# FINAL REPORT ON THE AUDIT OF EL SEGUNDO GENERATING STATION

## CONDUCTED UNDER GENERAL ORDER 167 TO DETERMINE COMPLIANCE WITH MAINTENANCE AND LOGBOOK STANDARDS

Electric Generation Performance Branch
Consumer Protection and Safety Division

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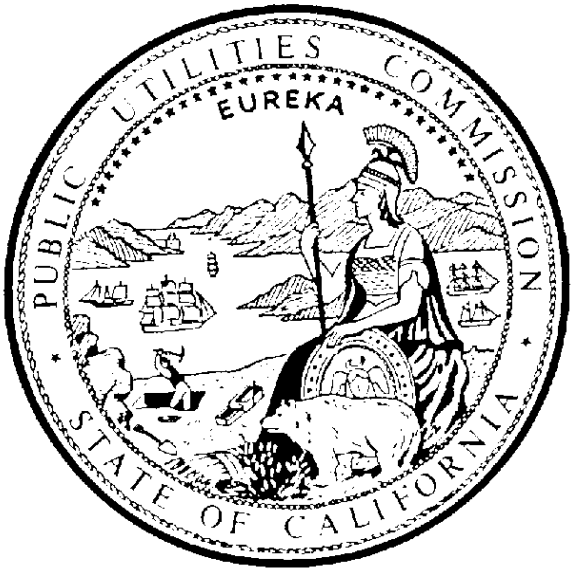
December 12, 2006
FINAL REPORT

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# EXECUTIVE SUMMARY AND AUDIT CONCLUSIONS

The Commission's Consumer Protection and Safety Division (CPSD) presents this Final Report of the audit of the El Segundo Generating Station ("El Segundo" or "the plant"). CPSD audited the plant for compliance with the California Public Utilities Commission's (the Commission's) General Order 167, which includes operation and maintenance and logbook standards for power plants. The audit did not cover Operation Standards, which were adopted in September 2005, and were therefore not in effect when this audit began.

In October 2004, CPSD contacted El Segundo to schedule the audit, and requested pertinent documents and data. After reviewing this material, auditors spent a week at the plant site, inspecting equipment, examining documents, observing plant operations, and interviewing plant staff and managers. CPSD issued its Preliminary Audit Report ("Preliminary Report") dated August 12, 2005, and requested submission of a response, including a Corrective Action Plan, by August 26, 2005. After requesting and receiving an extension of this deadline, the plant submitted its response on October 15, 2005. CPSD and El Segundo met and conferred on October 25, 2005. In response to this meeting and subsequent staff inquiries, El Segundo provided additional information. CPSD now issues this Final Audit Report.

In the Preliminary Report, CPSD found nine potential violations , most relatively minor, of various standards:

Finding 2.1-- The plant failed to study whether it was safe to remove half of the bolts securing the end plate of a large heat exchanger, a practice inherited from the plant's previous owner;

Finding 2.2-- Plant staff had left one-gallon bottles of acid on the floor and bench of the plant's chemistry laboratory without secondary containment (that is, a tray or barrier to contain accidental spills);

Finding 2.3-- Chemical containers were larger than necessary, causing risks to lab personnel;

Finding 2.4-- An auditor found the door open on a cabinet for the storage of flammable materials;

Finding 2.5-- The laboratory lacked a overhead drench shower for use in emergencies;

Finding 2.6-- The ventilation fan in the laboratory's fume hood barely worked;

Finding 2.7-- Plant procedures did not include notification to CPSD of safety problems, as required by GO 167;

Finding 2.8-- Plant logbooks lacked entries on fuel type and availability and contained non-standard abbreviations, as required by Logbook Standards for Thermal Plants;

Finding 2.9-- Procedures for cleaning the plant's boiler feedwater had incorrect page references to "blow-down" instructions.

A summary table of these findings, prescribed corrective actions, and the outcomes and needed follow-up of corrective actions are included in Appendix 1 ("Table of Findings").

Although the plant disputes many of CPSD's findings and their characterization as violations, the plant agreed to take various corrective actions, discussed in the report in sections entitled "Final Outcome and Follow-up." CPSD is satisfied that the corrective actions adequately address the issues raised in the Preliminary Report.

# INTRODUCTION

On October 29, 2004 CPSD contacted El Segundo to schedule the audit, and requested pertinent documents and data. After reviewing the material, CPSD's audit team, consisting of Ben Brinkman, James Cheng, Steven Espinal, Winnie Ho, and Alan Shinkman, visited the plant December 6, 2004 through December 10, 2004. During the visit, auditors inspected equipment, examined documents, observed plant operations, and interviewed plant staff and management.

On August 12, 2005, CPSD issued its Preliminary Audit Report ("Preliminary Report") and asked the plant to respond by August 26, 2005 with a Corrective Action Plan. After requesting and receiving an extension of this deadline, the plant submitted its response on October 15, 2005. CPSD and El Segundo met and conferred on October 25, 2005. In response to this meeting and subsequent staff inquiries, El Segundo provided additional information. CPSD now issues this Final Audit Report.

During the audit, CPSD focused on the following areas:

1) Logbooks, training, and human resources
2) Equipment, parts, and tools
3) Chemistry
4) Regulatory, engineering support, and safety
5) Maintenance planning, performance, and documentation specifically related to:
   a) Boiler tube leaks.
   b) Boiler circulation pumps.
   c) Electrical system, specifically the main transformer and exciter
   d) Circulating water system.
   e) Steam turbines.

The team found nine potential violations of standards and of GO 167. As stated in Section 1 of this report, none of these violations presented an imminent safety hazard. Section 2 of the report describes the nine potential violations, most relatively minor, as well as the plant's response to them. Section 3 describes other audit activities where auditors found no violation of standards.

Although the plant disputes many of CPSD's findings and their characterization as violations, the plant agreed to take various corrective actions, discussed in the report in sections entitled "Final Outcome and Follow-up." CPSD is satisfied that the corrective actions taken by the plant will adequately address the issues raised in the Preliminary Report.

# Plant Description

El Segundo Generating Station generates a total of 670 megawatts, and is located on the Pacific Coast in the City of El Segundo, near Los Angeles International Airport. Two of the plant's older units, 1 and 2, retired from service on January 1, 2003. The remaining Units, 3 and 4, built in 1964 and 1965, respectively, burn natural gas and generate 335 megawatts each. El Segundo's boilers, unlike most, burn fuel at the top and use pumps to force water downward through boiler tubes. The plant takes water for cooling from the ocean nearby and runs it once through the plant's condensers. The plant can be controlled remotely through automatic generation control (also called AGC).

While the plant was built to serve base load, it now operates largely as a peaking plant. Because it uses single-cycle steam technology, the plant is less efficient than new combined-cycle plants. Therefore, the California ISO generally dispatches those more efficient plants first, and dispatches El Segundo only when demand is relatively high. As a result, the unit cycles up and down as demand rises and falls during the day and year.

Southern California Edison Company built and operated the plant until California restructured its electric industry. El Segundo is now owned by a Limited Liability Company (LLC) of the same name. At the time of the audit, NRG and Dynegy each owned 50 percent of the plant through their subsidiary, West Coast Power, also a Limited Liability Company (LLC). In March 2006, NRG acquired 100 percent of West Coast Power, and therefore 100 percent of the plant.

# Plant Performance

Since the retirement of the plant's older units, the plant has had relatively few forced outages; in fact, the CPSD inspected outages at the plant only twice in 2003 and four times in 2004. CPSD and CAISO data show that most of the forced outages at the plant stem from leaks in boiler tubes. As described below, the plant has also worked on boiler pumps, the cooling water system, and a main transformer that was damaged by fire.

In response to repeated outages, the plant rebuilt the six pumps which circulate water through the boiler (see above). Each of the two units requires three pumps to operate at full capacity. Each unit can operate on one or two pumps but at reduced capacity. Gaskets on the pumps repeatedly leaked between June and August 2003, significantly limiting production at the plant. El Segundo engineers worked with a contractor to diagnose the problem, and found that output from the pumps was less than expected, probably due to misdesigned check valves. In the spring of 2004, El Segundo rebuilt all six of the pumps, taking each unit out of service for a month in order to perform this work.

The plant's cooling water system requires regular maintenance, including cleaning cooling water tunnels. The plant performed this work during major planned outages in 2003 and 2004.

One of the plant's lightning arrestors caught fire on November 17, 2004. As part of this audit, CPSD reviewed the plant's analysis of the root cause of this fire (see Observation 3.7).

# SECTION 1—Safety Hazards Requiring Immediate Corrective Action

Auditors found no safety hazards requiring immediate corrective action.

# SECTION 2—Other Potential Violations of Standards Requiring Corrective Action

This section describes nine potential violations discovered during the audit of the Maintenance and Logbook Standards, as well as the plant's response to these findings. Most of these findings are relatively minor. The plant has corrected or has committed to correct all problems identified by the audit.

Maintenance Standard 1—Safety

*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.*

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.*
   *3. Demonstrating a willingness to identify problems and ensure they are corrected.*

B. *Managers in the organization contribute to the safety culture of the work environment through:*
   *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*
   *3.* Ensuring safety concerns are promptly identified and resolved.

Maintenance Standard 14—Engineering and Technical Support

*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.*

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

## Finding 2.1 – Missing end plate bolts and nuts on the heat exchanger for bearing cooling water

The plant failed to study whether it was safe to remove half of the bolts securing the end plate of a large heat exchanger, risking failure of the remaining bolts. Failure of these bolts could send the plate, as well as hot water or steam, flying through the work area of the plant creating a hazardous condition. Failure of the heat exchanger could also reduce the plant's output. Failure to study the possibility of such a failure potentially violates Maintenance Standards 1 on Safety and 14 on Engineering and Technical Support.

In response to an auditor's inquiry, the Maintenance Supervisor and the Technical Manager said that this practice was "inherited" from the previous owner of the plant. Current plant personnel have never examined or asked engineers to analyze this practice. The CPSD finds this practice questionable, because it reduces by 50 percent the component's ability to resist surges in cooling water pressure (see Figure 1).

**Figure 1: Bearing cooling water heat exchanger is missing 50% of the endplate bolts and nuts.**

When designing equipment, engineers estimate the maximum stress that a plant component will encounter in service, and design the component to withstand a multiple of that stress. That multiple, called a "safety factor," compensates for corrosion and other wear over time, as well as potential errors in design, fabrication, or maintenance. Therefore, reducing the number of bolts reduced the safety factor of the heat exchanger. The plant should have studied the heat exchanger to determine whether the exchanger end plate would remain secure under all foreseeable pressures and temperatures, including a reasonable safety factor.

**Final Outcome and Follow-up**

In response, El Segundo issued Maintenance Work Order C111381 on August 18, 2005 to replace the missing fasteners. On May 9, 20006, El Segundo submitted photographs confirming that the plant had completed the work.

No further action is needed.

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*C. Work practice norms in the organization promote the safety culture through:*

*3. Ensuring safety concerns are promptly identified and resolved.*

## Finding 2.2--Laboratory acids lacked secondary containment.

Auditors found one-gallon bottles of acid without secondary containment (that is a tray or barrier to contain accidental spills) on the floor and the bench of the plant's chemistry laboratory, a potential violation of safety standards (see Figures 2 to 4). Acid burns, stains and rings on the bench and storage areas serve as evidence of this prolonged practice. Without secondary containment, spills of corrosive materials could damage surrounding equipment and injure plant staff. Failure to use secondary containment also violates Occupational Safety and Health Administration (OSHA) standards.[1]

1 OSHA Regulation; 1910,1450 App. A; Subsection D.2.b., states:

*"Chemicals which are highly toxic or other chemicals whose containers have been opened should be in unbreakable secondary containers"*

## Final Outcome and Follow-up

In response, El Segundo stated that all bottles of acid have been placed in secondary containers via Maintenance Work Order C111376, which was written on August 18, 2005. The work was completed on October 5, 2005.

The plant should inspect the laboratory regularly to eliminate such hazards.

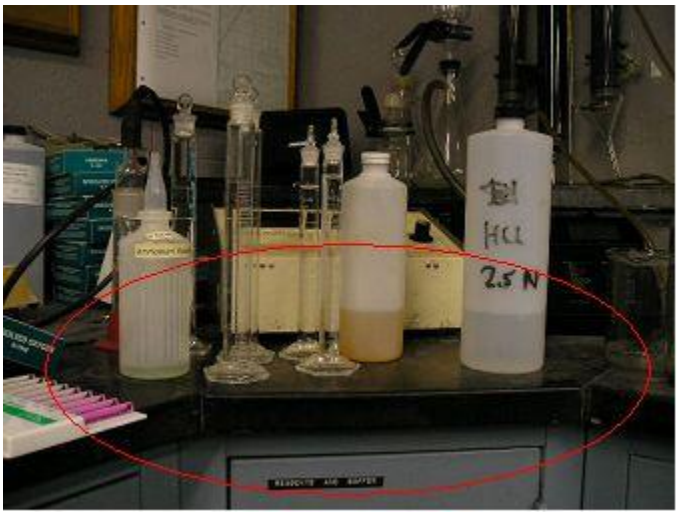


**Figure 2: Acid and reagents left on the edge of the bench in the chemistry laboratory.**

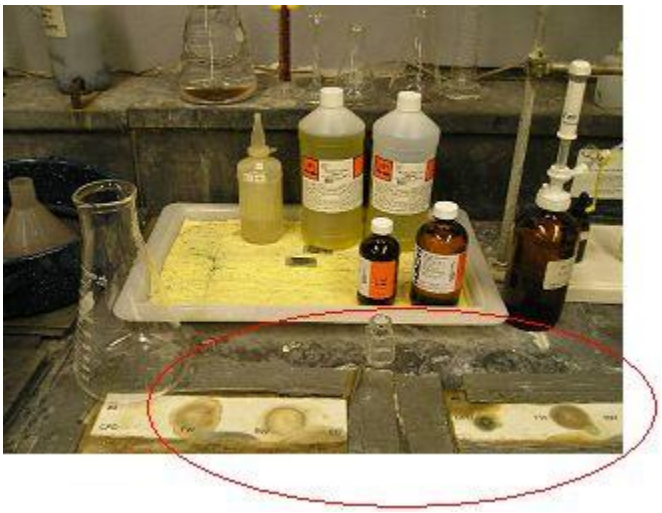

**Figure 3 : Acid burns on the bench counter top.**

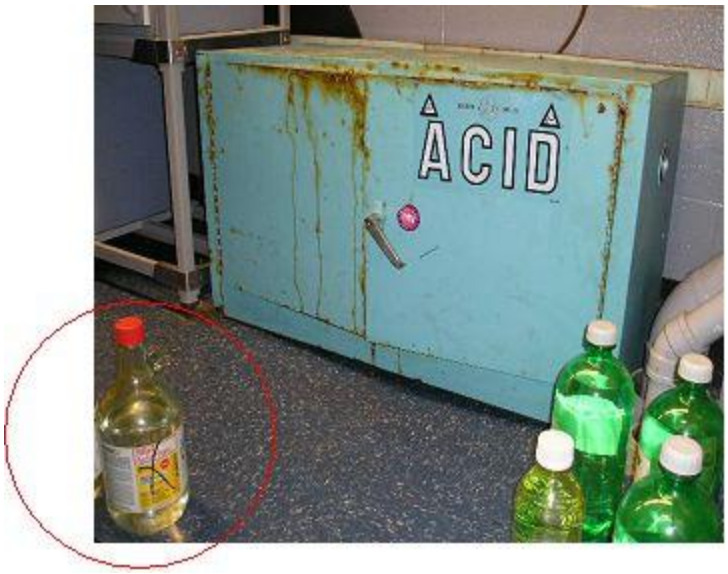


**Figure 4: Nitric acid left out of the cabinet on the floor with no secondary containment.**

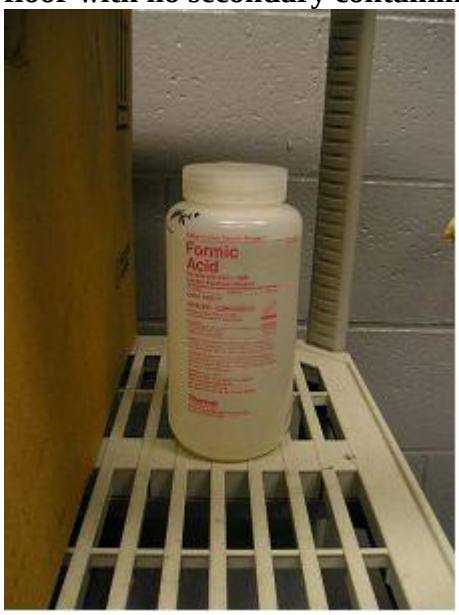


**Figure 5: Formic acid on a plastic shelf without secondary containment.**

## Finding 2.3 --The chemistry laboratory stored corrosive chemicals in larger-than-necessary containers.

In the plant's chemistry laboratory, CPSD auditors found reagent and acid stored in one-pint bottles, a potential violation of safety standards. Use of larger than necessary

containers increases risks due to spills. This volume is larger than required for testing needs, and should be reduced to meet OSHA regulations (See Figures 2 to 5 above).[2]

**Final Outcome and Follow-up**

In response, El Segundo said that pint bottles are the smallest practical size. On reconsideration, CPSD agrees that the use of pint bottles is reasonable.

No further action is necessary.

## Finding 2.4 – Plant staff left open the door of a cabinet that held flammable materials.

Auditors found an open cabinet containing flammable substances in an unattended chemical laboratory, a potential violation of safety standards (see Figure 6). Such cabinets should be closed except when staff is moving materials in or out to reduce the risk of fire. Closed doors isolate fumes and trap spills, preventing combustion of flammable materials stored within.


**Figure 6: Flammable containment vault in the chemistry laboratory left open with combustible material stored on top.**

[2] OSHA Regulation; 1910,1450 App. A; Subsection D.2.d states:

> *"Laboratory Storage: Amounts permitted should be as small as practical. Storage on bench tops and in hoods is inadvisable..."*

**Final Outcome and Follow-up**

In response, El Segundo plant ordered a new cabinet with a self-closing door through Maintenance Work Order C111376, dated August 18, 2005. The plant completed the work on October 5, 2005. Additionally, the plant pointed out that it trains staff in the proper storage of flammable material during its annual training on the handling of hazardous materials.

The plant should check for such hazards through regular inspection.

## Finding 2.5 – No emergency overhead drench shower in the chemistry laboratory, in addition to the eye wash station.

The chemistry laboratory lacked an emergency overhead drench shower (see Figure 7), a potential violation of safety standards. In the event an employee contacts acids or other hazardous materials, such showers can prevent or reduce resulting injuries. The laboratory's eye wash station contained minimal amounts of water and could not remove large amounts of hazardous materials. Furthermore, lack of a drench shower potentially violated OSHA standards.[3]

[3] Occupational Safety and Health Administration (OSHA) Regulation; 1910,1450 App. A; Subsection C.1.d, states, *"Laboratory facilities should have other safety equipment including eyewash fountains and drench showers..."*

**Figure 7: Eye wash station with no emergency shower overhead.**

**Final Outcome and Follow-up**

El Segundo responded that there is an emergency drench shower just outside the chemical laboratory on the turbine deck. Employees in the chemical laboratory can access the drench shower within 10 seconds, as required by the California Code of Regulations, Title 8, Section 5162, section c.

During discussions with El Segundo, auditors pointed that an injured employee could be disoriented, and might have trouble finding his or her way out the laboratory door to the drench shower. In response, NRG's Regional Safety Manager ordered the installation of a drench hose inside the laboratory and a panic bar on the door leading to the drench shower on the turbine deck. El Segundo submitted pictures of the newly installed shower to CPSD on May 9, 2006.[4]

No further action is required.

[4] El Segundo stated that the measure satisfies the "reasonable protection" requirement of OSHA's standard (NSPA, ANSI Z358.1), considering that the laboratory rarely uses reagents in quantities exceeding one milliliter. The drench hose and panic bar were recommended by the Bradley Corporation of Menomonee, Wisconsin, which the plant hired to do a site evaluation.

## Finding 2.6 –Ventilation system for the chemistry laboratory's fume hood was not working.

The fan was broken in the laboratory's fume hood, potentially exposing plant staff to hazardous chemicals, a potential violation of safety standards. In an interview with the auditor, the plant's chemist confirmed that "the fume hood needs a new motor and the fan rattles. It pulls just a small amount of air."

**Final Outcome and Follow-up**

In response, El Segundo created Maintenance Work Order C110177 on December 9, 2004. The plant eventually replaced the motor and fan through this work order. CPSD verified that the work order was completed on 12/30/2005.

The plant should inspect the laboratory regularly and correct any problems found.

GO167, Section 10.4: Information Requirements

*Within 24 hours of its occurrence, a Generating Asset Owner shall report to the CPSD Director or designee, either verbally or in writing, any safety-related incident involving a Generating Asset. Such reporting shall include any incident that has resulted in death to a person; an injury or illness to a person requiring overnight hospitalization; a report to Cal/OSHA, OSHA, or other regulatory agency; or damage to the property of the Generating Asset Owner or another person of more than $50,000. The Generating Asset Owner shall also report any other incident involving a Generating Asset that has resulted in significant negative media coverage…*[1]

## Finding 2.7 – The plant lacks procedures for reporting safety-related incidents to the CPSD

El Segundo lacked procedures for reporting safety-related incidents to the CPSD, as required by General Order 167. In particular, GO 167 requires that Generating Asset Owners (GAOs) report to CPSD all safety-related incidents that result in death, injuries which require overnight hospitalization, damages exceeding $50,000, or which require a report to Cal/OSHA, OSHA, or other regulatory agencies.

When a CPSD auditor inquired about the presence of the reporting requirement in the plant's procedures, the Regional Safety Manager stated that she did not believe this requirement appeared in their safety documents.

Auditors found no safety problems that should have been reported to the CPSD. The plant log showed three safety incidents after the effective date of GO 167, but none required overnight hospitalization or met the other criteria that should trigger such a report. These incidents occurred on July 19, 2004, August 17, 2004, and September 28, 2004. In compliance with CAL-OSHA regulations, the plant logged each incident on OSHA Form 300, "Log of Work Related Injuries and Illnesses."

**Final Outcome and Follow-up**

El Segundo agreed to add CPSD contacts to the plant's emergency contact list.

GO 167, Sections 5.6 and 5.6.3

> *5.6 Compliance Document. Each Generating Asset Owner shall prepare and maintain a compliance document. The compliance document will be available at the generation facility site or remote control or switching center. The compliance document will show:*
>
> > *5.6.3. Any necessary format or presentation protocols that must be understood to decipher the meaning of the electronically or manually maintained data.*

Generator Logbook Standards (Thermal Energy)

> *Information in the Plant Status Entry shall include…Unit Status, if on line, including…Fuel type and availability*

## Finding 2.8 – Plant logs use non-standard terms and lack entries for fuel type and availability

Some entries in the plant's operator log lacked entries on the generator's fuel use, and others employ non-standard abbreviations and acronyms, a potential violation of GO 167 and Logbook Standards. Among other things, Logbooks Standards require generators to record the fuel type and availability in a daily entry on plant status.[5]

El Segundo's control room operators filled out a unit status form daily. That form was largely in compliance with logbook standards but, as confirmed by plant staff, the form lacked a field for fuel type and availability. The CPSD auditor reviewed unit status sheets for March 27-29, 2004. The only reference to fuel on the status sheet was a field marked "Chevron." (Chevron supplies some gas used at the plant). The significance of this entry was unclear.

Finally, the plant log included non-standard abbreviations and acronyms. Such acronyms could be confusing to plant staff, causing problems in operations, as well as to auditors or other regulatory staff. Therefore, to satisfy logbook standards, the plant should maintain a glossary for such terms, or use standard abbreviations and acronyms.

**Final Outcome and Follow-up**

El Segundo has removed the field titled "Chevron" from the daily status form, and has added fields for primary fuel and fuel availability. Further, the plant has added a glossary to the Compliance Document, which the plant maintains in compliance with Logbook Standards

[5] General Order 167. Appendix B: Generator Logbook Standards (Thermal Energy), Pg. 34.

Maintenance Standard 8 — 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. 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.*

Assessment Guidelines

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

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…*
*2. Procedures specify portions or steps of other documents that are to be referenced or used when a procedure is performed.*

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

## Finding 2.9 – Table of Contents of "Unit 3 & 4 Procedures for Chemical Tests and Corrections by Operators" not up to date

Plant documents list incorrect page references for "blow-down" procedures, making those procedures difficult to find, and causing a potential violation of GO 167 and Operation Standards. As described below, blow-down procedures maintain the quality of boiler feedwater, in turn preventing corrosion of boiler tubes. Maintenance Standard IV.A.1 requires clear and technically accurate procedures to ensure safe and reliable operations. Indeed, El Segundo has not followed its own maintenance plan, as required by GO 167. That plan requires supervisors to assure the accuracy of revised technical documents.[6]

[6] El Segundo procedures OPT-4012, "Design Changes, Effective date: 11/9/04", section 5.3 states:

In particular, page 3, section C.2 of the document entitled "Unit 3 & 4 Procedures for Chemical Tests and Corrections by Operators" states "the degree of contamination will determine the rate of blow down. (Refer to pages 18 and 19 for blow down capacities.)" The reference is inaccurate; in fact, blow-down capacities do not appear on pages 18 and 19, or anywhere else in the document.

| Test Procedure Name | Page Number Listed in the Table of Contents | Actual Page Number the Procedure Is Located |
|---|---|---|
| Sodium Chloride | 9 | 10 |
| Hardness (CaCO3) | 10 | 11 |
| Dissolved Oxygen (O2) | 11 | 12 |
| Conductivity | 12 | 13 |
| PH Measurements | 14 | 15 |
| PH Correction | 16 | 18 |

Blow down procedures remove the most contaminated portions of boiler feedwater (or cooling water), often by skimming or draining. Blow down therefore reduces contaminants in the remaining water, bringing chemical concentrations to desired levels and/or correcting the water's pH.

If operators cannot find such procedures, they may misadjust the plant's water chemistry which, over a period of time, can cause maintenance problems such as leaks in boiler steam tubes. Plants do monitor water chemistry automatically, so that severe excursions in water chemistry should trigger alarms; however, it is best not to trigger those alarms in the first place.

## Final Outcome and Follow-up

El Segundo agreed to correct the page references by the end of October 2005. The plant submitted several drafts of corrections, and sent an acceptable document to the CPSD in June, 2006.

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> *"Design Change Sponsors are responsible for the technical aspects of the system to be modified and for determining which drawings, databases and documents will be revised and replaced. Design Change Sponsors are also responsible for verifying that technical information, specifications and related work procedures, parts lists and operations procedures are revised accurately. They are responsible for creating, managing and completing the Design Change Work Package."*

El Segundo procedures OPT-4012, "Design Changes, Effective date: 11/9/04", section 5.6 states:

> *"Maintenance supervisors are responsible for updating and revising maintenance databases, spare parts tags, maintenance and testing procedures, parts lists and procedures, parts lists and procurement procedures for new or revised equipment in cooperation with Design Change Sponsor."*

El Segundo should periodically review its procedures in order to make sure page references are correct, and to assure that personnel can quickly find important operations procedures.

# SECTION 3 –Other Audit Observations

This section describes other audit activities where auditors found no violations of standards. Of course, audits are by their nature limited, and cannot identify each and every violation that may be present in any particular plant activity, or in the activities of the plant as a whole.

GO 167, Sec. 5.6

> *<u>Compliance Document</u> Each Generating Asset Owner shall prepare and maintain a compliance document. The compliance document will be available at the generation facility site.*

Generator Logbook Standards (Thermal Energy)

> *Each facility must record a Plant Status Entry each calendar day.*
> *The first entry in the Control Operator Log at the start of a shift shall identify each operator on the shift.*

## Observation 3.1 – Logbook Entries

The CPSD auditor confirmed that, in conformance with the Commission's logbook standards, the plant maintains a Compliance Document that describes where the plant keeps required data. The plant's Compliance Document is titled "SOP OPO-4001 Control Room Logs Standard Operating Procedure". This document contains a copy of the entire logbook standards from General Order 167, directs staff to fill out logbooks in a manner in keeping with these standards, and specifies where data required by logbooks standards can be found.

The CPSD auditor reviewed three chronological logbook entries for 2004 (March 27, 28, and 29)**.** These logbook entries contained eight of the ten items required for daily status entries by the logbook standards. The fuel type and availability were missing (see section 2 of this report). The CPSD auditor also verified that these logbooks contained shift change entries that listed all the operators. These personnel are always listed in a particular order, with the control room operator listed first and the shift supervisor listed last.

Maintenance Standard 1--Safety

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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…*

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*

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## Observation 3.2 – Individual Accountability, Tools and Small Equipment

CPSD auditors examined the plant's work environments, as well as, its policies and procedures in promoting a safe culture. The CPSD auditor made the following

observations at the plant related to the above-mentioned standard and the associated guidelines.

In the plant's ground-level area for hazardous material collection, auditors found that a cabinet for flammable materials was properly equipped with self-closers (see Figure 8).[7] Self closers help ensure that cabinets will isolate fumes and prevent combustion of flammable materials. [8]

**Figure 8: Flammable cabinet with self-closers**

Individual Accountability - The CPSD auditor attended a 7:00 AM shift change meeting and observed that:

- Staff in attendance was reminded to carry a copy of the Personal Accountability System Survey (PASS) card at all times.
- The PASS Card authorizes each individual to assess working conditions, make safety decisions, and to stop work if conditions are unsafe.
- This card reminds staff of their role in personal accountability and in contributing to overall plant safety. Additionally, management can ask staff to produce the PASS card at anytime to check on his or her associated safety knowledge and behavior.
- Individuals were encouraged to discuss safety issues at the plant by the Regional Safety Manager. The instructor asked individuals questions during the discussion to encourage participation and to assess individual comprehension.

[7] However, CPSD did make a finding of a potential violation (Finding 2.4) for a similar cabinet in the plant's chemistry laboratory, which was left open and unattended and did not have self-closers.
[8] Indeed, OSHA requires self-closers on new storage cabinets.

- NRG's OSHA Regional Safety Manager showed the CPSD auditor the plant's Safety Reporting System (SRS). Staff uses the SRS system to report unsafe plant conditions and ways to avoid safety incidents. Each month, management recognizes individuals who submit reports by way of a commendation notation in his or her personnel file.

Tools and Small Equipment – The plant contracts with Total Western to provide maintenance service at the plant (see Observation 3.6). The CPSD auditor toured the on-site maintenance facilities and obtained the following information about hand tools and small equipment maintenance from the from Total Western's site supervisor:

- Total Western tests all extension cords and hand power tools monthly. Staff is directed to use only power cords and power tools marked with the current month's color code. This color-coding method provides an easy identification for equipment has been properly tested for usage that month.

- At the time of the audit, the plant was installing electric outlets which trip in response to shorts (Ground Fault Circuit Interrupt Outlets).

Maintenance Standard 2 – Maintenance Organization Management and Leadership

*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.*

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*

## Observation 3.3 – Organization and Staffing

The plant's files related to organization and staffing were available in the conference room at the plant at the time of the audit and contain the following documents:

- NRG SOS HR-002 Management Philosophy
- NRG SOS HR-003 Organization Structure
- NRG SOS HR-004 Staffing Guidelines

The CPSD auditor also reviewed the existing organizational charts for the plant.

The CPSD auditor verified that the plant has an engineering group called the Technical Services Group, which consists of a manager and three full time engineers. They were the main technical contacts for the auditors. The duties of this group are detailed on page 12 of the "2004 El Segundo Annual Operating Plan and Budget" for the El Segundo Power Plant. The CPSD auditor reviewed this document. The group is responsible for oversight of all major projects and outages, analysis of predictive maintenance, economic evaluations, and maintaining the plant's technical documents. An engineer is assigned to environmental issues such as permitting. The current organizational structure appears to comply with the documents listed above.

The plant compiled specific documents relating directly to the maintenance standards. These are collected in a group of documents called the "Standard Operating System." The Standard Operating System includes 35 formal documents on subjects including, but not limited to:

- NRG SOS OPO-008 Incident Assessment
- NRG SOS OPO-003 Significant Events
- NRG SOS OPM-001 Strategic Maintenance Guidelines
- NRG SOS OPM-003 Maintenance Standards

In addition, the plant hired an outside auditor, Shaw Corporation, to conduct a mini-audit of the plant maintenance documentation prior to the CPSD audit. The Shaw Corporation's work for El Segundo was not an audit of the actual maintenance programs, but a paperwork audit to ensure there was documentation covering all areas of the maintenance standards.

Maintenance Standard 3 – Maintenance Management and Leadership

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

Assessment Guidelines

*A4. Personnel throughout the organization are aligned to achieve common goals.*

*B2. Goals are established to challenge the organization to continuously improve. Results are measurable and are periodically evaluated to determine effectiveness.*

*D6. Monitoring and Assessing. Managers continuously and effectively monitor and assess the performance of maintenance activities, with particular attention to… General area housekeeping*

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## Observation 3.4 – Employee Evaluation

CPSD asked how the plant reviews employee performance and determines compensation. The plant manager stated that employee reimbursement is based on two factors. First, there are union regulations requiring specific pay levels. Second, bonuses are based on plant performance as assessed by Key Performance Indicators, which are tied to plant commercial availability. Availability is reported in a Monthly Plant Performance report. All employees receive bonuses, which are a percentage of their base pay level. This percentage is the same for all employees with satisfactory evaluations.

According to the plant manager, all employee evaluations are performed annually, at a minimum, and operator evaluations are performed quarterly. The CPSD auditor saw a schedule in the Instrument and Control Room blackboard that showed three employees scheduled for December performance reviews. According to the plant manager, benchmarks are developed for each employee at each annual or quarterly review. Then employees are evaluated in the next annual or quarterly review against the benchmarks established at the prior review. The CPSD auditor reviewed three randomly selected monthly plant performance reports and one employee review report.

Maintenance Standard 4—Problem Resolution and Continuous Improvement

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

Assessment Guideline B

*A systematic approach and process is used to identify and report problems, determine the cause(s) and establish corrective actions to prevent recurrence...*

## Observation 3.5 – Electronic Checklist and Root Cause Analysis

Track Smart - Plant management installed a specialized computer program and device called "Track Smart" to improve reliability and operation. The key component of this program is the usage of a handheld device that generates an electronic checklist for each piece of equipment in the plant. Staff currently uses this device during daily walk down inspections and shift changes. During a walk down, staff scans the unique bar code on equipment to retrieve desired operating conditions on the electronic device's display. Then staff checks the equipment's current condition against the desired conditions and enters his or her findings into the device. Upon returning to the control room, staff places the device in its cradle and the inspection information is automatically downloaded to a desktop computer. A computer program stores the information and tracks equipment operating conditions, which will be used by operation staff to anticipate or prevent future equipment failures.

Root Cause Analysis - The plant staff used root cause analysis and systematic incident assessment in several situations. For example, a 2002 analysis of the motor on the boiler circulating pumps led to overhaul of these pumps and some critical piping modifications to improve reliability.

The following formal documentation relative to overall plant performance improvement, and systematic methods for the investigation of problems were noted by CPSD auditors:

- NRG SOS OPO-003 Significant Events
- NRG SOS OPO-008 Incident Assessment
- NRG SOS OPO-004 Key Process Indicators
- NRG SOS OPO-207 Root Cause Analysis
- NRG SOS OPO-401 Performance Optimization

Maintenance Standard 5—Maintenance Personnel Knowledge and Skills

*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.*

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.*

## Observation 3.6 – Maintenance Staff Qualification and Certification, and Training

Maintenance Staff - In response to a CPSD auditor's inquiry about the number of permanent and contract maintenance staff on site, the plant manager stated that NRG has a permanent plant maintenance staff composed of an Instrumentation and Control Manager, an Electrician, and three Instrumentation and Control Technicians. This group is dedicated to the El Segundo plant, and is on-site at all times. NRG contracts most of the other plant maintenance work to Total Western, Inc. Total Western also has a permanently assigned contract maintenance staff at the plant. Prior to Total Western, the maintenance duties were contracted to Irwin, Inc. According to the plant manager, there are eight full-time contract maintenance personnel, including a welder, two mechanics, a boiler mechanic, a millwright, and three electricians on site full time, along with a maintenance supervisor. In the event of major problems, there are reserve crews available at all times to work at the plant from the Total Western headquarters.

Maintenance Staff Qualification and Certification - The CPSD auditor also verified the qualifications and certifications of plant personnel by sampling qualifications and certifications of the contract maintenance personnel. The CPSD auditor reviewed a copy of the welding certificate for a welder. This certificate documents that the person is a qualified welder in accordance with the Boiler and Pressure Vessel Code, Section IX, QW-301.

Maintenance Staff Training - The CPSD auditor verified that the plant maintains training records for all contract employees. The CPSD auditor reviewed the records for three contract employees. The forms listed 30-40 courses for each contract employee. Those employees had completed more than three-quarters of the required training in the year before the audit, suggesting that training is repeated at reasonable intervals. The records included both safety and skill training. The CPSD auditor also reviewed copies of formal, written examinations given to Journeyman Electricians and Mechanics who work at the plant for Total Western. The examinations appeared to be comprehensive.

The plant requires every operator starting work at the plant to take a computer-based training program, designed by Fossil Consulting Services, a consulting firm based in Columbia, Maryland. The plant manager stated that the plant had spent $600,000 on the training program, in part in an effort to comply with maintenance and operation standards. The CPSD auditor reviewed three large volumes, titled "Thermal Power Plant Sciences and Operations Training Program" which accompany the training. The volume systematically presents increasingly technical information about power plant systems, and appears to be comprehensive.

The CPSD auditor also accompanied the NRG Regional Manager for Occupational Health, Safety and Security during her annual plant safety audit. She stated that Total Western conducts weekly safety training.

Each session covers one or more key topics including fire extinguishers, forklifts, scaffolding, confined space, hazardous materials, and electrical hazards. At every second meeting, staff views a relevant safety videotape. The safety topics are prepared and presented by Total Western personnel assigned to the task. Files indicating the dates of training, the individual responsible for preparing each of the training sessions, and the individuals trained on each major safety topic are stored in the plant's office. The auditor reviewed three sign-in sheets for training on confined space, fire extinguishers, and forklift practices. All staff scheduled to attend the training and listed on the sign-in sheets appear to have signed-in. Roughly ten staff attended each of the three classes.

NRG's regional manager also stated that videotapes were available on a comprehensive list of topics for personnel unable to attend safety classes. The CPSD auditor saw several videotapes but did not review each tape's actual contents. All on-site contractors and plant personnel receive the same training.

Maintenance Standard 7—Balance of Maintenance Approach

*The maintenance program includes the proper balance of the various approaches to maintenance, e.g., preventative, 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 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, transmission lines, penstocks, flumes, exhaust system, etc.*

Assessment Guidelines

*A. Preventative maintenance is proper for the equipment whose failure adversely impacts safety or reliable operation or results in forced outages, or significant derates.*
*B. Preventative 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. *Preventative maintenance tasks are technically based, including vendor input and industry experience.*
E. Prev*entative maintenance tasks are properly documented in procedures, and receive appropriate planning prior to scheduling…*
*G. Preventative 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*

## Observation 3.7 – Record review, personnel interviews, and field observations of electrical and boiler systems

The CPSD auditors reviewed the plant maintenance program through record review, personnel interviews, and field observations of the following systems.

Electrical System

- In response to a CPSD auditor's question regarding El Segundo's maintenance program, an operator stated that predictive maintenance is conducted throughout the year. Preventative maintenance includes vibration analysis, oil sampling, and thermography. The El Segundo operator stated, "Maintenance is about 40% corrective, 40 % preventative and 20% predictive." The plant conducts oil analysis and vibration analysis once a quarter and once a year, respectively. This appears to be supported by the work planned and performed on the MainSaver maintenance list; the MainSaver database is discussed in detail in Observation 3.9. Based on the work conducted, which is illustrated in the MainSaver database, the El Segundo staff conducts daily, weekly and monthly preventative maintenance.

- A CPSD auditor asked Total Western, Inc. personnel about an outage in November 2004 on unit 3 caused by the failure of a lightning arrestor. CPSD also sent the plant a data request on June 23, 2005 for a root cause analysis of this incident. Total Western personnel responded that their analysis so far indicates that moisture got into the arrestor, and caused a short circuit, resulting in the middle section of the arrestor exploding into tiny pieces. Total Western explained that this problem has never occurred before at this power plant, but has occurred at other plants. A replacement arrestor has arrived, but it has to be machined before installation at this plant.

Boiler System

- The annual piping inspection reports began in 1986 with Southern California Edison. It included welds and boiler tube wall thickness and preventative maintenance analysis.
- Piping reports include main steam, hot reheat, cold reheat, auxiliary steam, boiler feed water and condensate piping. The focus is on field, high stress, longitudinal, and high erosion welds.
- The El Segundo staff recommends on-line service hours of 40,000 to 80,000 hours for inspection of boiler tube welds. The inspection methods include magnetic particle testing, radiography, ultrasound and/or replication (explained at the end of this section)
- The plant has developed a spreadsheet for the critical piping system for each unit. This lists all critical weld joints, indicating the year of inspection, and the recommended on-line hours between inspections.
- El Segundo staff monitors the boiler and boiler tubes annually. This information includes tracking 323 welds, hours remaining until next inspection, inspection date, recommended hours until the next inspection.
- El Segundo power station has contracted with Total Western for all duties related to the maintenance all of its high-energy piping.
- Water softening and filtering for steam is contracted out with NALCO and Arrowhead.

- The El Segundo staff conducts studies to determine the cause of boiler tube deterioration. During the annual spring outage, predetermined tubes are cut out for visual inspection.
- Edison International is also under contract to conduct yearly ultrasonic analysis tests. Blistering and expansion is studied using nondestructive analysis, which consists of visual examination, thermography and boroscope analysis.
- The plant keeps detailed piping history for all high-energy piping and follow-up repairs are conducted on an as needed basis.
- The following studies will be conducted on the boiler and the boiler tubes during the Spring outage of 2005:
    - Visual and Dimensional Analysis
    - Metallographic Analysis
    - Hardness Testing
    - Deposit Loading Analysis
    - Chemical Analysis
    - Pictures of broken tubes.
    - Photomicrographs taken at edge of the ruptures (100X & 400X)

Explanations of the testing methods used follow below.

Ultrasonic Testing (UT) is typically used to determine the thickness of materials. Ultrasonic sound waves are sent through the material by transducers and recorded by receivers. The ultrasonic waves are projected either perpendicular (Straight Beam) or at an angle (Shear Wave) to the surface of the pipe or fixture in question. The receiver records the echo. The time of flight diffraction indicates the wall thickness. Changes in the flight diffraction can indicate the presence of flaws and their location. This type of testing can be used on both the base metal (undisturbed by welding or bending) and fabricated metal (welded or bent). Longitudinal UT uses a collar with transducers wrapped around the pipe. The transducers send ultrasonic waves longitudinally along the pipe, and can detect inner and outer wall loss. Typical test lengths range from 100 to 300 feet.

Magnetic Particle Testing (MT) uses an induced magnetic field and magnetic particles to evaluate surface discontinuities on a pipe or part in question. This is very similar to holding a magnet under a sheet of paper and sprinkling iron filings on the top to see the magnetic lines of flux. Upon inducing a magnetic flux, (on a pipe in this case) a powder or solution of magnetic particles is dispersed on the surface. The orientation of the particles is regular and along magnetic flux lines for undisturbed or uniformly fabricated pipes. Damaged pipe will have discontinuities or flaws that interfere or distort these lines. Wet fluorescent (black light sensitive) magnetic particles are especially well suited for the examination of pipes and associated welds.

Classic or conventional Radiography (RT) uses X-rays or Gamma rays to penetrate the object and develop an image of the material on film. This is very similar to X-rays used in medical exams. Advances in technology have allowed for the development of digital radiography. Digital radiography (DRT) uses smaller handheld devices coupled to a

portable computer that stores the images. Digital radiography has advantages with a wide range of sensitivity, which allows for the examination of a large range of pipe thicknesses.

Replication is a method used to look at the granular configuration of material. Highly stressed materials show distorted grain boundaries and microscopic cracks known as "dislocations". These dislocations can lead to premature failure of the material. Replication uses acetate and a solvent such as methyl-ethyl-ketone (MEK) to make an impression of the material. The solvent is applied to the surface of the metal and the acetate is pressed into the solvent. The impression is then fixed into the acetate for microscopic evaluation. This method is especially useful for evaluating the cause of fractured or ruptured piping.

Hardness testing can be used to determine the stress on, and the life remaining in a piping system. The Rockwell hardness test is a scalar (non-dimensional) number and represents the amount of penetration a 1/16-inch diameter steel ball has on the surface of the material in question. The force on the ball is standardized and the measurements are used in a comparative way. The Brinell hardness test is typically in metric units where the area of the indentation caused by a 10 millimeter steel ball under a fixed load is calculated. Changes in hardness from one year to the next can indicate several conditions. Decreases can indicate overheating or annealing of the material. This can lead to bending pipes, blisters and "fish mouth" ruptures. Increases can indicate low temperature stresses and lose of ductility and toughness. These temperature stresses can cause premature and sometimes catastrophic failure by fractures in piping systems.

Thermography uses a portable infrared heat sensor coupled to a portable computer to map the exterior temperature distribution of components. Such components can be a turbine, boiler or other associated pieces of equipment. Heat loses and hot spots can be identified and treated accordingly to reduce the associated negative effects on the equipment.

Boroscope analysis uses a catheter (long flexible and movable tube) lens that can be inserted into the equipment or pipe to actually look at the interior surface of the part in question. A scale, usually in millimeters is projected with the images to provide perspective and analysis. As with all testing and analysis methods, digital systems are replacing analog systems. Here digital boroscope cameras have replaced analog video cameras. Digital images allow for spectral (light and color) manipulation and more advanced types of analysis.

Maintenance Standard 8--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. 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.*

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*

## Observation 3.8 – Control room operator duties, inspection procedures, procedure review, corrective maintenance and lock out/tag out procedures

Control Room Operator Duties - The Operations and Maintenance Manager stated that there are two operators on duty at all times in the control room, a main control room operator and an assistant control room operator. These operators run the console that controls the generating unit. There is also an outside field operator responsible for physically inspecting various pieces of equipment as required.

The CPSD auditor reviewed task lists for the control room operator and the outside field operator for inspections of the circulating water system, and the associated lube water and lube oil system. These are task lists, which list all items that need to be checked in some manner by the control room operator or outside field operator. The task lists include checks of traveling screen differential, wash pumps, chain guards, motor heaters, oil levels, lubricating water, bearings, upper and lower oil levels, and trash racks. Task lists do not specify the frequencies of these checks, nor do the task lists include boxes or lines on these lists for checking off items that were inspected. However, failure to record such information in task lists does not appear to violate maintenance or operation standards because the plant monitors and keeps records on plant systems through other inspections and automatic monitoring systems, as described below.

Inspection Procedures – The plant conducts comprehensive and regular inspections of equipment variously through the MainSaver, Distributed Control, and/or Track Smart systems. First, the plant programs some inspections into the MainSaver maintenance system as specific predictive maintenance tasks, or PMs. As described below, the auditor examined the records stored in MainSaver and confirmed that the plant had completed all PMs scheduled for the circulating water pumps during the last twelve months. (PMs and MainSaver are explained in detail in Observation 3.9). These tasks are performed by operators, as called for in the task lists (see above). Second, the Distributed Control System (DCS) monitors multiple points on the pumps and screens for various performance parameters such as pressures, temperatures and motion. Therefore, problems in the operation of these systems are readily apparent to control room operators. Finally, the outside operator performs some tasks and inspections during the daily "walkdowns" of the units. These tasks are programmed into the "TrackSmart" handheld device discussed in Observation 3.5. The plant manager further explained that in order to effectively utilize the time of the outside operator, plant management must decide which items must be physically checked daily, and which items can rely on automated examination by the DCS.

Procedure Review - El Segundo has various procedures for many different areas. The CPSD auditor limited review of the following procedures:

- Boiler Acids
- Circulation Boiler Gauge Glass
- Eye Protection
- Routine Lubrication Schedule
- Transformer Replacement
- Plant Engineering Records
- Steam Blanket on Deaerator
- NPSH Control for Boiler Pump Protection
- Testing of Boiler, Turbine and Generator Protective Devices
- Heat Treatment of Units 1 and 2 Circulatory Water System
- Boiler Blowdown Treatment System
- Procedure for Washing Fire Side of a Boiler
- Use of Survivair Equipment
- Metal Clad Switchgear Breaker Maintenance
- Protective Relay Testing
- Maintenance Records of Burners dated 10/1/88
- Condenser Maintenance
- Boiler Hydrostatic Code or other Pressure Tests
- Main and Auxiliary Generator and Exciter Maintenance
- Cathodic Protection
- Battery Maintenance
- Steam Generators Waterside Repairs Main, Auxiliary and Station Service
- Transformer and Neutral Reactor Maintenance

- Insulation Testing Electrical Apparatus
- Boiler Cleanliness
- Handling Chemical Procedures
- Ion Exchange Systems
- Testing and Maintenance of Automatic Burner Control Equipment
- Boiler Safety Valve
- Planning Unit Outages and Instruments Check-off

Chemistry test procedures include the following:

- Sodium Chloride
- Hardness
- Dissolved Oxygen
- Conductivity Measurement
- PH measurements
- PH corrections to 25$^{o}$C
- Blowdown Capacity Boilers 3 and 4
- SOP OPM-003 (SOP)
- SOP OPM-005 (Work Management System)
- OPO-306 Plant Chemistry
- Operating Instructions: EL OI4-3

Corrective Maintenance and Lock out/Tag out Procedures - The auditor attended a shift change meeting and interviewed plant personnel as to how corrective maintenance is handled at the plant. A plant operator stated that the operators write a work request, which generates a maintenance tag and locks out the equipment. The operator describes the maintenance problem and identifies the piece of equipment by its asset number. The shift supervisor determines the seriousness of the problem and then prioritizes the work. Maintenance supervisors must approve any work before it is conducted. The maintenance crews and supervisors hold a daily shift change meeting to discuss what work is being conducted.

A maintenance planner who works with the maintenance supervisor schedules the short-term and long-term maintenance work that is necessary. The maintenance planner schedules corrective maintenance, preventative maintenance and scheduled outages. Once the work is scheduled the maintenance supervisor will then ask a mechanic to conduct the appropriate repairs.

If parts are not available to perform the work, they are ordered and the order is recorded in El Segundo's MainSaver program. MainSaver tracks every piece of equipment in the plant, which has an asset number. MainSaver contains information on the priority of the work, work status, and parts status. Preventative maintenance work is shown in MainSaver database.

Maintenance Standard 13 – Equipment Performance and Materiel Condition

*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.*

Assessment Guidelines

*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…*

*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.*

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

## Observation 3.9 – MainSaver software tool, circulating water system, equipment protection devices, structural concrete repair, preventive maintenance scheduling, and PI (Plant Information) historian

MainSaver Software Tool - In response to an auditor's inquiry on preventive management, the plant manager stated that a software tool called MainSaver is used to create and manage Preventative Maintenance (PM) documents that have information about each piece of equipment (also called an "asset"). MainSaver generates a single preventative maintenance task called a "PM" for each piece of equipment. The PM is stored in the MainSaver database and includes the task to be performed, the asset number it is to be performed on, the frequency of the (daily, monthly, etc.), the discipline/skill necessary and responsible for performing the task (Electrical, Operations, Mechanical, etc), the PM creation date, and a historical record of the maintenance activity for the PM.

From the information in each PM, the MainSaver tool automatically creates work orders (WO) when it is time to perform the PM task. The maintenance personnel check the WO daily to schedule their activities. When the work is completed, the individual who performed the work closes the work order in MainSaver. Also, each PM contains a record of the results of the maintenance work once it is completed.

Circulating Water System - During a tour of the plant on the first day of the audit, the CPSD auditor noted several details indicating that the plant maintains its circulation water system. First, circulating water pumps had been freshly painted. Second, there was a bucket and a location specifically marked for taking unit samples of circulating water from the underground tunnels. These unit samples are used to periodically analyze the seawater used for the circulating water system.

The CPSD auditor asked whether tide levels are a problem at the intake of the circulating water system. The plant engineer stated tides have not presented a problem up to this time, because the intake was 200 yards offshore, where water level is deep at all times. The plant engineer pointed to two buoys offshore as the intake location. New buoys, in a covered storage area, were shown to inspectors. According to the plant engineer the plant replaces these buoys annually.

The CPSD auditor then asked for all PMs related to the circulating water system. The CPSD auditor checked the PMs on the following tasks:

- Traveling Screen Inspection
- Traveling Screen Bearing Lubrication
- Tunnel Gate Valve Service
- Traveling Screen Shear Pin Alarm Test
- Fish Impingement Count And Basket Dump
- Hydro blasting of lines
- Replacement of Pump Filters
- Heat treatment

All of these PMs were scheduled to be performed monthly. Each month, the software generates a work order for each task; the responsible staff member closes the work order after performing each task. The CPSD auditor asked to see work orders for these tasks during the previous 12 months. All work orders had been closed, with the exception of

the fish impingement count and basket dump, and the heat treat. As described below, plant staff satisfactorily explained why these tasks had been delayed.

Heat Treatments – Every month, the plant is supposed to "heat treat" intake pipes for sea water in order to kill and remove marine life that could clog those pipes. Work orders associated with the PMs for heat treats revealed that the plant had treated pipes monthly up to August 2, 2004. However, the plant did not treat the pipes between August 2 and the audit in December, a period of four months. The plant manger explained that in order to run a successful heat treat, two conditions must be met; first, both units must be in operation; second, the California Independent System Operator must give the plant permission to perform the heat treat. During that four month period the plant had been unable to meet both conditions. In order to detect potential blockage of cooling pipes, operators are trained to watch many DCS readings, including waterbox differential, water temperature, condenser vacuum, and turbine backpressure.

Fish Impingement Count and Basket Dump – Every month, the plant is supposed to count and remove fish killed by the circulating water system, but the last work order produced and completed was dated June 2004. The plant manager explained that a contractor, MDK, Inc., conducts this work, which is required by the plant's permit under the National Pollutant Discharge Elimination System. In this case, the MainSaver system is only used for accounting purposes to provide payment to the contractor. After six months of entries, sufficient documentation is present to supply the contractor with the entire annual payment.

In order to verify that the fish counts were actually conducted every month, the CPSD auditor reviewed the NPDES permit, and found it up-to-date. The CPSD auditor asked to see the document supporting the NPDES permit and was given the NPDES Survey for 2003. The survey showed monthly, detailed measurements of fish kill and impact on other marine life from the cooling water system's discharge. The CPSD auditor requested and received several pages of this document.

In order to verify records for 2004, the CPSD auditor was shown raw fish count records from MDK, that indicate the counts were performed every month in 2004. The plant engineer stated that MDK was preparing an NPDES survey for 2004, which will be ready by the end of the year.

Equipment Protection Devices - The CPSD auditor asked the plant engineer about the use of cathodic protection and space heaters for the circulating water pump. The plant engineer stated that passive cathodic protection was used on the circulating water pumps. The auditor did not physically check the cathodes.

The plant engineer further stated that space heaters were neither used nor necessary on the circulating water pumps, but were used in many other areas of the plant, particularly

around seldom-used, critical electrical equipment such as relays or motors. During a walkdown of the plant, the auditor verified that space heaters were in use.

Structural Concrete Repair - Recognizing that the deterioration of structural concrete is an ongoing problem with aging power plants in moist, seaside environments, the CPSD auditor asked about maintenance and inspection of concrete at the El Segundo plant. The "2004 El Segundo Annual Operating Plan and Budget" called for $80,000 to be budgeted for concrete repair on Units 3 and 4, which are the operational units. This sum was budgeted for the month of February 2004. The plant manager stated that this work had been completed.

Preventive Maintenance Scheduling - Upon inquiry by the CPSD Auditor about the methods for establishing maintenance schedules, the plant manager stated that four sources of information are used to establish the maintenance schedule from which PMs are created for inclusion in MainSaver. These sources are the original Southern California Edison Division Orders information (most of which is out-of-date, per the Regional Plant Manager), Original Equipment Manufacturer (OEM) literature (including updates from the OEM), the results of work from the PMs, and knowledge gained from the work itself. The main sources of information are the last two items mentioned above, per the Regional Plant Manager.

The plant's plan for preventive maintenance of the circulating water system meets or exceeds the recommendations of a consultant's recommended 10-year plan for the plant. The consultant, Aptech, Inc. prepared a document entitled "Ten-Year Maintenance, Inspection Plans, and Budget for El Segundo Units 3 and 4," covering all major pieces of equipment at the plant. The report called for major maintenance on the circulating water pumps every seven years, the bearing cooling water pumps every three years, and the tunnels every major outage, and as required by inspection. Page 10 of the "2004 El Segundo Annual Operating Plan and Budget" states that the plant should adhere to the report's recommendations. The plant plans major maintenance for the circulating water pumps every five years, more frequent than Aptech's recommended seven-year cycle. The maintenance on the bearing cooling water pumps and tunnels meets Aptech's recommendation.

PI (Plant Information) Historian – In addition to displaying data in real time in the control room, the DCS continuously stores data using a computer software system called PI Historian, which the plant uses to detect and display trends in the data. The plant uses the program to analyze trends in the data. The plant engineer printed out a listing of over 200 measurement points (called "tags" in the PI system) associated with the cooling water system.

The CPSD auditor asked to see data for turbine backpressure and waterbox differential pressure for October 2004. These measurements may indicate clogged condenser tubing. Using PI Historian, the plant engineer produced a graph of these measurements, which showed no obvious problems.

Maintenance Standard 15—Chemistry Control

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

Assessment Guidelines

*A. Chemistry specification 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.*

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

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

## Observation 3.10 – Maintenance of plant water chemistry

The following information is related to the maintenance of plant water chemistry at El Segundo power station.

- The El Segundo staff monitors water chemistry every four hours during plant operation. Completed data sheets were available for PUC review.

- According to El Segundo management and past calibration records, two operators calibrate water-monitoring equipment. The equipment monitors pH, conductivity, oxygen content, etc.

- In the case of a water-chemistry emergency, El Segundo contacts one of two available chemists. One is an independent consultant who works at El Segundo once a month. If that consultant is unavailable or needs additional assistance, the plant can contact another chemist who works for Southern California Edison. The plant reports that water-chemistry emergencies are very rare; El Segundo has notified SCE regarding water chemistry emergencies just three times in the last 14 years.

- A CPSD auditor evaluated a Laboratory Analysis report regarding iron and copper in steam water. The report appears to be complete and the iron and copper content assay is run on a monthly basis.

- The Arrowhead Company, a subcontractor to United Water, checks resins from the demineralizer and filters on the equipment three times a week for proper functionality.

- Plant operators conduct the following water chemistry assays every four hours during plant operation: conductivity, pH, dissolved oxygen, ammonia, phosphate and sodium chloride. The various water chemistry probes throughout the plant are crosschecked against a standard every four hours during plant operation.

- The resins in the water softener are portable and are stored on trucks. The filters are replaced annually and the resins usually last five years.

Maintenance Standard 16--Regulatory Requirements

*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.*

Assessment Guideline B

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

## Observation 3.11 – Liquid waste tank levels

The CPSD auditor made the following observations at the plant regarding these standards and associated guidelines.

- The waste oil and solvent accumulation area have secondary containment reservoirs under and around them (See Figure 9) [9] Such reservoirs limit the spread of liquids in case of a leak or spill.

**Figure 9: Secondary containment is adequate**

- The clean-up and spill -response station appears well stocked; stocked materials are readily available. See Figure 10.

[9] Note that the plant's chemistry laboratory lacked proper secondary containment. See Finding 2.1.


**Figure 10: Spill response station is within easy access and is readily available.**

- Spill containment dams and absorbent pads are stored in a highly visible area adjacent to the oil accumulation area. See Figure 11 below.

**Figure 11. Spill containment dams and absorbent pads are stocked in a highly visible location.**

- See also the NPDES permit work, above.

Maintenance Standard 17 – 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.*

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.*

## Observation 3.12 – Calibration program for tools and equipment

The CPSD auditor reviewed the plant's calibration program for tools and equipment. The CPSD auditor learned that meters are sent to vendors for calibration four times per year. The plant keeps track of the calibrations via Mainsaver. Further, the manufacturers of some pieces of equipment send reminder notices to the plant if calibration or maintenance is required. In addition, to identify necessary maintenance and calibration, plant personnel track purchases of tools, parts, and equipment through written logs.

The CPSD auditor interviewed Total Western, Inc. personnel concerning maintenance of the plant's transformers. Each week, plant personnel visually inspect the batteries, brushes, insulator color, and oil levels. Each year, plant personnel take thermographic readings and check transformer pressure and fluid levels. Twice annually, the plant takes samples of transformer oil and sends them to Oil Analysis, Inc. a local company, which returns test results within three days. When problems are found, the plant creates a PM (see above) to schedule necessary maintenance tasks. Finally, the plant uses capacitance testing to predict wear on transformer bushings; as a result, the plant replaced five out of six of the main transformer's low-end bushings during 2004 maintenance outages.