Modeling RAS & SPS

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  - Remedial Action Schemes (RAS)
    - also known as Special Protection Schemes
    - fast acting controls that insure adequate power system performance for contingencies
    - allow for “brinkmanship” operation
    - provide a substitute for “wires in the air”

Remedial Action Schemes

- RAS
  - Consists of the following
    - Gen tripping, load tripping, DC tie tripping, line tripping, reactive switching, etc
  - Usually armed by pre-contingency operation past some setpoint
    - Tested for by boolean logic and if-then filters
  - May operate in a post contingency environment
    - Overcurrent line relays, undervoltage load shedding, etc

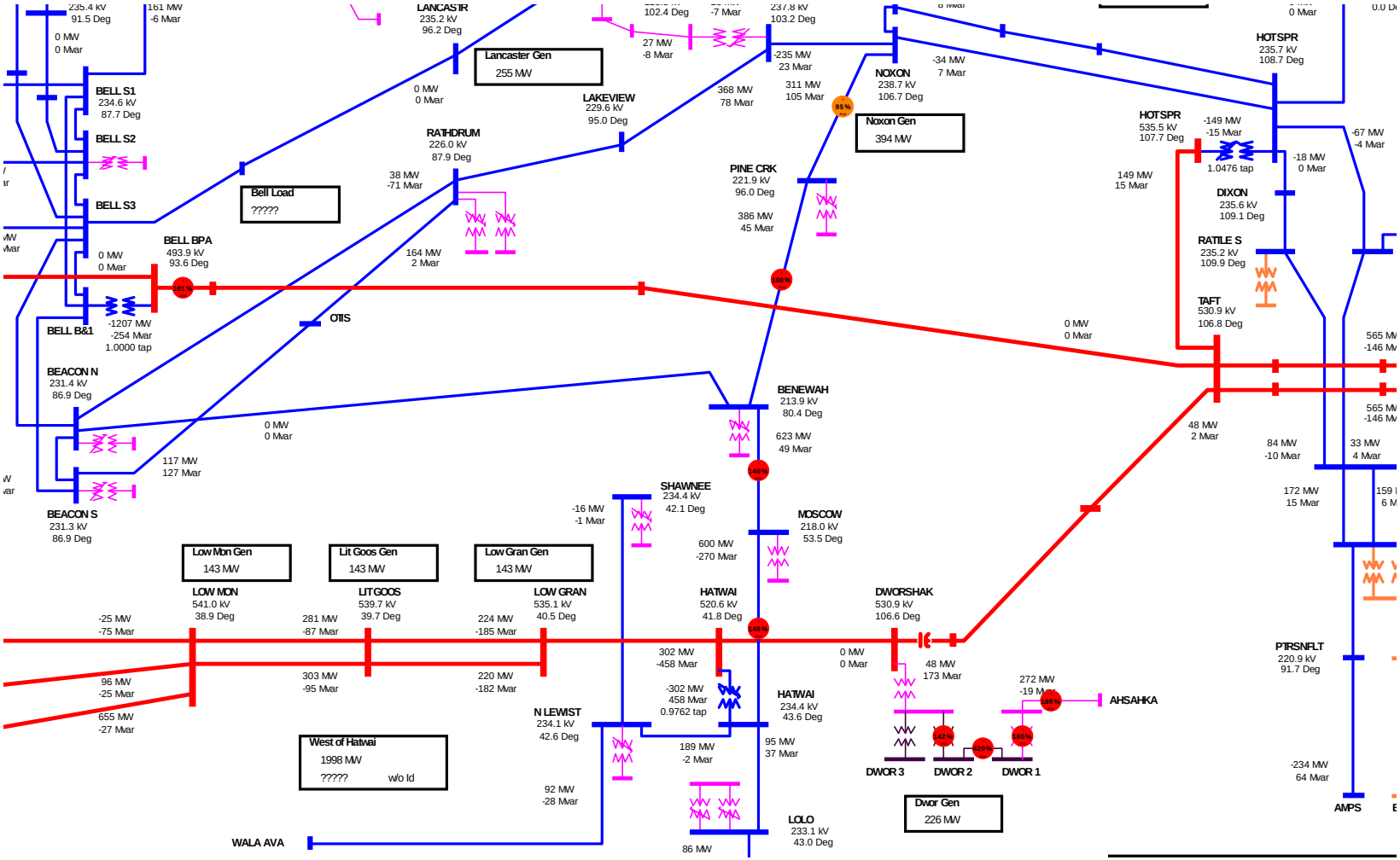
RAS in the WECC

- Hydro rich system
  - Tends to have excess generation in NW
  - For line loss gen tripping is the norm
- Gen tripping for single line loss
  - can be as high as 2800 MW for N-1
  - RAS controllers are redundant
  - RAS communications are redundant
  - RAS is fast (<8 cycles)

Contingency Analysis

- Outstanding tool within Simulator
  - Models nearly ALL aspects of contingency operations (N-1, N-2, RAS, etc)
  - Allows for:
    - model conditions (if-then testing)
    - model filters (boolean logic on model conditions)
    - model expressions (equation based RAS)
    - “governor” powerflow (makeup power for gen tripping)
    - bus load “throwover” (load switching)

Hatwai-Dworshak 500 kV



Contingency Syntax

```
//-------------------------------------------------------------------------------
// THE FOLLOWING SECTION CONTAINS A DESCRIPTION OF THE CONTINGENCY RECORDS.
//-------------------------------------------------------------------------------
DATA (CONTINGENCY, [CTGLabel,CTGSkip,CTGProc,CTGSolved,LoadMW,QVAutoplot])
{
"01 (N-1):  Dworshak - Hatwai 500 kV (no RAS)" "NO " "YES" "YES"  0.000 "NO "
  <SUBDATA CTGElement>
    "BRANCH 40369 40521 1  OPEN" "" CHECK
  </SUBDATA>
"02 (N-1):  Dworshak - Hatwai 500 kV (w/RAS)" "NO " "YES" "YES"  0.000 "NO "
  <SUBDATA CTGElement>
    "BRANCH 40369 40521 1  OPEN" "" ALWAYS
    "CTGELEMENTBLOCK 'Dworshak RAS (gen trip & brkr opening)'" "" ALWAYS
    "CTGELEMENTBLOCK 'Libby Gen Trip (units 1-5)'" "WMH > 700" CHECK
    "CTGELEMENTBLOCK 'Garrison Reactor trip (1 in service)'" "" ALWAYS
    "CTGELEMENTBLOCK 'Miles City DC tie tripping'" "MT TO NW > 1400" CHECK
    "CTGELEMENTBLOCK 'Noxon Gen Trip (units 1-4)'" "WMH > 1300" CHECK
    "CTGELEMENTBLOCK 'Lancaster Gen Trip'" "" ALWAYS
    "CTGELEMENTBLOCK 'Benewah - Moscow 230 kV line trip (AVA)'" "Benewah - Moscow 230 > 100%" POSTCHECK
    "GEN 62048 1  OPEN" "" NEVER //Large Unit Colstrip Trip
  </SUBDATA>
```

Model Condition Syntax

```
// THE FOLLOWING MODEL CONDITIONS ARE NEEDED BY THE CONTINGENCY RECORDS WHICH FOLLOW
DATA (MODELCONDITION, [ObjectType,WhoAmI,WhoAmI:1,FilterName,FilterLogic,FilterPre,MeetsCriteria])
{
"Interface" "Interface<KEY1>West MT Hydro</KEY1>" "Interface West MT Hydro (192)" "WMH > 700" "AND" "YES" "YES"
  <SUBDATA Condition>
    FGMW >= 700.00000
  </SUBDATA>
"Interface" "Interface<KEY1>MONTANA-NW</KEY1>" "Interface MONTANA-NW (8)" "MT TO NW > 1400" "AND" "YES" "YES"
  <SUBDATA Condition>
    FGMW >= 1400.00000
  </SUBDATA>
"Interface" "Interface<KEY1>West MT Hydro</KEY1>" "Interface West MT Hydro (192)" "WMH > 1300" "AND" "YES" "NO "
  <SUBDATA Condition>
    FGMW >= 1300.00000
  </SUBDATA>
```

Contingency Block Syntax

```
//-----------------------------------------------------------------------------------
// THE FOLLOWING SECTION CONTAINS A DESCRIPTION OF THE CONTINGENCY BLOCK RECORDS.
//-----------------------------------------------------------------------------------
DATA (CTGELEMENTBLOCK, [CTGLabel,CTGSkip])
{
"Libby Gen Trip (units 1-5)" "NO "
  <SUBDATA CTGElement>
    "GEN 40653 1  OPEN" "" ALWAYS //Tripped if WMH > 700 MW
    "GEN 40653 2  OPEN" "" ALWAYS //Tripped if WMH > 700 MW
    "GEN 40653 3  OPEN" "" ALWAYS //Tripped if WMH > 700 MW
    "GEN 40653 4  OPEN" "" ALWAYS //Tripped if WMH > 700 MW
    "GEN 40653 5  OPEN" "" ALWAYS //Tripped if WMH > 700 MW
  </SUBDATA>
"Dworshak RAS (gen trip & brkr opening)" "NO "
  <SUBDATA CTGElement>
    "BRANCH 40361 40363 1  OPEN" "" ALWAYS //USACOE XJ-J sectionalizing breaker
    "GEN 40363 1  OPEN" "" ALWAYS
    "GEN 40365 1  OPEN" "" ALWAYS
  </SUBDATA>
```

Contingency Reporting

PowerWorld Simulator 10.0 OPF, ATC, PVQV, SimAuto. Status: Initialized Case: 04ls1ap_woh_test.pwb - [Contingency Analysis]

File Simulation Case Information Options/Tools LP OPF Voltage Stability Window Help

Abort | Edit Mode | Run Mode | Script Mode | Log | Single Solution - Full Newton

Options

Contingencies | Lines, Buses, Interfaces | Options | Summary

	Label	Skip	Processed	Solved	Islanded L	QV Autopl	Violations	Max Branc	Min Volt	Max Volt	Max Interf
1	01 (N-1): Dworshak - Hatwai 500 kV (no RAS)	NO	YES	YES	0.00	NO	17	418.5			
2	02 (N-1): Dworshak - Hatwai 500 kV (w/RAS)	NO	YES	YES	0.00	NO	3	112.0			

Violations

Show related contingencies | Combined Tables >

	Category	Element	Value	Limit	Percent	Assoc. Area Name	Assoc. Nom kV
1	Branch Amp	DWOR 2 (40363) -> DWOR 1 (40361) CKT 1 at DWOR 2	12552.42	2999.71	418.45	NORTHWES-NORTHWES	13.8
2	Branch Amp	AHSAHKA (40023) -> OROFINO (48303) CKT 1 at AHSAHKA	1432.56	618.02	231.80	NORTHWES-NORTHWES	115.0
3	Branch MVA	DWOR 1 (40361) -> DWORSHAK (40367) CKT 1 at DWOR 1	283.24	150.00	188.83	NORTHWES-NORTHWES	115.0
4	Branch Amp	DWORSHAK (40367) -> AHSAHKA (40023) CKT 1 at DWORSHAK	1441.52	776.01	185.76	NORTHWES-NORTHWES	115.0
5	Branch Amp	NEZPERCE (48261) -> CRAIGMNT (48091) CKT 1 at NEZPERCE	662.07	431.00	153.61	NORTHWES-NORTHWES	115.0
6	Branch MVA	DWOR (41201) -> DWOR 2 (40363) CKT 1 at DWOR	314.78	219.00	143.74	NORTHWES-NORTHWES	100.0
7	Branch Amp	MOSCOW (48249) -> HATWAI (40519) CKT 1 at MOSCOW	1726.02	1204.00	143.36	NORTHWES-NORTHWES	230.0
8	Branch Amp	BENEWAH (48037) -> MOSCOW (48249) CKT 1 at BENEWAH	1668.11	1200.01	139.01	NORTHWES-NORTHWES	230.0
9	Branch Amp	OROFINO (48303) -> NEZPERCE (48261) CKT 1 at OROFINO	781.24	618.02	126.41	NORTHWES-NORTHWES	115.0
10	Branch Amp	WESTBPA1 (41275) -> WEST (48463) CKT 1 at WEST	1164.85	997.01	116.83	NORTHWES-NORTHWES	230.0
11	Branch Amp	WEST (48463) -> WESTBPA2 (41276) CKT 1 at WESTBPA2	1115.75	997.01	111.91	NORTHWES-NORTHWES	230.0
12	Branch MVA	COULEES2 (41357) -> COULEE (40287) CKT 1 at COULEE	1455.89	1344.00	108.33	NORTHWES-NORTHWES	500.0
13	Branch Amp	CRAIGMNT (48091) -> SWEETWTR (48423) CKT 1 at CRAIGMNT	650.92	603.00	107.95	NORTHWES-NORTHWES	115.0
14	Branch Amp	SWEETWTR (48423) -> LOLO (48195) CKT 1 at SWEETWTR	627.89	603.00	104.13	NORTHWES-NORTHWES	115.0
15	Branch MVA	BELL BPA (40091) -> BELL S4 (40092) CKT 1 at BELL BPA	1247.72	1220.00	102.27	NORTHWES-NORTHWES	500.0
16	Branch Amp	PINE CRK (48317) -> BENEWAH (48037) CKT 1 at PINE CRK	1000.53	1006.00	99.46	NORTHWES-NORTHWES	230.0
17	Branch Amp	OROFINO (48303) -> JULIAETT (48169) CKT 1 at OROFINO	574.60	603.00	95.29	NORTHWES-NORTHWES	115.0

Status: Finished with 20 Violations and 0 Unsolveable Contingencies. Initial State Restored.

Refresh Displays After Each Contingency

Load | Auto Insert | Save | Other > | Start Run | Close | Help

Run Mode | Paused/Stopped | AC | Viewing Current Case

Demo

- Ctg DEMO

Suggestions

- Tips for using Contingency Anaylsis
  - Map out logic first
  - Use standard naming convention
    - 01 (N-1) Dworshak - Hatwai 500 kV (BPA)
  - Use RAS blocks
    - helpful for multiple use of RAS
  - Comment freely
  - Pay attention to “unlinked elements”
    - shows up when using ctg *.aux file on new case
      - new bus numbers or bus names

Questions