



# Asset Failure Analysis

## Ignition Extent of Condition Report

Index # 450 | Alleghany-1101

Failure Sub Driver: Fatigue + Workmanship

Incident Date: April 18, 2022

Failure Analysis Engineer: [REDACTED]

AFA Manager: [REDACTED]

Report Date: April 30, 2022 | Rev 01





# Photographs

Index # 450 | Alleghany-1101, H-Type Connector | 4/18/2022

## Incident Photographs

From ground photo #1 (4/18/2022)

Clamp of photo (04/18/22)



After the incident (April, 2022)

Drone photo (2019)





# Timeline of Relevant Events

Index # 450 | Alleghany-1101, H-Type Connector | 4/18/2022

1952

## Structure install date

Address: 20SE/0 OFF SSD 2707 STATE HWY 49.

05/14/19

## EC #117235246 - Loose guys - Complete

Review completed by EC Optimization Review Team on 8/2/2019, confirming that this work can be executed on an individual tag basis and released to normal workflow.

04/18/22

## H-Type connector failure

[22-0051067](#) -LR 804 Veg outage - 3 phase fault

LR - Reclosed twice before locking out.

04/18-19/22

[EC # 123360159](#) - Roadside connector failed and caused burned jumper

- i. REPLACED 6 CONNECTORS
- ii. 2 JUMPERS
- iii. INSTALLED HIGH SIGNS.

04/22/22

EC# 123360159 High Sign  
Tag close 05/09/22



# Executive Summary

Index # 450 | Alleghany-1101, H-Type Connector | 4/18/2022

## Overview

At 1500 hours, a PG&E Troubleman was dispatched to the Alleghany 1101, a 12kV Distribution Circuit near State Highway 49, 1.80 miles East of Forest Route 93 in Sierra City in response to an area outage. Upon entering the rural area, the Troubleman was met by Fire Department on the side of the road requesting his assistance. Initial analysis indicates equipment failure caused the ignition. Once the Fire Department made the scene safe and allowed PG&E to enter, the Troubleman began his assessment and found the connector had failed at the aluminum to copper connection. At 1809 the t-man then made the line safe by opening LR 804 de-energizing the line. This failure caused the ignition that was .25 acres in size. The fire was suppressed by Sierra City Fire Department. This incident led to an outage affecting 604 customers. Due to the remoteness of the area, and a one-way feed, the town was fed by a generator through the night. A PG&E Crew, along with the responding PG&E Troubleman returned to the site on April 19, 2022, to replace the connector and re-energize electricity to the impacted area.

## Details

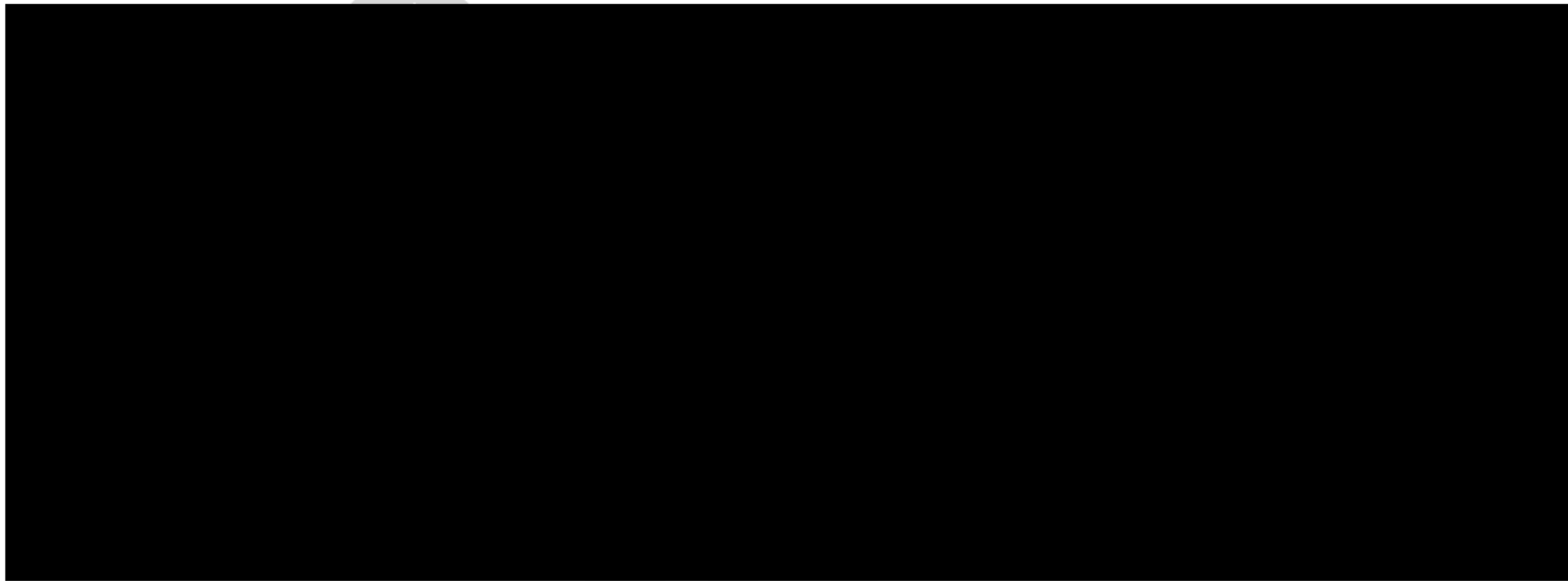
Ignition Database Index	450	Circuit	Ignition Tracker Column DG
Date & Time of Incident	4/18/2022 , 1500	SAP ID	100111818
High Fire Threat District	Tier 2	Fire Size	< 0.25
Failure Driver	Connector	Weather & Estimated Wind	The high temperature was 44.0F at 1345 hours and the low temperature was 27.6F at 0230 hours. The relative humidity was as high as 97% at 2345 hours and as low as 38% at 0700 hours. The maximum wind speed was 13.0 mph from the east at 1515 hours.
Failure Sub-Driver	Veg Contacting the 12KV line	EPSS Enabled Circuit?	NO
ILIS	22-0051167	Burn Scar?	NA
Relevant Pre-Existing Tags	117235246		
Reviewer Notes	Overhead splice/connector failure resulted in melting of the connector causing the incident. Cause of the equipment failure is unknown at this time. The ensuing fire was 3 meters - 0.25 acre in size. No photos available in EC notification 123360159, or FAS tag. This information is preliminary.		
Additional Comments	Not Corrosion Zone		



# Circuit Single Line

Index # 450 | Alleghany-1101, H-Type Connector | 4/18/2022

Alleghany-1101# / Sierra / SAP ID#10011818





# Historical Outage Information

Index # 450 | Alleghany-1101, H-Type Connector | 4/18/2022

## Circuit ILIS Historical Reference

100111818

100103442

104026332

ILIS Outage	OIS	Start	End	Cause	Additional Information	LR 804
<a href="#">22-0014306</a>	1612190	01/25/22 17:18	01/26/22 15:08	Vegetation, Tree - fell into line	Line to Line	3 phase fault
<a href="#">22-0028403</a>	1640087	03/01/22 15:59	03/01/22 20:17	Unknown Cause, Patrol - found nothing	Transformer – No overload condition	
<a href="#">22-0031685</a>	1654301	3/23/22		Planned	WSIP/System Hardening	
<a href="#">22-0051167</a>	1676079	04/18/22 18:09	04/19/22 12:10	H-Type Connector Failure Equipment Failure	Index #450	Force Out
<a href="#">22-0051067</a>	1675911	04/18/22 14:20	04/18/22 16:53	Vegetation, Tree - fell into line	Three Phase Fault	3 Phase fault
<a href="#">22-0055653</a>	1684001	04/28/22 15:08	04/28/22 15:51	Lightning Arrestor, Burned/flashed ARRESTOR LD SIDE OF FU 7701 EXTENDED PLANNED OUTAGE 22-27066	3rd Party, Customer Equipment	Line to ground Phase A to ground fault
<a href="#">22-0027066</a>	1683675	04/28/22 08:45	04/28/22 19:54	Planned	BLOWN CUST LIGHTNING ARRESTOR,	Line to ground Phase A to ground fault



# Historical Information

Index # 450 | Alleghany-1101, H-Type Connector | 4/18/2022

Six major incidents happened from 01/01/22 to 04/30/22

Evt	Date	Time	Type	IA	IB	IC	3I0	VA	V	
34	22/04/18	6:09:16 PM	MAN/EXT TRIP/LO	9	13	13	0	0		
35	22/04/18	6:09:16 PM	<b>CONTROL LOCKOUT</b>	9	13	13	0			
36	22/04/18	6:08:26 PM	NON-RECLOSE ON	9	12	13	1	0		
37	22/04/18	4:54:25 PM	non-reclose off	23	17	20	1	0	0	0
38	22/04/18	4:52:56 PM	LR IS CLOSED	79	82	32	2	0		
39	22/04/18	4:52:56 PM	SEQUENCE RESET	0	0	0	0	0		
40	22/04/18	4:52:56 PM	MANUAL/EXT CLOSE	0	0	0	0	0		
41	22/04/18	2:21:36 PM	NON-RECLOSE ON	0	0	0	0	0	0	0
42	22/04/18	2:19:27 PM	LR is OPEN	0	0	0	0	0	0	0
43	22/04/18	2:19:27 PM	LR IS CLOSED	0	0	0	0	0	0	0
44	22/04/18	2:19:27 PM	LR is OPEN	0	0	0	0	0	0	0
45	22/04/18	2:19:27 PM	FAULT DATA (pri)	248	258	244	2	0	0	0
46	22/04/18	2:19:27 PM	OVERCURRENT TRIP	247	257	244	1	0		
47	22/04/18	2:19:27 PM	<b>CONTROL LOCKOUT</b>	247	257	244	1			
48	22/04/18	2:19:23 PM	LR IS CLOSED	218	242	244	1	0		
49	22/04/18	2:19:23 PM	sw mode cut-out	0	0	0	0	0		
50	22/04/18	2:19:23 PM	SW MODE CUT-IN	0	0	0	0	0		
51	22/04/18	2:18:58 PM	LR is OPEN	0	0	0	0	0		
52	22/04/18	2:18:58 PM	LR IS CLOSED	0	0	0	0	0	0	0
53	22/04/18	2:18:58 PM	LR is OPEN	0	0	0	0	0	0	0
54	22/04/18	2:18:58 PM	FAULT DATA (pri)	249	259	245	2	0	0	0
55	22/04/18	2:18:58 PM	OVERCURRENT TRIP	249	259	245	1	0	0	0

T-man manual  
Open due to H-  
Type  
Conn. failure

SCADA manual  
Closed to restore  
service

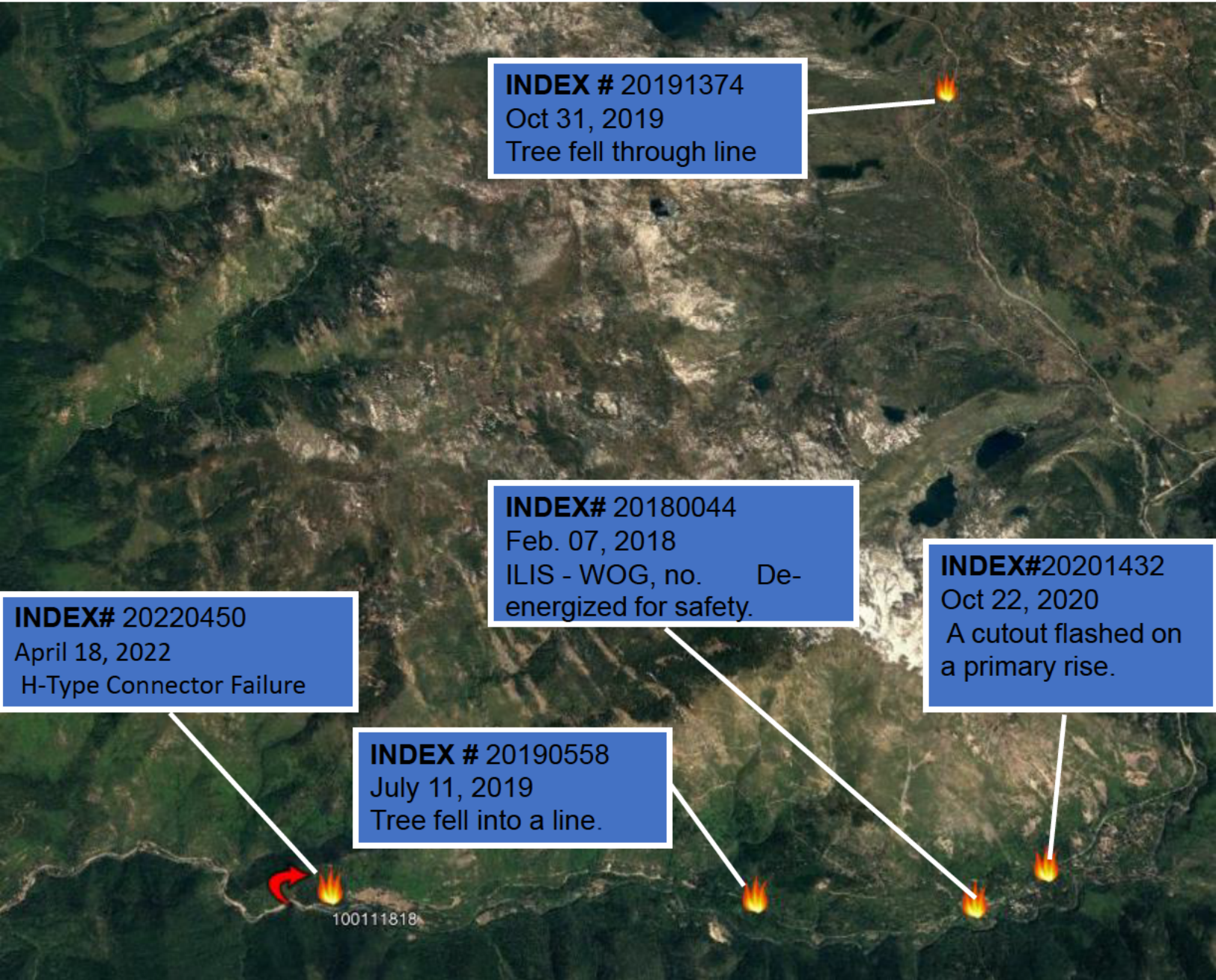
Veg. Contact 3-  
ph fault, Closed  
back onto a  
Fault after 25s,  
to lockout



# Historical Fire Incident On Alleghany -1101 circuit

Index # 450 | Alleghany-1101, H-Type Connector | 4/18/2022

## EII ignition data 2019 - 2022



# Electric Standards/Asset Strategy

Index # 450 | Allegheny-1101, H-Type Connector | 4/18/2022

Equipment Type	H-Type Connector	Standard Engineer		Standard Doc #	041010
Asset. Str. Eng.		Standard Construction Spec.			

## Known Kind of Failure

These Connectors rarely Fail

- Possible failure causes
  - Various fault conditions in the past
  - Age
  - Workmanship

## Build Up to Standard

No, there was one less crimp than required per 041010, Additionally, it was noted that a 'no-oxide' (corrosion inhibitor) applied and may have corroded internally due to signs of heat damage observed, as indicated in [TD-2907P-01](#) "Installing Overhead Conductor Splices".

- Table 4 Doc 041010 - Aluminum H-Type Compression Connectors
  - Material Code# 305509
  - Corrosion zone required inhibitor compound to prevent

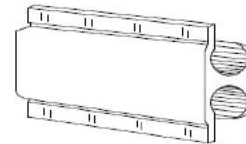


Table 4 Aluminum H-Type Compression Connectors

Code	Manufacturer & Catalog Number						Tool & Die Data			
							12-Ton Tool		6-Ton Tool <sup>4</sup>	
Code	Anderson	Blackburn	Burndy	Kearney	Penn-Union	Homac	Die	Required number of compressions	Die	Required number of compressions
305507	AC506-82	WR159	YHO-100	506-82	KO-R06	OB-44	U-O	2	W-O	4
305509	AC508-82	HC101 <sup>2</sup>	YHO-150	508-82	KO-R08	OB-101 <sup>2</sup>				5 <sup>2</sup>
305510	AC502-82	HC202 <sup>2</sup>	YHD-200	502-82	KD-R02	DB-202 <sup>2</sup>	U-D	2	W-D	5 <sup>2</sup>
305519	AC504-82	WR279	YHD-300	504-82	KD-R04	DB-2020				
305520	AC503-82	HC404 <sup>2</sup>	YHD-250	503-82	-	DB-404 <sup>2</sup>				
305830	AC505-82	WR399	YHD-350	505-82	-	DB4020	U-D	3	W-D	7
305831	AC507-82	WR419	YHD-400	507-82	-	DB4040				
305832	AC481	WR715	YHN-500	481	-	NB-60020	U-N	2	-	-
305833	AC482-81	WR835	YHN-550	482-81	-	NB-50040				
305834	AC484	WR775	YHN-450	484	-	NB-500				
Connectors for Connection to Secondary Street Light Conductors										
305842	-	WR139	-	-	-	OB-2014	U-O	2	W-O	4
305843	-	WR502	-	-	-	-	-	-	W-D	4
305926	-	WR9	-	-	-	UB-214	-	-	W-BG	1 <sup>3</sup>

Figure 2 H-Type Connector

<sup>1</sup> Use UT-15 tool with 15CAP adapter on Burndy dies for #4 through 1/0 only.

Note: Do not use the N die with UT-15 tool.

<sup>2</sup> These connectors require 4 crimps instead of 5 with the mechanical tools.

<sup>3</sup> UT-33 tool with Red 5/8 die may be used, but 3 crimps are required.

<sup>4</sup> Includes mechanical tool except as noted in Note 2.



# Extent of Condition

Index # 450 | Alleghany-1101, H-Type Connector | 4/18/2022

## Extent of Condition Details

<b>Failure Type</b>	Failed connector
<b>Apparent Cause</b>	Workmanship / exacerbated by a 3-phase fault caused by vegetation on the line and several recloses.
<b>Previously Identified Cause</b>	N/A
<b>Issue Details</b>	See Overview <a href="#">Slide 3</a>
<b>Equipment Age</b>	H-type connector , unknown Pole ~ 70 years old
<b>Failed Barrier</b>	N/A
<b>Where Else</b>	The Safety Condition Assessment Review (SCAR) did not identify additional connector issues near the incident site. Five poles were inspected to the east of the incident pole and five poles were inspected to the west of the incident pole.

# ATS Summary

Index # 450 | Alleghany-1101, H-Type Connector | 4/18/2022



## Index 450 ALLEGHANY 1101 Connector, Summary

Distribution Contact: Brian Shade

Date Identified: 4/18/22  
Fire Index: 450, Tier 2

Circuit: ALLEGHANY 1101  
City: Sierra City  
Division: Sierra

Failure Impacts  
EC #: 123360159  
OIS#: 1676079  
ILIS #: 22-0051167  
Pole SAP#: 100111818

### Background (Source: Ignition Tracker)

On April 18, 2022 at 18:17 hours, a PG&E Troublemaker was dispatched to the Alleghany 1101, a 12kV Distribution Circuit near State Highway 49, 1.80 miles East of Forest Route 93 in Sierra City in response to an area outage. Upon entering the rural area, the Troublemaker was met by Fire Department on the side of the road requesting his assistance. He then realized this was more than an area outage. Initial analysis indicates equipment failure caused the ignition. Once the Fire Department made the scene safe and allowed PG&E to enter, the Troublemaker began his assessment and found the connector had failed at the aluminum to copper connection. This failure caused the ignition that was .25 acres in size. The fire was suppressed by Sierra City Fire Department. This incident led to an outage affecting 604 customers. Due to the remoteness of the area, and a one way feed, the town was fed by a generator through the night. A PG&E Crew, along with the responding PG&E Troublemaker returned to the site on April 19, 2022 to replace the connector and re-energize electricity to the impacted area.

Safety: Ignition is a public safety event.  
Customer Impact: 604 customers out of power.

### Preliminary Failure Mode/Discussion

The jumper failure within the compression connector appears to be at least partially attributed to a fatigue fracture. There was little to no deformation observed on fracture surface on three of the copper strands. Workmanship may have also contributed to the failure as the connector had one less crimp than required per 041010 page 6 note 2 for the Hmac OB-101 connectors. The broken strands and/or workmanship could contribute to localized arcing and thermal damage within the joint.

### Proposed Testing Plan (if approved)

- Failed component sent to ATS: received 5/5/2022 (Photos next slide), ATS22-0411
- Testing Plan
  - Conduct an initial visual examination to document the failed splice. – Complete
  - Conduct optical microscopy to document the morphology of the fracture surface. – Complete
  - Conduct fractography by scanning electron microscopy (SEM) to confirm failure mode. – if approved/authorized

Internal



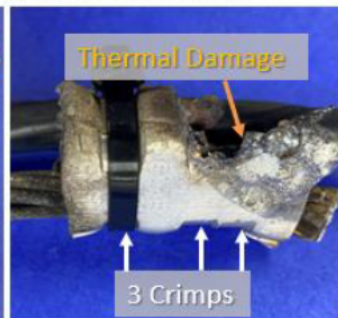
## Index 450 ALLEGHANY 1101 Connector, Summary

### EQUIPMENT INFO

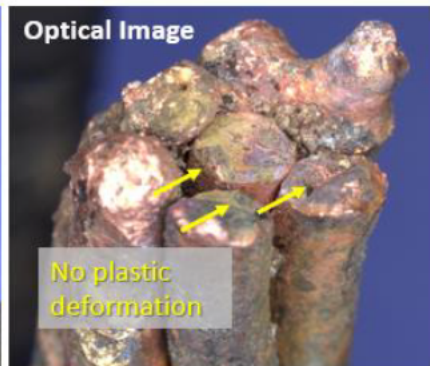
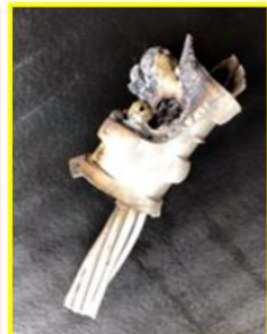
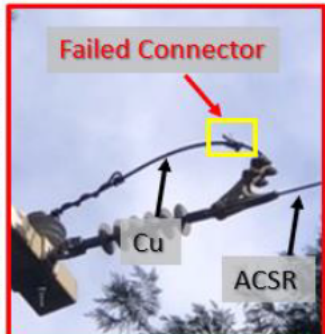
Connector  
TYPE: ACSR  
Size: #2  
SAP Equipment: 100111818  
Year installed: 1952 (EDGIS)  
Index: 450

Lat: 39.566413686100  
Long: -120.709930295300

### As-Received Photos



### Field Photos





# Corrective Actions

Index # 450 | Alleghany-1101, H-Type Connector | 4/18/2022

Overall Status

## Evaluative Actions

EA#	Description	Owner	Due Date	Status	Timeline
1	SCAR will be identifying H-type connector conditions on the adjacent poles.		07/15/22	Complete	
2	Inspection committee to consider adding H-type connector on the Job Aid that supports the GO 165 Inspection Checklist		01/31/24	In progress	
3	Based on count of historical ignitions, determine if system hardening risk rank should be elevated. See appendix for details		09/30/21	Complete	
4	Follow up on escalated tag that resulted from SCAR E Tag to B tag. Ensure completion in a timely manner.	Ignition Investigations	12/31/22	Complete	

## Corrective Actions

CA#	Description	Owner	Due Date	Status
1	Add Clean and Sealing guidance for connectors in guidance document for General Applications of Conductors for Overhead Distribution Lines (Guidance Document: 059690)		06/30/2023	In Progress



# Appendix

[Redacted text block]





# SCAR Follow Up

## Index # 450 | Alleghany-1101, H-Type Connector | 4/18/2022

Follow up on SCAR findings to ensure corrective action (not a connector issue)

FW: Dispatch Request for Pole SAP ID: 100104643

Reply Reply All

Expires 8/31/2027

From: [Redacted]  
Sent: Thursday, September 1, 2022 12:55 PM  
To: [Redacted]  
Cc: [Redacted]  
Subject: RE: Dispatch Request for Pole SAP ID: 100104643

Thanks [Redacted] the tman is heading out to respond to both poles. Let us know if you need anything in the meantime and we are on it.

The field order of reference: 0008902579

From: [Redacted]  
Sent: Thursday, September 1, 2022 11:25  
To: [Redacted]  
Cc: [Redacted]  
Subject: Dispatch request for Pole SAP ID: 100104643

Hello Team,

I have a dispatch request for the pole SAP ID: 100104643

The Secondary connectors installed in the primary, 20 feet of PG&E conductor is hanging at the phone level, which needs to be removed. There was already an ignition on the adjacent pole this year.( Index 450, 4/18/2022)

Location Description 1	Access Info	Functional Location ID	Local Office ID	Map Office	Service Area	Division	District	City	County
16SE/O OFF SSD 2707 STATE HWY 49	Readily Accessible	ED.22- F170000000.STRU.POLE	Grass Valley - 22	AUBURN	Northern	Sierra	Nevada	Sierra City	Sierra

# Alleghany-1101 SH Overview

Index # 450 | Alleghany-1101, H-Type Connector | 4/18/2022

## Alleghany-1101 SH Risk Rank by Segment

**Summary:** The nine circuit segments on the Alleghany 1101 all rank in the top third of HFTD circuit segments (see last column). The historical ignitions highlighted are located on the 1101804 and 11011978 which are in light and dark green in the mapped model view below (dark green- top 10-15%, light green- top 5-10%)

Circuit Segment Name	Primary Ovhd Length (miles)	Secondary Ovhd Length (miles)	HFTD Length (miles)	SH Risk Pixel Count	SH Ignition Probability	Rank: SH Ignition Probability	Consequence v3.4	Rank: Consequence v3.4	SH Risk	Rank: SH Risk
ALLEGHANY 1101VR816	4.10	2.08	6.18	74	0.000574	4,604	30.76	362	0.0162	128
ALLEGHANY 1101CB	4.36	1.69	6.05	92	0.000476	5,639	30.59	364	0.0142	170
ALLEGHANY 1101806	11.31	0.79	12.10	232	0.000438	6,032	26.25	430	0.0106	254
ALLEGHANY 1101183068	3.37	0.01	3.38	65	0.000448	5,933	11.34	787	0.0048	563
ALLEGHANY 1101804	18.49	3.09	21.57	350	0.000410	6,335	10.68	814	0.0040	652
ALLEGHANY 11011101/2	0.04	-	0.04	1	0.000686	3,270	5.07	1,134	0.0030	829
ALLEGHANY 11011101/2	0.04	-	0.04	1	0.000666	3,270	5.07	1,134	0.0030	829
ALLEGHANY 1101808	6.18	-	6.18	125	0.000380	6,696	5.89	1,078	0.0024	953
ALLEGHANY 1101978	29.30	1.88	12.60	587	0.000192	10,173	4.43	1,195	0.0009	1,570

There is an existing process to evaluate circuit segments at least annually to determine system hardening priority.



# Field Comment After Repair

Index # 450 | Alleghany-1101, H-Type Connector | 4/18/2022

The troubleman created EC Tag # [EC # 123360159](#) .

The repairs were completed the following day (April 19, 2022) by a PG&E crew. Downieville service was switched from the temporary generation back to the Alleghany 1101 12kV Distribution circuit around 1210 hours

- Roadside connector failed and caused jumper burnt
  - i. REPLACED 6 CONNECTORS
  - ii. 2 JUMPERS
  - iii. INSTALLED HIGH SIGNS.