DCISC

DIABLO CANYON INDEPENDENT SAFETY COMMITTEE

COMMITTEE MEMBERS

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By Email and Federal Express

September 5, 2013

Mr. Jonathan Bishop
Chief Deputy Director
State Water Resources Control Board
1001 I Street, 24th Floor
Sacramento, California 95814

Re: Diablo Canyon Independent Safety Committee's Evaluation of Safety Issues for Several Alternative Cooling Technologies or Modifications to the Existing Once-Through Cooling System for the Diablo Canyon Nuclear Power Plant

Dear Mr. Bishop,

In early 2011, the California State Water Resources Control Board appointed a "Review Committee to Oversee Special Studies for the Nuclear-Fueled Power Plants Using Once-through Cooling" (the "Review Committee") to assist it in evaluating various technical options that might be used to replace once-through cooling at the two nuclear power plants then operating along California's Pacific coast, Diablo Canyon and San Onofre. Subsequently, guided by input from the Review Committee, Pacific Gas and Electric Company and Southern California Edison Company, the operators of the two nuclear plants, jointly entered into a contract with Bechtel Power Corporation ("Bechtel") to perform certain studies related to the technical topics at issue.

Bechtel, again guided by input from the Review Committee, undertook a series of technical studies. Based on their work, Bechtel published a preliminary study in November 2012 (Ref. 1), and then a few weeks ago, in mid-August 2013, published a follow-up technical study (Ref. 2) that extends their earlier work in much more detail on the safety issues, and that provides a technical evaluation of the safety issues with each alternative option.

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During its meeting in Sacramento on August 13, 2013, the Review Committee requested the Diablo Canyon Independent Safety Committee (DCISC) to provide its own independent safety evaluation of the various alternative options, which as a practical matter means, in part, carrying out a technical evaluation of Bechtel's safety analyses and conclusions in their second report. This letter provides that safety evaluation. The DCISC's evaluation has also relied in part on the earlier (November 2012) Bechtel study, because it provides important background information and analyses.

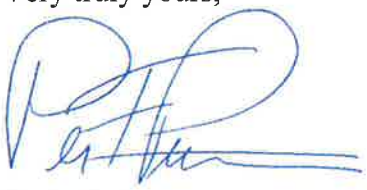
Following the DCISC's receipt of the Review Committee request, the three individual DCISC members each performed his own review of the relevant technical information. The DCISC had the benefit of a previous briefing from PG&E about some of the technical issues at its Public Meeting on February 15-16, 2011, and one of our members (Dr. Budnitz) had attended an earlier Review Committee meeting in August 2012, during which the Bechtel team made a technical presentation concerning some of that team's early work. The DCISC is pleased to be able to meet the requirement to provide its evaluation to the Review Committee on or before September 5, 2013.

The DCISC developed a draft response, which was modified, and then unanimously approved by the membership at the DCISC's public meeting held on September 4, 2013. That response is attached to this letter as Exhibit "A", representing the collective concurrence of all three DCISC members concerning their "*Evaluation of Safety Issues for Several Alternative Cooling Technologies or Modifications to the Existing Once-Through Cooling System for the Diablo Canyon Nuclear Power Plant.*" The public meeting was videotaped and the comments on the draft response by the DCISC members and technical consultants, as well as from several members of the public, are available for your review. The video should be available beginning today (September 5) and can be viewed by accessing the "Meeting Videos" link located on the DCISC's homepage at www.dcisc.org. Members of the public making comments on the report at this meeting were supportive of the DCISC's conclusions and findings.

Because additional information concerning this issue is still being developed by Bechtel, and further design and analysis work will be developed in the future either by Bechtel or by PG&E, it is possible that the Committee may, after review of the additional information, modify its evaluation. In continuing to fulfill its charge from the California Public Utilities Commission to review Diablo Canyon operations for purposes of assessing the safety of operations and suggesting any recommendations for safe operations, the DCISC commits to remaining technically involved, and in particular to be alert to any new information that might lead the DCISC to modify its conclusions about safety as set forth in Exhibit A. If anything new arises, the DCISC will keep the Governor, the Attorney General, the Energy Commission, the SWRCB, and the CPUC fully informed in a timely manner. Accordingly, please provide written acknowledgment of your receipt of this letter together with information concerning the Review Committee's plans for continuing the process of evaluating alternative cooling methods and the Review Committee's disposition of the DCISC's evaluation, findings, conclusions and recommendation.

On behalf of myself and the other members of the Diablo Canyon Independent Safety Committee, please accept our thanks for this opportunity to review the Bechtel report and to contribute to the SWRCB's assessment of these important issues and their potential to affect the future safety of the Diablo Canyon Nuclear Power Plant. Should you have any questions or concerns about the substance or nature of the DCISC's evaluation or the findings, conclusions or recommendation therein, please do not hesitate to communicate with us.

Very truly yours,



Per F. Peterson
Chair

References:
(1) Bechtel Power Corporation, "Independent Third-Party Interim Technical Assessment for the Alternative Cooling Technologies or Modifications to the Existing Once-Through Cooling System for Diablo Canyon Power Plant," Report No. 25762-000-30R-G01G-00009 (November 2012)
(2) Bechtel Power Corporation, "Alternative Cooling Technologies or Modifications to the Existing Once-Through Cooling System for the Diablo Canyon Power Plant," Report No. 25762-000-30R-G01G-00010 (August 2013)

Attachment (Exhibit A)

cc (w/att.):
Hon. Edmund G. Brown, Jr., Governor, State of California
c/o Mr. Ken Alex, Senior Policy Advisor/Director of Planning & Research
Hon. Kamala Harris, Attorney General, State of California
c/o Ms. Megan Hey, Deputy Attorney General
Hon. Robert B. Weisenmiller, Chair, California Energy Commission
Ms. Joan Walter, Senior Nuclear Policy Advisor, California Energy Commission
Hon. Michael R. Peevey, President, California Public Utilities Commission
Mr. Thomas Hipschman, DCPP Senior Resident Inspector, U.S. Nuclear Regulatory Commission.
Mr. Ed Halpin, Senior Vice President & Chief Nuclear Officer, PG&E
Mr. Barry Allen, Site Vice President, Diablo Canyon
Mr. Douglas E. Dismukes, Bechtel Power Corporation
Ms. Marleigh Wood, Senior Staff Counsel, California State Water Resources Control Board (SWRCB)
Ms. Victoria Whitney, Director of Water Quality, SWRCB
Mr. Rik Rasmussen, Surface Water Assistant Deputy Director, SWRCB
Mr. Paul Hann, Watershed Ocean and Wetlands Section Chief, SWRCB
Dr. Maria de la Paz Carpio-Obeso, Ocean Unit Chief, Division of Water Quality SWRCB

Exhibit A

Diablo Canyon Independent Safety Committee's Evaluation of Safety Issues for "Independent Third Party Final Technologies Assessment for the Alternative Cooling Technologies or Modifications to the Existing Once-Through Cooling System for the Diablo Canyon Power Plant"

5 SEPTEMBER 2013

Concurred in by the Three Members of the DCISC at the DCISC Public Meeting on 4 September 2013

Robert J. Budnitz
Peter Lam
Per F. Peterson

Background: The request from the SWRCB "Review Committee"

In early 2011, the California State Water Resources Control Board appointed a special committee, a "Review Committee to Oversee Special Studies for the Nuclear-Fueled Power Plants Using Once-through Cooling" (the "Review Committee") to assist it in evaluating various technical options that might be used to replace or reduce the environmental impacts of once-through cooling (OTC) at the two nuclear power plants along California's Pacific coast, Diablo Canyon and San Onofre. To discharge its charter, the Review Committee requested the two companies then operating those nuclear power plants, Pacific Gas and Electric Company and Southern California Edison Company, to contract for a technical evaluation.

Bechtel Power Corporation was selected as the contractor, and its technical work is the subject of the evaluation here. Specifically, Bechtel published a preliminary study in November 2012 (Reference 1), and then in August 2013 published a follow-up technical study (Reference 2) that extends their earlier work in more detail. The current study remains at the conceptual level but contains sufficient details to reach some high-level conclusions on the nuclear-reactor-safety issues. The level of design detail remains insufficient to assess the impact of the potential design changes on the plant reliability and frequency of trips and forced outages, and to assess potential safety impacts that could occur during or after construction of the modified cooling systems.

The original scope for Bechtel was to provide information and analysis related to both Diablo Canyon and San Onofre. However, in summer 2013 Southern California Edison announced that San Onofre would be permanently closed, after which Bechtel's work has concentrated only on Diablo Canyon. The scope of the DCISC's evaluation here is also related only to the Diablo Canyon Power Plant (DCPP).

During its meeting on 13 August 2013 in Sacramento, the Review Committee made a request of the DCISC. The specific request was that the DCISC provide a technical evaluation of the nuclear-reactor-safety issues associated with seven alternative cooling technologies or modifications to the existing once-through cooling system for DCPP.

The request asked if the DCISC could provide its evaluation by 5 September 2013, which represented a very tight schedule. One of the DCISC's three members (Dr. Budnitz) attended the 13 August meeting, at which he agreed that the DCISC could and would do such an evaluation and would try to meet this schedule. The DCISC's evaluation has concentrated on Bechtel's second report (Reference 2), but has also relied in part on Bechtel's earlier work in Reference 1 as a source of important technical information.

Additional information related to the evaluation

1) Light water power reactors, like the two units at Diablo Canyon, produce large amounts of "waste heat" that must be discharged to the environment. During normal operation, the waste heat is discharged to the Pacific Ocean from the Condenser via the Condenser Circulating Water System. During off-normal or emergency conditions or when one or both reactors are shut down, residual decay heat can be ultimately discharged to the Pacific Ocean via a separate safety-related Auxiliary Saltwater (ASW) System termed the "ultimate heat sink" (UHS), and we will use that term here.

2) Today, Diablo Canyon's normal heat discharge to the adjacent Pacific Ocean uses the specific technology called once-through cooling (OTC), in which cool ocean water is pumped into the plant, warmed up about 20 degrees Fahrenheit, and returned to the ocean. The current OTC approach inevitably produces environmental impacts on the nearby ocean, and the motivation for the current review of OTC is a desire to decrease these impacts by a change in cooling technology. While each of the seven alternatives being evaluated by Bechtel has a different mix of environmental impacts, and although the waste heat must go "somewhere in the environment," this set of environmental-impact issues is beyond the scope of DCISC's evaluation here.

3) The SWRCB is currently considering a new regulatory position that would require Diablo Canyon to replace its current OTC system with a system that would produce smaller environmental impacts on certain aspects of the ocean environment.

4) A paraphrasing of Bechtel's initial scope is that Bechtel was asked to identify a very large range of technically feasible cooling alternatives that might be deployed at Diablo Canyon. It discharged that assignment in its first report (November 2012, Reference 1).

5) The SWRCB Review Committee reviewed Bechtel's report, and based on criteria that are beyond our scope here, the Review Committee directed Bechtel to narrow the options to seven that were to be evaluated further. In the next phase of Bechtel's work (Phase 2), more detailed conceptual designs and engineering analyses were completed for each of these seven options, and Bechtel also performed a review of the relevant nuclear-reactor-safety issues for each. A cost study is also part of Bechtel's Phase 2 work, but evaluating it is outside of the DCISC's scope.

The seven technologies are as follows:

- Inshore mechanical (active) intake fine mesh screening systems
- Offshore modular wedge wire systems

- Closed-cycle cooling systems (5 different approaches):
  - Passive draft dry/air cooling
  - Mechanical (forced) draft dry/air cooling
  - Wet natural draft cooling
  - Wet mechanical (forced) draft cooling
  - Hybrid wet/dry cooling

6) Providing reliable and effective cooling is an important aspect of the overall safety of a nuclear power plant's design, and, as noted above, the DCISC's concern here is to evaluate the implications of a change in cooling technology on the overall nuclear-reactor safety at Diablo Canyon.

Bechtel's safety assessment and conclusions

As noted above, in Bechtel's recent report (Reference 2) the Bechtel team has performed an assessment of the nuclear-reactor safety of each of the seven alternative cooling options that might replace OTC at Diablo Canyon. Bechtel based its assessment on a set of criteria specified by the Review Committee. This set of criteria, called in the Bechtel report "Criterion 10," covers eight "*areas of NRC interest,*" against each of which the assessment was performed. The NRC regulation 10 CFR 50.59 (Reference. 3) is a major basis for these criteria. Diablo Canyon's Final Safety Analysis Report Update (Reference. 4) is cited by Bechtel as one of the major regulatory documents used by the NRC and the plant to document the plant's safety analyses.

The eight areas are:

- Seismic issues
- Operability
- Transient analyses
- Nuclear fuel (accident analyses)
- Single failures
- Hydraulic design
- Probabilistic risk assessment
- Instrumentation controls and alarms

The Bechtel report states, "*Criterion 10 is a feasibility assessment based on regulatory requirements established by 10 CFR 50.59 to determine whether NRC approval of the alternative technology is required.*"

For each of the seven alternative UHS options, Bechtel has concluded as follows (Reference. 2, Section 1.5, "Conclusions"):

"*Based on the results of the feasibility assessment and when more detailed engineering information becomes available, the anticipated responses to the following eight 10 CFR 50.59 criteria questions for each of the proposed modifications would be NO:*"

1. Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the FSARU [Final Safety Analysis Report Update]?

2. Result in more than a minimal increase in the likelihood of occurrence of a malfunction of an SSC [structure, system, or component] important to safety previously evaluated in the FSARU?

3. Result in more than a minimal increase in the consequences of an accident previously evaluated in the FSARU?

4. Result in more than a minimal increase in the consequences of a malfunction of an SSC important to safety previously evaluated in the FSARU?

5. Create the possibility of an accident of a type different from any previously evaluated in the FSARU?

6. Create the possibility of a malfunction of an SSC important to safety with a result different from any previously evaluated in the FSARU?

7. Result in a design basis limit for a fission product barrier as described in the FSARU being exceeded or altered?

8. Result in a departure from a method of evaluation described in the FSARU used in establishing the design bases or in the safety analyses?

The Bechtel report continues: "*Consequently, subject to the limitations of the Phase 2 assessment information, implementation of the closed cooling technology, the inshore dual-flow fine mesh screens, or the offshore modular wedge wire screening system design alternatives is believed to not require a License Amendment Request (LAR) in accordance with 10 CFR 50.59.*"

Among the crucial words in these two quotes are the "conditional words," as follows: *"the anticipated responses . . . would be NO"* [first sentence in the above quote], and *"subject to the limitations of the Phase 2 assessment information, implementation [of any of the options] is believed not to require a License Amendment Request"* [final sentence in the above quote.]

Bechtel's conclusion concerning safety and DCISC's evaluation of it

We understand Bechtel's conclusion to mean the following: Although more information would be needed to support a definitive conclusion, Bechtel, applying its expert judgment and based on the information at hand, concludes that any of the proposed cooling options can be implemented in a way that will meet NRC requirements vis-à-vis nuclear-reactor-safety. In fact, Bechtel's conclusion is stronger than that. Bechtel's judgment is that it is likely that for any of the seven cooling options under consideration, the nuclear-reactor-safety impact on the plant would be modest enough that PG&E would not even need to request a NRC license amendment request (LAR) before it could proceed with installing that option at Diablo Canyon. (All of this is subject to

Bechtel's appropriate *caveat* that more detailed information will ultimately be needed, as the specific design details are developed, before a sufficient basis will be available for a firmer judgment.)

The DCISC has reviewed Bechtel's conclusion and the basis for it. We believe that not enough information is available now to conclude definitively that any of the seven options will meet NRC's nuclear-reactor-safety regulations. That will need to await specific design details that are not available now.

We conclude that the Bechtel assessment that no LAR is required might be correct for the inshore fine-mesh screening system option, because this option involves the least extensive modifications to the plant; however, this assessment is questionable for the off-shore, modular wedge-wire system, because this option requires the installation of a new, safety-related stop-log system in the plant intake cove. The addition of a new, safety-related system will certainly require a NRC LAR.

We conclude that the Bechtel assessment is likely to be incorrect for the various closed-cycle cooling options. All of these options involve very extensive modifications to the plant, including modifications to the plant intake structure that also houses the ASW system, protected area boundary, turbine building (which houses safety-related emergency diesel generators and electrical switchgear), and rerouting of the plant's 230-kV alternate offsite power transmission system. These major modifications have the potential to affect the operability of safety-related systems both during and following construction, and potential undesirable interactions will require detailed design review by the NRC to identify and mitigate.

While we conclude that most of the proposed cooling system modifications would require a NRC license amendment request, Bechtel's conceptual design study has sufficient detail to allow a preliminary conclusion that NRC approval of the license amendment could likely be obtained. The most important bases for this, in our view, are two:

1. First, Bechtel has performed a set of nuclear-reactor-safety evaluations against each of the various 10 CFR 50.59 criteria for each of the seven alternative cooling technologies.

2. Second, around the world there are a wide variety of cooling designs deployed today at the few hundred operating nuclear power plants. The seven options under consideration here are each represented (broadly, although not in technical detail) elsewhere, and at large numbers of plants for the closed-cycle options. Less experience exists with intake fine screening and offshore modular wedge-wire systems under conditions relevant to the Diablo Canyon site, and we therefore believe that a testing program should be conducted or actual experience elsewhere reviewed to verify performance of either system before it should be selected. Furthermore, for any of the seven proposed alternatives, there is the potential for a significant reduction in the plant's reliability and for an increase in the frequency of trips and forced outages. Much additional work would be needed before assurances could be had that the overall safety impact of these potential issues is manageable. However, because these cooling technologies exist, can be and have been designed and operated safely

elsewhere, we judge that it is probably feasible to deploy any of these seven options at Diablo Canyon in a manner that will meet NRC safety regulations.

However, this finding on our part is not sufficient for us. That is, the DCISC has developed a different criterion for judging the safety of an alternative cooling technology at Diablo Canyon. The next section will explain why we have a different criterion, after which we will present our safety criterion and our evaluation based on it.

The ultimate heat sink

The preceding discussion covered the normal non-safety-related plant cooling system, which discharges waste heat from the condenser to the Pacific Ocean via a Once-Through Cooling System. A totally separate system, the nuclear-safety-related Auxiliary Saltwater System, discharges plant decay heat to the Pacific Ocean in certain shutdown, off-normal, and emergency conditions. This arrangement is called the Ultimate Heat Sink (UHS) because it is the final or ultimate opportunity to keep the plant cool and safe if all other methods are unavailable or have failed.

With two exceptions the seven cooling alternatives proposed by Bechtel would be independent and separate from the UHS, and thus should normally have no adverse impact on nuclear-reactor safety from the UHS standpoint. The two exceptions are the following options:

- Inshore mechanical (active) intake fine mesh screening systems
- Offshore modular wedge wire systems

We are also concerned about a third issue:

- Effects of construction/installation on AWS/UHS

The first two alternative cooling options both utilize the current OTC intake cove and intake structure, which also house the ASW System, part of the UHS. At this stage it appears that these two options would affect the UHS, but final design and analysis would be necessary to permit a determination of the significance. The third item, construction/installation, could adversely impact ASW/UHS, which concerns the DCISC at this conceptual stage. We believe that compensatory measures would likely be taken; however, we reserve final judgment until more is known about this impact.

The DCISC has been studying this issue since December 2010, and in its most recent 2010 – 2011 Annual Report (Reference 11), it concluded the following:

"A range of adverse nuclear safety impacts is known qualitatively at this time and is of concern to the DCISC. The DCISC will continue to take seriously the charge to review the safety impacts of the elimination of Once Through Cooling (OTC) at DCPP and provide analysis and input to the process."

Bechtel concluded the following:

"*The safety-related ASW system is not affected by this modification. The CWS* (Circulating Water System) *and the SCW* (Service Cooling Water*) system do not provide cooling to any component required for safe shutdown. The CW* (Circulating Water) *pumps are not required for the safety of the units. A complete shutdown of the SCW system would not affect safe shutdown of the reactor. The replacement of the once-through cooling with closed cycle cooling would result in an increase in circulating water temperature. This increase is not expected to adversely affect FSARU accident analyses since these systems serve no safety related functions.*"

The DCISC agrees that the alternative cooling systems would not adversely affect the FSARU accident analyses provided that the ASW/UHS is not affected by the proposed alternative cooling system, which appears to be the case based on Bechtel's conceptual studies performed to date, but the reliability of this non-safety related equipment may affect the frequency of plant trips and equipment failures that require safety-related equipment to function in order to prevent or mitigate accidents. Insufficient information is available to answer the question of whether the alternative cooling systems might affect the frequency of accident initiating events.

Effects of plant modifications on plant reliability

One of DCISC's principal concerns with the proposed alternative cooling options is their potential impact on the plant's reliability, and the potential to increase the frequency of plant trips and forced outages that stress plant safety systems (e.g., ASW/UHS) and can provide initiators for accidents. Much of the improvement in nuclear plant safety around the world in the last three decades has come from improved operational methods that have greatly reduced the frequency of plant trips and forced outages.

While the DCISC assesses that the proposed alternative cooling methods could be successfully licensed by the NRC, the level of design detail and information is insufficient to assess the likely affects of the design changes on plant reliability. For example, the closed-cycle options all involve a substantial increase in the operating pressure of the circulating water system, and the potential for increased flooding risk can only be assessed following detailed design. Likewise, the wet closed cycle options include a water storage capacity of only two hours (Reference 2, Section 4.3.4.1) so any outage of the water supply system exceeding this will result in a plant trip. For all systems, there will be a learning curve associated with the transition to alternative cooling that will result in increased risk of plant trips during the learning period.

The importance of the ultimate heat sink in reactor safety, and how an understanding of this importance is developed

Before describing the nuclear-reactor-safety criterion that the DCISC has used in this evaluation, we need to explain something about nuclear-power-plant risk, and about how it is understood by the community of nuclear-power-plant safety analysts.

Every operating US nuclear power reactor, including the two units at Diablo Canyon, meets all applicable NRC regulations. (Otherwise, it would not be operating.) However, this does not mean that any of these reactors presents zero risk to the public. While the NRC has judged the risks acceptably low, the possibility of a release of radioactivity that might affect the public does exist. We will call the ensemble of these risks of a radioactive release the "residual risk," the word "residual" meaning to imply that these are the risks that remain after all of the hard work has been done to reduce the risks to low levels that are acceptable to the NRC and to the DCISC.

Reactor safety analysts study these risks using many different approaches. The approach that provides the most realistic understanding is embodied in an analysis technology known as "probabilistic risk assessment" (PRA), which delineates every important "accident sequence" that might arise at a given reactor. In the PRA, each such accident sequence begins with a specified "initiating event" (such as an equipment failure, a human error, an electrical fire, or an event external to the plant like an earthquake), proceeds through a series of other failures (either equipment failures or operator errors), and ends up with an end-state other than a "safe, stable" end state. (A PRA sequence that ends up at a "safe, stable" end-state is not an "accident.") For those sequences that do not end "safe and stable," the PRA evaluates the overall annual probability of occurrence, the sequence of events that would take place, and the consequences were the sequence to occur. The consequences are analyzed and described quantitatively in terms of damage to the reactor core, the potential for releases of radioactivity from the core to the building, the physical, chemical, and radiological character of those releases, and ultimately the possible release of radioactivity to the environment outside the plant.

It is important to note that the initiating events that can lead to accidents do not necessarily involve safety related systems. Instead, as the reactor-safety community knows from both analysis and operating experience, sometimes these accident sequences may initially involve failures of non-safety related equipment, which then require that safety-related systems function in order to prevent or mitigate an accident. Thus data for the reliability of non-safety-related equipment and systems is a key input to PRA assessments, in addition to that for safety-related systems.

The Diablo Canyon station has performed a PRA of good quality (Reference 5), which is used essentially every day to help understand various issues at the plant as they arise. This PRA is currently being updated in important ways, a process that goes on periodically at Diablo Canyon as elsewhere around the country, because new PRA methodologies are continually being developed, data bases for equipment failures and the like are continually being revised with new information, and there is now a methodology standard for PRA (Reference 6) that is used throughout the U.S. to which the Diablo Canyon PRA is being compared.

The DCISC has reviewed the Diablo Canyon PRA, and also studied several later reviews of it by others (References 7, 8, and 9). We judge that the residual risk as described in the PRA is acceptably small, and have used that judgment as one basis for our conclusion that the plant's two reactors are now being operated safely.

As noted, many different types of accident sequences can occur at Diablo Canyon, and the PRA analyzes them. Among these accident sequences are some that involve prolonged loss of the function of discharging the waste heat to the environment. Prolonged loss of this function can lead to a serious accident, which is why great care is taken at every nuclear plant in the design and operation of the equipment and structures that carry out this function. There are potential sequences in which loss of this function is the initiating event, and others in which this function is lost as a consequence of another initiating event, such as an equipment failure elsewhere in the plant.

The DCISC has reached two important conclusions about Diablo Canyon that need to be understood before we can explain our evaluation here. First, the DCISC judges (as noted above and based in part on the PRA) that the current level of safety achieved at Diablo Canyon is acceptable. Second, the PRA, which the DCISC judges to be technically sound, finds that none of the major contributors to the residual risk from accident sequences at Diablo Canyon involve prolonged loss of the normal function of discharging the waste heat to the environment.

While prolonged loss of circulating water system (CWS) function is not an important contributor to risk at DCPP with today's configuration, abrupt loss of CWS results in one of the more severe types of transients the plant can experience. The risk arises from the coupling between different pieces of equipment during the transient, which can affect equipment reliability in ways not fully captured by the normal reliability data. In the case of abrupt failure of CWS, a normal turbine and reactor trip occur, but the capability to dump excess steam to control the primary system pressure and temperature is reduced because the capacity of the turbine condenser to accept steam is lost. Thus abrupt CWS failures result in a larger temperature and pressure transient to the primary system than during normal plant trips. While these temperatures and pressures remain within the design capability of the primary system, the greater stresses increase the probability of failures of safety-related components. For this reason, the DCISC recommends that special attention be paid to assure that any cooling system modifications do not result in a significant reduction in the reliability of the CWS function.

Another consideration is important to mention here. As a result of insights from the Fukushima nuclear-plant accident in Japan in March 2011, the NRC has ordered all US operating reactors to perform certain studies and based on them to carry out certain safety improvements; other safety improvements may be required by the NRC in the future based on technical studies now under way. In parallel, the US nuclear-power-reactor industry as a whole has undertaken other studies, and has taken the initiative to propose a set of safety improvements that it believes are required and beneficial. Among these latter is an industry initiative, known as "FLEX" (Reference 10), that among other benefits will provide each nuclear plant with a more robust capability to respond in the unlikely event of a prolonged loss of ultimate heat sink. We note that the specifics of these FLEX improvements have not yet been finalized, either at Diablo Canyon or anywhere else, but they are surely going to be installed in one form or another, and they will provide Diablo Canyon with an even stronger basis for the safety performance of its current UHS.

The DCISC's safety criterion

As background, we first reiterate something we noted above, which is that the current OTC approach for providing the normal cooling function at Diablo Canyon meets all applicable NRC requirements. The DCISC is acutely cognizant of the US NRC's nuclear-reactor-safety criteria for this function, and would not provide a positive evaluation for any technology that did not meet those criteria. However, we have approached our safety evaluation using a different set of criteria. Our position is that, although replacement cooling technology could meet all NRC regulations, it could still represent an unacceptable degradation of the overall nuclear-reactor-safety performance at Diablo Canyon when compared to the current configuration. For this reason, the DCISC criterion can be stated as follows:

> *Having concluded that the current OTC approach for performing the normal plant cooling function at Diablo Canyon has adequate safety, the DCISC's safety criterion is that any alternative proposed as a replacement should provide at least approximately the same level of overall nuclear-reactor safety.*

In the DCISC's view, this mainly (but not entirely) comes down to asking the following question of any technology that might be proposed to replace once-through cooling to perform the normal cooling function at Diablo Canyon, after stipulating that the technology must also meet all applicable NRC regulations:

> *As analyzed in the plant PRA, will the contribution of accident sequences involving loss of cooling remain as only a modest contributor to the total residual risk at Diablo Canyon?* [*]

The DCISC cannot answer this question today, because the analysis has not been performed. However, the DCISC is willing to offer the following assessment: Based on our review of the technical information in front of us, meaning the information in the two Bechtel reports (supplemented by our knowledge of how various cooling technologies perform at other nuclear power plants around the world), we judge it likely that none of the proposed new technologies would pose a significant safety problem at Diablo Canyon, if they do not degrade significantly the plant's reliability and increase the frequency of plant trips. However, this is not a strong conclusion based on evidence, but merely a judgment based on what we know so far. Crucially, more analysis is needed. Any new technology must be designed, installed, and operated to high reliability standards, and the first step would be the design step, where details must be developed that will lead to an acceptable design solution.

To summarize: While the DCISC has a technical basis for optimism, we cannot determine from the available conceptual information whether any of the proposed alternative technologies will contribute more to the overall plant risk profile at Diablo Canyon than the modest contribution made today by the current cooling technology

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[*] The comparison between the current cooling configuration and any proposed new one should, in our view, account for the safety benefits to be realized when the new FLEX equipment is installed, because that equipment will surely be available long before any proposed change in the cooling configuration at Diablo Canyon would occur.

(using once-through cooling) -- and we believe that nobody else can fully determine this yet either.

Summary of DCISC findings, conclusions and recommendation

o Bechtel's assessment (as we have paraphrased it) is that if any of the seven alternative options under consideration were to be selected to replace OTC at Diablo Canyon, the nuclear-reactor-safety impact on the plant would not be significant enough that PG&E would even need to ask for an NRC license amendment before it could proceed with installing that option at Diablo Canyon. The DCISC has reviewed Bechtel's conclusion and the basis for it. We find that this conclusion is questionable for the offshore wedge-wire system, because this system requires that a new safety-related system be designed and installed in the plant intake structure. We also find that it is unlikely, given how extensive the plant modifications are, that the installation of any of the five closed cooling options could be performed without a license amendment request.

o We find that the nuclear safety impacts of the alternative cooling options, if and when they are appropriately designed, manufactured, and installed, would likely be sufficiently small that NRC approval could be obtained. However, the DCISC has an additional criterion for judging the safety impact of an alternative plant cooling technology at Diablo Canyon. That is because, in our view, meeting NRC's safety regulations is necessary to support a decision to proceed, but not sufficient.

o Based on our review of the technical information in front of us, we judge it probable that none of the proposed new technologies, if and when they are developed and implemented in accordance with established safety practices, would pose a sufficient safety problem to preclude NRC licensing of the modified design. However, this is not a strong conclusion based on evidence, but merely a judgment based on what we know so far.

o One of our primary concerns with any of the proposed alternative cooling methods involves the potential impact on plant reliability, in particular whether the modified configuration might be more prone to generating plant trips and forced outages, with a potential impact on plant safety, in particular a potential impact on ASW/UHS.

o **The DCISC recommends that additional analysis be performed and more design detail be provided by Bechtel or by PG&E in order to assess the likely effects of the alternative cooling methods on plant reliability and to determine whether the DCISC safety criterion will be met.**

DCISC follow-on activities

These are all interim DCISC findings and conclusions, in the sense that as new information is developed (and it will be) any of them is subject to updated evaluation. In particular, as a follow-on to the work done so far on this set of issues, we will undertake the following:

- We (the DCISC) will continue to review the latest technical information developed by both Bechtel and PG&E; will follow and review any other new information as it comes to our attention; and will also review any NRC evaluations if the NRC becomes involved.

- We will review any new information about these issues that may emerge in the engineering community more broadly for possible relevance to Diablo Canyon, quite apart from whether it is associated with the current proposals.

All of the above would be a part of our normal DCISC scope to review operational safety at Diablo Canyon, but because of the special inquiry made by the California SWRCB, we will be especially alert about these issues.

References

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2. Bechtel Power Corporation, "Alternative Cooling Technologies or Modifications to the Existing Once-Through Cooling System for the Diablo Canyon Power Plant," Report No. 25762-000-30R-G01G-00010 (August 2013)

3. U.S. Nuclear Regulatory Commission, Title 10 Code of Federal Regulations Part 50.59, "Changes, Tests, and Experiments" (64 Federal Register (FR) 53613, Oct. 4, 1999, as amended at 66 FR 64738, Dec. 14, 2001; 72 FR 49500, Aug. 28, 2007)

4. Pacific Gas and Electric Company, "Diablo Canyon Power Plant Unit 1 and 2 Final Safety Analysis Report Update" (revised by the plant on a continuing basis; part of the NRC docket for DCPP)

5. Pacific Gas and Electric Company, "Long Term Seismic Program Final Report," submitted to the NRC in Dockets No. 50-275 and 50-323 (31 July 1988)

6. American Society of Mechanical Engineers (ASME) and American Nuclear Society (ANS), "ASME-ANS RA-Sa-2009, Addendum A to RA-S-2008, "Standard for Level 1-Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications" (2009). A new "Addendum B" to this standard is in the final stages of editing now and will be published in late 2013.

7. Brookhaven National Laboratory, "Review of the Diablo Canyon Probabilistic Risk Assessment," NUREG/CR-5726, prepared for the U.S. Nuclear Regulatory Commission (1994)

8. U.S. Nuclear Regulatory Commission, "Individual Plant Examination Program: Perspectives on Reactor Safety and Plant Performance," Report NUREG-1560 (1977)

9. U.S. Nuclear Regulatory Commission, "Perspectives Gained from the Individual Plant Examination of External Events (IPEEE) Program," Report NUREG-1742 (2002)

10. Nuclear Energy Institute, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Report No. NEI 12-06, Washington DC (August 2012)

11. "Diablo Canyon Independent Safety Committee Twenty First Annual Report on the Safety of Diablo Canyon Nuclear Power Plant Operations, July 1, 2010 – June 30, 2011", Approved October 11, 2011, Volume II, Exhibit D.7, Section 3.1, "EPA Closed Cooling."