

DEC Record Reliability & How DA Contributed

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Powering Business Worldwide

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Delaware Electric Cooperative

"We Keep the Lights On!"

- Founded in 1936
- Delaware's only electric cooperative
- Serves 114,000 meters
- Service territory of 2,000 square miles
- 24 distribution substations, 91 feeders
- 4,200 miles of distribution wire
- 50 miles of transmission wire
- 168 employees



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Distribution Automation

How our Distribution Automation works?



Safety & Protection for the crews and public

Outage Statistics & Reliability 2022

Current Wins for 2023

How DA & SCADA is evolving at DEC

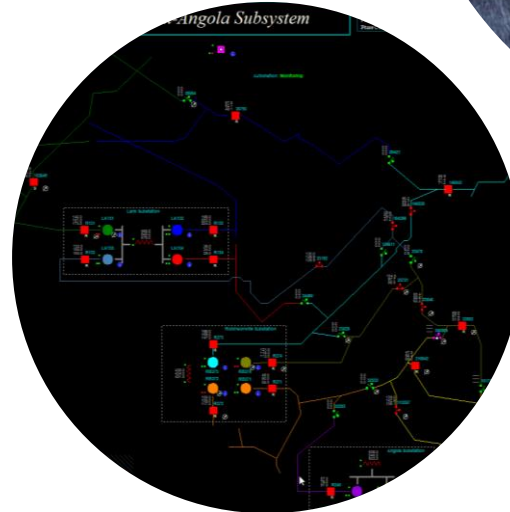
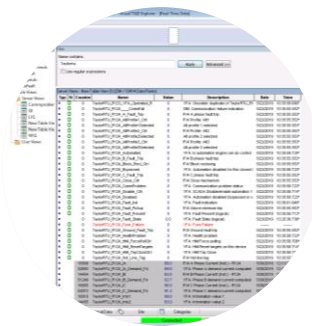


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Distribution Automation System Attributes

- Fault Isolation and Restoration
- Back feed for loss of voltage or for differential lockout on station transformer
- Fix mis-coordination events
- Can perform load management (DEC does not currently use)
- Can include DERs in load calculations (DEC does not currently use)
- **All devices are monitored on SCADA from the DA system. OMS receives ALL operations to correctly display outages.**



Fault Automation Process



Transmission Loss & Differential LO

- Looks at the first device out for loss of voltage
 - Waits 60 seconds to confirm the loss of transmission
 - Opens all feeders before making ties to backfeed
- DEC has custom logic at the substation level designed to open all feeders in the event of a Differential LO to prevent backfeeding
 - A status point is sent to DA to tell it DEC opened the circuits and wants backfeeding to take place

Prevents Miscoordination

- When a feeder at the substation opens for a fault faster than a downstream recloser, DA looks at all downstream devices to determine the actual fault zone. This is very useful when dealing with high current fault locations right outside of the substation.
- As the downstream reclosers and/or switches bring back fault information, DA determines the precise location to isolate. DA can then restore the feeder up to the isolated zone. This properly isolates the outage when a recloser could not.

System Visibility and Event Simulation

- Detailed logs after every event can be emailed to crews or managers for better explanation of events. Also includes full historian for full event review of all YFA operations.
- YFA does data acquisition, processing and controls just like a stand-alone SCADA system. It has displays that can be utilized for monitoring or controls.
- Easy to view real time data for commissioning and testing.
 - Simulation mode to test the functionality of all scenarios before loading for production
 - Allows new features to be tested in a controlled environment with set values

EATON
Yukon FA

Summary

Activity Details

Connected Zones

Reconnected Zones

Disconnected Zones

Isolated Zones

Automation Operations

Normal Operations

Automation Late Reasons

Feeders

Summary

Site	DEC 20211210 SussexNW additions
Subsystem	L-A-R-Sub
Start Time	Jan 16 2022, 09:17:41 PM (-05:00)
Duration	3 minutes
Type	Fault
Outcome	Success
Outcome details	Automation completed successfully
Initial condition	Switching Device R131: New fault
End Time	Jan 16 2022, 09:20:41 PM (-05:00)

Activity Details

09:17:41 - Start of event (0 milliseconds)

09:17:41 00:00:00 Start of event

09:17:41 - Fault isolation (1265 milliseconds)

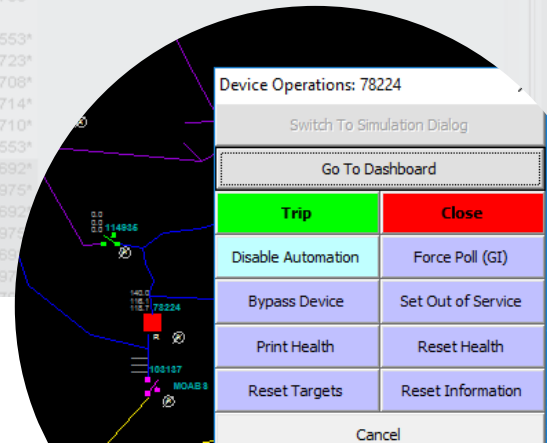
09:17:41	00:00:00	Switching Device R131: New fault
00:00:00	5.0000040	Automation control on 152649: set position to open
00:00:01	2.5000020	Automation control on 152649: opened by YFA

Automation (27 seconds and 173 milliseconds)



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Equipment

- DEC uses Eaton Triple Singles and S&C MOABS.
- The MOABS' do not have CTs (even though it is supported in YFA) so we can't use them as normally closed switches.
- Triple Singles are programmed either as reclosers for protection or switches for fault identification and isolation.
 - DEC clearly marks their poles and SCADA displays for easy identification.
 - Reclosers will trip for faults and are coordinated for the system.
 - Switches can only be operated by hand, SCADA, or DA. They don't trip for faults but do check for fault current and targets.



SCADA Integration - Displays

DA POLE 19655 FORM 6 CONTROL PANEL

COMMUNICATION WITH RTU: **ACTIVE** 02/10/22 15:04:38

PEPPER N SUSSEX DA

- NO POLE AC PWR
- VOLTAGE LOSS
- INTERRUPT MALF
- RECL RETRY FAIL
- CTL CKT IRPT
- FAIL TO TRIP
- FAIL TO CLOSE
- FACEPLATE ILLUM
- REVERSE POWER
- YELLOW HANDLE ALM
- PHASE OC ALARM
- GROUND OC ALARM

BATTERY
VOLTS 27.0
STATUS **NORMAL**
TEST

<input type="checkbox"/> CONTROL OK	<input type="checkbox"/> A PHASE FAULT	<input type="checkbox"/> ALARM	<input type="checkbox"/> A PHASE VOLT	<input type="checkbox"/> SPT TRIP1PH LO
<input type="checkbox"/> CONTROL POWER	<input type="checkbox"/> B PHASE FAULT	<input type="checkbox"/> ABOVE MIN TRIP	<input type="checkbox"/> B PHASE VOLT	<input type="checkbox"/> SPT TRIP3PH LO
<input type="checkbox"/> CONTROL LOCKOUT	<input type="checkbox"/> C PHASE FAULT	<input type="checkbox"/> A PHASE CLOSED	<input type="checkbox"/> C PHASE VOLT	<input type="checkbox"/> SPT TRIP3PH HI
<input type="checkbox"/> RECLOSER OPEN	<input type="checkbox"/> GROUND FAULT	<input type="checkbox"/> B PHASE CLOSED	<input type="checkbox"/> FREQ TRIP	<input type="checkbox"/> INDICATOR 7
<input type="checkbox"/> RECLOSER CLOSED	<input type="checkbox"/> SENSITIVE GROUND	<input type="checkbox"/> C PHASE CLOSED	<input type="checkbox"/> VOLTAGE TRIP	<input type="checkbox"/> AUTO PROFILE

METERING	AMPS	VOLTS	SETTINGS
KW 1033	29 A	7207 A	
PF 1.00	63 B	7191 B	
FREQ 60.00	52 C	7134 C	
	31 G	7149 LOAD	

F1 F2 F3 F4

OPER COUNTER
RESET ALARMS
CHANGE

COOPER Power Systems F6 Recloser Control

TRIP CLOSE

ON OFF

RECLOSE MODE

RECLOSE ALT

AUTO PROFILE OPTION #2 SWITCH ALT

RELOCK CLPU
RELOCK FAST TRIPS

FAULT AMPS
0 A
0 B
0 C
0 MAX

TRIP COUNTER
0 A
4 B
7 C
1 G

PEAK DEMAND AMPS
60 A
110 B
94 C
45 G

RESET PEAK

SETTINGS
PH 300
GRD 150

COLD LOAD
PH 400
GRD 180

DA MOABS 34264 CONTROL

BENNETT PEPPER N SUSSEX DA BT SWITCHING PR SWITCHING 02/10/22 15:05:20

SINGLE PH VOLT	123.0	EXTERNAL TEMP	62
CABINET TEMP	83	ACTUATOR POS	2
BATT VOLT	25.1	BATT HOURS REM	83

SWITCH
CLOSED
OPEN

ALIGN MODE

SOLID RED = NOT READY

AC POWER FAIL

SCADA CONTROL
REMOTE LOCAL

AUTOMATIC OPERATION
ENABLED DISABLED

TEST BATTERY

CLEAR ERRORS

CLEAR WARNINGS

CLEAR ALARMS

COMMS
PORT A RCV XMT
PORT B

DATA PORTS USE ONLY ONE

ERROR DETECTED PERFORM DIAG.

PROCESSOR STATUS INDICATES OK

BATTERY TEST

OC FAULT
A
B
C

DISABLED LOC/REM BATT STAT MAINT REQ AC POWER FAIL

BATTERY TEST CAB DOOR STATE DECOUPLED INSPECT REQ CALIBRATE REQ

UNRECOVER ERR HANDLE NOT STOW ALIGN MODE BAD BATT TEST HW INTERLOCK OPEN

WARNINGS ALARMS ERRORS COMMUNICATION **ACTIVE**

Safety Features

- Overload prevention - All amperage settings for tie points are based off the wire size. Amperage settings are updated annually after all large projects are completed.
- 3 Phase Operations – While triple singles can lockout a single phase based on loading; DA only operates in 3 phase gang operated mode.
- Multiple Faults – DA will handle faults simultaneously **ONLY** if they are in different Subsystems. Faults in the same Subsystem will be handled one at a time.

Safety Features continued...

- Communication Losses – DA will act as if any device without communications is protected and will not re-energize on either side of the device.
- Timeout on Restoration and Retries – DA has a timer on each fault it analyzes. This timer can be set based on the needs of the company. DEC sets its timer to **8 minutes** to allow for loss of voltage restoration.
- Non-Reclose – DA will always put a device in non-reclose before attempting to restore any members. This prevents further hits to the line and protects against any new faults during its isolation period.

Crew Safety Features

- Backfeeding – DA will never re-energize a faulted/isolated section. It will NOT use it to backfeed with if another fault occurs. Any isolated section not considered to be part of the system until it is re-energized manually in the field or by a manager.
- HLT (Hot Line Tag) – When any device on a feeder/circuit is placed in HLT, DA will block any automation on the entire feeder.
 - Depending on a company's needs, DA can block the entire feeder for any device on the feeder that has a comm loss, is in local mode or is put in non-reclose.

DA Effects on Reliability

- Large Impact: Circuit outages can be up to 1500 members without power. Can be from accidents, weather, trees, etc... **DA isolates the faulted area, provides easier troubleshooting and can restore at least half of the members with midline devices before they impact SAIDI and SAIFI numbers.**
- Largest Impact: Substation outages can be up to 5000 members without power. Can be from a transmission line fault, transformer differential LO or problems on the substation bus. **DA can backfeed members and alleviate the rush to get crews onsite for switching or repairs.**



#173959243

DA Success Stories in 2022

Circuit Outage (Lank 131) – MVA 1/16/2022 9:17:41 PM

- 2322 members out, opened mid-line TS/S, restored from sub to the TS/S
- 1297 members restored in 28 seconds
- 1025 members out for total of 3 hours
- **55.86% of members restored. 233,460 total outage minutes for members saved.**

Substation Outage (Meredith) – Transmission Loss from DPL – 5/31/2022 12:12:19pm

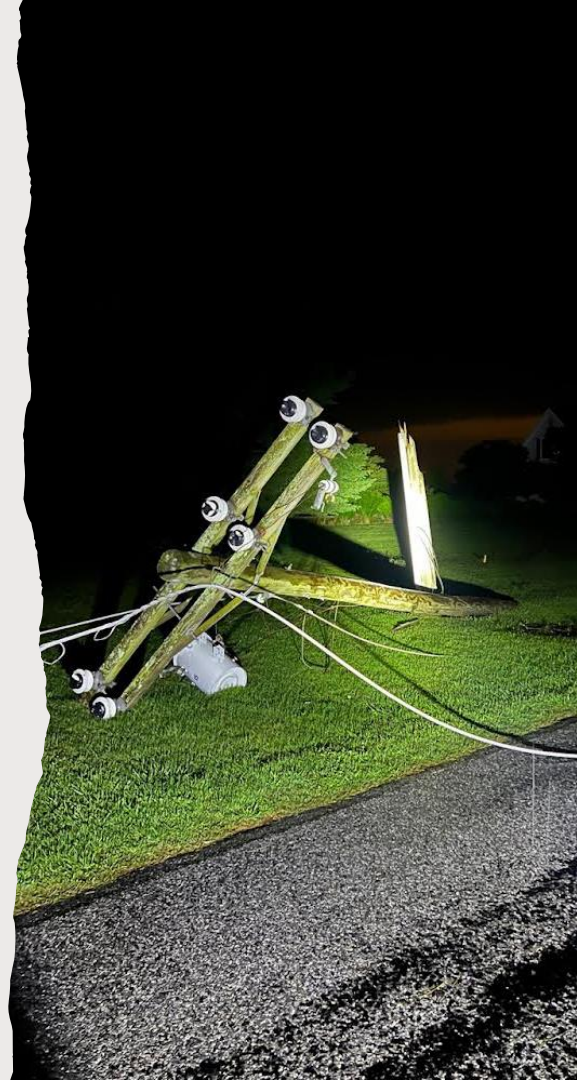
- 4642 members out, opened circuit reclosers and backed from MOABS tie points
- 909 members restored in 1 minute and 38 seconds
- 931 members restored in 2 minutes and 16 seconds
- 1297 members restored in 3 minutes and 4 seconds
- 1505 members restored in 3 minutes and 16 seconds
- **100% of members restored in under 5 minutes so it didn't hit our indices.**



DA Success Stories in 2022 continued...

Circuit Outage (Vernon 64) – Tree 1/3, Tornado 7/12 and MVA 8/1

- 1152 members out, opened tap TS/S, restored from sub along the backbone
- 343 members restored in approximately 30 seconds each time
- **In 2021, 4 outages occurred on this circuit which prompted the installation of the tap TS/S. In 2022, with the 43 circuit outages we restored 29.77% of the members saving over 280,500 total outage minutes.**
- Due to the number of circuit outages consistently in this area, we have increased the frequency in our tree trimming on this circuit and will be looking to add another midline TS/S to allow for members to be restored in the future.



DA Success Stories in 2022 continued...

Circuit Outage (Robinsonville 273) – Storms/Tree took down primary – 9/13 3:47:42 pm

- 2811 members out, opened mid-line TS/S, restored from another sub to the TS/S
- 1305 members restored in 13 seconds
- 1506 members out for total of 2.5 hours
- **46.42% of members restored. 225,900 total outage minutes for members saved.**



Circuit Outage (Lank 133) – PMH Overloading – 9/16 9:10:03 am

- 1707 members out, opened two mid-line TS/S, restored the 1st half from the circuit and the 2nd half from a MOABS tie
- 18 members restored in 1 minute and 30 seconds
- 684 members restored in 4 minutes and 37 seconds
- 1005 members out for remainder of outage at 2 hours and 35 minutes long
- **41.12% of members restored. 108,810 total outage minutes for members saved.**

DA Success Stories in 2022 continued...

Substation Outage (Angola) – Transmission Line Fault – 12/6 and 12/14

- Currently this substation only had one circuit on DA that could be restored.
- 8323 members out for the whole substation. The circuit had 1465 members out and DA opened the circuit recloser and backfed from a MOABS tie
- All 1465 members were restored in approximately 15 seconds both times
- The other 6858 members were out for total of 1 hour between both events
- **21.36% of members were restored but DA restored 100% of what it was able to and 87,900 total outage minutes for members were saved.**
- *This event is the driving force behind finishing all substations by the end of 2023. Between these events and the Meredith Substation loss in May, we are pushing to have ties for all circuits and for DA to have full back-feeding capabilities. Transmission loss is not in our control, but the speed of restoring the members is!*

DA Success Stories in 2023 – Major Wins for New Reliability Record

Circuit Outage (Vaughn 51) – Small storm brought down tree limb close to the sub – 2/12 10:09:05 pm
SUPERBOWL SUNDAY!!!

- Additions to mid-lines and tie points in 2022 and early 2023 have allowed for the restoration of even more members in this area. DEC is pushing to ensure all circuits have at least one midline device for isolation and back-feeding. However, once that project is complete, we will be looking for more areas to restore larger member counts.
- 2198 members out, opened mid-line TS/S, restored from another sub up to the TS/S
- 2109 members were restored in 3 minutes and 32 seconds
- 89 members out for total of 1 hour and 33 minutes
- **95.95% of members restored. 196,137 total outage minutes for members saved.**



DA Success Stories in 2023 – Major Wins for New Reliability Record

Double Operation During Tornado (Sussex NW Subsystem)

– 4/1

- First fault on Kratz 93, a pole came down at the end of the line with no possible ties
- Transmission loss on all of Kratz Substation due to 18 DPL poles being down occurred a half hour later while crews were replacing the original broken pole
- DA restored 2448 members out of 2653 that were on at the time of the voltage loss (2 out of 3 circuits, the third had no tie)
- Tornado then traveled between two substations (Bennett 142 and Kratz 91). DA reisolated the newly faulted areas and restored 834 members by opening a midline and back-feeding from another substation
- 1408 members out while all crews were called in to assess the full extent of the damage
- Over 28 poles were found broken, dozens of spans of wire were down and trees had to be trimmed in multiple locations by contractors.
- **Full Restoration of all but 15 members in 15 hours and Total Restoration in 28 hours.**



DEC's History

- Started with a DA pilot on 11 circuits/4 substations totaling 40 devices. Within 6 months we added extra midline devices and expanded DA to our office feeder.
- Began installing MOABS in 2017
 - Allowed for manual restoration of transmission loss as well as faster switching
 - Expanded across system allowing for frequent switching out of substations

DEC Today



Expanded DA to restore circuits due to a differential lockout on the station transformer. Isolates the transformer and substation bus and restores circuits where available.



Expanded DA to our Northern County and half of our Southern County

These expansions added 7 substations, expanded on 4 substations for a total of 29 additional feeders



Expanded DA to include communications to new padmount reclosers. Allows for protection in our beach area with heavy population density and a lot of underground development



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DEC End Goal

DEC currently has DA on:

- 57 circuits
- 17 substations
- total of 171 devices involved

By the end of the year:

- 91 circuits
- 24 substations
- Total of 269 devices involved

By the end of 2024:

- Include new substation and future midline device installs
- Incorporate Solar/DER logic and settings in DA
- Incorporate load management in heavily loaded areas for switching
- Utilize profile switching in DA for auto profile logic
- Continue utilizing all new features for the advantage of the system

Key Benefits



1. Reliability improvements

All outage types
Smaller Areas to Ride for Fault
No/less crews needed for transmission loss



2. Safety

Faster back feed before public starts to roam the site
Crew concerns are utilized in the configuration to build trust and ensure their protection



3. Improved Maintenance

Easier switching for substations
Less crews involved / no calling crews in early



4. System Decisions/Solutions are Predetermined

Rules are created/programmed in advance
The system is tested and commissioned well before events occur

- No pressure on staff to make rushed decisions due to outages
- Helps in the event of reduced staffing or retirement of key personnel



Any Questions??