ACE DIVERSITY INTERCHANGE
Evaluation
February 2008

Background

In 2006, five control areas or balancing authorities (British Columbia Transmission Corporation, Idaho Power Company, NorthWestern Energy, PacifiCorp-East and PacifiCorp-West) entered into a Memorandum of Understanding and thereafter, an agreement (the ACE Diversity Interchange Agreement) in order to implement a software tool, ACE Diversity Interchange (ADI), that assists the balancing authorities in their management of generation and load within parameters established by NERC and WECC. The mechanics of ADI are set forth in Exhibit A to the ACE Diversity Interchange Agreement.[1]

As part of the ACE Diversity Interchange Agreement, these balancing authorities and the host for the project, British Columbia Transmission Corporation (BCTC), committed to evaluating ADI in order to ensure efficient and reliable implementation. The purpose of this document is to communicate the results of the evaluations that have been performed.

ADI was implemented March 31st for NorthWestern Energy, PacifiCorp-E, and PacifiCorp-W. Idaho Power Company implemented ADI June 26th. ADI expanded in January 2008 to include Arizona Public Service Co., and in February 2008 to include Nevada Power, Sierra Pacific Power, and Public Service Company of New Mexico although ADI is not yet operational for the new participants. Any balancing authority within the Western Interconnection,

[1] The ACE Diversity Interchange Agreement (including its exhibits) is available on the internet at http://nttg.biz/site/index.php?option=com_content&task=view&id=14&Itemid=83.

adjacent to and interconnected with one or more of these balancing authorities is eligible to participate in ADI.

Impacts Associated with ADI

While the value of ADI is derived from the diversity of many balancing authorities' Area Control Errors, the benefits are particular to a given balancing authority due to the applicable governing policies, operational characteristics, resource portfolios, etc. For example, NorthWestern Energy has no rate-based generation of its own, PacifiCorp has a dynamic overlay between its two balancing authorities and, the resource portfolios and development plans of each of the balancing authorities are quite different. As a result, the participants have not evaluated all of the same aspects of ADI but instead, all have evaluated some aspects including:

(1) the extent of the ADI corrections;
(2) the impact on accumulated inadvertent interchange;
(3) the impact on generator control;
(4) the impact on Control Performance; and,
(5) the extent to which ADI has been suspended.

These five elements are discussed in more detail below.

(1) What Has Been the Extent of Net and Applied ADI Corrections?

The ADI host (BCTC) summarized the ADI Corrections for a seven (7) month time period (June 21, 2007 – January 22, 2008). These data are relevant because they indicate the magnitude of the ADI corrections, both in terms of a net correction (the difference between the positive and negative corrections) and in terms of the total correction (reported as absolute values). These corrections were reported for each balancing authority, as well as for the four balancing authorities together.

The results indicate that over seven months, the net ADI correction for the combined four balancing authorities was -0.20 aMW[2] and the applied correction for all four balancing authorities combined was about 11.5 aMW. Importantly, these corrections do not necessarily translate into actual corrections applied to generator control, due to each Participating Balancing Authority Operator's Energy Management System software that ultimately directs control (and rejects corrections that would cause a change in sign (-/+) and considers AGC deadbands, etc.). The reported diversity indicates that over this time period PacifiCorp's two balancing authorities had generation that was in excess of load while Idaho and NorthWestern Energy's balancing authorities loads were typically greater than generation.

[2] The "-" or negative sign indicates net "over-generation".

	Net ADI Correction (Positive + Negative)	**Applied Correction** (Sum of Absolute Value)
Idaho Power Company	1,349 MW-hours 0.26 aMW	14,606 MW-hours 2.8 aMW
NorthWestern Energy	801 MW-hours 0.15 aMW	6,524 MW-hours 1.3 aMW
Pac-East	-2,610 MW-hours -0.50 aMW	12,680 MW-hours 2.4 aMW
Pac-West	-589 MW-hours -0.11 aMW	26,069 MW-hours 5.0 aMW
Aggregate	-1,049 MW-hours -0.20 aMW	59,879 MW-hours 11.5 aMW

Notes:
"-" values reflect generation in excess of load
Data period: June 21, 2007 - January 22, 2008

(2) How Has ADI Impacted Accumulated Inadvertent Interchange?

An objective of ADI was to keep the accumulation of inadvertent interchange small recognizing that over time the quantity should move toward zero. The ADI participants have concluded that the accumulated ADI corrections (reported above) are a reasonable proxy for assessing the contribution that ADI has had to inadvertent interchange. As anticipated, the accumulated ADI corrections are small in comparison with the participants' inadvertent interchange quantities. Again, it is noteworthy that the ADI corrections are "virtual" corrections in that it is not clear to what extent these corrections actually result in an impact on generator control.

NorthWestern Energy also compared the standard deviations in its monthly ACE values in order to answer this question. Below are the results of this analysis which contains the monthly average of daily standard deviations of NorthWestern Energy's ACE (with the time error term included) for each month in 2006 and 2007. The bold-faced calculations are those months when ADI was active and it appears that the standard deviation in the months with ADI reflect a lower standard deviation or in other words, less variability in ACE values and less inadvertent interchange.

Months	Standard Deviations of ACEs	
	2006	2007
January	16.7	15.8
February	16.3	14.5
March	14.9	15.6
April	21.2	**13.1**
May	18.6	**12.5**
June	21.3	**15.5**
July	25.9	**13.8**
August	15.6	**13.1**
September	14.6	**13.2**
October	14.8	**16.0**
November	15.7	15.0
December	14.6	16.6

(3) How Has ADI Impacted Generation Control?

ADI is intended to relax generation control by enabling the participating balancing authorities to rely upon each other and the ADI algorithm to take advantage of the diversity among area control errors. The ADI project was anticipated to reduce generation changes and thereby reduce generator wear-and-tear so that generator reliability increases.

Idaho Power Company evaluated this aspect of ADI by tracking the control pulses issued by its AGC. Three time periods surrounding events of ADI suspension were evaluated: the 60 minutes prior to ADI suspension; the first 60 minutes of ADI suspension; and, the first 60 minutes after ADI resumed. Only events that met the following criteria were evaluated and are summarized below:

(1) a suspension of ADI for at least one hour; and,
(2) AGC control action not influenced by planned hourly changes in Net Scheduled Interchange.

This evaluation reflects twelve events that occurred from September 3, 2007 to January 21, 2008. The table below shows that the sum of AGC control pulse widths issued was approximately halved when ADI was in place and supports the conclusion that ADI reduces generator movement and the wear-and-tear on generators.

Accumulated Affect of ADI on Generator Control

time period	sum of pulse widths (ms)
First 60 minutes prior to ADI Suspension	342,664
First 60 minutes of ADI Suspension	620,447
First 60 minutes of ADI Resumption	342,211

(4) How has ADI Impacted Control Performance?

The ADI project was anticipated to have a neutral or beneficial impact on Control Performance Standards (CPS). PacifiCorp has tracked its CPS1 and CPS2 and CPS2 violations with and without ADI for both of its East and West balancing authorities. The impact of ADI on CPS2 has been consistently beneficial and it appears that ADI has consistently reduced CPS 2 violations.

Impact ADI has on Control Performance Standards

	PacifiCorp – East		PacifiCorp – West	
	with ADI	**without ADI**	**with ADI**	**without ADI**
October 2007				
CPS1	184.69%	184.94%	174.01%	174.41%
CPS2	95.44%	93.61%	94.90%	91.76%
CPS2 Violations	202	283	226	365
November 2007				
CPS1	189.43%	189.82%	181.27%	181.61%
CPS2	96.99%	95.95%	96.39%	93.70%
CPS2 Violations	127	171	153	267
December 2007				
CPS1	186.48%	187.35%	181.22%	181.75%
CPS2	97.54%	96.47%	95.88%	93.48%
CPS2 Violations	108	155	181	286
January 2008				
CPS1	188.01%	188.66%	181.50%	180.72%
CPS2	96.80%	96.08%	97.39%	94.82%
CPS2 Violations	138	169	113	224

(5) To What Extent Has ADI Been Suspended and Why?
The ADI Suspension Protocols direct the Host to suspend if: (1) the system fails; (2) a Participating Balancing Authority Operator's ACE data exceed a 10 second time skew; and, (3) fewer than three Balancing Authority Operators are participating. The protocols also direct the Participating Balancing Authority Operators to suspend if: (1) a Northwest Power Pool reserve sharing event is in effect; (2) a frequency problem is detected; (3) an Operating Transfer Capability (OTC) violation is in progress or expected; (4) AGC is suspended for any reason; (5) directed to do so by the Reliability Coordinator; and, (6) because of any other operating concern.[3] The ADI Suspension Protocols are posted on all Participating Balancing Authority Operators' OASISs.

BCTC has maintained suspension statistics that indicate that over the time period June 21, 2007 – January 22, 2008, ADI was suspended a total of 2,624 minutes or 0.84% of the total time (nearly 216 days) and the cause of suspension was 65% or 1,699 minutes a result of less than three Participating Balancing Authority Operators and 35% or 925 minutes, due to a NWPP Reserve Sharing Event. During this period of time there were no manual suspensions by the Host; no manual suspensions by the Participants; no suspensions for frequency deviations and, no suspensions that were directed by the Reliability Coordinator.

ADI Algorithm Parameters
The ADI algorithm has a number of parameters that can be adjusted, at the direction of the ADI Operating Group. Below, the parameters, all of which are configurable, are listed.

- ACE calculated: every 2 seconds
- ACE values sent to Host: every 1 second
- AGC signaled (by Participating Balancing Authority Operators): (at least) every 4 seconds
- Acceptable Time Skew: less than or equal to 10 seconds
- ADI Limit/Participating Balancing Authority: 25 MW[4]
- ADI Adjustment cannot cause a sign change
- Minimum Available ACE: 1 MW
- Minimum Number of Participating Balancing Authorities: 3

In the event, the ADI Operating Group decides to change one or more of the parameters, the ADI Change Management Form would be prepared. Below is an example of the form that is available for this purpose.

[3] The ADI Operating Group is evaluating the suspension protocols in light of the balancing authorities that joined the agreement in 2008.
[4] The ADI Operating Group is evaluating increasing the 25 MW limit to 30 MW starting March 1, 2008.

ACE DIVERSITY INTERCHANGE (ADI)
CHANGE MANAGEMENT FORM

Change Sequence: Number 1

Change Requested: Initiator of Change Request: _____ Date: _____

_____ Accepted/Denied_____ Greg Travis (GTravis@idahopower.com) Idaho Power Company _____ Accepted/Denied_____ Richard Setterstrom (Richard.Setterstrom@northwestern.com) NorthWestern Energy _____ Accepted/Denied_____ Robert Williams (Robert.Williams@pacificorp.com) PacifiCorp – East _____ Accepted/Denied_____ Robert Williams (Robert.Williams@pacificorp.com) PacifiCorp – West

Host Accepted/Denied: _____ (comments) _____ Thomas Fung (Thomas.Fung@bctc.com) or Greg Dwernychuk (Greg.Dwernychuk@bctc.com) BCTC

Implementation Date:

Conclusion

The ADI project is working well in that the effort has not caused any negative impacts on operations or reliability and the anticipated benefits have been confirmed. The ADI Agreement and Operating Groups have concluded that while further evaluation is not necessary, continued monitoring of the project has value and will be done as new participants join and, to determine whether changes in parameters would be beneficial.