SCOPE OF WORK REPORT

by the
Review Committee
to Oversee Special Studies
for the Nuclear-fueled Power Plants
Using Once-through Cooling

November 7, 2011

Nuclear Review Committee Members

Mr. Eric Greene, Public Utilities Commission

Ms. Melissa Jones, California Energy Commission

Mr. Tom Luster, California Coastal Commission

Mr. Jon Bishop, State Water Resources Control Board (Committee Chair)

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Dr. Peter Von Langen, Central Coast Regional Water Quality Control Board

Mr. David Barker, San Diego Regional Water Quality Control Board

Mr. Mark Krausse, Pacific Gas and Electric

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1. Background

1.1 Once-Through Cooling Water Policy

The Statewide Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling (Policy) was adopted by the State Water Resources Control Board (State Water Board) on May 4, 2010, under Resolution No. 2010-0020. The Policy was approved by the Office of Administrative Law on September 27, 2010, and became fully effective on October 1, 2010. The Policy establishes uniform, technology-based standards to implement federal Clean Water Act (CWA) section 316(b), which requires that the location, design, construction, and capacity of cooling intake structures reflect the best technology available for minimizing adverse environmental impact.

The policy applies to 19 existing power plants located along the California coast that withdraw coastal and estuarine waters for cooling purposes, using a single-pass system known as once-through cooling (OTC). Cooling water withdrawals cause adverse impacts when larger aquatic organisms, such as fish and mammals, are trapped against a facility's intake screens (impinged) and when smaller life forms, such as larvae and eggs, are killed by being drawn through the cooling system (entrained).

1.2 Policy Requirements for Special Studies for Nuclear Power Plants

Two of the coastal power plants are nuclear generating stations. The Policy contains special provisions for the existing nuclear-fueled power plants that use once-through cooling water technology, including the San Onofre Nuclear Power Plant (operated by Southern California Edison) and the Diablo Canyon Power Plant (operated by Pacific Gas and Electric). These Policy provisions require the owner or operator of a nuclear facility to undertake specials studies to investigate alternatives for the facility to meet Policy requirements. The special studies must be conducted by an independent third party contractor (Consultant) .

1.3 The Nuclear Review Committee

The Policy requires the establishment of a Review Committee to oversee these special studies. The Review Committee includes representatives from the Statewide Advisory Committee on Cooling Water Intake Structures (SACCWIS) agencies, the nuclear power companies, the environmental community, and staffs of the State Water Board and appropriate Regional Water Boards. The Review Committee is tasked with providing a report detailing the scope of the special studies by October 1, 2011. A final report, detailing the results of the special studies, must be prepared for public comment by October 1, 2013. The State Water Board will consider the results of the special studies, including costs and feasibility, in evaluating the need to modify the Policy with respect to the nuclear-fueled power plants.

1.4 Public Process

Meetings of the Review Committee are open to the public and were noticed at least ten days in advance of the meetings. All products of the Review Committee were made available to the public. The public in attendance at the meetings were invited to speak during the public participation items of the agenda.

1.5 Nuclear Review Committee Meetings

The Review Committee has met four times. The first meeting was held on March 28, 2011 and involved and introduction to policy and power-point presentations were shown as an introduction to the San Onofre and Diablo nuclear power plants. An overview of the public process and ground rules were also established and discussed. The second meeting was held on April 28, 2011 and involved working on an approach to writing the scope for the special studies. The Review Committee also began developing criteria and qualifications for the Consultant. The third meeting was held on September 23, 2011 and involved finalizing the draft scope and discussing a timeline for the Consultant to follow once chosen and contract begins. The Review Committee also discussed the public comment period for this report. The fourth meeting was held on November 7, 2011 and involved addressing comments received on the draft scope, making the needed edits, and approved the document. The Review Committee also discussed the next scheduling steps for the public process.

2.0 Selecting a Consultant – Criteria

In order to ensure that a Consultant has the appropriate qualifications to be considered for completing this scope of work, a Consultant criteria list was developed by the Review Committee. The list includes the following:

- Do We Have A Current Contract With Them?
- Are They a USA/STARS Supplier? (cooperative of nuclear plant operators)
- Do They Have a California Presence?
- Could There Be a Conflict of Interest?
- Do They Have Relevant Design Experience?
- Do They Have Relevant Build Experience?
- Specifically, Do They Have Relevant Cooling Tower Experience?
- Specifically, Do They Have Relevant Cooling Tower Alternatives Experience?
- Do They Have Relevant Environmental Experience?
- Specifically, Do They Have Relevant §316(b) Experience?
- Do They Have Relevant Project Management Experience?
- Do They Have Relevant Nuclear Experience?
- Do They Have Contemporary DCPP or SONGS Experience?

Upon the recommendation developed by the nuclear power facilities, the Executive Director will select the final consultant as stated in the Implementation Provisions Section 3.D.(2) of the Policy.

3.0 Scope of Work for the Special Studies

3.1 Objective

The objective of this document is to satisfy the requirement established by the State Water Resources Control Board (SWRCB) for Southern California Edison (SCE) and

Pacific Gas and Electric (PG&E) to jointly create a scope document containing criteria to be used by a Consultant to conduct evaluations to assess compliance alternatives to once-through cooling for the San Onofre Nuclear Generation Station (SONGS) and the Diablo Canyon Nuclear Power Plant (DCPP).

The selected Consultant will conduct a detailed evaluation based on detailed criteria of each technology, on a site specific basis, based on their independent assessment. Prior studies are provided for reference and made available for review by the Consultant. The Consultant must clearly document the basis on which any portion of these prior studies are used in any way as part of their independent and comprehensive assessment of feasibility.

3.2 Guidance for Feasibility Assessment

1. The review process is a systematic approach to identify and consider all the impacts of each conceptual technology, and to assess for feasibility[1] of each technology. Every criterion for each conceptual technology must be assessed to determine feasibility for the technology. To reach a conclusion of feasibility, the Consultant performing this assessment must demonstrate and document the basis for such a conclusion.

When performing this work, the Consultant must consider and report on conceptual technologies that may be applied to each power generating unit for each nuclear plant. For example, if a technology is likely to be successful at reducing impingement and/or entrainment, but may be only installed at one of the two units at a plant, the Consultant shall report that.

3.3 Guidance for Feasibility Assessment – Criterion Checklist (not in priority order)

1. FIRST OF A KIND TO SCALE Identify whether the proposed technology has been demonstrated in a power plant-scale application. Identify whether the technology is commercially obtainable. Regardless of previous application scales, evaluate whether the technology would work considering the site settings and physical characteristics of the nuclear plant; particularly from the perspective of cooling tower retrofit or alternative cooling retrofit.

2. EXTERNAL APPROVAL AND PERMITTING (NON-NUCLEAR LICENSING) All external organizations other than the Nuclear Regulatory Commission (such as the California Coastal Commission, local Air Pollution Control District/AQMD with jurisdiction, etc.) that must approve the technology installation project have been identified. The process for obtaining the approval has been identified. Identify and assess possible permitting constraints. Consider site specific topographical constraints, including plant site and adjacent land ownership, use, and control issues.

[1] "Not feasible" for purposes of this work product, will be defined as it is in the Policy; that is, "Cannot be accomplishabled because of space constraints or the inability to obtain necessary permits due to public safety considerations, unacceptable environmental impacts, local ordinances, regulations, etc. Cost is not a factor to be considered when determining feasibility under Track 1." Other criteria in the Criterion Checklist included herein that do not meet the Policy requirements may also be reported on but should not be the primary criteria used to determine feasibility.

3. OPERABILITY GENERAL SITE CONDITIONS Assess operability and operational issues that are specific to the study sites. Ensure that the proposed technology change is acceptable/feasible to operate in site specific environmental conditions. Assessment should consider such issues as existing cooling source water conditions including currents, temperature ranges, occurrence of detrimental ocean storm/high-swell conditions, range of water column debris loading conditions, and marine biofouling concerns.

4. IMPINGEMENT/ENTRAINMENT DESIGN Assess the effectiveness of the technology to reduce cooling water impingement and entrainment losses, either alone or in combination with another technology. Reductions in impingement and entrainment achievable by each technology (or combination of technologies) being considered will be measured and discussed by the Consultant, and will be assessed in comparison to Track 1 and Track 2 of the Policy. An Evaluation of the potential or probability that a reduction in one detrimental cooling water use impact would likely be offset by an increase in another impact with known or unknown consequences (i.e. plant entrainment reduction through screening technology application could result in significantly increased impingement losses) should be conducted.

5. OFFSETTING ENVIRONMENTAL IMPACTS Evaluate the potential that the technology installation would create additional and/or offsetting detrimental environmental impacts. Specifically, the assessment should consider impacts beyond water quality issues (i.e., significant increases in facility air emissions would result in order to achieve reductions in source cooling water withdrawals, etc.)

6. SEISMIC AND TSUNAMI ISSUES Assess cost and engineering constraints of constructing and operating each technology being considered in a seismically active zone. This shall be done considering current design standards only. Consultant should note that these standards may potentially change and depending on studies to be completed in 2015. The independent third party shall, to the extent practicable, incorporate these changed standards into the cost and engineering constraints. Specific seismic upgrades or requirements may be needed for each technology being considered (i.e. could natural draft cooling towers effectively be installed when considering the seismic characteristics of the plant site) based upon the results of the studies to be completed in 2015. To the extent possible, the Consultant shall attempt to estimate the cost and engineering constraints of future ground motions, which the studies could determine to be higher or lower.

7. STRUCTURAL Identify the critical loading conditions and determine that the new structures, and impacts to existing structures, can be accommodated during a detailed design phase of the technology.

8. CONSTRUCTION A conceptual technology installation design will be sufficiently detailed to determine that fabrication, required access and availability of space for

installation and staging activities, installation, and associated physical modifications to the plant can be accomplished.

9. MAINTENANCE Identify maintenance activities for the design that will not create a personnel hazard, and/or an unrealistic (non-commercially viable) operational maintainability burden.

NUCLEAR SPECIFIC ASSESSMENT CRITERION:

10. LICENSING NUCLEAR SPECIFIC Perform a 10CFR50.59 feasibility assessment to determine whether approval by the Nuclear Regulatory Commission (NRC) would be required. Scope the Nuclear Design Change Criteria that must be considered and addressed to develop a comprehensive and complete Operating License Amendment Request (LAR).

    a. SEISMIC NUCLEAR SPECIFIC Identify all seismic issues and determine if there is reasonable assurance that all aspects of seismic design and potential seismic interaction with Seismic Category I structure systems and components (SSC's) can be addressed in the detailed design phase. Potential impact on plant reliability for a seismic event that is less than the design basis earthquake must be considered.

    b. OPERABILITY NUCLEAR SPECIFIC Assess if operation of the technology at the plant site would potentially increase nuclear unit trip risks, and/or design or operational issue that must be addressed to ensure additional risks are not realized. Assessment should consider, but not be limited to, issues such as reliability of main and auxiliary electrically transmission systems, reliability of emergency diesel generator systems, potential for increased corrosion and degradation of plant equipment and control systems, and potential for plant flooding (i.e. resulting from elevated cooling system configurations).

    c. TRANSIENT ANALYSES Perform a transient analysis to assess plant impacts considered in the design to determine if all impacts have been explicitly identified and are appropriately conservative to determine plant impact and response to the transients.

    d. NUCLEAR FUEL (ACCIDENT ANALYSES) Perform a feasibility assessment of the UFSAR Accident Analyses and determine that the impact due to the proposed design change is acceptable.

    e. SINGLE FAILURE Identify Updated Final Safety Analysis Report (UFSAR) Single Failure Analyses issues and determine that there is reasonable assurance that these are acceptable.

    f. HYDRAULIC DESIGN Identify impacts to hydraulic designs and ensure that sufficient analysis has been performed to determine that the systems will function within sufficiently conservative design parameters.

    g. PROBABILISTIC RISK ASSESSMENT Identify Probabilistic Risk Assessment issues and determines their acceptability.

h. INSTRUMENTATION, CONTROLS, AND ALARMS Assess whether the conceptual design is sufficiently detailed to determine what instrumentation, controls and alarms are required. Assess the proposed instrumentation, controls and alarms that may be installed, provide adequate monitoring and are acceptable to support safe, correct and efficient operation of the units.

11. DETAILED COST AND SCHEDULE Produce a detailed cost and schedule, required as part of any major project. Provide separate costs for: (a) planning, construction and installation and (b) downtime (i.e. lost generation and replacement). Costs estimated will be on a wholesale basis, and not profits lost. According to D.7 of the Policy, costs of compliance (in total $ and $/MW amortized 20 years) and engineering constraints may also be considered.

3.4 Evaluation Process

The criteria checklist (see Section 3.3) will be used in such a manner as to afford the special study Consultant an opportunity to conduct an efficient assessment process of available technologies. The technology assessment should progress in two distinct phases. The general assessment criterion list provided should be considered first. Each technology shall be evaluated based on engineering/construction and operational factors. Those technologies that have serious flaws in meeting the entire general criterion, and upon consultation with the Nuclear Review Committee, should not be considered for further, more detailed assessment.

The nuclear specific assessment criterion should only be evaluated in the event a technology has been agreed upon to have a reasonable likelihood of being considered feasible in the initial phase.

The entire criteria checklist may not apply to every item evaluated for each technology being considered.

The check list will be previewed, however, for each technology, and an agreement established with the Consultant as to an organized, efficient and systematic approach conducive to an optimized cost and schedule approach. A single point of contact from each utility will assist in this preview.

3.5 Technologies and Strategies to be Evaluated (not in priority order)

Evaluation shall include but not be limited to the following industrial technologies as addressed in the reports and evaluations listed for each nuclear site:[2]

1) Closed-Cycle Cooling Systems (Cooling System Retrofit)
   a) Passive Draft Dry / Air Cooling System
   b) Mechanical (Forced) Draft Dry / Air Cooling System

[2] Consultant may propose the evaluation of alternate technologies, alone or in combination, after consultation with the Review Committee

c) Hybrid Wet[3] / Dry Cooling System (Evaporation Enhanced Dry Cooling Radiator System)
d) Wet (*) Natural Draft Cooling Tower System
e) Wet (*) Mechanical (Forced) Draft Cooling Tower System
i) Surface freshwater or groundwater resources
ii) Reclaimed freshwater resources

2) Inshore mechanical (active) intake fine mesh screening systems. Include site specific screen sizing requirements. Assess probable operational efficacy of an installed fine mesh screening system:
a) Structural survivability and reliable operability in site-specific environmental conditions.
b) Probable/Potential screened marine organism impingement survivability and subsequent viability.
i) Possible combination with a fish return system or other impingement reduction technology)
c) Probable operational issues associated with screen loading (debris accumulation and/or differential pressures).

3) Offshore modular wedgewire or similar exclusion screening systems. Include site specific screen sizing requirements. Assess probable operational efficacy of installed wedgewire screening arrays or similar system:
a) Evaluate site specific current regimes (reliable currents necessary for successful screen back-flushing operations).
b) Structural survivability and reliable operability in site-specific ocean and environmental conditions.
c) Probable/Potential screened marine organism impingement survivability and subsequent viability.
d) Potential operational issues associated with offshore screening array reliability (fouling control and thru flow).

4) Initial intake relocation; offshore intake (DCPP), shoreline intake (SONGS).
5) Deep water offshore intake (point of initial intake to piping/conveyance systems).
6) Variable speed cooling water pumping systems.
7) Source water substrate filtering/collection systems
a) Shoreline (beach) sand well collection system
b) Benthic substrate filtration collection system
8) Operational strategies to reduce impingement and entrainment

4.0 Reporting Provisions

For each facility, review and assess the following documents, reports and regulatory agency evaluations:

[3] For wet closed-cycle cooling systems, evaluate site-specific makeup water restrictions for evaporative or blow-down loss replenishment. Determine any primary dependency on a specific makeup water source, i.e. seawater or freshwater. Evaluate the general availability of freshwater resources in proximity to each plant. The assessment shall include availability of any infrastructure that would be necessary to deliver sufficient freshwater (if such sources exist).

- San Onofre Nuclear Generating Station (SONGS) - Appendix A
- Diablo Canyon Power Plant (DCPP) - Appendix B

5.0 Deliverables

There are two distinct types of deliverables for this effort; progress reports and a final work product. Progress reports are required bi-monthly and/or after any single technology evaluation has been fully completed. Progress reports necessitate detailed status, schedule updates, and identification of barriers to completing evaluations as expected.

The final work product is to be provided in both written and electronic report format, with supporting references that sufficiently and succinctly address the feasibility of each of the technologies evaluated for each facility. Due to the plausible dissimilarities between each unit's operating designs and site conditions, opportunities for possible misperceptions will be avoided by producing an individual detailed report addressing each facility. An executive summary will be produced describing the overall conclusion of the special study for each site. This will include a tabular listing of all the technologies evaluated with a corresponding determination of feasible or not-feasible for implementation.

Individual summary evaluations of each technology feasibility assessment and associated conclusions will also be provided. This will include a tabular listing of the entire criteria check list items evaluated with a corresponding determination of feasible, not-feasible, or not evaluated for each. Include or reference relevant supporting information from existing technology feasibility assessments, and any additional application specific assessments conducted in support of the determinations. A 'not evaluated' determination is appropriate/applicable to criteria after a not-feasible determination is assessed for any one of the criteria on the check list.

6.0 Schedule

General Process Schedule:

- Start Consultant RFP and Contracting Process – 11/15/2011
- Complete Selection and Contracting ofITP Consultant - 03/16/2012
- Initial Meeting of Consultant and Nuclear Review Committee (RC) - March 2012
- Interim Report from Consultant to RC Outlining Site Specific Feasibility of Technologies Provided in Work
- Scope. RC Determination on Technologies to Further Investigate - Summer 2012.
- 1st Draft Comprehensive Consultant ITP Technologies Assessment Report to RC - March 2013
- 2nd Draft Comprehensive ITP Technologies Assessment Report to RC - June 2013
- Final Technologies Assessment Report provided for public review and comment - 10/012013

Appendix A

Note: Nuclear Review Committee Chair provided preference for newer (last decade) study information & documents.

San Onofre Nuclear Generating Station (SONGS)
Reference Documents Provided in Chronological Order:

1) *Final Report of the Marine Review Committee to the California Coastal Commission*, MRC Document 89-02, August 1989. (http://marinemitigation.msi.ucsb.edu/documents/MRC_reports/final_report/mrc-final-rpt_to_ccc.pdf)

2) Southern California Edison Company's (SCE) coastal development permit for the San Onofre Nuclear Generating Station (SONGS) Units 2 and 3 (permit no. 6-81-330A, formerly 183-73).

3) *Comprehensive Demonstration Study for Southern California Edison's San Onofre Nuclear Generating Station* Final Report, January 2008.

4) *California's Coastal Power Plants: Alternative Cooling System Analysis*. Tetra Tech Inc., February 2008. Chapter-7 Facility Profiles, Section N. San Onofre Nuclear Generating Station [Pages N-1 through N-42]. (*Report Independently Prepared for the California Ocean Protection Council*)

5) *Feasibility Study for Installation of Cooling Towers at San Onofre Nuclear Generating Station*. Enercon Services Inc., September 2009.

Additional Relevant Documents for Consideration:

Assessment of Marine Review Committee Recommendations for SONGS Units 2 and 3, prepared by PLG, Inc. (formerly Pickard, Lowe, and Garrick) as part of a multi-year study by the independent Marine Review Committee (MRC), February 1990.

Issues Analysis of Retrofitting Once-Through Cooled Plants with Closed-Cycle Cooling California Coastal Plants, Electric Power Research Institute [EPRI], 2007
Substantial for San Onofre Section B.15 & General Technologies Info; DCPP Only Brief w/References Section 6.3.2.

Preliminary Costs and Benefits of California Draft Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling, prepared by NERA Economic Consulting, September 2009

Note: Nuclear Review Committee Chair provided preference for newer (last decade) study information & documents.

Appendix B

Diablo Canyon Power Plant (DCPP)

Reference Documents Provided in Chronological Order:

1) Diablo Canyon Power Plant Cooling 316(b) Demonstration Report. Tenera Environmental Services, 2000. Section 6.0 Evaluation of Alternative Intake Technologies [Pages 6-1 through 6-36].

2) Evaluation of Cooling Systems Alternatives, Diablo Canyon Power Plant. Tetra Tech Inc., 2002. (*Report Independently Prepared for the Central Coast Regional Water Quality Control Board*)

3) Feasibility of Retrofitting Cooling Towers at Diablo Canyon Power Plant Units 1 & 2. Burns Engineering Services Inc., 2003.

4) Staff Testimony for Regular Meeting of July 10, 2003 Pacific Gas and Electric Company's (PG&E's) Diablo Canyon Power Plant Renewal of NPDES Permit. Central Coast Regional Water Quality Control Board (CCRWQCB), 2003. [Pages 1-18].

5) California's Coastal Power Plants: Alternative Cooling System Analysis. Tetra Tech Inc., 2008. Chapter-7 Facility Profiles, Section C. Diablo Canyon Power Plant [Pages C-1 through C-40]. (*Report Independently Prepared for the California Ocean Protection Council*)

6) Feasibility of Installation of Closed-Cycle Cooling Towers at the Diablo Canyon Power Plant. Enercon Services Inc., 2009.

<u>Additional Relevant Documents for Consideration</u>:

Assessment of Alternative Intake Technologies for the Diablo Canyon Power Plant, Tera Corp., 1982. Older Comprehensive Study Used as Reference in All Primary Listed Documents

Issues Analysis of Retrofitting Once-Through Cooled Plants with Closed-Cycle Cooling California Coastal Plants, Electric Power Research Institute [EPRI], 2007
Substantial for San Onofre Section B.15 & General Technologies Info; DCPP Only Brief w/References Section 6.3.2.

Appendix C

Other Reference Documents to Consider

Jaske, Michael R et.al. CEC-200-2009-013-SD - Implementation of Once-through Cooling through Energy Infrastructure Planning and Procurement. Jul 2009.

Moss Landing Marine Laboratories. CEC-500-2007-120 - Understanding Entrainment at Coastal Power Plants: Informing a Program to Study Impacts and their Reduction. (*Report Prepared for the California Energy Commission*). March 2008.