

# LTC Conditional Maintenance

# Load Tap Changer (LTC)



Figure 1. 3-phase Tap Changer. Adapted from "Understanding Load Tap Changers  
By Steve Skinner in Transformers, Circuit Breakers | August 23, 2017". Retrieved from  
<http://www.artspphotoarchive.com/dancingindakota-112>. 2023

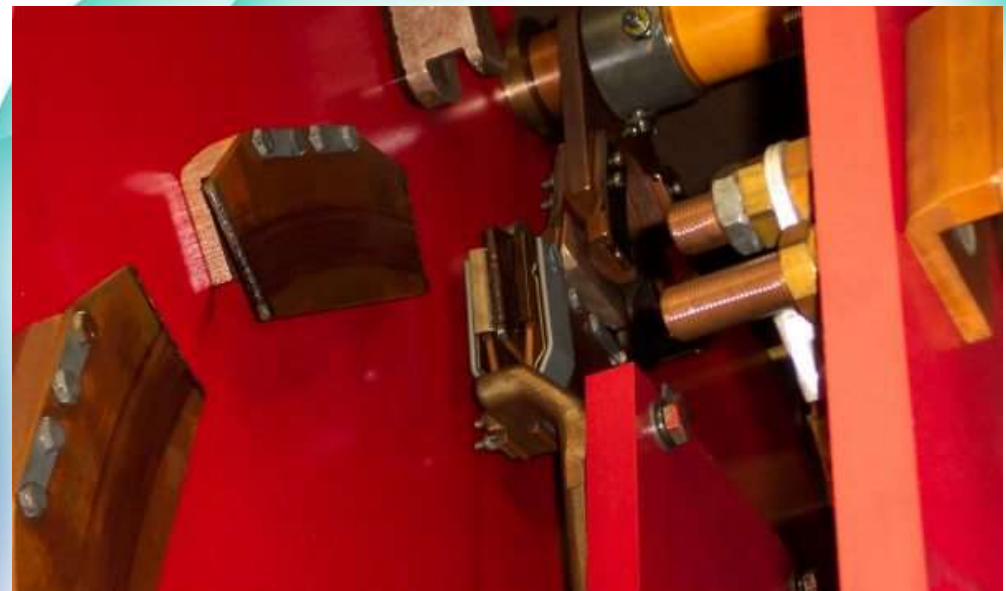
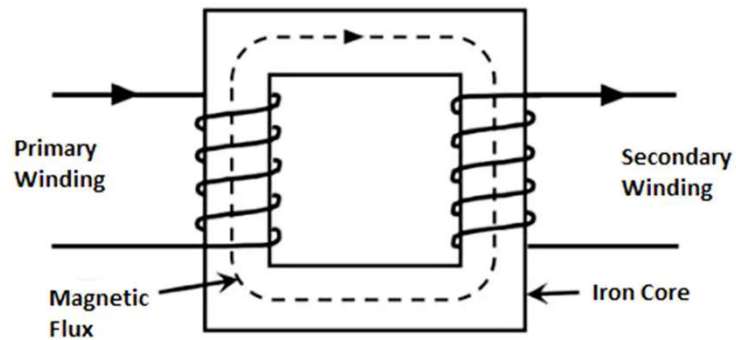


Figure 2. Sliding Contact. Adapted from "Understanding Load Tap Changers  
By Steve Skinner in Transformers, Circuit Breakers | August 23, 2017". Retrieved from  
<http://www.artspphotoarchive.com/dancingindakota-112>. 2023

# Transformer Coils



**Core Type Transformer**

Figure 3. Transformer types.  
 Adapted from "Difference Between Core  
 and Shell Transformers  
 by Viral Nagda".  
 Retrieved from  
 "https://instrumentationtools.com/difference-between-core-and-shell-transformers/".

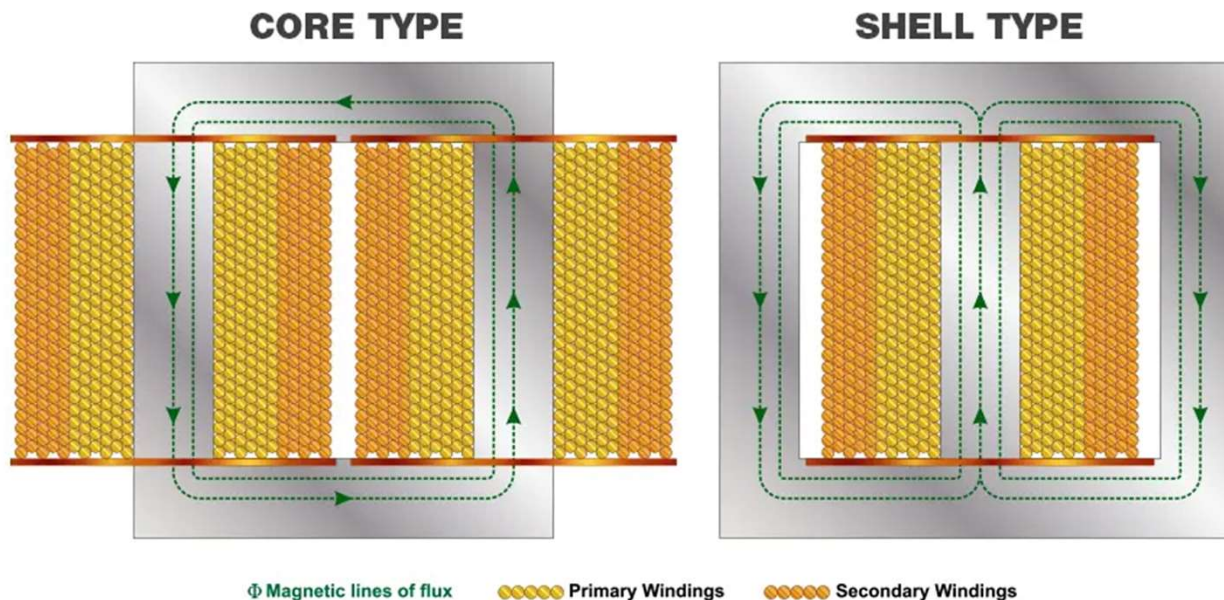
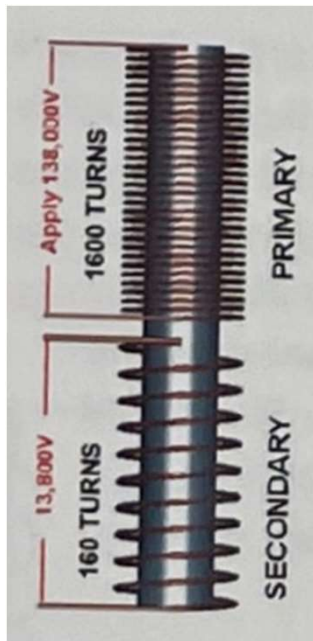


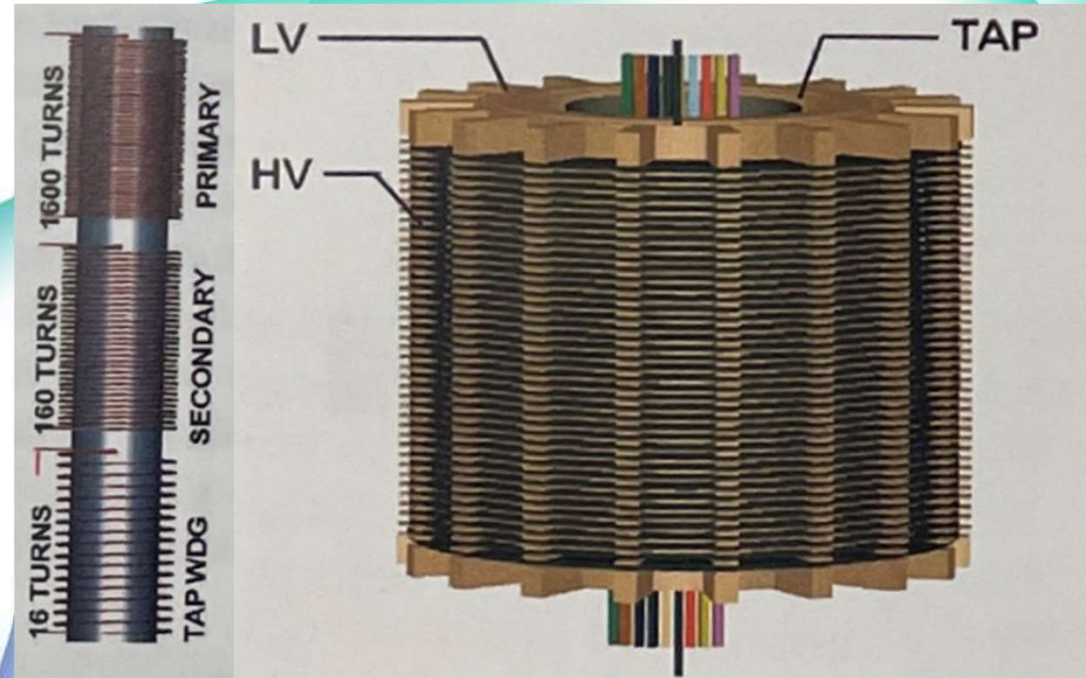
Figure 4. Transformer types. Adapted "Core Type vs. Shell Type Distribution Transformers  
 By Chris Davis, Senior Market Specialist – Electric Utility".  
 Retrieved from <https://solutions.borderstates.com/core-type-vs-shell-type-distribution-transformers/>.



# Transformer Coils



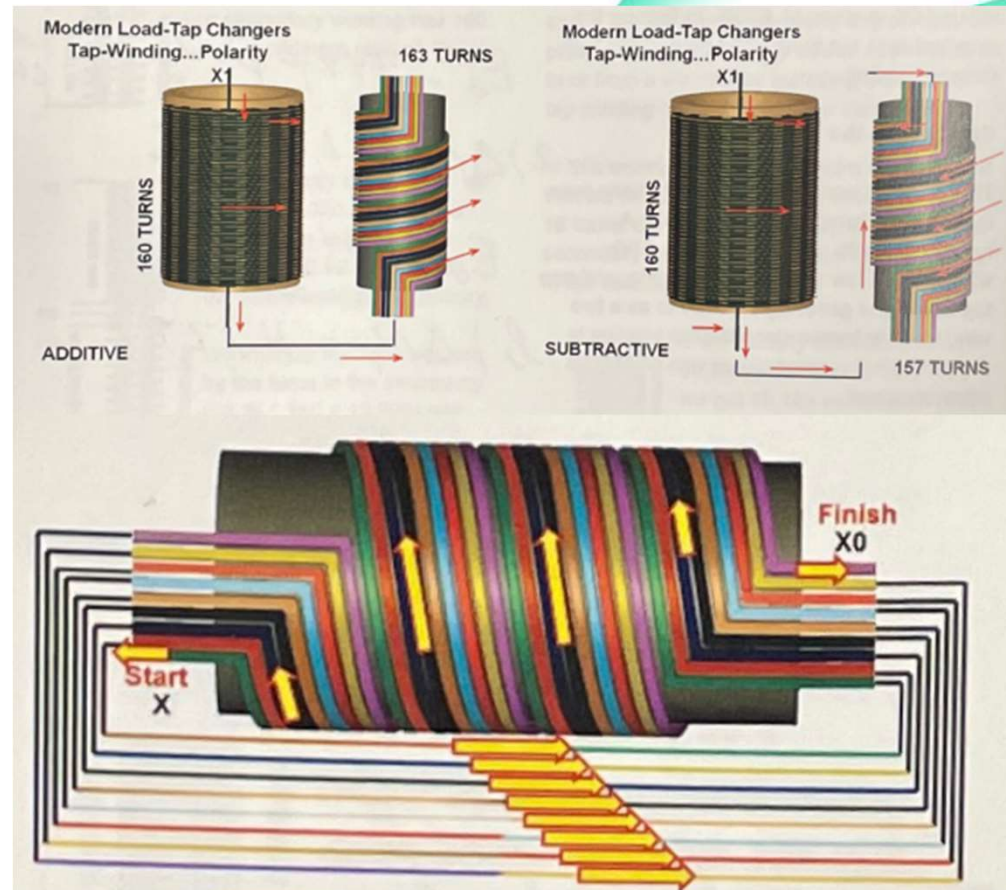
Primary Coil : Secondary Coil  
10 : 1  
138kV : 13.8kV



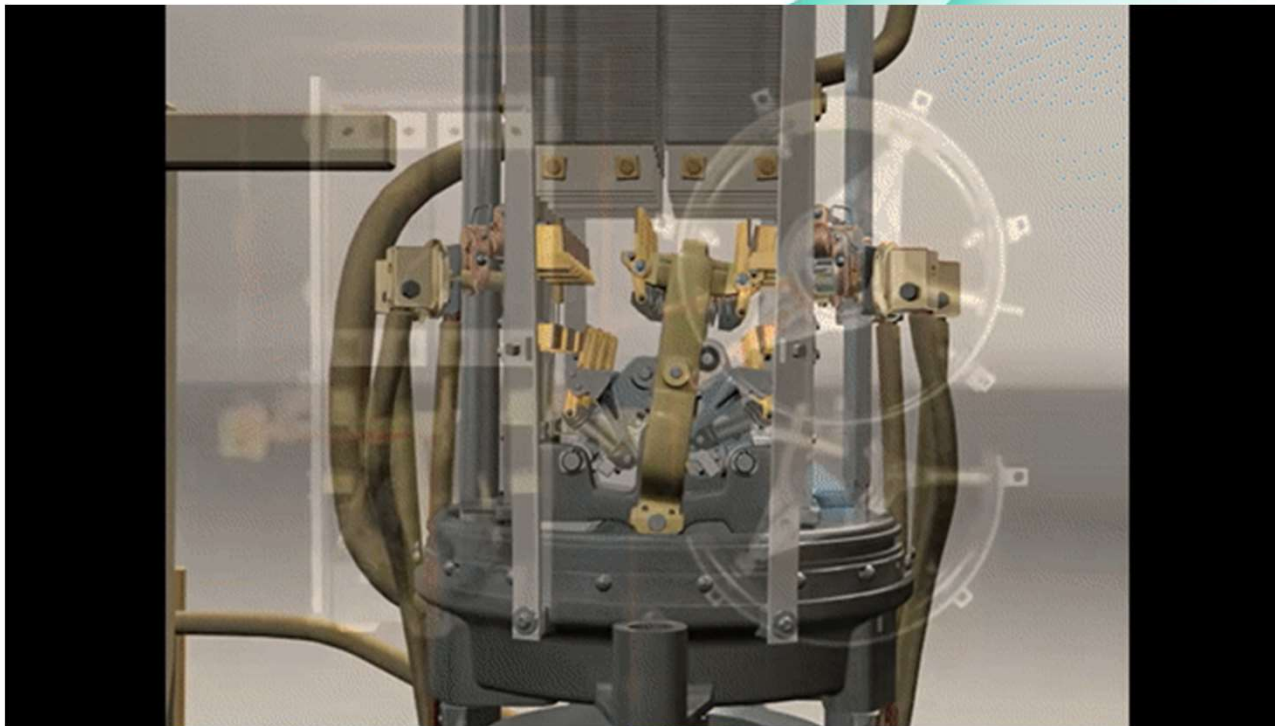
# Tap Winding

Multiple connection options and reverse polarity switch results in:

+- 10% voltage  
 16 + position  
 16 – position  
 1 neutral position



# Tap changing





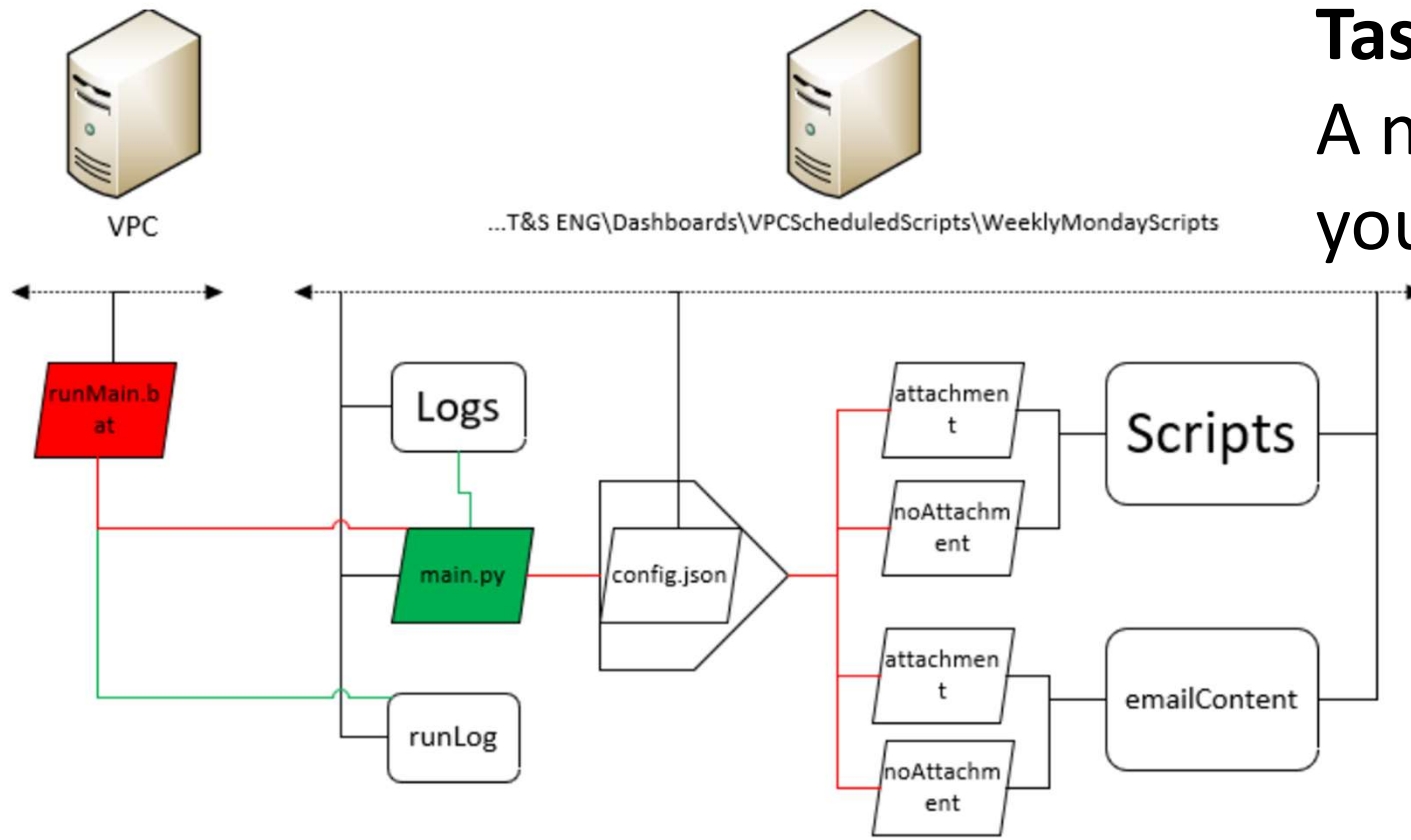
# Alerts - Python



- Programming language
- Easy to learn
- Dynamically typed
- Open-Source/Libraries
- Fast development



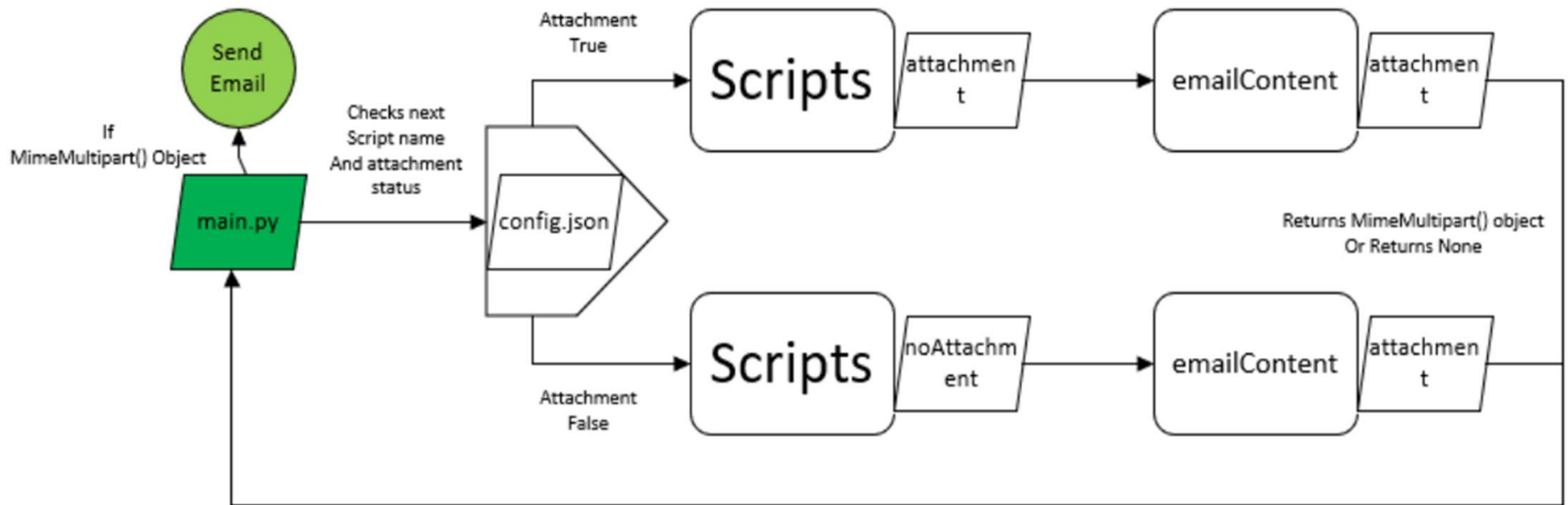
# Alerts - Python



**Task Scheduler –**  
A native app on  
your windows pc












# Alerts - Python



# Scheduled Report Scripts

```
{
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    "Tuesday": [],
    "Wednesday": [],
    "Thursday": [],
    "Friday": [],
    "Saturday": [],
    "Sunday": []
  },
  "scriptFunctionName": "ActiveNoPosition",
  "hasAttachment": "false",
  "htmlFunctionName": "ActiveNoPosition",
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    "Pankaj.Jain",
    "andrew.reindel",
    "Irene.Nakigudde",
    "Paul.Brown2"
  ]
},
{
  "schedule": {
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    "Wednesday": [],
    "Thursday": [],
    "Friday": [],
    "Saturday": [],
    "Sunday": []
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  "recipients": ["jin.cao",
```

# Scheduled Report Scripts

	s Python: WorkWeek 2310 Open Compressor PMs BuckMont 53 Found, Report Ran at 11:11:...	Tue 3/7/2023 11:1...	6
	Python has Scanned Cascade and is now emailing you.		
	s PUC IM Dashboard 5 week inspections - 18 Workorders found on 03/06/23	Mon 3/6/2023 12:...	1
	WARNING - This email/attachments may contain non-public transmission information. Pursuant to the FERC Standards of Conduct, this		
	s Demarcated data by percentages of PA-PUC I&M FORWARD LOOKING DASHBOARD - UNIT ...	Mon 3/6/2023 12:...	1
	WARNING - This email/attachments may contain non-public transmission information. Pursuant to the FERC Standards of Conduct, this		
	s OTSGP Remediation WO Report Ran at 08:46:57 on 03/06/23.	Mon 3/6/2023 8:4...	1
	Python has Scanned Cascade and is now emailing you.		
	s Python: WorkWeek 2310 as left manual or tagged analysis, Unit and Tag Type 54 Found, R...	Mon 3/6/2023 7:3...	2
	WARNING - This email/attachments may contain non-public transmission information. Please use caution when disseminating and		
	s Python: Units TC vs MT Temp Type-550 > 8C and all other types > 10C or Units with TC inte...	Mon 3/6/2023 7:3...	1
	Python has Scanned Cascade and is now emailing you.		
	s Found 1 Active PowerBase Status with different Cascade Status, Report Ran at 07:33:59 on ...	Mon 3/6/2023 7:3...	6
	WARNING - This email/attachments may contain non-public transmission information. Pursuant to the FERC Standards of Conduct, this		
	s Found 2 Active Equipment without Position, Report Ran at 07:33:14 on 03/06/23.	Mon 3/6/2023 7:3...	6
	WARNING - This email/attachments may contain non-public transmission information. Pursuant to the FERC Standards of Conduct, this		
	s Python: Powers with TC vs MT Temp or TC internal sched or TC DGA code = 4 or Ethy/Acyl ...	Mon 3/6/2023 7:3...	9
	Python has Scanned Cascade and is now emailing you.		
	s Python: WorkWeek 2309 as left manual or tagged analysis, Unit and Tag Type 57 Found, R...	Fri 3/3/2023 1:50 ...	2
	WARNING - This email/attachments may contain non-public transmission information. Please use caution when disseminating and		
	s Python: WorkWeek 2309 Open Compressor PMs BuckMont 58 Found, Report Ran at 13:49:...	Fri 3/3/2023 1:49 ...	6
	Python has Scanned Cascade and is now emailing you.		

# Unit TC report

Python: Units TC vs MT Temp Type-550 > 8C and all other types > 10C or Units with TC internal scheduled 60 Found, Report ...



svc\_pecoaha\_report\_p

To: [Swiatek, Jeffrey:\(PECO\)](#); [Shaw, Suzanne K:\(PECO\)](#); [Leinhauser Jr, George T:\(PECO - TSA\)](#); [Reindel, Andrew C:\(PECO\)](#); [Franchitti, Anthony J:\(PECO\)](#); [Packer, Kevin:\(PECO\)](#); [Davis, Craig L:\(PECO\)](#); [Pidloan, Eugene A:\(PECO\)](#); [Jain, Pankaji:\(PECO\)](#); [Leopold, David G:\(PECO - TSA\)](#); **+10 others**

Mon 3/6/2023 7:34 AM

Retention Policy Entire Mailbox - 2 Year Delete (2 years)

Expires 3/5/2025

[If there are problems with how this message is displayed, click here to view it in a web browser.](#)



Python has Scanned Cascade and is now emailing you.

**REPORT PURPOSE:** To provide Engineering Unit Transformers that have TCs hotter than MT of > 8 Degrees c for Type-550 and > 10 degrees c for all other types OR Units with a TC internal open Work order scheduled.

**The Attached File is a list of Unit Transformers with TC hotter than MT for last inspection reading OR having a TC internal WO open:**

This report also gives you the last oil DGA and fluid quality info, and includes percent due DT and any open TC internal, Oil Samples, DT, or oil correct WOs and thier schedule Dates. If a Row is highlighted Red, it is due to TC hotter by more than 9 degrees C from MT!

Sincerely,  
PECO Python

Quote of the day!

Quote
"A diverse mix of voices leads to better discussions, decisions, and outcomes for everyone." ~Sundar Pichai



# Units TC Excel Sheet

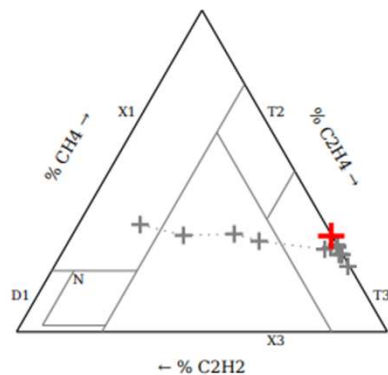
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
		Asset	TC Type	Last Reads	TC Temp C	MT Temp C	Delta	Sample Date	A H2O	DGA code	C2H4	C2H2	IC2H2	IC2H4	CH4	code	D877	IFT	Acid	Low Avg	Level W O Correct	left TC control	AO Tag	LTC ops	Internal Date	Sample Date	% Due	Next DT	Neutral	Last TC Internal Date
1	0	CHARLTON 1	WEST: URS-D 33.0 Taps	2023-02-23	21.8	10.8	11	11/01/2022	15	1	4	11	0.36	2.75	5	1	44	47.6	0.01	2	NO	Auto	NONE	0	NO	03/28/2023	6.3	NO	10/05/2022	02/04/2016
3	1	WESTTOWN 1	WEST: URS 33.0 Taps	2023-02-22	20.4	8.2	12.2	05/26/2022	32	1	138	142	0.97	1.03	13	1	40	31	0.03	0	NO	Auto	NONE	1	NO	03/21/2023	119	05/04/2023	09/09/2019	No Previous
4	2	BELMONT 2	WEST: URS-D 33.0 Taps	2023-02-27	36	22	14	10/13/2022	19	1	74	89	0.83	1.2	18	1	39	42.5	0.01	3	NO	Auto	NONE	0	NO	03/28/2023	62.9	03/13/2023	09/07/2022	02/23/2018
5	3	BELMONT 1	WEST: URS-C 33.0 Taps	2023-02-27	54	24	30	10/13/2022	34	4	5264	100	52.6	0.02	520	1	37	42.5	0.01	0	NO	Manua	AO	0	NO	NO	0.1	NO	09/21/2021	03/02/2023
6	4	MIDWAY 5	GE: LRT-68 33.0 Taps	2023-03-01	36	15.8	20.2	04/04/2022	9	1	0	0			1	1	57	35.9	0.01	0	NO	Auto	NONE	0	NO	04/04/2023	126.8	12/29/2023	03/01/2023	No Previous
7	5	PENNSBURY 1	WEST: URS-C 33.0 Taps	2023-02-16	45	24	21	10/20/2022	20	3	1421	122	13.6	0.09	397	1	48	41.1	0.01	1	NO	Auto	NONE	0	03/27/2023	NO	79.9	03/27/2023	12/08/2022	10/13/2016
8	6	KLEYONA 4	WEST: URS-C 33.0 Taps	2023-02-24	49.2	14.2	35	02/23/2023	33	4	29734	108	275	0	12661	1	33	38.9	0.01	1	04/10/2023	Auto	NONE	0	04/10/2023	NO	81.3	04/10/2023	05/06/2016	No Previous
9	7	LANDENBERG 1	PENN: TYPE-220 33.0 Taps	2023-01-30	22.6	12.4	10.2	11/15/2022	12	1	38	1	38	0.03	15	1	50	40.4	0.01	0	NO	Auto	NONE	0	NO	NO	69.8	NO	01/30/2023	No Previous
10	8	ABINGTON 1	WEST: URS-C 33.0 Taps	2023-01-31	34	23	11	12/15/2022	19	2	228	73	3.12	0.32	46	1	38	42.8	0.01	1	NO	Auto	NONE	0	NO	NO	33.9	NO	01/31/2023	06/17/2020
11	9	KULPS 3	WEST: URS-D 33.0 Taps	2023-02-08	32	15	17	02/13/2023	17	1	43	20	2.15	0.47	25	1	53	42	0.01	1	NO	Auto	NONE	0	04/27/2028	03/14/2023	35.6	NO	01/04/2023	11/14/1997
12	10	COATESVILLE 1	WEST: URS-C 33.0 Taps	2023-02-12	33	18	15	01/26/2023	18	1	145	219	0.66	1.51	108	1	46	42	0.01	0	NO	Auto	NONE	5	NO	03/14/2023	23.6	NO	02/12/2023	04/14/2021
13	11	PAOLI 3	WEST: URS-C 33.0 Taps	2023-02-23	33.4	16.4	17	01/10/2023	26	1	75	39	1.92	0.52	11	1	52	43	0.01	1	NO	Auto	NONE	6	NO	03/28/2023	14	NO	02/23/2023	05/25/2016
14	12	PAOLI 4	WEST: URS-C 33.0 Taps	2023-02-23	24.4	13.8	10.6	01/10/2023	16	2	279	51	5.47	0.18	23	1	54	45.4	0.01	1	NO	Auto	NONE	5	03/20/2023	NO	57.9	03/20/2023	02/23/2023	10/11/2019
15	13	NOTTINGHAM UNIT 11	WEST: URS-C 33.0 Taps	2023-01-29	39	19	20	02/27/2023	21	4	1192	66	18.1	0.06	398	2	54	46.9	0.01	0	NO	Auto	NONE	0	NO	NO	74.8	NO	08/06/2020	01/25/2021
16	14	COATESVILLE 3	WEST: URS-C 33.0 Taps	2023-02-12	40	21	19	01/26/2023	30	4	12288	64	192	0.01	3768	1	39	38.1	0.01	1	NO	Auto	NONE	1	05/08/2023	NO	73.6	05/08/2023	02/12/2023	04/14/2017
17	15	ELLWOOD 1	WEST: URS-C 33.0 Taps	2023-02-27	53	28	25	09/29/2022	36	4	8902	26	342	0	1726	1	39	32.9	0.02	2	NO	Auto	NONE	0	04/20/2023	NO	17	NO	02/10/2022	No Previous
18	16	LEOPARD 4	WEST: URS-D 33.0 Taps	2023-02-23	28.2	14.2	14	07/21/2022	27	1	395	397	1	1.01	141	1	36	34.8	0.01	0	NO	Auto	NONE	3	NO	03/28/2023	6.8	NO	08/30/2022	08/21/2022
19	17	CONCORD UNIT 12	PENN: TYPE-550 33.0 Taps	2023-02-20	14.8	11.6	3.2	08/10/2022	40	4	7748	624	12.4	0.08	1959	1	35	43.3	0.01	0	NO	Auto	NONE	1	12/19/2024	NO	77.6	NO	02/20/2023	12/18/2016
20	18	BROOMALL 1	BALANCE BEAM: TYPE-550 33.0 Taps	2023-02-24	16	17	-1	05/25/2022	16	4	2231	64	34.9	0.03	330	1	55	37.9	0.01	1	NO	Auto	ACT	1	03/25/2024	NO	96.9	03/25/2024	01/23/2018	01/19/2018
21	19	PALOMINO 4	WEST: URS-C 33.0 Taps	2023-02-06	28	20	8	11/19/2022	30	4	18803	138	136	0.01	7471	3	51	29	0.03	0	NO	Auto	NONE	0	02/09/2024	NO	88.3	NO	09/03/2021	02/07/2008

# PECO PYTHON – CASCADE - DGA

Lab report number	6989 - 6:D2322706BEE	1457 - 6:D23125F9FF3	5458 - 6:D23118C3F6E	5956 - 5:D221137B17C	6166 - 5:D22713FDC12	
Sample date	2023-02-23	2023-01-26	2023-01-18	2022-10-25	2022-07-13	
Sample temp	10	13	20	21	37	°C
Hydrogen (H <sub>2</sub> )	2098***	1472**	1307**	1213*	2356***	μL/L
Methane (CH <sub>4</sub> )	12661.0***	8469.0***	8407.0***	6975.0***	7623.0***	μL/L
Ethane (C <sub>2</sub> H <sub>6</sub> )	6832.0	4926.0	4884.0	3212.0	3022.0	μL/L
Ethylene (C <sub>2</sub> H <sub>4</sub> )	29734.0***	23348.0***	22650.0***	21912.0***	21256.0***^	μL/L
Acetylene (C <sub>2</sub> H <sub>2</sub> )	108.0	49.0	42.0	66.0	77.0^	μL/L
Ethylene/Acetylene (C <sub>2</sub> H <sub>4</sub> /C <sub>2</sub> H <sub>2</sub> )	275.3***	476.5***	539.3***	332.0***	276.1***	
Acetylene/Ethylene (C <sub>2</sub> H <sub>2</sub> /C <sub>2</sub> H <sub>4</sub> )	0.0	0.0	0.0	0.0	0.0	

# PECO PYTHON – CASCADE - DGA

## Duval Triangle Diagnosis



Triangle Diagnosis: T3  
 High-range thermal fault (above 700°C).

## Moisture Analysis

Lab report number	6989 - 6:D2322706I	:D23223EDA3E
Sample date	2023-02-23	2023-02-23
Sample temp	10	10
Moisture	33*	29
Relative saturation	94	83
Dew point	9	6
Moisture result	2	1
Moisture diagnosis	WET-OIL	

Symbol legend: \*: abnormal level

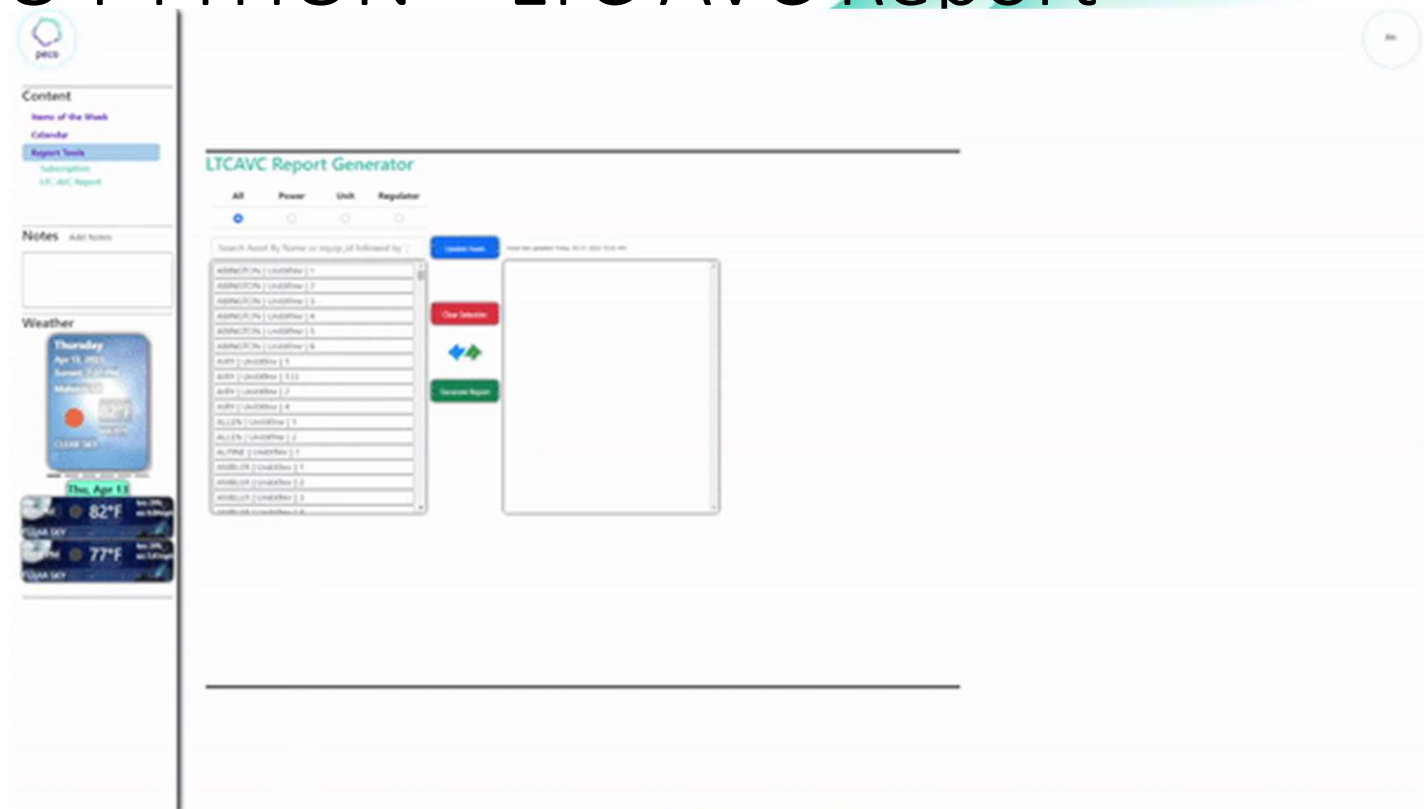


# PECO PYTHON – WEB APP

*“Our hub for readily available custom tools”*



# PECO PYTHON – LTC AVC Report



The screenshot displays the LTCAVC Report Generator web application. On the left is a sidebar with navigation links: Content, Home of the Week, Calendar, Report Tools, Subscriptions, and LTC AVC Report. Below these are sections for Notes (with an 'Add Notes' button), Weather (showing a forecast for Thursday, April 15, 2021, with a high of 82°F and a low of 77°F), and a calendar view for April 15. The main content area is titled 'LTCAVC Report Generator' and features tabs for All, Power, Unit, and Regulator. A search bar is present with the text 'Search Report By Name or equip\_id followed by :'. Below the search bar is a list of reports, each showing a name and a date in parentheses. To the right of the list are three buttons: 'Generate Report' (blue), 'Clear Selection' (red), and 'Generate Report' (green). A large empty box is positioned to the right of the buttons.

**LTCAVC Report Generator**

All Power Unit Regulator

Search Report By Name or equip\_id followed by :

Generate Report

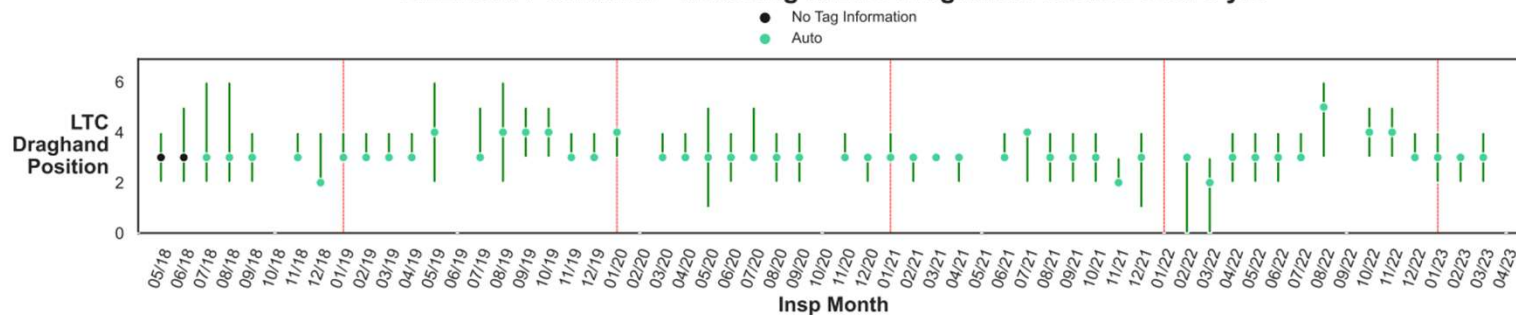
Clear Selection

Generate Report

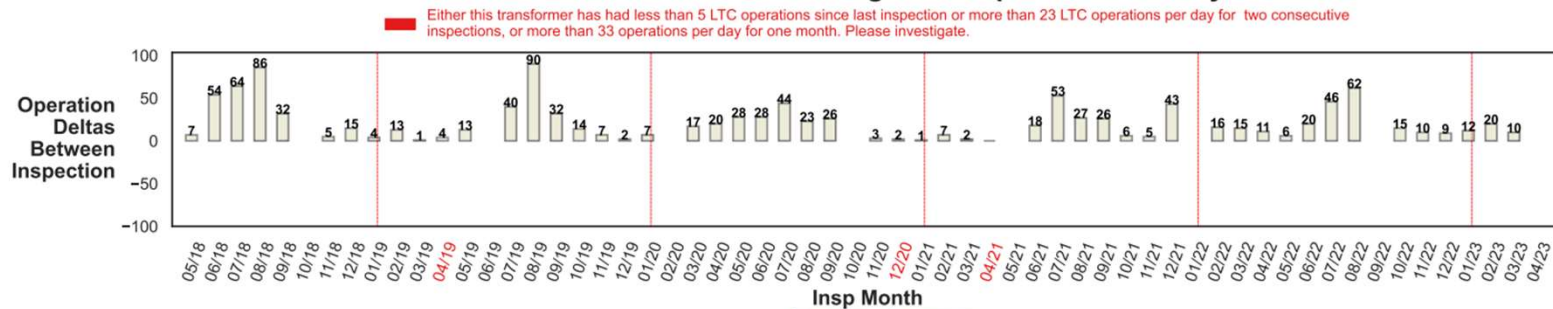
Report Name	Date
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ALLEN (unit) 2	(unit) 2
ALLEN (unit) 3	(unit) 3
ALLEN (unit) 4	(unit) 4
ALLEN (unit) 5	(unit) 5
ALLEN (unit) 6	(unit) 6
ALLEN (unit) 7	(unit) 7
ALLEN (unit) 8	(unit) 8
ALLEN (unit) 9	(unit) 9
ALLEN (unit) 10	(unit) 10
ALLEN (unit) 11	(unit) 11
ALLEN (unit) 12	(unit) 12
ALLEN (unit) 13	(unit) 13
ALLEN (unit) 14	(unit) 14
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ALLEN (unit) 91	(unit) 91
ALLEN (unit) 92	(unit) 92
ALLEN (unit) 93	(unit) 93
ALLEN (unit) 94	(unit) 94
ALLEN (unit) 95	(unit) 95
ALLEN (unit) 96	(unit) 96
ALLEN (unit) 97	(unit) 97
ALLEN (unit) 98	(unit) 98
ALLEN (unit) 99	(unit) 99
ALLEN (unit) 100	(unit) 100

# PECO PYTHON – LTC AVC Report

**KLEYONA UnitXfmr 4: looking at LTC Draghand Position over 5 yrs**

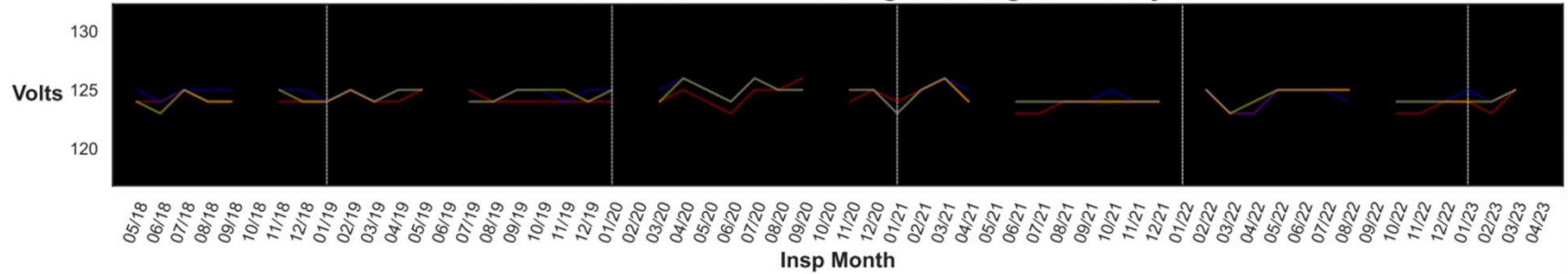


**KLEYONA UnitXfmr 4: looking at LTC operations over 5 yrs**

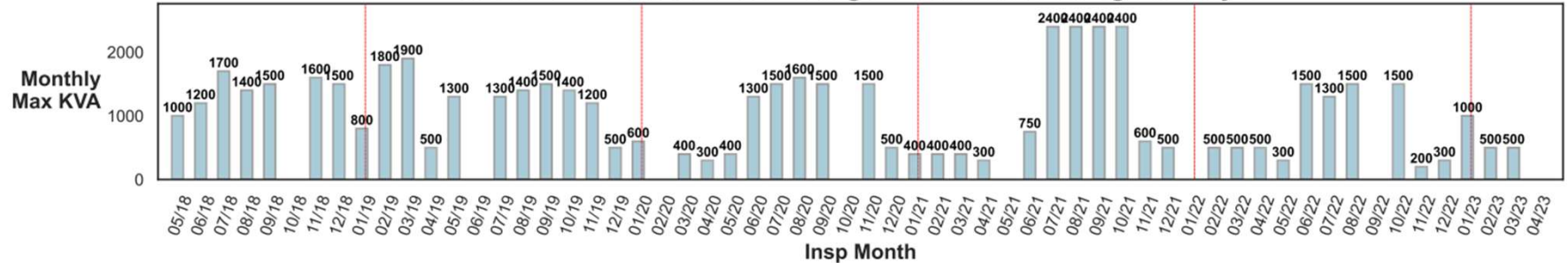




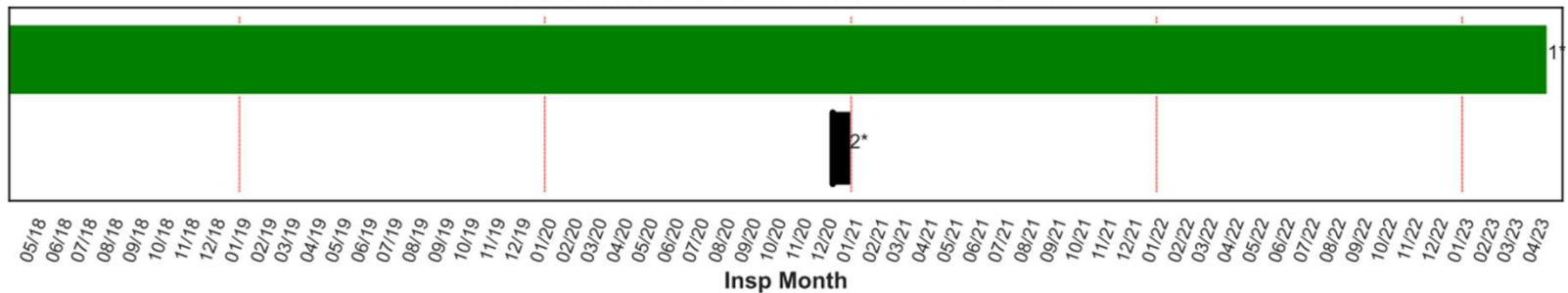
KLEYONA UnitXfmr 4: looking at Voltages over 5 yrs



KLEYONA UnitXfmr 4: looking at Unit Max Loading over 5 yrs







KLEYONA UnitXfmr 4: MX Work Orders



1: Miscellaneous Corrective - UnitXfmr; KLEYONA TRAN-4 REPLACE T/C COUNTER KLEYONA TRAN-4 REPLACE T/C COUNTER tap changer counter has not moved . broken? (MxOrder - 2017-3000390278 / Miscellaneous Corrective - UnitXfmr)

2: Miscellaneous Corrective - UnitXfmr; KLEYONA TRAN-4 MISCELLANEOUS CORRECTIVE - UNITXFMR KLEYONA TRAN-4 MISCELLANEOUS CORRECTIVE - UNITXFMR TAP CHANGER TEMP 32 DEG C MAIN TANK TEMP 19 DEG C . MORE THAN 10 DEG DIFFERENCE. GET PDM TO CHECK TAP CHANGER TEMPERATURE.^ [MXORDER - 2020-3001381313 / MISCELLANEOUS CORRECTIVE - UNITXFMR]

# PECO PYTHON – CASCADE

 <b>TranUnit LTC(Except Type-550) Hotter than MT</b> Trigger Group: Transformer Unit LTC(Except Type-550) Hotter than MT	 <b>Unit Transformer LTC Oil Low for 3 Cnsc</b> Trigger Group: Tran Unit LTC Oil Low for 3 cnsc
 <b>LTC Oil Quality Condition Code Unacceptable</b> Trigger Group: TOA4 UnitXfmr LTC Oil Quality Unacceptable	 <b>LTC DGA Condition Code Unacceptable</b> Trigger Group: TOA4 UnitXfmr LTC DGA Cond Unacceptable



# PECO PYTHON – Internal Inspection

## Job Scope:

- Take oil samples per CM-PE-101001. record TC counter readings drags hands position.
- Visually check equipment and submit work orders for any abnormalities.
- Note counter readings, drag hand position any thermos & acoustics results on Lab slip
- Max load reading (Units)where available.
- Deliver oil samples to Lab for processing within 5 days.
- MT Voltages 200kV or higher must have 2 quart bottles

## Create Comments

KLEYONA TRAN-4 OIL SAMPLE EMERGENT/TREND/ACOUS/THERM- UNITXF  
KLEYONA TRAN-4 OIL SAMPLE EMERGENT/TREND/ACOUS/THERM- UNITXF

TAP CHANGER HAS BEEN SHOWING SIGNS OF EXTREME HEATING (LARGE TEMPERATURE  
DELTA'S AND LARGE QUANTITIES OF HOT METAL GASES IN DGA). TAP CHANGER

INTERNAL INSPECTION IS SCHEDULED FOR APRIL 2023. BASED ON RESULTS OF THIS  
SAMPLE, IT MAY BE DETERMINED THAT TAP CHANGER INTERNAL NEEDS TO PERFORMED  
BEFORE SCHEDULED DATE. ENGINEERING WILL REVIEW AND WORK WITH WM. PLEASE  
TAKE SAMPLE IN THE NEXT 2-3 WEEKS. ^

[MXORDER - 2023-3001874560 / OIL SAMPLE EMERGENT/TREND/ACOUS/THERM- UNITXFM  
R] JOB SCOPE:

- TAKE OIL SAMPLES PER CM-PE-101001. RECORD TC COUNTER READINGS DRAGS HANDS  
POSITION.
- VISUALLY CHECK EQUIPMENT AND SUBMIT WORK ORDERS FOR ANY ABNORMALITIES.



# PECO PYTHON – Kleyona Unit 4 Transformer

