Nuclear Review Committee Concerns
Bechtel Response Revision 1

Comment set 1:

1. As well as looking at desalination as a supplemental supply of makeup water for closed cycle cooling with other sources from WWTPs etc. the Bechtel Study should look at desalination water as being the only source of makeup water.

   BECHTEL RESPONSE:

   The use of desalination as a makeup source for the CCW wet systems was added to the report in several areas (DCPP Sections 3.2.1, 3.22.1, 4.1.1.1, 4.1.1.2, and 4.5.1 SONGS 3.2.1, 3.2.2.1, 4.1.1.1, 4.1.1.2, and 4.5.1), the design and location of the desalination units will be evaluated as part of Phase 2.

2. Page 8 incorrectly uses the acronym CCRWQCB as Coastal Commission Regional Water Quality Control Board rather than Central Coast Regional Water Quality Control Board.

   BECHTEL RESPONSE:

   This has been corrected in the report.

3. The last sentence on page 17 should say "they" rather than "hey".

   BECHTEL RESPONSE:

   This has been corrected in the report.

4. Page 18 states, "In addition to this federal permit, there is a somewhat parallel state regulatory review process, which culminates in the issuance of a Clean Water Act Section 401 Water Quality Certificate by the SWRCB. No separate application is required for this permit and it generally is issued shortly after the Section 404 permit is issued."

   BECHTEL RESPONSE:

   We could not identify this issue on page 18 on either the DCPP or SONGS reports. The text has been revised on pages 58, 64, and 72 of the DCPP report and pages 52, 60, and 70 of the SONGS report to reflect that the 401 Water Quality Certificate will be issued by the RWQCB prior to the issuance of the Section 404 permit by the Army Corps of Engineers.

5. The RWQCB normally issues the 401 Water Quality Certification and it is required before the 404 permit can be authorized by the ACOE.

BECHTEL RESPONSE:

The text has been revised to reflect that the 401 Water Quality Certificate will be issued by the RWQCB prior to the issuance of the Section 404 permit by the Army Corps of Engineers.

6. Not sure if the report used the 1-2 mm wedge wire screens as well as the 6 mm wedge wire screens

BECHTEL RESPONSE:

The report followed the technical evaluation to support a Phase 1 recommendation for a 6 mm slot opening wedge wire screens. However, the report also is open to the use of smaller slot opening sizes of 2 mm slot if the in-situ testing of wedge wire screens for 2 mm slot and 6-mm slot can demonstrate 2 mm slot is the optimum size addressing effectively entrainment/impingement reduction while not resulting in operation difficulty due to debris clogging or biofouling.

Comment set 2:

There were four issues or concerns raised by the Nuclear Committee in the last two meetings regarding the Phase 1 draft reports that Bechtel agreed to address including:

1. The possibility that back pressure issues would eliminate dry cooling as an option for SONGS, but not for Diablo Canyon.
2. The screen size for wedgewire screens.
3. Vertical wells as an alternative to horizontal substrate filtering.
4. The impingement and entrainment reductions associate with different levels of derate of the facilities.

The back pressure issues appear to have been adequately addressed in the revised SONGS report on p. 12.

There appear to be some remaining issues associated with the other alternatives as presented below:

Wedgewire Screens:

- For both Diablo Canyon and SONGS, Bechtel indicated in the last Committee meeting that it was uncomfortable with using a slot size for wedge wire screens lower than

6-8 mm and that they believed there is a significant improvement in entrainment with a 6 mm slot size.

BECHTEL RESPONSE:

Cylindrical wedgewire screens are a well-established intake screen technology that has a track record of successfully minimizing the loss of aquatic organisms at water intake structures, including those used for cooling purpose. The successful application of wedgewire screen technology depends on three factors in determining site-specific performance of wedgewire screens (William Dey 2003):

1. The slot width relative to the size of aquatic organisms that need to be protected;
2. Through-slot velocity; and
3. Velocity of water currents sweeping across the face of screen.

In the final reports for both plant sites the 2nd and 3rd factors have been clearly discussed. The low through slot velocity (0.5 fps or lower) is a key sizing criterion for the screens and that there is sufficient water current velocity to sweep potentially entrained or impingement organisms along the face of the wedgewire screens. The importance of the first factor, the screen slot width, was also discussed but additional details are added here and in the final report. While it is well recognized that the smaller the slot width, coupled with low through screen velocity and high sweeping current velocities tend to have a higher success rate in entrainment reduction. The ever decreasing slot width will also drastically increase the potential of screen fouling which could result in reduced or even total stoppage of cooling water flow through the intake. Once fouling is developed over and within the slot openings the effectiveness with respect to the entrainment reduction benefits will quickly diminish due to much increased through slot velocity. The key challenge is to find an acceptable slot size that will not only significantly reduce the entrainment and impingement of aquatic organisms and at the same time not result in severe operational difficulty or unintended plant shutdown. This is precisely the reason why Bechtel is not comfortable in endorsing the use of a narrow slot screen such as a 2 mm slot opening at this time. A final slot size needs to be determined through a site-specific testing program that would be carried out for the DCPP and SONGS sites for both 2-mm slot width and the 6-mm slot width if this technology is selected for installation at either site. Additionally, there are a wide range of industry tests that are ongoing that will be also factored into the final slot size selection.

Testing on effectiveness of various slot widths (0.5 mm, 1 mm, 2 mm and 3 mm) were conducted and summarized (William Dey 2003) on three species in the Hudson River

Estuary, American shad, Striped bass and Bay anchovy. Owing to their relatively large eggs, length at hatch, and rapid growth rates all these slot widths result in substantial reduction in the Age 1 equivalent American shad lost to entrainment. The shad entrainment reduction of 87-99 percent for the 3 mm slot width wedgewire screen as compare to 99 to 100 percent reduction with 0.5-mm slot width screens was measured. The striped bass exhibited greater variability in protection from entrainment across slot width and intake location, with entrainment reduction from 26 to 39 percent at 3 mm slot width to 97-99 percent at 0.5 mm slot width. Therefore, depending on the aquatic species, 3-mm slot width as presented in the reference (William Dey 2003) can be very effective too.

Similarly, Enercon conducted alternative intake technologies evaluation for Indian Point 2 &3 (Enercon 2010) and concluded that use of the wedge wire screens can be effective in reducing entrainment up to 89.8 percent and impingement up to 99.9%. It also concluded that use of both 2 mm slot and 9 mm slot would achieve substantial EA1 (Equivalent Age 1) impingement and entrainment reduction. EA1 is defined as the number of age 1 fish that eggs, larvae, and juveniles lost to entrainment would have been expected to produce had they not been entrained. Due to the uncertainty with ice buildup on screen and debris clogging for narrow slot openings (2 mm slot or lower), Indian Point also intends to conduct site specific testing using two slot sizes, 2 mm slot and 9 mm slot. This approach is consistent to our recommendation to DCPP and SONGS to conduct the testing for 2 mm slot as well as 6 mm slot opening.

<u>References:</u>

William Dey, 2003, "Optimum Slot-Width Selection for Wedge Wire Screens," Proceedings Report, Symposium of Cooling Water Intake Technologies to Protect Aquatic Organisms, May 6-7, 2003, Arlington, VA.

Enercon 2010, Evaluation of Alternative Intake Technologies at Indian Points Units 2 & 3, Enercon Services, February 2010.

- SWRCB staff in our last meeting indicated that part of the OTC Policy is protecting organisms of 1 mm in size from entrainment and that 6 mm slot size for the screens may not be adequate to meet the OTC policy. This element of the policy should be included in the discussion of the policy in both reports.

BECHTEL RESPONSE:

Aquatic organism, egg, larval, juvenile and adult fish, can be effectively protected by the use of wedge wire screens. Both final reports provide a long list of advantages of wedgewire screens over the existing intake scheme at both plants. These advantages are low intake velocity, sweeping currents, hydrodynamic shape and fish deterrent screen body shape. The challenge is to find an optimum wedge wire screen slot size that can greatly reduce the entrainment and impingement of these aquatic organisms and at the same time, does not result in severe fouling or clogging by debris. Once fouling is developed over and within the narrow slot openings, the effectiveness with respect to the entrainment reduction benefits will quickly diminish due to much increased through slot velocity that will entrain (pull) the aquatic organisms in from surrounding flow fields and through the slot opening.

At this time, Bechtel can not endorse the narrow slot screens (2 mm or smaller) other than a 6 mm slot width. Prior to the procurement of the screens the selection of the slot size would be determined based on insitu testing at each plant site and available industry test results at the time.

- The SWRCB and other staff believed that additional information, including quantification of impacts, on the both the larger and smaller slot size was necessary. In the meeting Bechtel indicated that they would look into it and respond to comments.

BECHTEL RESPONSE:

Bechtel has looked into this and will add additional details into Section 4.2.8 of the final reports adding quantification of impacts on both the larger and smaller slot sizes, as follows:

(a) In the cited reference below (SCWR 2011), Tenera Environmental performed the Open Ocean Intake Effects study, a pilot study for the evaluation of a narrow-slot cylindrical wedgewire screen. The pilot study examined the following operational characteristics of the screen in situ:

- Larval entrainment
- Impingement
- Screen corrosion/biofouling
- Hydrodynamics around the screen during pumping.

The pilot scale intake screen had a 2 mm slot opening and was sized to ensure a maximum through-screen velocity of 0.33 fps. Results of the pilot studies testing showed that Z-alloy proved to be resistant to biofouling over 13-months, and the qualitative evaluation of dye in water moving around the cylindrical wedge wire screens showed currents and wave motion helping to clean the screen. That together with a low intake velocity prevented impingement of small organisms.

The intake effects assessment study as presented in the cited reference below compared the screened intake with an unscreened intake to study the operational effectiveness of the screen on larval entrainment. The data from the pump samples were analyzed to determine if any differences could be detected between concentration of fish, caridean shrimp, and cancrid carb larvae from the screened and unscreened intake. The analysis showed: 1) the standard 2 mm narrow-slot wedge wire screen intake screen excluded 100% of adult and juvenile fish species in the area. 2) The unscreened intake entrained juvenile and adult fishes, and 3) while no statistically significant reduction in entrainment was found, annualized screen-test results demonstrated that the screen resulted in 20% reduction in total annual fish entrainment.

(b) In addition, Zeitoun, et al (1981), in the below cited reference, studied the effectiveness of both 2 mm narrow slot and 9.5 mm slot opening wedge wire screens in reducing entrainment. Juvenile fish and fish larvae sense the screens and avoid entrainment and they are less sensitive to the slot size. Zeitoun, et al. conducted field entrainment experiments with samples of ichthyoplankton collected through 2.0-mm and 9.5-mm-slot opening cylindrical wedge-wire screens in June, July, and August off the southeast shore of Lake Michigan at a depth of 10.7 m. Ambient composition and density of ichthyoplankton were determined by net tows. Rainbow smelt (*Osmerus mordax*), alewife (*Alosa pseudoharengus*), and yellow perch (*Perca flavescens*) larvae were common in both entrainment and tow collections. Eggs were found almost exclusively in entrainment collections. Ambient larval fish densities were about 11 times greater than those found in entrainment collections. Total entrainments through either screen [slot size] were not statistically significant. Larval avoidance and, to a lesser extent, screen exclusion were responsible for the low entrainment. These field experiments estimated that about 90% of native fish larvae at the site avoided pumping.

(c) Testing on effectiveness of various slot widths (0.5 mm, 1 mm, 2 mm and 3 mm) were conducted and summarized (William Dey 2003) on three species in the Hudson River Estuary, American shad, Striped bass and Bay anchovy. Owing to their relatively large eggs, length at hatch, and rapid growth rates all these slot widths result in substantial reduction in the Age 1 equivalent American shad lost to entrainment. The shad entrainment reduction of 87-99 percent for the 3 mm slot width wedgewire screen as compare to 99 to 100 percent reduction with 0.5-mm slot width screens was measured. The striped bass exhibited greater variability in protection from entrainment across slot width and intake location, with entrainment reduction from 26 to 39 percent at 3 mm slot width to 97-99 percent at 0.5 mm slot width. Therefore, depending on the aquatic specifies, 3-mm slot width as presented in the reference (William Dey 2003) can be very effective also.

(d) Enercon conducted alternative intake technologies evaluation for Indian Point 2 &3 (Enercon 2010) and concluded that use of the wedge wire screens with slot sizes of 9.0, 6.0, 3.0, 2.0, 1.5 and 1.0 mm can be effective in reducing EA1 (Equivalent Age 1) entrainment loss up to 89.8 percent and impingement loss up to 99.9% from the regulatory baseline. It also concluded that use of both 2 mm slot and 9 mm slot sizes would achieve substantial EA1 impingement and entrainment reductions. According to Enercon, the regulatory baseline is a regulatory construct that employs certain operation and survival assumptions, which have been used by the New York State Department of Environment Conservation (NYSDEC) in State Pollutant Discharge Elimination System (SPDES) permit proceedings for other New York power plants.

Potential percent reduction of monthly and annual EA1 impingement and entrainment losses from the regulatory baseline due to use of wedgewire screens with through slot velocity of 0.5 fps was listed in the below table.

Month	EA1 Entrainment Loss Reduction						EA1 Impingement Loss Reduction
	9.0 mm	6.0 mm	3.0 mm	2.0 mm	1.5 mm	1.0 mm	
January	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.6%
February	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.5%
March	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	13.1%
April	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	8.2%
May	8.3%	8.3%	8.3%	8.3%	8.3%	7.9%	10.0%
June	28.2%	28.2%	28.2%	28.3%	28.2%	27.7%	12.7%
July	26.5%	26.5%	26.5%	26.5%	26.6%	26.6%	5.5%
August	14.8%	14.8%	14.8%	14.8%	14.8%	14.8%	5.7%
September	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.0%
October	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	5.1%
November	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.7%
December	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.8%
Annual	89.6%	89.6%	89.7%	89.8%	89.7%	88.8%	99.9%

As can be seen, for the Indian Point Units 2 & 3 assessment, use of wedgewire screens of 1 mm to 9 mm all exhibit high and comparable improvement of equivalent age 1 (EA1) impingement and entrainment loss reductions from the regulatory baseline.

In summary, it is prudent to conclude that, smaller slot opening wedge wire screens, including narrow slot sizes, results in same or better performance in entrainment reduction than coarser slot opening wedgewire screens. More dependable measure would be the EA 1 impingement and entrainment reduction, in which Enercon shows that use of either 1 mm, 2 mm, 6 mm, or 9 mm makes no practical differences for Indian Point Units 2 & 3. Nonetheless, actual quantification impacts to the in-situ aquatic organism conditions for each of the two plants need to be conducted before a conclusion is drawn on the optimum slot opening (whether 2 mm slot or 6 mm slot). This certainly needs to consider the potential effect of debris clogging and fouling to the operation of wedge wire screens.

References:

SCWR 2011, City of Santa Cruz Water Control Board, Evaluation of a Screened Open Ocean Intake and Subsurface Intake Options for a Seawater Desalination Facility in Santa Cruz, California, November 2011.

Zeitoun et al, 1981: I. H. Zeitoun, J. A. Gulvas, D. B. Roarabaugh, Effectiveness of Fine Mesh Cylindrical Wedge-Wire Screens in Reducing Entrainment of Lake Michigan Ichthyoplankton, Canadian Journal of Fisheries and Aquatic Sciences, 1981.

William Dey, 2003, "Optimum Slot-Width Selection for Wedge Wire Screens," Proceedings Report, Symposium of Cooling Water Intake Technologies to Protect Aquatic Organisms, May 6-7, 2003, Arlington, VA.

Enercon 2010, Evaluation of Alternative Intake Technologies at Indian Points Units 2 & 3, Enercon Services, February 2010.

- There is a very limited discussion of the smaller slot size that has been added in the final report, but it is quite superficial and doesn't really address the issues raised.
- For example, in both report there is a short discussion of some field experiments (Zeitoun 1981) that looked at 2 mm to 9 mm wedge wire screens. (It appears in two places: on p. 37 of Diablo Canyon Report and, p.35 of SONGS Report). However, the discussion makes no distinction between entrainment/impingement impacts associated with the smaller vs. larger screens. As a result it doesn't really provide any useful information to help understand impacts from the either larger or smaller slot size. (As currently

written one might conclude from this discussion that the size of the screen doesn't matter in that the impacts for 2-9 mm slot size are the same.) This discussion is not very responsive to the Committee's request for additional information (including quantitative info) on the smaller slot size for wedge wire screens.

- There is a minimal mention of 2 mm slot size in a couple of places in both reports. This is not very responsive to the Committee's request for additional information about the vertical wells and their possible use.
- In the wedge wire discussion of entrainment/impingement design (starting on p.85 in the SONGs report and p.39 of the Diablo Canyon report) it isn't clear whether you are talking about 6 mm or smaller. This would have been one place where Bechtel could have included additional information on the smaller slot size.

BECHTEL RESPONSE (for the four bullets above):

Bechtel has looked further into this and has added additional details into the final reports on smaller slot sizes, specifically various testing reports we found over the web with comparison of effectiveness of various screen sizes including narrow slot sizes (2 mm and smaller). However, we want to clarify that the Committee is requesting additional information on narrow slot sizes (2 mm and lower) in this section and not about the vertical wells and their possible use which is addressed elsewhere in this document and in the final reports.

In addition to the Zeitoun et 1981 reference, Bechtel has evaluated additional references (SCWR 2011, Dey 2003, and Enercon 2010) that provide support on equal or better performance of finer slot opening than coarse slot opening such as 9 mm slot as related to the entrainment reductions. The discussion below will be added to Section 4.2.8.

Testing on effectiveness of various slot widths (0.5 mm, 1 mm, 2 mm and 3 mm) were conducted and summarized (Dey 2003) on three species in the Hudson River Estuary, American shad, Striped bass and Bay anchovy. Owing to their relatively large eggs, length at hatch, and rapid growth rates all these slot widths result in substantial reduction in the Age 1 equivalent American shad lost to entrainment. The shad entrainment reduction of 87-99 percent for the 3 mm slot width wedgewire screen as compare to 99 to 100 percent reduction with 0.5-mm slot width screens was measured. The striped bass exhibited greater variability in protection from entrainment across slot width and intake location, with entrainment reduction from 26 to 39 percent at 3 mm slot width to 97-99 percent at 0.5 mm slot width. Therefore, depending on the aquatic species, 3-mm slot width as presented in the reference (Dey 2003) can be very effective also.

The pilot scale intake screen conducted by Tenera Environmental (SCWR 2011) had a 2 mm slot opening and was sized to ensure a maximum through-screen velocity of 0.33 fps. Results of the pilot studies testing showed that Z-alloy proved to be resistant to biofouling over 13-months, and the qualitative evaluation of dye in water moving around the cylindrical wedge wire screens showed currents and wave motion helping to clean the screen and together with a low intake velocity prevented impingement of small organisms.

The intake effects assessment study as presented in this reference compared the screened intake with an unscreened intake to study the operational effectiveness of the screen on larval entrainment. The data from the pump samples were analyzed to determine if any differences could be detected between concentration of fish, caridean shrimp, and cancrid carb larvae from the screened and unscreened intake. The analysis showed: 1) the standard 2 mm narrow-slot wedge wire screen intake screen excluded 100% of adult and juvenile fish species in the area. 2) The unscreened intake entrained juvenile and adult fishes, and 3) while no statistically significant reduction in entrainment was found, annualized screen-test results demonstrated that the screen resulted in 20% reduction in total annual fish entrainment.

More dependable measure in impingement and entrainment reduction would be to look at equivalent age 1 (EA 1) conditions. Enercon studies for Indian Point 2 & 3 indicated that use of the wedge wire screens result in substantial EA1 impingement and entrainment reduction from the regulatory baseline. Potential percent reduction of monthly and annual EA1 impingement and entrainment losses due to use of wedgewire screens with through slot velocity of 0.5 fps was listed in the below table.

Month	EA1 Entrainment Loss Reduction						EA1 Impingement Loss Reduction
	9.0 mm	6.0 mm	3.0 mm	2.0 mm	1.5 mm	1.0 mm	
January	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.6%
February	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.5%
March	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	13.1%
April	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	8.2%
May	8.3%	8.3%	8.3%	8.3%	8.3%	7.9%	10.0%
June	28.2%	28.2%	28.2%	28.3%	28.2%	27.7%	12.7%
July	26.5%	26.5%	26.5%	26.5%	26.6%	26.6%	5.5%
August	14.8%	14.8%	14.8%	14.8%	14.8%	14.8%	5.7%
September	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.0%
October	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	5.1%
November	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.7%
December	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.8%
Annual	89.6%	89.6%	89.7%	89.8%	89.7%	88.8%	99.9%

As it can be seen, for the Indian Point Units 2 & 3 assessment, use of wedgewire screens of 1 mm to 9 mm all exhibit high and comparable improvement of equivalent age 1 (EA1) impingement and entrainment loss reduction from the regulatory baseline.

Again, it can be concluded that smaller slot opening wedge wire screens, including narrow slot sizes, results in the same or better performance in entrainment reduction of aquatic organisms than coarser slot opening wedgewire screens. The actual impingement and entrainment performance on a EA 1 basis would be quite similar, as in the case of Indian Point 2 & 3. Actual quantification impacts to the in-situ aquatic organism conditions for each of the two plants needs to be tested before a conclusion is drawn on the optimum slot opening. This testing certainly needs to consider the potential effect of debris clogging and biofouling to the operation of wedge wire screens.

References:

SCWR 2011, City of Santa Cruz Water Control Board, Evaluation of a Screened Open Ocean Intake and Subsurface Intake Options for a Seawater Desalination Facility in Santa Cruz, California, November 2011.

William Dey, 2003, “Optimum Slot-Width Selection for Wedge Wire Screens,” Proceedings Report, Symposium of Cooling Water Intake Technologies to Protect Aquatic Organisms, May 6-7, 2003, Arlington, VA.

Enercon 2010, Evaluation of Alternative Intake Technologies at Indian Points Units 2 & 3, Enercon Services, February 2010.

Zeitoun et al, 1981: I. H. Zeitoun, J. A. Gulvas, D. B. Roarabaugh, Effectiveness of Fine Mesh Cylindrical Wedge-Wire Screens in Reducing Entrainment of Lake Michigan Ichthyoplankton, Canadian Journal of Fisheries and Aquatic Sciences, 1981.

Substrate Filtering:

- SWRCB staff indicated that Bechtel should look at vertical (Rainey(?) wells). Bechtel agreed to look into the issue.

  BECHTEL RESPONSE:

  Bechtel will add additional details on vertical wells (traditional and radial collector wells) to the final report; see response to the next bullet.

- A very short and superficial discussion (1/2 page) of vertical wells is presented on p. 49 of the Diablo Canyon report and on p. 42-43 of the SONGS report. It mentions that there is another type of source water collection system and concludes it as being less efficient for production of large quantities of water as the horizontal substrate filtering. There is no real discussion of why it is more efficient or substantiation for the conclusion.

  BECHTEL RESPONSE:

  Revised discussion has been provided, see below, explaining in greater details that the horizontal substrate filtering scheme is relatively more efficient for the production of large quantities of water as compare to the collection of individual vertical wells scheme. Horizontal substrate filtering scheme is based on a collection of flows collected via arrays of offshore horizontal laterals to various piping manifolds and eventually to the central pumping station on shore. However, vertical wells (conventional or Rainey wells) will be on-shore and have individual pumping system, and each well tends to have very limited pumping capacity. The revised discussion will show that, in order to produce 1.7 million gpm once through cooling flows, vast numbers of onshore vertical wells will be needed. Due to the spacing requirements to reduce interference effects between screens for the vertical wells, greater vertical penetrations and limitation of natural formation of hydraulic conductivity, spacing large number of vertical wells on shore, with individual pumping systems to a central circulation water pumping station would not be practical. In any case, both substrate filtering system using laterals or vertical wells system are fatal flaws in terms of first-of-kind-to-scale, operability or maintenance.

Improved writeup which has been added to Section 3.8 of both reports is provided below:

The source water substrate filtering collection system is more efficient for production of large quantities of water as compared to onshore wells (either conventional vertical wells or radial collector wells). Conventional vertical wells are placed in vertically oriented boreholes and consist of a well screen and blank casing. In general, the maximum yield of a typical vertical well is approximately 6,000 gpm for a 30 inch diameter well (Sterrett, 2007), which is about the practical well size limit of conventional drilling equipment. For a 1.7 million gpm design capacity, approximately 280 vertical wells and associated pumping stations would be required if the maximum yield exists from each well. This maximum yield assumes that a highly permeable material, such as a gravel deposit, is present in the subsurface, which is not the case at either DCPP or SONGS; hence the total number of vertical wells needed to meet the design flow rate capacity would be significantly greater than 280. The vast network of pumping station delivering flows to a central collection point will not be practical onshore. Radial collector wells (also known by the proprietary name Ranney Wells) consist of a central caisson and associated pumping skid, with well screens extending laterally outward beneath the water source. Radial collector wells have been designed with capacities from 2 to 80 mgd (Riegert, 2006) or 1,400 to 56,000 gpm. Using this range of capacity, it would require between 30 to 1400 radial collector wells and associated pumping installations to meet the design flow rate capacity, assuming ideal subsurface conditions, i.e. a gravel deposit. The subsurface conditions at DCPP and SONGS suggest that high numbers of radial collector wells would be required.

Onshore vertical and radial collector wells have the following limitations:

- Greater horizontal spacing requirements to reduce interference effects between conventional wells or to allow lateral placement for radial collector wells.
- Greater vertical penetration to produce optimum flow to well.
- Well production rate limited to natural formation hydraulic conductivity.
- Geological conditions at DCPP indicate the presence of shallow bedrock not conducive to large flows.
- Geological conditions at SONGS indicate the presence of shallow sandstone bedrock that may be conducive to large flows but additional study is needed to

confirm. Pumping information at the SONGS site is not available due to salt water intrusion concerns.

These limitations would be expected to result in a larger well field area and a more complex pumping system and on an onshore installation, it is not really practical. As a result the vertical or radial collector wells were not considered in this evaluation.

REFERENCES

Sterrett, R.J., 2007, *Groundwater and Wells*, 3rd edition, Johnson Screens, New Brighton, MN.

Riegert, D.S., 2006, Reassessing Ranney Wells, *Public Works*, April.

- Both reports states the due to a number of limitations (listed as bulleted items) that would be expected to result in larger well system and a more complex pumping system, and hence a greater environmental impact than for substrate filtering, vertical wells were not considered in the evaluation. However, there is no substantiation for why environmental impacts would be a fatal flaw.

BECHTEL RESPONSE:

Discussion has been revised to focus on the technical impracticality of using vast number of onshore vertical wells and associated pumping scheme over the offshore substrate filtering scheme as the reason of rejecting the vertical well system from further evaluation in this section. Revised section writeup below will be added to Section 3.8 of the report.

Improved writeup to be added to Section 3.8 of both reports:

The source water substrate filtering collection system is more efficient for production of large quantities of water as compared to onshore wells (either conventional vertical wells or radial collector wells). Conventional vertical wells are placed in vertically oriented boreholes and consist of a well screen and blank casing. In general, the maximum yield of a typical vertical well is approximately 6,000 gpm for a 30 inch diameter well (Sterrett, 2007), which is about the practical well size limit of conventional drilling equipment. For a 1.7 million gpm design capacity, approximately 280 vertical wells and associated pumping stations would be required if the maximum yield exists. This maximum yield assumes that a highly permeable material, such as a gravel deposit, is present in the subsurface, which is not the case at either DCPP or SONGS; hence the total number of vertical wells needed to meet the design flow rate capacity would be significantly greater than

280. The vast network of pumping station delivering flows to a central collection point will not be practical onshore. Radial collector wells (also known by the proprietary name Ranney Wells) consist of a central caisson and associated pumping skid, with well screens extending laterally outward beneath the water source. Radial collector wells have been designed with capacities from 2 to 80 mgd (Riegert, 2006) or 1,400 to 56,000 gpm. Using this range of capacity, it would require between 30 to 1400 radial collector wells and associated pumping installations to meet the design flow rate capacity, assuming ideal subsurface conditions, i.e. a gravel deposit. The subsurface conditions at DCPP and SONGS suggest that high numbers of radial collector wells would be required.

Onshore vertical and radial collector wells have the following limitations:

- Greater horizontal spacing requirements to reduce interference effects between conventional wells or to allow lateral placement for radial collector wells.
- Greater vertical penetration to produce optimum flow to well.
- Well production rate limited to natural formation hydraulic conductivity.
- Geological conditions at DCPP indicate the presence of shallow bedrock not conducive to large flows.
- Geological conditions at SONGS indicate the presence of shallow sandstone bedrock that may be conducive to large flows but additional study is needed to confirm. Pumping information at the SONGS site is not available due to salt water intrusion concerns.

These limitations would be expected to result in a larger well field area and a more complex pumping system and on an onshore installation, it is not really practical. As a result the vertical or radial collector wells were not considered in this evaluation.

REFERENCES

Sterrett, R.J., 2007, *Groundwater and Wells*, 3rd edition, Johnson Screens, New Brighton, MN.

Riegert, D.S., 2006, Reassessing Ranney Wells, *Public Works*, April.

Variable Speed Pump (or Operational Strategies):

- Bechtel agreed to provide information on the impingement and entrainment impacts associated with different levels of derate (by percentage) of the plants. The only place a possible derate of either plant is discussed is in relation to the variable speed pump technology.

BECHTEL RESPONSE:

The impingement and entrainment impacts associated with different levels of derate (by percentage) can be found in Sections 4.2.8, for both plants, related to the evaluation of Variable Speed Pump technology.

- For Diablo Canyon, on p. 56 the report states that flow rate reductions are "proportional" to reductions in impingement/entrainment improvement. But this doesn't address the question of what impingment/entrainment impact reductions can be expected from different levels of derate (percentages).

BECHTEL RESPONSE:

Section 3.9 for both reports provide the general description of the variable speed pump technology under consideration and what this technology can do. The full evaluation of entrainment and impingement design as related to impingement and entrainment reduction should be found on Section 4.2.8 of both reports. The specific generation output under different de-rating scenarios vs. flow can be determined based on acceptable condenser back pressure, design condenser inlet temperature, condenser cleanliness factor. However, the calculated generation outputs for different condenser flow rate will show a much higher condenser temperature rise with reduced flow as compare to the base load condition. For this assessment, it is necessary that the condenser temperature rise be kept constant for different plant de-rating conditions, so not to cause thermal discharge permitting and thermal impacts issue at discharge. In which case, the amount of plant de-rate will closely match the amount of condenser flow reduction.

In summary, one can conclude that the plant percent de-rate will approximately equal to the percent condenser flow reduction and proportional to the reduction in impingement/entrainment improvement.

- Both reports say that for variable speed pumps to reduce flow to 0.5 fps or more requires reduction of 83% or more, which would render the pumps inoperable due to the current practical limit of 15-30% flow reduction achievable with pumps this size. Even if practical, the reduction in output would be over 50%. Again, this could be a place to add discussion about other levels of derate.

BECHTEL RESPONSE:

In Section 4.2.8 of both reports, it was stated that, in order to reduce flow to 0.5 fps or more will require de-rate of 83% for SONGS and derate of 75% for DCPP, respectively. In both cases, this level of derating will not be achievable or practical as it would render the pumps in-operable due to min flow requirements for continuous pump operation. Also in Section 4.2.8, it was discussed that the practical range of flow reduction of the large scale circulating water pumps would be about 15 to 30%. This range of flow reduction will directly result in the equal percentage of the entrainment reduction and appreciated reduction on impingement reduction. Impingement reduction associated with flow reduction can not be quantified or estimated linearly as would be the case for the entrainment reduction, since through screen velocity would be still above 0.5 fps after 15 to 30% flow reduction.

Bechtel will update Section 4.2.8 to add clarification of percent entrainment reduction vs. percent derate from 0 to 30%. As discussed in the last bullet, with the assumption that the condenser temperature rise must be kept constant under different plant de-rate conditions so not to cause additional adverse environmental impact to the circulating water discharge temperature, the percent plant de-rate will roughly be in the same order as the percent condenser flow rate reduction. Therefore, a condenser flow reduction of 0 to 30% due to use of variable speed will result in approximate plant de-rate of up to 30%.

- Finally, both reports (SONGs report on p. 89, Diablo Canyon on p. --) state "Finally, an EPRI study (EPRI 2007) concludes that such reduction in load may have significant impacts on the electric generation supply to the grid when most needed." The EPRI Report contains dated information on the supply and demand conditions in California, which have changed significantly, especially with both SONGS units currently offline. This sentence should be deleted.

BECHTEL RESPONSE:

The sentence states a conclusion derived from a valid EPRI study which we believe is accurate. A large reduction in load from any one of the studied units will have an impact on the grid that must be accounted for. Therefore, we have not removed the sentence from the reports.

Comment set 3:

On the Closed-Cycle Cooling Report of Bechtel

It is recognized that Bechtel has found that none of the alternatives proposed for Phase 2 have "fatal flaws", yet they may all have extreme environmental and cost implications for Californian's. Absent objections from California's permitting agencies, it believed that Phase 2 should proceed to investigate the full costs of each alternative; including realistic time estimates for permit approval and legal challenges.

California, and in some cases the federal government, may need to give permission to do many of the following:

- Build ten 570 ft. towers in the coastal zone
- Lease additional federal (military land)
- Place miles of pipes underground for water
- Find fresh water in an area often near or in drought conditions
- Use reclaimed water that could better serve agriculture, industry and residential
- Buy fresh or reclaimed water
- Move and/or reconstruct buildings on the east side of highway101
- Mitigate particulate matter from steam
- Take over state park land
- Reduce parking space
- Wait 8-15 years for alternatives
- Allow continued degradation of marine life until 2020 to 2022 (current end of operating permit)
- Adopt Phase 1 without the benefit of expert Marine Biologist input
- Purchase from a list of out-of-state vendors
- Rely on the NRC process for approval of safety-related components
- Require additional energy to operate generators in a currently constrained area.
- Invest in technology that has not been tested at any other California coastal facilities, much less nuclear facilities (SONGS Steam Generators)
- Increase water use and emissions during construction
- Litigate years of disagreements in what has historically been a very costly legal process for nuclear investments.

While the above list of negative impacts for alternatives cooling is not all-inclusive it does highlight issues that have been historically unpopular with the coastal communities and/or have found their way into lengthy court challenges. In addition, many cost estimates related to nuclear projects have resulted in major cost overruns. For this reason, it's encouraged that Phase 2 reviewers leave no economic or environmental stone unturned, allowing for a recommendation that is factually based and in the best interest of California residents and utility ratepayers.

BECHTEL RESPONSE:

Bechtel intends to work closely with the utilities and the Review Committee to develop workable conceptual designs for each of the Phase 2 technologies that pass criterion 10 to develop an estimate that meets the Class 3 based on AACE Recommended Practice No. 17R-97: "Cost Estimate Classification System" and 18R097 "Cost Estimate Classification System-as Applied in Engineering, Procurement, and Construction for the Process Industries". This process will result in a cost estimate and a design and installation schedule that should support the Review Committee needs in evaluating the viability of each of the Phase 2 technologies.