BEFORE THE PUBLIC UTILITY COMMISSION

OF OREGON

UE 196

In the Matter of PORTLAND GENERAL ELECTRIC COMPANY Application to Amortize the Boardman Deferral.	ORDER

DISPOSITION: REQUEST FOR AMORTIZATION GRANTED IN PART

I. INTRODUCTION

Portland General Electric Company (PGE) upgraded the two low pressure (LP) turbines at its Boardman generating plant (Boardman) in 2000 by installing new rotors that were designed to increase efficiency. In 2005, a crack developed in the rotor of the LP1 turbine, causing an unexpected and prolonged outage at Boardman. In docket UM 1234, the Public Utility Commission of Oregon (Commission) authorized deferral of $26.439 million in excess replacement power costs incurred during the outage.[1] In this docket, PGE seeks authorization to recover the $26.439 million. PGE proposes offsetting the deferred amount with existing customer credits so there will be no increase in customer rates.

To prevail in its request, PGE must prove that the excess replacement power costs were prudently incurred.[2] The key question is what caused the crack in the LP1 turbine rotor. Only by answering this question can we determine whether the crack resulted from PGE's imprudent conduct. In this order, we find that the crack was caused by high cycle fatigue resulting from operational misalignment of Boardman's generator train. The evidence supports the conclusion that the misalignment was caused by a combination of factors acting simultaneously, but that any one of these factors in isolation would not have caused the problem. One of these factors—an improperly supported bearing pedestal under the LP1 turbine—resulted from PGE's imprudent conduct. We therefore allow PGE only partial recovery of the deferred excess replacement power costs.

[1] Order No. 07-049; *recons den*, Order No. 07-227.
[2] ORS 757.259(5).

II. BACKGROUND

A. Procedural Background

PGE filed its amortization request on October 9, 2007. Commission Staff (Staff), the Industrial Customers of Northwest Utilities (ICNU), and the Citizens' Utility Board of Oregon (CUB) participated as parties in the proceeding. After five rounds of prefiled written testimony, a hearing was held on July 23, 2008. The administrative law judge (ALJ) issued a ruling closing the record on August 19, 2008. The parties submitted simultaneous opening briefs and simultaneous reply briefs in September 2008.

After determining that further information was needed to reach a decision in this docket, the Commissioners directed the ALJ to issue a bench request asking PGE to respond to eight questions related to the installation and maintenance of the LP1 turbine. As part of the bench request, the ALJ also reopened the record to allow PGE to submit testimony responding to the bench request and to allow other parties to submit rebuttal testimony.

ICNU and CUB filed a joint application for reconsideration of the decision to reopen the record on January 15, 2009, arguing primarily that reopening the record violated their procedural due process rights. PGE submitted a response in opposition to the application for reconsideration on January 30, 2009. The Commission denied the application and affirmed the ALJ's decision to reopen the record in Order No. 09-046, issued February 5, 2009.[3]

After three rounds of additional testimony, a second hearing was held on April 20, 2009. The ALJ closed the record on April 23, 2009. PGE submitted its opening brief on June 12, 2009. Staff, CUB, and ICNU submitted opening briefs on July 17, 2009. PGE filed its reply brief on August 7, 2009.

B. Factual Background

In 2000, PGE decided to upgrade the two low pressure (LP) turbines at Boardman. PGE worked with Siemens for three years to design new turbine rotors, which Siemens manufactured and installed in the LP1 and LP2 turbines. The installation was completed in June 2000. Although the existing LP turbines were expected to last for the useful life of Boardman, PGE wanted to increase efficiency and output by installing turbine rotors that would allow increased electricity generation using the same amount of fuel.

The LP1 and LP2 turbines are part of the Boardman turbine generator train. The generator train also includes a generator and a combination high and intermediate pressure (HPIP) turbine. These components are bolted together end-to-end to form the train, which is over 100 feet long. The individual components are supported by bearings, which are in turn supported by bearing pedestals. The entire generator train sits on a large concrete foundation. The total weight of the generator train is over 190 tons.

[3] ICNU raises its due process arguments again in its Opening Brief in Reopened Docket (Jul 17, 2009). We decline to reexamine ICNU's arguments and incorporate our decision in Order No. 09-046 as part of this order.

Although perfect alignment of a generator train is not possible, all of the generator train components and the bearings that support them must be aligned within calculated safety tolerances to ensure proper operation. PGE hired Siemens to calculate those tolerances and to align the generator train. The calculations that Siemens used to determine the safety tolerances were proprietary. PGE also contracted with Siemens for major maintenance of the LP turbines.

PGE monitors vibration levels on the generator train "to detect any anomalous conditions or stresses on the turbines."[4] In July 2005, PGE noticed a slight increase in the vibration levels on the LP1 turbine. By October 2005, the vibration levels had increased, and Siemens recommended that PGE shut down the LP1 turbine. Investigation into the cause of the increased vibration levels ultimately led to the discovery of a crack in the LP1 turbine rotor on November 18, 2005. The rotor was removed, repaired, and reinstalled. Although PGE could have had Siemens repair the rotor under warranty, PGE chose Alstom to do the repair because Alstom could complete the repair significantly faster than Siemens. The outage caused by the cracked rotor ended on February 5, 2006. PGE later discovered two loose and two missing fasteners on the pedestal under one of the bearings supporting the LP1 turbine.

PGE commissioned Alstom to analyze the turbine failure and determine a root cause for the rotor crack. Based on a review of PGE's operational data and a metallurgical analysis, Alstom concluded that the design, manufacture, and operation of the turbine did not cause or contribute to the crack in the LP1 turbine rotor. Alstom determined that the rotor crack was caused by high cycle fatigue (HCF). HCF is damage caused by the application of repeated stresses that occur while a turbine is operating. HCF damage is cumulative and eventually results in component weakening and failure. Although Alstom could not definitively determine a cause for the HCF, Alstom stated that "[t]he results of the analysis, [*sic*] point in the direction of a misalignment of the train and an unsecured bearing pedestal. All the data and associated information indicates the root cause for this failure lies in a combination of factors."[5]

Siemens also performed a root cause analysis. Like Alstom, Siemens could not identify a definitive cause of the rotor crack, but "concluded that high cycle fatigue due to excessive misalignment induced by an unknown operational condition is the most probable root cause of LP#1 rotor cracking."[6] Siemens further concluded that neither PGE's operation of the turbine rotor, nor the turbine rotor's design and manufacture, caused or contributed to the crack in the LP1 turbine rotor.

PGE conducted its own root cause analysis and concluded that "the LP1 rotor most probably failed due to misalignments resulting from a combination of factors that were present concurrently."[7] PGE agreed with Siemens's and Alstom's conclusions about the turbine rotor's design, manufacture, and operation.

[4] PGE's Opening Brief in Reopened Docket at 3 (Jun 12, 2009).
[5] PGE/105C-B, Quennoz/41.
[6] PGE/105C-C, Quennoz/35.
[7] PGE/105C-A, Quennoz/7.

During the Boardman outage, PGE needed to obtain power from other sources to serve its customers. From November 18, 2005, through February 5, 2006, PGE incurred $45.7 million in replacement power costs. In Order No. 07-049, the Commission determined that the full amount was eligible for deferral as an extraordinary expense, but adjusted the amount to reflect the normal business risk of greater-than-expected forced outages. The Commission also required PGE to absorb 10 percent of the adjusted amount as a matter of policy to create an incentive for utilities to minimize the duration of forced outages and replacement power costs. The Commission therefore authorized deferral of $26.439 million in excess replacement power costs (the Deferred Amount). In this docket, PGE seeks to recover the Deferred Amount from its customers. PGE proposes offsetting the amortization of the Deferred Amount with simultaneous amortization of existing customer credits so there will be no increase in customer rates.

III. PROCEDURAL ISSUES

A. Motion to Abate

On July 25, 2008, Staff filed a motion to abate this docket pending a decision in *Turlock Irrigation District v. Portland General Electric Co.*, a civil lawsuit currently being litigated in the Multnomah County Circuit Court.[8] Staff argues that one of the issues in *Turlock* is whether the Boardman outage at issue in this docket was caused by PGE's negligence. Staff is concerned that discovery in that case could uncover information that the parties in this docket have been unable to obtain. CUB filed a response in support of Staff's motion on August 7, 2008.

PGE filed a response to Staff's motion on August 11, 2008. PGE opposes the request to abate and argues that abatement is unnecessary because this docket and *Turlock* involve different legal standards. PGE adds that it has provided all necessary documents and information to allow the Commission to decide the issues in this docket. PGE further argues that it is unreasonable to indefinitely delay this docket.

We deny the motion to abate the proceedings. Because the applicable legal standards are different in this docket and *Turlock*, the outcome of the *Turlock* case is irrelevant to our determination of whether PGE acted prudently. In addition, the parties have presented sufficient evidence in this docket for this Commission to make an informed decision, and it is therefore unnecessary to wait for additional information, if any, that may be discovered in the *Turlock* case.

B. Discovery Issues

In its testimony and briefing, CUB states that it had significant difficulty obtaining documents and information from PGE. CUB asks this Commission to admonish PGE for not timely producing requested documents and for not providing documents in another company's (such as Siemens) possession. PGE responds that CUB should have conducted its own third-party discovery: "[N]either CUB nor ICNU has taken a deposition,

[8] Multnomah County Circuit Court Case No. 0710-12156.

or served a single discovery request on anyone other than PGE, or even attempted to contact Siemens or any other third party."[9]

We agree with CUB that PGE has not been as forthcoming with documents and information in this docket as it should have been. For example, in response to certain findings in the root cause analyses, PGE hired Sensoplan to conduct a frame foot test and another consultant to check the alignment of the generator train. PGE mentioned this in testimony as evidence that PGE acted prudently after the turbine failure, but did not provide copies of the reports prepared by these consultants until after the record was reopened and we specifically requested the documents. These reports were relevant to the issues in this docket and should have been provided with PGE's application for amortization.

Furthermore, PGE's assertion that CUB and ICNU should have sought information and documentation directly from Siemens or other third parties demonstrates ignorance of this Commission's rules. Under OAR 860-014-0070 and 860-014-0065, data requests may only be served on parties to the proceeding and depositions may only be taken of witnesses in the proceeding.[10] PGE hired Siemens to install and maintain the LP1 and LP2 turbines. PGE should have been able to produce documents related to the installation and maintenance of the turbines. If PGE did not retain these documents, then PGE—not CUB or ICNU—should have requested the information from Siemens. PGE also should have considered presenting witnesses from Siemens who participated in the installation and maintenance of the LP1 turbine rotor.

Although we believe that PGE should have been more forthcoming in this docket, there are limits to the negative inferences we may draw from general assertions that PGE failed to adequately respond to discovery requests. We encourage CUB and other parties to bring discovery disputes to the Commission's attention early in the proceedings, rather than in testimony and briefing, so the Commission can react appropriately. We emphasize, however, that utilities should err on the side of producing too much information rather than too little. We also expect all parties in Commission proceedings to conform to the rules of professional conduct applicable to Oregon attorneys,[11] including Oregon Rules of Professional Conduct 3.3 (candor towards the tribunal) and 3.4 (fairness to opposing party and counsel).

IV. LEGAL STANDARD

Amortization of deferrals is governed by ORS 757.259(5), which permits the Commission to allow deferrals into rates if the deferred amounts were prudently incurred and upon review of the utility's earnings:

> [Deferrals] shall be allowed in rates only to the extent authorized by the commission in a proceeding under ORS 757.210 to change rates and upon review of the utility's earnings at the time of application to amortize the deferral. * * * The commission's final determination

[9] PGE's Reply Brief in Reopened Docket at 8 (Aug 7, 2009).
[10] OAR 860-014-0070 (data requests); OAR 860-014-0065 (depositions).
[11] *See* OAR 860-012-0005.

> on the amount of deferrals allowable in the rates of the utility is subject to a finding by the commission that the amount was prudently incurred by the utility.

The utility bears the burden of proving that the deferred amounts were prudently incurred. This burden must be met by the preponderance of the evidence, which means that the utility must establish that the fact asserted is more probably true than not.[12] In a prudence review, the Commission examines the objective reasonableness of a utility's actions at the time the utility acted: "Prudence is determined by the reasonableness of the actions 'based on information that was available (or could reasonably have been available) at the time.'"[13]

In addition to finding that the deferred amounts were prudently incurred, the Commission must also conduct an earnings review to determine if the utility's earnings were sufficient at the time of the deferral to absorb the deferred amounts and still earn a reasonable return on investment. If the utility's earnings were sufficient, then the Commission will deny recovery of the deferred amounts, even if prudently incurred.

V. DISCUSSION AND DECISION

The parties' arguments in this docket can be distilled into five primary issues: (1) whether PGE's earnings during the deferral period support amortization of the Deferred Amount into customer rates; (2) whether PGE's strategy for acquiring replacement power was prudent; (3) whether PGE's decision to upgrade the LP1 and LP2 turbines with new rotors was prudent; (4) whether PGE prudently installed and maintained the LP1 turbine rotor; and (5) whether PGE prudently operated the LP1 turbine rotor. The first two issues are undisputed and are summarized below. We then address the three disputed issues.

A. Undisputed Issues

1. Earnings Test

ORS 757.259(5) requires the Commission to review a utility's earnings when deciding whether deferred amounts should be amortized into customer rates. Commission rules state that the "period selected for the earnings review will encompass all or part of the period during which the deferral took place or must be reasonably representative of the deferral period."[14]

In this docket, PGE provided evidence showing that its earnings from October 2005 through September 2006, which encompasses all of the deferral period, were well below authorized earnings. Without recovery of the Deferred Amount, PGE's earned return on equity (ROE) on an adjusted basis was 3.55 percent, which was significantly lower than PGE's authorized ROE of 10.5 percent. With full recovery of the Deferred Amount, PGE's ROE for the deferral period would be 5.14 percent. PGE argues, and no party disputes, that the earnings review supports amortization of the Deferred Amount. We agree.

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[12] *See Jackson v. U S WEST Communications, Inc*., Docket No. UC 373, Order No. 99-040 at 4 (Jan 27 1999).
[13] *In re PGE*, Docket No. UE 102, Order No. 99-033 at 36-37 (Jan 27 1999).
[14] OAR 860-027-0300(9).

ORS 757.259 also states that the total rate effect of the amortization of deferrals in any year cannot exceed three percent of the utility's revenue from the previous year. Because PGE proposes offsetting the amortization of the $26.439 million with simultaneous amortization of existing customer credits, the amortization of the Deferred Amount does not have any rate effect and the three-percent limitation is not implicated.

2. Replacement Power

PGE argues that its strategy for replacing Boardman's power output during the outage was prudent and minimized replacement power costs. PGE initially believed that the outage would be short and replaced the lost output with wholesale purchases from the day-ahead or real-time markets. When PGE discovered the crack in the LP1 turbine rotor and realized that the outage period would be significantly longer than anticipated, PGE evaluated its replacement power options and concluded that forward wholesale power prices were below the generating cost of PGE's only power plant with available output during December 2005 and January 2006. PGE therefore purchased replacement power on a forward basis for the expected outage period. In addition, Boardman had been scheduled for a planned maintenance outage from April 29, 2006, through May 27, 2006. PGE performed the scheduled maintenance during the forced outage instead and sold the replacement power it had already purchased for the planned maintenance outage. PGE used the revenue from the sale to partially offset replacement power costs, which saved $3.2 million.

PGE further reduced replacement power costs by choosing Alstom to repair the LP1 turbine rotor. PGE could have minimized or eliminated repair costs by requiring Siemens to repair the rotor under warranty, but Alstom could repair the rotor almost a month earlier than Siemens. PGE also transported the rotor by plane in order to reduce outage duration. PGE chose to pay for the repair and transport and did not seek recovery of those costs from its customers.

No party disputes PGE's assertion that its strategy for replacing Boardman's power output was prudent. We agree.

B. Disputed Issues

1. Was PGE's Decision to Upgrade the LP1 and LP2 Turbines Prudent?

a. Parties' Positions

CUB and ICNU argue that it was imprudent for PGE to upgrade the LP1 and LP2 turbines with a new, "experimental," and "untested" rotor design without adequately protecting itself and its customers through contractual guarantees and warranties. CUB asserts that PGE provided a surprising lack of documentation showing that PGE appropriately analyzed the risks of the upgrade, particularly given the fact that the existing turbines were expected to last until Boardman's retirement and did not need to be replaced. CUB and ICNU point out that PGE's contract for the new turbine rotors protected Siemens from liability for consequential damages such as replacement power costs except under certain limited circumstances during the first year of the contract.

PGE objects to CUB and ICNU's characterization of the new turbine rotor design as "experimental" and "untested." Although PGE acknowledges that the new LP1 and LP2 turbine rotors were the first with this specific design, PGE states that the differences between the new and old turbine rotors were minimal, and the new design used accepted technology that had been used in other turbine designs. PGE argues that the only risk presented by the new turbine rotors was that the new design would not result in the efficiency gains that PGE hoped to achieve. According to PGE, the contract with Siemens adequately protected PGE and its customers against this risk. PGE states, and Staff agrees, that the new rotors did improve efficiency and output by approximately seven percent, which results in long-term savings for PGE's customers. PGE also asserts that neither CUB nor ICNU claim that the design caused or contributed to the crack in the LP1 turbine rotor, and therefore CUB and ICNU's argument is irrelevant. PGE notes that both Siemens's and Alstom's root cause analyses concluded that the rotor design did not cause or contribute to the crack.

b. Resolution

In this docket, we must determine whether the excess power costs resulting from the extended outage at Boardman were prudently incurred. Under some circumstances, PGE's decision to install turbine rotors with a new, untested design would be relevant to our determination. But in this case, all three root cause analyses conclude that the design of the turbine rotors did not cause or contribute to the crack. In fact, CUB and ICNU do not even argue that the new design contributed to the turbine failure. Instead, CUB and ICNU argue that PGE's contract with Siemens should have included more protections for PGE and its customers against any risks associated with the new, untested rotor design. Even assuming CUB and ICNU are correct, CUB and ICNU's arguments are irrelevant to our determination because there is no evidence that the design caused or contributed to the turbine failure.

Furthermore, the Commission allowed PGE to recover the costs of the turbine upgrade in rates in docket UE 115. CUB and ICNU did not object to the prudence of the upgrade at that time, and although not specifically addressed in the final order in docket UE 115, the Commission would not have authorized recovery of the turbine upgrade costs if those costs had not been prudently incurred.[15] Because prudence determinations are based upon information that was known or reasonably should have been known at the time the decision was made, we will not second-guess that determination based on events that occurred five years later. We also note that the savings to PGE's customers that resulted from the increased efficiency achieved with the new rotor design are greater than the costs of the turbine rotor upgrade, even if we allowed full recovery of the Deferred Amount in this docket.

[15] *See, e.g., In re PacifiCorp*, Docket Nos. UM 995, UE 121, & UC578, Order No. 02-469 at 7 (Jul 18, 2002). (Commission's final order in a rate case discusses only those issues raised by the parties or by the Commission. If neither the parties nor the Commission proposes a change to a particular rate base item, then the item is adopted when the Commission issues its final order, even if not specifically addressed in the order).

2. Did PGE Prudently Install and Maintain the LP1 Turbine Rotor?

a. Parties' Positions

PGE hired Siemens, the original equipment manufacturer (OEM) to install the upgraded LP1 and LP2 turbine rotors and to perform major maintenance. This included alignment of the generator train. PGE argues that it is standard industry practice to rely on the OEM for installation and major maintenance, and Staff agrees.

ICNU and CUB appear to agree that it is prudent to rely on the OEM for installation and major maintenance of the turbine rotors as long as the utility adequately monitors the OEM's activities and has sufficient quality controls in place. ICNU and CUB argue that PGE's employees did not have the expertise or experience to adequately monitor Siemens's work, and therefore PGE should have hired an experienced project manager. ICNU and CUB also assert that there is no evidence that Siemens has a quality assurance and quality control (QA/QC) program for installation and maintenance, although it is clear that they have a robust program for rotor manufacture. ICNU questions Siemens's experience with installation and maintenance of this type of turbine rotor.

ICNU and CUB further argue that two potential causes have been clearly identified for the LP1 turbine rotor crack: (1) the two loose and two missing fasteners on the pedestal under bearing 3; and (2) misalignment of the generator train. ICNU and CUB assert that the loose and missing fasteners are evidence of PGE's lack of appropriate quality control and maintenance, and that PGE has not proven that it was reasonable to fail to discover the loose and missing fasteners. ICNU and CUB also argue that PGE has failed to prove that Siemens properly aligned the generator train and, because Siemens considered the calculations used to determine proper alignment and safety tolerances to be proprietary, PGE lacked the necessary information to adequately oversee Siemens's work.

PGE responds that it actively monitored Siemens's work and, although PGE's employees do not have the expertise to do some of the work themselves (such as calculating the safety tolerances); the employees have sufficient expertise and experience to adequately understand and monitor Siemens's installation and maintenance. PGE states that its employees' lack of expertise in this area is precisely why reliance on the OEM is necessary and reasonable. PGE argues, and Staff agrees, that Siemens has a robust QA/QC program for not only manufacture of the turbine rotors, but also for installation and maintenance, although PGE did not retain copies of all documentation provided by Siemens regarding its QA/QC program. Staff states that Siemens's QA/QC program is ISO 9001 certified. PGE and Staff also state that it would be unusual for a utility to have an independent QA/QC program for work performed by an OEM.

PGE does not believe that misalignment due to incorrect safety margin calculations or installation errors was the cause of the rotor crack. PGE asserts that the generator train was always aligned within the manufacturer's safety tolerances when idle. The safety tolerances are designed to compensate for movement during operation to ensure that the generator train remains in proper alignment while operating. PGE states that neither Alstom nor Siemens were able to definitively identify a cause for the crack, although it

appears that the several simultaneous factors caused the generator train to move out of alignment during operation, resulting in the HCF that caused the crack.

PGE also does not believe that the two loose and two missing fasteners were a factor in the LP1 turbine rotor crack. PGE states that "there is no compelling evidence" that the loose and missing fasteners "contributed in any significant way" to the crack.[16] PGE states that a loose bearing pedestal, in the absence of evidence that the condition caused a "soft foot" or insufficiently stiff foundation joint (such as cracked or loosened grout), would not create enough stress on the generator train to cause HCF. There was no loose or cracked grout near or under the pedestal under bearing 3. In addition, a consultant hired by PGE determined that there was no "soft foot."

b. Resolution

We agree with PGE and Staff that it is prudent for a utility to rely on the OEM to install and perform major maintenance on equipment such as the LP1 and LP2 turbines, assuming the utility provides adequate oversight and management. We further agree that PGE did provide adequate oversight and management of Siemens's installation and maintenance work. PGE's employees had sufficient experience and training to oversee Siemens's work. It would not be efficient for utilities to keep experts in all aspects of utility plant operations on staff, and it is therefore necessary for utilities to hire outside experts for certain tasks. Logically, that means that PGE's employees have less expertise than the expert PGE has hired, but that does not equate to an inability to adequately oversee the expert's work. It is somewhat troubling that PGE could not confirm the calculations used to determine the safety tolerances for alignment of the generator train, but we accept that it is standard industry practice for an OEM to keep such information proprietary. We also find that PGE prudently relied on Siemens's QA/QC program for the installation and maintenance work that Siemens performed. It would be unnecessarily duplicative for PGE to have an independent QA/QC program when Siemens already has an ISO 9001 certified program in place.

We next address CUB and ICNU's argument that PGE failed to prove that the generator train was properly aligned. We first clarify that "proper" alignment does not mean perfect alignment. To prove that it acted prudently, PGE need only show that it acted reasonably to ensure that the generator train was aligned within appropriately calculated safety margins when idle and adequately monitored operation of the generator train to detect problems.

PGE lacked the expertise to align the generator train. PGE therefore hired Siemens, the designer and manufacturer of the turbine rotors and a recognized expert in alignment, to install and maintain the LP1 and LP2 turbine rotors. This included alignment of the generator train. Siemens calculated safety margins designed to compensate for movement of the generator train during operation. Siemens adjusted the alignment of the generator train over time, but the alignment of each component was always within Siemens's safety margins. PGE monitored Siemens's work to ensure that the generator train was

[16] PGE Opening Brief at 16 (Sept 3, 2008).

aligned within the safety margins. PGE also monitored vibrations along the generator train to detect problems, which ultimately led to discovery of the rotor crack.

We find that PGE acted prudently in hiring a recognized expert and the OEM of the turbine rotors to align the generator train. As discussed above, we also find that PGE's employees had the experience, expertise, and knowledge to adequately monitor Siemens's work. PGE also acted prudently by monitoring vibration levels along the generator train and responding quickly to address any anomalies. This monitoring likely averted catastrophic failure of the LP1 turbine. Based on the evidence in this record, we find that it is more likely than not that Siemens aligned the generator train within appropriate safety margins. We therefore conclude that PGE's and Siemens's actions in aligning and monitoring the generator train were prudent.

We emphasize that we are not concluding that a utility may insulate itself from responsibility by hiring an outside expert to perform installation, maintenance, or repair work. If there was evidence that Siemens acted imprudently, then PGE would be held responsible for Siemens's imprudent conduct. In this case, however, the evidence supports the conclusion that the generator train was aligned within appropriately calculated safety margins while idle. Although there is some evidence that "non-optimal" bearing alignments contributed to the misalignment that caused the HCF, there is no evidence that the bearing alignments were outside the safety margin. The prudency standard does not require perfection; it requires only that PGE's and Siemens's actions were reasonable.

The final issue is whether it was prudent for PGE to install larger and heavier rotors in the LP1 and LP2 turbines without first physically inspecting the turbines' support structure and ensuring that all fasteners were present and properly secured. We are not persuaded by PGE's attempts to dismiss the significance of these missing and loose fasteners. The preponderance of evidence shows that the missing and loose fasteners contributed to the initiation of the crack in the LP1 turbine rotor and likely contributed to the crack's propagation:

- PGE's own root cause analysis states that replacing and tightening the missing and loose fasteners "improved stiffness and stability in the affected area" and indicates that the fasteners "could have been a contributor to the combined stress along the turbine train."[17]

- Alstom concluded that the loose and missing fasteners on the sole plate of the pedestal supporting the LP1 turbine possibly contributed to the initiation of the crack and likely helped to propagate the crack.[18]

[17] PGE/105C-A, Quennoz/5-6.
[18] PGE/105C-B, Quennoz/41.

- After PGE fixed the loose and missing fasteners upon discovery, temperature and vibration measurements indicated that the stresses on bearing 3 (where the crack initiated) were reduced and the shaft was noticeably stiffer.[19]

- When PGE's consultant conducted the frame foot test, it did not reproduce the conditions at the time of the crack. Instead, the consultant loosened only one fastener at a time because to do otherwise would be "unsafe."[20]

- PGE's witness admitted that "misalignments and loose sole plates can be causes of issues with regard to the high cycle fatigue," although he downplayed the significance of those factors in this case.[21]

Neither are we persuaded by PGE's argument that the loose and missing fasteners were not easily seen and were covered by plywood decking during the turbine upgrade, so it was not imprudent for PGE to have failed to notice the loose and missing fasteners. PGE admits that the structure supporting the LP1 and LP2 turbines is "critical" and that the turbine rotors were "highly sensitive" to bearing elevation.[22] PGE further admits that, although Siemens reviewed the design and engineering of the supporting structure, neither Siemens nor PGE physically inspected the structure prior to the turbine upgrade and, "in hindsight," PGE "probably should have" checked the fasteners.[23] PGE states that if it had found any loose or missing fasteners in normal course, it would cause "concern."[24] PGE also instituted a fastener inspection program as part of its normal maintenance after the loose and missing fasteners were discovered.[25]

Under these circumstances, we cannot conclude that it was reasonable for PGE to install larger and heavier turbine rotors in the LP1 and LP2 turbines without first physically inspecting the support structure. Because the support structure is critical to proper operation of the turbines, and because the turbine rotors were highly sensitive to bearing elevation, PGE or Siemens should have ensured that the support structure under the bearings was in good condition and all necessary fasteners were in place and properly tightened.

3. Did PGE Prudently Operate the LP1 Turbine Rotor?

a. Parties' Positions

ICNU argues that PGE was imprudent in its operation of Boardman. Specifically, ICNU asserts that the design output of Boardman was 580 MW after the LP1 and LP2 turbines upgrade and that PGE routinely operated Boardman above this maximum design output capacity. ICNU argues this increased the stress on the LP1 turbine and was a

[19] ICNU/312, Martin/4.
[20] Tr. at 287.
[21] *Id*. at 48-49.
[22] *Id*. at 233.
[23] *Id.*
[24] *Id*. at 231.
[25] *Id*. at 249-251.

contributing factor in its failure. PGE responds that ICNU confuses contractually guaranteed megawatt output with maximum design capacity, and further confounds exceeding the contractually guaranteed megawatt output with operating the plant above maximum steam pressure. PGE states that the contract with Siemens guaranteed certain megawatt output to compensate for the risk that the new turbine design would not result in increased output using the same amount of fuel. Boardman did regularly exceed the 580 MW contractually guaranteed output, but PGE states that it did not routinely operate the plant at greater than 100 percent steam pressure. PGE states that, although turbines are designed to withstand 105 percent steam pressure, PGE chooses not to regularly exceed 100 percent to avoid overtaxing the turbines. PGE admits that it has operated Boardman above 100 percent steam pressure to test the plant's capabilities during an emergency and during the 2000-2001 Energy Crisis, but only for limited periods of time.

ICNU also argues that an analysis conducted to determine the root cause of a second unrelated outage at Boardman is proof that PGE imprudently operates Boardman. That analysis concluded that the generator failure that caused the second outage was "the direct result of management failing to ensure that critical personnel remained qualified to properly operate the assets."[26] ICNU contends that this analysis shows that "poor management practices * * * were prevalent at the Boardman plant."[27] ICNU asks this Commission to infer that these management practices also led to the failure of the LP1 turbine rotor. PGE responds that the two outages are unrelated and therefore understanding the cause of the second outage is irrelevant to determining the cause of the first outage. PGE argues that the second outage does not create a presumption the PGE negligently operated Boardman. PGE also points out that both Siemens and Alstom concluded that PGE's operation of Boardman was not a factor in the LP1 turbine failure.

b. Resolution

We find that PGE was prudent in the operation of the LP1 turbine at Boardman. Although ICNU attempts to dismiss the distinction between megawatt output and steam pressure, we find this distinction significant. The design specifications give approximate maximum megawatt output numbers when the plant is operated under certain conditions (for example, 100 percent steam pressure and two inches of vacuum). The key measure for determining whether the plant is being operated in a manner that increases stresses on the generator train is steam pressure, not megawatt output. The fact that PGE operated Boardman above the approximate maximum megawatt output does not mean that PGE exceeded 100 percent steam pressure. As PGE notes, it could operate at one inch of vacuum and increase megawatt output without exceeding 100 percent steam pressure. ICNU did not produce sufficient evidence to contradict PGE's evidence that it did not routinely operate Boardman above 100 percent steam pressure.

In addition, we decline to infer from one root cause analysis of an unrelated generator rotor failure that PGE's management of Boardman is deficient generally. We instead rely on Alstom's and Siemens's root cause analyses of this turbine rotor failure,

[26] Staff/203, Durrenberger/4.
[27] ICNU's Opening Brief at 22 (Sept 3, 2008).

which both conclude that PGE's operation of the turbine was not a factor in the turbine failure.

VI. CONCLUSION

To obtain recovery of the Deferred Amount, PGE must prove that the excess replacement power costs were prudently incurred. The key question is what caused the crack in the LP1 turbine rotor.

Based on the three root cause analyses, we find that high cycle fatigue resulting from operational misalignment of Boardman's generator train caused the crack in the LP1 turbine rotor. We further find that a combination of factors acted together to create the operational misalignment, although no one factor in isolation would have caused the crack. Although CUB and ICNU question the impartiality of the root cause analyses, we find that PGE conducted a reasonable inquiry into the possible causes of the rotor crack. The impartiality of Siemens and PGE may reasonably be debated, but Alstom's root cause analysis was thorough and impartial.

One of the factors that contributed to the operational misalignment—an improperly secured bearing pedestal—resulted from PGE's imprudent conduct. Although the unsecured bearing pedestal in isolation did not create enough stress on the turbine shaft to cause the crack, the evidence supports the conclusion that improper support of the turbine train contributed to the initiation and propagation of the turbine crack. PGE could have prevented this problem had it physically inspected the turbine's support structure to ensure that all fasteners were present and properly secured.

Because PGE imprudently failed to inspect the LP1 turbine's support structure before installing a new rotor, we deny full recovery of the Deferred Amount. We find, however, that partial recovery is warranted because PGE's imprudence was not the sole cause of the outage. The question is how much PGE should be allowed to recover. We find it difficult to determine the relative weight to assign to one contributing cause versus another based on this record, particularly because not all possible contributing causes could be identified. This prevents a precise allocation of responsibility. In the face of this uncertainty, we treat the unsecured bearing pedestal and the unidentified causes as if each contributed 50 percent to the operational misalignment that caused the high cycle fatigue. We therefore reduce by 50 percent the recovery requested by PGE and authorize amortization of $13.2 million of the Deferred Amount.

VII. ORDER

IT IS ORDERED that:

1. Portland General Electric Company is authorized to amortize $13.2 million, plus interest, through the date of this Order.

2. Portland General Electric Company must offset the amortization of the $13.2 million, plus interest, effective on the date of this Order, with simultaneous amortization of an equal amount in customer credits from the Trojan Nuclear Decommissioning Trust.

Made, entered, and effective FEB 11 2010.

Lee Beyer
Chairman

John Savage
Commissioner

Ray Baum
Commissioner

A party may request rehearing or reconsideration of this order under ORS 756.561. A request for rehearing or reconsideration must be filed with the Commission within 60 days of the date of service of this order. The request must comply with the requirements in OAR 860-014-0095. A copy of any such request must also be served on each party to the proceeding as provided in OAR 860 013-0070(2). A party may appeal this order by filing a petition for review with the Court of Appeals in compliance with ORS 183.480 through 183.484.