BLACK & VEATCH

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Black & Veatch Corporation

Delta Power Company
Chino Combined Cycle Power Project

B&V Project 64888
B&V File 41.0203
April 12, 2001

Southern California Edison Company
2244 Walnut Grove Avenue
Rosemead, CA 91770

Attention: Mr. Ray Turner

Gentlemen:

Enclosed is one copy each of the following information, which I also sent to you electronically via e-mail today:

- Aerial Photograph of site vicinity, showing relative locations of 230 kV Chino Substation, Chino-Walnut transmission line, etc.
- Turbine-generator modeling data for the project (governor, exciter, power system stabilizer)

We believe that this information, in conjunction with the electrical one-line diagram sent to you yesterday, completes the technical information that will be required for you to perform your system impact study. Please give this a quick review and let us know if there are any additional pieces of data that you require, or if you have any questions regarding any of the information provided.

We will work with Delta Power Company to formalize the Transmission Owner Tariff Application for Service in accordance with your requirements.

Delta Power Company
Chino Combined Cycle Power Project

B&V Project 64888
B&V File 41.0203
April 12, 2001

Thank you very much for your assistance in getting us to this point. Please give me a call at (913) 458-2511, or call Mr. Mike Kelly at (913) 458-2566, if you have any questions.

Very truly yours,

BLACK & VEATCH CORPORATION

Stephen L. Heyborne
Project Manager

dlc
Enclosures

cc: Mr. Jay Roland


Central Ave

GENERATOR DATA	SC - TYPICAL of Each LM 6000 Combustion Turbine Units CT-1 and CT-2				
Manufacturer *(If available)*	GE			Model:	LM 6000
TYPE					
Synchronous	X	Induction	Phases:Single	Three	X
Rated Output:	60,499		Kilowatts 71,176		Kilovolt-Ampere
Rated Power Factor	.85 Leading	%	Rated Voltage 13,800	Volts Rated Amperes:	2,981
Energy Source *(Gas, Hydro, Wind, Co-Gen., Geothermal, etc.)*:	GAS				
Plant Load *(Auxiliaries)*	1,300 @ 2.15%		kW	685 @ 85% Pf Aux	kVAr
Net Maximum Power Output @ 0.85Pf	48,700 @ Max - Aux		kW	25,654 @ 85 % Pf	kVAr
Operating Dates and Capacity:	BY Delta Power		kW	BY Delta Power	Date
Ultimate Output *(Max.)*	See Net Maximum Output		kW	See Net Maximum Output	Date
Estimated Peak and Energy Production *(Ultimate Output)*					
January	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
February	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
March	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
April	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
May	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
June	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
July	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
August	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
September	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
October	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
November	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
December	BY DELTA POWER		peak kW	BY DELTA POWER	kWh

Block 1 - SC - TYPICAL of Each LM 6000 Combustion Turbine Units CT-1 and CT-2

ELECTRICAL AND SYNCHRONOUS MACHINE INFORMATION

1. Electrical One-Line Diagram of the generation Project that includes proposed protective relaying, breaker and switching arrangements, ground sources (zero sequence), ground resistance (Project to remote earth), and assumed line parameters for and Project tie lines. **See Reference Drawing SK-2001A**

2. Shunt capacitors associated with the Project for power factor correction. **N/A** kV **N/A** kVA

3. Step-up transformer nominal voltage [**13.2/230** kV/kV/(kV)], impedance [**9.4** % @ **60** MVA], MVA rating(s) [**60/80/100 OA/FA/FA 65°C** MVA], the electrical configuration *(e.g.,delta-wye)* **[DELTA-WYE Gnd** and taps and tap range **219/224/230/236/242 kV** **NOTE – Two Combustion Turbines Connected to One Step-up Transformer**].

4. Station service load *(both and kW and KVAR)* and the type of load *(e.g., 70% motors and 30% heating)*.

SEE GEN DATA PLANT LOAD	kW	**SEE GEN DATA PLANT LOAD**	kVA	**70% MOTORS-30% HEATING or OTHER**	Load

5. The following machine data:

71.176	MVA	Machine base rating on which the data is on *(for each unit)*
13.8	kV	Rated kV
0.85	P.F.	Power factor of machine
1.309	H	Inertia constant of the machine, MW-sec./MVA (Turbine & Generator)
0.034	Ra	Armature resistance, pu
2.35	Xd	Direct axis unsaturated synchronous reactance, pu
2.10	Xq	Quadrature axis unsaturated synchronous reactance, pu
0.20	X'd	Direct axis unsaturated transient reactance
0.397	X'q	Quadrature axis unsaturated transient reactance
0.144	X"d	Direct axis unsaturated subtransient reactance
0.113	Xl	Stator leakage reactance
7.50	T'do	Direct axis transient open circuit time constant, sec
1.50	T'qo	Quadrature axis transient open circuit time constant, sec
0.054	T"do	Direct axis subtransient open circuit time constant, sec
0.107	T"qo	Quadrature axis subtransient open circuit time constant, sec
50.0	P max	Maximum power output of the turbine in MW
0.087	S(1.0)	Machine data at 1.0 per unit of rated voltage
0.268	S(1.2)	Machine data at 1.2 per unit of rated voltage

6. The type of exciter, block diagram, and parameters in IEEE, PTI or WSCC format. **INCLUDED**

7. The type of power system stabilizer, block diagram and parameters in IEEE, PTI, or WSCC format. **INCLUDED as Required by WSCC**

8. The type of governor and turbine, block diagram and parameters in IEEE,PTI or WSCC format. **INCLUDED**

9. The turbine frequency versus time operation limits. **N/A**

GENERATOR DATA	SC - TYPICAL of Each LM 6000 Combustion Turbine Units CT-1, CT-2, CT-3, and CT-4				
Manufacturer *(If available)*	GE			Model: LM 6000	
TYPE					
Synchronous X	Induction	Phases:Single		Three X	Frequency (Hz) 60
Rated Output: 60,499		Kilowatts 71,176			Kilovolt-Ampere
Rated Power Factor 0.85 Leading	%	Rated Voltage 13,800		Volts Rated Amperes: 2,981	Amps
Energy Source *(Gas, Hydro, Wind, Co-Gen., Geothermal, etc.)*: GAS					
Plant Load *(Auxiliaries)*	1,300 @ 2.15%		kW	685 @ 85% Pf Aux	kVAr
Net Maximum Power Output @ 0.85Pf	48,700 @ Max - Aux		kW	25,654 @ 85 % Pf	kVAr
Operating Dates and Capacity:	BY Delta Power		kW	BY Delta Power	Date
Ultimate Output *(Max.)*	See Net Maximum Output		kW	See Net Maximum Output	Date
Estimated Peak and Energy Production *(Ultimate Output)*					
January	BY DELTA POWER		Peak kW	BY DELTA POWER	kWh
February	BY DELTA POWER		Peak kW	BY DELTA POWER	kWh
March	BY DELTA POWER		Peak kW	BY DELTA POWER	kWh
April	BY DELTA POWER		Peak kW	BY DELTA POWER	kWh
May	BY DELTA POWER		Peak kW	BY DELTA POWER	kWh
June	BY DELTA POWER		Peak kW	BY DELTA POWER	kWh
July	BY DELTA POWER		Peak kW	BY DELTA POWER	kWh
August	BY DELTA POWER		Peak kW	BY DELTA POWER	kWh
September	BY DELTA POWER		Peak kW	BY DELTA POWER	kWh
October	BY DELTA POWER		Peak kW	BY DELTA POWER	kWh
November	BY DELTA POWER		Peak kW	BY DELTA POWER	kWh
December	BY DELTA POWER		Peak kW	BY DELTA POWER	kWh

SC - TYPICAL of Each LM 6000 Combustion Turbine Units CT-1, CT-2, CT-3, and CT-4

ELECTRICAL AND SYNCHRONOUS MACHINE INFORMATION

1. **Electrical One-Line Diagram** of the generation Project that includes proposed protective relaying, breaker and switching arrangements, ground sources (zero sequence), ground resistance (Project to remote earth), and assumed line parameters for and Project tie lines. **See Reference Drawing SK-2001A**

2. **Shunt capacitors** associated with the Project for power factor correction. **N/A** kV **N/A** kVA

3. **Step-up transformer** nominal voltage [13.2/230 kV/kV/(kV)], impedance [9.4 % @ 60 MVA], MVA rating(s) [60/80/100 OA/FA/FA 65°C MVA], the electrical configuration *(e.g.,delta-wye)* [DELTA-WYE Gnd and taps and tap range 219/224/230/236/242 kV NOTE – Two Combustion Turbines Connected to One Step-up Transformer].

4. **Station service load** *(both and kW and KVAR)* and the type of load *(e.g., 70% motors and 30% heating).*

SEE GEN DATA PLANT LOAD	kW	SEE GEN DATA PLANT LOAD	kVA	70% MOTORS-30% HEATING or OTHER	Load

5. **The following machine data:**

71.176	MVA	Machine base rating on which the data is on *(for each unit)*
13.8	kV	Rated kV
0.85	P.F.	Power factor of machine
1.309	H	Inertia constant of the machine, MW-sec./MVA (Turbine & Generator)
0.034	Ra	Armature resistance, pu
2.35	Xd	Direct axis unsaturated synchronous reactance, pu
2.10	Xq	Quadrature axis unsaturated synchronous reactance, pu
0.20	X'd	Direct axis unsaturated transient reactance
0.397	X'q	Quadrature axis unsaturated transient reactance
0.144	X"d	Direct axis unsaturated subtransient reactance
0.113	Xl	Stator leakage reactance
7.50	T'do	Direct axis transient open circuit time constant, sec
1.50	T'qo	Quadrature axis transient open circuit time constant, sec
0.054	T"do	Direct axis subtransient open circuit time constant, sec
0.107	T"qo	Quadrature axis subtransient open circuit time constant, sec
50.0	P max	Maximum power output of the turbine in MW
0.087	S(1.0)	Machine data at 1.0 per unit of rated voltage
0.268	S(1.2)	Machine data at 1.2 per unit of rated voltage

6. **The type of exciter**, block diagram, and parameters in IEEE, PTI or WSCC format. **INCLUDED**

7. **The type of power system stabilizer**, block diagram and parameters in IEEE, PTI, or WSCC format. **INCLUDED as Required by WSCC**

8. **The type of governor and turbine**, block diagram and parameters in IEEE,PTI or WSCC format. **INCLUDED**

9. **The turbine frequency versus time** operation limits. **N/A**

GENERATOR DATA	CC - TYPICAL of Each LM 6000 Combustion Turbine Units CT-1 and CT-2				
Manufacturer *(If available)*	GE			Model:	LM 6000
TYPE					
Synchronous	X	Induction	Phases: Single	Three	X
Frequency (Hz)	60				
Rated Output:	60,499	Kilowatts	71,176	Kilovolt-Ampere	
Rated Power Factor	0.85 Leading	%	Rated Voltage	13,800	Volts Rated Amperes: 2,981 Amps
Energy Source *(Gas, Hydro, Wind, Co-Gen., Geothermal, etc.)*:	GAS				
Plant Load *(Auxiliaries)*	4,023 @ 6.65%	kW	2,119 @ 85% Pf Aux	kVAr	
Net Maximum Power Output @ 0.85Pf	45,980 @ Max – Aux	kW	24,221 @ 85 % Pf	kVAr	
Operating Dates and Capacity:	BY Delta Power	kW	BY Delta Power	Date	
Ultimate Output *(Max.)*	See Net Maximum Output	kW	See Net Maximum Output	Date	
Estimated Peak and Energy Production *(Ultimate Output)*					
January	BY DELTA POWER	peak kW	BY DELTA POWER	kWh	
February	BY DELTA POWER	peak kW	BY DELTA POWER	kWh	
March	BY DELTA POWER	peak kW	BY DELTA POWER	kWh	
April	BY DELTA POWER	peak kW	BY DELTA POWER	kWh	
May	BY DELTA POWER	peak kW	BY DELTA POWER	kWh	
June	BY DELTA POWER	peak kW	BY DELTA POWER	kWh	
July	BY DELTA POWER	peak kW	BY DELTA POWER	kWh	
August	BY DELTA POWER	peak kW	BY DELTA POWER	kWh	
September	BY DELTA POWER	peak kW	BY DELTA POWER	kWh	
October	BY DELTA POWER	peak kW	BY DELTA POWER	kWh	
November	BY DELTA POWER	peak kW	BY DELTA POWER	kWh	
December	BY DELTA POWER	peak kW	BY DELTA POWER	kWh	

Block 1 - CC - TYPICAL of Each LM 6000 Combustion Turbine Units CT-1 and CT-2

ELECTRICAL AND SYNCHRONOUS MACHINE INFORMATION

1. **Electrical One-Line Diagram** of the generation Project that includes proposed protective relaying, breaker and switching arrangements, ground sources (zero sequence), ground resistance (Project to remote earth), and assumed line parameters for and Project tie lines. **See Reference Drawing SK-2001A**

2. **Shunt capacitors** associated with the Project for power factor correction. **N/A** kV **N/A** kVA

3. **Step-up transformer** nominal voltage [**13.2/230** kV/kV/(kV)], impedance [**9.4** % @ **60** MVA], MVA rating(s) [**60/80/100 OA/FA/FA 65°C** MVA], the electrical configuration *(e.g.,delta-wye)* **[DELTA-WYE Gnd** and taps and tap range **219/224/230/236/242 kV** **NOTE – Two Combustion Turbines Connected to One Step-up Transformer**].

4. **Station service load** *(both and kW and KVAR)* and the type of load *(e.g., 70% motors and 30% heating).*

SEE GEN DATA PLANT LOAD	kW	**SEE GEN DATA PLANT LOAD**	kVA	**70% MOTORS-30% HEATING or OTHER**	Load

5. **The following machine data:**

71.176	MVA	Machine base rating on which the data is on *(for each unit)*
13.8	kV	Rated kV
0.85	P.F.	Power factor of machine
1.309	H	Inertia constant of the machine, MW-sec./MVA (Turbine & Generator)
0.034	Ra	Armature resistance, pu
2.35	Xd	Direct axis unsaturated synchronous reactance, pu
2.10	Xq	Quadrature axis unsaturated synchronous reactance, pu
0.20	X'd	Direct axis unsaturated transient reactance
0.397	X'q	Quadrature axis unsaturated transient reactance
0.144	X"d	Direct axis unsaturated subtransient reactance
0.113	Xl	Stator leakage reactance
7.50	T'do	Direct axis transient open circuit time constant, sec
1.50	T'qo	Quadrature axis transient open circuit time constant, sec
0.054	T"do	Direct axis subtransient open circuit time constant, sec
0.107	T"qo	Quadrature axis subtransient open circuit time constant, sec
50.0	P max	Maximum power output of the turbine in MW
0.087	S(1.0)	Machine data at 1.0 per unit of rated voltage
0.268	S(1.2)	Machine data at 1.2 per unit of rated voltage

6. **The type of exciter**, block diagram, and parameters in IEEE, PTI or WSCC format. **INCLUDED**

7. **The type of power system stabilizer**, block diagram and parameters in IEEE, PTI, or WSCC format. **INCLUDED as Required by WSCC**

8. **The type of governor and turbine**, block diagram and parameters in IEEE,PTI or WSCC format. **INCLUDED**

9. **The turbine frequency versus time** operation limits. **N/A**

GENERATOR DATA	CC - Steam Turbine Unit ST-1				
Manufacturer *(If available)*	N/A			Model: N/A	
TYPE					
Synchronous X	Induction	Phases:Single		Three X	Frequency (Hz) 60
Rated Output: 23.0		Kilowatts 28.75			Kilovolt-Ampere
Rated Power Factor 0.80 Leading	%	Rated Voltage 13,800		Volts Rated Amperes: 2,981	Amps
Energy Source *(Gas, Hydro, Wind, Co-Gen., Geothermal, etc.)*: GAS					
Plant Load *(Auxiliaries)*	N/A - Aux from CT's		kW	N/A - Aux from CT's	kVAr
Net Maximum Power Output @ 0.80Pf	25,000 @ Max – 0 for Aux		kW	13,170 @ 80 % Pf	kVAr
Operating Dates and Capacity:	BY Delta Power		kW	BY Delta Power	Date
Ultimate Output *(Max.)*	See Net Maximum Output		kW	See Net Maximum Output	Date
Estimated Peak and Energy Production *(Ultimate Output)*					
January	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
February	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
March	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
April	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
May	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
June	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
July	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
August	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
September	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
October	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
November	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
December	BY DELTA POWER		peak kW	BY DELTA POWER	kWh

CC - Steam Turbine Unit ST-1

ELECTRICAL AND SYNCHRONOUS MACHINE INFORMATION

1. Electrical One-Line Diagram of the generation Project that includes proposed protective relaying, breaker and switching arrangements, ground sources (zero sequence), ground resistance (Project to remote earth), and assumed line parameters for and Project tie lines. **See Reference Drawing SK-2001A**

2. Shunt capacitors associated with the Project for power factor correction. **N/A** kV **N/A** kVA

3. Step-up transformer nominal voltage [**13.8/230** kV/kV/(kV)], impedance [**8.0** % @ **15** MVA], MVA rating(s) [**15/20/25 OA/FA/FA 65°C** MVA], the electrical configuration *(e.g.,delta-wye)* [**DELTA-WYE Gnd** and taps and tap range **219/224/230/236/242 kV** **NOTE – Steam Turbine has Captive Step-up Transformer**].

4. Station service load *(both and kW and KVAR)* and the type of load *(e.g., 70% motors and 30% heating).*

SEE GEN DATA PLANT LOAD	KW	SEE GEN DATA PLANT LOAD	kVA	70% MOTORS-30% HEATING or OTHER	Load

5. The following machine data:

28.75	MVA	Machine base rating on which the data is on *(for each unit)*
13.8	kV	Rated kV
0.80	P.F.	Power factor of machine
5.03	H	Inertia constant of the machine, MW-sec./MVA (Turbine & Generator)
0.0014	Ra	Armature resistance, pu
1.25	Xd	Direct axis unsaturated synchronous reactance, pu
1.22	Xq	Quadrature axis unsaturated synchronous reactance, pu
0.232	X'd	Direct axis unsaturated transient reactance
0.715	X'q	Quadrature axis unsaturated transient reactance
0.12	X"d	Direct axis unsaturated subtransient reactance
0.134	Xl	Stator leakage reactance
4.75	T'do	Direct axis transient open circuit time constant, sec
1.50	T'qo	Quadrature axis transient open circuit time constant, sec
0.059	T"do	Direct axis subtransient open circuit time constant, sec
0.21	T"qo	Quadrature axis subtransient open circuit time constant, sec
25.0	P max	Maximum power output of the turbine in MW
0.279	S(1.0)	Machine data at 1.0 per unit of rated voltage
0.886	S(1.2)	Machine data at 1.2 per unit of rated voltage

6. The type of exciter, block diagram, and parameters in IEEE, PTI or WSCC format. **INCLUDED**

7. The type of power system stabilizer, block diagram and parameters in IEEE, PTI, or WSCC format. **INCLUDED as Required by WSCC**

8. The type of governor and turbine, block diagram and parameters in IEEE,PTI or WSCC format. **INCLUDED**

9. The turbine frequency versus time operation limits. **N/A**

GENERATOR DATA	CC - TYPICAL of Each LM 6000 Combustion Turbine Units CT-1 and CT-2				
Manufacturer *(If available)*	GE			Model:	LM 6000
TYPE					
Synchronous	X	Induction	Phases:Single	Three	X
Rated Output:	60,499		Kilowatts 71,176		
Rated Power Factor	0.85 Leading	%	Rated Voltage 13,800	Volts Rated Amperes:	2,981
Energy Source *(Gas, Hydro, Wind, Co-Gen., Geothermal, etc.)*:	GAS				
Plant Load *(Auxiliaries)*	4,023 @ 6.65%		kW	2,119 @ 85% Pf Aux	kVAr
Net Maximum Power Output @ 0.85Pf	45,980 @ Max – Aux		kW	24,221 @ 85 % Pf	kVAr
Operating Dates and Capacity:	BY Delta Power		kW	BY Delta Power	Date
Ultimate Output *(Max.)*	See Net Maximum Output		kW	See Net Maximum Output	Date
Estimated Peak and Energy Production *(Ultimate Output)*					
January	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
February	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
March	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
April	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
May	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
June	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
July	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
August	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
September	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
October	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
November	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
December	BY DELTA POWER		peak kW	BY DELTA POWER	kWh

Block 1 - CC - TYPICAL of Each LM 6000 Combustion Turbine Units CT-1 and CT-2

ELECTRICAL AND SYNCHRONOUS MACHINE INFORMATION

1. Electrical One-Line Diagram of the generation Project that includes proposed protective relaying, breaker and switching arrangements, ground sources (zero sequence), ground resistance (Project to remote earth), and assumed line parameters for and Project tie lines. **See Reference Drawing SK-2001A**

2. Shunt capacitors associated with the Project for power factor correction. **N/A** kV **N/A** kVA

3. Step-up transformer nominal voltage [13.2/230 kV/kV/(kV)], impedance [9.4 % @ 60 MVA], MVA rating(s) [60/80/100 OA/FA/FA 65°C MVA], the electrical configuration *(e.g.,delta-wye)* [DELTA-WYE Gnd and taps and tap range 219/224/230/236/242 kV NOTE – Two Combustion Turbines Connected to One Step-up Transformer].

4. Station service load *(both and kW and KVAR)* and the type of load *(e.g., 70% motors and 30% heating).*

SEE GEN DATA PLANT LOAD kW	SEE GEN DATA PLANT LOAD kVA	70% MOTORS-30% HEATING or OTHER	Load

5. The following machine data:

71.176	MVA	Machine base rating on which the data is on *(for each unit)*
13.8	kV	Rated kV
0.85	P.F.	Power factor of machine
1.309	H	Inertia constant of the machine, MW-sec./MVA (Turbine & Generator)
0.034	Ra	Armature resistance, pu
2.35	Xd	Direct axis unsaturated synchronous reactance, pu
2.10	Xq	Quadrature axis unsaturated synchronous reactance, pu
0.20	X'd	Direct axis unsaturated transient reactance
0.397	X'q	Quadrature axis unsaturated transient reactance
0.144	X"d	Direct axis unsaturated subtransient reactance
0.113	Xl	Stator leakage reactance
7.50	T'do	Direct axis transient open circuit time constant, sec
1.50	T'qo	Quadrature axis transient open circuit time constant, sec
0.054	T"do	Direct axis subtransient open circuit time constant, sec
0.107	T"qo	Quadrature axis subtransient open circuit time constant, sec
50.0	P max	Maximum power output of the turbine in MW
0.087	S(1.0)	Machine data at 1.0 per unit of rated voltage
0.268	S(1.2)	Machine data at 1.2 per unit of rated voltage

6. The type of exciter, block diagram, and parameters in IEEE, PTI or WSCC format. **INCLUDED**

7. The type of power system stabilizer, block diagram and parameters in IEEE, PTI, or WSCC format. **INCLUDED as Required by WSCC**

8. The type of governor and turbine, block diagram and parameters in IEEE,PTI or WSCC format. **INCLUDED**

9. The turbine frequency versus time operation limits. **N/A**

GENERATOR DATA	CC - TYPICAL of Each LM 6000 Combustion Turbine Units CT-3 and CT-4				
Manufacturer *(If available)*	GE			Model:	LM 6000
TYPE					
Synchronous	X	Induction	Phases:Single	Three	X
Rated Output:	60,499		Kilowatts 71,176		Kilovolt-Ampere
Rated Power Factor	0.85 Leading	%	Rated Voltage 13,800	Volts Rated Amperes:	2,981
Energy Source *(Gas, Hydro, Wind, Co-Gen., Geothermal, etc.)*:	GAS				
Plant Load *(Auxiliaries)*	4,023 @ 6.65%		kW	2,119 @ 85% Pf Aux	kVAr
Net Maximum Power Output @ 0.85Pf	45,980 @ Max – Aux		kW	24,221 @ 85 % Pf	kVAr
Operating Dates and Capacity:	BY Delta Power		kW	BY Delta Power	Date
Ultimate Output *(Max.)*	See Net Maximum Output		kW	See Net Maximum Output	Date
Estimated Peak and Energy Production *(Ultimate Output)*					
January	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
February	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
March	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
April	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
May	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
June	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
July	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
August	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
September	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
October	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
November	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
December	BY DELTA POWER		peak kW	BY DELTA POWER	kWh

Block 1 - CC - TYPICAL of Each LM 6000 Combustion Turbine Units CT-3 and CT-4

ELECTRICAL AND SYNCHRONOUS MACHINE INFORMATION

1. Electrical One-Line Diagram of the generation Project that includes proposed protective relaying, breaker and switching arrangements, ground sources (zero sequence), ground resistance (Project to remote earth), and assumed line parameters for and Project tie lines. **See Reference Drawing SK-2001A**

2. Shunt capacitors associated with the Project for power factor correction.

N/A kV **N/A** kVA

3. Step-up transformer nominal voltage [**13.2/230** kV/kV/(kV)], impedance [**9.4** % @ **60** MVA], MVA rating(s) [**60/80/100 OA/FA/FA 65°C** MVA], the electrical configuration *(e.g.,delta-wye)* **[DELTA-WYE Gnd** and taps and tap range **219/224/230/236/242 kV** **NOTE – Two Combustion Turbines Connected to One Step-up Transformer**].

4. Station service load *(both and kW and KVAR)* and the type of load *(e.g., 70% motors and 30% heating).*

SEE GEN DATA PLANT LOAD	kW	**SEE GEN DATA PLANT LOAD**	kVA	**70% MOTORS-30% HEATING or OTHER**	Load

5. The following machine data:

71.176	MVA	Machine base rating on which the data is on *(for each unit)*
13.8	kV	Rated kV
0.85	P.F.	Power factor of machine
1.309	H	Inertia constant of the machine, MW-sec./MVA (Turbine & Generator)
0.034	Ra	Armature resistance, pu
2.35	Xd	Direct axis unsaturated synchronous reactance, pu
2.10	Xq	Quadrature axis unsaturated synchronous reactance, pu
0.20	X'd	Direct axis unsaturated transient reactance
0.397	X'q	Quadrature axis unsaturated transient reactance
0.144	X"d	Direct axis unsaturated subtransient reactance
0.113	Xl	Stator leakage reactance
7.50	T'do	Direct axis transient open circuit time constant, sec
1.50	T'qo	Quadrature axis transient open circuit time constant, sec
0.054	T"do	Direct axis subtransient open circuit time constant, sec
0.107	T"qo	Quadrature axis subtransient open circuit time constant, sec
50.0	P max	Maximum power output of the turbine in MW
0.087	S(1.0)	Machine data at 1.0 per unit of rated voltage
0.268	S(1.2)	Machine data at 1.2 per unit of rated voltage

6. The type of exciter, block diagram, and parameters in IEEE, PTI or WSCC format. **INCLUDED**

7. The type of power system stabilizer, block diagram and parameters in IEEE, PTI, or WSCC format. **INCLUDED as Required by WSCC**

8. The type of governor and turbine, block diagram and parameters in IEEE,PTI or WSCC format. **INCLUDED**

9. The turbine frequency versus time operation limits. **N/A**

GENERATOR DATA	CC - Steam Turbine Unit ST-1				
Manufacturer *(If available)*	N/A			Model: N/A	
TYPE					
Synchronous X	Induction	Phases: Single		Three X	Frequency (Hz) 60
Rated Output: 23.0		Kilowatts 28.75			Kilovolt-Ampere
Rated Power Factor 0.80 Leading	%	Rated Voltage 13,800		Volts Rated Amperes: 2,981	Amps
Energy Source *(Gas, Hydro, Wind, Co-Gen., Geothermal, etc.)*: GAS					
Plant Load *(Auxiliaries)*	N/A - Aux from CT's		kW	N/A - Aux from CT's	kVAr
Net Maximum Power Output @ 0.80Pf	25,000 @ Max – 0 for Aux		kW	13,170 @ 80 % Pf	kVAr
Operating Dates and Capacity:	BY Delta Power		kW	BY Delta Power	Date
Ultimate Output *(Max.)*	See Net Maximum Output		kW	See Net Maximum Output	Date
Estimated Peak and Energy Production *(Ultimate Output)*					
January	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
February	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
March	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
April	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
May	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
June	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
July	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
August	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
September	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
October	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
November	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
December	BY DELTA POWER		peak kW	BY DELTA POWER	kWh

CC - Steam Turbine Unit ST-1

ELECTRICAL AND SYNCHRONOUS MACHINE INFORMATION

1. **Electrical One-Line Diagram** of the generation Project that includes proposed protective relaying, breaker and switching arrangements, ground sources (zero sequence), ground resistance (Project to remote earth), and assumed line parameters for and Project tie lines. **See Reference Drawing SK-2001A**

2. **Shunt capacitors** associated with the Project for power factor correction. **N/A** kV **N/A** kVA

3. **Step-up transformer** nominal voltage [13.8/230 kV/kV/(kV)], impedance [8.0 % @ 15 MVA], MVA rating(s) [15/20/25 OA/FA/FA 65°C MVA], the electrical configuration *(e.g.,delta-wye)* [DELTA-WYE Gnd and taps and tap range 219/224/230/236/242 kV NOTE – Steam Turbine has Captive Step-up Transformer].

4. **Station service load** *(both and kW and KVAR)* and the type of load *(e.g., 70% motors and 30% heating)*.

SEE GEN DATA PLANT LOAD	KW	SEE GEN DATA PLANT LOAD	kVA	70% MOTORS-30% HEATING or OTHER	Load

5. **The following machine data:**

28.75	MVA	Machine base rating on which the data is on *(for each unit)*
13.8	kV	Rated kV
0.80	P.F.	Power factor of machine
5.03	H	Inertia constant of the machine, MW-sec./MVA (Turbine & Generator)
0.0014	Ra	Armature resistance, pu
1.25	Xd	Direct axis unsaturated synchronous reactance, pu
1.22	Xq	Quadrature axis unsaturated synchronous reactance, pu
0.232	X'd	Direct axis unsaturated transient reactance
0.715	X'q	Quadrature axis unsaturated transient reactance
0.12	X"d	Direct axis unsaturated subtransient reactance
0.134	Xl	Stator leakage reactance
4.75	T'do	Direct axis transient open circuit time constant, sec
1.50	T'qo	Quadrature axis transient open circuit time constant, sec
0.059	T"do	Direct axis subtransient open circuit time constant, sec
0.21	T"qo	Quadrature axis subtransient open circuit time constant, sec
25.0	P max	Maximum power output of the turbine in MW
0.279	S(1.0)	Machine data at 1.0 per unit of rated voltage
0.886	S(1.2)	Machine data at 1.2 per unit of rated voltage

6. **The type of exciter**, block diagram, and parameters in IEEE, PTI or WSCC format. **INCLUDED**

7. **The type of power system stabilizer**, block diagram and parameters in IEEE, PTI, or WSCC format. **INCLUDED as Required by WSCC**

8. **The type of governor and turbine**, block diagram and parameters in IEEE,PTI or WSCC format. **INCLUDED**

9. **The turbine frequency versus time** operation limits. **N/A**

GENERATOR DATA	CC - Steam Turbine Unit ST-2				
Manufacturer *(If available)*	N/A			Model: N/A	
TYPE					
Synchronous X	Induction	Phases:Single		Three X	Frequency (Hz) 60
Rated Output: 23.0		Kilowatts 28.75			Kilovolt-Ampere
Rated Power Factor 0.80 Leading	%	Rated Voltage 13,800		Volts Rated Amperes: 2,981	Amps
Energy Source *(Gas, Hydro, Wind, Co-Gen., Geothermal, etc.)*: GAS					
Plant Load *(Auxiliaries)*	N/A - Aux from CT's		kW	N/A - Aux from CT's	kVAr
Net Maximum Power Output @ 0.80Pf	25,000 @ Max – 0 for Aux		kW	13,170 @ 80 % Pf	kVAr
Operating Dates and Capacity:	BY Delta Power		kW	BY Delta Power	Date
Ultimate Output *(Max.)*	See Net Maximum Output		kW	See Net Maximum Output	Date
Estimated Peak and Energy Production *(Ultimate Output)*					
January	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
February	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
March	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
April	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
May	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
June	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
July	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
August	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
September	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
October	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
November	BY DELTA POWER		peak kW	BY DELTA POWER	kWh
December	BY DELTA POWER		peak kW	BY DELTA POWER	kWh

CC - Steam Turbine Unit ST-2

ELECTRICAL AND SYNCHRONOUS MACHINE INFORMATION

1. Electrical One-Line Diagram of the generation Project that includes proposed protective relaying, breaker and switching arrangements, ground sources (zero sequence), ground resistance (Project to remote earth), and assumed line parameters for and Project tie lines. **See Reference Drawing SK-2001A**

2. Shunt capacitors associated with the Project for power factor correction. **N/A** kV **N/A** kVA

3. Step-up transformer nominal voltage [13.8/230 kV/kV/(kV)], impedance [8.0 % @ 15 MVA], MVA rating(s) [15/20/25 OA/FA/FA 65°C MVA], the electrical configuration *(e.g.,delta-wye)* [DELTA-WYE Gnd and taps and tap range 219/224/230/236/242 kV NOTE – Steam Turbine has Captive Step-up Transformer].

4. Station service load *(both and kW and KVAR)* and the type of load *(e.g., 70% motors and 30% heating).*

SEE GEN DATA PLANT LOAD	KW	SEE GEN DATA PLANT LOAD	kVA	70% MOTORS-30% HEATING or OTHER	Load

5. The following machine data:

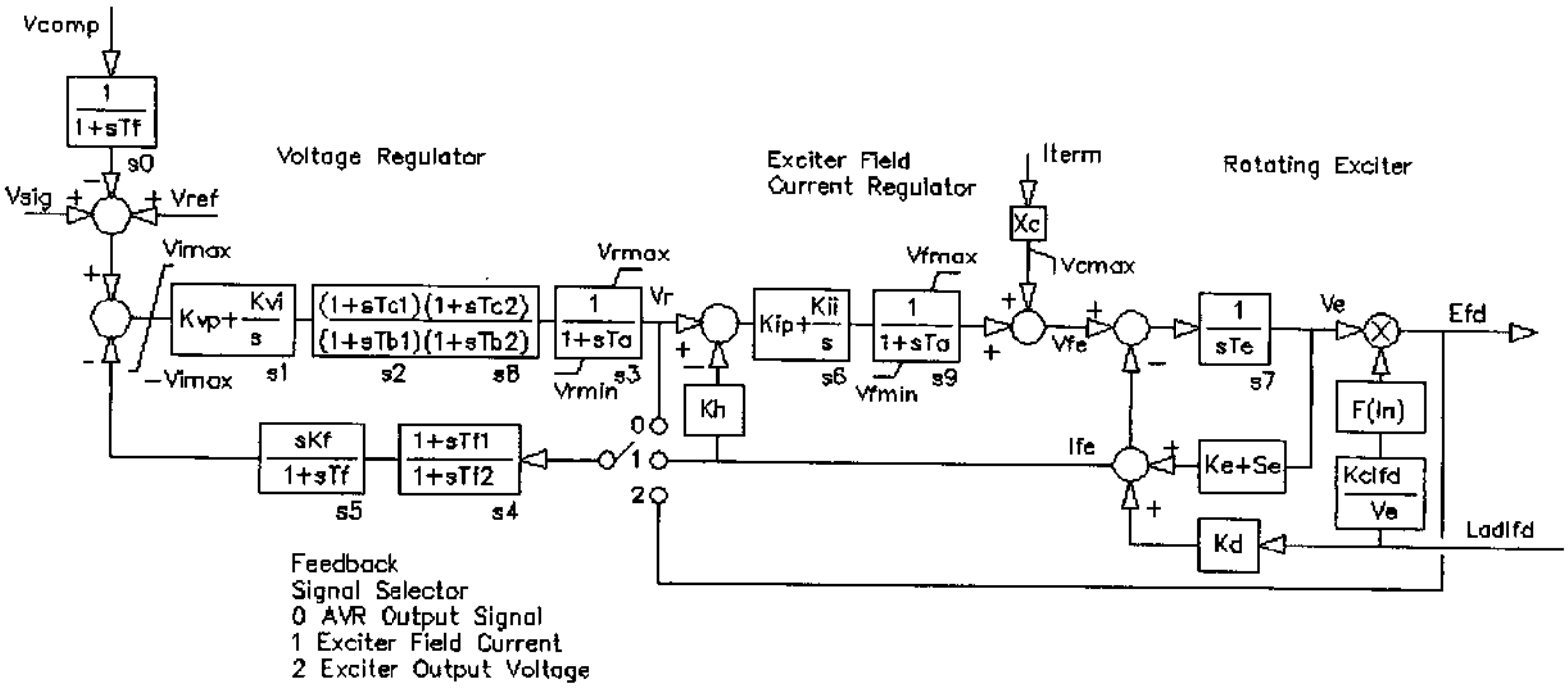
28.75	MVA	Machine base rating on which the data is on *(for each unit)*
13.8	kV	Rated kV
0.80	P.F.	Power factor of machine
5.03	H	Inertia constant of the machine, MW-sec./MVA (Turbine & Generator)
0.0014	Ra	Armature resistance, pu
1.25	Xd	Direct axis unsaturated synchronous reactance, pu
1.22	Xq	Quadrature axis unsaturated synchronous reactance, pu
0.232	X'd	Direct axis unsaturated transient reactance
0.715	X'q	Quadrature axis unsaturated transient reactance
0.12	X"d	Direct axis unsaturated subtransient reactance
0.134	Xl	Stator leakage reactance
4.75	T'do	Direct axis transient open circuit time constant, sec
1.50	T'qo	Quadrature axis transient open circuit time constant, sec
0.059	T"do	Direct axis subtransient open circuit time constant, sec
0.21	T"qo	Quadrature axis subtransient open circuit time constant, sec
25.0	P max	Maximum power output of the turbine in MW
0.279	S(1.0)	Machine data at 1.0 per unit of rated voltage
0.886	S(1.2)	Machine data at 1.2 per unit of rated voltage

6. The type of exciter, block diagram, and parameters in IEEE, PTI or WSCC format. **INCLUDED**

7. The type of power system stabilizer, block diagram and parameters in IEEE, PTI, or WSCC format. **INCLUDED as Required by WSCC**

8. The type of governor and turbine, block diagram and parameters in IEEE,PTI or WSCC format. **INCLUDED**

9. The turbine frequency versus time operation limits. **N/A**


Vcomp
1/(1+sTf)
s0
Vsig
Vref
Voltage Regulator
Exciter Field
Current Regulator
Iterm
Rotating Exciter
Xc
Vcmax
Vimax
-Vimax
Kvp+Kvi/s
s1
(1+sTc1)(1+sTc2)/(1+sTb1)(1+sTb2)
s2
s8
Vrmax
1/(1+sTa)
Vr
Vrmin
s3
Kh
Kip+Kii/s
s6
Vfmax
Vfmin
s9
Vfe
1/sTe
s7
Ve
Efd
F(In)
Kclfd/Ve
Ke+Se
Kd
Ife
sKf/(1+sTf)
s5
(1+sTf1)/(1+sTf2)
s4
0
1
2
LadIfd
Feedback
Signal Selector
0 AVR Output Signal
1 Exciter Field Current
2 Exciter Output Voltage

Model Name: rexs

Description: General Purpose Rotating Excitation System Model

Prerequisites: Generator model ahead of this model in the dynamics models table

Inputs: Compounded generator terminal voltage, generator field current, generator speed

Output Channels:

Record Level	Name	Description
1	if	Generator field current p.u.
1	vr	Voltage regulator output p.u.
1	vfe	Exciter field voltage p.u.
1	ife	Exciter field current p.u.

Invocation:

```
rexs [<nf>] {<namef> <kvf>} <id> :
```

Parameters:

	Name	EPCL Variable	Description	Value
0.0	tr		Voltage transducer time constant, sec	0.025
2894.00	kvp		Voltage Regulator Proportional Gain	1.
0.0	kvi		Voltage Regulator Integral Gain	0.0
0.100000	vimax		Voltage Regulator Input Limit, p.u.	0.1
0.010000	ta		Voltage Regulator time constant, sec	0.03
0.0	tb1		Lag time constant, sec`	0.036
0.0	tc1		Lead time constant, sec	2.
0.0	tb2		Lag time constant, sec`	0.
0.0	tc2		Lead time constant, sec	0.
47.0000	vrmax		Maximum controller output, p.u.	6.
-20.0000	vrmin		Minimum controller output, p.u.	-6.
0.050000	kf		Rate feedback gain,	0.05
1.000000	tf		Rate feedback time constant, sec	1.
0.0	tf1		Feedback lead time constant, sec	0.
0.0	tf2		Feedback lag time constant, sec	0.075
1.000000	fbf		Rate feedback signal flag	<0,1,2>
1.000000	kip		Field Current Regulator Proportional Gain	1.
0.0	kii		Field Current Regulator Integral Gain	2.
0.0	tp		Field current Bridge time constant, sec	0.02
47.0000	vfmax		Maximum Exciter Field Current, p.u.	5.
-20.0000	vfmin		Minimum Exciter Field Current, p.u.	-5.
0.0	kh		Field voltage controller feedback gain	1.
1.000000	ke		Exciter field proportional constant	1.
1.2000	te		Exciter field time constant, sec	0.3
0.050000	kc		Rectifier regulation factor, p.u.	0.1
2.0000	kd		Exciter regulation factor, p.u.	0.8
3.0000	e1		Exciter flux at knee of curve, p.u.	1.5
0.000100	se1		Saturation factor at knee	0.02
4.0000	e2		Maximum exciter, p.u.	3.
0.001000	se2		Saturation factor at max flux	0.05
0.0	rcomp		Regulator compensating resistance, p.u.	0.
0.0	xcomp		Regulator compensating reactance, p.u.	0.05
0.0	nvphz		Pickup speed of v/Hz limiter, p.u.	0.975

0.0	kvphz	V/Hz limiter gain	2.
0.0	flimf	Limit type flag	<0,1>
0.0	xc	Exciter compounding reactance, p.u.	0.5
0.0	vcmax	Maximum compounding voltage, p.u.	0.6

Notes:

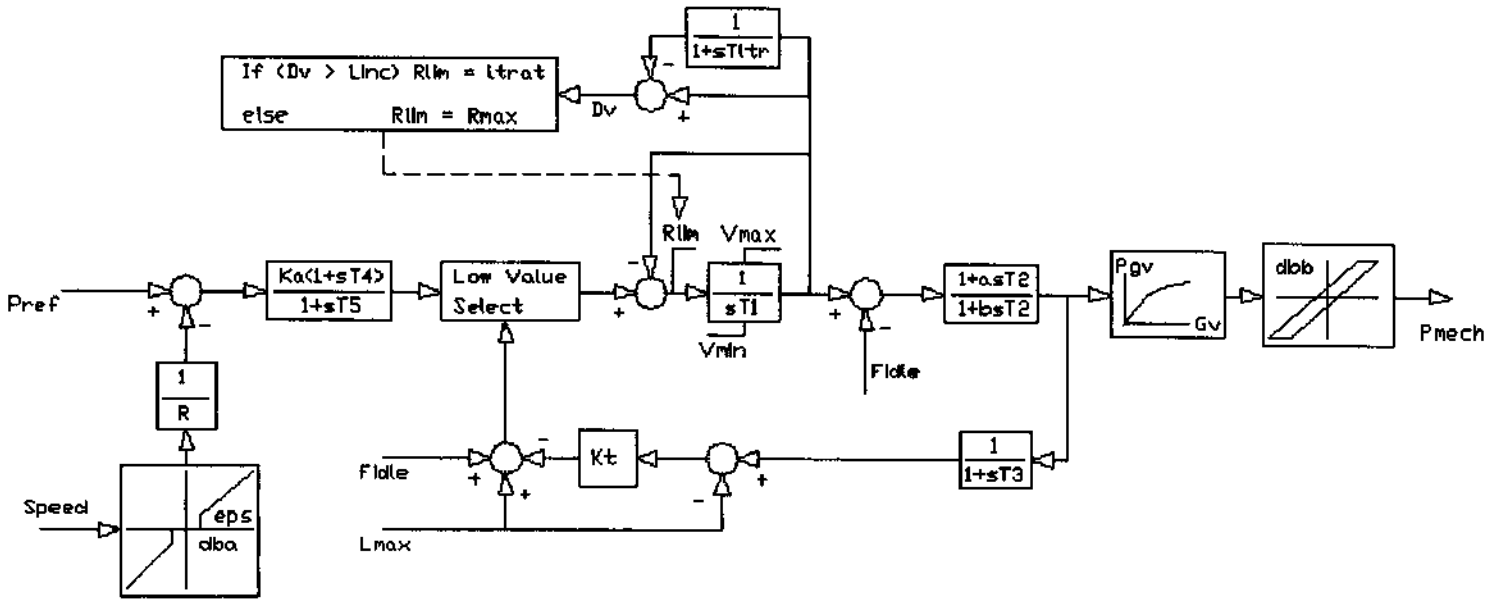
1. This model can be used to represent a wide range of excitation systems whose DC power source is an AC or DC generator. It encompasses IEEE type AC1, AC2, DC1, and DC2 excitation system models and the EXBBB and EXBAS model of the PSLF/PSDS program.
2. The rotating exciter may be of either DC or Brushless AC type. To model a DC exciter, set kc = kd = 0.
3. An AC exciter can be modeled either by setting kc and kd to non- zero values to represent the armature reaction of the exciter and the regulation of the rotating rectifier, respectively, or by specifying the saturation factors, se1, se2 to represent the excitation-output-voltage curve of the exciter as loaded by the field resistance of the main generator. It is preferable to use the first approach (kd != 0) since the later approach does not represent the effect of armature reaction in the exciter on its field current and hence invalidate the model when field current is sensed by the voltage regulator.
4. When this model is used to represent a separately excited exciter the value of ke should normally to close to unity. A shunt excited DC exciter can be modeled by setting ke to the appropriate small negative value needed represent the relationship between the exciter's air gap line and field resistance line. Note though, that this model does not determine the value of ke automatically when a shunt field DC exciter is being represented.
5. The voltage regulator may be of proportional or proportional-plus-integral form. Either kvp or kvi, but not both, may be zero. Ta, Tb1, Tb2, Tf2, Tf and Tr may be zero. Te must be non-zero.
6. The voltage regulator output may be either the field voltage applied directly to the exciter or the input to an exciter field current regulator by choice of values of Kip, Kii, and Kh. Either or both of Kip and Kii must be non-zero. If Kii is non-zero, Kh should normally be non-zero.
7. The voltage regulator reference is modified by a volts-per-hertz limiter when shaft speed falls below nvphz. When the shaft speed is below nvphz the regulator reference is reduced as follows:
   effective vref = vref(1.-kvphz(speed - nvphz))
   The volts-per-hertz limiter can be disabled by setting nvphz = 0 or kvphz = 0.
8. The rate feedback signal used by the voltage regulator can be selected by setting the feedback signal flag, fbf, as follows:

fbf	signal used for rate feedback
0	voltage regulator output voltage (same as exciter field voltage)
1	exciter field current
2	output voltage of the exciter

9. The voltage regulator output limits, vrmax, vrmin must be stated as multiples of the value of exciter field current needed to maintain the exciter output at its base value. The field current limit, vlr, must be stated as a multiple of the exciter field current needed to maintain the exciter output at its base value. That is, vrmax, vrmin must be stated in terms of the per unit exciter output voltage to which they correspond in the steady state.
10. The regulator output limit flag indicates whether the control power supply for the voltage regulator is a transformer at the generator terminals or an independent source such as a permanent magnet generator. Set flimf as follows:
    flimf = 0 the limits on regulator output are vrmax, vrmin, vfmax

and vfmin

flimf = 1 the limits on regulator output are (vrmax*vterm), (vrmin*vterm), (vfmax*vterm), and (vfmin*vterm).


If (Dv > Dinc) Rlim = Dtrat
else Rlim = Rmax
1/(1+sTl-tr)
Dv
Rlim
Vmax
Vmin
Pref
Ka(1+sT4)/(1+sT5)
Low Value Select
1/sTl
1+asT2/1+bsT2
Pgv
Gv
dbb
Pmech
Fidle
1/R
Speed
eps
dba
Kt
1/(1+sT3)
Lmax

Model Name: gast

Description: Single shaft gas turbine

Prerequisites: Generator model ahead of this model in the dynamic models table

Inputs: Shaft speed

Output Channels:

Record Level	Name	Description
1	pm	Turbine power, MW

Invocation: gast [<n>] {<name> <kv>} <id> : [mwcap=<value>]

Parameters:

Name	EPCL Variable		Description
0.040000	R	r	Permanent droop, pu
0.400000	T1	t1	Governor mechanism time constant, sec
0.500000	T2	t2	Turbine power time constant, sec
3.0000	T3	t3	Turbine exhaust temperature time constant, sec
1.000000	Lmax	lmax	Ambient temperature load limit
3.0000	Kt	kt	Temperature limiter gain
1.5000	Vmax	vmax	Maximum turbine power, pu of mwcap
0.0	Vmin	vmin	Minimum turbine power, pu of mwcap
0.0	Dturb	dturb	Turbine damping coefficient, pu [NOT USED]
0.300000	Fidle	fidle	Fuel flow at zero power output, pu
0.010000	Rmax	rmax	Maximum fuel valve opening rate, pu/sec
0.050000	Linc	loadinc	Valve position change allowed at fast rate,pu
5.0000	Tltr	tltr	Valve position averaging time constant, sec
0.000500	Ltrat	ltrate	Maximum long term fuel valve opening rate, pu/sec
0.0	a	a	Turbine power time constant numerator scale factor
1.000000	b	b	Turbine power time constant denominator scale factor
0.0	db1	db1	Intentional deadband width, Hz.
0.0	eps	eps	Intentional db hysteresis, Hz.
0.0	db2	db2	Unintentional deadband, MW
0.0	GV1	gv1	Nonlinear gain point 1, p.u. gv
0.0	Pgv1	pgv1	Nonlinear gain point 1, p.u. power
0.0	GV2	gv2	Nonlinear gain point 2, p.u. gv
0.0	Pgv2	pgv2	Nonlinear gain point 2, p.u. power
0.0	GV3	gv3	Nonlinear gain point 3, p.u. gv
0.0	Pgv3	pgv3	Nonlinear gain point 3, p.u. power
0.0	GV4	gv4	Nonlinear gain point 4, p.u. gv
0.0	Pgv4	pgv4	Nonlinear gain point 4, p.u. power
0.0	GV5	gv5	Nonlinear gain point 5, p.u. gv
0.0	Pgv5	pgv5	Nonlinear gain point 5, p.u. power
0.0	GV6	gv6	Nonlinear gain point 6, p.u. gv
0.0	Pgv6	pgv6	Nonlinear gain point 6, p.u. power
0.0	Ka	ka	Governor gain
0.0	T4	t4	Governor lead time constant, sec
0.0	T5	t5	Governor lag time constant, sec

Notes:

a) Per unit parameters are on base of turbine MW capability. If no value is entered for "mwcap", the generator MVA base is used.

b) All parameters, except Vmin and T5 (see note i), must be greater than zero. Rmax thru Ltrat may be set to 99. to disable rate limiting.

Fidle through Ltrat may be omitted from the parameter list; they will default to Fidle = 0, and 99 for the last four values.

c) T1 represents the natural valve positioning time constant of the governor for small disturbances, as seen when rate limiting is not in effect.

c) T2 represents delay due to internal energy storage of the gas turbine engine. T2 can be used to give a rough approximation to the delay associated with acceleration of the compressor spool of a multi-shaft engine, or with the compressibility of gas in the plenum of a the free power turbine of an aero-derivative unit, for example.

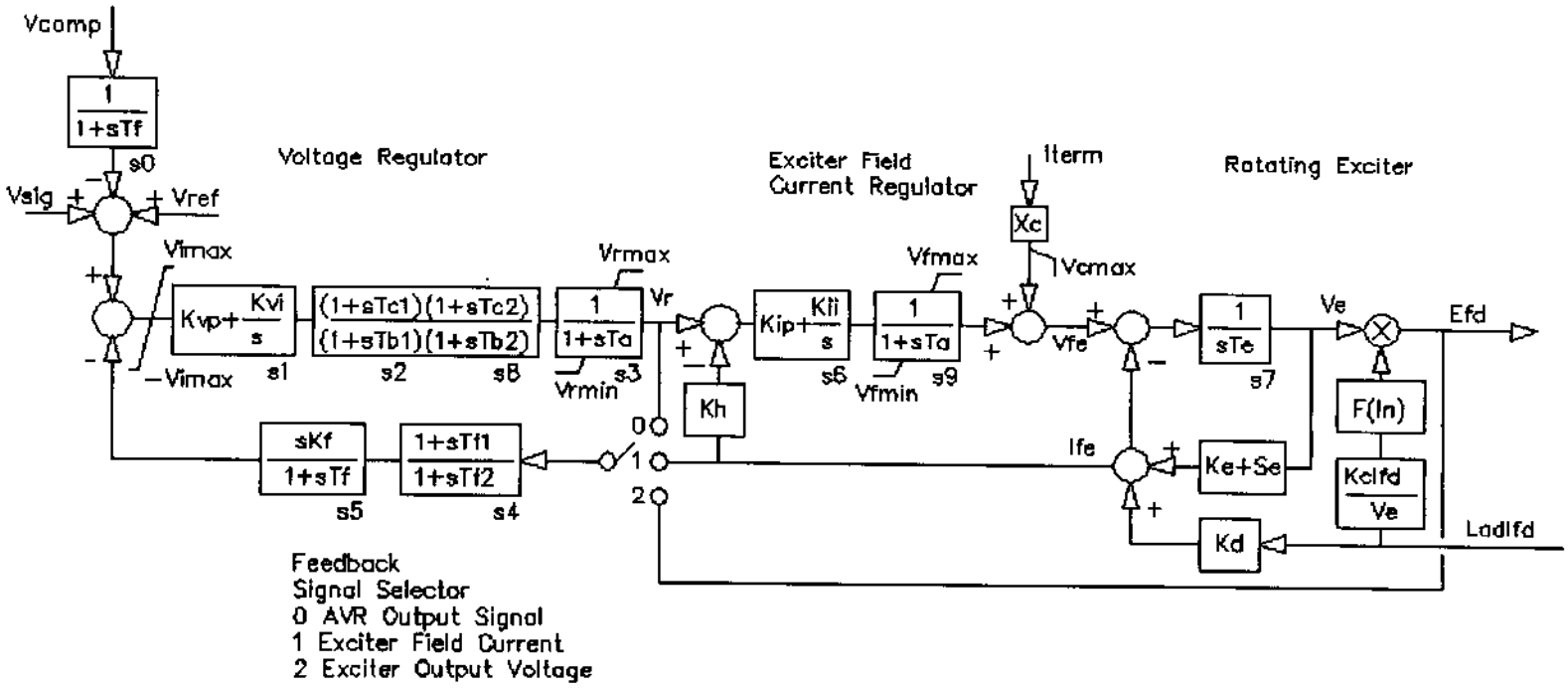
e) T3 represents delay in the exhaust temperature and load limiting system. Lmax is the turbine power output, in per unit, corresponding to the limiting exhaust gas temperature.

f) Rmax, Linc, Tltr, Ltrat represent a loading rate limit subsystem. For small excursions about a steady load the fuel valve can open at a rate of Rmax pu/sec. The time constant, Tltr, is used to obtain a long term average valve position. When a large output increase is called for, the fuel valve is allowed to open at the full rate only until the valve opening has moved ahead of the long term average position by Linc pu. After this the valve is permitted to open only at the rate, Ltrat, until the long term average position catches up.

g) The deadbands are implemented as described in section 3.10.2.

h) The nonlinear gain on the output may be input with up to 6 points. The (0.,0.) and (1.,1.) points are assumed and need not be input. The output is not allowed to go beyond 0. and 1. However, if (Vmax-Fidle) > 1., the input and output are scaled by this value. If input is omitted or if all zero values are input, a straight line is used

i) If T5 is zero, the entire gain and lead-lag block is bypassed.*vterm).


Vcomp
1/(1+sTf)
s0
Vsig
Vref
Voltage Regulator
Exciter Field
Current Regulator
Iterm
Xc
Rotating Exciter
Vimax
-Vimax
Kvp+Kvi/s
s1
(1+sTc1)(1+sTc2)/(1+sTb1)(1+sTb2)
s2
s8
Vrmax
Vrmin
1/(1+sTa)
s3
Vr
Kh
Kip+Kii/s
s6
Vfmax
Vfmin
s9
Vcmax
Vfe
1/sTe
s7
Ve
Efd
F(In)
Kclfd/Ve
LadIfd
Ke+Se
Kd
Ife
0
1
2
sKf/(1+sTf)
s5
(1+sTf1)/(1+sTf2)
s4
Feedback
Signal Selector
0 AVR Output Signal
1 Exciter Field Current
2 Exciter Output Voltage

Model Name: rexs

Description: General Purpose Rotating Excitation System Model

Prerequisites: Generator model ahead of this model in the dynamics models table

Inputs: Compounded generator terminal voltage, generator field current, generator speed

Output Channels:

Record Level	Name	Description
1	if	Generator field current p.u.
1	vr	Voltage regulator output p.u.
1	vfe	Exciter field voltage p.u.
1	ife	Exciter field current p.u.

Invocation:

```
rexs [<nf>] {<namef> <kvf>} <id> :
```

Parameters:

	Name	EPCL Variable	Description	Value
0.0	tr		Voltage transducer time constant, sec	0.025
2894.00	kvp		Voltage Regulator Proportional Gain	1.
0.0	kvi		Voltage Regulator Integral Gain	0.0
0.100000	vimax		Voltage Regulator Input Limit, p.u.	0.1
0.010000	ta		Voltage Regulator time constant, sec	0.03
0.0	tb1		Lag time constant, sec`	0.036
0.0	tc1		Lead time constant, sec	2.
0.0	tb2		Lag time constant, sec`	0.
0.0	tc2		Lead time constant, sec	0.
47.0000	vrmax		Maximum controller output, p.u.	6.
-20.0000	vrmin		Minimum controller output, p.u.	-6.
0.050000	kf		Rate feedback gain,	0.05
1.000000	tf		Rate feedback time constant, sec	1.
0.0	tf1		Feedback lead time constant, sec	0.
0.0	tf2		Feedback lag time constant, sec	0.075
1.000000	fbf		Rate feedback signal flag	<0,1,2>
1.000000	kip		Field Current Regulator Proportional Gain	1.
0.0	kii		Field Current Regulator Integral Gain	2.
0.0	tp		Field current Bridge time constant, sec	0.02
47.0000	vfmax		Maximum Exciter Field Current, p.u.	5.
-20.0000	vfmin		Minimum Exciter Field Current, p.u.	-5.
0.0	kh		Field voltage controller feedback gain	1.
1.000000	ke		Exciter field proportional constant	1.
1.2000	te		Exciter field time constant, sec	0.3
0.050000	kc		Rectifier regulation factor, p.u.	0.1
2.0000	kd		Exciter regulation factor, p.u.	0.8
3.0000	e1		Exciter flux at knee of curve, p.u.	1.5
0.000100	se1		Saturation factor at knee	0.02
4.0000	e2		Maximum exciter, p.u.	3.
0.001000	se2		Saturation factor at max flux	0.05
0.0	rcomp		Regulator compensating resistance, p.u.	0.
0.0	xcomp		Regulator compensating reactance, p.u.	0.05
0.0	nvphz		Pickup speed of v/Hz limiter, p.u.	0.975

0.0	kvphz	V/Hz limiter gain	2.
0.0	flimf	Limit type flag	<0,1>
0.0	xc	Exciter compounding reactance, p.u.	0.5
0.0	vcmax	Maximum compounding voltage, p.u.	0.6

Notes:

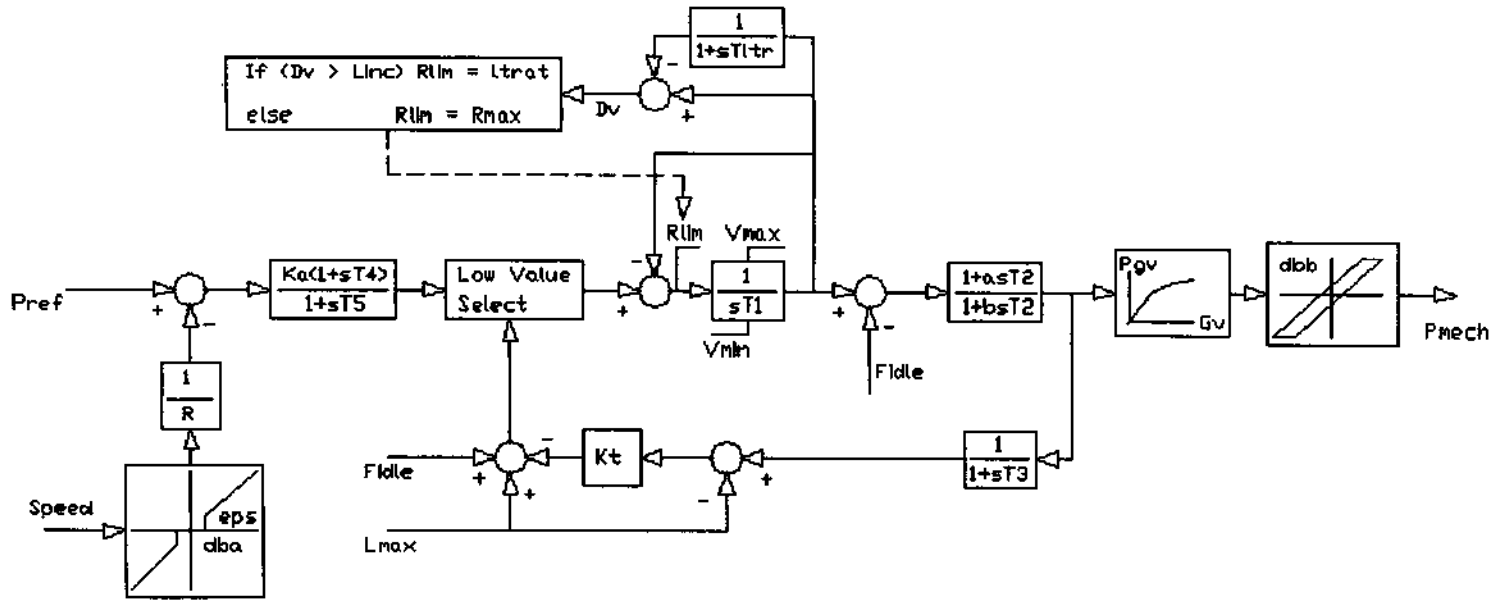
1. This model can be used to represent a wide range of excitation systems whose DC power source is an AC or DC generator. It encompasses IEEE type AC1, AC2, DC1, and DC2 excitation system models and the EXBBB and EXBAS model of the PSLF/PSDS program.
2. The rotating exciter may be of either DC or Brushless AC type. To model a DC exciter, set kc = kd = 0.
3. An AC exciter can be modeled either by setting kc and kd to non- zero values to represent the armature reaction of the exciter and the regulation of the rotating rectifier, respectively, or by specifying the saturation factors, se1, se2 to represent the excitation-output-voltage curve of the exciter as loaded by the field resistance of the main generator. It is preferable to use the first approach (kd != 0) since the later approach does not represent the effect of armature reaction in the exciter on its field current and hence invalidate the model when field current is sensed by the voltage regulator.
4. When this model is used to represent a separately excited exciter the value of ke should normally to close to unity. A shunt excited DC exciter can be modeled by setting ke to the appropriate small negative value needed represent the relationship between the exciter's air gap line and field resistance line. Note though, that this model does not determine the value of ke automatically when a shunt field DC exciter is being represented.
5. The voltage regulator may be of proportional or proportional-plus-integral form. Either kvp or kvi, but not both, may be zero. Ta, Tb1, Tb2, Tf2, Tf and Tr may be zero. Te must be non-zero.
6. The voltage regulator output may be either the field voltage applied directly to the exciter or the input to an exciter field current regulator by choice of values of Kip, Kii, and Kh. Either or both of Kip and Kii must be non-zero. If Kii is non-zero, Kh should normally be non-zero.
7. The voltage regulator reference is modified by a volts-per-hertz limiter when shaft speed falls below nvphz. When the shaft speed is below nvphz the regulator reference is reduced as follows:
   effective vref = vref(1.-kvphz(speed - nvphz))
   The volts-per-hertz limiter can be disabled by setting nvphz = 0 or kvphz = 0.
8. The rate feedback signal used by the voltage regulator can be selected by setting the feedback signal flag, fbf, as follows:

fbf	signal used for rate feedback
0	voltage regulator output voltage (same as exciter field voltage)
1	exciter field current
2	output voltage of the exciter

9. The voltage regulator output limits, vrmax, vrmin must be stated as multiples of the value of exciter field current needed to maintain the exciter output at its base value. The field current limit, vlr, must be stated as a multiple of the exciter field current needed to maintain the exciter output at its base value. That is, vrmax, vrmin must be stated in terms of the per unit exciter output voltage to which they correspond in the steady state.
10. The regulator output limit flag indicates whether the control power supply for the voltage regulator is a transformer at the generator terminals or an independent source such as a permanent magnet generator. Set flimf as follows:
    flimf = 0 the limits on regulator output are vrmax, vrmin, vfmax

and vfmin

flimf = 1 the limits on regulator output are (vrmax*vterm), (vrmin*vterm), (vfmax*vterm), and (vfmin*vterm).


If (Dv > Linc) Rlim = Ltrat
else Rlim = Rmax
1
1+sTltr
Dv
Rlim
Vmax
Pref
Ka(1+sT4)
1+sT5
Low Value
Select
1
sT1
Vmin
Fidle
1+asT2
1+bsT2
Pgv
Gv
dbb
Pmech
1
R
Speed
eps
dba
Fidle
Kt
1
1+sT3
Lmax

Model Name: gast

Description: Single shaft gas turbine

Prerequisites: Generator model ahead of this model in the dynamic models table

Inputs: Shaft speed

Output Channels:

Record Level	Name	Description
1	pm	Turbine power, MW

Invocation: gast [<n>] {<name> <kv>} <id> : [mwcap=<value>]

Parameters:

Name	EPCL Variable	Description	
0.040000	R	r	Permanent droop, pu
0.400000	T1	t1	Governor mechanism time constant, sec
0.500000	T2	t2	Turbine power time constant, sec
3.0000	T3	t3	Turbine exhaust temperature time constant, sec
1.000000	Lmax	lmax	Ambient temperature load limit
3.0000	Kt	kt	Temperature limiter gain
1.5000	Vmax	vmax	Maximum turbine power, pu of mwcap
0.0	Vmin	vmin	Minimum turbine power, pu of mwcap
0.0	Dturb	dturb	Turbine damping coefficient, pu [NOT USED]
0.300000	Fidle	fidle	Fuel flow at zero power output, pu
0.010000	Rmax	rmax	Maximum fuel valve opening rate, pu/sec
0.050000	Linc	loadinc	Valve position change allowed at fast rate,pu
5.0000	Tltr	tltr	Valve position averaging time constant, sec
0.000500	Ltrat	ltrate	Maximum long term fuel valve opening rate, pu/sec
0.0	a	a	Turbine power time constant numerator scale factor
1.000000	b	b	Turbine power time constant denominator scale factor
0.0	db1	db1	Intentional deadband width, Hz.
0.0	eps	eps	Intentional db hysteresis, Hz.
0.0	db2	db2	Unintentional deadband, MW
0.0	GV1	gv1	Nonlinear gain point 1, p.u. gv
0.0	Pgv1	pgv1	Nonlinear gain point 1, p.u. power
0.0	GV2	gv2	Nonlinear gain point 2, p.u. gv
0.0	Pgv2	pgv2	Nonlinear gain point 2, p.u. power
0.0	GV3	gv3	Nonlinear gain point 3, p.u. gv
0.0	Pgv3	pgv3	Nonlinear gain point 3, p.u. power
0.0	GV4	gv4	Nonlinear gain point 4, p.u. gv
0.0	Pgv4	pgv4	Nonlinear gain point 4, p.u. power
0.0	GV5	gv5	Nonlinear gain point 5, p.u. gv
0.0	Pgv5	pgv5	Nonlinear gain point 5, p.u. power
0.0	GV6	gv6	Nonlinear gain point 6, p.u. gv
0.0	Pgv6	pgv6	Nonlinear gain point 6, p.u. power
0.0	Ka	ka	Governor gain
0.0	T4	t4	Governor lead time constant, sec
0.0	T5	t5	Governor lag time constant, sec

Notes:

a) Per unit parameters are on base of turbine MW capability. If no value is entered for "mwcap", the generator MVA base is used.

b) All parameters, except Vmin and T5 (see note i), must be greater than zero. Rmax thru Ltrat may be set to 99. to disable rate limiting.

Fidle through Ltrat may be omitted from the parameter list; they will default to Fidle = 0, and 99 for the last four values.

c) T1 represents the natural valve positioning time constant of the governor for small disturbances, as seen when rate limiting is not in effect.

c) T2 represents delay due to internal energy storage of the gas turbine engine. T2 can be used to give a rough approximation to the delay associated with acceleration of the compressor spool of a multi-shaft engine, or with the compressibility of gas in the plenum of a the free power turbine of an aero-derivative unit, for example.

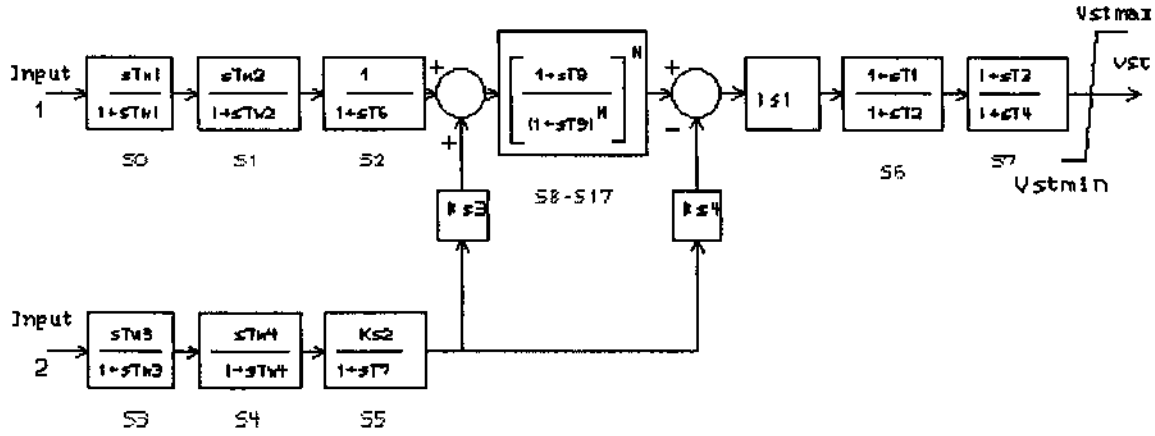
e) T3 represents delay in the exhaust temperature and load limiting system. Lmax is the turbine power output, in per unit, corresponding to the limiting exhaust gas temperature.

f) Rmax, Linc, Tltr, Ltrat represent a loading rate limit subsystem. For small excursions about a steady load the fuel valve can open at a rate of Rmax pu/sec. The time constant, Tltr, is used to obtain a long term average valve position. When a large output increase is called for, the fuel valve is allowed to open at the full rate only until the valve opening has moved ahead of the long term average position by Linc pu. After this the valve is permitted to open only at the rate, Ltrat, until the long term average position catches up.

g) The deadbands are implemented as described in section 3.10.2.

h) The nonlinear gain on the output may be input with up to 6 points. The (0.,0.) and (1.,1.) points are assumed and need not be input. The output is not allowed to go beyond 0. and 1. However, if (Vmax-Fidle) > 1., the input and output are scaled by this value. If input is omitted or if all zero values are input, a straight line is used

i) If T5 is zero, the entire gain and lead-lag block is bypassed.*vterm).


Input
1
sTw1
1+sTw1
sTw2
1+sTw2
1
1+sT6
1+sT9
(1+sT9)
N
1+sT1
1+sT3
1+sT2
1+sT4
Vstmax
Vst
Vstmin
S0
S1
S2
S8-S17
S6
S7
Input
2
sTw3
1+sTw3
sTw4
1+sTw4
Ks2
1+sT7
S3
S4
S5

Model Name: pss2a

Descriptions: Dual input Power system stabilizer (IEEE type PSS2A)

Prerequisites: Generator model ahead of this model in dynamic models table

Inputs:
Generator shaft speed
Frequency of generator terminal or system bus voltage
Generator electric power or accelerating power
Voltage amplitude of generator terminal bus or system bus
Current amplitude in specified branch

Output Channels:

Record Level	Name	Description
1	vs	Stabilizer output signal, p.u.

Invocation: pss2a [<n>] {<name> <kv>} <id> :

Parameters:

	Name	EPCL Variable	Description
1.000000	j1	j1	Input signal #1 code
0.0	k1	k1	Input signal #1 remote bus number
3.0000	j2	j2	Input signal #2 code
0.0	k2	k2	Input signal #2 remote bus number
2.0000	tw1	tw1	First washout on signal #1, sec
2.0000	tw2	tw2	Second washout on signal #1, sec
2.0000	tw3	tw3	First washout on signal #2, sec
0.0	tw4	tw4	Second washout on signal #2, sec
0.0	t6	t6	Time constant on signal #1, sec
2.0000	t7	t7	Time constant on signal #2, sec
1.000000	ks2	ks2	Gain on signal #2
1.000000	ks3	ks3	Gain on signal #2
1.000000	ks4	ks4	Gain on signal #2
0.500000	t8	t8	Lead of ramp tracking filter
0.100000	t9	t9	Lag of ramp tracking filter
1.000000	n	n	Order of ramp tracking filter
5.0000	m	m	Order of ramp tracking filter
10.0000	ks1	ks1	Stabilizer gain
0.250000	t1	t1	Lead/lag time constants, sec
0.040000	t2	t2	Lead/lag time constants, sec
0.200000	t3	t3	Lead/lag time constants, sec
0.030000	t4	t4	Lead/lag time constants, sec
0.100000	vstmax	vstmax	Stabilizer output max limit, p.u.
-0.10000	vstmin	vstmin	Stabilizer output min limit, p.u.

Notes:

a) TW1 and TW3 must be greater than zero.
b) Setting TW2 or TW4 to zero will bypass the washout function.
c) T1, T2, T3, T4, T6, T7, T8, and T9 may be zero.
d) Set T9 = 0 or n = 0 to get a null effect from the ramp tracking filter.
e) The product of n*m can not be greater than 10.
f) The input signal code, j, and the remote bus number, k, specify the input signal used by the stabilizer. If k is zero the signal is taken from the shaft or terminals of the generator on which the stabilizer is located. If k is non-zero the signal is taken from bus number k (for j = 1, 2, 3, 4, or 5).
g) To use branch current as an input, the branch is specificed using the ([<mon_i>] {<name> <kv>} [<mon_j>] {<name> <kv>} <ck> <sec>) data in the DYD file or in the "edds" table. Note that only one branch current may be used as input to this model.

The input signal code, j, is

1	for shaft speed
2	for frequency of bus voltage
3	for generator electrical power
4	for generator accelerating power
5	for amplitude of bus voltage
7	for amplitude of branch current