PACIFICORP, JIM BRIDGER

SERIAL # - 180x496, 180x547, 180x548, 180x752

GENERATOR UPRATE STUDY REPORT

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Revision 0 – 8/03/2009, draft report issued
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I Executive Summary of Study and Ratings

This detailed study provides a full assessment of the capability of the generators 180x496, 180x547, 180x548 and 180x752 located at PacifiCorp Jim Bridge Power station. The uprate goal for each unit is 586 MWe and to maintain the same MVARs or more than present. Over the years, there has been considerable improvement in the technology and the tools used to evaluate the generator components. The study reviewed the major generator components for each unit to identify the components that would require replacement or upgrade to meet the Jim Bridger's uprate goal of 586 MWe. The below information for each unit is based on GE records and does not account for any non-GE upgrade done on these generators. All the analysis for the field is based on the assumption that the original fields are in their original units and upgrades have been performed as given below.

180x496 –

- The analysis is based on new stator winding, new EX2100 and field rewind done in 1986.

180x547 -

- The analysis is based on new stator winding, new EX2100 and field rewind done in 2005.

180x548 -

- The analysis is based on new stator winding, new EX2100 and the original field winding.

180x752 -

- The analysis is based on new stator winding, new EX2100 and a replacement field.

See the below matrix for the stator and field combination based on the information received from the customer.

Stator	180x496	180x547	180x548	180x752
Field	180x547	180x496	180x752	(Seed Field - Replacement Field)

Table 1 compares the generator operating point to the proposed uprate option. Table 2 identifies the components that were evaluated, with recommendations for their modifications.

ASSUMPTIONS:

1) The study assumes that all the comments are in " New and Clean" condition. The condition of the generator components that will not be replaced needs to be assessed before operating the generator at uprated levels.
2) The generator has been evaluated to meet the customer goal of 586 MWe.
3) The data in this study is based on preliminary electromagnetic designs at the proposed rating and preliminary component designs for those components that would be replaced. Final design would be performed after receipt of order for the upgraded generator components.
4) A new nameplate, characteristic curves, and revised Instruction Book sheets would be supplied as part of the final design process after an order is received and is contingent on implementation of the recommended upgrades.

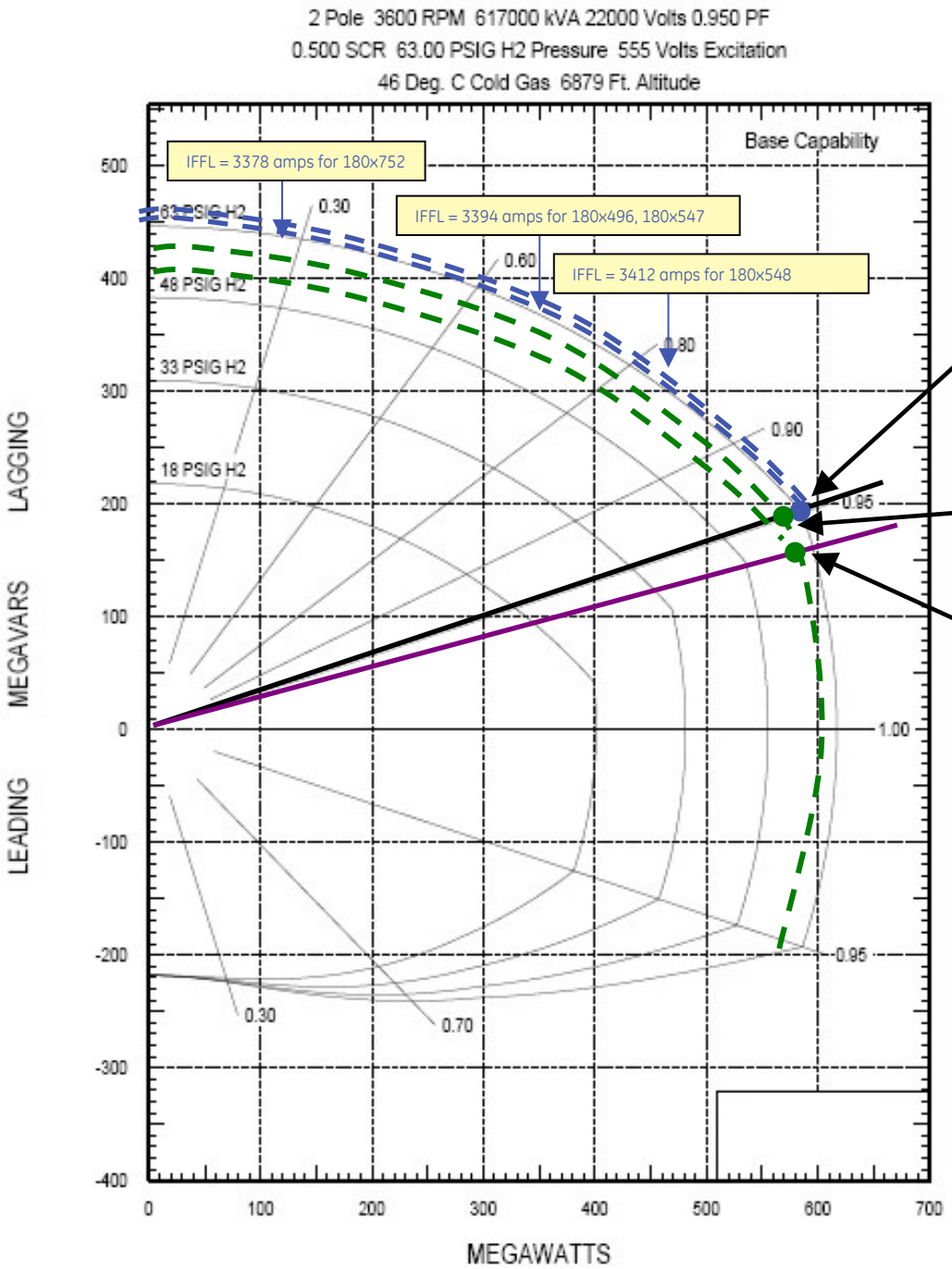
Table 1: Generator Ratings Summary

GENERATOR SERIAL NO.	180x496, 180x547, 180x548	180x752	180x496, 180x547	180x548	180x752
DESCRIPTION, COMMENTS	Present Nameplate Rating	Present Nameplate Rating	Proposed Uprate Rating	Proposed Uprate Rating	Proposed Uprate Rating
GENERATOR NAMEPLATE RATING					
MVA RATING	608.29	608.29	617	617	617
KV	22	22	22	22	22
POWER FACTOR	0.95	0.96	0.95	0.95	0.95
MWe RATING	578	584	586.2	586.2	586.2
MVAR RATING	190	170	193	193	193
LINE CURRENT	15963	15963	16192	16192	16192
FULL LOAD FIELD CURRENT, IFFL	3371	3324	3394	3412	3378
H2 PRESSURE (PSIG)	63	63	63	63	63

Notes:

1. The Generator Rating refers to the "corner point" on the generator reactive capability curve (RCC). The stator capability and the field capability meet at this point. See the attached RCC curve for a good depiction of the RCC corner point. The generator may be operated anywhere on or within the RCC.
2. The "Generator Output at Rated Turbine MWe" corresponds to a particular operating level on or within the reactive capability curve.

Figure 1 - PRELIMINARY REACTIVE CAPABILITY CURVE



Proposed Uprate Rating for 180x496, 180x547, 180x548, 180x752 – 617 MVA, 0.95 PF

Present Nameplate Rating for 180x496, 180x547, 180x548 – 608.29 MVA, 0.95

Present Nameplate Rating for 180x752 – 608.29 MVA, 0.96

Table 2 Evaluations of Generator Components

	Modifications Required for 180x496, 180x547, 180x548, 180x752 to operate at 617 MVA , 0.95 p.f	Comments
Stator and Related Components		
Stator Frame, End Shield, H2 Seals	OK	
Stator Core	OK	
Stator Winding	OK	Based on new stator winding
Current Transformers	OK	Suitable for operation at the proposed uprate option.
High Voltage Bushings	OK	Suitable for operation at the proposed uprate option.
Rotor Components		
Field Winding & Related Winding Components	OK	Suitable for operation at the proposed uprate option based on the different upgrades done to the fields.
Generator Shaft: Torsional Stress	OK	
Brush Holder Rigging	OK	Suitable for operation at the proposed uprate option.
Collector Rings	OK	Suitable for operation at the proposed uprate option.
Auxiliary Systems		
Excitation System	OK	Based on the assumption of a new EX2100 system
Stator water cooling system	OK	
Stator water cooling system - coolers	OK at 90 F and 95 F	The coolers reach their maximum capability at 95 F

	Modifications Required for 180x496, 180x547, 180x548, 180x752 to operate at 617 MVA , 0.95 p.f	Comments
Hydrogen coolers	OK at 90 F and 95 F	The coolers reach their maximum capability at 95 F
Neutral tie	Requires evaluation by Jim Bridger	Not in original GE scope of supply.
Neutral Enclosure	Requires evaluation by Jim Bridger	Not in original GE scope of supply.

II – Evaluation of Generator Components

1. Stator Core

As is generally known, if the stator core end iron is over fluxed, core damage can result due to incremental arcing between punchings and gross overheating of the end iron structure. The damage can range from bluing of insulation, to local arc damage, to catastrophic cascading core arcing resulting in armature ground wall failure requiring partial/full re-stacking and re-winding. The flux in the end region is heavily dependent on the armature winding currents and the power factor. Of course, the armature winding currents increase in direct proportion to the generator MVA rating. The flux entering the core ends increases as the power factor is increased from the rated value to unity in the lagging portion of the reactive capability curve and proceeds to increase further as the unit is operated at leading power factors.

For these reasons, the core end capability was considered as part of the power uprate evaluation. The study demonstrated that the ends of the core are capable of being operated at the uprate level of 617 MVA in the lagging and leading power factor region for all 4 units.

2. Stator Winding

The generator stator will be rewound in the coming outage in 2010 with optimized stator bar design and is capable of supporting the proposed uprate rating of 617 MVA.

3. Rotor Mechanical Evaluation

As the rating of the generator (MW) increases higher torque levels and torsional stresses are imposed on the generator shaft, which can reduce the life of the shaft. All the rotors are mechanically capable of operating up to 617 MVA uprate rating in the steady state and transient conditions. All this analysis is for GE rotor only and does not account for any non-GE upgrades or components.

4. Field Winding

The field windings in all 4 generators are capable of operating at the proposed uprate rating at the higher field currents. This is assuming that the original rotors corresponding to the original serial numbers are in the appropriate generators.

5. Collector Rings, and Brush Riggings

The evaluation of the collector rings and brush rigging demonstrated that they are capable of handling the proposed uprate option without any modifications, provided that they are in "as new" condition.

6. Hydrogen Coolers

The present hydrogen coolers are suitable to support the proposed uprate at 90 F and 95 F lake water temperature, provided they are in new and clean condition. The coolers reach their maximum capability at 95 F lake water temperature.

7. Stator Water Cooling System and Coolers

The present stator water coolers and cooling system are suitable to support the proposed uprate at 90 F and 95 F lake water temperature, provided they are in new and clean condition The coolers reach their maximum capability at 95 F lake water temperature.

8. High Voltage Bushings

GE's review of the bushings indicates that the bushings are capable of supporting the proposed uprate rating of 617 MVA, which produces a bushing current of 16192 amps.

9. Current Transformers

Each current transformer is rated at 20000/5. The review indicates that the current transformers are acceptable for the rating of 617 MVA, which produces a bushing current of 16192 amps.

10. Excitation System – Alternator and Controls & Rectifiers

All the analysis for the exciter in this uprate study is under the assumption of a new EX2100. So the new EX2100 will be sized based on the field currents of each generator. The existing excitation system has not been studied in this uprate study.

11. Transformer

This study was undertaken to determine if the subject transformers are suitable for operation at 580MVA.

The following are the calculated losses and temperature rises at 580MVA.

Calculated Losses
@ 580MVA(65C) –345KVGRY-22KV
Load Loss (Kw) 1442.6
No Load Loss (KW) 313.7
Total Loss (KW) 1756.3

Calculated Temperature Over Ambient
@ 580MKVA(65C) –336.375KVGRY-22KV

Top Oil Rise	43.3 °C
HV Winding Rise	53.5°C
LV Winding Rise	55.1 °C

The following transformer components were analyzed.

A) The original windings.
B) Non-magnetic inserts on LV front
C) The internal LV connection from bushing to bus bars

D) The LV internal bus
E) The HV de-energized tap changer
F) The HV internal cables
G) The LV bushings
H) The HV bushings
I) The current transformers
J) The cooling system

All of the above except for B and F are suitable for operation at 580 MVA.

The HV cables rise exceeds the IEEE standard allowable of 80.0°C by 1.2°C. The cables will need to be increased in size to 850 MCM.

The non-magnetic insert temperature rise exceeds the allowable of 30°C by 4.0C. The insert needs to increase in length and width by 1.500 inches.

Other customers with transformers in the same age range as these have, in an effort to minimize risk, opted to rewind the windings. This is an option the customer may consider.

The customer specifically asked what would be the results if one fan were to go out of service and what will be the results if one cooler were to go out of service.

This transformer has a total of 6 coolers each with 4 fans for a total of 24 fans. Should one of the 24 fans go out of service the oil and winding rises will increase by approx. 1.8C, which is still within the IEEE temperature rise limit of 65C.

Top Oil Rise/Amb 45.1C
HV Winding Rise/Amb 57.8C
LV Winding Rise/Amb 59.4C

Should one of the 6 coolers go out of service the oil and winding rises will increase by approx. 8.3C

Top Oil Rise/Amb 51.6C
HV Winding Rise/Amb 64.3C
LV Winding Rise/Amb 65.9C

Note that with one cooler out of service the LV winding exceeds the IEEE temperature rise limit of 65C. To meet IEEE limits additional cooling is required. BY replacing the existing coolers with coolers of a more efficient design the rises will meet IEEE limits.

Top Oil Rise/Amb 50.9C
LV Winding Rise/Amb 63.6C
HV Winding Rise/Amb 65.0C

12. Other Equipment

Typical plant components that need to be reviewed in support of any generator uprate are the Iso Phase Bus, Volts/Hertz protection, over and under-excitation circuitry, relay protections, switchyard breakers, and control room instrumentation. These components are beyond the scope of this study.

III. Reliability Considerations

The uprate assessment assumes that all components are in the "as new" condition. Reliability issues associated with the age of components and TIL's should be considered. Testing and Inspection of all major generator components per GEK 103566 is also strongly recommended. Jim Bridger is encouraged to evaluate

the condition of all other generator auxiliaries on the basis of age, overall condition, and additional demands placed upon them by the power uprate.