Appendix 3A
Generator Interconnection Study Documents and Proof of Payment
Appendix 1 Interconnection Request
INTERCONNECTION REQUEST

Provide three copies of this completed form pursuant to Section 7 of this GIP Appendix 1 below.

1. The undersigned Interconnection Customer submits this request to interconnect its Generating Facility with the CAISO Controlled Grid pursuant to the CAISO Tariff (check one):
   - [ ] Fast Track Process.
   - [ ] Independent Study Process.
   - [x] Queue Cluster Process.
   - [ ] One-Time Deliverability Assessment pursuant to GIP Section 8.1.
   - [ ] Annual Deliverability Assessment pursuant to GIP Section 8.

2. This Interconnection Request is for (check one):
   - [ ] A proposed new Generating Facility.
   - [x] An increase in the generating capacity or a Material Modification to an existing Generating Facility.

3. Requested Deliverability Status is for (check one):
   - [x] Full Capacity (For Independent Study Process and Queue Cluster Process only)
     (Note – Deliverability analysis for Independent Study Process is conducted with the next annual Cluster Study – See GIP Section 4.6)
   - [ ] Energy Only

4. The Interconnection Customer provides the following information:
   a. Address or location, including the county, of the proposed new Generating Facility site or, in the case of an existing Generating Facility, the name and specific location, including the county, of the existing Generating Facility;
      
      Project Name: Huntington Beach
      
      Project Location:
      
      Street Address: 21730 Newland Street
      City, State: Huntington Beach, California
      County: Orange
      Zip Code: 92646
      GPS Coordinates (decimal format):
      Latitude: 33.64540833 Longitude: -117.9778917
   
   b. Maximum net megawatt electrical output (as defined by section 2.c of Attachment A to this appendix) of the proposed new Generating Facility or the amount of net megawatt increase in the generating capacity of an existing Generating Facility;
      
      Maximum net megawatt electrical output (MW): 938.612 MW at 85 °F  OR
      Net Megawatt increase (MW):
c. Type of project (i.e., gas turbine, hydro, wind, etc.) and general description of the equipment configuration (if more than one type is chosen include net MW for each):

- Cogeneration (MW)
- Reciprocating Engine (MW)
- Biomass (MW)
- Steam Turbine (MW)
- Gas Turbine (MW)
- Wind (MW)
- Hydro (MW)
- Photovoltaic (MW)
- Combined Cycle 938.612 (MW)
- Other (please describe): (MW)

General description of the equipment configuration (e.g. number, size, type, etc):
The project is comprised of two CCGT blocks (Block 1 and Block 2) having a maximum net output of 938.612 MW. Each block is comprised of 3 gas turbines rated at 113.825 MW, 119.815 MVA each and 1 steam turbine rated at 145.148 MW, 152.787 MVA.

d. Proposed In-Service Date (first date transmission is needed to the facility), Trial Operation date and Commercial Operation Date by day, month, and year and term of service (dates must be sequential):

- Proposed In-Service Date: Block 1: 01/01/2017, Block 2: 01/01/2020
- Proposed Trial Operation Date: Block 1: 06/01/2018, Block 2: 06/01/2021
- Proposed Commercial Operation Date: Block 1: 01/01/2019, Block 2: 01/01/2022
- Proposed Term of Service (years): 30 years (All blocks)

e. Name, address, telephone number, and e-mail address of the Interconnection Customer’s contact person (primary person who will be contacted):

- Name: John Kistle
- Title: Project Development Team
- Company Name: AES Southland
- Street Address: 690 N. Studebaker Road
- City, State: Long Beach, California
- Zip Code: 90803
- Phone Number: (562) 493-7894
- Fax Number:
- Email Address: John.Kistle@AES.com
- DUNS Number:

f. Approximate location of the proposed Point of Interconnection (i.e., specify transmission facility interconnection point name, voltage level, and the location of interconnection):

230 kV Huntington Beach Switching Station as shown in attached Site Drawing.

g. Interconnection Customer data (set forth in Attachment A)

The Interconnection Customer shall provide to the CAISO the technical data called for in GIP Appendix 1, Attachment A. Three (3) copies are required.
5. Applicable deposit amount as specified in the GIP made payable to California ISO. Send check to CAISO (see section 7 for details) along with the:
a. Appendix 1 to GIP (Interconnection Request) for processing.
b. Attachment A to Appendix 1 (Interconnection Request Generating Facility Data).

6. Evidence of Site Exclusivity as specified in the GIP and name(s), address(es) and contact information of site owner(s) (check one):
Current Title Report is available upon request.

Site is an existing generating facility, wholly owned by AES.
Plant Manager: Weikko Wirta
21730 Newland Street
Huntington Beach, CA 92646
714-374-1421

☐ Is attached to this Interconnection Request
☐ Deposit in lieu of Site Exclusivity attached, Site Exclusivity will be provided at a later date in accordance with this GIP

7. This Interconnection Request shall be submitted to the CAISO representative indicated below:

New Resource Interconnection
California ISO
P.O. Box 639014
Folsom, CA 95613-9014

Overnight address: California ISO, Attn: Grid Assets, 250 Outcropping Way, Folsom, CA 95630

8. Representative of the Interconnection Customer to contact:

[To be completed by the Interconnection Customer]
Name: Hala Ballouz, PE
Title: President
Company Name: Electric Power Engineers, Inc. (EPE)
Street Address: 9433 Bee Caves Road, Building 3, Suite 210
City, State: Austin, Texas
Zip Code: 78733
Phone Number: (512) 382-6700
Fax Number: (866) 379-3635
Email Address: hballouz@epeconsulting.com

9. This Interconnection Request is submitted by:

Legal name of the Interconnection Customer:

By (signature):

Name (type or print):
Title:
Date:
Attachment A Generating Facility Data
To GIP Appendix 1
Interconnection Request

GENERATING FACILITY DATA

Provide three copies of this completed form pursuant to Section 7 of GIP Appendix 1.

1. **Provide two original prints and one reproducible copy (no larger than 36” x 24”) of the following:**
   
   A. Site drawing to scale, showing generator location and Point of Interconnection with the CAISO Controlled Grid.
   
   B. Single-line diagram showing applicable equipment such as generating units, step-up transformers, auxiliary transformers, switches/disconnects of the proposed interconnection, including the required protection devices and circuit breakers. For wind and photovoltaic generator plants, the one line diagram should include the distribution lines connecting the various groups of generating units, the generator capacitor banks, the step up transformers, the distribution lines, and the substation transformers and capacitor banks at the Point of Interconnection with the CAISO Controlled Grid.

2. **Generating Facility Information**

   A. Total Generating Facility rated output (MW): **Gross: 973.246 MW at 85 °F and 95% PF**
   
   B. Generating Facility auxiliary Load (MW): **34.634 MW at 85 °F**
   
   C. Project net capacity (A-B)(MW): **938.612 MW at 85 °F and 95% PF**
   
   D. Standby Load when Generating Facility is off-line (MW): **0.9**
   
   E. Number of Generating Units: **2 blocks (each composed of 3 gas turbines and 1 steam turbine)**
   
   (Please repeat the following items for each generator)

   F. Individual generator rated output (MW for each unit):
   
   - **Gas:** 113.825 MW at 38.8°C rated coolant inlet temperature.
   - **Steam:** 145.148 MW at 38.8°C rated coolant inlet temperature.

   G. Manufacturer: **BRUSH (for all generators)**
   
   H. Year Manufactured: ________
   
   I. Nominal Terminal Voltage (kV): **13.8 (for all generators)**
   
   J. Rated Power Factor (%): **0.95 (for all generators)**
   
   K. Type (Induction, Synchronous, D.C. with Inverter): **Synchronous (for all generators)**
   
   L. Phase (three phase or single phase): **Three Phase (for all generators)**
   
   M. Connection (Delta, Grounded WYE, Ungrounded WYE, impedance grounded): **Impedance grounded**
   
   N. Generator Voltage Regulation Range (+/- %):
   
   - **Gas:** +/- 10%
   - **Steam:** Selectable from +/- 10% to +/- 25%
   
   O. Generator Power Factor Regulation Range: **Please refer to the attached generators PQ curves.**
   
   P. For combined cycle plants, specify the plant net output capacity (MW) for an outage of the steam turbine or an outage of a single combustion turbine: **710.962 MW at 85 °F and 95% PF for an outage of a single combustion turbine**

3. **Synchronous Generator – General Information:**

   (Please repeat the following for each generator model)

   A. Rated Generator speed (rpm): **3600 (for all generators)**
   
   B. Rated MVA:
Gas: 119.815 MVA each,  
Steam: 152.787 MVA each  

C. Rated Generator Power Factor: 0.95 (for all generators)  
D. Generator Efficiency at Rated Load (%):  
   Gas: 98.62% each  
   Steam: 98.67% each  

E. Moment of Inertia (including prime mover):  
   42,707 kgm² for each Gas Turbine + Generator,  
   6102 kgm² for each Steam Turbine + Generator.  

F. Inertia Time Constant (on machine base) H:  
   1.28 kW sec/kVA for each gas turbine generator,  
   1.09 kW sec/kVA for each steam turbine generator sec or MJ/MVA  

G. SCR (Short-Circuit Ratio - the ratio of the field current required for rated open-circuit voltage to the field current required for rated short-circuit current):  
   Gas: 0.53 each,  
   Steam: 0.49 each  

H. Please attach generator reactive capability curves.  
I. Rated Hydrogen Cooling Pressure in psig (Steam Units only):  
J. Please attach a plot of generator terminal voltage versus field current that shows the air gap line, the open-circuit saturation curve, and the saturation curve at full load and rated power factor.  

4. Excitation System Information  
(Please repeat the following for each generator model)  

A. Indicate the Manufacturer Gas: ABB inc., Steam: Brush and Type Gas: UNITROL 6000, Steam: Brushless of excitation system used for the generator. For exciter type, please choose from 1 to 9 below or describe the specific excitation system.  
   ☐ (1) Rotating DC commutator exciter with continuously acting regulator. The regulator power source is independent of the generator terminal voltage and current.  
   ☐ (2) Rotating DC commutator exciter with continuously acting regulator. The regulator power source is bus fed from the generator terminal voltage.  
   ☐ (3) Rotating DC commutator exciter with non-continuously acting regulator (i.e., regulator adjustments are made in discrete increments).  
   ☐ (4) Rotating AC Alternator Exciter with non-controlled (diode) rectifiers. The regulator power source is independent of the generator terminal voltage and current (not bus-fed).  
   ☐ (5) Rotating AC Alternator Exciter with controlled (thyristor) rectifiers. The regulator power source is fed from the exciter output voltage.  
   ☐ (6) Rotating AC Alternator Exciter with controlled (thyristor) rectifiers.  
   ☐ (7) Static Exciter with controlled (thyristor) rectifiers. The regulator power source is bus-fed from the generator terminal voltage.  
   ☐ (8) Static Exciter with controlled (thyristor) rectifiers. The regulator power source is bus-fed from a combination of generator terminal voltage and current (compound-source controlled rectifiers system).  
   ☒ (9) Other (specify):  
       Steam: as in #1 above.  
       Gas: Static Exciter with controlled (thyristors) rectifiers. The main power source for the Exciter is fed from an AC auxiliary source through a step down transformer  
B. Attach a copy of the block diagram of the excitation system from its instruction manual. The diagram should show the input, output, and all feedback loops of the excitation system.  
C. Excitation system response ratio (ASA):  
   Gas: 180% Ceiling Voltage; Steam: 2.4
D. Full load rated exciter output voltage: **Gas: 145 VDC (Based on Generator Field Data provided); Steam: 174 VDC**
E. Maximum exciter output voltage (ceiling voltage): **Gas: 263 VDC (Based on 180% Ceiling voltage requirement); Steam: 365 VDC**
F. Other comments regarding the excitation system?

---

5. **Power System Stabilizer Information**  
(Please repeat the following for each generator model. All new generators are required to install PSS unless an exemption has been obtained from WECC. Such an exemption can be obtained for units that do not have suitable excitation systems.)

A. Manufacturer: **Gas: ABB; Steam: Brush**
B. Is the PSS digital or analog? **Gas: Digital; Steam: Digital**
C. Note the input signal source for the PSS:
   - Bus frequency
   - Shaft speed
   - Bus Voltage
   - Other (specify source): **Gas: Three phase generator CT’s (Current Measurement); Steam: Active Electrical Power Frequency & Generator Internal Voltage. Both inputs derived from sensing transformer signals.**
D. Please attach a copy of a block diagram of the PSS from the PSS Instruction Manual and the correspondence between dial settings and the time constants or PSS gain.
E. Other comments regarding the PSS?

---

6. **Turbine-Governor Information**  
(Please repeat the following for each generator model)

Please complete Part A for steam, gas or combined-cycle turbines, Part B for hydro turbines, and Part C for both.

A. Steam, gas or combined-cycle turbines:
   (1) List type of unit (Steam, Gas, or Combined-cycle): **2 x Combined-cycle blocks (3 x Gas and 1 x Steam per block)**
   (2) If steam or combined-cycle, does the turbine system have a reheat process (i.e., both high and low pressure turbines)? **Non-Reheat**
   (3) If steam with reheat process, or if combined-cycle, indicate in the space provided, the percent of full load power produced by each turbine:
      - Low pressure turbine or gas turbine: ____%
      - High pressure turbine or steam turbine: ____%

B. Hydro turbines:
   (1) Turbine efficiency at rated load: ____%
   (2) Length of penstock: ____ ft
   (3) Average cross-sectional area of the penstock: ____ ft²
   (4) Typical maximum head (vertical distance from the bottom of the penstock, at the gate, to the water level): ____ ft
   (5) Is the water supply run-of-the-river or reservoir: ____
   (6) Water flow rate at the typical maximum head: ____ ft³/sec
   (7) Average energy rate: ____ kW-hrs/acre-ft
   (8) Estimated yearly energy production: ____ kW-hrs

C. Complete this section for each machine, independent of the turbine type.
1. Turbine manufacturer: **MHI for both Gas and Steam**
2. Maximum turbine power output: ____MW
3. Minimum turbine power output (while on line): ____MW
4. Governor information:
   (a) Droop setting (speed regulation): **Gas: 4%, Steam: >4%**
   (b) Is the governor mechanical-hydraulic or electro-hydraulic (Electro-hydraulic governors have an electronic speed sensor and transducer.)? **Electro-Hydraulic for both Gas and Steam**
   (c) Other comments regarding the turbine governor system?

7. Induction Generator Data:
   A. Rated Generator Power Factor at rated load: ____
   B. Moment of Inertia (including prime mover): ____
   C. Do you wish reclose blocking? [ ] Yes [ ] No
      Note: Sufficient capacitance may be on the line now, or in the future, and the generator may self-excite unexpectedly.

8. Generator Short Circuit Data
   For each generator model, provide the following reactances expressed in p.u. on the generator base:
   - X"1 – positive sequence subtransient reactance: **Gas: 0.121, Steam: 0.14** p.u**
   - X2 – negative sequence reactance: **Gas: 0.15, Steam: 0.182** p.u**
   - X0 – zero sequence reactance: **Gas: 0.082, Steam: 0.091** p.u**

   Generator Grounding (select 1 for each model):
   A. [ ] Solidly grounded
   B. [x] Grounded through an impedance
      (Impedance value in p.u on generator base: **R: 614.66 on 100 MVA base (for all generators)** p.u., **X: 249.95 on 100 MVA base (for all generators)** p.u.)
   C. [ ] Ungrounded

9. Step-Up Transformer Data
   For each step-up transformer, fill out the data form provided in Table 1.

10. Interconnection Facilities Line Data
    There is no need to provide data for new lines that are to be planned by the Participating TO. However, for transmission lines that are to be planned by the generation developer, please provide the following information:
    
    Nominal Voltage: **230kV**
    Line Length: **Block 1 two 3-phase lines, 0.22 Miles each**
    **Block 2 two 3-phase lines, 0.16 Miles each**
    Line termination Points: _____
    Conductor Type: **ACSR** Size: **1033.5 kcmil**
    If bundled, Number per phase: _____, Bundle spacing: _____ in.
    Phase Configuration. Vertical: **X** Horizontal: _____
    Phase Spacing: A-B: **15** ft., B-C: **15** ft., C-A: **30** ft.
    Distance of lowest conductor to Ground at full load and 40°C: **44.8** ft
Ground Wire Type: **AW** Size: **313.7** Distance to Ground: **49 ft**

Attach Tower Configuration Diagram

Summer line ratings in amperes (normal and emergency) **Normal: 1001.5 Amps (x 2; two 3-phase lines per block); Emergency: 1057.5 Amps (x 2; two 3-phase lines per block)**

Positive Sequence Resistance (R): **Block 1: 0.000038; Block 2: 0.000027 p.u.** (for entire line length)

Positive Sequence Reactance: (X): **Block 1: 0.000308; Block 2: 0.000224 p.u.** (for entire line length)

Zero Sequence Resistance (R0): **Block 1: 0.000157; Block 2: 0.000114 p.u.** (for entire line length)

Zero Sequence Reactance: (X0): **Block 1: 0.001064; Block 2: 0.000774 p.u.** (for entire line length)

Line Charging (B/2): **Block 1: 0.0003328; Block 2: 0.00024203 p.u.**

** On 100-MVA and nominal line voltage (kV) Base

10a. For Wind/photovoltaic plants, provide collector System Equivalence Impedance Data

Provide values for each equivalence collector circuit at all voltage levels.

Nominal Voltage: _____

Summer line ratings in amperes (normal and emergency) _____

Positive Sequence Resistance (R1): _____ p.u. ** (for entire line length of each collector circuit)

Positive Sequence Reactance: (X1): _____ p.u. ** (for entire line length of each collector circuit)

Zero Sequence Resistance (R0): _____ p.u. ** (for entire line length of each collector circuit)

Zero Sequence Reactance: (X0): _____ p.u. ** (for entire line length of each collector circuit)

Line Charging (B/2): _____ p.u. ** (for entire line length of each collector circuit)

** On 100-MVA and nominal line voltage (kV) Base

11. Wind Generators

Number of generators to be interconnected pursuant to this Interconnection Request: _____

Average Site Elevation: _____  Single Phase  Three Phase

Inverter manufacturer, model name, number, and version:

_____  

List of adjustable set points for the protective equipment or software:

- **Field Volts:** _____
- **Field Amperes:** _____
- **Motoring Power (MW):** _____
- **Neutral Grounding Resistor (If Applicable):** _____
- **I2t or K (Heating Time Constant):** _____
- **Rotor Resistance:** _____
- **Stator Resistance:** _____
- **Stator Reactance:** _____
- **Rotor Reactance:** _____
- **Magnetizing Reactance:** _____
- **Short Circuit Reactance:** _____
- **Exciting Current:** _____
- **Temperature Rise:** _____
- **Frame Size:** _____
- **Design Letter:** _____
- **Reactive Power Required In Vars (No Load):** _____
- **Reactive Power Required In Vars (Full Load):** _____
Total Rotating Inertia, $H$: _____ Per Unit on 100 MVA Base

Note: A completed General Electric Company Power Systems Load Flow (PSLF) data sheet must be supplied with the Interconnection Request. If other data sheets are more appropriate to the proposed device then they shall be provided and discussed at Scoping Meeting.

12. Load Flow and Dynamic Models:

Provide load flow model for the generating plant and its interconnection facilities in GE PSLF *.epc format, including new buses, generators, transformers, interconnection facilities. An equivalent model is required for the plant with generation collector systems. This data should reflect the technical data provided in this Attachment A.

For each generator, governor, exciter and power system stabilizer, select the appropriate dynamic model from the General Electric PSLF Program Manual and provide the required input data. The manual is available on the GE website at www.gepower.com. Select the following links within the website: 1) Our Businesses, 2) GE Power Systems, 3) Energy Consulting, 4) GE PSLF Software, 5) GE PSLF User’s Manual. Include any user written *.pEPCL files to simulate inverter based plants’ dynamic responses (typically needed for inverter based PV/wind plants). Provide a completed *.dyd file that contains the information specified in this section.

There are links within the GE PSLF User’s Manual to detailed descriptions of specific models, a definition of each parameter, a list of the output channels, explanatory notes, and a control system block diagram. The block diagrams are also available on the CAISO Website.

If you require assistance in developing the models, we suggest you contact General Electric. Accurate models are important to obtain accurate study results. Costs associated with any changes in facility requirements that are due to differences between model data provided by the generation developer and the actual generator test data, may be the responsibility of the generation developer.
### TABLE 1
TRANSFORMER DATA  
(Provide for each level of transformation)  

UNIT **Gas Generators (6 Identical Generators, 3 per Block)**  

<table>
<thead>
<tr>
<th>NUMBER OF TRANSFORMERS</th>
<th>1 per Gas Generator</th>
<th>PHASE</th>
<th>Three</th>
</tr>
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</table>

<table>
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<th>RATING</th>
<th>H Winding</th>
<th>X Winding</th>
<th>Y Winding</th>
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</thead>
<tbody>
<tr>
<td>Rated MVA</td>
<td>73/96/120</td>
<td>73/96/120</td>
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<tr>
<td>Connection (Delta, Wye, Gnd.)</td>
<td>Wye Grounded</td>
<td>Delta</td>
<td></td>
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<tr>
<td>Cooling Type (OA,OA/FA, etc) :</td>
<td>ONAN/ONAF/O NAF</td>
<td>ONAN/ONAF/ON AF</td>
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</tr>
<tr>
<td>Temperature Rise Rating</td>
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<td>65 °C</td>
<td></td>
</tr>
<tr>
<td>Rated Voltage</td>
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<tr>
<td>BIL</td>
<td>900</td>
<td>95</td>
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</tr>
<tr>
<td>Available Taps (% of rating)</td>
<td>+/- 10%</td>
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</tr>
<tr>
<td>Load Tap Changer? (Y or N)</td>
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<td>N</td>
<td></td>
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<tr>
<td>Tap Settings</td>
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<td>MVA Base</td>
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<th>Y</th>
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<tbody>
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<th>CURRENT TRANSFORMER RATIOS</th>
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<tbody>
<tr>
<td>H</td>
</tr>
</tbody>
</table>

Percent exciting current at 100% Voltage  
110% Voltage   
Supply copy of nameplate and manufacturer’s test report when available
# TABLE 1

**TRANSFORMER DATA**  
*(Provide for each level of transformation)*

**UNIT** Steam Generators *(2 Identical Generators, 1 per Block)*

**NUMBER OF TRANSFORMERS** 1 per Steam Generator  
**PHASE** Three

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<th>X Winding</th>
<th>Y Winding</th>
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<td>93/123/153</td>
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<td>Connection (Delta, Wye, Gnd.)</td>
<td>Wye Grounded</td>
<td>Delta</td>
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</tr>
<tr>
<td>Cooling Type (OA,OA/FA, etc) :</td>
<td>ONAN/ONAF/O NAF</td>
<td>ONAN/ONAF/ON AF</td>
<td></td>
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<tr>
<td>Temperature Rise Rating</td>
<td>65 °C</td>
<td>65 °C</td>
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<tr>
<td>Rated Voltage</td>
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</tr>
<tr>
<td>BIL</td>
<td>900</td>
<td>95</td>
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</tr>
<tr>
<td>Available Taps (% of rating)</td>
<td>+/- 10%</td>
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<tr>
<td>Load Tap Changer? (Y or N)</td>
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<td>N</td>
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<tr>
<td>Tap Settings</td>
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**IMPEDANCE**  
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**WINDING RESISTANCE**  
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**CURRENT TRANSFORMER RATIOS**  
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<th>X</th>
<th>Y</th>
<th>N</th>
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<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

Percent exciting current at 100% Voltage 110% Voltage

Supply copy of nameplate and manufacture’s test report when available
HUNTINGTON BEACH POWER PLANT

CAISO APPLICATION
Supplemental Information:

Appendix 1:

6. AES Legal Structure

Attachment A:

1.A. Project Site Drawing

1.B. Project single line diagram

10. Transmission Tower Configuration Diagram
Single Circuit Braced Post Delta
Structures: B2 - 2A & 2B

Double Circuit Braced Post
Structures: B1 - 2

Double Circuit Dead End
Structures: B1 - 1, B1 - 3, B2 - 1

230kV 60° A-Frame Dead End

NOT TO SCALE
HUNTINGTON BEACH POWER PLANT

CAISO APPLICATION

Gas Generator:

3.H. Reactive Capability Curves

3.J. Generator Terminal Voltage curves

4.B. Excitation System block diagram

5.D. PSS Block Diagram
VARIATION OF GENERATOR OUTPUT WITH COOLANT TEMP

YDAX 8-400ERH
13.80KV, 3 Ph, 60Hz
IEEE C50.13
Class B temperatures.
Up to 1000 meters ASL
Total temperatures Stator 123 Deg C
Rotor 125 Deg C
Coolant: Fresh Water

Output at Stated Power Factor: MW
Generator Coolant Inlet Temperature: Deg C
YDA8-400ERH
13.80kV, 3 Ph, 60Hz.

IN ACCORDANCE WITH
IEEE C50.13
Class B temperatures.

Up to 1000 meters ASL
Total temperatures
Stator 123 Deg C
Rotor 125 Deg C

Coolant: Fresh Water
VARIATION OF GENERATOR EFFICIENCY WITH LOAD

YDAX 8-400ERH
13.8 KV, 3 Ph, 60 Hz.

Efficiencies shown are guaranteed subject to the tolerance specified in IEC 60034-1.
YDA5 X-400ER
3Ph, 60Hz, 3600 RPM.
PERMISSIBLE DURATION OF NEGATIVE SEQUENCE CURRENT

\[ \frac{I}{I_t} = 30 \]

**NOTE:** For continuous operation, rated current must not be exceeded in any one phase.
Static Excitation System
Model Conversion to IEEE Type ST1A
1. **UNITROL 6000 AVR PARAMETERS AND IEEE MODEL**

The Unitrol 6000 Model for Static Excitation Systems is directly represented by the ST5B model as defined in IEEE Standard 421.5-2005. The introduction of this model into the IEEE standard is relatively recent and as a consequence, power system simulator software for modeling and analysis of excitation systems performance may not have the ST5B model included. Since the ST5B is a variation of the ST1A model (figure 1) the later can be used as an alternate model to represent the Unitrol 6000 static excitation system.

![Figure 1 IEEE Model Type ST1A for Static Excitation](image)

The following illustrates the conversion from Unitrol 6000 parameters to ST1A format:

- \( V_{R\text{Max}} = V_{A\text{max}} = \text{Upper Ceiling Factor Limit} = 1.35U_{ac}\cos(\alpha_{\text{min}})/(I_{AGL}U_{fn}/I_{n}) \text{ [pu]} \)
- \( V_{R\text{Min}} = V_{A\text{min}} = \text{Lower Ceiling Factor Limit} = 1.35U_{ac}\cos(\alpha_{\text{max}})/(I_{AGL}U_{fn}/I_{n}) \text{ [pu]} \)
- \( V_{I\text{Max}} = V_{R\text{Max}} / V_p \text{ [pu]} \)
- \( V_{I\text{Min}} = V_{R\text{Min}} / V_p \text{ [pu]} \)
- \( T_C = T_a \text{ [s]} \)
- \( T_B = T_a(V_p/V_p) \text{ [s]} \)
- \( T_{B1} = T_a(V_p/V_\infty) \text{ [s]} \)
- \( T_{C1} = T_b \text{ [s]} \)
- \( K_A = V_o \text{ [pu]} \)
- \( T_A = T_s = 0.003s \)
- \( K_F = 0.0 \) (not applicable to Unitrol)
- \( T_F = 0.001 \) (not applicable to Unitrol, but some programs do not accept 0.0)
- \( I_{LR} = 1.6*(I_n/I_{AGL}) \text{ [pu]} \)
- \( K_{LR} \triangleq V_p \text{ (ool) [pu]} \) (proportional gain of the Over-Excitation Limiter)
- \( K_C \) can be set to 0 since the excitation transformer calculation already considers the voltage drop caused by commutation overlap
- \( V_T \) variable representing the generator terminal voltage (excitation is fed from generator terminals).
Abbreviations:

- $\alpha_{\text{min}}$: Minimum thyristor firing angle (typically 10 deg)
- $\alpha_{\text{max}}$: Maximum thyristor firing angle (typically 150 deg)
- $I_{\text{AGL}}$: Field current on air gap line to give rated terminal voltage (@ no-load)
- $I_n$: Nominal (rated) excitation current
- $U_{\text{ac}}$: Excitation transformer rated secondary voltage
- $U_{n}$: Nominal (rated) excitation voltage
- $V_o$: PID AVR low frequency gain
- $V_p$: PID AVR proportional gain
- $V_{\infty}$: PID AVR high frequency gain
- $T_a$: PID AVR time constant
- $T_b$: PID AVR time constant
- $V_{p\ (\text{oel})}$: PID Maximum Field Current Limiter proportional gain
- $T_s$: Converter time delay (power stage)

Gain

\[
\begin{align*}
V_o & \quad V_{\infty} \\
V_p
\end{align*}
\]

\[
\frac{1}{T_a(V_o/V_p)} \quad \frac{1}{T_a} \quad \frac{1}{T_b} \quad \frac{1}{T_b(V_p/V_{\infty})} \quad f = \text{freq} = 1/(2\pi T)
\]

Figure 2 Unitrol 6000 PID-Filter characteristic

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Value range</th>
</tr>
</thead>
<tbody>
<tr>
<td>UpperCeilingFactorLimit</td>
<td>Calculated automatically by software</td>
<td>-100..100</td>
</tr>
<tr>
<td>LowerCeilingFactorLimit</td>
<td>Calculated automatically by software</td>
<td>-100..100</td>
</tr>
<tr>
<td>vo</td>
<td>PID AVR low frequency gain</td>
<td>0.01..10000</td>
</tr>
<tr>
<td>vp</td>
<td>PID AVR proportional gain</td>
<td>0.01..10000</td>
</tr>
<tr>
<td>voo</td>
<td>PID AVR high frequency gain</td>
<td>0.01..10000</td>
</tr>
<tr>
<td>ta</td>
<td>PID AVR time constant</td>
<td>0..100 s</td>
</tr>
<tr>
<td>tb</td>
<td>PID AVR time constant</td>
<td>0..10 s</td>
</tr>
<tr>
<td>vp (oel)</td>
<td>PID Maximum Field Current Limiter</td>
<td>0.01..10000</td>
</tr>
<tr>
<td>Rev. ind.</td>
<td>Page (P)</td>
<td>Chapt. (C)</td>
</tr>
<tr>
<td>----------</td>
<td>----------</td>
<td>-----------</td>
</tr>
</tbody>
</table>

ABB Inc.
3 Power system stabilizer

3.1 Computer representation of IEEE PSS 2B

![Diagram of PSS 2B](image)

Figure 3-1: Computer representation of PSS2B according to IEEE 421.5 2005

Short model description of PSS2B (ref. to Figure 3-1)

The model consists of the following sub models:

- Calculation of driving power
- Filtering of torsional oscillations and noise components
- Calculation of acceleration power
- Phase and gain conditioning for stabilizing signal

The required signals for the generations of stabilizing signals are the active power PT and the rotor angular frequency deviation.

Both signals are submitted to two wash-out stages which are provided for the elimination of steady state signal component.

An approach for the integral of electric power is obtained by applying the output of the second washout filter of power channel to a first order transfer function. The value T7 shall correspond washout time constants TW1, TW2, TW3 that are selected to allow the operation of the PSS in the frequency range of interest (e.g. >0.1 Hz). The constant Ks2 shall be equal to T7/(2H) in order to obtain a proper signal relationship for the calculation of the acceleration power.

Ks3 is provided for the fine scaling between signals coming from power and frequency channels. Normally Ks3 is equal to 1.

The integral of driving power is obtained from the summation of conditioned frequency signal and the calculated integral of electric power variation.

A selective low pass filter so called "ramp tracking filter" is provided for the suppression of high frequency components (e.g. shaft torsional oscillations).

The integral of acceleration power is calculated from the difference between integral of driving power and integral of electric power.

The conditioning network consisting of the gain Ks1 and three lead-lag stages are provided in order to achieve the required phase and gain compensation for the stabilizing signal. Finally the maximum and minimum amplitudes of stabilizing signal can be limited as well by individual and adjustable maximum and minimum adjustable limitation parameters (ref. PSS control logic).
3.2 Parameter list of PSS2B

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Unit</th>
<th>Standard settings</th>
<th>Proposed setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>TW1, TW2</td>
<td>Wash out time constants</td>
<td>s</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>TW3, TW4</td>
<td>Wash out time constants</td>
<td>s</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Ks1</td>
<td>PSS gain factor</td>
<td>p.u.</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>Ks2</td>
<td>Compensation factor for calculation of integral of electric power</td>
<td>p.u.</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Ks3</td>
<td>Signal matching factor</td>
<td>p.u.</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>T1, T3, T10</td>
<td>Lead time constants of conditioning network</td>
<td>s</td>
<td>0.20, 0.36, 0.01</td>
<td></td>
</tr>
<tr>
<td>T2, T4, T11</td>
<td>Lag time constants of conditioning network</td>
<td>s</td>
<td>0.04, 0.12, 0.01</td>
<td></td>
</tr>
<tr>
<td>TR</td>
<td>Active power transducer time constant</td>
<td>s</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>T6</td>
<td>Rotor angular frequency deviation transducer time constant</td>
<td>s</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>T7</td>
<td>Time constant for integral of electric power calculation</td>
<td>s</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>T8</td>
<td>Ramp tracking filter time constant</td>
<td>s</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>T9</td>
<td>Ramp tracking filter time constant</td>
<td>s</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>Ramp tracking filter degree</td>
<td>-</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>Ramp tracking filter degree</td>
<td>-</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

3.3 Correspondence between model parameters and equipment settings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Equipment settings correspondence for PSS2B</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR and T6</td>
<td>No correspondence, constant values</td>
</tr>
<tr>
<td>TW1</td>
<td>Reg_PSS_IEEE_2B.TW1</td>
</tr>
<tr>
<td>TW2</td>
<td>Reg_PSS_IEEE_2B.TW2</td>
</tr>
<tr>
<td>TW3</td>
<td>Reg_PSS_IEEE_2B.TW3</td>
</tr>
<tr>
<td>TW4</td>
<td>Reg_PSS_IEEE_2B.TW4</td>
</tr>
<tr>
<td>Ks1</td>
<td>Reg_PSS_IEEE_2B.Ks1</td>
</tr>
<tr>
<td>Ks2</td>
<td>Reg_PSS_IEEE_2B.Ks2</td>
</tr>
<tr>
<td>Ks3</td>
<td>Reg_PSS_IEEE_2B.Ks3</td>
</tr>
<tr>
<td>T1</td>
<td>Reg_PSS_IEEE_2B.T1</td>
</tr>
<tr>
<td>T2</td>
<td>Reg_PSS_IEEE_2B.T2</td>
</tr>
<tr>
<td>T3</td>
<td>Reg_PSS_IEEE_2B.T3</td>
</tr>
<tr>
<td>T4</td>
<td>Reg_PSS_IEEE_2B.T4</td>
</tr>
<tr>
<td>T7</td>
<td>Reg_PSS_IEEE_2B.T7</td>
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<tr>
<td>T8</td>
<td>Reg_PSS_IEEE_2B.T8</td>
</tr>
<tr>
<td>T9</td>
<td>Reg_PSS_IEEE_2B.T9</td>
</tr>
<tr>
<td>T10</td>
<td>Reg_PSS_IEEE_2B.T10</td>
</tr>
<tr>
<td>T11</td>
<td>Reg_PSS_IEEE_2B.T11</td>
</tr>
<tr>
<td>M</td>
<td>Reg_PSS_IEEE_2B.m</td>
</tr>
<tr>
<td>N</td>
<td>Reg_PSS_IEEE_2B.n</td>
</tr>
</tbody>
</table>
Gas Turbine Governor Model

1. Speed Droop ......................................................... $R = 0.04$
2. Controller Lag Time Constant ..................... $T_1 = 0.1$ second
3. Turbine Power Time Constant ..................... $T_2 = 1.0$ second
4. Turbine Exhaust Temperature Time Constant .......... $T_3 = 5.0$ second
5. Temperature Limiter Gain .......................... $K_t = 3 \left( 1 + \frac{1}{24s} \right)$
6. Maximum Valve Position .......................... $V_{g\max} = 1.0$
7. Minimum Valve Position .......................... $V_{g\min} = 0.05$
8. Turbine Damping Coefficient ..................... $D_{\text{turb}} = 0.10$

Block Diagram

(based on GAST)
HUNTINGTON BEACH POWER PLANT

CAISO APPLICATION

Steam Generator:

3.H. Reactive Capability Curves

3.J. Generator Terminal Voltage curves

4.B. Excitation System block diagram

5.D. PSS Block Diagram
VARIATION OF GENERATOR OUTPUT WITH COOLANT TEMP

BDAX 82-445ERH
13.80KV, 3 Ph, 60Hz.  IEEE C50.13
Up to 1000 meters ASL

IN ACCORDANCE WITH
Class B temperatures.
Total temperatures Stator 123 Deg C
Rotor 125 Deg C

Coolant: Fresh Water

Issue No. 1 : 16-Nov-2011
BDAX 82-445ERH IN ACCORDANCE WITH
13.80KV, 3 Ph, 60Hz IEEE C50.13
Class B temperatures.
Up to 1000 meters ASL Total temperatures Stator 123 Deg C
Coolant: Fresh Water
Rotor 125 Deg C
VARIATION OF GENERATOR EFFICIENCY WITH LOAD

U. P. F
0. 9 P. F
0. 85 P. F
0. 8 P. F

GENERATOR LOAD : MW
0 50 100 150 200 250

GENERATOR EFFICIENCY : %
99 98 97 96 95 94 93 92

BDAX 82-445ERH
13.8 KV, 3 Ph, 60 Hz.

Efficiencies shown are guaranteed subject to the tolerance specified in IEC 60034-1.

Issue No. 1: 16-Nov-2011
OPEN CIRCUIT AND SHORT CIRCUIT CHARACTERISTIC

S.C. LINE CURRENT : AMPS

O.C. TERMINAL VOLTAGE : KV

ROTOR CURRENT : AMPS

BDAX 82-445ERH
3Ph, 60Hz, 3600 RPM.

Issue No. 1: 16-Nov-2011
PERMISSIBLE DURATION OF NEGATIVE SEQUENCE CURRENT

\[
\frac{2}{1} t = 30
\]

NOTE: For continuous operation rated current must not be exceeded in any one phase.
EXCITATION SYSTEM MODEL

Transfer Function Diagram

Generator / Exciter Parameters at 100°C

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_R$</td>
<td>1 per unit exciter field voltage on air gap line (hot)</td>
</tr>
<tr>
<td>$R_E$</td>
<td>Exciter field resistance (hot)</td>
</tr>
<tr>
<td>$V_{PMG}$</td>
<td>AVR input voltage</td>
</tr>
<tr>
<td>$E_{FD}$</td>
<td>1 p.u. Exciter output voltage</td>
</tr>
<tr>
<td>$T_E$</td>
<td>Exciter field time constant</td>
</tr>
<tr>
<td>$K_E$</td>
<td>Exciter constant</td>
</tr>
<tr>
<td>$S_{E1}$</td>
<td>Exciter saturation function at 75% ceiling voltage</td>
</tr>
<tr>
<td>$E_1$</td>
<td>75% ceiling voltage</td>
</tr>
<tr>
<td>$S_{E2}$</td>
<td>Exciter saturation function at 100% ceiling voltage</td>
</tr>
<tr>
<td>$E_2$</td>
<td>100% ceiling voltage</td>
</tr>
<tr>
<td>$K_D$</td>
<td>Demagnetising factor (function of exciter reactance)</td>
</tr>
<tr>
<td>$K_C$</td>
<td>Rectifier loading factor</td>
</tr>
<tr>
<td>$V_{FEMAX}$</td>
<td>Maximum exciter field voltage</td>
</tr>
<tr>
<td>$V_{EMIN}$</td>
<td>Minimum exciter output</td>
</tr>
</tbody>
</table>

Automatic Voltage Regulator Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K_{PR}$</td>
<td>Voltage regulator proportional gain (adjustable in the range 1 to 80)</td>
</tr>
<tr>
<td>$K_{IR}$</td>
<td>Voltage regulator integral gain</td>
</tr>
<tr>
<td>$K_{DR}$</td>
<td>Voltage regulator derivative gain</td>
</tr>
<tr>
<td>$T_{DR}$</td>
<td>lag time constant</td>
</tr>
<tr>
<td>$K_{PA}$</td>
<td>$I_{EC}$ Regulator proportional gain</td>
</tr>
<tr>
<td>$K_{IA}$</td>
<td>$I_{EC}$ Regulator integral gain</td>
</tr>
<tr>
<td>$K_{F1}$</td>
<td>Excitation control stabilizer gain</td>
</tr>
<tr>
<td>$K_{F2}$</td>
<td>Excitation control stabilizer gain</td>
</tr>
<tr>
<td>$K_{F3}$</td>
<td>Field current stabilising feedback gain</td>
</tr>
<tr>
<td>$V_{RMAX}$</td>
<td>Maximum regulator output voltage</td>
</tr>
<tr>
<td>$V_{RMIN}$</td>
<td>Minimum regulator output voltage</td>
</tr>
<tr>
<td>$V_{AMAX}$</td>
<td>Maximum Regulator output V</td>
</tr>
<tr>
<td>$V_{AMIN}$</td>
<td>Minimum Regulator output V</td>
</tr>
<tr>
<td>$T_F$</td>
<td>Field current stabilising feedback time constant</td>
</tr>
<tr>
<td>$K_L$</td>
<td></td>
</tr>
<tr>
<td>$K_{E}V_T$</td>
<td></td>
</tr>
</tbody>
</table>

* Typical Settings
Transfer function diagram for excitation systems based on IEEE Std 421.5-2005 PSS2B model.

Note: Actual values should be determined from a power system study. The instruction manual provides additional information including confirmation of maximum and minimum values.
Turbine Dynamic Model Block Diagram

IEESGO : IEEE standard turbine-governor model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.004</td>
<td>$T_1$, Controller Lag (Seconds)</td>
</tr>
<tr>
<td>0.02</td>
<td>$T_2$, Controller Lead (Seconds)</td>
</tr>
<tr>
<td>0.35</td>
<td>$T_3$, Governor Lag (&gt;0) (Seconds)</td>
</tr>
<tr>
<td>0.06</td>
<td>$T_4$, Delay Due To Steam Inlet Volumes Associated With Steam Chest And Inlet Piping (Seconds)</td>
</tr>
<tr>
<td>0</td>
<td>$T_5$, Reheater Delay Including Hot And Cold Leads (Seconds)</td>
</tr>
<tr>
<td>0</td>
<td>$T_6$, Delay Due To IP-LP Turbine, Cross-Over Pipes, And LP End Hoods (Seconds)</td>
</tr>
<tr>
<td>20</td>
<td>$K_1$, 1/Per Unit Regulation</td>
</tr>
<tr>
<td>0</td>
<td>$K_2$, Fraction</td>
</tr>
<tr>
<td>0</td>
<td>$K_3$, Fraction</td>
</tr>
<tr>
<td>Max output [MW]</td>
<td>$P_{MAX}$, Upper Power Limit</td>
</tr>
<tr>
<td>0</td>
<td>$P_{MIN}$, Lower Power Limit</td>
</tr>
</tbody>
</table>

Only for Reference
### Remittance Advice Voucher

<table>
<thead>
<tr>
<th>Vendor ID</th>
<th>Vendor Name</th>
<th>Check Date</th>
<th>Check No</th>
<th>Invoice No</th>
<th>Invoice Date</th>
<th>PO#</th>
<th>Text</th>
<th>Gross Amount</th>
<th>Withholding</th>
<th>Tax Cash Discount</th>
<th>Net Amount</th>
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<td>California ISO</td>
<td>March 21, 2012</td>
<td>001103</td>
<td>CR031912</td>
<td>03/19/2012</td>
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<td>250,000.00</td>
<td>0.00</td>
<td>0.00</td>
<td>250,000.00</td>
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</table>

**TOTAL:**

|          |                  |                  |          |            |              |     |        | 250,000.00   | 0.00        | 0.00              | 250,000.00 |