



PowerWorld & NERC Physical Security CIP-014-01

Tracy Rolstad

May 2014 to October 2014

Greatest Engineering Achievements OF THE 20TH CENTURY

◆ [About](#) ◆ [Timeline](#) ◆ [The Book](#)

Welcome!

How many of the 20th century's greatest engineering achievements will you use today? A car? Computer? Telephone? Explore our list of the top 20 achievements and learn how engineering shaped a century and changed the world.

- | | |
|---|---|
| 1. Electrification | 11. Highways |
| 2. Automobile | 12. Spacecraft |
| 3. Airplane | 13. Internet |
| 4. Water Supply and Distribution | 14. Imaging |
| 5. Electronics | 15. Household Appliances |
| 6. Radio and Television | 16. Health Technologies |
| 7. Agricultural Mechanization | 17. Petroleum and
Petrochemical Technologies |
| 8. Computers | 18. Laser and Fiber Optics |
| 9. Telephone | 19. Nuclear Technologies |
| 10. Air Conditioning
and Refrigeration | 20. High-performance Materials |



Intro: Tracy Rolstad (Education)

- United States Navy (1980 to 2003)
 - Nuclear Power School
 - Various schools too numerous to list
- University of Idaho
 - BSEE, 1992
 - Engineering Advisory Board Member (Present)
- Naval War College
 - Diploma, Naval Command and Staff, 1999
 - Joint Professional Military Education, phase I

Intro: Resume...



- Avista Corporation
 - Senior Pwr Sys Consultant, System Planning
 - WECC TSS Chair



- Utility System Efficiencies
 - Senior Power Systems Analyst

- The Bonneville Power Administration
 - Senior Engineer, System Operations

- The Joint Warfare Analysis Center
 - EP Senior Analyst, PACOM Chief of Targets
 - Special Technical Operations Action Officer

- Nuclear Navy (Attack Submarines)
 - Engineering Watch Supervisor
 - Reactor Operator



Policy: Your Role

- YOU, the technically educated are:
 - THE EXPERTS
 - The first and last line of defense
 - Get the story straight, correct the inaccuracies, and calm the policy makers
 - There **ARE** people & organizations who are:
 - **The Prophets of Doom**
 - OR
 - **The Profits of Doom**
- Advocate for your industry
 - Make sure people get the facts straight!

Policy: Peak Reliability Point of View

- The Energy Policy Act of 2005 [requires] the establishment of **minimum** mandatory standards of reliability for the U.S. energy sector.
- Peak has guidance on CIP-014 that will be released soon.
 - WECC TSS input, WECC Compliance input, and DOE Office of Electric Reliability

How Did We Get Here?

Attack Ideas Available on the Internet

1/15/2013

“If someone decides to blast a transformer at its base as prepper Bryan Smith did, and the oil drains out, then the transformer either burns out catastrophically, or if the utility is lucky, a software routine notices the problem and shuts the substation (or at least the affected portion) down”
[\(http://www.bob-owens.com/2013/01/shock-the-system/\)](http://www.bob-owens.com/2013/01/shock-the-system/)



Attacks on Critical Infrastructure

Metcalf 4/16/2013



Shots in the Dark

A look at the April 16 attack on PG&E's Metcalf Transmission Substation

- | | | | | | | |
|---|---|--|---|--|---|---|
| <p>1
12:58 a.m.
Attackers cut telephone cables</p> | <p>2
1:31 a.m.
Attackers open fire on substation</p> | <p>3
1:41 a.m.
First 911 call from power plant operator</p> | <p>4
1:45 a.m.
Transformers all over the substation start crashing</p> | <p>5
1:50 a.m.
Attack ends and gunmen leave</p> | <p>6
1:51 a.m.
Police arrive but can't enter the locked substation</p> | <p>7
3:15 a.m.
Utility electrician arrives</p> |
|---|---|--|---|--|---|---|

Sources: PG&E; Santa Clara County Sheriff's Dept.; California Independent System Operator; California Public Utilities Commission; Google (Image) The Wall Street Journal

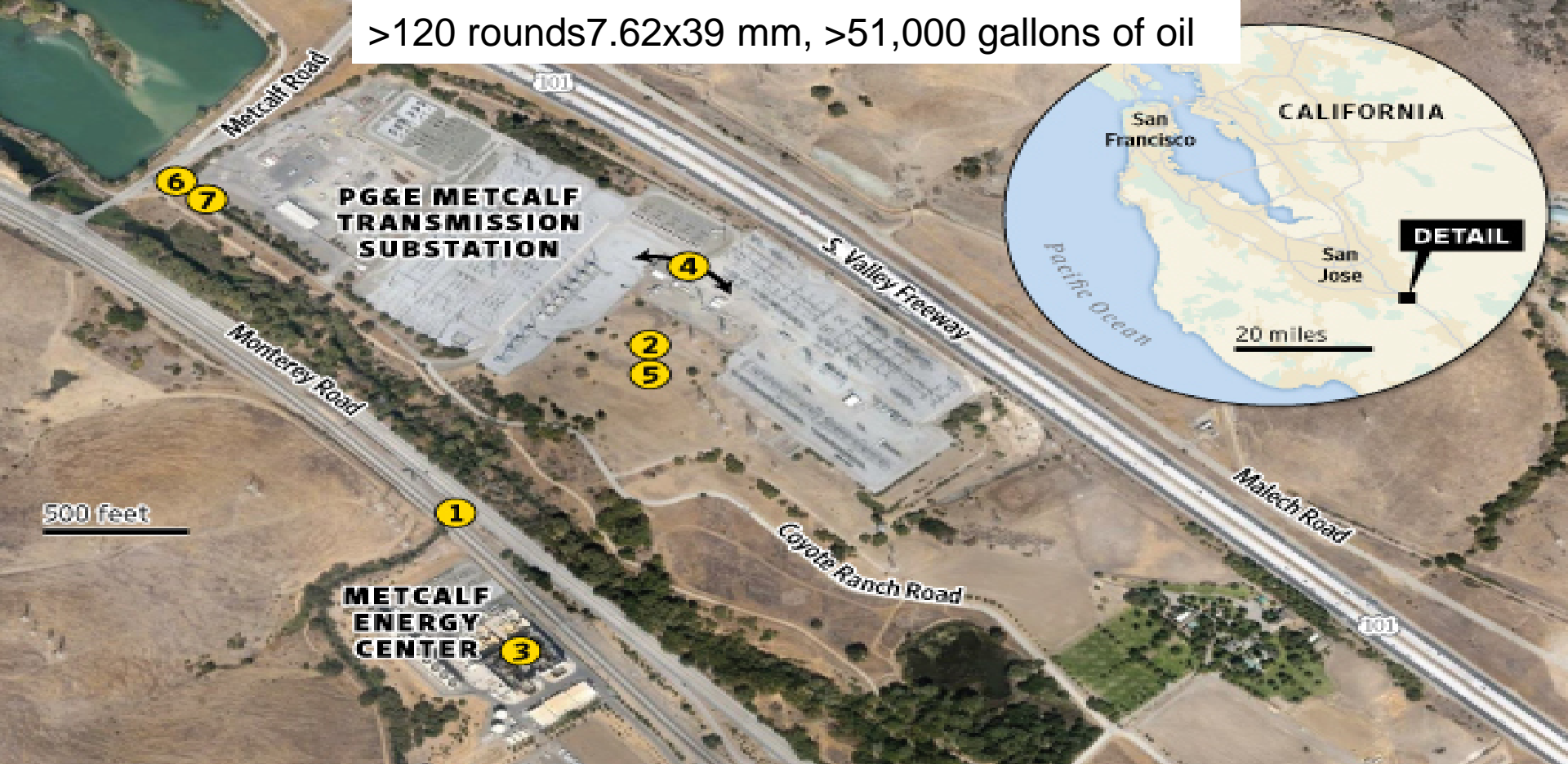
Arkansas 9/16/2013

ENERGY | 10/07/2013 @ 10:52AM | 69,137 views

Weekend Attacks on Arkansas' Electric Grid Leave 10,000 Without Power; 'YOU SHOULD HAVE EXPECTED U.S.'

20 comments, 2 called-out + Comment Now + Follow Comments

>120 rounds 7.62x39 mm, >51,000 gallons of oil



Shots in the Dark

A look at the April 16 attack on PG&E's Metcalf Transmission Substation

1

12:58 a.m.,
1:07 a.m.
Attackers cut
telephone
cables

2

1:31 a.m.
Attackers
open fire on
substation

3

1:41 a.m.
First 911 call
from power
plant
operator

4

1:45 a.m.
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Sources: PG&E; Santa Clara County Sheriff's Dept.; California Independent System Operator; California Public Utilities Commission; Google (image)
The Wall Street Journal

When seconds matter cops are only minutes away...



Damage to Substation





Event summary

- 0058 Hours
 - AT&T Fiber Cut
- 0107 Hours
 - Level 3 Line Cut
- 0137 Hours
 - Fence Alarm Activated
- 0138 Hours
 - Initial Transformer System Alarm
- 0141 Hours
 - 911 Call - Shooting
- 0151 Hours
 - Police Arrive On Scene





Damage at Scene





Damage to Facilities

- 500kV Yard
 - 10 transformers
- 230kV Yard
 - 7 transformers
- 115kV Yard
 - 6 circuit breakers
- Total of 52,000 gallons of oil
- \$15.4 in restoration costs
- No outages



Fanning the Flames?

Press Reports Fan The Flames... and Politics in Action...

Bloomberg News

Rifle-Toting Terrorists Pose Great Threat to Power Grid

By Brian Wingfield | November 20, 2012

THE WALL STREET JOURNAL.

U.S. Risks National Blackout From Small-Scale Attack

Federal Analysis Says Sabotage of Nine Key Substations Is Sufficient for Broad Outage

Wellinghoff: Physical security, not cybersecurity, threatens the grid

Details 30 Apr 2013



Smart Grid Security

Terrorist gunman could bring down the grid, warns FERC's Wellinghoff

Nov 26, 2012

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REP. WAXMAN AND SEN. MARKEY INTRODUCE GRID ACT TO PROTECT ELECTRICAL GRID FROM PHYSICAL, CYBERATTACK

News Release: March 7, 2014

Docket No. RD14-6-000

[Order](#) [PDF](#)



FERC Directs Development of Physical Security Standards

AVISTA

A Word on Metcalf

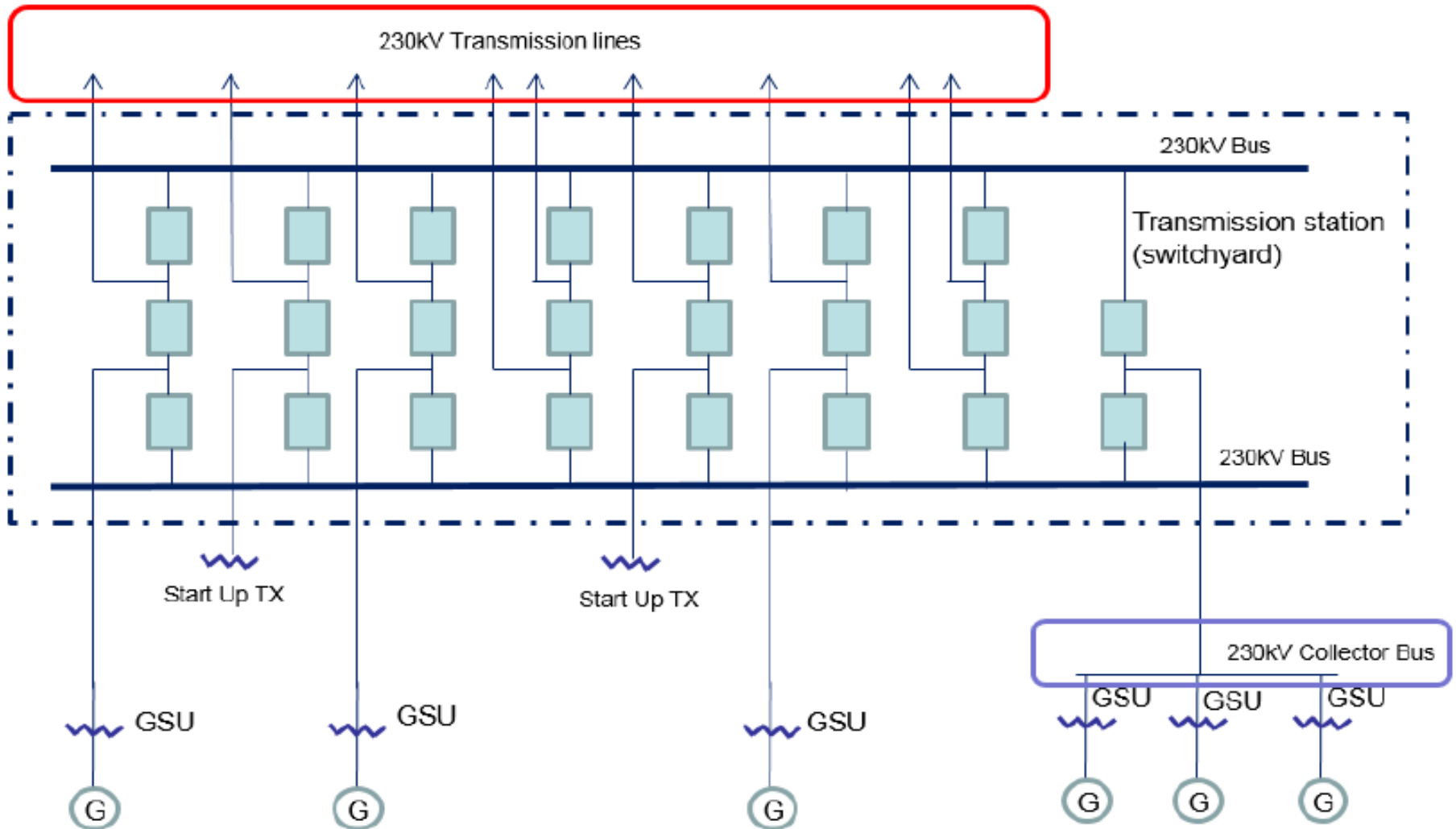
- It was either unsophisticated or sophisticatedly unsophisticated
 - Brass left at the scene
 - Cheap Soviet stuff (7.62 x 39 mm)
 - Noisy
 - No suppressors used. No subsonic ammunition used.
 - No combined effects munitions used
 - No truly diabolical methods employed
 - **No loss of service to PG&E customers!**
- Pretty ripe for conspiracy theories to be honest

The Standard (CIP-014-01)

- Identify Stations on the “List”...and IROL
 - All 500 kV stations
 - 200 kV to 499 kV with 3 or more lines and where the summed aggregate of the lines exceed 3000 (see table for weights):

Voltage Value of a Line	Weight Value per Line
less than 200 kV (not applicable)	(not applicable)
200 kV to 299 kV	700
300 kV to 499 kV	1300
500 kV and above	0

Generator Lead in vs Collectors

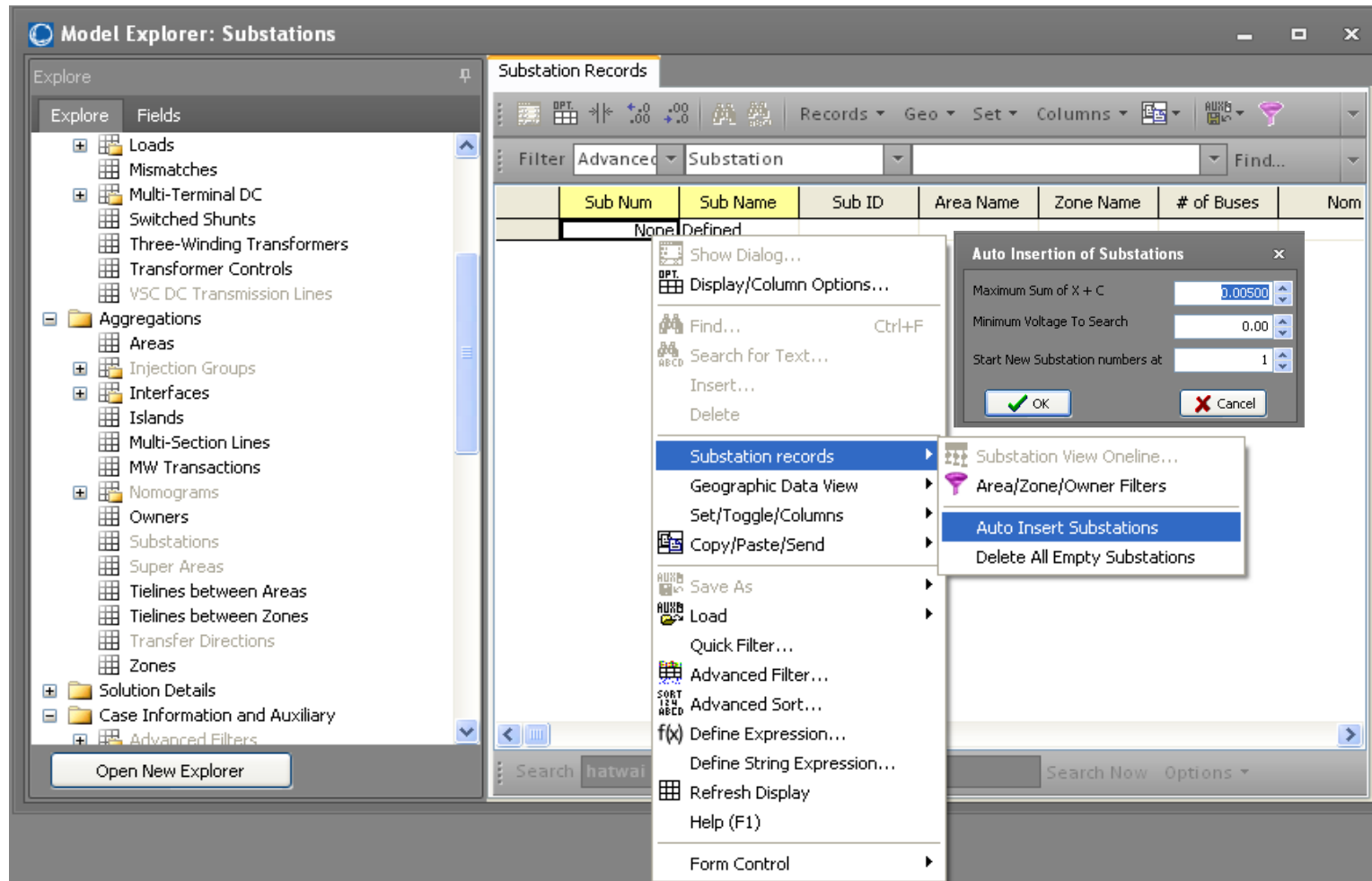
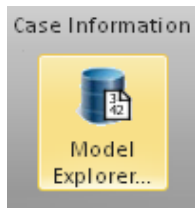


Step-by-step to deal with CIP-014-01

1. Create substations
2. Load and apply CIP_014_01.aux
3. Display column in substation table
4. Select stations
 1. >499 kV is IN automatically
 1. Might want to filter the results of the *.aux file to exclude 500 kV
5. Presumably perform substation outages

Step1a. Create substations

- Auto insert option



The screenshot displays the 'Model Explorer: Substations' window. On the left, the 'Explore' pane shows a tree view of substation components, including 'Loads', 'Multi-Terminal DC', 'Switched Shunts', 'Three-Winding Transformers', 'Transformer Controls', 'VSC DC Transmission Lines', 'Aggregations', 'Areas', 'Injection Groups', 'Interfaces', 'Islands', 'Multi-Section Lines', 'MW Transactions', 'Nomograms', 'Owners', 'Substations', 'Super Areas', 'Tielines between Areas', 'Tielines between Zones', 'Transfer Directions', 'Zones', 'Solution Details', 'Case Information and Auxiliary', and 'Advanced Filters'. The 'Substations' folder is expanded, showing a table of 'Substation Records'.

Sub Num	Sub Name	Sub ID	Area Name	Zone Name	# of Buses	Nom
None	Defined					

The 'Substation Records' table is currently empty. A context menu is open over the table, showing options such as 'Show Dialog...', 'Display/Column Options...', 'Find...', 'Search for Text...', 'Insert...', 'Delete', 'Substation records', 'Geographic Data View', 'Set/Toggle/Columns', 'Copy/Paste/Send', 'Save As', 'Load', 'Quick Filter...', 'Advanced Filter...', 'Advanced Sort...', 'Define Expression...', 'Define String Expression...', 'Refresh Display', 'Help (F1)', and 'Form Control'. The 'Auto Insert Substations' option is highlighted in the context menu.

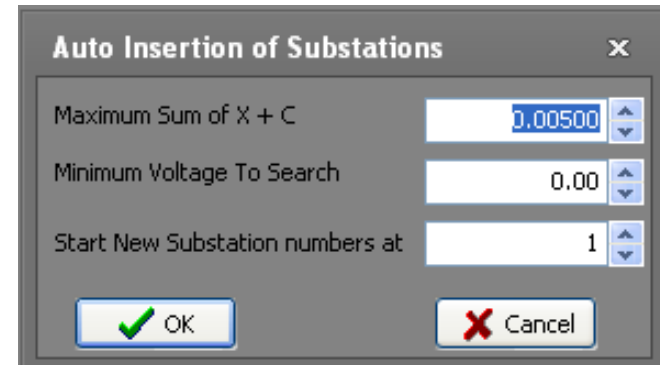
The 'Auto Insertion of Substations' dialog box is open, showing the following settings:

- Maximum Sum of X + C: 0.00500
- Minimum Voltage To Search: 0.00
- Start New Substation numbers at: 1

Buttons: OK, Cancel

Step1b. Create substations

- You might consider inserting substations manually
 - $X=0.0029$ for ZBR... $B=zero$?
 - Is this correct for your stations?
 - What about transformers?
 - What about proper naming convention?
 - It really isn't hard to do to insert manually
 - Populate your latitudes & longitudes as well!
 - GIC/GMD Standard needs this (i.e. TPL-07)



Step 2. Apply the CIP_014_01.aux

- Thanks Jamie!

// Step 1 Custom Expression

```
DATA (CUSTOMEXPRESSION,  
      [ObjectType,ObjectType:1,CustomExpressionString,VariableName,VarBlankIsZero])  
{  
"Branch:1" "Weight" "iif(x1 > 499.9, 0, iif(x1>299.9, 1300, iif(x1>199.9, 700, 0)))" "LineMaxNomVolt" "YES"  
}
```

// Step 2 Calculated Field

```
DATA (BGCALCULATEDFIELD,  
      [WhoAmI,ObjectType,VariableName,BGCalcFieldOperation,BGCalcFieldUseAbsolute,  
      BGCalcFieldBlankEntries,ObjectType:1,FilterName,FilterLogic,FilterPre])  
{  
"Sum of Inter-Substation Weights" "Branch" "CustomExpression" "Sum" "NO " "As Zeros" "Branch" "YES"  
  "AND" "NO "  
  <SUBDATA Condition>  
    SubNum <> "SubNum:1" 0 Field  
  </SUBDATA>  
}
```

<u>Symbol</u>	<u>Equivalent Description</u>
---------------	-------------------------------

IIF	If condition
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Example

Iif(1+1==2,4,5) = 4

Step 2a. The IIF Function

- Immediate If (aka IIF)
- OR-
- Inline If (aka IIF)

The [syntax](#) of the Iif function is as follows:

Iif(*expr*, *truepart*, *falsepart*) All three parameters are required:

expr is the expression that is to be evaluated.

truepart defines what the Iif function returns if the evaluation of *expr* returns true.

falsepart defines what the Iif function returns if the evaluation of *expr* returns false.

Step 3. Display Results...Review

The screenshot displays a software interface for reviewing substation records. On the left, the 'Model Explorer: Substations' window shows a tree view of the project structure, with 'Substations' selected. The main window shows a 'Substation Records' table with columns for Sub Num, Sub Name, Sub ID, and Sum of Inter-Substation Weights. A 'Display/Column Options' dialog is open, showing the 'Display Options' tab. The dialog lists available fields and allows users to select which fields to display in the table. The 'Sum of Inter-Substation Weights' field is highlighted in the 'Show these fields in this order' list.

Sub Num	Sub Name	Sub ID	Sum of Inter-Substation Weights
1	41346 Midway	MIDW	7000.00
2	40145 Boundary	BOUN	7000.00
3	41356 Grand Coulee 2	GCTW	6200.00
4	40091 Bell	BELL	5600.00
5	46831 Rocky Reach	RKYS	4900.00
6	48281 Noxon Rapids	NRS	4900.00
7	40723 McNary	MCNY	4800.00
8	40223 Chief Joseph	CHJO	4700.00

Display/Column Options Dialog - Display Options Tab

Available Fields:

- Sub Num
- Zone Name
- Zone Num
- Buses
- Calculated Field
- Branch : Sum of Inter-Substation W
- Contingency
- Custom
- Difference Flows
- Generators
- Geography
- Geomagnetically Induced Current
- Interchange MW Control
- Labels
- Limit Monitoring
- Line Correction
- Loads
- Loss

Show these fields in this order:

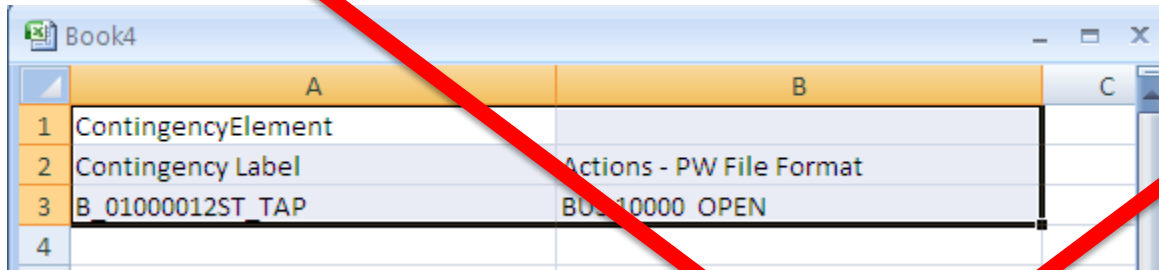
- Sub Num
- Sub Name
- Sub ID
- Calculated Field(Branch : Sum of Inter-Substation W)
- Area Name
- Zone Name
- Number of Buses
- Voltage(Max Nominal Voltage)
- Generators(MW)
- Generators(Mvar)
- Loads(MW)
- Loads(Mvar)
- Shunts(MW (total))
- Shunts(Mvar (total))

Buttons: Add ->, <- Remove, Move Up, Move Down, Highlight, Key Fields, Required Fields, Show Column Headers, Col Width (225), Total Digits (8), Dec Places (2), Remove trailing zeros after decimal point, Contour Column, Show Variable Names, String, Integer, Floating Point, Field is Shown, Frozen Columns (1), Reset to Factory Defaults, Save Custom Settings, Non Default Values, OK, Save, Cancel, Help.

Step 3a. What stations are in?

- Check your work!
 - **Stublets to generators ARE counted**
 - The *.aux file counts stublets
 - Generator collector buses are NOT to be considered
- The basics:
 - Any 500 kV station is in
 - A 345 kV station with more than 2 lines @ 345 kV
 - A 230 kV station with more than 4 lines @ 230 kV

Concatenate to Build Substation Outages

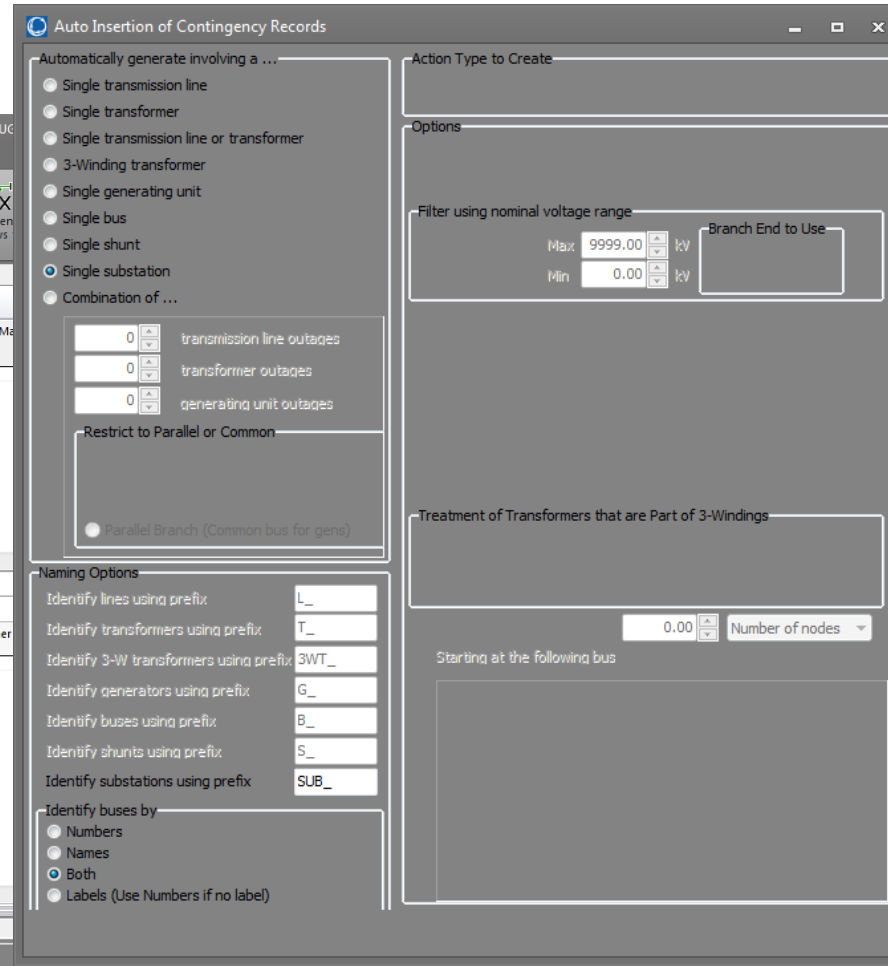
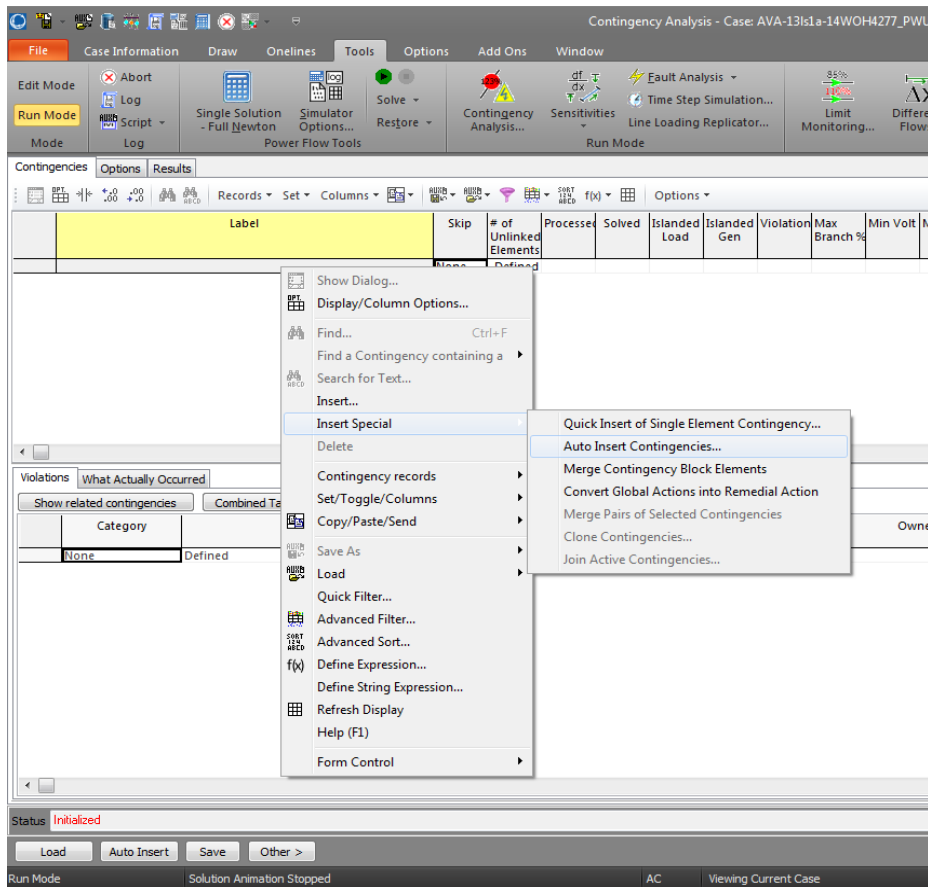


	A	B	C
1	ContingencyElement		
2	Contingency Label	Actions - PW File Format	
3	B_01000012ST_TAP	BUS_10000 OPEN	
4			

=CONCATENATE("Sub: ", C3)

=CONCATENATE("Bus ", A3, " OPEN")

Step 4. Use the Auto insert Substations



Step 4a. Examine the Results

	Label	Skip	# of Unlinked Elements	Processed	Solved	Islanded Load	Islanded Gen	Violations ▲	Max Branch %	Min Volt
1	SUB :45327WallaWallaPAC	NO	0	YES	NO	4.42		Unsolved		
2	SUB :41057Taft	NO	0	YES	NO			Unsolved		
3	SUB :40459Garrison	NO	0	YES	NO			Unsolved		
4	SUB :40369Dworshak	NO	0	YES	NO			Unsolved		
5	SUB :40091Bell	NO	0	YES	NO	103.08		Unsolved		
6	SUB :48305Osburn	NO	0	YES	YES	4.79		0		
7	SUB :48309OthelloSwSta	NO	0	YES	YES			0		
8	SUB :47505Hoodoo	NO	0	YES	YES	2.50		0		
9	SUB :48323Plummer	NO	0	YES	YES	17.97	4.50	0		
10	SUB :48339PostStreet	NO	0	YES	YES	9.28	23.00	0		
11	SUB :48369Rosalia	NO	0	YES	YES	2.61		0		
12	SUB :48311OtisOrchards	NO	0	YES	YES			0		
13	SUB :48371RossPark	NO	0	YES	YES	19.76		0		
14	SUB :48307Othello	NO	0	YES	YES	18.68		0		
15	SUB :48319PleasantView	NO	0	YES	YES	7.44		0		
16	SUB :40275CookeMountain	NO	0	YES	YES	7.74		0		
17	SUB :48009AirwayHeights	NO	0	YES	YES	21.22		0		
18	SUB :48343PoundLane	NO	0	YES	YES	9.14		0		
19	SUB :48419Stratford	NO	0	YES	YES	6.16	90.00	0		
20	SUB :48385Shawnee	NO	0	YES	YES	10.02		0		
21	SUB :48388SilverLake	NO	0	YES	YES	8.11		0		
22	SUB :48329PostFalls	NO	0	YES	YES	13.65	14.25	0		
23	SUB :48441Valley	NO	0	YES	YES	4.29		0		
24	SUB :47086PineStreet	NO	0	YES	YES	10.61		0		
25	SUB :48411Sprague	NO	0	YES	YES	0.79		0		
26	SUB :48313Palouse	NO	0	YES	YES	3.24		0		
27	SUB :48420TerraView	NO	0	YES	YES	2.26		0		

Step 5. “Rinse & Repeat”

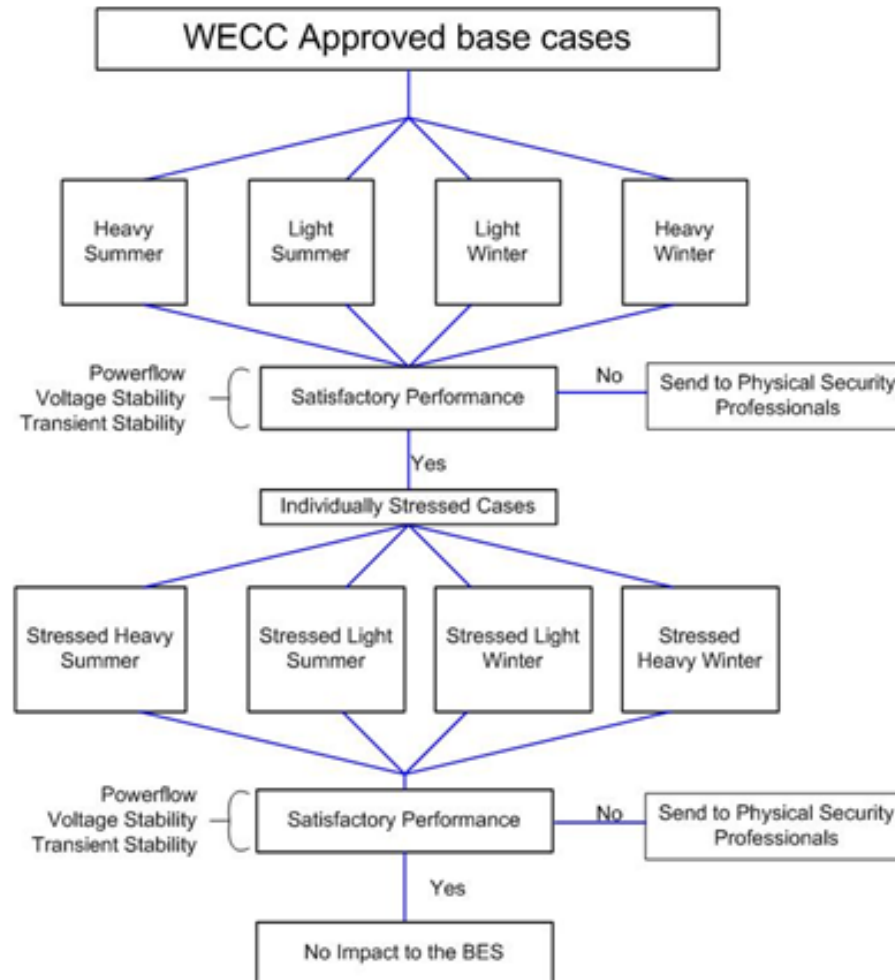
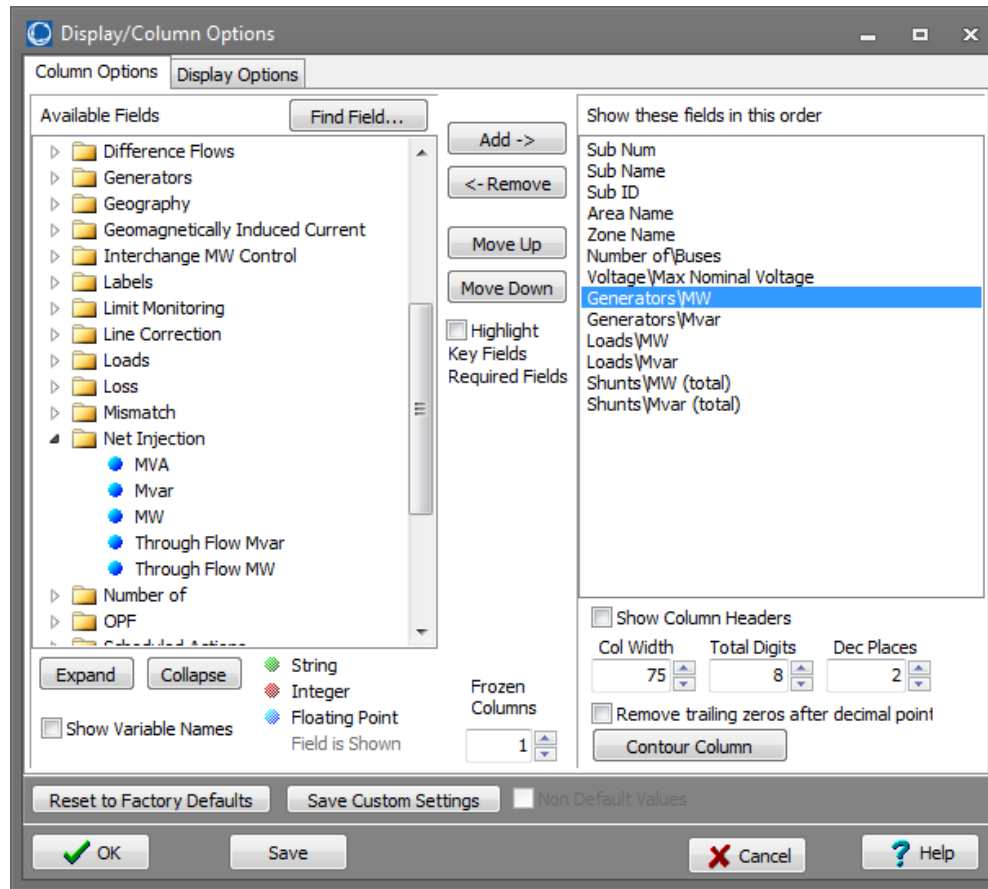


Figure 1: Basecase and Study Process Decision Tree

Stressed Case->Through Flows



Requirements for Stations on the “List”

1. Perform a risk assessment every 30 months to identify:
 - *Substations if damaged could result in instability*
 - *Primary Control Center that controls critical substations*
2. Have a third party verify the risk assessment
 - *Each Transmission Owner shall select an independent verifying entity that is either (i) a registered Planning Coordinator, Transmission Planner, or Reliability Coordinator or (ii) an entity that has transmission planning or analysis experience.*
3. Conduct an evaluation of the potential physical threats and vulnerabilities
4. **Develop and document physical security plans**
5. Have third party review the evaluation of potential physical threats and plans