

GRANTS/CONTINGENT AWARD REQUEST



To: Grants and Loans Office

Date: 3/29/2012

Project Manager: Joe O'Hagan

Phone Number: 916-327-1368

Office: Energy Generation Research Office

Division: Energy Research and Development

MS: 43

Project Title: Wind Barriers to Mitigate Wind Effects on Air-Cooled Condensers

Type of Request: (check one)

New Agreement: (include items A-F from below) Agreement Number: PIR-11-024

Program: PIER E / Environmental Area

Solicitation Name and/or Number: PON-11-502-06 (Solicitation to Address Environmental Issues Related to Clean Energy Systems)

Legal Name of Recipient: John Maulbetsch

Recipient's Full Mailing Address: 770 MENLO AVE STE 211
MENLO PARK, CA 94025-4764

Recipient's Project Officer: John Maulbetsch Phone Number: (650) 327-7040

Agreement Start Date: 6/25/2012 Agreement End Date: 3/31/2015

Amendment: (Check all that apply) Agreement Number: _____

Term Extension – New End Date: _____

Work Statement Revision (include Item A from below)

Budget Revision (include Item B from below)

Change of Scope (include Items A – F as applicable from below)

Other: _____

ITEMS TO ATTACH WITH REQUEST:

- A. Work Statement
- B. Budget
- C. Recipient Resolution, if applicable. (Resolution may be requested in Special Conditions if not currently available.)
- D. Special Conditions, if applicable.
- E. CEQA Compliance Form
- F. Other Documents as applicable
 - Copy of Score Sheets
 - Copy of Pre-Award Correspondence
 - Copy of All Other Relevant Documents

California Environmental Quality Act (CEQA)

CEC finds, based on recipient's documentation in compliance with CEQA:

Project exempt: _____ NOE filed: _____

Environmental Document prepared: _____ NOD filed: _____

Other: _____

CEC has made CEQA finding described in CEC-280, attached

Funding Information:

*Source #1: NG Amount: \$ 749,577.00 Statute: 10-11 FY: 11-12 Budget List #: 501.001E

*Source #2: _____ Amount: \$ _____ Statute: _____ FY: _____ Budget List #: _____

*Source #3: _____ Amount: \$ _____ Statute: _____ FY: _____ Budget List #: _____

If federally funded, specify federal agreement number: _____

* Source Examples include ERPA, PIER-E, PIER-NG, FED, GRDA, ARFVT, OTHER.

Business Meeting Approval: (refer to Business Meeting Schedule)

Proposed Business Meeting Date: 5/9/2012 Consent Discussion

Business Meeting Participant: Joe O'Hagan Time Needed: 5 minutes

Agenda Notice Statement: (state purpose in layperson terms)

Possible approval of a Grant / Contingent Award to...

Possible approval of agreement PIR-11-XXX for a grant of \$749,577 to Maulbetsch Consulting to conduct research on reducing wind effects on power plant air-cooled condenser performance. The length of this agreement is 33 months. (PIER natural gas funding) Contact: Joe O'Hagan. (5 minutes)

Project Manager _____ Date _____ Office Manager _____ Date _____ Deputy Director _____ Date _____

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TASK LIST

Task #	CPR	Task Name
1	N/A	Administration
2		Wind Barrier Technology Assessment
3		Computational Fluid Dynamics (CFD) Modeling
4	x	Physical Modeling
5	x	Field Testing
6		Data Analysis
7		Guidelines Development

KEY NAME LIST

Task #	Key Personnel	Key Subcontractor(s)	Key Partner(s)
1	J. Maulbetsch	DiFilippo Consulting	
2	J. Maulbetsch	DiFilippo Consulting	
3	J. Maulbetsch	Senta Engineering	
4	J. Maulbetsch	University of California, Davis	
5	J. Maulbetsch	DiFilippo Consulting, Howden Group, Ltd.	
6	J. Maulbetsch	DiFilippo Consulting	
7	J. Maulbetsch	DiFilippo Consulting	

GLOSSARY

Specific terms and acronyms used throughout this scope of work are defined as follows:

Term/ Acronym	Definition
ACCs	air-cooled condensers
CFD	computational fluid dynamics
CPR	Critical Project Review
Energy Commission	California Energy Commission
MW	Megawatt
PIER	Public Interest Energy Research

Problem Statement:

A major barrier to the deployment and permitting of new renewable and fossil fuel thermal generation is the significant freshwater demand from such facilities that use conventional wet cooling (cooling towers) technology for steam condensation, commonly referred to as power plant cooling. A 500-megawatt (MW) gas-fired

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combined cycle power plant can use up to three million gallons of water per day. The majority of this water use is for power plant cooling.

Air-cooled condensers (ACCs), commonly referred to as dry cooling, reject heat from steam condensation directly to the air, therefore requiring no water for the cooling process. This can potentially reduce overall power plant water demand by up to 95 percent. While dry cooling achieves significant reductions in plant water consumption, it does so at increased cost and reduced plant efficiency and output when compared to more commonly used closed-cycle wet cooling systems.

Wind, either on its own or in conjunction with high ambient temperatures, can significantly reduce ACC performance and can lead to reductions in generation or actual plant shutdown. For example, it has been shown that wind effects on an ACC at a 500 MW gas-fired, combined-cycle power plant with a 150-MW steam turbine can increase the steam turbine exhaust pressure by up to 2 inches of mercury at wind speeds over 20 mph and temperatures above 100°F. This can reduce steam turbine output by 10%, or a loss of approximately 15 MW. Even if these conditions occur only five percent of the year, an annual lost of over 6,000 megawatt hour (MWh) is incurred.

Wind affects ACC performance by causing the hot air exiting the condenser to be recirculated back into the condenser's intake, or by degrading condenser fan performance. ACCs rely on numerous fans to move air quickly through and out of the condenser, and cross winds may create low pressure zones beneath the fans, thereby reducing airflow through the condenser. Either mechanism raises the temperature of the air flowing through the condenser and reducing heat transfer.

An approach taken at some power plants to reduce the effect of wind on ACC performance has been to site wind screens or barriers beneath the condensers. These efforts have largely been ad hoc attempts with widely differing designs and arrangements, mainly implemented in retrofit situations on ACCs experiencing serious performance problems or fan damage during high wind conditions. In fact, research has shown that the use of wind screens at many power plants has little or no effect on wind patterns. It is estimated, however, that careful design and siting of wind barriers can reduce these losses by 50 percent.

The principal barrier to achieving this reduction in wind effects is inadequate understanding of the fluid mechanics governing the flow of air around and into the ACC. Gaining this understanding is hindered by the absence of well-developed computational methods with sufficient resolution to identify crucial flow details and the lack of reliable data at either model or full scale. Without this information, it is not possible to specify which wind barriers will reliably mitigate the deleterious effects of wind on ACC performance and protect ACC fans from wind-induced damage.

As more power plants in California and elsewhere are increasingly choosing air-cooled equipment to conserve water, a more rigorous and reliable approach to mitigating wind effects is necessary.

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Goals of the Agreement:

The goal of this Agreement is to advance understanding of how wind barriers affect air flow around and through ACCs and how such performance can be improved. Based upon this information, guidelines will be developed for ACC specification and design.

These goals will be met through the integrated use of mathematical modeling, wind tunnel experimentation, and field testing. Results from these activities will be analyzed and combined to develop correlations of wind barrier effectiveness with barrier characteristics and wind conditions.

Objectives of the Agreement:

The objectives of this Agreement are to develop guidance on the specification, design, and installation of effective wind barriers for ACCs at power plants. Success within the project will be defined as obtaining consistent results from mathematical modeling, physical modeling, and field testing, and translating those results into a set of clear, applicable guidelines.

Ultimate evidence of success will depend on the eventual acceptance and use of the guidelines in the commercial sector, resulting in ACCs that are less susceptible to deleterious performance effects and wind damage.

TASK 1 ADMINISTRATION

Task 1.1 Attend Kick-off Meeting

The goal of this task is to establish the lines of communication and procedures for implementing this Agreement.

The Recipient shall:

- Attend a “Kick-Off” meeting with the Commission Project Manager, the Grants Officer, and a representative of the Accounting Office. The Recipient shall bring its Project Manager, Agreement Administrator, Accounting Officer, and others designated by the Commission Project Manager to this meeting. The administrative and technical aspects of this Agreement will be discussed at the meeting. Prior to the kick-off meeting, the Commission Project Manager will provide an agenda to all potential meeting participants.

The administrative portion of the meeting shall include, but not be limited to, the following:

- Discussion of the terms and conditions of the Agreement
- Discussion of Critical Project Review (Task 1.2)
- Match fund documentation (Task 1.6). No work may be done until this documentation is in place.
- Permit documentation (Task 1.7)

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- Discussion of subcontracts needed to carry out project (Task 1.8)

The technical portion of the meeting shall include, but not be limited to, the following:

- The Commission Project Manager's expectations for accomplishing tasks described in the Scope of Work
- An updated Schedule of Products
- Discussion of Progress Reports (Task 1.4)
- Discussion of Technical Products (Product Guidelines located in Section 5 of the Terms and Conditions)
- Discussion of the Final Report (Task 1.5)

The Commission Project Manager shall designate the date and location of this meeting.

Recipient Products:

- Updated Schedule of Products
- Updated List of Match Funds
- Updated List of Permits

Commission Project Manager Product:

- Kick-Off Meeting Agenda

Task 1.2 Critical Project Review (CPR) Meetings

The goal of this task is to determine if the project should continue to receive Energy Commission funding to complete this Agreement and to identify any needed modifications to the tasks, products, schedule or budget.

CPRs provide the opportunity for frank discussions between the Energy Commission and the Recipient. The Commission Project Manager may schedule CPRs as necessary, and CPR costs will be borne by the Recipient.

Participants include the Commission Project Manager and the Recipient and may include the Commission Grants Officer, the Division team lead, other Energy Commission staff and Management as well as other individuals selected by the Commission Project Manager to provide support to the Energy Commission.

The Commission Project Manager shall:

- Determine the location, date, and time of each CPR meeting with the Recipient. These meetings generally take place at the Energy Commission, but they may take place at another location.
- Send the Recipient the agenda and a list of expected participants in advance of each CPR. If applicable, the agenda shall include a discussion on both match funding and permits.

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- Conduct and make a record of each CPR meeting. One of the outcomes of this meeting will be a schedule for providing the written determination described below.
- Determine whether to continue the project, and if continuing, whether or not modifications are needed to the tasks, schedule, products, and/or budget for the remainder of the Agreement. Modifications to the Agreement may require a formal amendment (please see section 8 of the Terms and Conditions).
- Provide the Recipient with a written determination in accordance with the schedule. The written response may include a requirement for the Recipient to revise one or more product(s) that were included in the CPR.

The Recipient shall:

- Prepare a CPR Report for each CPR that discusses the progress of the Agreement toward achieving its goals and objectives. This report shall include recommendations and conclusions regarding continued work of the projects. This report shall be submitted along with any other products identified in this scope of work. The Recipient shall submit these documents to the Commission Project Manager and any other designated reviewers at least 15 working days in advance of each CPR meeting.
- Present the required information at each CPR meeting and participate in a discussion about the Agreement.

Commission Project Manager Products:

- Agenda and a list of expected participants
- Schedule for written determination
- Written determination

Recipient Product:

- CPR Report(s)

Task 1.3 Final Meeting

The goal of this task is to close out this Agreement.

The Recipient shall:

- Meet with Energy Commission staff to present the findings, conclusions, and recommendations. The final meeting must be completed during the closeout of this Agreement.

This meeting will be attended by, at a minimum, the Recipient, the Commission Grants Office Officer, and the Commission Project Manager. The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be two separate meetings at the discretion of the Commission Project Manager.

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The technical portion of the meeting shall present an assessment of the degree to which project and task goals and objectives were achieved, findings, conclusions, recommended next steps (if any) for the Agreement, and recommendations for improvements. The Commission Project Manager will determine the appropriate meeting participants.

The administrative portion of the meeting shall be a discussion with the Commission Project Manager and the Grants Officer about the following Agreement closeout items:

- What to do with any equipment purchased with Energy Commission funds (Options)
- Energy Commission's request for specific "generated" data (not already provided in Agreement products)
- Need to document Recipient's disclosure of "subject inventions" developed under the Agreement
- "Surviving" Agreement provisions
- Final invoicing and release of retention
- Prepare a schedule for completing the closeout activities for this Agreement.

Products:

- Written documentation of meeting agreements
- Schedule for completing closeout activities

Task 1.4 Monthly Progress Reports

The goal of this task is to periodically verify that satisfactory and continued progress is made towards achieving the research objectives of this Agreement on time and within budget.

The objectives of this task are to summarize activities performed during the reporting period, to identify activities planned for the next reporting period, to identify issues that may affect performance and expenditures, and to form the basis for determining whether invoices are consistent with work performed.

The Recipient shall:

- Prepare a Monthly Progress Report which summarizes all Agreement activities conducted by the Recipient for the reporting period, including an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. Each progress report is due to the Commission Project Manager within 10 days of the end of the reporting period. The recommended specifications for each progress report are contained in Section 6 of the Terms and Conditions of this Agreement.

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Product:

- Monthly Progress Reports

Task 1.5 Final Report

The goal of the Final Report is to assess the project's success in achieving its goals and objectives, advancing science and technology, and providing energy-related and other benefits to California.

The objectives of the Final Report are to clearly and completely describe the project's purpose, approach, activities performed, results, and advancements in science and technology; to present a public assessment of the success of the project as measured by the degree to which goals and objectives were achieved; to make insightful observations based on results obtained; to draw conclusions; and to make recommendations for further projects and improvements to the project management processes.

The Final Report shall be a public document. If the Recipient has obtained confidential status from the Energy Commission and will be preparing a confidential version of the Final Report as well, the Recipient shall perform the following activities for both the public and confidential versions of the Final Report.

The Recipient shall:

- Prepare an Outline of the Final Report.
- Prepare a Final Report following the approved outline and the latest version of the Final Report guidelines which will be provided by the Commission Project Manager. The Commission Project Manager shall provide written comments on the Draft Final Report within fifteen (15) working days of receipt. The Final Report must be completed at least 60 days before the end of the Agreement Term.
- Submit one bound copy of the Final Report with the final invoice.

Products:

- Draft Outline of the Final Report
- Final Outline of the Final Report
- Draft Final Report
- Final Report

Task 1.6 Identify and Obtain Matching Funds

The goal of this task is to ensure that the match funds planned for this Agreement are obtained for and applied to this Agreement during the term of this Agreement.

The costs to obtain and document match fund commitments are not reimbursable through this Agreement. Although the Energy Commission budget for this task will be zero dollars, the Recipient may utilize match funds for this task. Match funds shall be

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spent concurrently or in advance of Energy Commission funds for each task during the term of this Agreement. Match funds must be identified in writing and the associated commitments obtained before the Recipient can incur any costs for which the Recipient

The Recipient shall:

- Prepare a letter documenting the match funding committed to this Agreement and submit it to the Commission Project Manager at least 2 working days prior to the kick-off meeting. If no match funds were part of the proposal that led to the Energy Commission awarding this Agreement and none have been identified at the time this Agreement starts, then state such in the letter. If match funds were a part of the proposal that led to the Energy Commission awarding this Agreement, then provide in the letter a list of the match funds that identifies the:
 - Amount of each cash match fund, its source, including a contact name, address and telephone number and the task(s) to which the match funds will be applied.
 - Amount of each in-kind contribution, a description, documented market or book value, and its source, including a contact name, address and telephone number and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or real property, the Recipient shall identify its owner and provide a contact name, address and telephone number, and the address where the property is located.
- Provide a copy of the letter of commitment from an authorized representative of each source of cash match funding or in-kind contributions that these funds or contributions have been secured. For match funds provided by a grant a copy of the executed grant shall be submitted in place of a letter of commitment.
- Discuss match funds and the implications to the Agreement if they are reduced or not obtained as committed, at the kick-off meeting. If applicable, match funds will be included as a line item in the progress reports and will be a topic at CPR meetings.
- Provide the appropriate information to the Commission Project Manager if during the course of the Agreement additional match funds are received.
- Notify the Commission Project Manager within 10 days if during the course of the Agreement existing match funds are reduced. Reduction in match funds must be approved through a formal amendment to the Agreement and may trigger an additional CPR.

Products:

- A letter regarding match funds or stating that no match funds are provided
- Copy(ies) of each match fund commitment letter(s) (if applicable)
- Letter(s) for new match funds (if applicable)
- Letter that match funds were reduced (if applicable)

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Task 1.7 Identify and Obtain Required Permits

The goal of this task is to obtain all permits required for work completed under this Agreement in advance of the date they are needed to keep the Agreement schedule on track.

Permit costs and the expenses associated with obtaining permits are not reimbursable under this Agreement. Although the Energy Commission budget for this task will be zero dollars, the Recipient shall budget match funds for any expected expenditures associated with obtaining permits. Permits must be identified in writing and obtained before the Recipient can make any expenditure for which a permit is required.

The Recipient shall:

- Prepare a letter documenting the permits required to conduct this Agreement and submit it to the Commission Project Manager at least 2 working days prior to the kick-off meeting. If there are no permits required at the start of this Agreement, then state such in the letter. If it is known at the beginning of the Agreement that permits will be required during the course of the Agreement, provide in the letter:
 - A list of the permits that identifies the:
 - Type of permit
 - Name, address and telephone number of the permitting jurisdictions or lead agencies
 - The schedule the Recipient will follow in applying for and obtaining these permits.
- Discuss the list of permits and the schedule for obtaining them at the kick-off meeting and develop a timetable for submitting the updated list, schedule and the copies of the permits. The implications to the Agreement if the permits are not obtained in a timely fashion or are denied will also be discussed. If applicable, permits will be included as a line item in the Progress Reports and will be a topic at CPR meetings.
- If during the course of the Agreement additional permits become necessary, provide the appropriate information on each permit and an updated schedule to the Commission Project Manager.
- As permits are obtained, send a copy of each approved permit to the Commission Project Manager.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the Commission Project Manager within 5 working days. Either of these events may trigger an additional CPR.

Products:

- Letter documenting the permits or stating that no permits are required
- A copy of each approved permit (if applicable)
- Updated list of permits as they change during the term of the Agreement (if applicable)

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- Updated schedule for acquiring permits as changes occur during the term of the Agreement (if applicable)

Task 1.8 Obtain and Execute Subcontracts

The goal of this task is for Recipients to identify any subcontracts required to carry out the tasks under this Agreement and to procure them consistent with the terms and conditions of this Agreement and the Recipient's own procurement policies and procedures. It will also provide the Energy Commission an opportunity to review the subcontracts to ensure that the tasks are consistent with this Agreement, that the budgeted expenditures are reasonable and consistent with applicable cost principles.

The Recipient shall:

- Prepare a letter documenting the subcontracts required to conduct this Agreement, and submit it to the Commission Project Manager at least 2 working days prior to the kick-off meeting. If there are no subcontracts required at the start of this Agreement, then state such in the letter. If it is known at the beginning of the Agreement that subcontracts will be required during the course of the Agreement, provide in the letter:
 - A list of the subcontracts that describes the anticipated maximum budget and general scope of work for each,
 - A description of the procurement process to be used, and
 - The schedule the Recipient will follow in applying for and obtaining these subcontracts
- Submit a draft of the subcontract that will include a budget with the information required in the budget details to the Commission Project Manager for review and approval, and incorporate any changes recommended by the Commission Project Manager.
- Submit a final copy of the executed subcontract.

Products:

- Letter describing the subcontracts needed, or stating that no subcontracts are required
- Draft subcontracts
- Final subcontracts

TECHNICAL TASKS

The Recipient shall prepare all products in accordance with the requirements in Task 1.5. Products not requiring a draft version are indicated by marking "no draft" after the product name.

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TASK 2 WIND BARRIER TECHNOLOGY ASSESSMENT

The goal of this task is to identify, locate, assemble, organize, and interpret all relevant existing research results, industrial designs and products, and operating experience on wind barriers. This will provide guidance on the modeling tasks of this assessment as well as result in a Technology Review Report documenting state-of-the art technology.

The Recipient shall:

- Conduct a comprehensive search of peer review and grey literature on wind effects and wind barrier approaches to performance improvement and equipment protection on air-cooled power plant cooling equipment.
- Extract modeling and experimental data and correlations.
- Identify all known installations and obtain full descriptions and performance data (before and after barrier installation, if available).
- Interview facility staff on performance and fan maintenance observations.
- Organize and interpret relationships between barrier type/arrangement and performance.
- Select important effects and knowledge gaps to guide computational fluid dynamics (CFD) and physical testing and field testing tasks.
- Prepare a *Wind Barrier Technology Review Report* that includes:
 - A listing of all information sources
 - Photographs and drawings of existing installations when available
 - A summary of significant and relevant data, literature and information
 - A list of recommended elements of the CFD and physical modeling and field testing tasks.

Products:

- Wind Barrier Technology Review Report

TASK 3 COMPUTATIONAL FLUID DYNAMICS (CFD) MODELING

The goal of this task is to conduct CFD modeling of large-scale air-cooled equipment with a variety of types/arrangements of wind barriers. Modeling results will be validated against limited data from existing installations and field data from Task 5, and compared with the results of physical modeling from Task 4.

The Recipient shall:

- Formulate a set of modeling criteria that will result in a model capable of simulating a range of equipment/barrier configurations and produce output in a form suitable for comparison to the results from existing installations and Tasks 4 and 5.
- Prepare a *CFD Modeling Plan* that includes a description of the proposed capabilities of the model and a preliminary list of cases to be modeled for

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review with the project team and the Energy Commission Project Manager.

- Create a computer model capable of performing the required simulations.
- Run the model to simulate the range of equipment arrangements, wind conditions, barrier types, barrier arrangements, and barrier configurations identified in the initial list of cases developed above.
- Conduct comparisons of model results with the results of Tasks 4 and 5 and data from existing installations.
- Adjust/modify the model as required to obtain satisfactory agreement with field data and physical modeling results.
- Prepare periodic *written notifications of changes to the list of cases to be modeled*.
- Prepare a *CFD Modeling Task Report* that:
 - Describes the approach and methodology used in the model
 - Demonstrates convergence and stability of the model operation
 - Lists all cases run
 - Presents in tabular and graphical form the results of the simulations in a form suitable for comparison to existing data and results of other tasks
 - Provides a manual that enables use of the model by others

Products:

- CFD Modeling Plan
- Written notification of changes to list of cases to be modeled (no draft)
- CFD Modeling Task Report

TASK 4 PHYSICAL MODELING

The goal of this task is to obtain results from a physical wind tunnel model of:

- Selected wind barrier arrangements applied to an operating ACC at the El Dorado Energy Center; and
- A fan or fans representative of the type used in full-scale equipment operating under varying wind conditions with differing degrees of screening.

The model results will be validated against limited data from the El Dorado site, other existing installations and field data from Task 5. They will also be compared with the results of CFD modeling from Task 3.

The Recipient shall:

- Formulate a set of physical wind tunnel modeling criteria that will result in a model capable of simulating a range of equipment/barrier configurations and produce output in a form suitable for comparison to the results from existing installations and Tasks 3 and 5.
- Prepare a *Physical Wind Tunnel Modeling Plan* for both the El Dorado installation and the individual fan element, a description of the proposed

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capabilities of the model, and a preliminary list of cases to be modeled for review with the project team and the Energy Commission Project Manager.

- Create suitable physical models to the appropriate scale for installation in the wind tunnel.
- Install and instrument the models in the wind tunnel.
- Run the model to simulate the range of cases for the El Dorado installation and the individual fan elements developed in the Physical Wind Tunnel Modeling Plan above.
- Participate in comparisons of model results with the results of Tasks 3 and 5 and with data from existing installations. Adjust/modify the model as required to obtain satisfactory agreement.
- Prepare periodic *written notifications of changes to the list of cases to be modeled*.
- Prepare a *Physical Modeling Task Report* that:
 - Describes the approach and methodology used in the model
 - Explains and justifies the modeling criteria used
 - Lists all cases run
 - Presents in tabular and graphical form the results of the simulations in a form suitable for comparison to existing data and results of other tasks
- Participate in a Critical Project Review and prepare a *CPR Report* per Task 1.2.

Products:

- Physical Wind Tunneling Modeling Plan
- Written notifications of changes to the list of cases to be modeled
- Physical Wind Tunnel Modeling Task Report
- CPR Report

TASK 5 FIELD TESTING

The goal of this task is to obtain field test data on full-scale operating equipment suitable for validation of the CFD and physical modeling effort. The data should include the recording of air flow patterns surrounding and entering fans on large, air-cooled exchangers and a measurement of forces and stresses on fans, fan blades, hubs, and mounting under a variety of wind conditions. In addition, the variation of air flow into the individual cell will be monitored as a function of wind speed and direction. The tests will be conducted at one or more operating power plants using ACCs.

The Recipient shall:

- Develop a set of requirements for field testing suitable for guidance of, comparison to, and validation of the results of the CFD and physical modeling work in Tasks 3 and 4.

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- Prepare a *Field Test Plan* to be conducted at a power plant that will satisfy the requirements developed above.
- Install and validate instrumentation and data acquisition equipment at the site.
- Conduct field tests over a sufficiently long period to obtain the required range of plant operation and wind conditions.
- Provide *written notification of modifications to the Field Test Plan*.
- Identify a second site with sufficiently different configuration to provide a complementary set of data to further assist in the validation of the model results.
- Obtain a site use agreement for testing at the second site (if available).
- Provide *written notification of the site use agreement for additional testing at a second site*. This will include the identification of the site, a description of the site and its attributes for additional testing, and a copy of the site use agreement.
- Install and validate instrumentation and data acquisition equipment at the site.
- Conduct field tests over a sufficiently long period to obtain the required range of plant operation and wind conditions.
- Participate in the comparisons of field test results with the results of Tasks 3 and 4 and data from other existing installations.
- Prepare a *Field Test Task Report*.

Products:

- Field Test Plan
- Written notification of Modifications to Field Test Plan (no draft)
- Written notification of agreement for testing at a second site (no draft)
- Field Testing Task Report

TASK 6 DATA ANALYSIS

The goal of this task are to: (1) analyze and compare the results from the mathematical modeling, wind tunnel experiments and field tests; (2) develop correlations of barrier effectiveness with ACC/barrier characteristics and wind conditions; and (3) create a set of useful guidelines for the selection and specification of wind barriers for use on large, air-cooled equipment at power plants. The recommendations will be supported by CFD and physical modeling results, field data, and information from existing installations.

The Recipient shall:

- Integrate and describe the results from the CFD, physical, and field test tasks.
- Compare the study results with all relevant experience and data at existing installations.

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- Assemble the results and comparisons in a tabular and graphical form that can be used to estimate the effect of various approaches in different situations.
- Postulate expected effects of types and arrangements of wind barriers on ACC/fan performance.
- Prepare a *Research-Level Report* on the project methods and results suitable for use by future researchers in the field.

Products:

- Research-Level Report

TASK 7 GUIDELINES DEVELOPMENT

The goal of this task is to organize the results of the study into a recommended set of wind barrier selection guidelines. The recommendations will be supported by CFD and physical modeling results, field data, and information from existing installations.

The Recipient shall:

- Develop generic guidelines for the selection and specification of promising wind barriers for application to individual situations.
- Prepare a *Guidelines Document* suitable for use by vendors and users of air-cooled equipment.

Products:

- Guidelines Document