

**GEN-2009-008**  
**Impact Restudy for**  
**Generator Modification**  
**(Turbine Change)**

**February 2015**  
**Generator Interconnection**



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## Executive Summary

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The GEN-2009-008 Interconnection Customer has requested a modification to its Generator Interconnection Agreement to change from one hundred seventeen (117) GE 1.7MW wind turbine generators (aggregate power of 198.9MW) to one hundred eleven (111) GE 1.79MW wind turbine generators (aggregate power of 198.69MW). Since the GE 1.79MW wind turbine generator has identical electrical characteristics as the GE 1.7MW wind turbine generator, a stability analysis assessment was not performed for this change request. The results of the system impact restudy performed for GEN-2009-008 (see [GEN-2009-008 Impact Restudy #2](#), posted 2/19/2013) are still valid for this generation interconnection request. As the original request for interconnection is for 199.5MW, the requested change is not considered a Material Modification.

Even though a restudy of the stability analysis was not performed for this interconnection change request, both a short circuit analysis and a reduced generation analysis were performed. These two analyses were implemented as requirements in system impact studies since the previous GEN-2009-008 restudy was completed. The short circuit analysis is discussed in the body of this report and the data are presented in the appendix. The reduced generation (due to unsuitable wind speeds, curtailment, etc.) analysis shows the need for approximately 16MVAR of reactor support on the 34.5kV side of the Customer's substation transformer. The reactor support may be in the form of external reactive devices or through the use of the GE wind turbine Wind Free option.

Power factor requirements for GEN-2009-008 can be found in its Generator Interconnection Agreement.

With the assumptions outlined in this report and with all the required network upgrades from the GEN-2009-008 GIA in place, GEN-2009-008 with the GE 1.79MW wind turbine generators should be able to reliably interconnect to the SPP transmission grid.

Nothing in this study should be construed as a guarantee of transmission service. If the Customer wishes to obtain deliverability to a specific customer, a separate request for transmission service shall be requested on Southwest Power Pool's OASIS.

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# 1. Introduction

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The GEN-2009-008 Interconnection Customer has requested a modification to its Generator Interconnection Agreement to change from the GE 1.7MW wind turbine generators to the GE 1.79MW wind turbine generators. In a previous system impact study<sup>1</sup>, GEN-2009-008 was studied with one hundred seventeen (117) GE 1.7MW wind turbine generator (aggregate power of 198.9MW). The requested change is to use one hundred eleven (111) GE 1.79MW wind turbine generators (aggregate power of 198.69MW). Since the GE 1.79MW wind turbine generator has identical electrical characteristics as the GE 1.7MW wind turbine generator, a restudy of the stability analysis was not performed for this change request. The results of the previous system impact restudy performed for GEN-2009-008 are still valid for this generation interconnection request. As the original request for interconnection is for 199.5MW, the requested change is not considered a Material Modification.

Even though a stability analysis was not performed for this interconnection change request, both a short circuit analysis and a reduced generation analysis were performed. These two analyses were implemented as requirements in system impact studies since the previous GEN-2009-008 restudy was completed.

Nothing in this System Impact Study constitutes a request for transmission service or grants the Interconnection Customer any rights to transmission service.

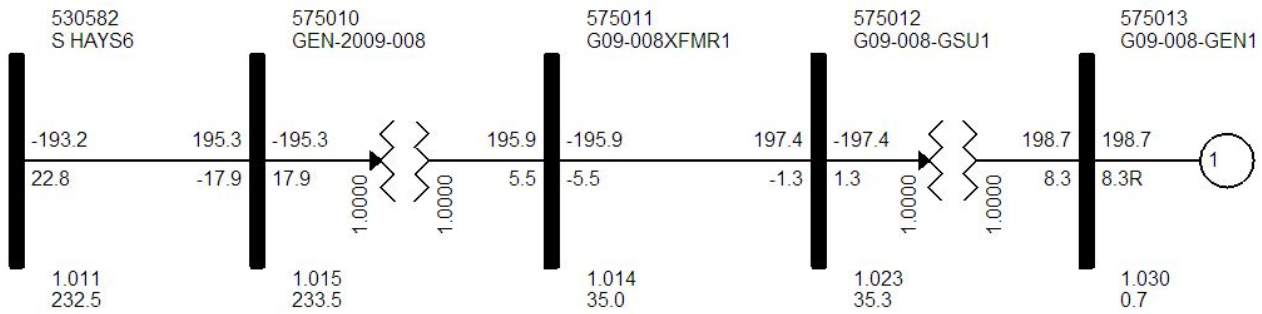
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<sup>1</sup> GEN-2009-008 Impact Restudy #2, posted 2/19/2013

## 2. Facilities

### Generating Facility

The point of interconnection (POI) for the GEN-2009-008 interconnection request is the Hays 230kV substation. **Figure 2-1** depicts the one-line diagram of the local transmission system including the POI as well as the power flow model representing the request.



**Figure 2-1: Proposed POI and Power Flow Model for GEN-2009-008**

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## 3. Stability Analysis

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Transient stability analysis is used to determine if the transmission system can maintain angular stability and ensure bus voltages stay within planning criteria bandwidth during and after a disturbance while considering the addition of a generator interconnection request. Since the GE 1.79MW wind turbine generator is electrically similar to the GE 1.7MW wind turbine generator, a stability analysis was not performed. The analysis performed in the previous restudy is still valid.

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## 4. Power Factor Analysis

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The power factor analysis was not performed for this change request. The power factor analysis performed in the previous restudy is still valid. The final power factor requirement for GEN-2009-008 will be the pro-forma 95% lagging to 95% leading at the POI and are listed in the Generator Interconnection Agreement for GEN-2009-008.

## 5. Reduced Generation Analysis

Interconnection requests for wind generation projects that interconnect to a 345kV or 230kV bus on the SPP system are analyzed for the capacitive charging effects during reduced generation conditions (due to unsuitable wind speeds, curtailment, etc.) at the generation site.

### Model Preparation

The project generators and capacitors (if any), and all other wind projects that share the same POI, were turned off in the base case. The resulting reactive power injection into the transmission network comes from the capacitance of the project’s transmission lines and collector cables. This reactive power injection is measured at the POI. Shunt reactors were added at the study project substation low voltage bus to bring the Mvar flow into the POI down to approximately zero.

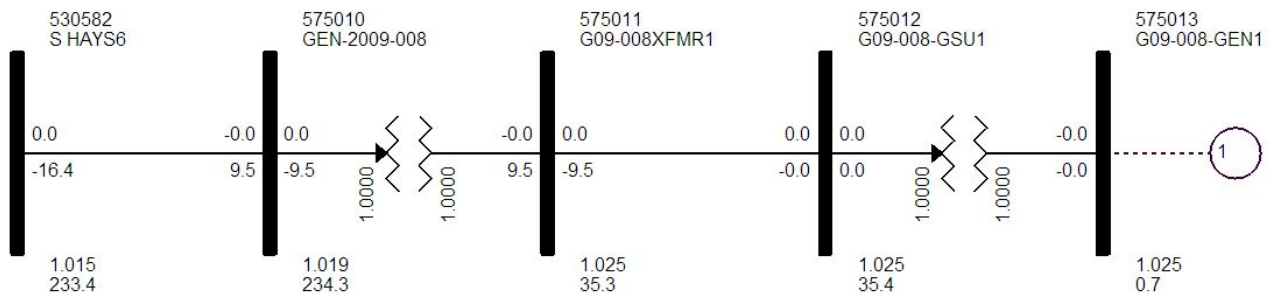
### Results

A final shunt reactor requirement for each of the studied interconnection requests is shown in **Table 5-1**. The results shown are for the 2025 summer case. The other two cases (2015 winter and 2015 summer) were almost identical since the generation plant design is the same in all cases.

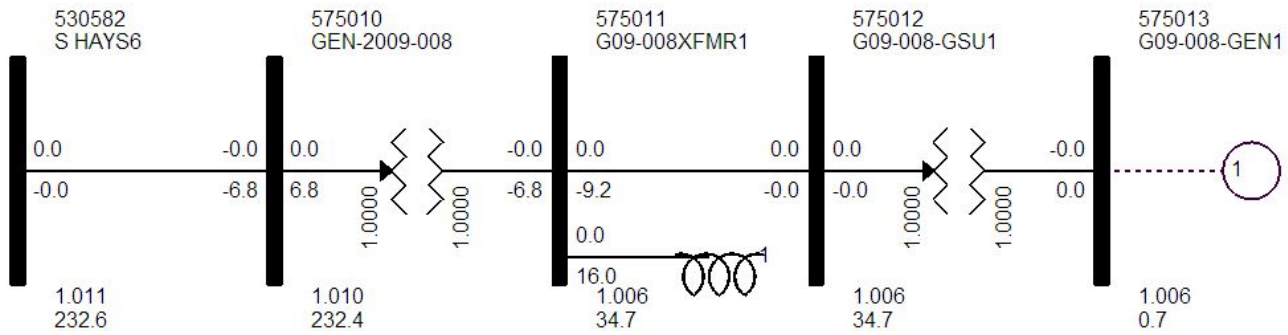
**Table 5-1: Summary of Shunt Reactor Requirements**

Request	Capacity	POI	Approximate Shunt Reactor Required
GEN-2009-08	198.69MW	Hays 230kV Substation	16Mvar

One line drawings used in the analysis are shown in **Figure 5-1** and **Figure 5-2**.



**Figure 5-1: GEN-2014-057 with generators off and no shunt reactors**



**Figure 5-2: GEN-209-008 with generator turned off and shunt reactor added to the low side of the substation 230/34.5kV transformer**



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## 6. Short Circuit Analysis

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The short circuit analysis was performed on the 2025 Summer Peak power flow case using the PSS/E ASCC program. Since the power flow model does not contain negative and zero sequence data, only three-phase symmetrical fault current levels were calculated at the POI up to and including busses five levels away.

### Results

The results of the short circuit analysis are shown in **Table A-1** in **Appendix A: Short Circuit Analysis Results**.

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## 7. Conclusion

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The GEN-2009-008 Interconnection Customer has requested a modification to its Generator Interconnection Agreement to change from GE 1.7MW wind turbine generators to the GE 1.79 wind turbine generator. The GE 1.79 wind turbine generator is electrically identical to the GE 1.7MW wind turbine generator. Since GEN-2009-008 was studied previously using the GE 1.7MW wind turbine generators, the results of that study are still applicable to GEN-2009-008 using the GE 1.79MW wind turbine generators.

A reduced generation analysis was performed for the interconnection request. GEN-2009-008 will be required to install approximately 16 Mvar of reactors. The reactor requirements can be implemented by external reactor banks or other means.

A short circuit analysis was performed for GEN-2009-008 request. The results of the short circuit value are shown in an appendix of this report.

Power factor requirements for GEN-2009-008 can be found in its Generator Interconnection Agreement.

Nothing in this study should be construed as a guarantee of delivery or transmission service. If the customer wishes to sell power from the facility, a separate request for transmission service must be requested on Southwest Power Pool's OASIS by the Customer.

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## **Appendix A: Short Circuit Analysis Results**

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**Table A-1: Short Circuit Currents at GEN-2009-008 POI (Hays 230kV, Bus #530582) and busses five levels away**

PSS(R)E-32.2.2 ASCC SHORT CIRCUIT CURRENTS

THU, FEB 12 2015 15:58  
 2014 MDWG PASS 8 WITH 2013 MMWG  
 MDWG 2025S WITH MMWG 2024S

OPTIONS USED:

- FLAT CONDITIONS
  - BUS VOLTAGES SET TO 1 PU AT 0 PHASE ANGLE
  - GENERATOR P=0, Q=0
  - TRANSFORMER TAP RATIOS=1.0 PU and PHASE ANGLES=0.0
  - LINE CHARGING=0.0 IN +/- /0 SEQUENCE
  - LOAD=0.0 IN +/- SEQUENCE, CONSIDERED IN ZERO SEQUENCE
  - LINE/FIXED/SWITCHED SHUNTS=0.0 AND MAGNETIZING ADMITTANCE=0.0 IN +/- /0 SEQUENCE
  - DC LINES AND FACTS DEVICES BLOCKED
  - TRANSFORMER ZERO SEQUENCE IMPEDANCE CORRECTIONS IGNORED

			THREE PHASE FAULT	
X-----	BUS	-----X	/I+/	AN(I+)
530582	[S HAYS6	230.00] AMP	8599.6	-83.64
530553	[S HAYS 3	115.00] AMP	8680.1	-83.21
530584	[POSTROCK6	230.00] AMP	10884.9	-84.74
530632	[SHYS1 1	12.470] AMP	17002.1	-88.48
539679	[GRTBEND6	230.00] AMP	8324.3	-82.44
575010	[GEN-2009-008230.00]	AMP	4517.3	-82.59
530552	[GORHAM 3	115.00] AMP	3115.2	-78.66
530558	[KNOLL 6	230.00] AMP	10745.5	-84.69
530562	[HAYS 3	115.00] AMP	8765.9	-81.79
530583	[POSTROCK7	345.00] AMP	7808.2	-84.81
530673	[POSTROCK1	13.800] AMP	79728.6	-86.85
530680	[HEIZER 6	230.00] AMP	8276.1	-82.45
532871	[CIRCLE 6	230.00] AMP	10622.0	-85.30
539678	[GRTBEND3	115.00] AMP	12746.0	-82.45
539695	[SPEARVL6	230.00] AMP	12713.7	-86.78
539920	[GRTBNDTT	13.800] AMP	33334.2	-86.64
575011	[G09-008XFMR134.500]	AMP	17518.8	-86.05
530561	[KNOLL 3	115.00] AMP	11455.6	-84.59
530591	[VINE 3	115.00] AMP	8802.6	-81.73
530592	[SMOKYHL6	230.00] AMP	6955.7	-84.32
530601	[HEIZER 3	115.00] AMP	12574.0	-82.49
530626	[HZRT1 1	12.500] AMP	17159.0	-87.52
530629	[KNLL1 1	11.490] AMP	35959.0	-88.81
530684	[RUSLPMP3	115.00] AMP	2026.9	-79.38
530686	[RICE 6	230.00] AMP	5002.1	-83.10
531468	[SPERTER1	13.800] AMP	12843.3	-89.74
531469	[SPERVIL7	345.00] AMP	14201.8	-85.79
532872	[EMCPHER6	230.00] AMP	9444.7	-84.39
532892	[CIRCLE 1	13.800] AMP	56632.4	-89.26
533413	[CIRCLE 3	115.00] AMP	29231.1	-86.58
539642	[ELLSWTP3	115.00] AMP	3970.9	-70.81
539666	[GBENDTP3	115.00] AMP	7579.9	-78.13
539677	[GRTBEND1	13.800] AMP	57368.6	-88.10
539681	[N-GBEND3	115.00] AMP	8273.0	-79.39

539684	[OTISSUB3	115.00]	AMP	2948.6	-74.09
539694	[SPEARVL3	115.00]	AMP	10473.6	-85.86
539719	[GRTBEND1	34.500]	AMP	4008.4	-84.71
539753	[SPEARVLE-EVB230.00]		AMP	12713.7	-86.78
539921	[GRTBENDT	7.2000]	AMP	8604.0	-87.97
539935	[SPERVLTT	13.800]	AMP	31546.8	-87.45
560242	[G11-017-TAP	345.00]	AMP	9976.2	-85.26
575012	[G09-008-GSU134.500]		AMP	16848.8	-85.11
579470	[GEN-2008-092230.00]		AMP	5350.1	-84.32
640065	[AXTELL 3	345.00]	AMP	8706.0	-84.76
530551	[SALINE 3	115.00]	AMP	4970.7	-78.76
530563	[HEIZER 2	69.000]	AMP	8804.8	-82.38
530581	[N HAYS3	115.00]	AMP	10007.7	-82.20
530593	[SMKYP1 6	230.00]	AMP	6041.1	-84.16
530599	[SMKYP2 6	230.00]	AMP	6454.1	-84.25
530602	[LAXTAP 3	115.00]	AMP	4086.3	-76.73
530605	[REDLIN 3	115.00]	AMP	3755.4	-71.70
530609	[HZRNGPL3	115.00]	AMP	7937.3	-81.83
530623	[RICE 3	115.00]	AMP	7220.1	-83.30
530627	[HZRT2 1	12.500]	AMP	11968.1	-82.73
530628	[HZRT3 1	12.500]	AMP	9553.8	-88.90
530676	[GMEC 3	115.00]	AMP	10923.3	-84.54
530677	[OGALATP3	115.00]	AMP	2602.0	-78.03
530687	[RICET1	12.470]	AMP	17045.6	-87.61
530688	[BUFLOCRK6	230.00]	AMP	3677.8	-83.52
531501	[BUCKNER7	345.00]	AMP	10609.4	-86.10
532873	[SUMMIT 6	230.00]	AMP	13581.7	-85.51
532894	[EMCPHER1	13.800]	AMP	54587.4	-88.11
533412	[ARKVALJ3	115.00]	AMP	10164.7	-70.45
533416	[RENO 3	115.00]	AMP	29649.7	-86.45
533417	[EMCPHER3	115.00]	AMP	15315.1	-85.58
533419	[HEC 3	115.00]	AMP	26680.2	-86.23
533421	[HEC GT 3	115.00]	AMP	28333.8	-86.58
533422	[HEC U4 3	115.00]	AMP	27524.4	-86.19
539643	[ROLLHLS3	115.00]	AMP	3640.2	-71.35
539661	[24-FREY3	115.00]	AMP	5586.9	-77.55
539692	[SEWARD 3	115.00]	AMP	5462.6	-73.70
539701	[RUSSELL3	115.00]	AMP	3469.8	-69.90
539721	[N-GBEND1	34.500]	AMP	3041.3	-84.20
539723	[OTISSUB1	34.500]	AMP	924.7	-83.23
539732	[SPEARVL1	34.500]	AMP	990.4	-84.22
539743	[SPWIND-T1	13.800]	AMP	36779.2	-89.48
539744	[SPWIND-T2	13.800]	AMP	31381.2	-89.55
539752	[GPEWIND1	34.500]	AMP	26386.5	-89.01
539759	[SPRVL 3	115.00]	AMP	11678.8	-87.64
539771	[NFTDODG3	115.00]	AMP	12607.0	-84.23
539790	[OTIS-2	34.500]	AMP	927.0	-84.76
539800	[CLARKCOUNTY7345.00]		AMP	12376.0	-85.60
539803	[IRONWOOD7	345.00]	AMP	13733.6	-85.75
539923	[NGBEND-T	13.800]	AMP	4672.7	-84.44
539925	[OTIS1-T	2.4000]	AMP	22221.6	-86.06
539926	[OTIS2-T	2.4000]	AMP	8504.6	-85.47
539936	[SPERVLDT	3.9840]	AMP	6145.9	-86.88
539960	[SPRVL-T	13.800]	AMP	27394.2	-89.19
562701	[GEN-2006-006345.00]		AMP	14201.8	-85.79
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579474	[G08-092XFMR234.500]		AMP	11108.4	-84.44
582016	[GEN-2011-016345.00]		AMP	7662.2	-81.65
582017	[GEN-2011-017345.00]		AMP	9257.4	-84.65

640066	[AXTELL 7	115.00]	AMP	13805.9	-84.45
640067	[AXTELL 9	13.800]	AMP	22751.1	-87.92
640312	[PAULINE3	345.00]	AMP	7579.7	-84.32
640374	[SWEET W3	345.00]	AMP	9628.2	-85.31
530557	[BEACH 3	115.00]	AMP	3604.2	-72.53
530560	[WKNNY 3	115.00]	AMP	2187.6	-77.73
530568	[GB NTH 2	69.000]	AMP	6769.6	-79.46
530586	[ALBERT 2	69.000]	AMP	3623.9	-69.41
530587	[WSPRTTP2	69.000]	AMP	5947.8	-74.81
530590	[BEMIS 3	115.00]	AMP	3957.0	-78.22
530595	[SHP134 1	34.500]	AMP	17942.8	-88.52
530603	[LACROS 3	115.00]	AMP	3539.5	-76.56
530604	[SHP234 1	34.500]	AMP	23601.8	-87.56
530608	[NEKOMA 3	115.00]	AMP	3950.5	-76.15
530618	[HUNTSVL3	115.00]	AMP	4035.8	-72.04
530620	[LYONS 3	115.00]	AMP	5810.8	-82.56
530633	[SMKYT1 1	13.200]	AMP	39048.9	-89.43
530634	[SMKYT2 1	13.860]	AMP	48179.5	-88.61
530674	[GMECG1 1	13.800]	AMP	28163.4	-88.81
530675	[GMECG2 1	13.800]	AMP	29775.0	-89.15
530679	[SEWRDMW3	115.00]	AMP	4864.6	-74.07
530681	[BUSHTON3	115.00]	AMP	5276.5	-81.32
530691	[BUFCRKT11	12.470]	AMP	47625.8	-85.76
530692	[PRWIND 1 XF	34.500]	AMP	23681.1	-84.65
531449	[HOLCOMB7	345.00]	AMP	12033.3	-86.48
531492	[OG ONEOK	115.00]	AMP	2109.0	-78.41
531502	[CIMRRN 7	345.00]	AMP	8292.9	-85.97
531504	[CPV_CIMRRN	7345.00]	AMP	10609.4	-86.10
532694	[HEC U4	18.000]	AMP	92360.6	-88.70
532696	[HEC GT2	13.800]	AMP	53637.8	-88.61
532697	[HEC GT3	13.800]	AMP	41571.6	-88.90
532698	[HEC GT4	13.800]	AMP	63756.5	-89.30
532771	[RENO 7	345.00]	AMP	12116.9	-86.28
532773	[SUMMIT 7	345.00]	AMP	10961.9	-86.10
532807	[RENO 1X1	14.400]	AMP	45040.7	-87.92
532810	[RENO 2X1	14.400]	AMP	44831.9	-87.96
532813	[SUMMIT 1	14.400]	AMP	30613.3	-87.12
532874	[UNIONRG6	230.00]	AMP	7314.4	-83.10
532896	[SUMIT2 1	13.800]	AMP	47777.6	-88.92
532897	[SUMIT3 1	13.800]	AMP	48818.5	-86.55
533381	[SUMMIT 3	115.00]	AMP	17635.3	-86.49
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533426	[MANVILE3	115.00]	AMP	11761.6	-83.99
533427	[REFINRY3	115.00]	AMP	14755.1	-85.65
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533438	[WMCIPHER3	115.00]	AMP	15899.8	-85.75
533440	[43LORAN	115.00]	AMP	16261.8	-84.91
533445	[HEC 1	34.500]	AMP	2498.0	-89.92
533513	[HEC 2	69.000]	AMP	11535.5	-88.14
539660	[EHALLTP3	115.00]	AMP	3300.5	-75.01
539671	[FTDODGE3	115.00]	AMP	12565.2	-84.22
539686	[PLAINVL3	115.00]	AMP	3680.8	-77.19
539688	[S-DODGE3	115.00]	AMP	8422.0	-80.65
539689	[2ND-KS 3	115.00]	AMP	5017.9	-77.15
539696	[ST-JOHN3	115.00]	AMP	4868.9	-74.40
539698	[WALDO 3	115.00]	AMP	2752.4	-69.14
539703	[RUSSELL1	34.500]	AMP	3346.6	-80.44
539707	[24-FREY1	34.500]	AMP	3166.9	-83.55

539756	[SPEARVLE-LVB34.500]	AMP	18256.0	-84.10
539758	[FORD 3 115.00]	AMP	5558.9	-78.19
539801	[THISTLE7 345.00]	AMP	15374.7	-85.82
539809	[IRONWOOD 1 7345.00]	AMP	13733.6	-85.75
539907	[24-FREYT 13.800]	AMP	3875.2	-85.13
539943	[RUSSEL-T 7.2000]	AMP	7075.6	-84.55
542901	[GPW-CB2 34.500]	AMP	22417.0	-86.41
562702	[G06-006XFMR134.500]	AMP	24916.6	-87.12
579472	[G08-092-GSU134.500]	AMP	10846.5	-83.36
579475	[G08-092-GSU234.500]	AMP	10853.5	-83.60
579480	[GEN-2008-124230.00]	AMP	19857.1	-85.73
580049	[GEN-2010-045345.00]	AMP	7287.2	-85.33
582008	[GEN-2011-008345.00]	AMP	9955.1	-75.05
582116	[G11-016XFMR134.500]	AMP	17647.5	-87.80
582117	[G11-017XFMR134.500]	AMP	25385.6	-88.02
583370	[GEN-2012-024345.00]	AMP	9850.0	-83.01
640183	[GENTLMN3 345.00]	AMP	14982.3	-87.25
640224	[HOLDREG7 115.00]	AMP	6122.8	-78.95
640250	[KEARNEY7 115.00]	AMP	11450.3	-80.93
640275	[MINDEN 7 115.00]	AMP	7024.0	-80.49
640277	[MOORE 3 345.00]	AMP	20364.5	-85.43
640313	[PAULINE7 115.00]	AMP	16067.2	-81.70
640315	[PAULINE9 13.800]	AMP	15810.4	-87.47
652571	[GR ISLD3 345.00]	AMP	11416.2	-85.04