POWER ENGINEERS

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AGENCY
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5/13/2011
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Subject: Calico Solar Project - Glint/Glare Analysis

Dear Jonathan:

After the recent Calico site visit and review of new BNSF issues concerning worker safety, POWER has revised its scope for the glint and glare analysis at the Calico Facility. Specifically, this proposal addresses the following Issues:

CEC/BNSF ISSUES

1. Changes in the train crews' vantage points with respect to the Solar Technology as the train travels along the ROW – POWER will perform a glare analysis along the entire length and within the BNSF ROW. The track, signal equipment and other important safety equipment will be analyzed. This will be conducted for both east and west travel. (POWER)

2. The effect(s) of the geometry of the track, the changes in elevation, and the direction of travel on the magnitude and pattern of Glare - POWER will use the best available terrain information and topographic feature data to perform the analysis. This will be conducted for both east and west travel. (POWER)

3. The effect(s) of the time of year, and day on the magnitude and pattern of Glare along the ROW - This will be conducted for both east and west travel. (POWER)

4. The extent to which a level of Glare exists that train crews may experience as a result of the Solar Technology, which does not rise to a level that would induce temporary flash blindness, but nonetheless causes discomfort or distraction that makes it difficult to attend in the direction of the Solar Technology (POWER/Hovis)

5. The effect(s) of perceived Glint (high-contrast flicker) in the train crews' peripheral visual field, which may prompt individuals to orient their eyes and attention away from where they should be attending – POWER will develop an animation of a worst case scenario demonstrating the movement of the train in relationship of passing solar equipment on engineers and train crews.(POWER/Hovis)

6. Visual obstructions, independent of Glare, resulting from the size of the Solar Technology (up to 40 feet tall in relation to SunCatchers and over six feet tall and approximately 160 feet wide in relation to PV modules arrayed in 48-module rows), which may prevent train crews from perceiving all job-critical information – POWER will perform a visibility analysis from the vantage of the train and train crews along the ROW. (POWER)

7. Light reflecting off the Solar Technology, which may result in a phenomenon known as a "phantom signal" whereby train signals, which are not actually illuminated, may appear to be because of intense light striking them at low angles – POWER will perform a geometric analysis to determine the angle of light entering the signal (if any). POWER assumes GPS locations of the equipment, type and height will be delivered by BNSF for study. POWER will collect information with GPS equipment if needed. POWER will deliver results of the analysis to DR. Hovis for analysis.

8. Since the trains are moving through the ROW, the distance traveled during expected look-away times as a result of distraction from the Solar Technologies' presence should be calculated and the consequences of such travel should be assessed – (POWER Hovis)

9. The effects of viewing multiple Solar Technologies simultaneously, rather than just one, which must be analyzed to understand any cumulative Glare effects that may arise; (POWER/Hovis)

10. The effects of viewing multiple Solar Technologies simultaneously, for the entire period of time that the train crew is passing through the ROW, which must be analyzed to understand any cumulative Glare effects that may arise over time; (POWER/Hovis)

11. Recommendations for how the construction and operation of the solar facility can mitigate the potential to create Glint and Glare that lead to Adverse Impacts for motorists, work crews and train operators; (POWER/Hovis)

12. Identification of safe orientation for non-operational Solar Technologies, to include stowage; (POWER/Hovis)

13. Identification of any further adverse health impacts to BNSF Employees, motorists and work crews

14. The extent to which Glint and Glare from the solar facility may cause Adverse Impacts for motorists, on-site workers and viewers

15. Views from CALTRANS Highway located to the south of the Calico facility. Up to 6 viewpoints will be studied to determine the location, duration, time of year and day glint and glare may occur to passing motorists.

POWER's project team will consist of:
- Jason Pfaff (Grade 9) -Project Manager
- Grade 6 - Senior Visualization Specialist
- Grade 4 - Visualization Specialist

## TASK SUMMARY, VISUALIZATION TECHNOLOGY PRODUCTS

- **TASK 1, 3D Development, Data Collection** – Task 1 is necessary to complete visualization technology tasks 2 through 4.

- **TASK 2, Glint and Glare analysis for CALTRANS (6 KOPs) Animated Photo-Simulations (CALTRANS)**

- **TASK 3, BNSF ROW ANIMATION DEVELOPMENT (BNSF)**

- **TASK 4, Geometric Glint and Glare Analysis** – POWER will review all of the animations and document results in a series of spreadsheets. Analysis will be performed for each month, day and hour throughout the year.

- **TASK 5, Glint and Glare Tech Memo** – POWER will provide kRoad Power with a glint and glare tech memo, describing the location, duration, time of day and year in which glint and glare may occur. This will include text, graphs, charts and figures to support the findings. In addition, the tech memo will include mitigation measures to eliminate or reduce the effects of glint and glare.

## WORK PLAN

### Task 1, 3D Development, Data Collection

The following tasks will be used to develop the 3D models for the photo-simulations and geometric analysis. Please note that this step will be required for all subsequent tasks but will only be charged once.

**Subtask 1.1 – 3D Development (102 hours)**

- *Suncatcher and Solar Array* (21 hours) – A combination of Suncatchers and single axis tracking solar panels will be developed as 3D Models. POWER will utilize the 3D Suncatcher models to save time and cost.

- *Terrain Modeling* (21 hours) – POWER will use elevation information to create a terrain of the study area. Terrain data and aerial photography will be acquired from kRoad Power, USGS or other applicable sources. Best available data will be used for the model. POWER will model the CALTRANS overpass at the southeast corner of the project. This is important, as the overpass may block most of the glint and glare impacts to the signals south of the highway.
  > Data Acquisition
  > Assembly – use the data to assemble the terrain and place aerial photography; merge with array

- *BNSF Track* (10 hours) – Many of the issues regarding glint and glare result from the BNSF track, and view height of train crews. Therefore, the BNSF track will be included in the terrain model as a hard break object, insuring elevations are accurate. POWER assumes the elevation and vector information can be delivered to POWER as a CAD or GIS file.
  > Data Acquisition
  > Assembly – use the data to assemble the track

- *Signal and Safety Equipment* (24 hours) – POWER will build 3D objects of the safety and signal equipment found in the BNSF ROW. The equipment will include correct geometry, height, location and rotation as found in the Calico Site. POWER will use GPS equipment to capture the information if it is not provided by BNSF.
  > Data Acquisition Includes site visit
  > Assembly – use existing and collected data to create the Signal and other safety equipment
- *Engine and Train-Car equipment* (26 hours) – POWER will use existing BNSF 3D Models as a baseline for the 3D Models. However, POWER will travel to a BNSF facility to take correct measurements of the engine cab, and other train crews view height.
  > Data Acquisition – Includes Travel
  > Assembly

**Subtask 1.2 – Photo Collection (0 hours)** *(to be collected during the Calico site visit)*

- *Data Collection (0 hours)*
  > Photography – collect supplementary data including:
    a. GPS points of KOP locations

b. Time of day
c. Atmospheric conditions
d. Camera lens
e. Viewing height

## TASK 2, Key Observation Point (KOPs) Animated Photo-simulations for CALTRANS

POWER will develop animations and 3D analysis for six (6) key observation points along the CALTRANS highway, south of the Calico project. The result is a spreadsheet that identifies the season, time of day, view orientation and duration that glint and glare may occur.

### Subtask 2.1 – KOP (Sun Movement) Animation Development (18 hours)

- *Animate Suncatchers* and single axis Solar Panels
- *Animate Daylight System* – The daylight system will be animated to accurately depict the sun angle from sunrise to sunset for each of the four days.
- *1 animation for each season*

### Subtask 2.2 – Video Editing (8 hours)

- *Video Compilation* – Compiling all of the separately rendered layers with the background image and adjusting accordingly. Solar Clock will be added to the video. Add text (day and time for each light condition). Deliver in the following formats:
  - > Print
  - > DVD animation
  - > Portable video files (PowerPoint, etc.)
  - > Web (i.e. Flash, WMA, QT)

### Deliverables

- **Print** – Print-ready graphics, delivered via electronic media. 1 Photo-simulation will be delivered, with 4 seasons (1 location, four seasons to total 4 total animations).
- **Animations** – High Def (1080p) Portable QuickTime, Windows Media, Flash files for use in presentations and Web site. One Animated Photo-simulations will be developed.

## TASK 3, BNSF ROW ANIMATION DEVELOPMENT

POWER will develop 3D animations for all operations in the BNSF ROW. The result is a series of 3D Models, animations and a spreadsheet that identifies the season, time of day, view orientation and duration that glint and glare may occur.

### Subtask 3.1 – Glint and Glare Analysis from the Engineers cab (Sun Movement) Animation Development (66 hours)

- *Animate Suncatchers* and single axis Solar Panels
- *Animate Daylight System* – The daylight system will be animated to accurately depict the sun angle from sunrise to sunset for each of the four days.
- *1 animation for each season and each day*

**Subtask 3.2 – Glint and Glare Analysis from the Safety Signals (Phantom Signal Analysis (66 hours)**

- *Animate Suncatchers* and single axis Solar Panels
- *Animate Daylight System* – The daylight system will be animated to accurately depict the sun angle from sunrise to sunset for each of the four days.
- *1 animation for each season and each day*

**Subtask 3.3 – Visibility Analysis (18 hours)**

- *3D Model Review- review 3D Model for visual obstructions. Perform for Train Crews, Safety crews, Crossings, Signals, etc)*

**Subtask 3.4 – Video Editing (40 hours)**

- *Video Compilation* – Compiling all of the separately rendered layers with the background image and adjusting accordingly. Solar Clock will be added to the video. Add text (day and time for each light condition). Deliver in the following formats:
  - > Print
  - > DVD animation
  - > Portable video files (PowerPoint, etc.)
  - > Web (i.e. Flash, WMA, QT)

**Deliverables**

- **Print** – Print-ready graphics, delivered via electronic media. 1 Photo-simulation will be delivered, with 4 seasons (1 location, four seasons to total 4 total animations).
- **Animations** – High Def (1080p) Portable QuickTime, Windows Media, Flash files for use in presentations and Web site. One Animated Photo-simulations will be developed.
- **3D Model** – During the research phase of the project, it may be determined that an interactive 3D Model may be delivered to the client. This may reduce the number of animations required, and give more control to the reviewers.

## Task 4 – Geometric Glint and Glare Analysis (Spreadsheet development)

POWER will develop a geometric glint and glare 3D analysis for all operations along the BNSF ROW and at the six (6) key observation points along the CALTRANS Highway. POWER will document the analysis in a spreadsheet, to be included in the lint and glare tech memo. During the analysis, each day will be reviewed and documented for the glint and glare

**Subtask 4.1 – Geometric Glint and Glare Analysis (60 hours)**

- *Analysis* and Spreadsheet Documentation (60 hours) – Setup of the analysis and location of the KOPs to be analyzed.

**Subtask 4.2 – Mitigation Analysis (20 hours)**

- *Mitigation – If areas of the model show glint and glare as an issue, POWER will work with kRoad and Dr. Hovis to analyze mitigation measures and effectiveness, including relocation of panels, Panel angle adjustment, BNSF Safety Equipment shielding.*

**Deliverables**

- **Spreadsheets**– POWER will deliver develop Excel spreadsheets, documenting the Glint and Glare Geometric Analysis. This will be included in the Glint and Glare tech memo. Deliver as PDF and Excel Files
- **3D Models and Animations** – POWER will deliver mitigation recommendations as 3D models and animations. This will demonstrate effectiveness during the CEC hearings.

### Task 5 – Glint and Glare Tech Memo

POWER will provide kRoad Power with a glint and glare tech memo, summarizing the location, duration, time of day and year in which glint and glare may occur. This will include text, graphs, charts and graphics, mitigation recommendations and results of the Geometric Analysis.

#### Subtask 4.1 – Glint and Glare Tech memo (65)

- *Draft Tech memo* (40 hours) – Deliver and review by client
- *Final Tech memo* (25 hours) – Modification and Delivery to client.

#### Deliverables

- **Report** – POWER will deliver the draft and final Glint and Glare Tech memo as both PDF files and MSWord. The report will include text, graphs, photos, charts, spreadsheets and other figures to supplement the report.

## ASSUMPTIONS

- All 3D data will be available from kRoad Power and will not require additional aerial survey, LiDAR or photogrammetric collection.
- It is imperative that KOP photography be taken on clear sunny days. Therefore, an additional field visit may be required at client's expense.
- POWER will have access to BNSF Equipment for 3D Model creation and development
- All BNSF Data including safety equipment will be made available and delivered to POWER in CAD, GIS or similar Vector based file. Data delivered to POWER will not require digitizing or interpretation.
- Changes to design, layout, mitigation animation sequences or other visualization information after client's approval, will be billed on a time and material basis.
- Air travel and lodging to the Calico site will be reimbursed by kRoad Power.

## COST ESTIMATE

POWER's budget is based on our understanding of this project's needs and incorporates our experience with the Imperial Valley Solar Project. POWER is able to re-use products and methodology that were recently completed for the Imperial Valley Solar Project. Doing so should result in a reduction in costs per task for the Calico Solar Project.

## SCHEDULE

Based upon discussion with you and review of the project scope, **POWER** can complete the glint and glare analysis within 6 weeks of project kick-off.

I want to thank you for this opportunity, and look forward to a successful project. If you have any questions regarding our proposal, please do not hesitate to call me at (509) 758-6029 or (208)914-1667, or email me at jason.pfaff@powereng.com.

Sincerely,

Jason Pfaff
Visual Services Department Manager