

What's New in Simulator Version 19



Caroline Marzinzik

WECC PowerWorld Users Group

June 30 – July 1, 2015



PowerWorld
Corporation

2001 South First Street
Champaign, Illinois 61820
+1 (217) 384.6330

caroline@powerworld.com
217-384-6330 ext. 12

What's New in Version 19



- Version 19 is a version with many, many, many small changes throughout
- Concentration this past year has been on improving existing features
 - Auxiliary File Format
 - Transient Stability
 - GIC
 - RAS

Special Auxiliary File Improvements

Version 18



- Cleaned up header to replace “DATA” with the object name instead
- No longer include the “CreatelfNotFound” field. YES is always assumed.
- Utilize the ObjectID field so we don’t need separate DATA sections
- Improving the variable names to make more sense
- Presently, only used for “WECC Contingency” file

```
Gen (ObjectID, CTGPreventAGC, CTGPartFact, CTGMaxResp, UseLineDrop, Xcomp)
{
"Gen 'Texan_69.0' '1'" "NO"      same      22.0      "NO"      0.0001
"Gen 'Jet_69.0' '1'"  "YES"     88.0      ""        "PostCTG" 0.0512
"Gen 77 '1'"         "RESPOND" same      0.0       "NO"      0.0001
"Gen 55 '1'"         "NO"      same      ""        "NO"      0.0001
}
```

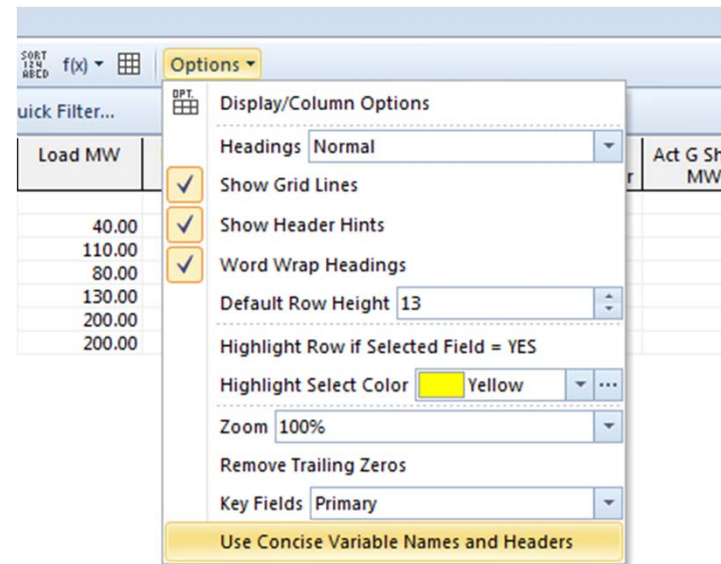
```
DATA (Gen, [BusName_NomVolt, GenID, GenPostCTGPreventAGC, GenParFac:1, CTGMakupGen, GenUseLDCRCC, GenXLDCRCC],
AUXDEF, YES)
{
"Gen 'Texan_69.0' '1'" "NO"      same      22.0      "NO"      0.0001
"Gen 'Jet_69.0' '1'"  "YES"     88.0      ""        "PostCTG" 0.0512
}
DATA (Gen, [BusNum, GenID, GenPostCTGPreventAGC, GenParFac:1,
CTGMakupGen, GenUseLDCRCC, GenXLDCRCC], AUXDEF, YES)
{
"Gen 77 '1'"         "RESPOND" same      0.0       "NO"      0.0001
"Gen 55 '1'"         "NO"      same      ""        "NO"      0.0001
}
```

Special Auxiliary File Improvements

Continue into Version 19



- All variable names throughout Simulator have been overhauled
- Easier access to concise format
 - New option on Case Information Toolbar to show in concise format
 - If option selected, any saved auxiliary file will be in concise format



Auxiliary Files



- Special string in place of value
 - "&Objecttype 'key fields'
variablename:location:digits:decimals"
 - Treated as though the value of the named object and object field is entered in the field
 - If not digits or decimals specified, 7 decimal places will be used
 - Trailing zeros will be removed if no decimals are specified

Rating Sets



- There are now 15 limits available with each branch and interface
- Rating sets can be given names
 - Useful for identifying different rating sets for different purposes
 - Different names for branches, interfaces, and buses
 - Names will then appear in column headers

Supplemental Data



- Supplemental Classification
 - Allows users to make their own groupings (Classification) and then assign objects to specific entities (Data) within these groupings
 - Example: Create Balancing Authorities as a Classification
 - Settings
 - **Contains Objects of Type**
 - Comma-delimited list of object types that are contained by Supplemental Data of this Classification
 - **User Assignable Object Types**
 - Comma-delimited list of object types that can be assigned to Supplemental Data of this Classification
 - **Allow Multiple**
 - If YES, An object can belong to more than one Supplemental Data of this Classification
 - **Inherits from Model Structure**
 - Set to YES to allow objects to inherit which supplemental data they are contained by from the model structure. For example, if a classification only is assigned buses, you may want a generator to inherit from its terminal bus which supplemental data it belongs to.
 - **Object Type**
 - Object Type: this is what will be used in AUX files as the field names to create supplemental data objects of this classification. It is the same as the classification name, but all spaces are removed and all of the following characters are replaced by an underscore \/:*?"<>|
- Supplemental Data
 - Assigned to a Supplemental Classification
 - Specific member of the classification
 - Example: Balancing Authority 1
 - Objects are assigned to Supplemental Data
 - Calculated fields can be used to return information about the objects in the Data groupings

Supplemental Data

Assigning Objects



- New fields become available depending on how the Supplemental Classification is defined
 - *Object Type*
 - Lists all of the Supplemental Data to which an object belongs
 - Field is available for any object types that can be contained in or assigned to Supplemental Data
 - *Object Type Append*
 - Add the name of new Supplemental Data to which an object is assigned
 - Field is available for any object types that can be assigned to Supplemental Data
 - *Object Type Assign*
 - List the name of ALL Supplemental Data to which an object belongs
 - Field is available for any object types that can be assigned to Supplemental Data

Geomagnetic Induced Currents



- Continues to be updated
- “Hot Spot Analysis”
 - Define location of hotspot
 - Define a specific value or multiplier for existing field

Transient Stability



- When viewing Multiple Contingencies table, **Processed** field expanded into **Processed**, **Solved**, and **Reason Not Solved** fields to provide more details on what happened
- Options for filtering what is shown in the Events table by level
 - Error, Info, Skipped, User, Transition, Model Trip, Relay Trip
- Option to auto insert Transient Contingencies with Label identifiers
- Added ability to use the special string @CTGMemo in transient stability plot definition strings
 - This string will be replaced with the memo of the transient contingency in the plot
- Option to save Min/Max results stored in RAM in PWB file instead of just always saving them
- Negative start times are allowed
- Continuing support for reading (*.SWT) switch files
- Support for reading DYD file with labels

New Transient Stability Models



- Area
 - AreaAGC
- Generator Machine Models
 - PV1G
 - PVD1
- Generator Relay
 - ATRRelay
 - GENOF
 - GP2
 - GVPHZFT
 - GVPHZIT
 - LHSRT
- Exciter
 - REEC_C
 - PV1E

New Transient Stability Models



- Line Relay
 - OOSMHO
- Load Relay
 - LSDT3
 - LSDT7
- Plant Controller
 - REPC_B
- Voltage Compensator
 - CCOMP4

Contingency Analysis Dialog



- Remedial Action Definitions
 - All of the objects necessary for designing RAS
- Legacy Definitions
 - Contingency Blocks and Global Actions
 - Going forward Remedial Actions should be used instead of Global Actions
 - Contingency Blocks can be converted into individual contingency elements or replaced with Injection Groups or Interfaces

Contingency Analysis



- Continue work on (*.OTG) format contingency files loading
- Continue work on (*.CON) format contingency files loading and saving
- **Total Dropped Load MW** field with contingency results records
- Auto-Insert functionality now has an option to identify contingencies by Label
- Can open a Bus View or Substation View from local menu of Violations table

Contingency Analysis

New Actions and Action Changes



- Added action to Open a Substation
 - Included in auto-insert options too
- Added action to change resistance of DC Line
- Added action to change MVA Limit of a Branch
- Added action to drop Number Elements in an Injection Group
- When opening Injection Group in Merit Order, added options to *Do Not Exceed Amount* and *Allow to Exceed Amount*
- Added option to **Evaluate Part Points in Reference State** for Injection Groups

Contingency Analysis

New Actions and Action Changes



- Injection Group Merit Order now includes Loads
 - No option to do this, just put loads in an injection group
 - IMPORTANT - If you have been using injection groups with loads, you will have to remove these to maintain the same functionality where only generators change
 - Both generators and loads will move to their appropriate limits based on the injection change
 - Loads where both Min and Max limits are 0 can only move to 0 MW
 - If using Merit Order OPEN and both generators and loads exist in an injection group, only loads will be opened if the change is to *increase* injection and only generators will be opened if change is to *decrease* injection
 - If using Merit Order OPEN and change is to *increase* injection and no loads exist in the injection group, generators will move towards their max limit
 - If using Merit Order OPEN and change is to *decrease* injection and no generators exist in the injection group, loads will move towards their max limit

Contingency Analysis

Time Delay



- Time to wait in seconds before an action is applied
- Serves as a relative ordering for implementation of actions during steady state analysis
- Actions with smallest delay (down to a microsecond) will be applied first during TOPOLOGYCHECK and POSTCHECK solution steps
- Ignored during CHECK solution step
- Default all time delays to 0 to ignore

Processing Order of Contingency

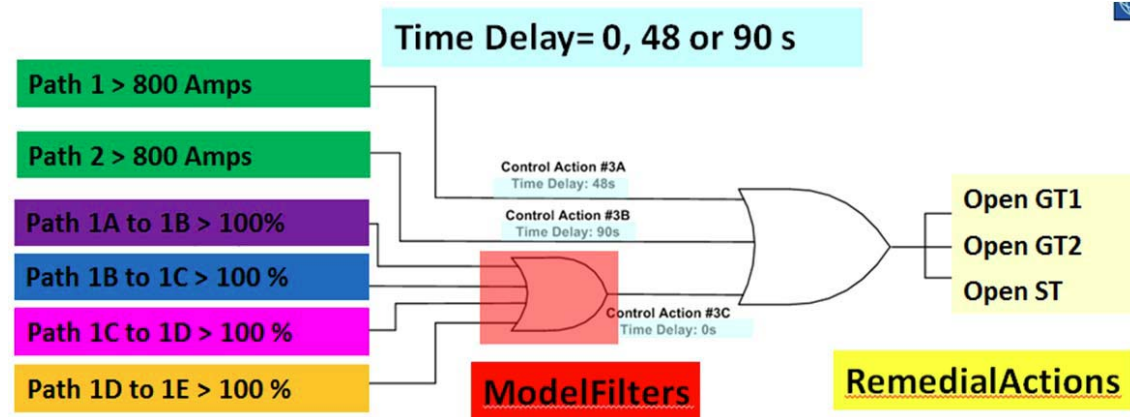


- Contingency Processing now goes as follows
 1. Apply ALWAYS actions and true CHECK actions
 2. Update topology (branch, bus status)
 3. Apply true TOPOLOGYCHECK actions
 1. TRANSIENT actions will also be evaluated
 2. TRANSIENT or TOPOLOGYCHECK actions with smallest Time Delay will be applied
 4. Solve power flow
 5. Apply true POSTCHECK actions and true TOPOLOGYCHECK actions
 1. TRANSIENT actions will also be evaluated
 2. TRANSIENT, POSTCHECK, or TOPOLOGYCHECK actions with smallest Time Delay will be applied
 6. If any POSTCHECK, TOPOLOGYCHECK, or TRANSIENT actions are implemented then repeat steps 2-6

Model Filter Condition Time Delay



- Time Delay has been added to a Model Filter Condition
 - Allows time delay on the input of a logic gate
 - Helpful when same exact actions need to occur based on Model Filters or Conditions being true at different time delays



ModelConditions

Model Filter Condition Time Delay



- Calculated Time Delay
 - For OR gate, calculated time delay equal to the minimum Time Delay associated with any of the Model Filter's TRUE inputs
 - For AND gate, calculated time delay equal to the maximum Time Delay associated with any of the Model Filter's TRUE inputs
 - If Remedial Action Element's Model Criteria is a Model Condition, calculated time delay is equal to the Time Delay of the Remedial Action Element
 - If Remedial Action Element's Model Criteria is a Model Filter, calculated time delay is the maximum of the Model Filter's calculated time delay and the Remedial Action Element's Time Delay

Contingency Analysis

Breaker Contingencies



- New option to create stuck breaker contingencies
 - Processes each contingency that has explicit breakers defined and creates new contingencies by treating each breaker as stuck in turn
 - New contingencies comprised of all existing elements, minus the stuck breaker outage, plus open actions for breakers that are identified to isolate the stuck breakers
- New option to create expanded breaker contingencies
 - Converts any *Open with Breakers* or *Close with Breakers* contingency actions into *Open* actions on explicit breakers

Converting Power Flow Contingencies to Transient Contingencies



- New option on Other> button of Contingency Analysis dialog
- Objects converted
 - Bus, Branch, Load, Switched Shunt, Generator, DC Line
- Default Assumptions
 - Fault on time: 1 second
 - Fault location:
 - If first element in contingency is a bus, apply fault at that bus
 - If first element in contingency list is a branch, apply fault at “from” bus of that branch
 - If first element is anything besides a bus or a branch (i.e. generator, etc.) do not apply any fault. Rather, open all elements ONLY if the bus voltage is 500 kV, 230 kV, or 115 kV at 1 second. The same is true if the object is part of the contingency when the first object is a bus or a branch.
 - Fault type: 3 phase bolted fault
 - Fault clearing time:
 - If bus fault
 - 500 kV bus, assume 1 second plus 3 cycles
 - 230 kV bus, assume 1 second plus 4 cycles
 - 115 kV bus, assume 1 second plus 6 cycles
 - If branch fault
 - 500 kV branch, assume 1 second plus 3 cycles at “from” end, 1 second plus 4 cycles at “to” end
 - 230 kV branch, assume 1 second plus 4 cycles at “from” end, 1 second plus 5 cycles at “to” end
 - 115 kV branch, assume 1 second plus 6 cycles at “from” end, 1 second plus 7 cycles at “to” end
 - Time to change remaining element topology
 - If bus fault, open all remaining elements when fault is cleared
 - If branch fault, open all remaining elements when “to” end of line is opened.

Treatment of **Transient Stability** Models in **Power Flow** Contingencies



- LHVRT Generator Relay now supported
- Some load relay models will be included

Voltage Control Group



- Models the Centralized Grid Capacitor Control (CGCC) algorithm for SCE
- New object Voltage Control Group
 - Status determines how they are used
 - ON – Normal behavior where the Control Group acts as expected as long as the global option for moving switched shunts is enabled
 - OFF – Control group is ignored and the individual switched shunts in the group revert back to their own individual control behavior
 - FORCEON – Ignore the global option (or Area record option) that disable switched shunt control and always force control enabled for this group. This option makes it easy to have control on ONLY for switched shunts in Voltage Control Groups.
 - Assign Switched Shunts to control group
- Voltage control range is still set with each Switched Shunt – Volt High and Volt Low

Voltage Control Group Algorithm



- Voltage Control Group processing occurs in the Voltage Control Loop of the Simulator Single Solution process
- Each Voltage Control Group processes its own list of switched shunts independently
 - Largest deviations are measured in kV and not per unit so that regulated buses with a higher nominal voltage have a higher precedence
 - Only switched shunts that are marked as Control Mode = *Discrete* participate in Voltage Control Groups. Any marked as *Continuous*, *SVC*, *Fixed*, or *BusShunt* will be ignored and will not switch at all.
 - Voltage Control Group processing
 - Determine the switched shunt that has the largest deviation below V_{low} (call this LowShunt)
 - Determine the switched shunt that has the largest deviation above V_{high} (call this HighShunt)
 - If LowShunt found, move that switched shunt UP by one step, Else if HighShunt found, move this switched shunt DOWN by one step
- Switched shunts that are not in Voltage Control Groups are processed after the control groups and operate as they always have

Time Step Simulation



- When changing the injection of an Injection Group and using Merit Order dispatch, loads are now included

PV Tool



- When changing the injection of an Injection Group and using Merit Order dispatch, loads are now included
- Added options to save PV plot images to file
- High Voltage Violations can now be monitored
 - Can stop when voltages become inadequate because they are too high

QV Tool



- Make-Up Power
 - System Slack
 - This is the default that had always existed
 - Too much reactive margin could result if all changes go to the system slack
 - Same as Contingency Analysis
 - Allows changes to be spread out across all generators in the system

Scaling



- When changing the injection of an Injection Group and using Merit Order dispatch, loads are now included

New Script Commands



- Remove3WXFormerContainer
- PVWriteInadequateVoltages
- CTGCompareTwoListsOfContingencyResults
- ReassignIDs
- OpenWithBreakers
- CalculateLODFAdvanced
- CTGCreateStuckBreakerCTGs
- CTGCreateExpandedBreakerCTGs
- CalculateLODFScreening
- MergeMSLineSections
- RenameInjectionGroup
- ATCCreateContingentInterface
- CTGCreateContingentInterface

Script Command Modifications



- Move
 - Can now move three-winding transformers
- OpenWithBreakers and CloseWithBreakers
 - Optional parameter to specify which switching devices to consider
 - Default is to only consider *Breakers*
- Allow special keyword @CASENAME to be used as part of the filename for SaveDataUsingExportFormat, SaveData, SaveDataWithExtra, SaveObjectFields, and WriteToTextFile script commands. This special keyword will be replaced with the actual name of the case when the file is saved.
- DeleteFile script can now use the special keywords starting with @

File Formats



- EPC file
 - Support for reading version 19
 - Prompt to save bus records if saving individual records for switched shunts, generators, and branches
- RAW file
 - Records with comments in the format /* [my label, my second label] */ will have labels automatically created for the object
- hdbexport CSV file
- PWB and AUX files

General



- Injection Group Participation Factors can be specified by Field or Model Expression

Available Transfer Capability Tool (ATC)



- Option to **Create Contingent Interface for Selection**

Integrated Topology Processing



- If there is a CLOSED switching device in parallel to an OPEN switching device, the OPEN switching device is not displayed (gets consolidated)
 - This is a special situation because normally both switching devices would be consolidated
 - In this situation the CLOSED switching device is marked as Allow Consolidation = NO or is part of an interface or tie-line

Full Topology Features



- ExpandBusTopology(BusIdentifier, TopologyType) script command
 - TopologyTypes
 - DoubleBusDoubleBreaker
 - MainTransfer
 - RingBus
 - BreakerAndAHalf
 - SingleBus
 - SectionalizeBus
- Will build out specified bus by adding breakers in the specified topology

Oneline Features



- Option to select objects on a oneline diagram and open case information displays of the selected objects
 - Intended as a way to create substations by selecting objects on a oneline
- Convert multi-section line to background line
- Albers Conic map projection (Alaska)
- Line drawn through switched shunts with Control Mode of *Continuous* or *SVC* to indicate shunt on automatic control
- While in Run Mode, left-clicking on bus name or number field will open the Bus View

Geographic Data Views



- Added option to allow contouring on geographic data view objects based on the object type they represent
- More options for managing the geographic data view objects on a oneline
- Added options to make it easier to create a new oneline for adding geographic data view objects
 - Option to add geographic borders

Case Information Displays



- **Reg Bus** field for transformers, generators, and switched shunts
 - Allows identification of the regulated bus by Label

Sensitivities



- $dAmp/dControl$ and $dMVA/dControl$ calculations available for Branches on Multiple Meters, Single Control Change dialog
- Generator MW can be selected as Control Type on Multiple Meters, Single Control Change dialog and Multiple Meters, Multiple Control Change dialog
- LODF Screening tool