CASE RESULTS

When the OD-VS workshop team designed the event data-sets, these are the characteristics of each event as determined by the team's analysis.

Oscillation Detection Case 1

	Event A	Event B	Event C	Event D	Event E
Time Start, sec	41.1	114.6	142.6	416.8	538.6
Window, sec	10	10	10	10	10
Signals Used	Power	Power	Power	Power	Power
Mode 1 Frequency [Hz]	0.22	0.233	0.246	0.251	0.232
Mode 1 Damping	15.17%	11.05%	11.84%	19.7%	13.96%
Mode 2 Frequency [Hz]	0.386	0.386	0.393	0.388	0.38
Mode 2 Damping	10.42%	10.9%	11.2%	12.2%	11.15%
Mode 3 Frequency [Hz]	0.675	0.683	0.689	0.693	0.67
Mode 3 Damping	10.3%	13.51%	14.48%	12.24%	14.4%
Mode 4 Frequency [Hz]	0.887	0.885	0.858	0.847	0.902
Mode 4 Damping	12.57%	12.8%	17.85%	12.88%	15.52%

Oscillation Detection Case 2

Source of Oscillation (Generator)	Generator 3
Time When Oscillation Detected [s]	245
Signals Used	Frequency, Real Power
Forced Oscillation Mode Frequency	1.25 Hz
Forced Oscillation Mode Damping Ratio	Sustained - (0 %)
Algorithm Used	Oscillation Detection Monitor

Voltage Stability Case 1

First Time of Unacceptable Operating Conditions	303.4 sec
Shunt Cap Switching Time	247.8 sec
Pre-Switching Real Power Margin	343.75 MW
Post-Switching Real Power Margin	400.00 MW
Real Power Margin @ 0 sec	618.75 MW
Real Power Margin @ 150 sec	506.25 MW
Real Power Margin @ 305 sec	112.50 MW
Real Power Margin @ 445 sec	400.00 MW
Description of Method	PV Analysis

Voltage Stability Case 2

First Time of Insecure (N-1) Operating Condition	1312 seconds
Reason(s) for Insecurity	Voltage Violation in Zone 10 – N-1 Outages
First Time of Unacceptable N-0 Operating Condition	None
Reason for Unacceptable Condition	N/A
Time of Instability	4012 seconds
Security Margin (Transfer into Zone 10) @ 1500 sec	50.0 MW
Stability Margin (Transfer into Zone 10) @ 1500 sec	250.0 MW
Security Margin (Transfer into Zone 10) @ 4000 sec	0.0 (-) – Insecure
Stability Margin (Transfer into Zone 10) @ 4000 sec	0.0 (-) – N-1 Unstable
Assumptions Used	50/50 Pickup
Noticeable System Changes	1. Line 115-130 Trips 2. Line 115-130 Returned to Service 3. Bus 122 STATCOM Trips 4. Bus 122 STATCOM Switched Back In 5. Bus 112 Shunt Cap Switches In 6. Line 116-120 Trips - Unstable
Description of Method	PV, Contingency Analysis

NASPI North American SynchroPhasor Initiative

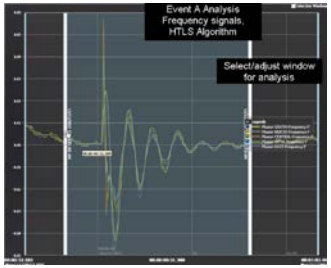
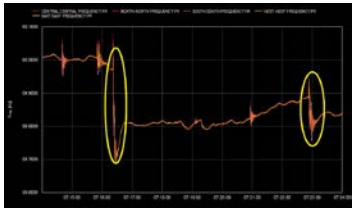
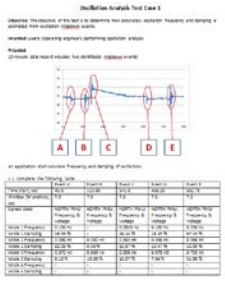
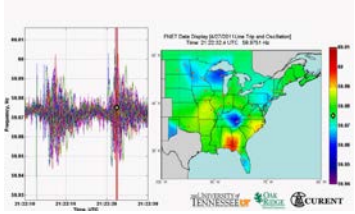
OSCILLATION DETECTION CASE 1
RESULTS AND COMMENT SHEET

Participant	Category	Event A	Event B	Event C	Event D	Event E
Alstom Grid	Time Oscillation Starts [sec]	41.8	115	145	419	539
	Time Window Used [sec]	11.7	14	15	11	9
	Predominant Mode 1 Frequency	0.382 Hz	0.376 Hz	0.385 Hz	0.385 Hz	0.384 Hz
	Predominant Mode 1 Damping Ratio	12.2 %	9.7v	17 %	10.1 %	10.53 %
	Predominant Mode 2 Frequency	0.23 Hz	0.734 Hz	0.109 Hz	0.246 Hz	0.686 Hz
	Predominant Mode 2 Damping Ratio	13.5 %	15 %	16.45 %	16.32 %	9.51 %
Electric Power Group	Time Oscillation Starts [sec]	40.9	114.4	142.2	416.8	533.3
	Time Window Used [sec]	10	10	11	10	14
	Predominant Mode 1 Frequency	0.38 Hz	0.38 Hz	0.40 %	0.38 Hz	0.40 Hz
	Predominant Mode 1 Damping Ratio	9.6 %	7.78 %	9.42 %	9.7 %	5.97 %
	Predominant Mode 2 Frequency	0.73 Hz	0.76 Hz	0.73 Hz	0.72 Hz	0.71 Hz
	Predominant Mode 2 Damping Ratio	6.68 %	4.35 %	6.32 %	5.10 %	4.50%
OSIsoft/UCSD	Time Oscillation Starts [sec]	40.5	110.65	141.9	416.25	532.75
	Time Window Used [sec]	7.5	7.5	7.5	7.5	7.5
	Predominant Mode 1 Frequency	0.150 Hz	-	0.0820 Hz	0.160 Hz	0.236 Hz
	Predominant Mode 1 Damping Ratio	18.38 %	-	29.24 %	18.43 %	97.15 %
	Predominant Mode 2 Frequency	0.389 Hz	0.380 Hz	0.393 Hz	0.389 Hz	0.389 Hz
	Predominant Mode 2 Damping Ratio	10.09 %	9.38 %	10.67 %	10.47 %	10.55 %
U. Tennessee – Knoxville	Time Oscillation Starts [sec]	42	112	143	418	537
	Time Window Used [sec]	23	28	27	22	28
	Predominant Mode 1 Frequency	0.38 Hz	0.37 Hz	0.39 Hz	0.39 Hz	0.38 Hz
	Predominant Mode 1 Damping Ratio	11.95 %	9.13 %	11.91 %	10.55 %	9.02 %
	Predominant Mode 2 Frequency	0.25 Hz	0.25 Hz	0.23	0.21 Hz	0.21 Hz
	Predominant Mode 2 Damping Ratio	10.95 %	15.82 %	11.36 %	8.09 %	8.30 %
Schweitzer Engineering Laboratories* NOTE -- SEL's code for this had an error that has been corrected in the corrected video.	Time Oscillation Starts [sec]	35	105	135	405	530
	Time Window Used [sec]	15	15	15	15	15
	Predominant Mode 1 Frequency	0.337 Hz	0.429 Hz	0.373 Hz	0.463 Hz	0.401 Hz
	Predominant Mode 1 Damping Ratio	1.783%	4.526%	6.825%	5.461%	5.488%
	Predominant Mode 2 Frequency	1.138 Hz	1.497 Hz	1.325 Hz	1.406 Hz	1.482 Hz
	Predominant Mode 2 Damping Ratio	1.263%	0.254%	0.225%	1.211%	0.861%

NASPI North American SynchroPhasor Initiative

OSCILLATION DETECTION CASE 1

Review Comments: Please provide any comments regarding the tools used. Clarity and readability of displays? Effective navigation? Usefulness of answer? Something excellent? Anything irritating? Please note these in the spaces below.

Alstom Grid 	**EPG** 
OSIsoft/UCSD 	**UTK** 

SEL

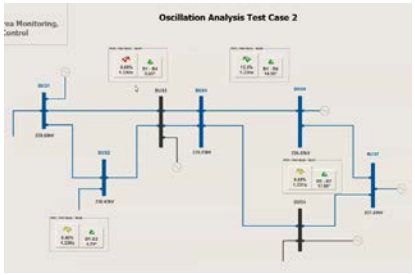
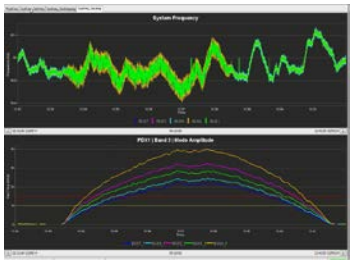
OSCILLATION DETECTION CASE 1
CLOSING COMMENTS?

OSCILLATION DETECTION CASE 2
RESULTS AND COMMENT SHEET

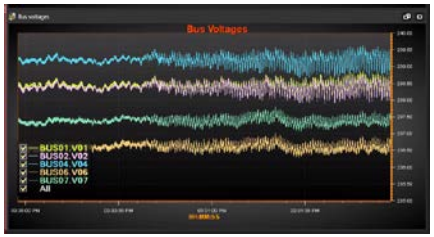
	Schweitzer Engineering Labs	**ABB**	**Space-Time Insight**	**Electric Power Group**	**Alstom Grid**
Source of Oscillation (Generator)	Generator 1	Not provided by tool	Generator 1	Generator 6	Generator 6
Time When Oscillation Detected [s]	230	234	232	248 s	10
Signals Used	Gen 1 Real Power	Angle differences, Reference - Bus 1	Voltage Magnitudes	Generator Real Powers	Bus Frequency, Line MW
Forced Oscillation Mode Frequency	1.263 Hz	1.3 Hz	1.25 Hz	1.25 Hz	1.25 Hz
Forced Oscillation Mode Damping Ratio	0.103 %	Near 0	-1% < DR < 2% throughout event	0.05 %	0.24 %
Algorithm Used	Total Least Squares	Kalman Filtering, subspace identification	STI Oscillation Detection Algorithm	Mode Meter	Alstom Phasor Dynamics eXtraction (PDX)

OSCILLATION DETECTION CASE 2

Review comments: Please provide any comments regarding the tools used. Clarity and readability of displays? Effective navigation? Usefulness of answer? Something excellent? Anything irritating? Please note these in the spaces below.

Schweitzer Engineering Labs 	**ABB** 
Space-Time Insight 	**Alstom Grid** 

EPG



OSCILLATION DETECTION CASE 2
CLOSING COMMENTS?

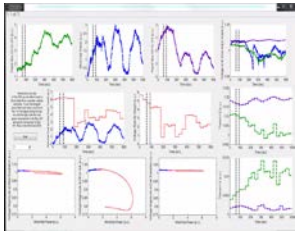
VOLTAGE STABILITY CASE 1
RESULTS AND COMMENT SHEET

	Electric Power Group	RPI	V&R	Alstom Grid	ABB
First Time of Unacceptable Operating Conditions	170	None	303.5	None	None
Shunt Cap Switching Time	247	247.8	245	247.8	248
Pre-Switching Real Power Margin	23.53 kV/100 MW	411	335	29	92
Post-Switching Real Power Margin	7.5 kV/100 MW	461	391	86	92
Real Power Margin @ 0 sec	0.38 kV/100 MW	645	617	Not Available	196
Real Power Margin @ 150 sec	3.1 kV/100 MW	520	515	76	193
Real Power Margin @ 305 sec	6 kV/100 MW	190	111	46	32
Real Power Margin @ 445 sec	2.9 kV/100 MW	388	385	69	107
Description of Method	Voltage Sensitivity to Change in Real Power	AQ Bus Method	Linear State Estimation, PV/QV Analysis	RVII – local voltage instability detector	Equivalencing, PV analysis

Review comments: Clarity and readability of displays? Effective navigation? Usefulness of answer? Something excellent? Anything irritating?

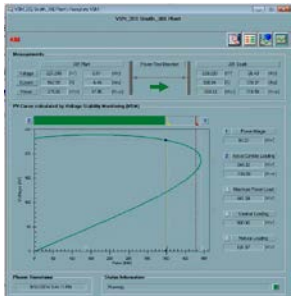
Electric Power Group

RPI



V&R Energy

ABB



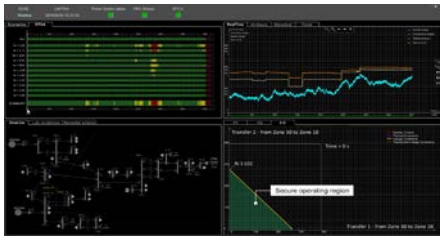
Alstom Grid

VOLTAGE STABILITY CASE 1
CLOSING COMMENTS?

VOLTAGE STABILITY CASE 2
RESULTS AND COMMENT SHEET

	Alstom Grid	V&R Energy
First Time of Insecure (N-1) Operating Condition	2410	1312
Reason(s) for Insecurity	Line L02	Contingency L02 Contingency L11
First Time of Unacceptable N-0 Operating Condition	4064	None
Reason for Unacceptable Condition	Voltage Violation @ Bus 113	N/A
Time of Instability	4070	4012
Security Margin (Transfer into Zone 10) @ 1500 sec	730	40
Stability Margin (Transfer into Zone 10) @ 1500 sec	760	250
Security Margin (Transfer into Zone 10) @ 4000 sec	170	Negative
Stability Margin (Transfer into Zone 10) @ 4000 sec	200	Negative
Assumptions Used	-Total generation is the sum of three branches: • Bus 151 to Bus 156 CKT 1 • Bus 151 to Bus 156 CKT 2 • Bus 136 to Bus 130 CKT 1 -Upper bound voltage limit criteria was relaxed -Bus 136 generator Pmax increased from 1000MW to 1070MW for transfer analysis	Ignored 500kV equivalents & their voltages
Noticeable System Changes	At t=502s, line 130-115 circuit 1 tripped and reconnected at t=800s At t=2246s, first shunt cap (100 MVAR at bus 112) gets switched in at load in zone 10=912MW At t=2868s, Second shunt cap (125 MVAR at bus 120) gets switched in at load in zone 10=1152MW	Event 1 - 502 s. Switching off line 130-115 “1”. Event 2 - 802 s. Line 130-115 “1” switched back. Event 3 - 1302 s. Switching off FACTS at bus 122. Event 4 - 1602 s. Switching in FACTS at bus 122. Event 5 - 2462 s. Shunt cap switching at bus 112. Event 6 - 2868 s. ("non-switching"). Increase in transformer 116-117 flow. FACTS reaches reactive limit, loses control of bus 116 voltage. Event 7 - 4012 s. Contingency 116-120 which causes system collapse at 4012 s. There is no State Estimator solution after this N-1 contingency occurs.
Description of Method	PV Analysis	Linear State Estimation, AC Contingency Analysis, VS assessment (PV/QV, Sensitivity)

Review comments: Clarity and readability of displays? Effective navigation? Usefulness of answer? Something excellent? Anything irritating?

ALSTOM GRID 	**V&R ENERGY** 

VOLTAGE STABILITY CASE 2
CLOSING COMMENTS?