

STATE OF CALIFORNIA
Energy Resources Conservation
and Development Commission



Application for Certification for the Hidden Hills)
Solar Electric Generating System) Docket No. 11-AFC-02
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APPLICANT'S SUR-REBUTTAL TESTIMONY

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February 20, 2013

Pursuant to the Committee's February 8, 2013 Order, the Applicant hereby submits its Optional Sur-Rebuttal Testimony Related to Avian Impacts from Flux.

Biological Resources—Solar Flux

Q. Please state your names and business affiliations.

A. My name is Gary Santolo. I am an Avian Scientist for CH2M Hill, Inc.

Q. Please describe your professional experience and qualifications in connection to your rebuttal testimony herein.

A. My qualifications are set forth in my direct testimony filed on January 22, 2012.

Q. What is the purpose of your rebuttal testimony, Mr. Santolo?

A: I was asked to review and rebut, if necessary, the Rebuttal Testimony filed by California Energy Commission (CEC) Staff on February 15, 2013.

Q: In Staff's Rebuttal Answer to Question No. 11, Staff alleges that there are flaws in the experimental study design of the Solar Flux Study (SFS) Report by Mr. Santolo. What is your response?

A: Staff has not shown "flaws in the experiments design". The study successfully did what it was designed to do: identify a solar flux level where singeing of feathers occurs in varying sizes of birds under the controlled conditions of the experiment. Like any experiment or study, it was intended to provide answers to specific questions and does not test every possible circumstance or seek to answer all possible questions. That fact, however, does not render the results invalid for the scenarios tested, nor does it mean one cannot draw reasonable conclusions and inferences based on the results. In my opinion, it is much more scientific to base conclusions on data resulting from real world tests with actual birds and real flux conditions than to dismiss such results entirely and rely instead upon purely theoretical engineering calculations that have not been validated by any real world testing. Indeed, this test allows reasonable inferences regarding Staff's calculations that 4 kW/m^2 can be sufficient to raise feather temperatures to 160°C . If Staff were correct, one would certainly expect to find observable damage to the tested birds at flux levels well below 50 kW/m^2 . That no effect was observed at flux levels an order of magnitude above Staff's 4 kW/m^2 threshold in actual tests certainly suggests that Staff's calculation is wrong. That the test conditions did not seek to observe all possible scenarios is irrelevant to the central point: that under the scenarios that were tested, the results differed dramatically from what Staff's calculations would predict. Staff's effort to discredit the testing does not offer any explanation for this very large discrepancy.

Q: In particular, Staff alleges that the birds used in the SFS are not representative of birds at the HHSEGS site. What is your response?

A: It is not unusual to use laboratory or domestic species to extrapolate to native species for experimentation as there are obvious limitations to obtaining and using native wild species and transporting them in and out of other countries. Three size classes of birds

were used that can, in fact, be used as surrogates for species that would be potentially exposed in the wild and to extrapolate to other species. The tests clearly showed that smaller birds are affected to a greater degree by solar flux than are larger birds; however, the solar flux level that caused feather effects were similar for all species. This indicates that all feathers, at least non-white feathers, are damaged at similar flux levels; it does not suggest that birds themselves are damaged at similar flux levels. As a professional avian biologist, I know of no reason that the feathers of the birds at the HHSEGS site would so materially differ from those of the birds used in the test as to render the test results invalid in this proceeding. Nor does Staff assert that there is any material difference.

Q: In several of Staff's Rebuttal Answers, Staff alleges that the SFS would not have identified damage to keratin comprising the feathers and therefore would not identify all structural damage. What is your response?

A: If there was "structural damage" to the feather it would be obvious and visual observation and manipulation by hand would identify it. Staff's claim that there is some invisible and unobservable effect to feathers that nonetheless renders them "structurally damaged" is unsubstantiated. In addition, it should be noted that areas of possible damage were examined with a 10 power loupe to determine damage that might not be visible to the naked eye. That examination informed and supported the conclusions of the report.

Q: Specifically, is thermo-gravimetric analysis of keratin in feathers necessary to provide evidence of feather damage?

A: No. Thermo-gravimetric analysis of keratin is not needed to identify damage or functionality. It was reported in the SFS that damage and functionality of feathers was caused by 50 kW/m² and the assumption is that temperatures between 160° and 400°C were reached in damaged feathers. "Singed" feathers were described in the SFS as not only feathers with evidence of carbonization, but also feathers that were discolored brittle, inflexible, or that tended to easily break back to the point where other evidence singeing was observed. Consequently, feathers were identified as subject to singeing when they experienced keratin damage in areas that included, but were not limited to carbonized locations. Portions of the feather that showed discoloration but were not carbonized, for example, also showed effects consistent with the breakdown of keratin and loss of mechanical properties. These areas were detected during the tests and included in the SFS findings as evidence of "singeing." As stated in the SFS and at the workshops, no reduced functionality was observed in feathers or portions of feathers that were not singed as that term was used in the SFS. Any structural damage to the feathers, including damage not necessarily evidenced by carbonization, was obvious, when it occurred, from visual observation and when feathers were examined physically by hand. When the structure of a feather was compromised, irrespective of carbonization, the barbs and barbules would no longer perform the function of holding the feather vane in place. The loss of this function was easily observed and identified in the field and was included in the analysis of damage reported in the SFS.

Q: In Staff's Rebuttal Answer to Question No. 10, Staff alleges that the thermocouple temperature data does not support the conclusions in the SFS Report. What is your response?

A: Staff's assertion misunderstands and mischaracterizes the use of the thermocouples as described in the SFS. As discussed in the SFS, and at the workshops, the thermocouples were not intended or used to measure feather surface temperatures during the study because these devices can not generate accurate data if exposed directly to solar flux. There was no attempt to represent or explain the extent of feather damage using the thermocouple data. As stated in the SFS, the thermocouples were mounted under the feathers and the skin and inside the body cavity of the test subjects. The only intended purpose of the thermocouples was to provide information about temperature changes in surface and deeper tissue locations during the flux exposures. The results were reported in the SFS to document the extent and speed of tissue temperature responses to solar flux. This data is not indicative of, and was not presented in any way to suggest, feather surface temperatures during each test.

Feather surface temperature data was obtained by using an infrared thermometer to measure feather surface temperature before exposure and 15 to 30 seconds after exposure. Issues with the characterization and interpretation of the thermocouple and infrared thermometer measurements have been identified in the SFS, during the workshops and in Staff and applicant testimony. Despite these issues, the measurement data does facilitate statistical and other analyses that otherwise might not be clear or overlooked. These findings include: (1) Larger birds were less affected than smaller birds and smaller birds showed a greater increase in body temperature than larger birds; (2) the higher the flux level, the higher the measured feather surface temperature using the infrared thermometer; (3) surface temperature decreased rapidly after exposure, even in birds that showed signs of singeing, where feather temperatures taken just 15 to 30 seconds after exposure dropped well below levels that could damage feather structure; and (4) feathers provide good insulation as under-the-skin temperatures were significantly lower during exposure than the assumed feather temperatures was (i.e., assuming feather temperatures for singeing was about 160°C and for carbonization of feathers about 400°C). Consequently, the thermocouple and infrared thermometer data did provide important information that was consistent with the observed feather effects but were not intended or used to measure feather surface temperatures.

Q: In Staff's Rebuttal Answer to Question No. 13, Staff alleges that the photos taken as part of the SFS do not support the conclusions in the report. What is your response?

A: Staff's Rebuttal Answer to Question No 13 asserts that the photos do not support the study, but fails to identify a single example of a photo being inconsistent with the SFS conclusions. Indeed, Staff's Rebuttal Answer to Question No 13 is little more than a complaint that the photos were not taken at a higher resolution and that the subject birds were not posed as Staff would prefer. The photos, however, were not meant as "photo documentation", as Staff claims, and were not presented as such. The photos were for my use as reference tools. Applicant agreed to allow Staff and others to view them as a

courtesy. In point of fact, the photos accurately show what was described in the SFS and support its conclusions.

Q: Why was feather singeing used as the effect metric?

A: Please see the response to the question regarding “thermo-gravimetric analysis of keratin” above. As discussed in that response, “singeing” was described in the SFS to include a wide range of feather damage, including carbonization, discoloration, and loss of physically observed feather mechanical properties. The design of the experiment was to use such singeing as an effect metric since the range of potential damage was broad in scope and readily observable by sight, by physical inspection, and with a 10-power magnifying loupe. Observational findings are empirical and provide a conservative metric that can be found in the field. Varying degrees of singeing also do not matter in the analysis; the testing was designed to identify solar flux intensities that could cause feather damage. Singeing as described in the SFS provided a clear method for delineating between a negative or positive result, and any evidence of singeing was considered an effect in the SFS.

Q: In Staff’s Rebuttal Answer to Question No. 16, Staff criticizes the SFS for not using a wider variety of exposure times. What is your response?

A: First, this was not a study that looked at flight times of birds through the solar field but a study to identify a level of effect. The SFS only discusses flight time and speed to provide context for the test duration. The testing time frames represent a realistic period of exposure given typical flight behaviors based on my professional experience. The tests were conducted for pre-determined and repeatable time periods so that potential effect levels could be identified under conditions that reduced the variability from ambient conditions and decreased uncertainty about the timing when an effect actually occurred. This study provides the best and most valid data available regarding solar flux effects on avian feathers, including empirical data on solar flux levels, exposure times, and effects observed for differently sized species of birds. The SRS results provide the basis for further studies that could be used to refine the effect levels. The duration of the exposures were not characterized as representing all potential exposure periods of wild birds at a site and the study in no way precludes extrapolating to longer or shorter exposure periods.

Q: Staff suggests an uncertainty factor (UF) of 10 is reasonable for solar flux. Do you agree?

A: The SFS describes the threshold where effects to feathers were actually observed at specifically measured solar flux levels. Since this information is known and documented, there is no justification for a UF of 10 (or any other substantial UF). Natural sunlight, for example, has an ambient maximum flux level of about 1 kW/m². Since this intensity is known and has been documented, there would be no reason to assume that solar flux effects were subject to a UF of 10, which would imply that effects could range from an exposure as low as 0.1 kW/m² to as high as 5 kW/m². The upper range of this

“uncertainty factor” extends above 4.9 kW/m², the level that Staff has asserted will cause feather damage. The arbitrary use of an UF where intensities and effects are known would paradoxically suggest that even natural sunlight could chronically singe or destroy the mechanical properties of avian feathers. As stated in the SFS and in workshops, 50 kW/m² is in fact a conservative estimate of the solar flux exposure that might cause systematic avian feather impacts because the SFS test subjects were dead, near-stationary birds fully exposed to a constant flux level. Live birds would be moving, changing orientation relative to the direction of any flux exposure, cooling by various natural methods (as explained in the SFS and in workshops), and constantly moving in and out of different levels of solar flux. These factors would tend to increase the level of solar flux exposure and duration that could be associated with for feather damage under real-world condition

STATE OF CALIFORNIA

Energy Resources Conservation
and Development Commission

Application for Certification for the HIDDEN)	
HILLS SOLAR ELECTRIC GENERATING)	Docket No. 11-AFC-2
SYSTEM PROJECT)	
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PROOF OF SERVICE

I, Karen A. Mitchell, declare that on February 20, 2013, I served the attached *Applicant's Sur-Rebuttal Testimony* via electronic mail to all parties and U.S. mail to parties requesting hard copies on the attached service list.

I declare under the penalty of perjury that the foregoing is true and correct.



Karen A. Mitchell

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