner to maintain safe and reliable unit operation. Different levels of control are provided for different types of tasks, depending on complexity and risk. The maintenance work management process addresses the following items:

- identification of deficient conditions
- generating repetitive tasks
- evaluating the impact of work activities on risk assessment
- planning and preparing work
- scheduling and coordinating work
- ensuring adequate resources to perform work
- establishing conditions to perform work
- conducting work activities
- controlling work during emergencies
- performing emergent work
- controlling non-department and contractor personnel working at the station
- documenting completed work
- post maintenance testing of work
- implementing removal/return-to-service procedures
- reviewing completed work records
- administrative procedures that describe the control of work, from identification and planning through completion, testing, review, and storage of history real data
- clear identification of responsibility for various types of work, such as packing adjustments, equipment lubrication, and maintenance on portable instrumentation
- a maintenance request (MR) form (electronic or hardcopy)(and/or work package) for directing and documenting maintenance activities -- The MR helps control maintenance activities by providing appropriate reviews and approvals and establishing necessary work controls for personnel safety, unit/system conditions, proper conduct of maintenance, and post-maintenance testing.
- controls on troubleshooting to prevent unauthorized work and equipment modifications
- a method to ensure that safety and risk significance are considered when planning maintenance on safety systems equipment that affects safety and reliability -- A balance is established between maximizing reliability and minimizing unavailability.

- technical reviews to ensure unauthorized modifications are not accomplished under the maintenance request and temporary repairs are appropriately controlled and identified for required permanent repairs, while monitoring to identify rework (maintenance that has to be repeated) and any related programmatic or performance deficiencies
- documentation of work accomplished and the results of post-maintenance tests, including satisfactory and expeditious return to service of the equipment or system
- management review of MRs following completion of maintenance to verify the activity was completed satisfactorily in accordance with maintenance procedures and standards and to capture maintenance history data
- control of non-department personnel and contractors conducting maintenance to ensure they are held accountable to the same policies and procedures as department personnel or that their procedures are reviewed and approved by maintenance management.
- management systems that accurately identify available human and equipment resources and coordinate them effectively to achieve optimum equipment availability and reliability
- provides for collecting and storing equipment maintenance data in the maintenance history database.

The work management process provides the data necessary to plan and schedule maintenance activities effectively. It also provides a means of collecting maintenance data that is used to identify, analyze, correct, and help prevent recurrence of equipment failures. The process used should be comprehensive enough to fulfill these functions, yet simple enough to function efficiently.

Operational control of maintenance is maintained by the proper use of process status and tagout procedures. Maintenance personnel are aware of activities that could impact the design configuration of the plant. These activities are identified and controlled to maintain plant design.

Configuration control is maintained by ensuring that systems and equipment are restored to their original conditions following maintenance. Maintenance personnel are aware of activities that could impact the design configuration of the plant. These activities are identified and controlled to maintain plant design.

Work planning is an important part of the maintenance process. In-depth work planning identifies the required support and detailed scope necessary to accurately schedule and effectively implement maintenance. Defining the work to be performed and providing appropriate procedures or instructions can reduce maintenance errors and improve efficiency of resource application. Assigning work priorities that reflect the relative importance of each job to unit operation maximizes the effect of maintenance in maintaining and improving safety and reliability. Planning also reduces work delays by ensuring that necessary support items such as special tools, other equipment, and repair parts and materials are

available when needed. This, in turn, results in increased worker efficiency and contributes to maintaining a higher level of material condition.

Scheduling of inspections, tests, corrective and preventive maintenance, and planned and forced outage work is necessary to ensure that maintenance is conducted efficiently and within a prescribed duration. Scheduling daily activities based on accurate planning estimates can improve the use of worker time and help reduce unit/system unavailability and cost. Scheduling of planned outages is important to support the return of the plant to service on schedule (and within the approved budget) and results in a high level of reliable plant operations. A contingency schedule for forced outages should be developed and maintained current so that forced outage time is minimized and effectively used and needed maintenance is performed before restart. Work activities for the contingency schedule are planned, material is staged, and the amount of resources is identified to reduce station downtime.

Coordinating maintenance activities is necessary to accomplish work effectively. Examples of areas where interdepartmental coordination is necessary include preparing and using work, fire or burn permits, entering confined spaces, preparing equipment clearance tagouts, and performing quality control verifications. Coordination is also needed among the mechanical, electrical, instrument and control, and contractor groups for many work activities. Assign a designated individual responsible for the major portion of the job as the lead in identifying and coordinating needed support.

Post-maintenance testing is used to verify that the maintenance was performed correctly (that is, original deficiency corrected) and the equipment performs its intended function within design criteria (that is, corrective maintenance has not created an additional problem). Post-maintenance tests are performed after corrective maintenance and some preventive maintenance activities. The tests are commensurate with the maintenance work performed and the importance of the equipment to safety and reliability. In some cases, this may include testing of additional equipment to verify system performance.

B. GUIDELINES

20. Work Management Procedure

Each unit should have a procedure describing the work management process. Requirements may be contained in separate documents covering individual areas or in one overall procedure that describes the control of maintenance activities. The work management procedure helps personnel understand the requirements and controls for performing work. To accomplish this, the procedure must be concise, user-friendly, and easily understood by all readers. Flowcharts are recommended to provide an overview of the process and a pictorial flow-path for sequencing work activities. The basic intent of

the work management process is to identify all plant deficiencies and work needed to be accomplished, to avoid redundant identification of these deficiencies, and to guide the accomplishment of work and subsequent post-maintenance activities. If the work management process does not include modifications, in-service test and inspections, work during emergencies, or preventive maintenance actions, the processes controlling these activities should interface with the work management process.

The work management procedure(s) describes the maintenance request (MR) form (electronic or hardcopy), including applicable attachments; and, as a minimum, addresses the elements listed below. In addition, elements that may be modified or bypassed during emergencies are clearly identified, and any compensatory requirements are defined. The procedure includes the following:

- personnel responsibilities for identifying deficiencies and initiating MRs that adequately describe the symptoms or problems
- management responsibilities for controlling the conduct of maintenance activities and processing MRs
- description of the process for initiating and processing the MR, including the pre-job review, approval cycle, and post-job review
- definition of the priorities used to schedule work
- resource loading of schedule
- determination of the impact of maintenance activities on operations
- work planning and scheduling
- requirements for personnel and equipment safety (for example, confined space entry permits, welding and burning permits, clearance tagouts, scaffolding, asbestos abatement)
- post-maintenance testing/operability testing
- collection of maintenance history and equipment failure data
- any applicable cross-reference to outage scheduling and management procedures

21. Maintenance Request

The station MR or another approved work management document controls maintenance performed on plant systems. This could be either an electronic or hardcopy process. In some instances, minor and less complex maintenance can be performed under a minor maintenance program without a detailed work plan. The documents clearly define the work to be performed and address the following items:

- equipment identification
- name of the person initiating the MR
- date MR initiated
- description of the symptom, problem, or work requested
- job priority

- personnel safety or permits (for example, confined space entry permit; welding and burning permit; clearance tagout; isolation, draining, and depressurization of the component)
- need for specialty contractor support
- applicable operating limitations and time restraints
- identification of qualification requirements (such as environmental code requirements and seismic qualifications)
- applicable work and foreign material exclusion instructions and references
- impact of maintenance activity on plant operations (such as derates)
- results of evaluation of risks to continued safe plant operation
- materials needed such as replacement parts, solvents, and lubricants
- inspection or safety hold points associated with the work
- required post-maintenance testing, inspections, and acceptance criteria
- authorization by the operations and maintenance management to commence work
- narrative description of conditions found by the craftsmen
- documentation of actual work performed with post-maintenance testing and inspection results
- documentation of measurement and test equipment used and applicable ranges
- acceptance of the equipment by operations
- final reviews and signoffs by maintenance and, when applicable, by other groups involved in the work
- documentation of lessons learned that would benefit the next individual assigned to perform the task

The MR is reviewed on as as-needed basis by applicable groups or representatives of these groups, such as maintenance, operations, technical support, and quality control during the planning process. This review can be simple or extensive, depending on various factors, such as the complexity of the job and its relation to safety or reliability. It is unnecessary and unproductive to have all groups review all MRs.

22. Review of Completed Maintenance

Requests for work on plant systems, a management review compares the work accomplished to the post-maintenance testing or inspection performed to determine that work is acceptable before the equipment or system is returned to normal service. Maintenance personnel review completed MRs for the adequacy of repair, completeness of documentation, and identification of rework. For complex or unusual maintenance work, a post-job review is held with the workers involved. This review could be a brief discussion or a comprehensive critique. The purpose is to determine if any unexpected problems occurred and if the activity can be accomplished more efficiently the next time and to identify best practices that could be applied to other jobs.

The technical support, engineering, and other departments as appropriate and in accordance with instructions accomplish reviews as required. Feedback is provided to planning, scheduling, and maintenance personnel that highlights areas that were completed exceptionally well and areas that need improvement.

23. Temporary Equipment Repairs

Temporary repairs are temporary modifications to the unit that allow equipment to remain in or be returned to service in a condition that is not the same as the original design specification. Before implementation, temporary repairs receive an engineering review to determine the adequacy of the repair and its effect on personnel and equipment safety and reliability. Temporary repairs are tracked after their completion for eventual implementation as permanent repairs. Permanent corrective action is taken as soon as practical.

24. Planning for Maintenance Activities

XII. a. Planning Group Organization

Planning maintenance activities can be accomplished by a dedicated planning staff or by maintenance managers, technical staff, workers, or a combination thereof. If a dedicated group is used, it may be established as a central planning group or decentralized with planners for each discipline working within their respective groups.

A centralized planning group offers the benefit of improving the coordination among the various station groups and providing a central point for obtaining planning and scheduling information. A decentralized planning group facilitates a closer working relationship between each planner and the individual shop worker and can lead to increased planner credibility. However, this approach can diminish coordination among the planners. In addition to maintenance personnel, including knowledgeable and experienced personnel from disciplines such as operations, quality control, and materials can enhance the planning process. The alternative of assigning maintenance managers the responsibility for planning work has the advantage of having highly knowledgeable individuals perform the planning. However, their workload must be adjusted to allow the maintenance managers to carry out all of their assigned responsibilities properly.

A unit with a small organization may function well with managers responsible for all planning. A unit with a larger organization may gain by having a dedicated planning group to relieve the first-line manager of most planning duties and allow time for other managerial duties such as observing and directing ongoing maintenance activities at the work sites.

XIII.

XIV. b. Planning Group Responsibilities

Screen maintenance requests to determine if detailed planning and scheduling are required or if the work can be performed directly by a fix-it-now or similar expedited work control process. Establish specific criteria for making these determinations.

Different levels of planning attention are applied to MRs designated for planning. For example, correcting a packing leak on a manual valve normally does not need the same level of planning effort as overhaul of a major pump. Address the following items in the review to determine the level of planning needed:

- definition of the problem and identification of the work scope (for example, by work site inspection, by review of preventive maintenance activities, and other corrective maintenance that should or could be worked within the tagout boundary for the equipment)
- identification of risks associated with on-line maintenance and applicable contingency plans
- identification and review of necessary procedures, drawings, vendor manuals, and maintenance history
- identification of needed and available data for use in analysis of maintenance problems
- review of in-house and industry experience for possible generic implications related to safety-related or reliability-related maintenance
- procurement of necessary repair parts, materials, tools, equipment, and services
- assessment of resources and skill requirements for all personnel with work instruction or work package detail tailored to the results of this assessment
- identification and review of resources including other tasks scheduled to occur in the immediate area during the same period
- identification of initial conditions and prerequisites, including applicable limitations on operations
- identification of industrial safety concerns
- identification of quality control inspection, or code inspection requirements
- establishment of equipment restoration and post-maintenance inspection or testing requirements
- review of work instructions or work packages for completeness
- staging, special permits

Following completion of the work, an administrative review should address the following items:

- completed work packages or governing document for proper documentation, post-maintenance testing, and possible changes to the preventive maintenance program
- equipment history update

XV. c. Troubleshooting

Troubleshooting is the systematic process for identifying equipment problems and their causes. The process starts from symptomatic reports of a problem and progressively refines the analysis of the problem until the cause is precisely located and resolved. The process includes gathering evidence of what happened and when, where, why, and how it happened. For complex equipment or equipment that could significantly impact plant operations, a more structured and documented process is typically used. This information is then used to develop a troubleshooting plan that includes the following:

- documentation of the problem and possible causes
- documentation of applicable test equipment, drawings, and documents used in the troubleshooting process
- documentation of risk assessment and management approval to proceed (if troubleshooting has the potential to cause a unit transient)
- documentation of configuration control (that is, lifted leads, valve manipulations, temporary modifications, components replaced)
- documentation of post-maintenance testing requirements

The plan is then implemented, the specific equipment malfunction determined and documented, corrective actions taken, and long-term corrective actions identified.

25. Training of Planning Personnel

Design, develop, implement, evaluate, and modify training and qualification programs to meet the needs of planning personnel. The training program evaluates the entry-level candidate's knowledge and skills from past experience and the aptitude to learn the administrative and technical responsibilities of the work planning function. The training program addresses the following knowledge and skill needs for planners, as applicable:

- Determine applicable safety, administrative, and technical procedures necessary to perform the maintenance tasks.
- Identify current revisions to procedures, vendor manuals, drawings, and other plant policies related to maintenance tasks.
- Determine equipment classification and qualification requirements for replacement parts or component assemblies.
- Determine quality assurance inspection requirements and hold points.
- Understand plant system interactions and component isolation capabilities. This knowledge would be required for initiating risk

assessments and contingency plans for on-line maintenance and other high-risk activities.

- Understand integrated scheduling techniques to evaluate how a specific work plan could affect another.
- Understand plant and equipment design for identification of large equipment transport paths, overhead lift capabilities, floor loading limits, and potential effects of a maintenance activity on surrounding equipment and systems.
- Determine the impact of the maintenance activity in the design configuration of the plant.
- Understand technical aspects and support activities required for the maintenance activity.
- Determine maintenance task schedule duration and resource requirements.
- Understand functional verification and retest programs.
- Understand the work management process.

26. Scheduling Maintenance Activities

XVI. a. Control of Work Backlog

The work management process provides the management with the means to identify and monitor the status of all valid MRs. It also helps other groups, such as engineering and materials management, identify work that is awaiting their support. The system should consider a MR as part of the backlog from the time the work is identified until all actions are complete, including post-maintenance testing and administrative reviews and signoffs. A serialized list of MRs with a brief description of the work requested, priority assigned, date the MR was initiated, and plant conditions required to perform the work is useful in managing work backlog. Other features of the process that could be helpful in managing the work backlog include the following:

- a computerized system with the ability to sort maintenance requests by priority, MR date, conditions required, systems affected, lead responsibility with support activities, and facilities or production equipment
- the integration of tests and inspection activities
- a status of MRs on hold for planning, parts, material dedication, engineering, or other constraints
- a tracking system to maintain the status of MRs currently being worked
- a tracking system to verify required post-maintenance and post-modification testing is accomplished before the return of a piece of equipment or a system to service (especially important following outages where many jobs may be performed on a system that is removed from service for an extended period or where several jobs are done under one clearance)

When feasible and when the balance between equipment reliability and availability indicates such actions are appropriate, accomplish all preventive and corrective maintenance activities on equipment when a tagout is issued for maintenance. These principles also apply on an interdisciplinary basis. For example, integrate operations, mechanical, electrical, instrumentation and control, and technical staff activities. Establish a communication method for advising all groups of short and long-range maintenance schedules. This communication may be done independent of or within the scheduling process. Regardless of the method used, it is essential that all affected groups have adequate advance notification of corrective and preventive maintenance action to be accomplished. As an example, design verifications and walkdowns requiring removal of a system from service should be planned and coordinated with preventive maintenance, corrective maintenance, and other inspections and tests to minimize system out-of-service time. Monitor the maintenance backlog to verify important jobs are not being delayed unnecessarily and that the amount of work in the backlog is controlled.

XVII. b. Assigning Work Priority

Personnel with strong knowledge of plant operations review each maintenance request to determine its impact on operations. Set meaningful priorities that determine how soon a maintenance request needs to be worked based primarily on personnel safety, unit reliability, and repair costs including generation losses. Establish communication among cognizant departments to set priorities properly. Implement a method that avoids congesting the work control process with jobs that are not important to safe and reliable operations.

Establish a priority system that is simple and flexible to enhance its use and accuracy. Assign corrective maintenance a priority based on the maximum time allowed before corrective action must be taken, as well as the system or equipment importance. Items to consider when assigning priorities to maintenance requests include the following:

- impact on plant safety or reliability until repairs are completed
- contingency or compensatory actions required while equipment is out of service
- availability of redundant equipment
- regulatory requirements (emission controls, OSHA)
- equipment and conditions required for equipment repair

The following listing illustrates a simple priority system:
<u>non-outage work</u>

- *Priority 1* -- emergency, significant impact on personnel safety or unit operation (top priority -- Work immediately and provide special

coverage if necessary; use of emergency work controls is authorized.)

- *Priority 2* -- urgent, hinders or strong potential to hinder continued unit operation; station operations limited or in derate (Schedule as soon as possible in accordance with normal station practices and procedures.)
- *Priority 3* -- necessary; has potential to degrade or hinder station operation (Schedule within the normal scheduling process.)
- *Priority* 4 -- as time permits, with little or no impact on continued plant operation or personnel safety

outage work (Subcategories for priority 5 and work as part of outage planning are also useful.)

- *Priority* 5 -- hot
- *Priority* 6 -- cold

Outage work is defined as work that must be performed with the unit not available.

27. Safety Management

Equipment important to safe and reliable plant operation requires careful consideration when maintenance is scheduled. The purpose of scheduling activities is to maximize and effectively balance systems' reliability and availability. For example, standby systems need to be not only available for operation, but also highly reliable, because they are required to successfully start and operate on demand. Therefore, it may be beneficial to take a system out of service for a short period to perform maintenance that will increase equipment reliability. Scheduling also takes into account the impact of maintenance on important support systems. For example, maintenance on support systems, such as cooling water, may render other systems incapable of operating for a period of time. When a system is out of service for maintenance, consider safety and reliability management when scheduling maintenance or activities on other plant equipment. Limit or reschedule activities that could result in a challenge to the remaining equipment and unit.

28. Training for Scheduling Personnel

Design, develop, implement, evaluate, and modify training and qualification programs to meet the needs of scheduling personnel.. The training program evaluates the entry-level candidate’s knowledge and skills from past experience and the aptitude to learn administrative and technical responsibilities of the scheduling function. The training program should be designed to enable scheduling personnel to accomplish the following:

- Determine resource requirements (worker hours and task qualification requirements) for schedule resource loading.

- Understand system interactions and operability requirements for schedule sequencing determinations.
- Understand parts inventory systems for parts availability verification before scheduling.
- Understand total activity duration as planned and contingency plans for job scope changes.
- Understand critical path identification and scheduling methods.
- Understand integrated scheduling techniques.
- Understand support group interaction requirements.
- Understand the work management process.

29. Coordination of Maintenance Activities

The planning group (or maintenance managers) maintain the status of all open MRs and preventive maintenance that are overdue or coming due. Schedulers and managers recommend work assignments from this list based on job priority. Meetings involving routine job scheduling need to be held on a regular basis to properly communicate priorities, current problems, job interference, and requests for support among departments. A designated individual closely involved in the planning and scheduling process chairs these meetings. Managers or responsible spokespersons from all maintenance disciplines, operations, quality control, contractors, technical support, and materials management attend these meetings; other personnel are invited as needed. Frequent informal communication among groups outside the meetings is strongly encouraged.

Apprise station personnel of scheduled maintenance activities that affect them to ensure proper activity coordination. Publishing and updating a short-duration rolling schedule may do this. This schedule identifies scheduled activities for the next one to two days and planned activities for the remaining days. It is updated either daily or every other day following the routine planning meeting.

The responsible maintenance manager is provided with work packages in time for adequate shop-level preparation before starting the job. Each manager has sufficient fill-in work assigned to maintain crew productivity. When feasible, this fill-in work is independent of unit condition requirements, is easily coordinated, and is easily initiated. If this is not the case, identify the fill-in work on the rolling schedule so all-cognizant groups are aware of the jobs that maintenance managers may initiate.

The schedule allows for unexpected, higher priority emergent work requirements. Identify maintenance requests that could be postponed or stopped, or use some similar method to allow the work force to accomplish emergent work. Appropriate managers approve such postponements and work stoppages to ensure emergent work has a higher priority.

After jobs have been assigned and scheduled on the rolling schedule, the group having responsibility for the most significant portion of the job (lead group) assumes the responsibility for support coordination. The lead group is then responsible for coordinating activities such as verifying that clearance tagouts are available as requested; quality control inspectors are available as required; applicable permits and industrial safety job coverage is available; parts are available at the job site, and turnovers among work groups and different shifts are properly performed. Turnovers clearly communicate job status, including work completed and work remaining; changes in schedule, work plans, or procedures; and any problems that occurred during the job. Face-to-face turnover is preferred. However, when that is not possible or practical, thorough and accurate turnover notes or logs are necessary.

An ongoing review of schedule effectiveness is performed. This review can assist the unit in evaluating the credibility of the schedule and the ability of the maintenance department to adhere to the schedule. Performance in this area could be quantified and challenging goals subsequently established regarding effective scheduling and performance of maintenance.

30. Outage Planning, Scheduling, and Coordination

Manage maintenance activities during forced outages and unplanned power reductions to return equipment to service in a timely manner. Maintain a list of corrective maintenance, modifications, test, inspection, preventive maintenance, special items, or commitments that must be performed under system or station outage conditions or power reduction. Prioritize these items based on their importance to operation. Establish resource requirements and task completion time for each of the identified jobs to aid in planning, scheduling, and coordination. To the extent possible, prepare an up-to-date list of prioritized outage tasks and assembled work packages indicating amount of required resources including support activities, procedures, repair parts and material, special tools, clearance boundaries, and permit forms (such as confined space entry permits). Stage repair parts and material and special tools ready for use.

Prepare a forced outage work list and coordinate outage activities. Conduct forced- outage planning meetings periodically to update the list. Communicate the forced outage list, reflecting current planning for forced outages, to appropriate station work groups.

If a forced outage or unplanned derate occurs, appropriate managers initiate selected work from the forced outage list based on the estimated duration of the outage and available resources. For longer-duration forced outages (commonly, greater than three days), begin preparations for additional outage work while managerial decisions are being made to determine the actual

length of the outage. In this case, each department reviews its current forced outage list and identifies any additional significant work to be conducted during the outage. If a forced outage is extended, consider assigning an outage manager to schedule and coordinate work for the expected duration.

Once the outage duration has been determined, conduct coordination meetings to determine the critical path and major milestones, evaluate the schedule for risk significance, and accept or reject any new or significant work to be accomplished. Support requirements are verified and coordinated among affected departments. During the outage, obtain a status during each shift to measure progress and make any required adjustments, such as coordinating special support needs. After completion of each forced outage, conduct a critique to determine how improvements could be made, and designate personnel to implement these improvements.

31. Post-maintenance and Post-modification Test Requirements

Establish a program to control and document post-maintenance and post-modification testing. This program may be a part of the work management process and may use the MR or work package to specify testing, assign responsibility, and document acceptance of all post-maintenance tests. The MR should provide specific instructions or cross-references a test procedure and is traceable to post-maintenance test data. This may be accomplished by recording the data directly on the MR or by referencing data recorded on post-maintenance test data sheets or documents.

A post-maintenance or post-modification test is any appropriate test, inspection, or surveillance performed following maintenance or modification installation to verify the following:

- A particular piece of equipment or system performs its intended function based on its design criteria.
- The original deficiency was corrected.
- New deficiencies were not introduced as a result of the repair or modification.

An operational test demonstrates normal operation of equipment under normal service conditions. A functional test demonstrates that a component is capable of performing its design functions. Evaluate operational or functional tests to ensure they fulfill the requirements of an adequate post-maintenance and post-modification test.

The assigned maintenance managers should review MRs received for planning to determine test requirements and whether the proposed repair is to equipment covered by applicable codes. Appropriate personnel review tests of any equipment affected by code requirements. These reviews ensure

incorporation of testing required by the applicable code and any additional testing, data recording, or special documentation requirements. Technical support department assistance may also be required on tasks that are complex, even though no code requirements apply. The MR is reviewed to verify that testing will determine whether the equipment will perform its design function. Review post-maintenance tests for the possibility of combining one or more tests.

XVIII. a. Post-maintenance and Post-modification Test Program Scope

Since the purpose of corrective maintenance and modification is to resolve a deficient condition, perform a retest to verify that the equipment functions properly. Some preventive maintenance activities also require testing. Base the rigor of the testing on the work done and the importance of the component to safe and reliable operation. Perform testing on equipment, systems, or activities such as the following:

- maintenance or modification that affects the integrity or operation of a system
- maintenance or modification that affects mechanical strengths of components or fittings
- equipment that is included in special programs such as the in-service inspection and environmental qualification programs
- maintenance or modification that affects or removes design-approved temporary installations
- temporary systems that have been installed as substitutes for normally operational systems or portions of systems
- modified computer program software

Test equipment that is important to reliable operation in accordance with written instructions or approved procedures. Test procedures should contain acceptance criteria that aid in measuring the performance of repaired equipment. Provide baseline data, if applicable, for use in future condition monitoring.

If the entire procedure is not to be performed, identify the applicable sections, including necessary prerequisites and precautions. An engineering or system acceptance test procedure, alignment checks procedure, generic test procedure, or special test procedure also may be used to provide test instructions. Test procedures used for a range of generic equipment, such as manual valves or flow controllers, should have data sheets for specific equipment if acceptance specifications or performance data are required.

For troubleshooting MRs, it may not be feasible to fully determine the post-maintenance test requirements until the troubleshooting is complete. The responsible individual adds instructions to the troubleshooting MR stating that post-maintenance test instructions will be specified following

the work. Upon completion of the work, the appropriate post-maintenance test is specified, verified by the appropriate individuals, and performed.

The following are examples of tests:

- hydrostatic or other pressure tests with visual inspection for leaks
- visual inspection for loose fasteners and mechanical misalignment or nondestructive examinations
- operational stem thrust measurements, including checks such as valve stroke time; measurement of vibration, flow, pressure, and temperature; operation of interlocks; and comparison against other applicable equipment calibration or alignment of an instrument or loop
- response time test of an instrument or instrument loop
- continuity, voltage, or current checks
- system or component inspections for cleanliness
- validation/verification of a computer software program

Specify a single test or a combination of tests such as those listed above to provide complete post-maintenance testing. On the MR or test procedure, reference the specific testing that is to be performed.

XIX. b. Post-maintenance and Post-modification Test Control

Establish a program to control testing. When more than one group is involved in the test or in a situation in which the test must be delayed until conditions permit, one organization, such as the operations department, should be responsible for coordinating testing performance. The designated organization reviews the total work scope to minimize redundant testing. The department performing or having the lead for performing the test assigns an individual with overall responsibility for conducting the test and an individual for reviewing test data and determining the acceptability of equipment.

If conditions dictate that testing cannot be completed immediately after maintenance or modification is performed, the MR or document is held open, or some other tracking method is used by the department having lead responsibility for testing until the equipment can be tested. Equipment is not declared operable until testing has been satisfactorily completed. However, equipment may sometimes be declared available for operation while still technically not declared operable pending testing. Operators must know the status of equipment on hold for testing and minimize the amount of equipment in this condition. This status is reviewed before any scheduled mode change. Equipment that can be tested during the upcoming mode is identified, and the tests are accomplished in the process of, or as soon as feasible after, reaching the new condition.

XX. c. Post-maintenance and Post-modification Test Performance, Documentation, and Acceptance

The operations department is typically assigned responsibility for the operational acceptability of all equipment and systems under its control. Accordingly, operators normally perform or are closely involved in testing. Maintenance, technical support, quality control, and other personnel may also be involved in or called upon to perform testing. For tests involving participation of more than one group, an individual in the lead group is assigned to coordinate testing activities. Minor equipment testing may be performed by the operator returning the equipment to service, the worker performing the maintenance, the engineer following the maintenance, or a combination of these and other needed individuals. The department responsible for specifying the test reviews the work actually performed to ensure that the test is appropriate. Any questions are resolved with the department that determined the testing requirements.

Operational acceptance of the equipment, based on satisfactory test completion, is verified by the operations department by signature on the MR or other reference document. Where possible, acceptance criteria are generated and available before the test and are included or referenced as part of the test instructions. This verification is made from objective evidence such as conducting or witnessing the post-maintenance test or reviewing completed procedures and documented test results. Test data and its acceptability are entered or cross-referenced to maintenance history.

Deficiencies identified during testing are documented and corrected on the original MR or control document, by a new MR or control document, or on another reporting system before the original MR is accepted as complete by operations. The original documents reference follow-up actions.

If a test fails and the equipment or system cannot be repaired and tested satisfactorily in a short period (normally, before the next shift change), the degraded or inoperable status of the equipment is documented so that operators understand the limitations of this equipment and/or system. Technical specifications are consulted for safety-related equipment or equipment that has an impact on safety-related systems, and appropriate actions are taken until the equipment is properly tested and returned to service.

VI. Procurement of Parts, Materials and Services

A. INTRODUCTION

The timely availability of parts, materials, and services is a key element of a strong and effective maintenance program. Correct parts and materials in good condition are necessary to maintain design configuration and maintenance requirements for activities during normal operating periods and to support both forced and planned outages. Services periodically are needed to provide unique or supplementary maintenance support. An effective materials management process ensures that parts, materials, and services are available when needed. Proper care of parts, materials, and equipment is required from the time an item is received until it is installed in the station. This includes all phases of receiving, inspecting, handling, storing, retrieving, and issuing material. It also includes the return of unused parts and material to the warehouse.

Many personnel are involved in some portion of the materials management process. Policies and procedures are established to clearly define the company and station responsibilities and to ensure that proper parts, materials, and services are purchased, received, inspected, handled, and stored so that they are easily retrievable and usable when they are issued to support maintenance activities. These policies and procedures must be understood by materials management personnel and other groups that interface with the materials management process, such as purchasing, quality assurance, quality control, engineering, operations, and maintenance.

B. GUIDELINES

32. Procurement

XXI. a. Policies and Procedures

Establish policies for early identification and timely procurement of parts, material, and services. These policies must be understood by materials management, materials engineering, systems engineering, design engineering, procurement engineering, purchasing personnel, and other plant personnel who interface with the procurement process, such as maintenance managers and planning and scheduling personnel. Prepare procedures specifically to describe the responsibilities of the company and station personnel involved in the procurement function. Include specific activities in these procedures that describe the procurement process. Establish a system as part of the design change process to update spare parts needs and remove outdated and obsolete materials from the stock system.

XXII. b. Procurement Initiation

Timely procurement of parts, materials, and services for maintenance activities can be enhanced by considering items such as the following:

- early identification of "long lead-time" items
- selection of procurement sources based on approved vendors and past vendor performance
- thorough classification of parts; identification of appropriate quality; and engineering, environmental, shelf-life, preventive maintenance, and vendor technical manual requirements
- review of "like-for-like" or similar spare parts in replacement of obsolete, unavailable components, including technical evaluation of such parts
- update of spare part stocking levels following design modifications, including removal from stock of any items made obsolete by design modifications
- participation in a pooled spare parts system with other units within the company or with other companies (Additionally, informal communications with other utilities to establish commonality of stocked items is a method to avoid overstocking.)
- comparison of usage rate and lead time to ensure adequate stock and avoid inappropriate (too high or low) inventory of an item
- identification of proper handling and storage provisions during shipping to avoid damage
- update of spare part modification and part number changes upon vendor notification
- use of commercial dedication when necessary

XXIII. c. Procurement Control

Develop and maintain controls throughout the procurement process to help obtain parts, materials, and services in a timely manner. Provide controls such as the following:

- Verify reliability of supplier performance. This can be accomplished by audits, inspections, or surveillance of supplier facilities, processes, methods, or records relevant to the part, material, or service provided.
- Segregate deficient or nonconforming items from accessible conforming materials and ensure deficiencies resolved in an effective and timely manner. Promptly initiate technical reviews to aid in the resolution of these items.
- Control and maintain records to provide documentation of acceptability for qualified parts and materials and to ensure traceabiIity of parts and materials.

Pre-engineered procurement specifications are available for applicable items to expedite the procurement process. Provide a process for acceptable substitution to obtain parts that are no longer available from

the original supplier that have new identification numbers or different material specifications. Provide engineering and maintenance experience to support this process.

Appropriate personal review design requirements to ensure that upgraded or substitute parts are consistent with the application of the part and component. Retrievable documentation supports the identification of inspection and testing results that confirm the qualification and acceptability of the part.

Develop emergency procurement and an expediting process to obtain parts, materials, and services that are needed immediately to support safe and reliable operation. Clearly identify need dates for parts, materials, and services that require emergency procurement. This may include establishing predefined blanket orders with suppliers to expedite the procurement process.
Establish a parts and materials reorder system that provides stocked material availability for anticipated usage and minimizes unnecessary inventory. For example, a minimum/maximum stock level could be established to determine when to initiate reorders (the minimum level) and limit the amount ordered (the maximum level). Control changes to these levels by a review of usage history, maintenance experience, and other economic order quantity data.

When developing minimum/maximum levels, identify and consider parts or materials that have multiple applications or are used in more than one system or piece of equipment.

The stores group and other user groups track procurement progress and take necessary measures to meet maintenance and outage schedules. An effective system tracks the status of a part from the time need is identified by the maintenance request until the part is made available to the craftsmen. TraceabiIity to the maintenance request is maintained.

XXIV. d. Services

Identify the need for specialized services from vendors early to provide for timely submittal of bid proposals and contract awards. When possible, provide for general service agreements so that services can be supplied at short notice.

33. Material Receipt, Inspection, Handling, Storage, Retrieval, and Issuance

XXV. a. Receipt and Inspection

Upon receipt, qualified materials management personnel inspect parts, materials, and equipment before acceptance for storage or use to verify that the material delivered agrees with the approved purchase

documentation, is packaged in accordance with purchase order specifications, has necessary product control requirements furnished by the vendor such as special storage or shelf-life information, and appears to be in good condition. In the case of designated critical items that are important to reliable operations, physically inspect the items to ensure that the vendor has supplied what was ordered, that the necessary formal documentation has accompanied the shipment or is otherwise on hand, and that items appear to have been received in an acceptable condition. Engineering staff and maintenance personnel may be needed to assist in the inspection of more complicated parts, materials, and equipment. Engineering staff and quality control personnel approve any deviation from design specifications of material or equipment received before it is accepted or returned into the stores system. An acceptance tag or label placed on the received material may be used to signify that the receipt inspection was satisfactory and that the applicable requirements have been met. Provide a separate receiving and inspection area and a separate hold area. The latter area is used to hold material and equipment that has not been officially received into the stores system because of a nonconformance. Nonconforming material is clearly tagged or labeled and segregated to prevent inadvertent issue. Establish a tracking or follow-up method to resolve nonconformance problems promptly. Develop a method to accept material that has been repaired or reworked by maintenance. Whenever materials or parts are repaired or reworked, suitable testing and inspection requirements are specified by engineering to ensure the material or part will perform acceptably when placed in service. This method should also address material that has been issued and is sent back to stores. Update warehouse documents to reflect receipt of the material and any shelf life or preventive maintenance requirements.

XXVI. b. Handling

Prepare procedures for items requiring special handling instructions. Include items such as the weight, size, orientation requirements, chemical reactivity, radioactivity, and susceptibility to temperature, humidity, physical shock, damage, or electrostatic sensitivity. Clearly identify sling location balance points, method of attachment to the load, and other pertinent factors in handling the load. Sound handling practices are followed whether a specific procedure is used or not. Hoisting equipment should be certified by the manufacturer and indicate maximum loads to be handled. The inspection program for hoisting equipment and rigging is applied to items that are used in the stores operation. Properly train and qualify personnel required to operate cranes, forklifts, and other lifting equipment.

XXVII. c. Storage of Material and Equipment

Material and equipment should be stored in a manner that provides appropriate protection and ready availability for its intended use with due consideration for environmental conditions. For example, perform

preventive maintenance on large pumps and motors (more than 25 horsepower) that are in storage. This includes periodically checking energized heaters; periodically changing desiccant, meggering motors; rotating shafts on pumps and motors; changing oil on rotating equipment; and meeting other maintenance requirements specified by the vendor. Also, develop a method to provide controlled access to storage areas. Establish controls for field storage of consumables such as lubricants and solvents to ensure they are stored, identified, and properly used.

Provide a shelf-life control program for items with finite storage lifetimes, such as gasket material, rubber components, silicon sealants, certain paints, photosensitive chart paper, photographic material, certain pre-lubricated bearings, capacitors, resins, chemicals, reagents, and organics. Also, track complete assemblies containing these items so stock that has exceeded its shelf life is not issued. Any material reaching the end of its shelf life should receive proper engineering analysis with appropriate vendor input to extend its storage lifetime or should be disposed of and reordered. Determine the method of disposal taking into account environmental restrictions that may apply to some of the materials above. Consider material lead times in the reorder date so that sufficient material with good shelf-life is ready for issue.

Establish a method to identify parts or materials that are designated for maintenance activities or modifications. Methods such as staging, physical or electronic tagging, or other designations could be used.

Promptly document items placed into or removed from stores so the stores inventory accurately reflects current status. Indicate the location of materials and parts in the warehouse, stores issue room, or other designated storage areas in the stores record system.

Periodically inspect the stores issue room(s) and warehouse areas (for example, quarterly). These inspections include stored parts and materials, fire extinguishers, and eyewash stations. The following are examples of items to be inspected and corrected if improperly stored:

- Corrosive chemicals are segregated and not near equipment and metal stock.
- Flammables are stored in appropriate containers and fire-rated cabinets.
- Stainless steel components are protected from direct contact with other metals, particularly carbon steel.
- Relief valves, motors, and other equipment are stored on their bases.
- Elastomers and polypropylene parts are properly stored in areas not exposed to light.
- Machined surfaces are protected.
- Hazardous chemicals or solvents are stored in accordance with Material Safety Data Sheet instructions.

- Equipment internals are protected from intrusion of foreign materials.

XXVIII.

XXIX. d. Retrieval and Issuance

Parts, materials, or equipment removed from storage receives the same care as when stored. Establish procedures to control parts, toxic or hazardous chemicals, solvents, materials, and equipment after issue to ensure proper chemical control, including use in the correct application, and to maintain traceabiIity. Complete all receipt documents and inspections before an item is issued. For safety-related and environmentally qualified spare materials and parts, maintain proper documentation to ensure tractability. Prior to use in the plant, remove all extraneous packing material from items to reduce fire hazards that are generated when parts are unpacked at the work location. Develop a parts, materials, and equipment catalog that allows personnel to determine what is available for issue. Include a cross-reference listing that provides information such as the manufacturer part number, station or part number, noun name, and component or system for which the part is used. This catalog could assist in more efficient planning or execution of maintenance activities.

VII. Equipment Performance and Materiel Condition

A. INTRODUCTION

The goal in achieving excellent equipment performance and materiel condition is to ensure that events are not caused or contributed to by malfunctioning equipment, important equipment operates when needed, operators are not burdened with compensatory actions as a result of equipment performance problems, and equipment malfunctions or deficiencies are corrected in a timely manner and seldom recur. Achievement of excellent equipment performance and materiel condition involves many factors. This includes establishment and communication of high standards, identification of degraded equipment, ongoing maintenance (corrective and preventive), routine condition monitoring and testing of equipment, proper maintenance of chemistry in fluid systems, controlled and effective modifications, and a design that supports safe and reliable plant operation.

A key indicator of a well-maintained and operated station is proper functioning of facilities, systems, and equipment. Excellent equipment performance and materiel condition can be established and maintained by knowledgeable individuals who are responsible for monitoring system and equipment for degraded performance, adverse trends, and incipient failures, and who take prompt corrective action prior to failure. Additionally, periodic, focused inspections can help identify and correct deficiencies, especially in areas of the plant that are remote or infrequently accessed. Excellent equipment performance and materiel condition is also important because high quality work conditions can result in improved worker attitudes that enhance work performance.

Maintaining systems and equipment within design conditions results in benefits such as increasing system availability, increasing equipment reliability, reducing operator burdens and control room alarms caused by malfunctioning equipment, minimizing fluid leakage, and maintaining equipment environmental integrity.

Maintaining system chemistry is extremely important to maintenance of materiel condition. Improper chemistry is not readily discernable while performing routine inspections and tours, and damage can be significant before it is detected. Therefore, an aggressive sampling and control program is extremely important to protect the life of the asset.

The equipment performance and materiel condition at a unit is a direct result of the effectiveness of the maintenance program. However, a maintenance program extends beyond the organizational boundaries of the maintenance organization. Thus, many of the principles discussed in this document are applied effectively at a unit with excellent performance in this area.

B. GUIDELINES

34. Standards

Effectively communicate standards for equipment performance and materiel condition to all personnel. Managers assess adherence to these standards. These standards apply to equipment important to unit safety and reliability. Examples of standards that contribute to this include the following:

- Plant availability and capacity meet or exceed company and industry goals.
- Safety performance meets or exceeds company and industry goals.
- Plant systems operate within their design parameters.
- Rotating equipment operates in accordance with design specifications (for example, bearing temperatures normal, vibration levels normal, and shaft seal leakage limited to that required to cool and lubricate the shaft seals).
- Energized electrical and electronic equipment is operable, supplied from normal power sources, and protected from adverse environmental and operational effects such as high temperature and humidity or excessive cycling.
- Equipment is properly serviced (for example, lubrication, drive belts, filters).
- Newly installed or modified systems and equipment are tested and verified to satisfy all design requirements and to be in good working order in all required operating modes before operational acceptance.
- Instruments and gauges are operational, calibrated, and on scale; and indicate values representative of the existing system and equipment conditions. Instrumentation with automatic control features is reliable and does not have to be operated in manual.
- Fluid system integrity is maintained. Leaks that can be corrected during operation are repaired in a timely manner. Leakage from components that cannot be repaired under existing station conditions is collected and routed to appropriate drains or collection facilities, particularly if this leakage could cause a further degradation of equipment, present a safety hazard, or cause the spread of hazardous chemicals.
- Chemistry controls optimize chemistry conditions during all phases of plant operation and system non-operational periods.
- Fasteners and supports, including mechanical equipment and electrical enclosures, are installed properly.
- Equipment and systems are insulated to control heat transfer to or from the environment, to control ambient noise levels, and to promote personnel safety.

- Equipment, structures, and systems are protected with a preservative to minimize corrosion.
- Equipment is clean (for example, dirt, debris, tools, parts, and miscellaneous materiels are not allowed to accumulate on equipment or inside electrical panels).
- Temporary repairs are evaluated, controlled, and tracked. The use of temporary repairs is minimized, and permanent repairs are made at the earliest reasonable opportunity. Additionally, temporary modifications are minimized to the extent practicable.
- Temporary environmental protection (for example, dust, humidity, freeze, shock) is provided as appropriate, including protection for plant equipment when needed to support construction, outages, or maintenance activities.
- Unauthorized modifications or changes to the unit do not exist.
- Materiel deficiencies are identified and tracked, are in the maintenance work management process, and are corrected in a timely manner.
- Illumination of areas, rooms, and grounds is sufficient to perform work activities and inspections properly and safely.
- Equipment is maintained in the required environmental condition (for example, room heat load is within specification).

35. Training

Personnel must be aware of the management standards and expectations for equipment performance and materiel condition. Appropriate personnel are aware of the importance of maintaining good equipment performance and plant materiel condition.

36. Monitoring and Assessing Equipment Performance and Materiel Condition

Management implements an ongoing program for monitoring and assessing materiel condition. This aspect of the maintenance program is typically the primary responsibility of the engineering and technical support organization. One aspect is an aggressive program that periodically reviews system and equipment performance and provides for visual inspections when appropriate. Assessment of equipment performance and materiel condition includes analysis of the aggregate of indicators such as equipment history, system and equipment performance monitoring, and station or industry events that may identify less obvious problems.

Precursors to degrading equipment performance are identified and evaluated to preclude conditions that adversely impact plant operations. These precursors may include a number of temporary leak repairs, overdue preventive maintenance tasks, and a number of equipment deficiencies requiring compensatory operations.

XXX. a. Inspection Program

Properly used, a materiel condition inspection is an important component of the overall program to identify and correct equipment performance problems and degraded components. Include the following elements in the inspection:

- procedures that describe the inspection and define expected standards
- a method for deficiency reporting and corrective action follow-up, including definition of responsibilities

XXXI. b. Reviews

1. Event Investigations

   Review unit unplanned automatic shutdowns or other significant plant events thoroughly to identify any improper performance of equipment challenged by the event. Systems or equipment not fulfilling design requirements under these conditions represent a degradation of material condition and require management attention and prompt corrective action.

2. Maintenance History

   Perform periodic and systematic reviews of maintenance history to identify any trends of degraded equipment performance. These reviews include the performance of similar components installed in other locations to obtain the best information available on the performance of specific components. Components showing an abnormal failure rate are subjected to root cause analysis for corrective measures.

3. Monitoring Data

   Selected data can indicate overall material condition. Equipment predictive maintenance and system performance monitoring can indicate degradation in sufficient time to allow corrective actions to be planned and executed to prevent failures. Overall plant performance measures, such as gross heat rate and unplanned capability loss factor, could provide an overall indication of material condition. Investigate adverse deviation from the median for these and other indicators, and take corrective action as necessary.

4. Equipment Aging

   Periodically review maintenance history to determine equipment failure trends attributed to aging. Based on the frequency recommended in vendor manuals or determined by station and industry operating experience, periodically replace items, including the following:

   - electronic and electrical components such as power supplies, batteries, capacitors, solenoids, and relays

- rubber and polymer o-rings and sealants that may degrade as a result of temperature, pressure, and ultra-violet radiation

XXXII. c. Chemistry program

Clear organizational responsibility and accountability is defined for monitoring chemical parameters of fluid systems, making adjustment to chemistry as required. This includes activities necessary to support sampling, analysis, trending, and technical evaluation of current and proposed new control schemes. This program ensures:

- Chemistry specifications are clear and properly implemented.
- Proper sampling, analysis and evaluation parameters are established and implemented to ensure specifications are maintained.
- Specifications are modified as appropriate for different system conditions.
- Monitoring and analytical equipment is properly maintained and calibrated.
- Personnel are adequately trained and qualified.
- Chemicals are properly stored and handled to prevent injury to personnel or damage to equipment.

VIII. Maintenance History

A. INTRODUCTION

Maintenance history documents data, provides historical information for future maintenance planning, and supports maintenance trending of systems and equipment. The documentation of complete, detailed, and usable history is becoming increasingly important as historical data is analyzed for optimum maintenance actions that maximize equipment reliability and as support for plant life extension decisions. Trending is directed toward identifying improvements for the maintenance program and needed equipment modifications. The objective of good equipment history is to be able to readily retrieve equipment maintenance, performance, and reference information. The maintenance request (MR) work package may be useful as a maintenance history data collection tool. Maintenance history includes documentation of component identification and description, vendor reference information and correspondence, diagnostic monitoring data, corrective and preventive maintenance or modification information, and spare parts information. Maintenance standards should clearly define guidance addressing maintenance history for the systems and equipment to be included, what to collect, how to record data, and how the data is to be used. This history may be maintained centrally or locally by the individual group responsible for collecting the data. In either case, provide easy access to all groups needing this information.

B. GUIDELINES

37. Program Development

XXXIII. a. Equipment Identification

Procedural controls for maintenance history clearly define the systems and equipment that require documentation and retention of historical data. At a minimum, include systems and components that could affect safe and reliable operation in the maintenance history program. Equipment requiring repetitive maintenance should also be considered for inclusion. Maintain this compilation of system and equipment information in an engineering database and allow easy cross-reference to information such as the equipment unique identification number and name, system, manufacturer, model, serial number, other appropriate nameplate data, lubrication data, applicable vendor manuals and drawings, spare parts reference numbers, setpoint data (control of data changes should be maintained), environmental qualification requirements, and common equipment cross-references. The master equipment list may be used to establish this baseline compilation.

XXXIV. b. Data Identification

Clearly define the type of data to be collected and recorded. Some examples of data to include or cross-reference in equipment history are as follows:

- corrective maintenance records with failure modes and causes included
- appropriate preventive and predictive maintenance records and design modification packages
- as-found condition during corrective and preventive maintenance
- vendor repair information (for example, correspondence on component repairs and modification bulletins)
- startup tests and other baseline data
- appropriate surveillance test data
- calibration data
- spare parts information
- applicable industry experience information

38. Data Collection

Data collected for maintenance history should be complete and comprehensive, with sufficient review to identify and correct deficient input. Data on systems and equipment that has been selected for history retention is sent to the person or group responsible for maintenance history entry. Maintenance requests are reviewed for history retention applicability, and data is entered in the maintenance history program. Any apparent errors, inconsistencies, or lack of detail are referred back to the maintenance manager or another appropriate manager for resolution.

39. Program Use

Provide readily available maintenance history data for use by all departments, especially maintenance, training, and technical support departments. If maintenance history is computerized, train users to access and manipulate the history databases.

Maintenance planners, coordinators, managers, and craftsmen may use maintenance history on a routine basis for maintenance planning to provide data such as previous maintenance work and results, special tool needs, type and quantity of lubricants needed, manpower and time requirements, parts information, and procedure or instruction needs.

Maintenance history should be periodically and systematically reviewed and problems trended. This can be done manually or with automated analysis techniques. Persistent or recurring equipment and system problems should be reported to maintenance or technical support engineers for corrective

action. This review should include recurring failures of a specific component and also failures of the same make/model component used in other applications. These reviews can also help identify areas where decreased maintenance effort is warranted (for example, reduced preventive maintenance frequency).

Uses of maintenance history data are as follows:

- reliability-centered maintenance analysis (provides essential data for identifying failure modes and failure causes and mechanisms)
- conduct of maintenance assessments -- provides an input to identify rework for the purpose of identifying maintenance program improvements
- preventive maintenance effectiveness -- provides some of the data useful for program assessment, identifying and justifying preventive maintenance scope and frequency adjustments
- program changes and evaluation of preventive maintenance necessity to reduce standby safety system unavailability
- outage planning -- provides some of the data useful for post-outage evaluation and as a basis for planning the next outage
- budget preparation -- provides an input for determining future maintenance needs based on experience and a justification for these expenditures
- provides some of the data needed to support extension of plant design life
- review of training effectiveness; knowledge of persistent system problems that may provide insight to training program revision

IX. Maintenance Facilities, Tools and Equipment

A. INTRODUCTION

Facilities, equipment, and tools must effectively support maintenance and maintenance training. Maintenance facilities directly affect the ability of personnel to maintain plant equipment in an optimum state of readiness. Facilities include storage for equipment, tools, supplies, and parts.

An adequate and readily available supply of tools and measurement and test equipment directly affects the ability of the maintenance department to maintain station equipment in a safe and reliable operating condition.

Adequate facilities, tools, and equipment support successful accomplishment of maintenance activities. Industrial safety, location, accessibility, communication, environmental controls, power sources, and the type of activity to be performed are examples of items to be considered in providing maintenance support facilities. Maintenance training facilities, shops, satellite work areas, laydown and staging areas, storage facilities, mockups, temporary facilities, decontamination facilities, shower and toilet facilities, lunch areas, conference areas, and offices are examples of maintenance support facilities. Office equipment is provided that supports efficient and effective work. The objective is to create and maintain a safe, professional, and productive workplace where high-quality work is performed.

Review maintenance facilities, tools, and equipment use periodically, and make appropriate adjustments to support effective, high-quality maintenance. Staff size, special equipment needs because of station modifications, planned outage workload, and the increased sophistication of maintenance activities can change the needs for existing maintenance facilities. Managers recognize that inadequate facilities, tools, and equipment may be masked by worker compensatory actions such as increased pace of work or tacit acceptance of conditions. Managers are responsible for optimizing the use of existing maintenance facilities, tools, and equipment and for recognizing areas where performance could be enhanced.

The process of providing tools and test equipment for the station includes proper storage and issuance controls. Workers have ready access to the tools and equipment needed to perform maintenance and then return them as soon as practical after the work. Tools and test equipment are kept in a high state of readiness, some by inclusion in the preventive maintenance program.

B. GUIDELINE

1. Facilities

a. Shops and Satellite Work Areas

The layout of shop and satellite work areas should be designed to support worker safety and efficiency. As shops are modified and satellite work areas are changed throughout the life of the station, these remain foremost considerations.

Location and type of work performed should be considered in determining the types and level of environmental controls and services to be included in each maintenance shop and satellite work area.

Environmental conditions often have a significant impact on personnel performance. Managers need to maintain workplace environmental controls conducive to maintenance quality and work efficiency.

Shop and satellite work area storage facilities should be convenient and facilitate workers keeping the area neat and clean. Shelves, cabinets, lockers, and toolboxes are examples of storage facilities that could be provided for items such as tools, parts, reference materials, and personal items.

b. Laydown and Staging Areas

When maintenance laydown and staging areas are established, clearly communicate responsibility for area upkeep and control. Include items such as the following:

- authorization for access, with provisions for security and fire protection
- maintaining operating access to equipment
- labeling of facilities to designate responsibility and entry authorization
- temporary storage of parts with controls commensurate with each part's requirements
- contingency plans for changes (such as weather) that could reduce a facility's usability
- plan outages with assigned staging and laydown areas for equipment, special tools, rigs, and parts

c. Temporary Facilities

Temporary facilities may be needed for during outages. When planning temporary facilities coordinate with other groups, such as construction or specialty contractors, results in more efficient use of space. Provide necessary services such as communications, electrical power, compressed air, water, environmental controls, and lighting at temporary support facilities Major temporary facilities should be

controlled through the plant's configuration control programs to ensure consideration for code compliance, fire protection, etc.

2. Tool Control

a. Storage and Issuance

Responsibility should be assigned for the proper storage and issuance of both stationary and portable tools and equipment.

Permanent issuance of tools to individuals or groups of workers who routinely use them and who are responsible for maintaining them contributes to worker efficiency. Other tools and equipment are readily available as needed. For these items, proper storage facilities are centrally located to shops and normal work areas and should be readily accessible to the workers to promote efficiency. Consider controls, such as sign-out sheets and tool room attendants, for these storage areas to provide accountability and availability of tools. Several stations have found bar-coding technologies useful in tool control programs.

A policy for the storage, issue, decontamination, and reuse of contaminated tools and equipment should be developed and implemented

Special tools and equipment sometimes are obtained on a temporary basis from sources such as vendors or contractors. Establish a method to identify the availability and sources for these special tools and equipment so they can be obtained and made ready for use when needed. When these special tools and equipment are at the station, they are controlled in the same manner as in-house tools and equipment.

b. Tool and Equipment Maintenance

Selected maintenance tools and other support equipment should be in the preventive maintenance program. Inclusion in the preventive maintenance program enhances the availability and reliability of equipment such as cranes, portable lifting and rigging equipment, welding machines, weld rod ovens, shop machinery, and measurement and test equipment.

Segregate worn, defective, or otherwise unusable tools so that only safe, usable tools are available for use. Dispose of unrepairable tools in a timely manner.

c. Personal Protective Equipment

A readily accessible supply of personal protective equipment, such as various types of work gloves, eye and hearing protection, and fall protection devices, such as harnesses, is provided. Issuance of

protective equipment with tools promotes worker safety and reinforces concepts of safe work practices.

d. Use of Special Tools and Equipment

Ensure that special tools, test rigs, lifting and rigging equipment, and mockups are suitable for their intended use and are properly identified. Provide instructions for their use, where appropriate, to improve tool and equipment use and enhance job performance, personnel safety, and efficiency.

Maintenance managers should review proposed special tool and equipment designs to determine effectiveness, safety considerations, cost justification, and the need for reviews by other departments. Store and control these tools in accordance with the guidance provided above.

Provide specific instructions to control the use of lifting and rigging equipment. The following are some of the controls that should be in the instructions:

- Identify all rigging equipment with a unique tag to assist in providing positive verification of preventive maintenance and inspections.
- Implement methods to effectively determine currency of inspection and approval for use. Several stations use color-coded tags to track current maintenance and inspections.
- Set allowable lifting configurations and limits for different types of loads.
- For major lifts, establish safe load paths and floor loading patterns.
- Establish training and qualification requirements for workers using lifting and rigging equipment.

3. Measurement and Test Equipment

a. Identification

Each piece of measurement and test equipment should be assigned a unique identification number that is permanently marked on or attached to the equipment. (This may be the manufacturer's serial number.) These numbers assist in identifying, tracking, and positively controlling measurement and test equipment. Maintain a master list of all controlled measurement and test equipment. If separate organizations control their own measurement and test equipment, each organization maintains or has access to a list of its own equipment. Lists and master lists should include the following, as a minimum:

- generic description of equipment, trade or marketing name, manufacturer, model, and serial number
- equipment range(s) and accuracy

- unique identification number
- calibration procedure
- calibration frequency
- responsible department
- any unique considerations, such as storage requirements and training and qualification requirements

b. Calibration

1. Calibration Standards

   Only calibration standards set by the National Institute of Standards and Technology or other nationally recognized standards should be used to calibrate measurement and test equipment. If repair or calibration of a standard is necessary, the recalibration should be traceable to the National Institute of Standards and Technology or to the standard of record for the measurement and test equipment. Keep calibration standards at the station in appropriately designed and maintained calibration facilities and label them appropriately. If calibration standards are issued for field use, the manager responsible for the standard should authorize and minimize the period of issue. Discourage issuance of laboratory standards for field use. Calibrate standards on a frequency consistent with vendor recommendations and utility experience. Calibration records for standards should be consistent with those of all other measurement and test equipment. Use approved procedures with appropriate acceptance criteria and tolerances for the calibration of measurement and test equipment.

2. Calibration Frequency

   Determine measure and test equipment calibration frequency based on the manufacturer recommendations, usage, historical reliability, and consequences of being out of calibration. Consider the amount and type of measurement and test equipment available for use compared to the measurement and test equipment needed to support peak activity periods such as outages. This information can help determine calibration frequency and schedule requirements that result in measurement and test equipment support for station needs.

3. Functional Checks

   When operational tests, functional checks, or battery checks of measurement and test equipment are performed, clearly specify the desired response or acceptance criteria, or indicate it on the equipment. These types of checks are intended to detect measurement and test equipment problems before and after an instrument is used in the field. These checks are not substitutes for calibration checks.

c. Control

1. Un-calibrated Measurement and Test Equipment
   Calibrate new measurement and test equipment before use to verify it meets acceptance criteria, is functional, and is safe to use. Clearly mark uncalibrated test equipment used only for troubleshooting so that it is not used as measurement and test equipment for taking data. Test equipment used only for troubleshooting and not for taking readings and measurements does not need to be fully calibrated, but it should be checked periodically for operability and safety. For example, a volt-ohm meter might be operability checked every six months.

2. Measurement and Test Equipment with Limited Use
   Clearly label measurement and test equipment that has special uses, limitations, or restrictions to describe its applications or limitations. Also, segregate such equipment, where possible, to avoid inadvertent use or possible misapplication. The following are examples of information that should be reflected on the measurement and test equipment tag or label:
   - scales or ranges that are inaccurate or inoperable, including some indication of the amount of inaccuracy
   - calibrations that do not include the full indicating range
   - internal radioactive contamination
   - limited or restricted use such as on oil, oxygen, saltwater, or demineralized water systems

3. Issue and Recall
   Provide traceabiIity of measurement and test equipment to support a timely evaluation of instruments, systems, and other equipment associated with measurement and test equipment found to be deficient. This can be accomplished by recording the measurement and test equipment user, when the equipment was used, what instrument or equipment it was used on, for what purpose (typically by referencing the maintenance request or procedure number), and what ranges were used or values read with the measurement and test equipment. Maintenance history that can be readily sorted by specific measurement and test equipment used to perform maintenance is an alternative method of providing traceability. Several stations have found bar-coding technologies useful in providing traceability of measurement and test equipment.

   Implement a recall system to ensure measurement and test equipment is removed from service before or at the expiration of its calibration. This recall system can be enhanced by the use of calibration stickers on each item of measurement and test

equipment. If used, attach such a sticker to the measurement and test equipment, designating, as a minimum, the date recalibration is required. This information normally is needed for work documentation; therefore, calibration stickers provide a convenient method for the user to obtain this information and to ensure the measurement and test equipment currently is calibrated. Stagger calibration due dates to meet measurement and test equipment needs for peak use periods such as outages and routine use.

4. Control of Software Used in Process Control Applications
The configuration control process should control the configuration of software and firmware used in process control instrumentation. The specific software revision level should be identified as part of the plant equipment configuration control program. Changes made to software used in process control equipment are controlled to prevent unauthorized changes.

A replacement process for control equipment that includes software should be purchased to specifications to ensure the installed software is compatible with and replicates the software under the plant's configuration control program.

(END OF APPENDIX C)