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Substation Fires: Working with First Responders

Lessons Learned Webinar

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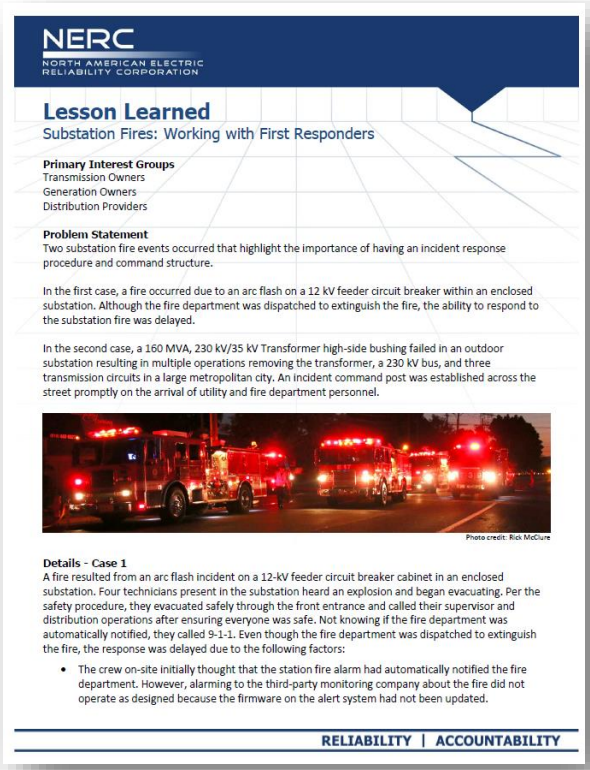
June 19, 2019

RELIABILITY | ACCOUNTABILITY




Introduction

- Substation fires have their own unique dangers and response needs. Preparation ahead of such events will help keep first responders safe, minimize damage, and improve substation cleanup and recovery times.
- This webinar is designed to encourage discussion & preparation between the electrical utility industry & first responders.
- The Lesson Learned posted at the NERC website discusses two example substation fire events highlighting the importance of prepared incident response procedures and command structures.



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Lesson Learned
Substation Fires: Working with First Responders

Primary Interest Groups
Transmission Owners
Generation Owners
Distribution Providers

Problem Statement
Two substation fire events occurred that highlight the importance of having an incident response procedure and command structure.

In the first case, a fire occurred due to an arc flash on a 12 kV feeder circuit breaker within an enclosed substation. Although the fire department was dispatched to extinguish the fire, the ability to respond to the substation fire was delayed.

In the second case, a 160 MVA, 230 kV/35 kV Transformer high-side bushing failed in an outdoor substation resulting in multiple operations removing the transformer, a 230 kV bus, and three transmission circuits in a large metropolitan city. An incident command post was established across the street promptly on the arrival of utility and fire department personnel.

Photo credit: Rick McClure

Details - Case 1
A fire resulted from an arc flash incident on a 12-kV feeder circuit breaker cabinet in an enclosed substation. Four technicians present in the substation heard an explosion and began evacuating. Per the safety procedure, they evacuated safely through the front entrance and called their supervisor and distribution operations after ensuring everyone was safe. Not knowing if the fire department was automatically notified, they called 9-1-1. Even though the fire department was dispatched to extinguish the fire, the response was delayed due to the following factors:

- The crew on-site initially thought that the station fire alarm had automatically notified the fire department. However, alarming to the third-party monitoring company about the fire did not operate as designed because the firmware on the alert system had not been updated.

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Description

- In the 1st case, a fire occurred due to an arc flash on a 12-kV feeder circuit breaker within an enclosed substation.
- Although the fire department was dispatched to extinguish the fire, the ability to respond to the substation fire was delayed due to access problems and confusion about who was in charge.

Lesson Learned Description

- In the 2nd case, a 160 MVA, 230 kV/35 kV Transformer high-side bushing failed in an outdoor substation removing the transformer, a 230 kV bus, and three transmission circuits in a large city.

- An incident command post was established across the street promptly on the arrival of utility and fire department personnel.

Lessons Learned

There were numerous Corrective Actions used for these 2 cases, however a discussion of generic Lessons Learned is most valuable

- Before a substation fire occurs, utilities need to establish a working relationship with local fire departments. Discuss the hazards present in substations and exchange information on how to address substation fires. Use the Substation Fires Lessons Learned and the recording from this 2019 webinar as a starting point.
- Emergency Notifications: Even if a station has central station monitoring, an automated notification to the fire department does not properly prepare them for the conditions they may face.
- The first person to discover a fire is responsible to report it via 911 regardless of any central station monitoring that may be present

Lessons Learned

- Incident Command: To have the best alignment with first responders' training & expectations, use the FEMA framework of the Incident Command System. Utility personnel responding to a substation fire should be trained to the basic ICS 100 level.
- Develop joint access procedures with local fire departments. Fire service personnel in many cases are not fully trained or prepared to deal with the electrical/industrial hazards found in a substation. Entry into the station needs a utility escort capable of explaining hazards, mitigating hazards and performing switching.
- Identify the Point of Contact / Incident Commander. Some utilities use a different hard hat color identify its POC/IC for first responders. Standard NIMS ICS Vests can also be used.

Adeel Laeeq, Florida Power & Light

Responding to Substation Fires

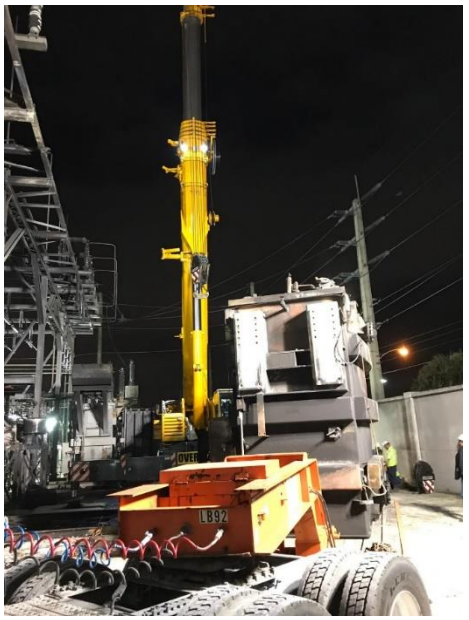
First Responders

Safety - Check in with BES and distribution dispatcher and verify if it is safe to enter.

Work with the dispatcher to de-energize the station

- Dispatcher normally provides verbal switching order for isolation of substation
- Feeder breakers are opened (Distribution crews work to pickup load in field)
- Line switches and opened to isolate the substation from high side transmission line

Other departments are contacted in parallel for support required



Working with Firefighters

Once station is isolated (All energized sources are opened on high and low side), Firefighters are allowed to work on taking out the fire

Firefighters use Foam (if available) or water (not preferred due to oil) to extinguish the fire

FPL employee scans the equipment (transformer, breaker, etc.) to make sure there is no increase in temperature

Once the fire is extinguished, one station truck is on stand by for few hours

Adeel Laeeq, Florida Power & Light

Clearances

Clearances are only issued when the fire is completely out

FPL's Clearance process requires them to hang tags on the equipment, which may not be possible or safe to do so during the fire.

Once fire is out, FPL employee works with BES and distribution dispatcher to obtain a clearance boundary to work in the station

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Adeel Laeeq, Florida Power & Light

Mike Bocovich on Transformer Failures

- Transformer failures occur for many reasons.
  - IEEE C57.125: IEEE Guide for Failure Investigation, Documentation, and Analysis for Power Transformers and Shunt Reactors
    - Provides a good procedure for failure analysis
    - Includes several failure modes
  - NERC Failure Modes and Mechanisms (FMM) for Oil Filled Transformers
    - Chart Provides a good flow chart of various failure modes and mechanisms
    - Living Document available upon request
- Try to prevent a failure
- Do what you can to minimize damage if failure does occur

Mike Bocovich on Transformer Failures

- Fast (3-1/2 cycle) clearing prevented a fire associated with this transformer failure (this event did not make the news headlines)
  - Most of the 20,400 gallons of oil was sprayed and spilled
  - The soil is the oil containment system at this site

Reference: M. Bocovich. Transformer Failure Analysis on Three Failures at Xcel Energy Substations – Chisago, Harrison & Fifth Street. University of Minnesota College of Continuing Education, Minnesota Power Systems Conference. November 5, 2013

Mike Bocovich on Transformer Failures

- This event made the news!

See Youtube Video: https://www.youtube.com/watch?v=Ux0TeP7oufU
Denver substation explosion June 7, 2010, Published on Jun 7, 2010

Mike Bocovich on Transformer Failures

Fire Trucks used to throw water over substation wall

See Youtube Video: https://www.youtube.com/watch?v=Ux0TeP7oufU
Denver substation explosion June 7, 2010, Published on Jun 7, 2010

Mike Bocovich on Transformer Failures

- Many Lessons Learned were generated from this event

Reference: M. Bocovich. Transformer Failure Analysis on Three Failures at Xcel Energy Substations – Chisago, Harrison & Fifth Street. University of Minnesota College of Continuing Education, Minnesota Power Systems Conference. November 5, 2013

Mike Bocovich on Transformer Failures

- Hazards that may be encountered with transformer fires:
  - Everything in the substation
  - Energized Equipment
  - Flames, Heat, Burning Oil, Gasses
  - Weather
  - Polychlorinated Biphenyls (PCBs)
    - May be present with older equipment
  - Byproducts of Burning Material
    - Plastics and metals may produce toxins when burned
  - Porcelain
  - Falling Equipment
    - Bus sections, switches, insulators, …, anything in the air
  - Trip Hazards
    - Ground rods, ground conductors, other materials

Anthony Natale, Emergency Preparedness, Consolidated Edison NY

Lessons Learned

- ***Identify Issues***
- ***Develop Appropriate Response Tactics***
- ***Memorialize Them Into a Policy***
- ***Policy is the Platform for Training***

History

Shared Problems of the Utility & Fire Services

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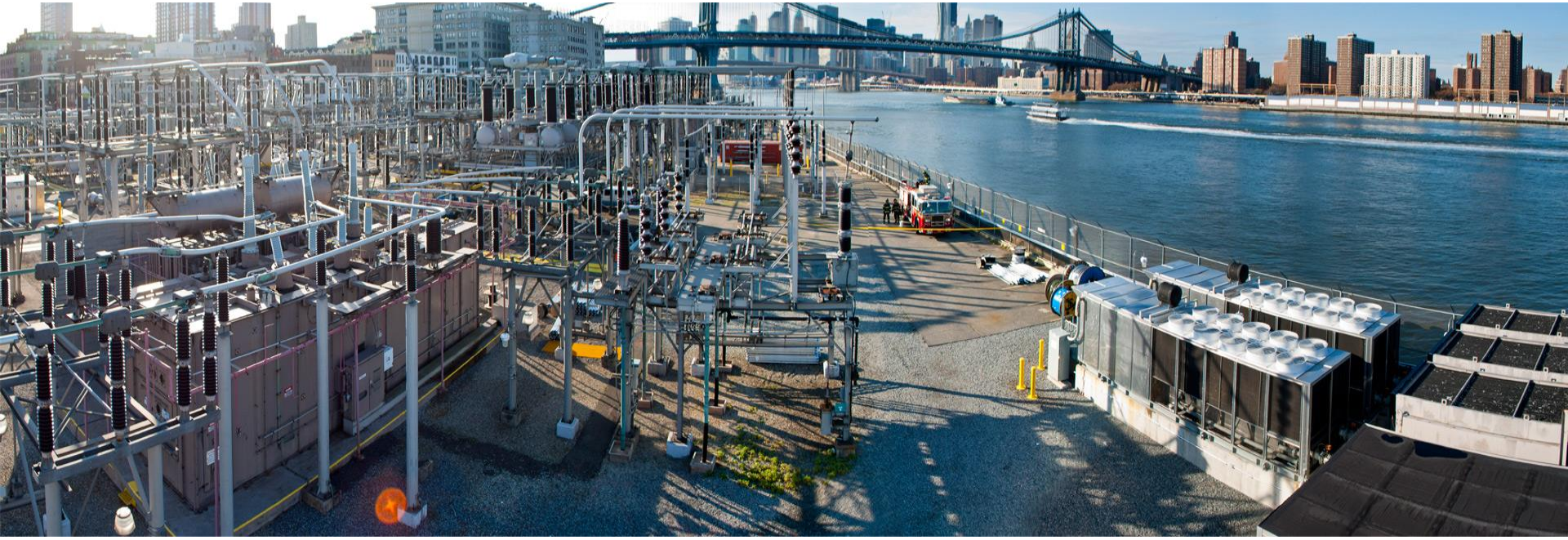
Low Frequency High Hazard Incidents



Let It Burn

East River Substation Fire 2002

On Arrival

Establishing Priorities

ConEd Substation* Do not enter*Wait for White Hat* Call 212 460-XXXX*Assume all liquid & smoke to contain PCB*138,000v Do not raise TL * Do not charge Siamese

CIDS INFORMATION

CRITICAL INFORMATION DATA SYSTEM

Incident Objective

- **Extinguish a Class B Fire in a Class C Environment**
  - Transformer is Denergized
  - Surrounding Conductors are Alive
- **What You CAN'T Do**
  - Extinguish a Class B/C Fire
  - Breaker is Stuck Closed
  - Must be Resolved by Utility

Normal Transformer Fire

Smoke & Flame

Abnormal Transformer Fire

Blue Flame – Minimal Smoke

Dangerous Condition

Forced Entry

Hazards Exceed Skillset

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Access Policy

White Hat Sign


FIRE DEPARTMENT
CITY OF NEW YORK
CHIEF
F.D.N.Y.
conEdison

=


STOP

Staging

Smoke & Shrapnel

Why Stand There ?

Bomb Concept

Utility Incident Commander

Tactical Direction

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Identifying the Incident Commander

One Voice for the Company

Site Information

Decision Making Tools

Answers Responder Questions

Voltage & Standoff Distance
Site Map
Aerial Photo
Chemical SDS
Transformer Oil Capacity

Interacting with First Responders

Incident Management

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Designated Meeting Location

Utility Representative & Escort

Initial Conditions Discussion

The "Size Up"


LIFT PLOW
DO NOT BLOCK DRIVEWAY
24 HOUR ACCESS REQUIRED
STOP

Size Up Discussion

- **Electrical Hazards**
  - **4 Rules**
- **Chemical Hazards**
- **Response Tactics**
  - Exposure Control
  - Fire Suppression

Rule 1 – Don't Climb

Rule 1 – Don't Climb

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Rule 2 – Don't Invade Fenced Areas

Rule 2 – Don’t Invade Fenced Areas

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Rule 3 – Don't Cut Locks

Rule 3 – Don't Cut Locks

Rule 4 – NO Tools

Chemical Hazards

- Transformer Oil
  - PCB's
- Sulfur Hexafluoride
  - HF
- Dielectric Fluid
  - Feeder Oil
- Edisol XT
  - Cap-Banks
- Sulfuric Acid
  - Station Batteries

Safe Suppression

The Three P's

Products


FireAde AR
3% X 3%
National
UNIVERSAL
GOLD
Fire Aid – Universal Gold – Cold Fire
Thunderstorm – F-500 – Fire Ice

Pattern

Pressure

Agents & Appliances

No Salt Water Drafting

NO WATER "Boil Over"

No Aspirating Nozzles

30 Degree Fog – 345kV

Oscillating Fog Nozzle

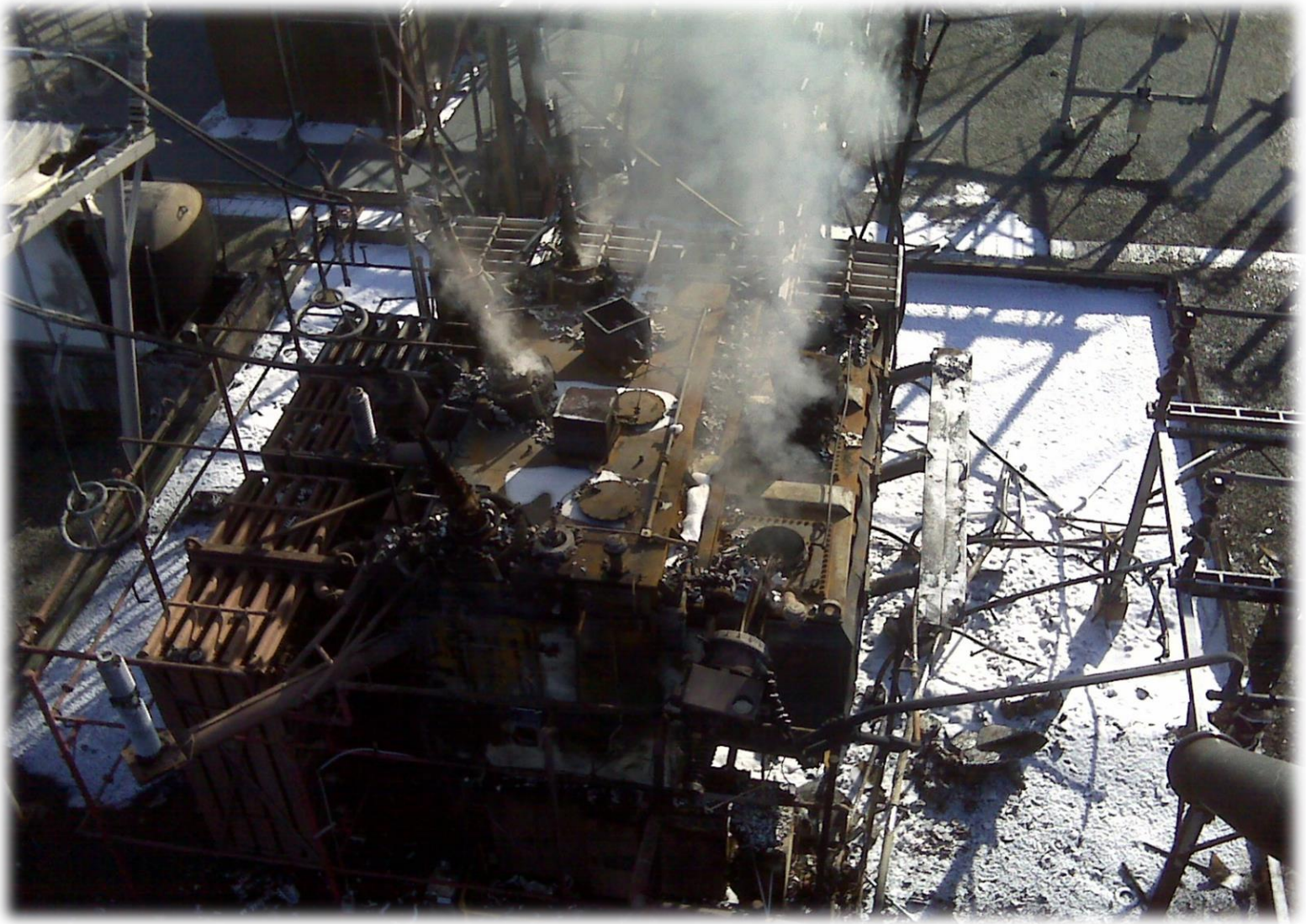
Blitzfire

Suppression Tactics

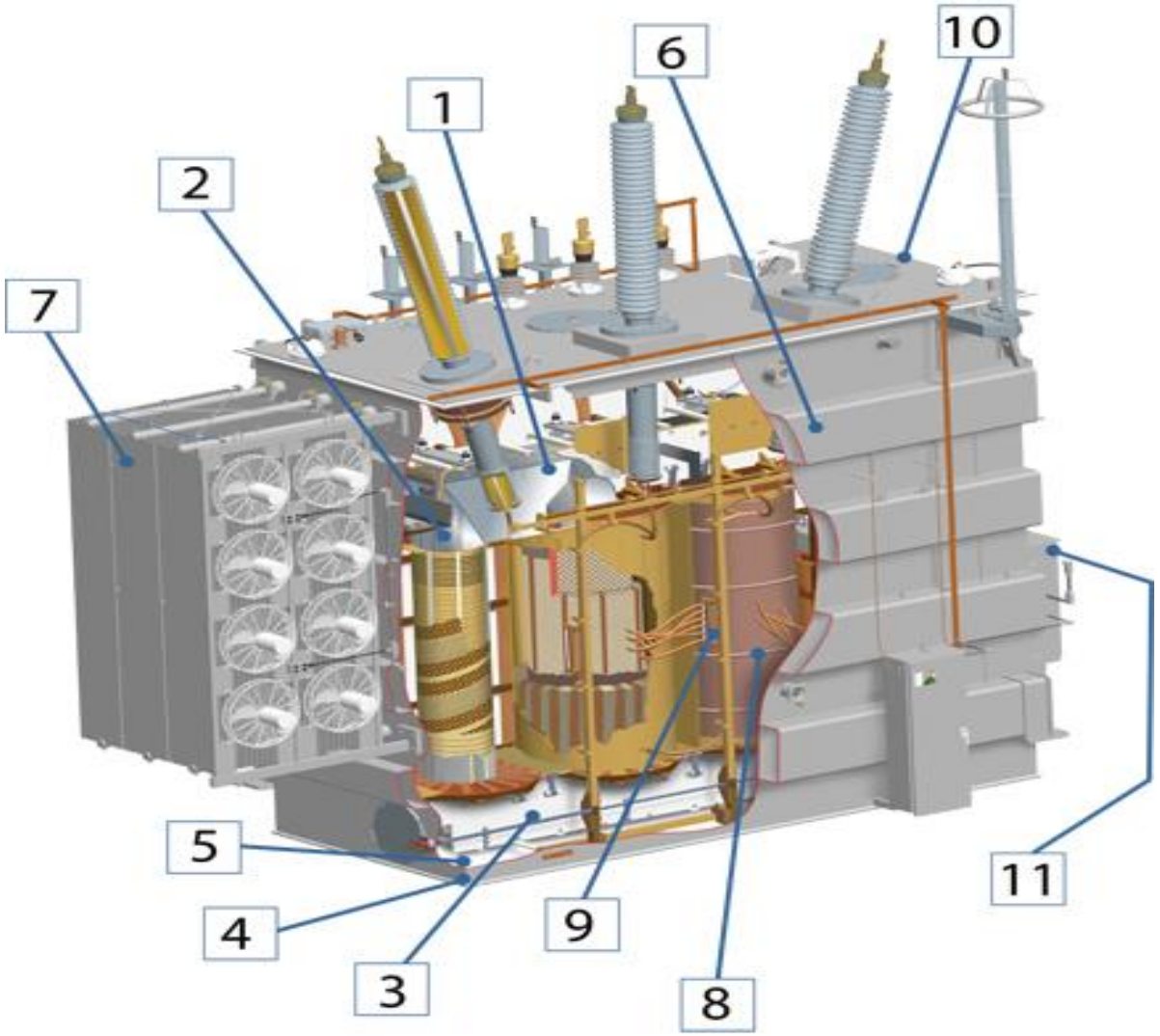
Lessons Learned

Knock Down Main Body of Fire

Internal Attack
No Banking or Bouncing



Ineffective Foam Operations



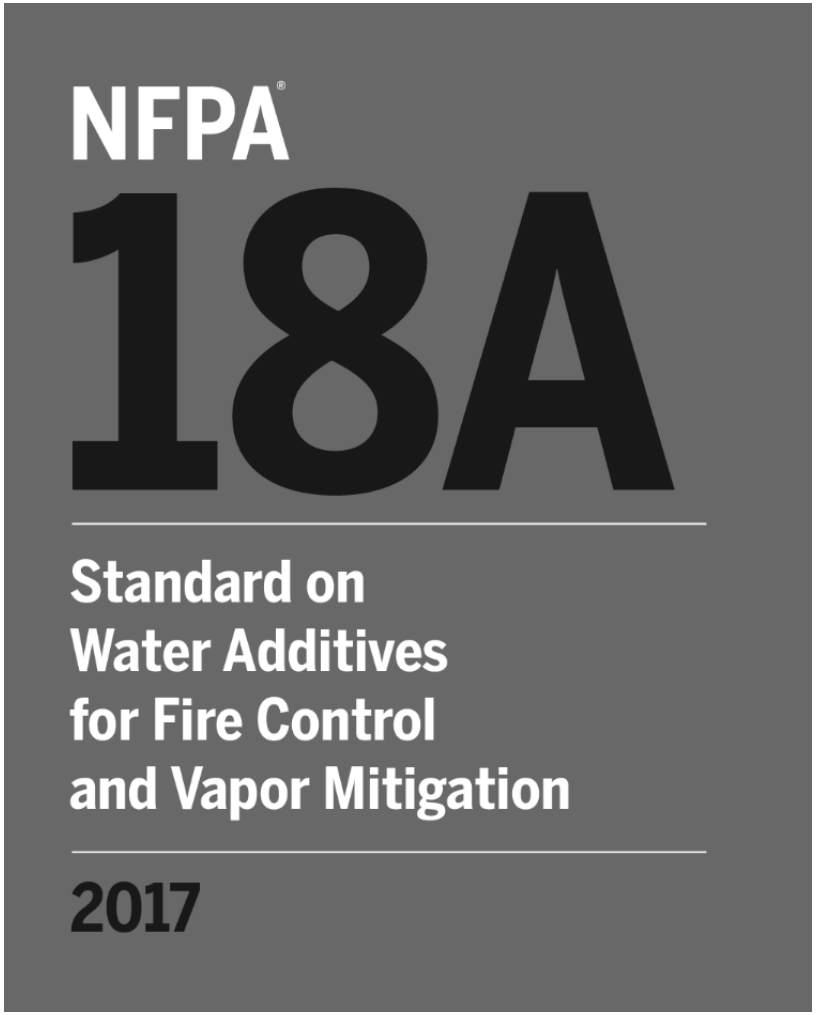
Post Suppression Investigation

Capturing Internal Fire

Selecting a Suppression Agent

Utility & Fire Department

Class C Suppression Test Standard



Live Testing 345kV

Developing the Partnership

Commitment to Each Others Safety

Dovetail Policies

Draft

A.U.C. 338
April 20th 2016

Substation Fire Fighting

Revision 10

1. INTRODUCTION

1.1 The Department in conjunction with Con Edison has developed a protocol for controlling fires on electrical equipment. Once a transformer has suffered a catastrophic failure which results in a fire, the breakers supplying transformer open automatically. So essentially, members will not be fighting "energized" fires. However equipment surrounding the failed transformer will in most cases remain energized. The protocol discusses the initial considerations, size-up, hazards along with recommended suppression agents. In addition to Con Edison there are seven other power providers in New York City; this policy can be applied universally since all these facilities have similar equipment.

2. PURPOSE

2.1 Failed transformers cannot be salvaged and are of no useful value to the utility. The intention of this protocol is to prevent collateral damage from fire & smoke impinging adjacent equipment which can result in large scale blackouts. This would compromise civilian safety and over-tax the response capabilities of the first response community.

3. UTILITY TERMINOLOGY

3.1 Utilities classify electrical equipment at their facilities as follows:

3.1.1 **Energized:** Equipment that is connected to an electrical source. *Illustrated in attachment 7.1*

3.1.2 **De-energized:** Circuit breakers supplying the equipment are open. No power is flowing but is treated as "Live" since the equipment is not isolated and grounded. *Illustrated in attachment 7.2*

3.1.3 **Isolated:** A physical break exists and equipment is isolated from all electrical sources but is not grounded. A static charge can remain on the equipment and is treated as "Live". *Illustrated in attachment 7.3*

SUBSTATION FIRE FIGHTING		
Number: 0300-0028/02 Date Issued:	**PROCEDURE** Substation Operations	Revised: Anthony Natale Approved: Bruce Gavioli

TABLE OF CONTENTS

Stakeholder Training

- Probationary Firefighters
  - General Utility Hazards Overview
- Lieutenants
  - The First 15 Minutes
- Captains
  - Defensive Tactics
- Battalion Chiefs
  - Hazards & Response Tactics
- Fire Marshals
  - Craftsmanship, End of Useful Life & Tampering

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Familiarization Tours

Field & TTX Exercises

Field & TTX Exercises

Moving Forward

NFPA Training Grant

NFPA®

Texas A&M Industrial Fire School

Utility Props

Going Home

Scott Cox, Georgia Power: Foam Trailers

- Not every fire department has CO2 or foam trucks. However, if your department has the resources, this issue may be solved with scripted message during a notification to 911 for a fire that requests a foam tender for the fire services.
- Another option would be to purchase and store suppression agent at major substations

Based on geographic locations of the stations it may be more cost effective for entities to purchase a few foam trailers which could be stored at entity facilities and towed out to a fire.

Scott Cox, Georgia Power: Foam Trailers

Georgia Power

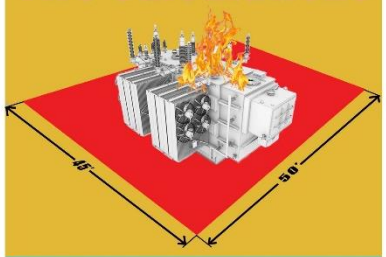
EMERGENCY RESPONSE TRAILER

FireAde
Don't fight fires ... extinguish them!™

Fire Personnel

- Ensure Station is De-Energized
- Do Not Use Water to Suppress Fire
- Once Foam is Applied Only Use Foam
- More Foam can be Delivered
- 100gal FireAde 2000 Class A&B
- 3300gal Water Onsite
- Reference Fire Calculations
- Initial Attack Raindown Technique
- If Fire Smolders
  - o Internal Components are Class A
  - o Place Cellar Nozzle in Breach
  - o Use Foam with Cellar Nozzle

Fire Calculations



AREA	x	Rate of Application	=	GPM Solution
2250	x	.10	=	228 GPM
GPM Application	x	% FireAde	=	GPM Concentrate
228	x	3%	=	6.8 GPM
GPM Application	x	% Water	=	GPM Water
228	x	97%	=	221.2 GPM
GPM Concentrate	x	Time (Minutes)	=	Concentrate Amount
6.8	x	15	=	100 Gallons
GPM Water	x	Time (Minutes)	=	Water Amount
221.2	x	15	=	3318 Gallons

**** Largest Fire Exempted = 2250 sqft

Utility Personnel

- Secure Substation
- De-Energize Substation
- Locate Water Drains
- Apply Oil Containment
- Call Environmental
- Call Media Relations

IMPORTANT NUMBERS

Transmission Control Center	[redacted]
Transmission Support	[redacted]
Environmental	[redacted]
Distribution Control Center	[redacted]
Heavy Hauling (Business Hours)	[redacted]
Heavy Hauling Emergency (After Hours)	[redacted]
GPC Security	[redacted]
GPC Media Relations	[redacted]
FireAde Support (24/7 Number)	[redacted]
Scott Cox	[redacted]

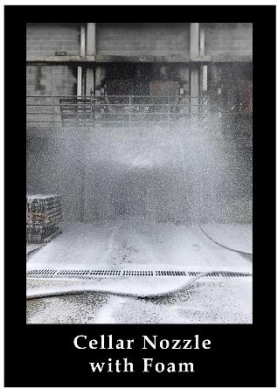
Available Fire Equipment in Cabinet


Fire Hose Nozzle


100′ Fire Hose


In-Line Foam Eductor


Cellar Nozzle


Cellar Nozzle with Foam

Environmental Response

- Ensure Drains are Secure
- Dig Trough to Contain Oil
- Order Tanker to Offload Oil
- Oil will Travel Under Gravel
- Oil will Travel in Conduit

Special Thanks

First Responder reviews & inputs were provided by members of:

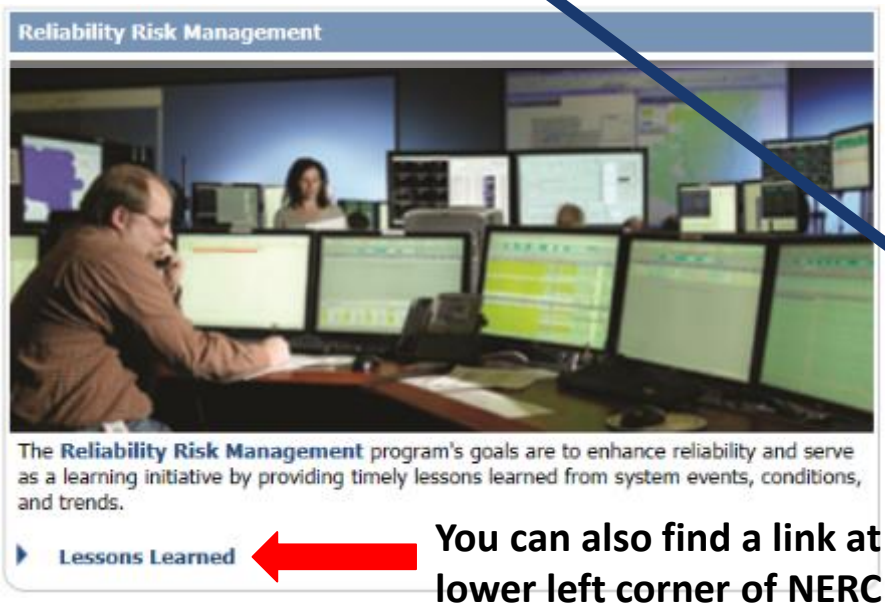
International Association of Fire Chiefs & **National Volunteer Fire Council**

Ways to Access NERC Lessons Learned

On the NERC website,

Go to www.nerc.com > Click on the "**Program Areas & Departments**" tab, then click "**Reliability Risk Management**"

Then, on the left side menu under "**Event Analysis,**" click "**Lessons Learned**"



You can also find a link at the lower left corner of NERC website homepage

Questions and Answers

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