



**SYSTEM IMPACT STUDY FOR
NETWORK TRANSMISSION SERVICE**

SPS OASIS No. 793334

New 160 MW Network Resource
Oldham County, Texas

August 29, 2005

Xcel Energy Services, Inc.
Transmission Planning

Executive Summary

Xcel Energy Commercial Enterprises has requested a System Impact Study for network transmission service to determine adverse impacts caused by the designation of the Wildorado Wind, LP wind energy facility (the "Facility") as a new network resource. The request is being done on behalf of the Native Load Customers of Southwestern Public Service (SPS), for network transmission service within the SPS control area. It is the intention of SPS to purchase the output of the Facility, up to 160 MW. SPS plans to receive the wind-generated energy into its transmission grid at the Bushland Interchange 230kV bus located approximately 10 miles west of Amarillo, Texas.

Power flow analysis has indicated that the addition of this new network resource will cause adverse impacts to the SPS transmission system. During the study process the control areas of all first tier interconnected companies were also monitored for adverse impacts. The control areas of these companies include the transmission systems of Sunflower Electric Power Corporation, West Plains Energy and AEP West. The study indicated that due to the addition of the Facility, the transmission system of SPS was the only transmission system impacted, as determined by the Planning criteria. As for the transmission systems of the first tier companies, no impacts were found requiring system upgrades.

The impacts on the SPS transmission system included both thermal and voltage impacts. To mitigate the impacts, transmission system upgrades will be required. The total estimated cost for the upgrades, by in-service year, are show in Table 1 below. Additionally, a detailed list of the required system upgrades is also shown in Table 2, along with their respective cost estimate and required in-service date.

As for the Available Transfer Capacity (ATC), indicating the amount of power that can be transferred without impacting the limiting element, this value is shown as the ATC value in Table 1.

Table 1, Estimated Costs for System Upgrades by Year

Upgrades By In-Service Date	Estimated Cost	ATC
2007 Upgrades	\$1,600,000	0
2010 Upgrades	\$3,850,000	69
2015 Upgrades	\$18,350,000	0
Total Upgrades	\$23,800,000	—

It is suspected that completing the analysis of a subsequent transmission service study to the SPS transmission system in eastern New Mexico could possibly eliminate some of these system upgrades due to the counter flow of power. Any results determined as a result of this effect will be published in with the system impact study currently being performed for the wind energy facility in New Mexico. Additionally, a turbine selection for this Facility has yet to be made, once the selection is made a transient stability study may be performed to determine if additional system upgrades may be required. The proposed commercial operation date for the Facility is September 2006.

As for the upgrades required for this transmission service request, Southwestern Public Service at their discretion reserves the right to change these system upgrades. The upgrades could be changed in order meet present and long-term goals, however changes will be accomplished provided the new upgrades meet the same level of system reliability and safety.

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1. Introduction

Xcel Energy Commercial Enterprises on behalf of the Southwestern Public Service (SPS) Native Load Customers is requesting that the Renewable Energy Purchase Agreement (the "REPA") between Wildorado Wind, LP ("Customer") and SPS be designated as a network resource. The Customer's intention is to construct, own and operate a wind turbine generating facility with an output of 160 MW in Oldham County, Texas. The Facility is located north and west of Bushland, Texas with the interconnection point to the SPS transmission system located on the 230kV bus at Bushland Interchange; approximately 10 miles west of Amarillo, TX. A map showing the point of interconnection and the local transmission system is shown in Figure 1 of Appendix A.

Since Xcel Energy Commercial Enterprises on behalf of the Southwestern Public Service Native Load Customers has requested the Facility be designated a new network resource, it is the intention of SPS to purchase the 160 MW of wind generated electric energy that could be produced by the Facility. The point of receipt will be at the interconnection point on the 230kV bus at Bushland Interchange.

The objective of this study is to determine all adverse system impacts introduced by the addition of the Facility. The areas of study include the entire SPS control area and all first tier interconnected companies, which include the transmission systems of Sunflower Electric Power Corporation, West Plains Energy and AEP West.

Additionally, cost estimates associated with all the necessary upgrades required to mitigate any adverse impacts will also be provided, if such system upgrades are deemed necessary.

2. Study Methodology

A total of eleven seasonal models with firm transactions throughout the SPP region were used for this study. The load flow cases used were derived from the 2005 Model Series which include the 2006 April Minimum (06AP), 2006 Spring Peak (06G), 2006 Summer Peak (06SP), 2006 Summer Shoulder (06SH), 2006 Fall Peak (06FA) and 2006 Winter Peak (06WP). The 2007 and 2010 load flow cases included the Summer Peak and Winter Peak models (07SP, 07WP, 10SP and 10WP). Finally, the last model is the 2015 Summer Peak (15SP) model, which is the end of the current planning horizon. These load flow cases are those presented to the Southwest Power Pool (SPP) in January of 2005, and include firm transmission service requests granted by the SPP for the respective model year/season. The active transmission service requests were added to the different models by the SPP in accordance with the respective start and ending dates. Each of the load flow cases includes two scenarios: the first set of cases has SPS exporting power outside their control area, and the second set has SPS importing power from outside their control area making it a total of 22 seasonal models.

A comparative study approach was used to determine the system impacts caused by this proposed Facility for the seasonal cases considered. The base case models include the cases with transmission service requests granted by the SPP for the respective year/season studied, without the Facility. All additional transfer cases include the proposed Facility at 160 MW output and modeled as noted in the System

Impact Study (SPP #GEN-2002-022, dated November 2003). As for the power factor at the point of interconnection, it was at 99 percent with the real power output at 158.6 MW and taking in approximately 21 MVAR from the local transmission system. As for the violations from these contingencies, they were compared to their respective violation, under the same contingency, in the base case and the impact was thus determined.

This study was performed using the Power Technologies, Inc. (PTI) Power System Simulator/Engineering (PSS/E) program and contains a steady-state analysis using AC Contingency Checking (ACCC) with a Fixed Slope Decoupled Newton–Raphson (FDNS) solution. The study was done ensuring that current SPS/SPP criteria and NERC Planning Standards are fulfilled. As an example, for system intact conditions bus voltages must be maintained between 0.95 – 1.05 per-unit of their nominal value and thermal system intact conditions must not exceed their designated A-rating. For contingencies, the voltages are allowed to deviate between 0.90 – 1.10 per-unit of their nominal value. An exception to the criteria is the 230kV bus voltage at Tuco Interchange, which has a voltage stability limit of 0.925 per-unit of nominal, during single element contingencies. Additionally, the loading on transmission system equipment cannot exceed 100% of the system emergency B-rating.

For any transmission system element to be considered as having a thermal impact, the element must show up as an impact in the transfer cases with a TDF¹ greater than 3%. A solution to alleviate the impacted element must then be available, whether as an operating procedure or a system upgrade that alleviates the thermal impact.

As for the generation patterns used for this study, native SPS generation equal to the output of the Facility was re-dispatched in accordance with guidelines set forth by SPP and SPS. In each of the study cases, the generation pattern varies, taking into account both seasonal system load conditions and generator maintenance schedules.

3. Results

The results are for the study cases studied and do not indicate the absence of both thermal and voltage violations for the complete range of load, generation patterns and network transmission service currently granted by the SPP. The violations observed throughout the SPS transmission system could result in additional violations or the absence of present violations noted in this study, assuming different generation patterns and transmission system transfers are granted.

3.1. System Intact Conditions

System intact violations within the SPS control area are present in some of the study models. During the study process, several exploratory projects currently under investigation were used to confirm that the system intact violations could be mitigated. Since most of the violations occur in the later year models, these transmission system projects are subject to change in order to meet present and long-term goals, provided the same level of system reliability and safety is met. As

¹ Transmission Distribution Factor

such, these repetitive system violations were ignored in the study results, except as mentioned.

3.2. Non-Convergent Contingencies

The contingency producing non-convergent results is the loss of the 345kV transmission circuit from Tolk Station to Eddy County Interchange. As a result of displacing traditional generation in the southwest portion of the transmission system to accommodate the added wind generation in the Texas Panhandle, reactive power is diminished in New Mexico. This causes voltage collapse issues on the New Mexico transmission system and the problem is more evident during periods of light load when less traditional generation is required to serve the light load condition. To mitigate the problem, capacitor banks are required to replace the reactive power that has been displaced. Although the addition of static capacitor banks solves the voltage collapse issue, the dynamic response of the displaced reactive power is lost.

3.3. Thermal/Voltage Contingency Analysis

The addition of this new network resource during the contingency analysis of this study showed adverse impacts within the SPS control area. Impacts in excess of the 3% TDF within the control area of the first tier companies were not evident. The thermal impact along with associated contingency is listed in Table 3 of Appendix A. Since the Facility is scheduled to be in-service towards the end of 2006, the 2006 impacts shown in Table 3, triggered by the addition of the Facility, are considered unrealistic.

Assuming that commercial operation of the Facility will be towards the end of 2006, capacitor banks on the 230kV bus at Chaves County Interchange and the 115kV bus at Gaines County Interchange are required. The 50 MVAR capacitor bank at Chaves County and 14.4 MVAR capacitor bank at Gaines County will require that they be in-service prior to the 2007 winter peak season. These capacitors, in addition to having both the Jal Substation and Seven Rivers Interchange capacitors ON, are required to mitigate the non-convergence of the Tolk–Eddy 345kV contingency.

Other required system upgrades include a second 230/115kV autotransformer at Lea County Interchange to mitigate the thermal overload of the Cunningham and existing Lea County 230/115kV autotransformers. A 50 MVAR capacitor bank on the 230kV bus at Potash Junction is also required to mitigate the non-convergence contingency of the Tolk–Eddy 345kV transmission line. Both items need to be in-service by December 1, 2010.

The remaining upgrades need to take place before the summer peak of 2015. These upgrades include a second 230/115kV autotransformer at Tuco Interchange and the replacement of an existing 150 MVA 230/115kV autotransformer at Chaves County Interchange with a 225 MVA unit. These two projects mitigate the overload on the existing autotransformers at their respective locations. To mitigate the overload on the 115kV line from Randall County Interchange to Happy, a new 115kV transmission line is required to alleviate this north–south interface constraint. The

new 115kV transmission line (20 miles) will tie Kress Interchange to a new 230/115kV Interchange just north of Hart, TX. For the thermal overload of the 115kV line from Hereford to Friona, it is recommended that this circuit be re-conducted to 397 AS to mitigate the loss of a Tolk to Roosevelt 230kV line, and 50 MVAR capacitors be installed on the Roosevelt and Eddy County 230kV buses for voltage support.

A check was also performed on the system intact north-south interface power flows to verify that the 800 MW stability limit was not violated. In both the export and import models the north-south interface power flows was well within the designated stability limit. The power flow of the north-south interface for the cases studied is supplied in Table 4 and Table 5 of Appendix A, for both the import and export cases, respectively.

4. Requirements For Transmission Service

The requirements for granting transmission service for this proposed Facility includes the transmission system upgrades noted in Table 2. These upgrades are required to mitigate adverse system conditions created by the addition of the Facility, as determined by this study. These transmission system upgrades however, at the discretion of SPS, may be change to develop an improved transmission system plan that encompasses other projects while maintaining present and long-term goals and meeting equivalent reliability and safety measures.

5. Conclusion

Network transmission service for this proposed network resource should be granted provided the transmission upgrades outlined in this study are built by or before the required in-service date.

Appendix A

Table 3, Thermal Violations, Before System Upgrades

Study Case	From Area	To Area	Monitored Branch Over 100% Rate B	Rate <MVA>	BC % Loading	TC % Loading	% TDF	Outaged Branch Causing Overload	ATC (MW)
06SH	SPS	SPS	51014 OSAGE--3 115 to 51080 CANYNE3 115 CKT 1	99	88.5	109.9	13.2	50993 BUSHLND6 230 to 51111 DFSMTH6 230 CKT 1	86
06SP	SPS	SPS	51014 OSAGE--3 115 to 51080 CANYNE3 115 CKT 1	99	75.4	100.9	15.8	50993 BUSHLND6 230 to 51111 DFSMTH6 230 CKT 1	154
10WP	SPS	SPS	52204 LEACO3 115 to 52205 LEACO6 230 CKT 1	168	85.1	119.7	36.4	52208 CUNNINH3 115 to 52209 CUNNINH6 230 CKT 1	69
10WP	SPS	SPS	52204 LEACO3 115 to 52205 LEACO6 230 CKT 1	168	79.5	110.0	32.1	51952 SNANDR3 115 to 51962 DNVRS3 115 CKT 1	107
10WP	SPS	SPS	52204 LEACO3 115 to 52205 LEACO6 230 CKT 1	168	73.7	104.0	31.8	51930 SHEL23 115 to 51938 SHLC3T3 115 CKT 1	139
10WP	SPS	SPS	52204 LEACO3 115 to 52205 LEACO6 230 CKT 1	168	73.1	103.3	31.7	51928 ALLRDT3 115 to 51938 SHLC3T3 115 CKT 1	142
10WP	SPS	SPS	52204 LEACO3 115 to 52205 LEACO6 230 CKT 1	168	75.2	105.2	31.5	51930 SHEL23 115 to 51962 DNVRS3 115 CKT 1	132
10WP	SPS	SPS	52204 LEACO3 115 to 52205 LEACO6 230 CKT 1	168	72.2	101.8	31.0	51952 SNANDR3 115 to 51996 AMERADA3 115 CKT 1	150
10WP	SPS	SPS	52208 CUNNINH3 115 to 52209 CUNNINH6 230 CKT 1	168	87.1	106.5	20.3	52204 LEACO3 115 to 52205 LEACO6 230 CKT 1	107
10WP	SPS	SPS	52029 GAINES2 69 to 52045 TENNECO2 69 CKT 1	64	77.9	123.5	18.3	51952 SNANDR3 115 to 51962 DNVRS3 115 CKT 1	78
10WP	SPS	SPS	51966 MUSTGN3 115 to 51969 MUSTANG6 230 CKT 1	150	95.1	101.0	5.4	51891 YOAKUM6 230 to 52205 LEACO6 230 CKT 1	134
15SP	SPS	SPS	51532 TUCO3 115 to 51533 TUCO6 230 CKT 1	252	95.0	101.3	9.9	51533 TUCO6 230 to 51699 JONES6 230 CKT 1	127
15SP	SPS	SPS	51532 TUCO3 115 to 51533 TUCO6 230 CKT 1	252	98.6	104.8	9.7	51320 SWISHER3 115 to 51321 SWISHER6 230 CKT 1	36
15SP	SPS	SPS	51532 TUCO3 115 to 51533 TUCO6 230 CKT 1	252	98.6	104.8	9.7	51316 KRESS3 115 to 51320 SWISHER3 115 CKT 1	35
15SP	SPS	SPS	51532 TUCO3 115 to 51533 TUCO6 230 CKT 1	252	98.5	104.4	9.2	51646 CARLISL3 115 to 51647 CARLISL6 230 CKT 1	41
15SP	SPS	SPS	51532 TUCO3 115 to 51533 TUCO6 230 CKT 1	252	104.0	109.7	9.0	51533 TUCO6 230 to 51647 CARLISL6 230 CKT 1	0
15SP	SPS	SPS	51106 HEREFD3 115 to 51122 FRIONA3 115 CKT 1	99	98.3	106.8	5.3	51203 ROOSEVL6 230 to 51435 TOLKE6 230 CKT 2	33
15SP	SPS	SPS	51106 HEREFD3 115 to 51122 FRIONA3 115 CKT 1	99	99.0	107.5	5.3	51203 ROOSEVL6 230 to 51437 TOLKW6 230 CKT 1	18
15SP	SPS	SPS	51106 HEREFD3 115 to 51122 FRIONA3 115 CKT 1	99	94.4	102.5	5.1	51202 ROOSEVL3 115 to 51203 ROOSEVL6 230 CKT 1	110
15SP	SPS	SPS	51020 RANDALL3 115 to 51082 PALODU 3 115 CKT 1	99	97.0	103.5	4.1	51316 KRESS3 115 to 51320 SWISHER3 115 CKT 1	74
15SP	SPS	SPS	51020 RANDALL3 115 to 51082 PALODU 3 115 CKT 1	99	96.9	103.5	4.1	51320 SWISHER3 115 to 51321 SWISHER6 230 CKT 1	75
15SP	SPS	SPS	51082 PALODU 3 115 to 51302 HAPPY3 115 CKT 1	99	94.6	101.1	4.0	51320 SWISHER3 115 to 51321 SWISHER6 230 CKT 1	133
15SP	SPS	SPS	51082 PALODU 3 115 to 51302 HAPPY3 115 CKT 1	99	94.6	101.1	4.0	51316 KRESS3 115 to 51320 SWISHER3 115 CKT 1	132
15SP	SPS	SPS	51020 RANDALL3 115 to 51021 RANDALL6 230 CKT 1	258.75	99.8	102.2	4.0	50915 NICHOL6 230 to 51041 AMARLS6 230 CKT 1	14

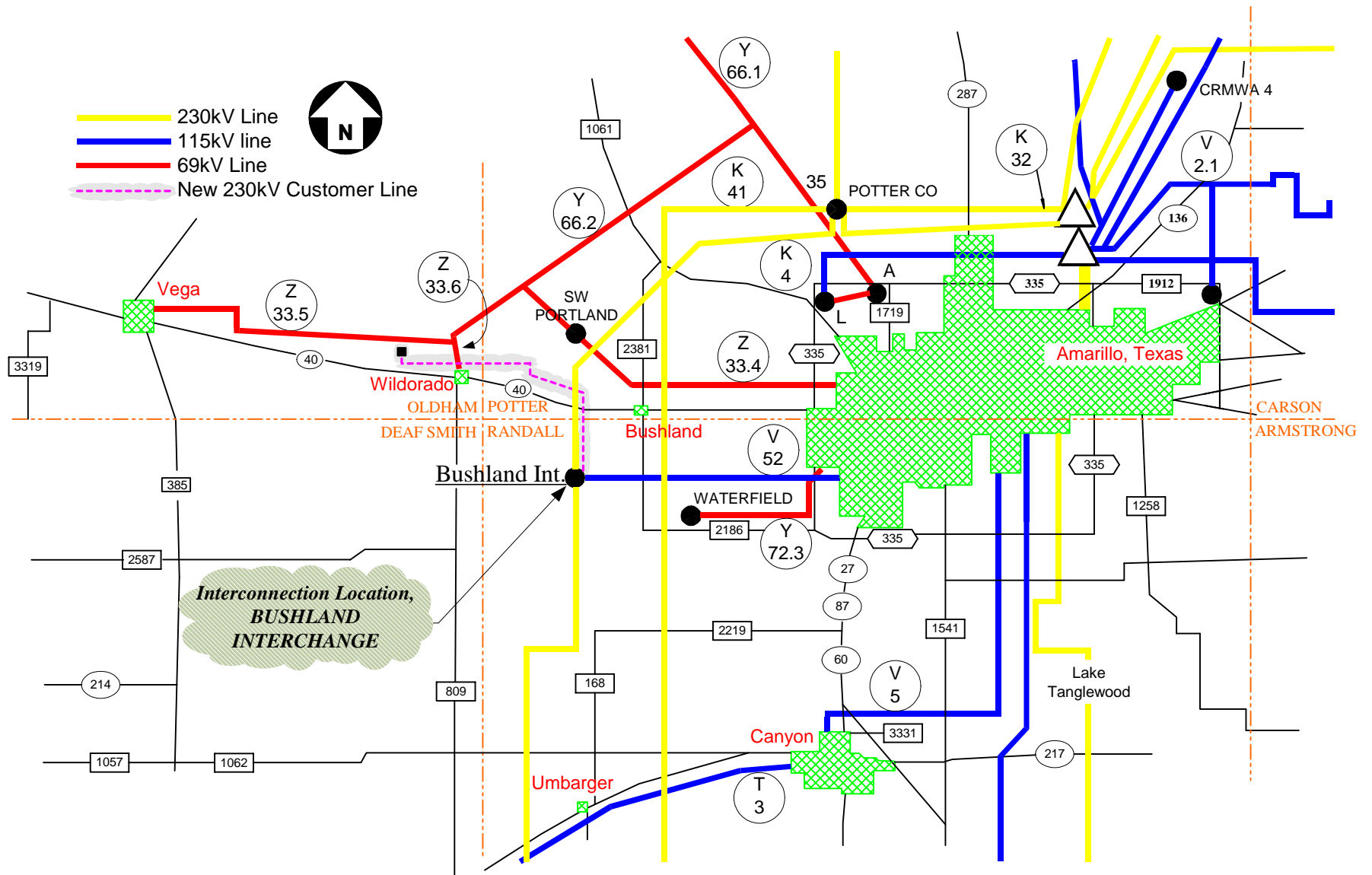


Figure 1 Interconnection Point

Table 4, System Intact North-South Flows, Import Cases

Model Name	Case Name	Flow (MW)
2006 April Minimum	06AP2(00)-50524-B010.sav	635.8
2006 Fall Peak	06FA2(00)-50524-B010.sav	650.3
2006 Spring Peak	06G2(00)-50524-B010.sav	523.2
2006 Shoulder	06SH2(00)-50524-B010.sav	646.6
2006 Summer Peak	06SP2(00)-50524-B010.sav	584.6
2006 Winter Peak	06WP2(00)-50524-B010.sav	679.0
2007 Summer Peak	07SP2(00)-50524-B010.sav	523.2
2007 Winter Peak	07WP2(00)-50524-B010.sav	634.4
2010 Summer Peak	10SP2(00)-50524-B010.sav	515.9
2010 Winter Peak	10WP2(00)-50524-B010.sav	552.4
2015 Summer Peak	15SP2(00)-50524-B010.sav	432.1

Table 5, System Intact North-South Flows, Export Cases

Model Name	Case Name	Flow (MW)
2006 April Minimum	06AP1(00)-50524-A010.sav	83.8
2006 Fall Peak	06FA1(00)-50524-A010.sav	311.1
2006 Spring Peak	06G1(00)-50524-A010.sav	138.9
2006 Shoulder	06SH1(00)-50524-A010.sav	166.1
2006 Summer Peak	06SP1(00)-50524-A010.sav	265.6
2006 Winter Peak	06WP1(00)-50524-A010.sav	170.5
2007 Summer Peak	07SP1(00)-50524-A010.sav	229.5
2007 Winter Peak	07WP1(00)-50524-A010.sav	66.2
2010 Summer Peak	10SP1(00)-50524-A010.sav	164.3
2010 Winter Peak	10WP1(00)-50524-A010.sav	131.7
2015 Summer Peak	15SP1(00)-50524-A010.sav	47.3

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