



HAZMAT
193

PEORIA FIRE-MEDICAL
191

PEORIA FIRE-MEDICAL
199

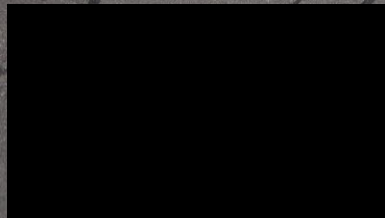
PEORIA FIRE-MEDICAL
199

PEORIA FIRE-MEDICAL
197

PEORIA FIRE-MEDICAL
197

PEORIA FIRE-MEDICAL

PEORIA FIRE-MEDICAL





1. Training Captain Peoria Fire Medical
2. 20+ years of service
3. Paramedic 2005
4. Hazmat Technician 2007
5. Union President for Local 493 Peoria Chapter





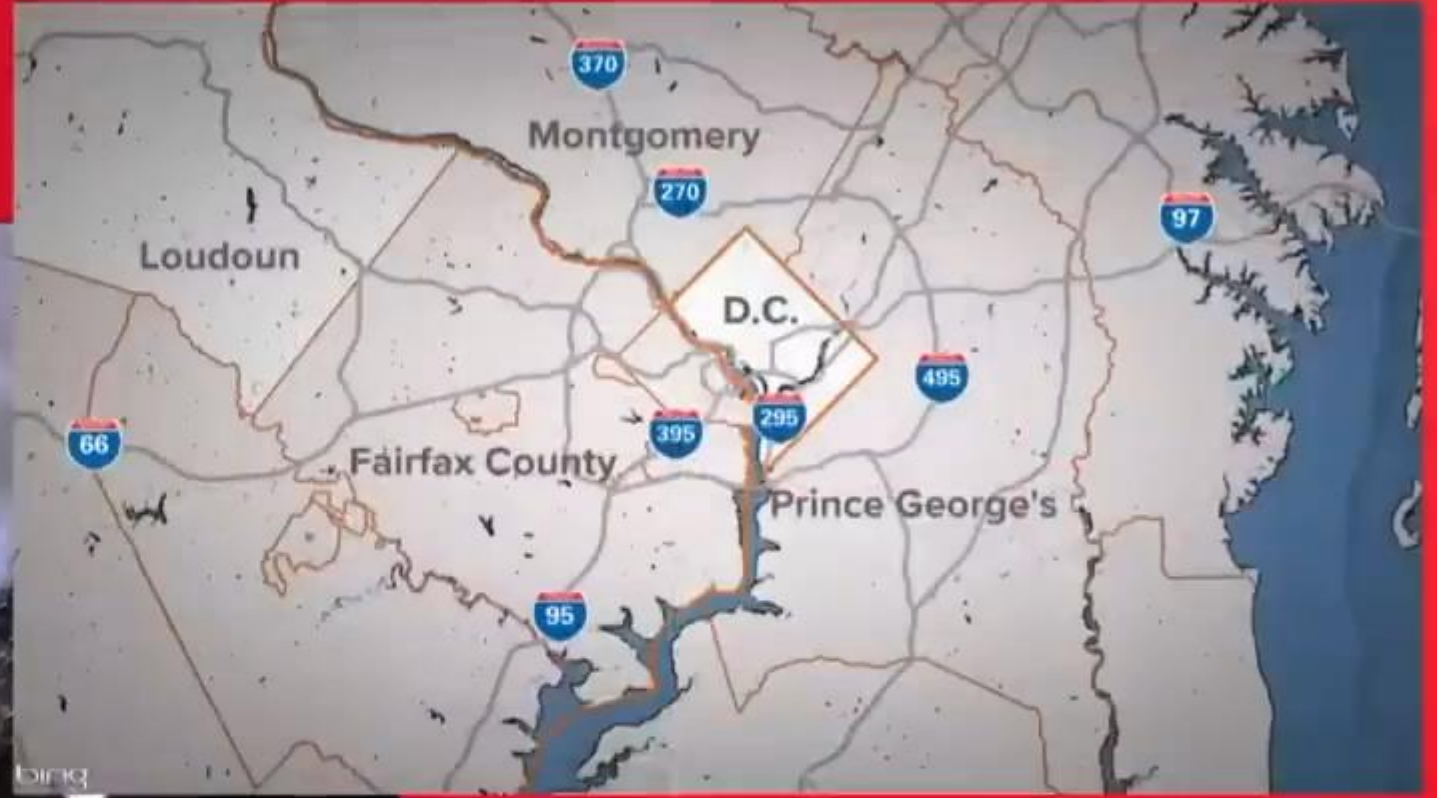
Hazmat Hazards

▶ LA City Fire Local 112



▶ Loudoun County Fire Rescue







THROUGH

STRENGTH

UNITY

AFL-CIO



UNITED
FIREFIGHTERS

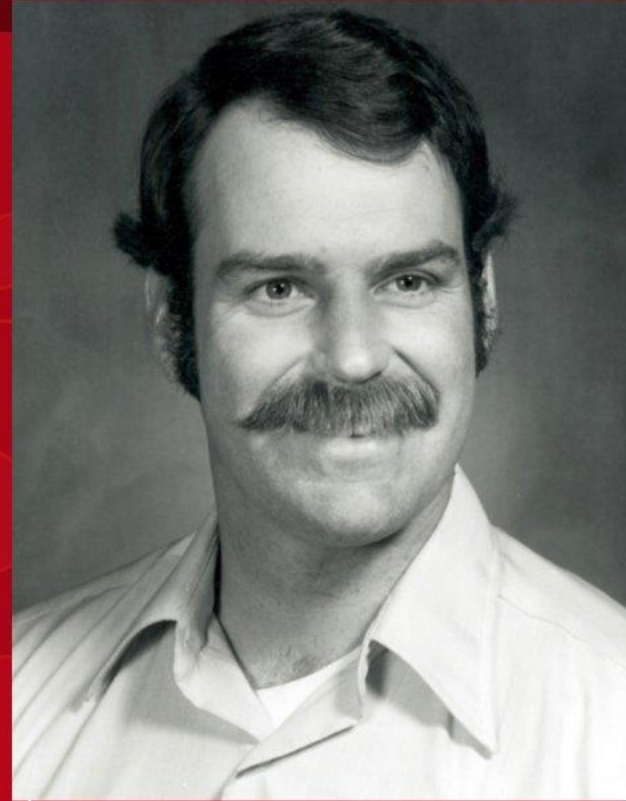
OF
LOS ANGELES CITY

RICKY PEARCE

Last alarm: Nov. 15, 1984

Engineer and HazMat Technician Ricky Pearce, part of HazMat Ladder 4, responded to a distress call involving a worker trapped in a chemical silo tank. Tragically, during the rescue attempt, the silo exploded, resulting in Ricky Pearce's death.

His death forever changed the way Phoenix Fire trains and operates to protect firefighters on Special Operations incidents.

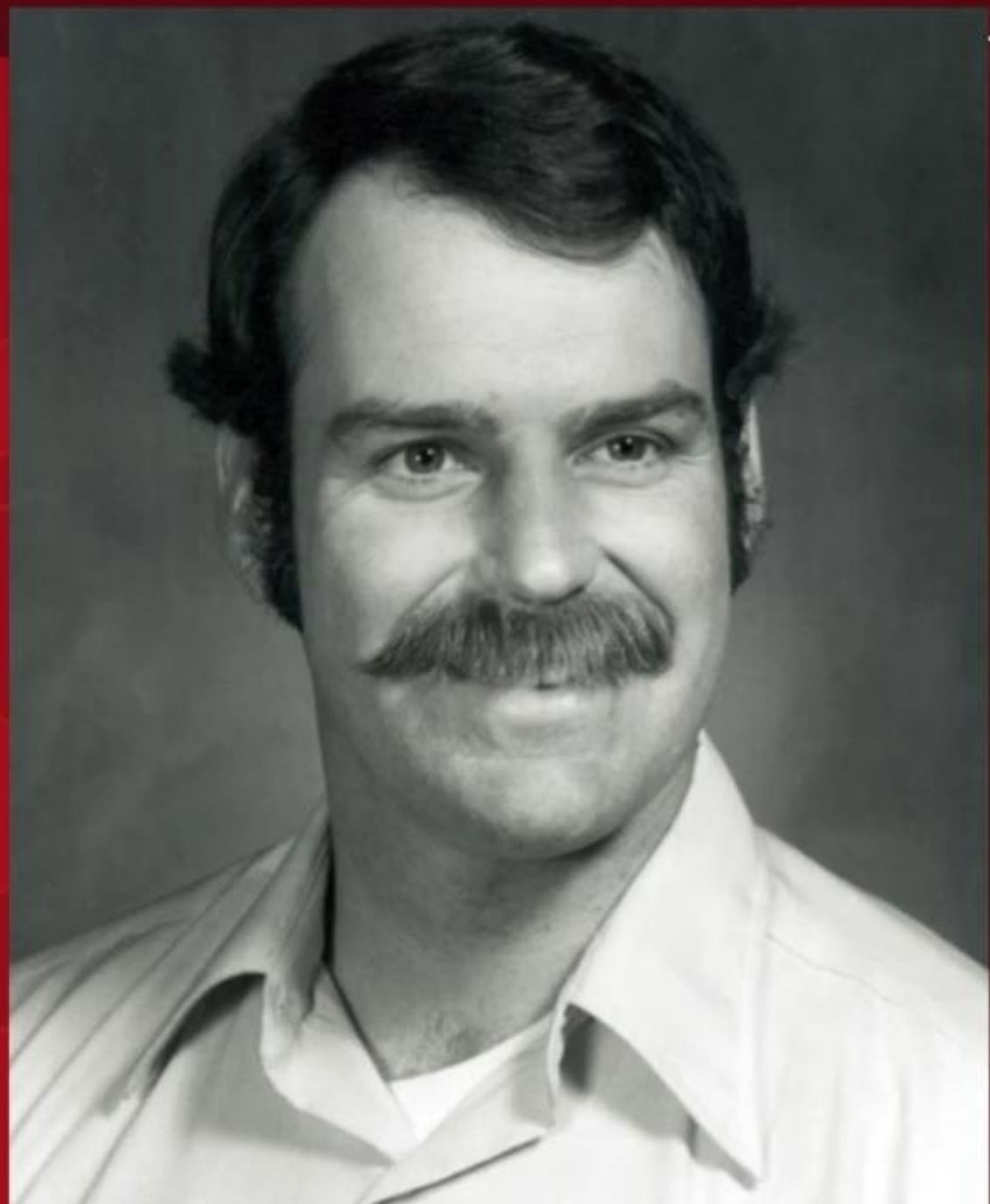


IN REMEMBRANCE

RICKY PEARCE

Last alarm: Nov. 15, 1984

Engineer and HazMat Technician Ricky Pearce, part of HazMat Ladder 4, responded to a distress call involving a worker trapped in a chemical silo tank. Tragically, during the rescue attempt, the silo



Phoenix Metro Automatic Aid System

Phoenix Fire Department Dispatch

29 Departments

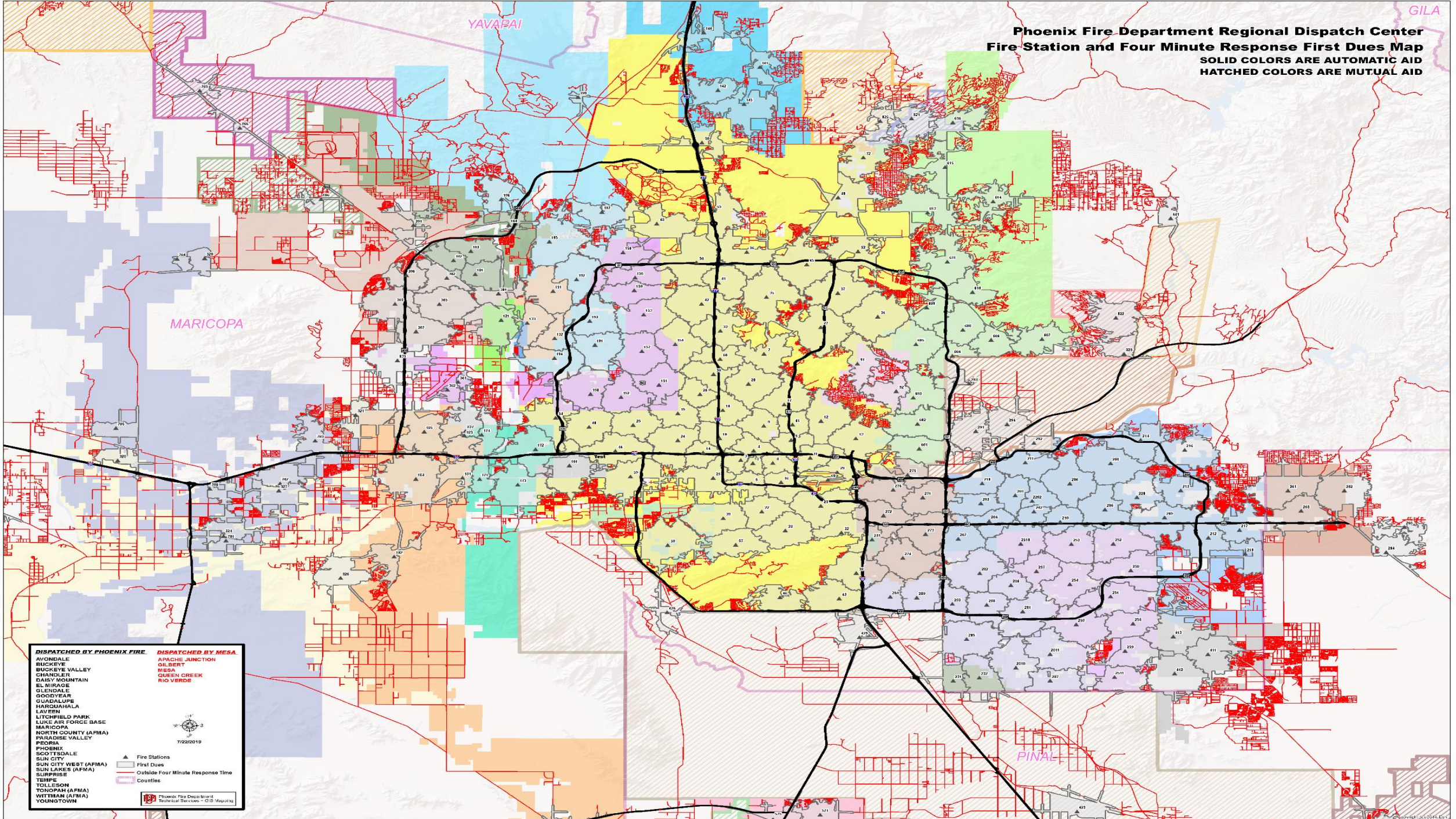
643 pieces of apparatus

14,599 Square Miles

4.9 million People



**Phoenix Fire Department Regional Dispatch Center
Fire Station and Four Minute Response First Dues Map**
SOLID COLORS ARE AUTOMATIC AID
HATCHED COLORS ARE MUTUAL AID



DISPATCHED BY PHOENIX FIRE	DISPATCHED BY MESA
AVONDALE	APACHE JUNCTION
BUCKEYE	GILBERT
BUCKEYE VALLEY	MESA
CHANDLER	QUEEN CREEK
DAISY MOUNTAIN	RIO VERDE
EL MIRAGE	
GLENDALE	
GOODYEAR	
GUADALUPE	
HARDWARE	
LAVIN	
LITCHFIELD PARK	
LUKE AIR FORCE BASE	
MARICOPA	
NORTH COUNTY (AFMA)	
PARADISE VALLEY	
PEORIA	
PHOENIX	
SCOTTSDALE	
SUN CITY	
SUN CITY WEST (AFMA)	
SUN LAKES (AFMA)	
SURPRISE	
TEMPE	
TOLLESON	
TONOPAH (AFMA)	
WITTMAN (AFMA)	
YOUNGTOWN	

▲ Fire Stations
 □ First Dues
 □ Outside Four Minute Response Time
 □ Counties

Phoenix Fire Department
 Technical Services • GIS Mapping

7/22/2019

GILA

MARICOPA

YAVAPAI

PINAL

Surprise Fire Medical Department

9 stations

12 pieces fire apparatus

169 sworn members

4/2 rescues/medic Units

144,000 residents (2020)

111 Square Miles



Peoria Fire Medical Department



9 stations

14 pieces fire apparatus

219 sworn members

6 rescues

191,000 residents (2020)

180 Square Miles

Regional Training Maricopa County

5 Regional Fire Academies (Phoenix/Mesa/Glendale/Gilbert/Chandler)

Initial Fire Academy Training

Fire

640 Hours

40 Hours Hazmat First Responder

40 Hours Wildland

40 EMS Refresher

EMS (EMT or Paramedic)

200 Hours (EMT)

1440 Hours (Paramedic)

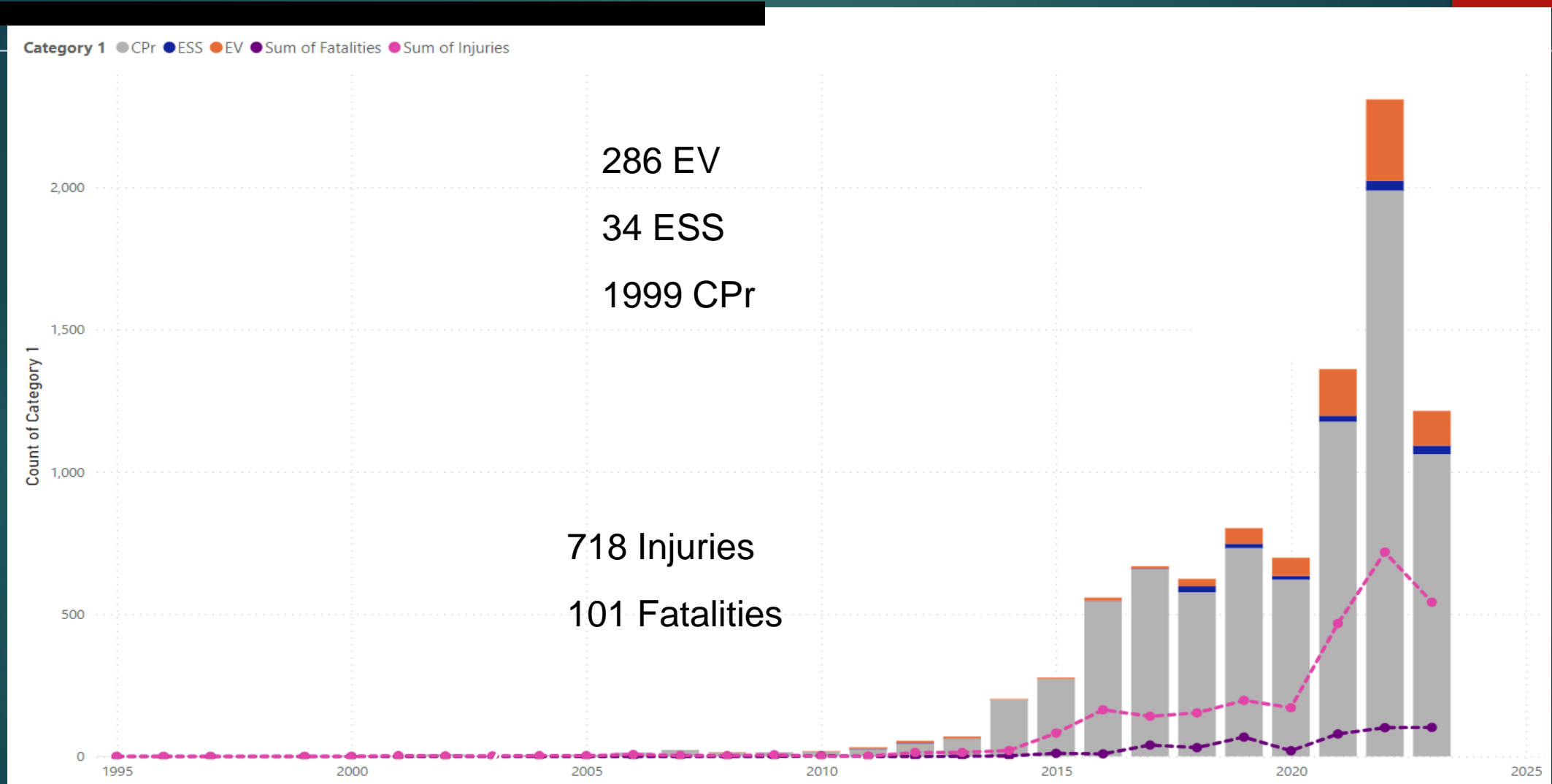
East/Central/West Consortium

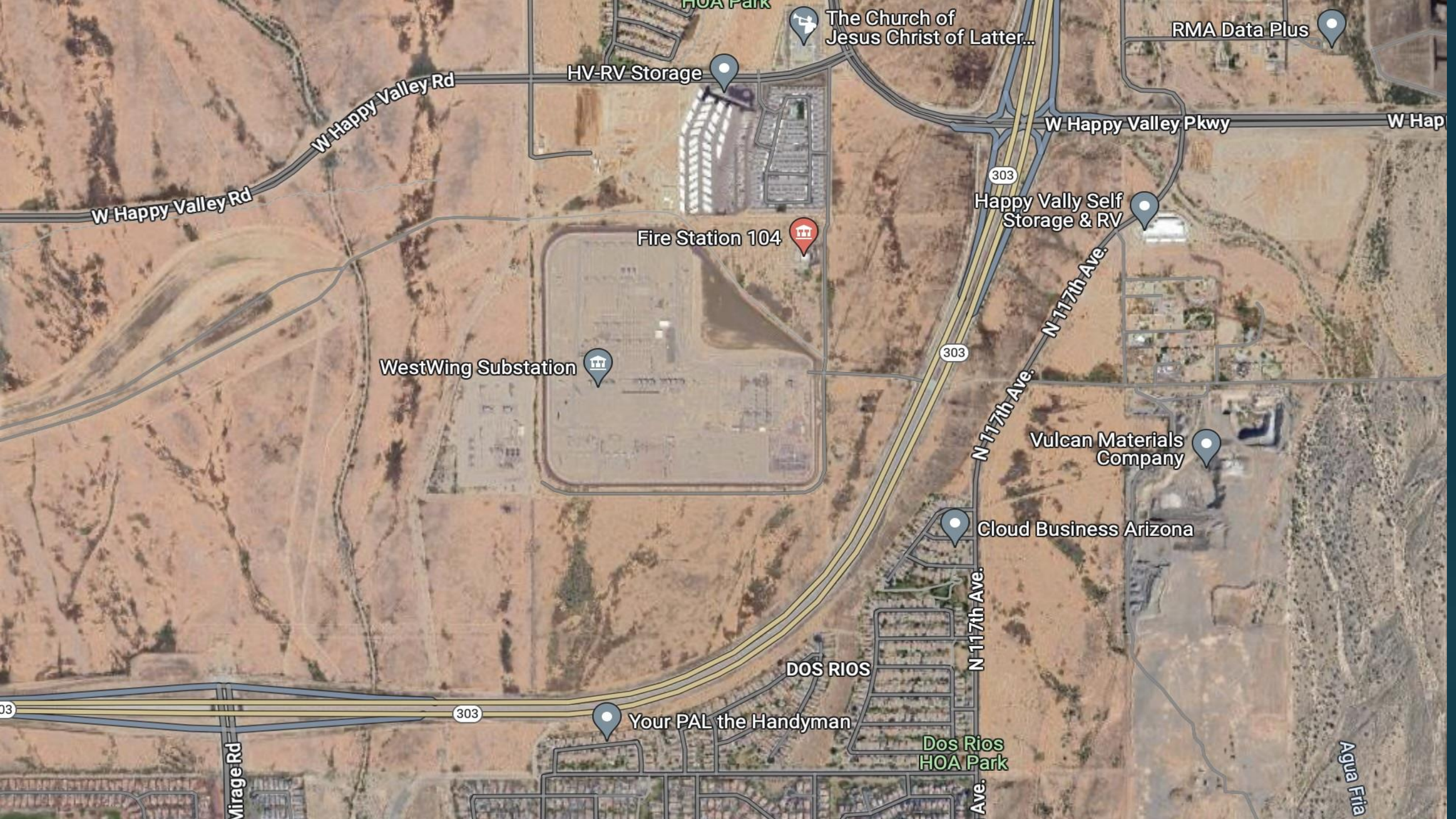
Special Operations/Medical/Fire Services all set to standards

Special Operations (Hazmat/Technical Rescue/Rescue Swimmer)

200 Hours Technician Classes

Lithium-ion Battery Thermal Runaway Incidents





The Church of Jesus Christ of Latter...

RMA Data Plus

HV-RV Storage

W Happy Valley Pkwy

W Hap

W Happy Valley Rd

303

Happy Vally Self Storage & RV

Fire Station 104

303

WestWing Substation

N 117th Ave.

Vulcan Materials Company

Cloud Business Arizona

N 117th Ave.

DOS RIOS

Your PAL the Handyman

Dos Rios HOA Park

Mirage Rd

303

N 117th Ave.

Agua Fria



APS Transformer Fire July 4th 2004

5 transformers destroyed, 7 replaced
Dropped power supply by 20%



TRACKING STORMS

MONSOON 2019



CONCERNS OVER BATTERIES STORED BY APS



ARIZONA

6:32 96°

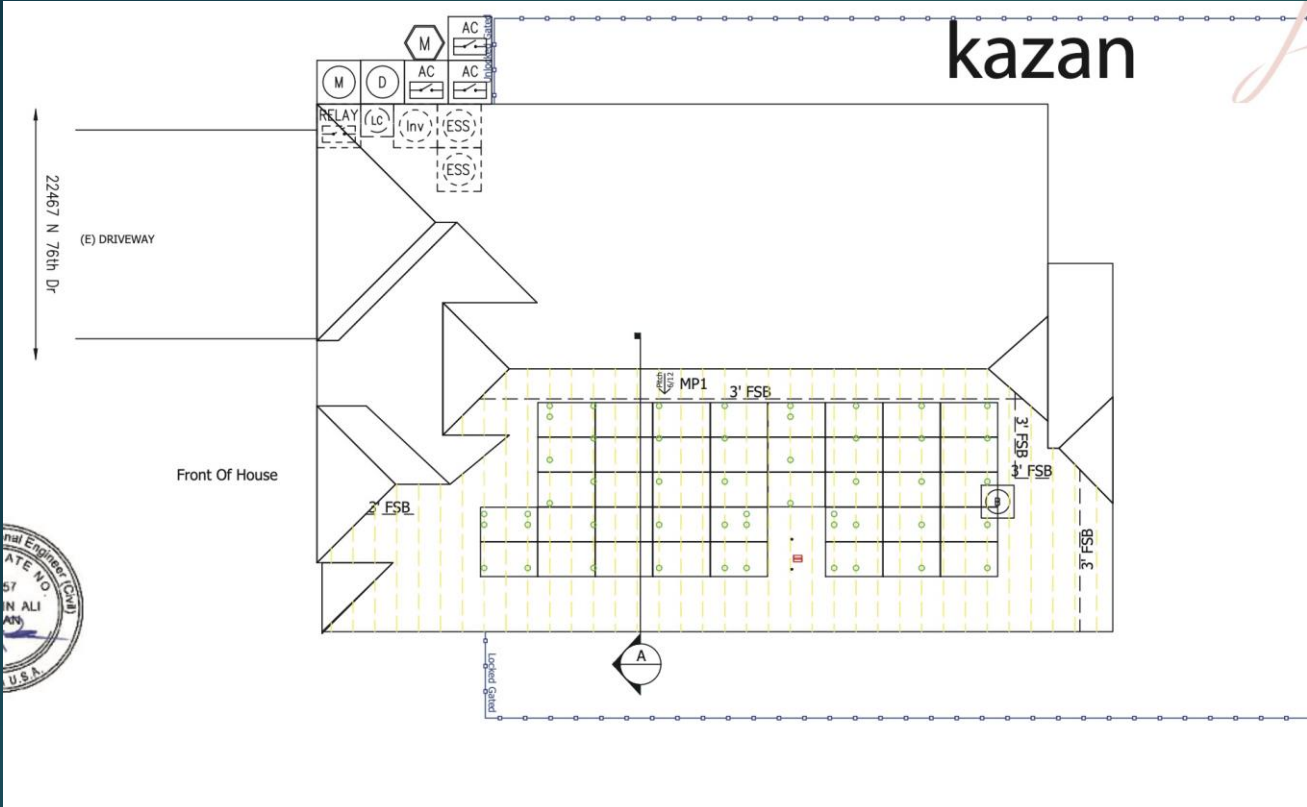
GRUBER MOTOR COMPANY

Electric Vehicle Division







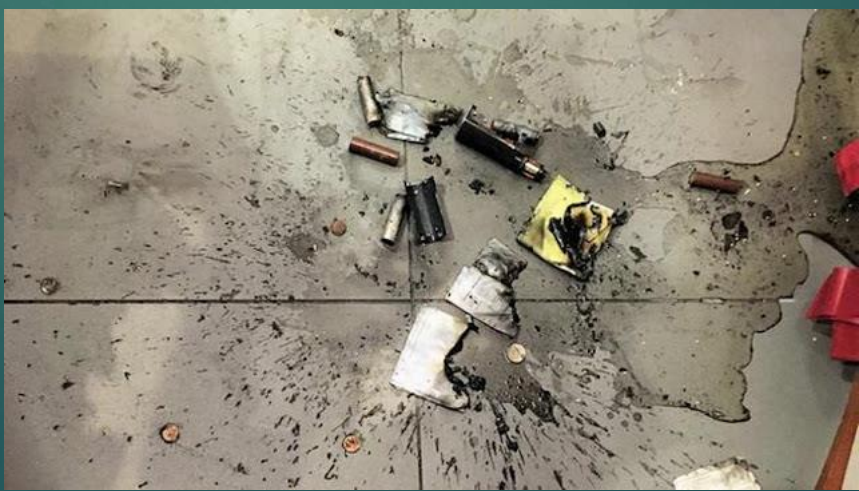


CAUTION

POWER TO THIS BUILDING IS ALSO SUPPLIED FROM THE FOLLOWING SOURCES WITH DISCONNECTS LOCATED AS SHOWN:
- Address: 22467 N 76th Dr

PHOTOVOLTAIC BACK-FED CIRCUIT BREAKER IN MAIN ELECTRICAL PANEL IS AN A/C DISCONNECT PER NEC 690.17

OPERATING VOLTAGE = 240V JB-85324244-00





aps





 **aps**



Background of Facility

- 2 MW/2.16 MWh lithium-ion battery ESS
 - Placed in service 2017
 - (10,584 lithium nickel manganese cobalt)
 - (LiNiMnCoO₂)
- Average home in Arizona consumes 1 MWh/month (60 homes for 2-days)
- ESS owned by local electric utility (APS)
- Batteries manufactured by LG Chem
- ESS designed by the integrator (Fluence)
- ESS maintained by contractors to the integrator (Sturgeon)
- Flooding clean agent, HVAC, smoke detection
- Four firefighters (Peoria HAZMAT team) seriously injured
- Four firefighters (Surprise E304) held overnight for suspected exposure to HCN



Time frame

Battery Incident 1654

NOVAC 1230 system activates 1655

Dispatch from passer-by caller 1741

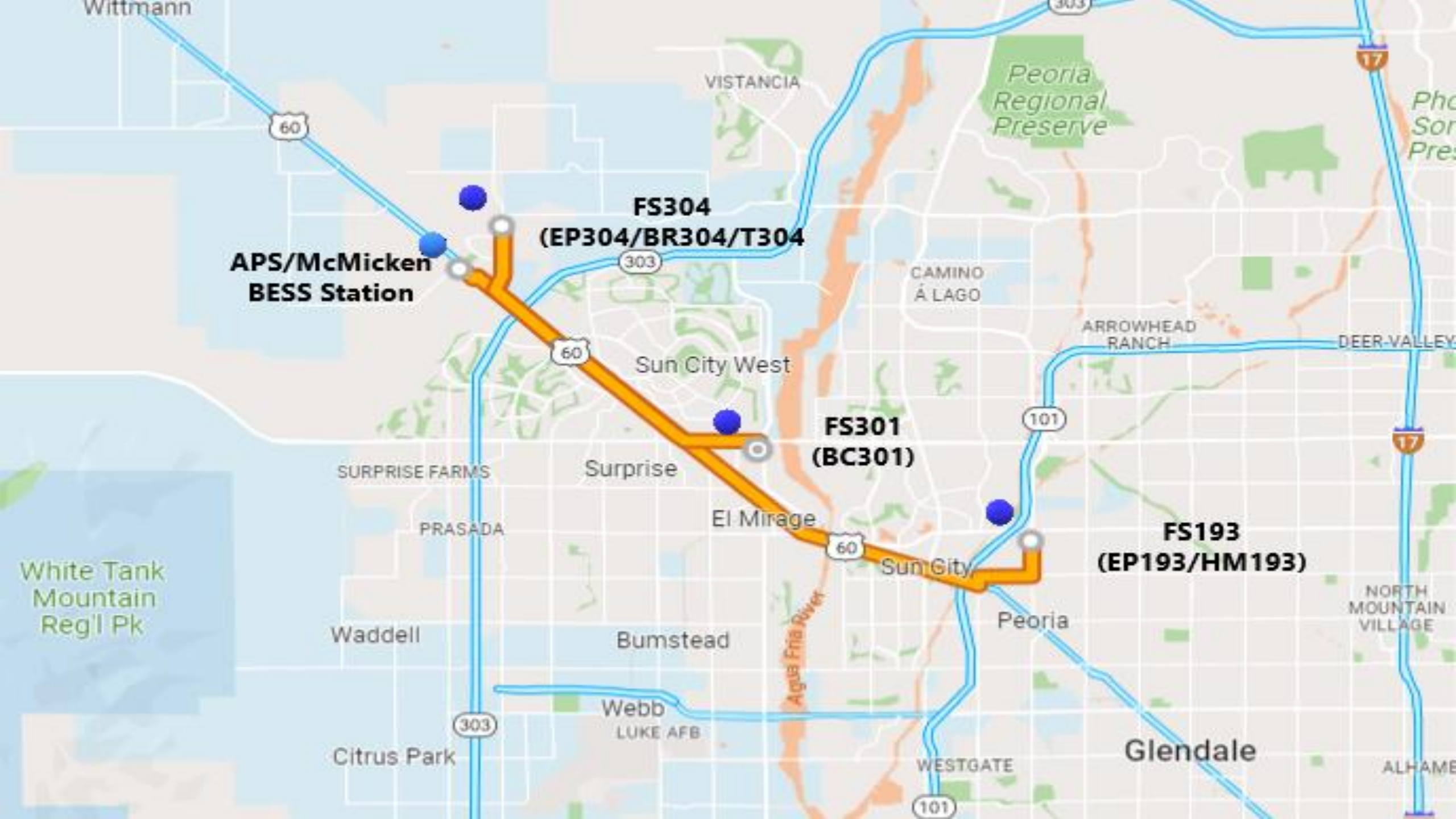
Entry Times 1837, 1851, 1910

Final Entry 1958

Door Open 2000

Deflagration Incident 2003

Less than 3 minutes after opening the door



**APS/McMicken
BESS Station**

**FS304
(EP304/BR304/T304)**

**FS301
(BC301)**

**FS193
(EP193/HM193)**

White Tank
Mountain
Reg'l Pk

Peoria
Regional
Preserve

Pho
Sor
Pres

Sun City West

Surprise

El Mirage

Sun City

Peoria

Glendale

SURPRISE FARMS

PRASADA

Waddell

Bumstead

Citrus Park

Webb
LUKE AFB

WESTGATE

NORTH
MOUNTAIN
VILLAGE

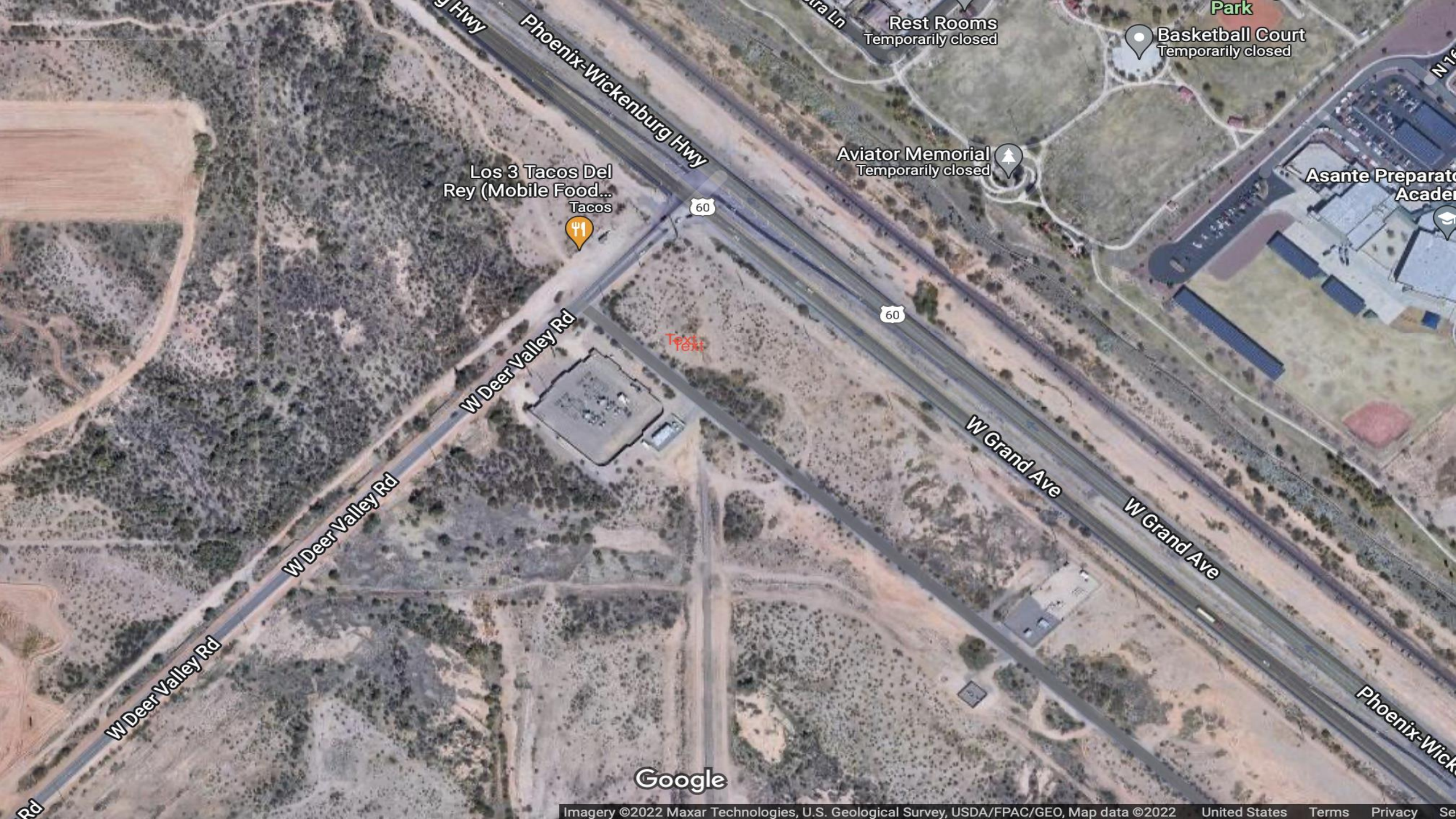
ALHAMBRA

VISTANCIA

CAMINO
Á LAGO

ARROWHEAD
RANCH

DEER-VALLEY



Los 3 Tacos Del Rey (Mobile Food... Tacos



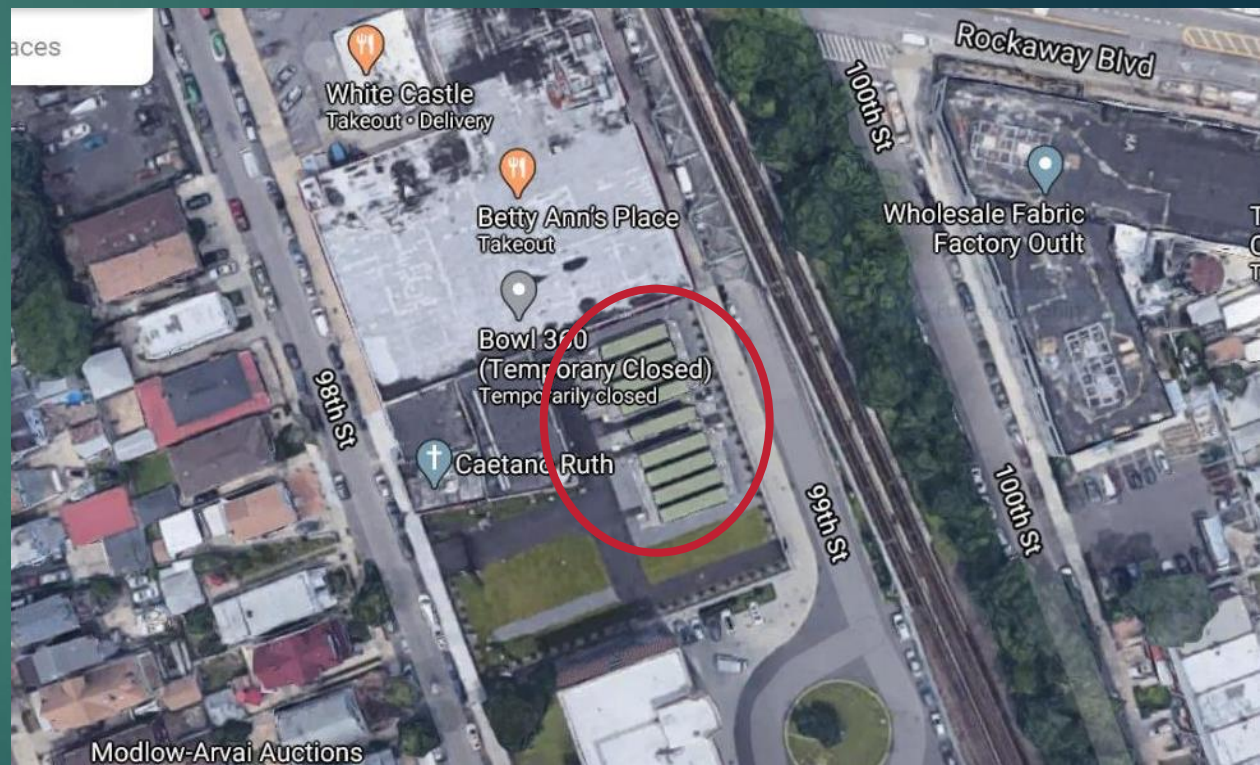
Aviator Memorial
Temporarily closed



Basketball Court
Temporarily closed

Asante Preparatory Academy

Google



Google Earth photos



W Deer Valley Rd

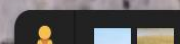
W Deer Valley Rd

W Deer Valley Rd

Phoenix-Wickenburg Hwy

60

Google





aps



What We Used & Why

- ▶ Gas Range
 - ▶ CO – 0 -5000 PPM
- ▶ TIC
- ▶ Drager Tubes & Chips
 - ▶ 0.2%
 - ▶ 0.5%
- ▶ Multi Rae (5 Gas)
 - ▶ PID – 10.6eV – 0 -1,000 PPM
 - ▶ Oxygen – 0 – 30%
 - ▶ CO2 – 0 – 50,000PPM
 - ▶ VOC – 0 - 1,000 PPM
 - ▶ CO – x2 – 0 – 500 PPM & 0 – 1,500 PPM
 - ▶ LEL – 0 - 100%
 - ▶ HCN – 0 – 50PPM
 - ▶ NO2 – 0 – 20PPM



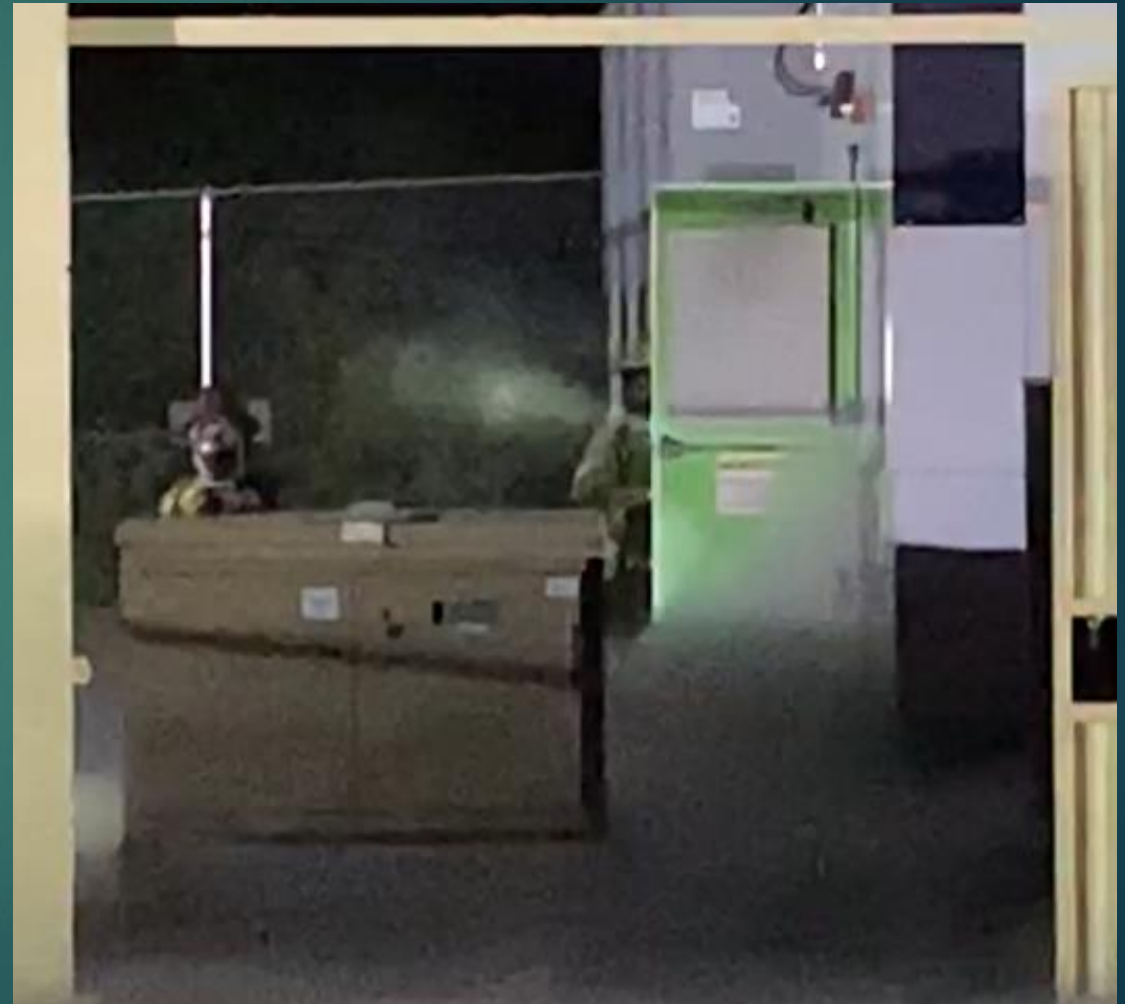
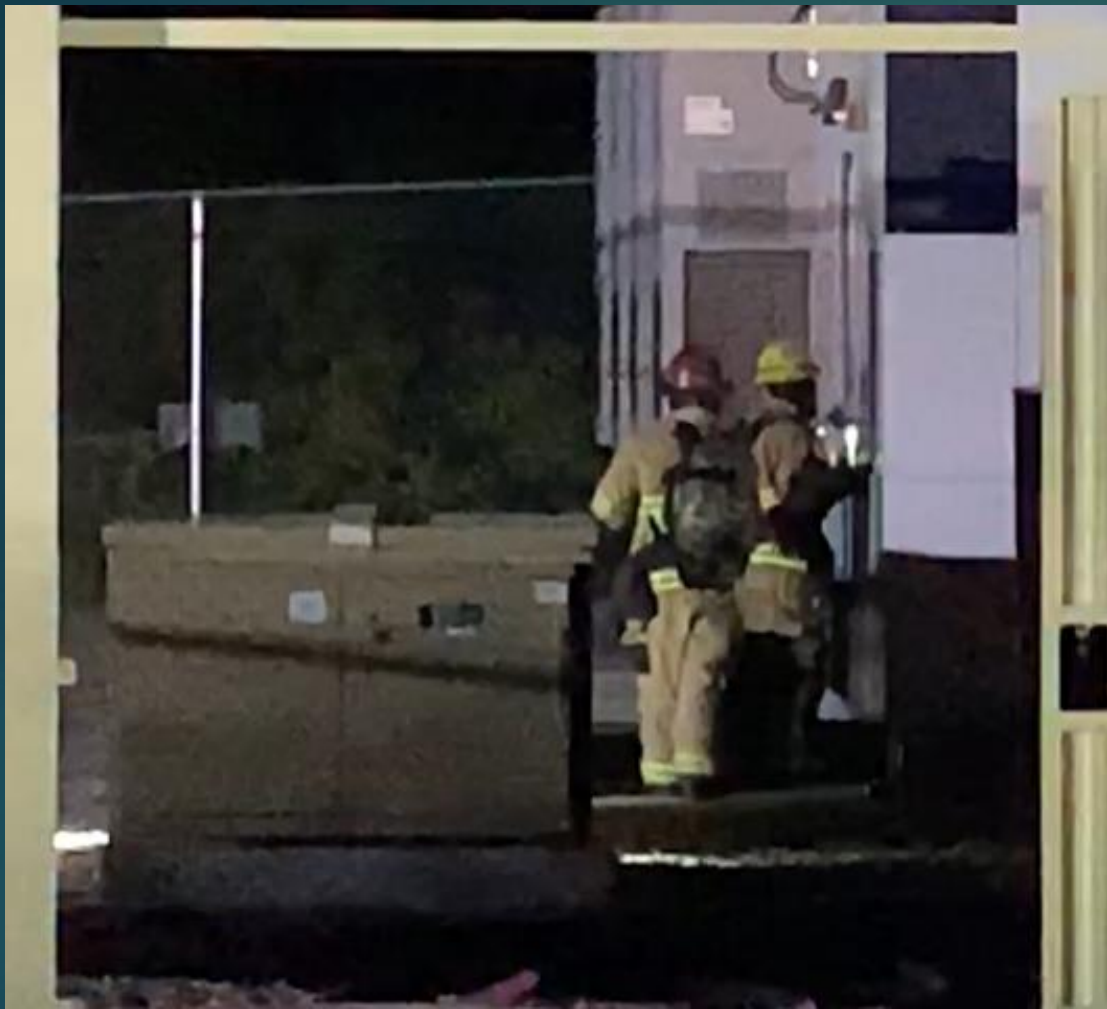






Photos courtesy of APS





Photos courtesy of APS



Photos courtesy of APS









ADOSH Investigation

Arizona Division of Occupational Safety and Health

- ▶ ADOSH

- ▶ Teams acted appropriately
- ▶ Companies followed current recommendations and standards
- ▶ Fire Department personnel should communicate with site owners
- ▶ Pre-incident planning should be included on all facilities
- ▶ Training should be conducted in the future between entities

- ▶ Note:

- ▶ Initial reported sited potential violations of NFPA 855 which was not in use at the time of the incident

Arizona Cooperation Commission

- ▶ After reviewing three (3) separate APS incidents, Lithium-ion batteries create unacceptable risk and other alternatives should be explored
- ▶ Batteries have been continuously charged against their design
- ▶ Inadequate electrical circuit protections to prevent heat build up or arcing
- ▶ MSDS at facility showed failures were “anticipated” yet protections in place were not designed to handle a fire or runaway issues

APS verse LG Chem Reports

- ▶ APS claims
 - ▶ Faulty battery components
- ▶ LG Chem claims
 - ▶ External source failure
 - ▶ Arch or unintended heat build-up
- ▶ Both agree
 - ▶ Thermal runaway occurred
 - ▶ Gasses accumulated
 - ▶ Safety systems need to be altered
 - ▶ Door being opened did contribute to deflagration happening sooner

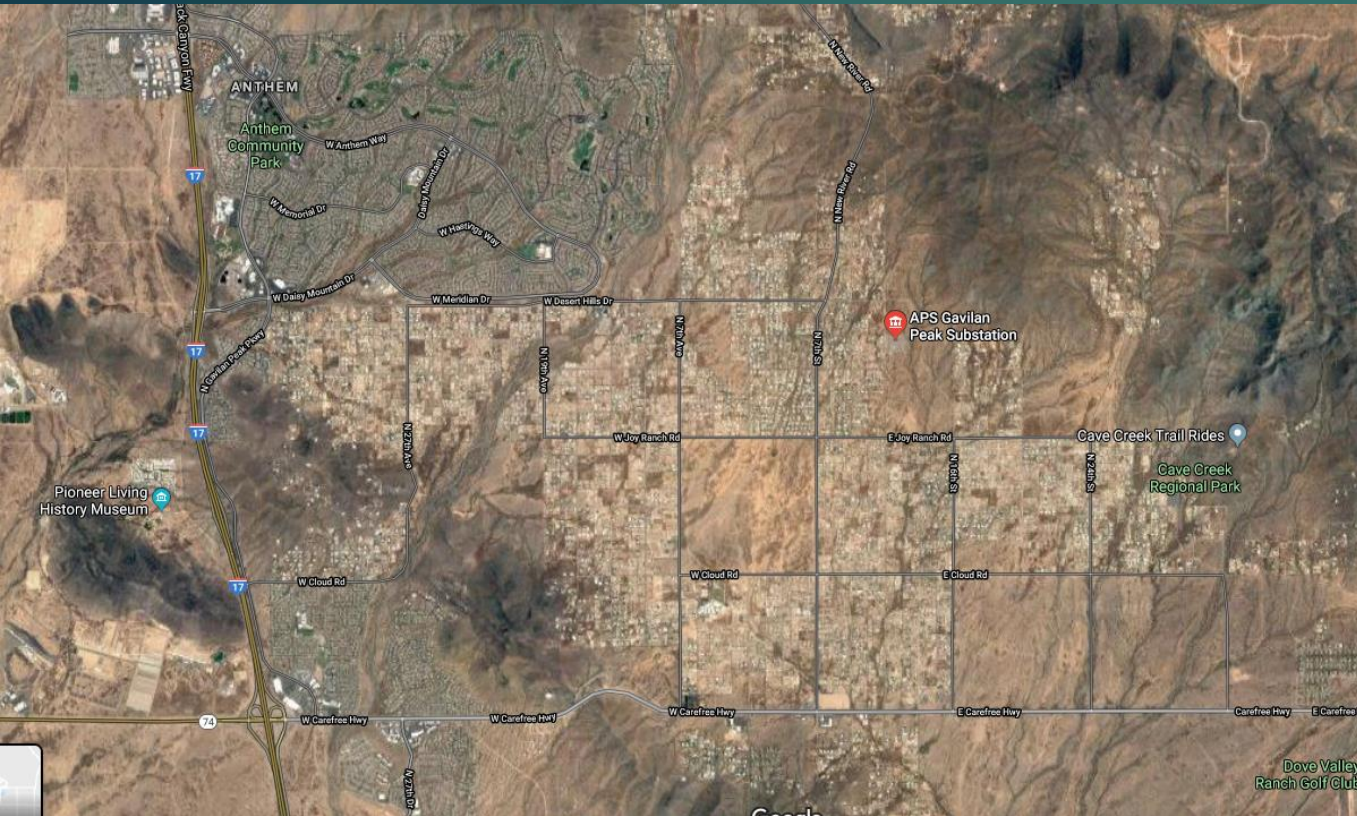
Actions in Arizona

- ▶ APS

- ▶ Decommissioned the sister facility within months of the April 19th incident
- ▶ Made a concentrated effort to now outsource all storage

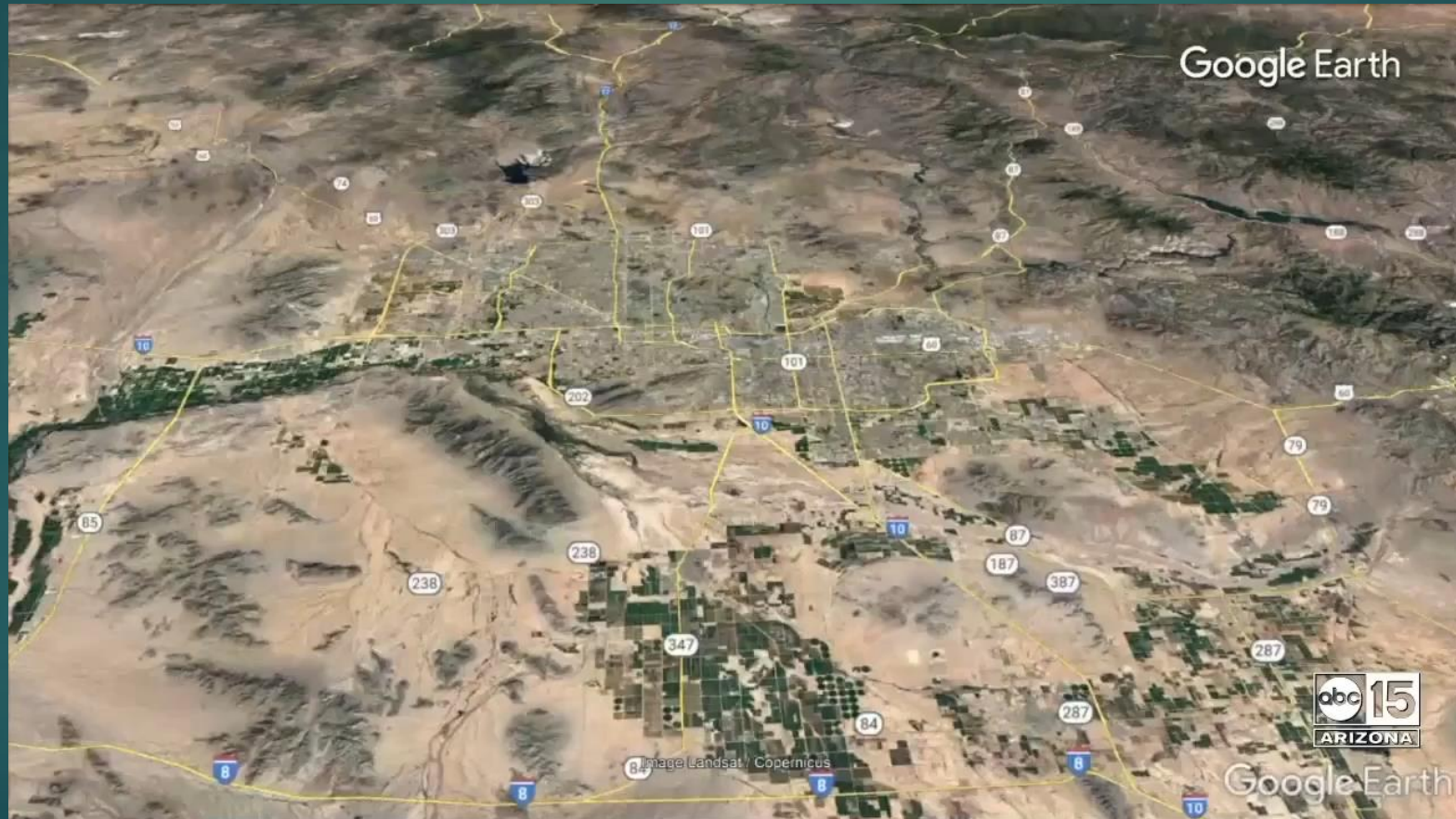
- ▶ Industry

- ▶ Improved battery design
- ▶ Improved building layouts
- ▶ Exploring ventilation systems
- ▶ Defining suppression systems
- ▶ Improve real-time data from inside impacted areas



Fire Code in Phoenix Metro Area

- ▶ Changes have been made to the fire code
- ▶ Some cities have adopted the codes
- ▶ Some cities have already issued exception permits
- ▶ Utility companies recommend that home installers follow industry guidelines but do not enforce them
- ▶ Buildings and Permits is not necessarily tracking locations and installation of in home systems.



SRP Facility

- ▶ Chandler Arizona
- ▶ April 18th 2022
- ▶ 10 MW facility
- ▶ Industrial Complex
- ▶ Sprinklers
- ▶ April 29th
- ▶ May 1st





Evacuation Area



Road Closes at 6 pm



W Frye Rd

E Frye Rd

N 56th St

INTERSTATE
10

ARIZONA
202

E Fairview St

S 54th St



S 56th St

W Morelos Pl



Ed Pastor Fwy

160
10

202L

202

550

202

202

202

202

202

10

161A

Maticopa Fwy

ALB Piping
Products & Services

Titan Engineered
Solutions

E Fairview St

E Fairview St

E Fairview St

SurfacePrep -
SPS Division

Honeyville, Inc

Perfect Pallets

Gateway Crate
and Freight

Fogco

Apollo Mechanical

Stahls

Arizona Nutritional
Supplements

DBSI - Design Build Firm

Vermeer Mountain West

Pyramid Services

905 S 54th Street

Verizon wireless
Corporate Campus

W Pecos Rd

W Pecos Rd

W Pecos Rd

W Pecos Rd

Phoenix Premium
Outlet Mall East Lot

Stoneworks - Cornerstone
Building Brands

Gila River Fire Fleet

Kik Inc

AvAIR

Rinchem



ALB Piping
Products & Services

Silver Fern Landscaping
Titan Engineered
Solutions

Fireworks Productions
of Arizona
Fireworks store

Complete Mobile
Home Service Inc

Vermeer Mountain West

Offshore Manufacturing
and Design

Pyramid Services

AWP Safety

Honeyville, Inc

SurfacePrep -
SPS Division

Nikola Fabrication

AES SRP Battery
Warehouse

905 S 54th Street

FusionHPX

Perfect Pallets

Gateway Crate
and Freight

Jasper Engines
& Transmissions
Auto repair shop

Apollo Mechanical

Fogco

DBSI - Design Build

W Morelos Pl

Verizon wireless
Corporate Campus

W Pecos Rd

W Pecos Rd

W Pecos Rd

W Pecos Rd

S 56th St

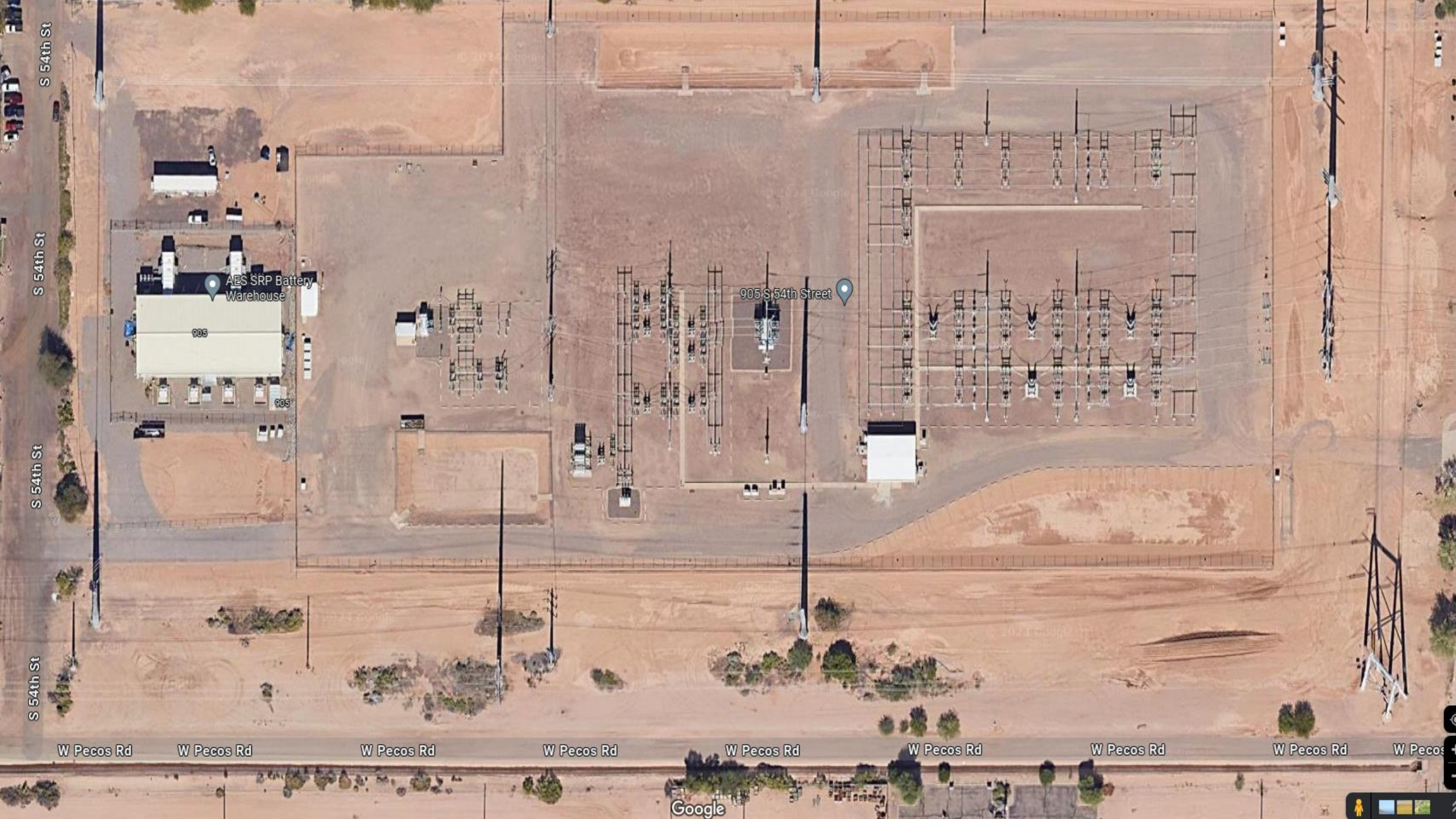
S 56th St

S 54th St

S 54th St

S 54th St

S Weber Dr



S 54th St

S 54th St

S 54th St

S 54th St

W Pecos Rd

W Pecos Rd

W Pecos Rd

W Pecos Rd

W Pecos Rd

W Pecos Rd

W Pecos Rd

W Pecos Rd

W Pecos Rd

AES SRP Battery Warehouse

905

905

905 S 54th Street

Google



SECT #1
SRP Metering

SECT #2
Disconnector

SIEMENS
SECT #3
Main Breaker

SIEMENS
SECT #4
Breaker
Cores 1 & 2

SIEMENS
SECT #5
Breaker
Cores 3 & 4



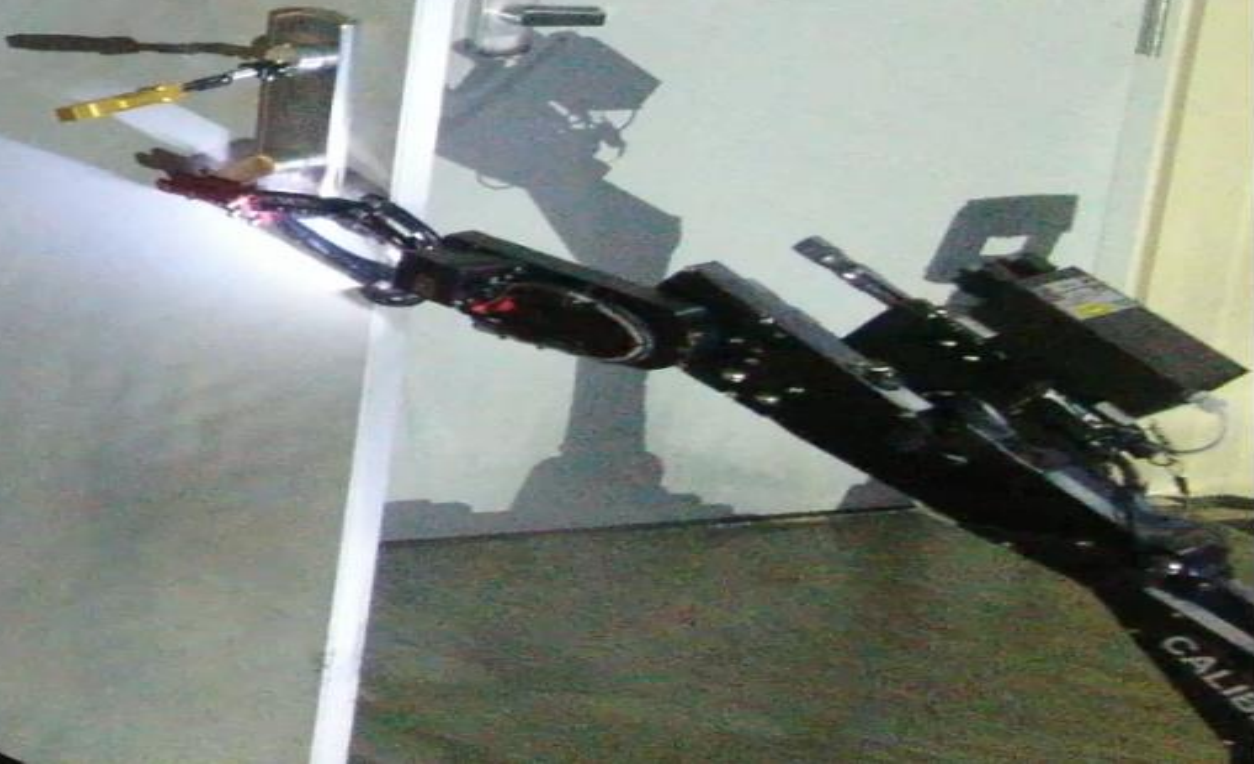
FIRE
ALARM
PANEL



100



FIRE
ALARM
PANEL









▶ SRP 25 MW

▶ Peoria Az

▶ Tesla







Nikola Truck fires x4

fedex.com





2021-05-23 星期日 08:21:56

newsflare

Camera 01



Battery Test
Lithium-Ion Battery Array



2023-04-11 08:30:46 -0600
AXON BODY 3 X60AC497T





TRAINING BULLETIN

JULY 2022

Why Is BESS Important?

The rise in the number of residential Battery Energy Storage Systems (BESS) requires the need for responding companies to have a heightened understanding of the hazards involved through comprehensive initial size-ups and greater situational awareness. Always consider contacting the proper utilities, your Fire Prevention team, and the BESS manufacturing company for any fire incident with BESS on the property.

Hazards Associated With BESS

All firefighters should be aware of the following hazards:

Thermal Runaway: Thermal runaway in a single cell can result in an uncontrolled chain reaction that heats up neighboring cells. As this process continues, it can result in a battery fire or explosion.

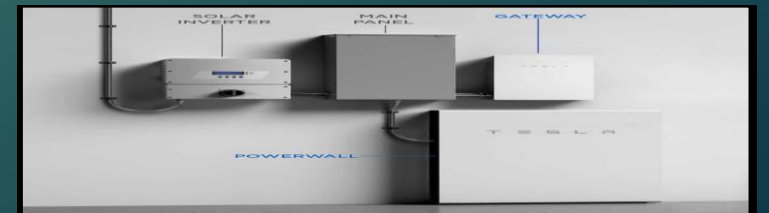
Stranded Energy: As with most electrical equipment there is a shock hazard present, but what is unique about BESS is that often, even after being disconnected and/or involved in a fire, there is still stored energy within the BESS that can result in shock or reignition.

Toxic & Flammable Gases: Most batteries create toxic and flammable gases when they undergo thermal runaway which can easily lead to the creation of an explosive atmosphere inside of the BESS room (garage).

Deep Seated Fires: BESS are comprised of batteries housed in protective metal/plastic casings which will block water from accessing the seat of the fire. This means it will take large amounts of water to effectively dissipate the heat generated by BESS fires.

Operational Considerations For Fires Involving Residential BESS

- Pre-Plan residences in your 1st due with Solar & BESS.
- Utilize CAD premise alerts when responding to incidents.
- SLOW DOWN** & conduct a complete size-up with 360°.
- Be aware of the explosive potential for any BESS.
- Due to explosive risks, avoid staging companies in the front of garages or near BESS.
- White colored smoke from a compartment containing a BESS is a good indication of hazardous off-gassing.
- Any smoke or odors from BESS are indications of a hazard.
- If a BESS is involved in a fire, ensure foam is off and apply substantial water to the battery enclosure and exposures, from a safe distance in a defensive posture.
- Never open any doors or remove any panels to BESS units
- Shutting off the battery disconnect or residential/solar power supply does **NOT** remove energy from the battery.
- Thermal imaging cameras may not be reliable identifiers of heat signatures due to BESS construction.
- The ensure foam is off absolutely if it is a traditional foam, but F500 (not a foam but encapsulator) has been successful when the cells are exposed, refer to your specific FD guidelines.
- In most residential applications, the BESS will be located inside the garage or outside on an exterior wall. IF WE KNOW OR SUSPECT A BESS IS PRESENT, STAY AWAY FROM IT. IF IT IS IN THE GARAGE DO NOT MAKE ENTRY INTO THE GARAGE.** If possible, check with the homeowner on the presence and location of the BESS.





Deflagration and ESS

- March 3, 2022
- Bodnegg, Germany
- ESS in basement, PV on roof
- Pressure wave “pushed several windows and doors open” and “lifted the entire roof structure”
- No injuries



July 2018

Plant was almost new: Battery for photovoltaics exploded - 100.000 euros damage caused by fire in Lower Franconia

April 2020

Grub am Forst: Storage battery triggers explosion

March 2022

Ravensburg District
 Battery storage detonated: violent explosion in the house in Bodnegg - residents are very lucky



The battery storage of a photovoltaic system in the basement of a



Field Incidents with Li-ion Batteries in Residences

Montreal, Canada - July 27, 2019

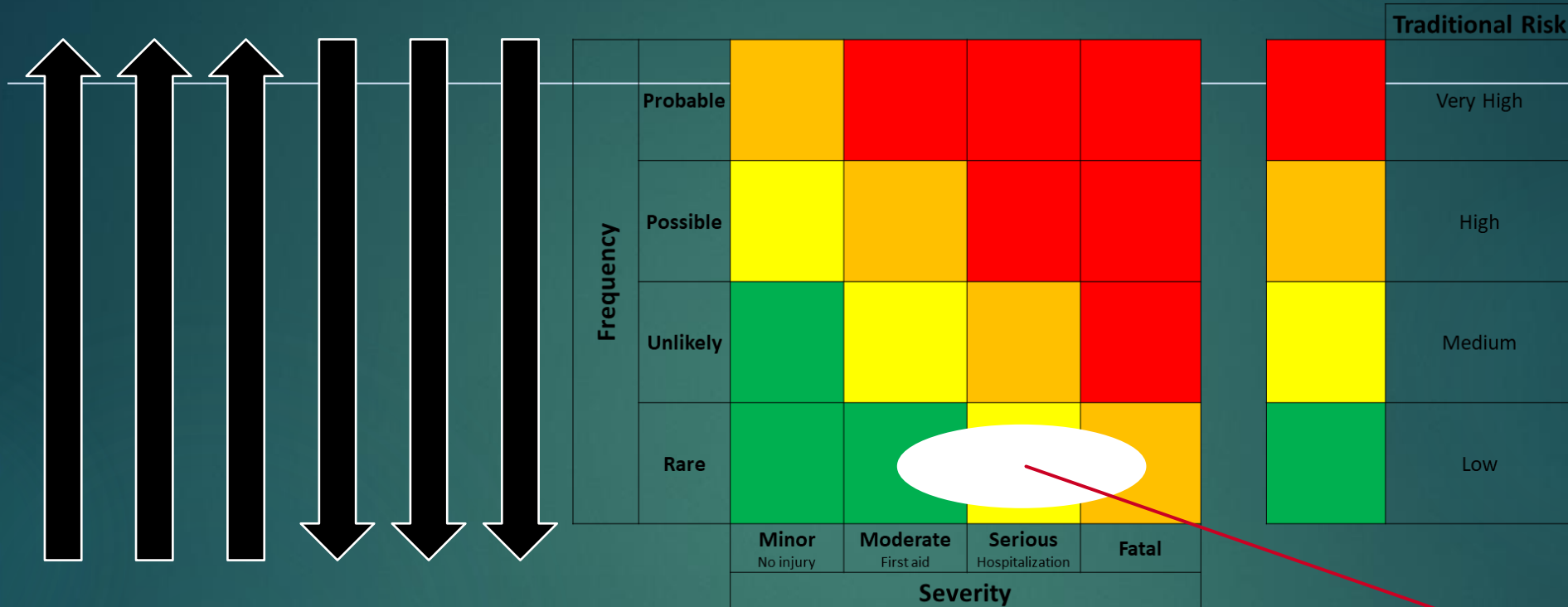
- ▶ Erie, CO, USA – April 11, 2023
- ▶ Video courtesy of Mountain Video Fire Department



INFO



Background – Li-ion ESS Thermal Runaway Risk



ESS?

Risk = frequency × severity



Fire Service Training Resources



Research: Fire Safety Hazards of Lithium-Ion Battery Powered e-Mobility Devices

FSRI research study of e-mobility device fire safety, in partnership with the Fire Department of the City of New York.



Research: The Impact of Batteries on Fire Dynamics

FSRI research into understanding fire and explosion hazards associated with lithium-ion batteries in residential compartments.



Presentation

Download a PDF of the complete Lithium-Ion Battery Symposium: Challenges for the Fire Service presentation deck.

Please note: video files within the presentation are not accessible.



Want to Learn More?

Download the guide: *The Science of Fire and Explosion Hazards from Lithium-Ion Batteries*.



Research: Fire Safety of Batteries and Electric Vehicles

FSRI research into the understanding of hazards generated by electric vehicle (EV) battery fires to enable the development of firefighting tactics for effective EV fire control.



Online Training

Learn how to identify the risks associated with lithium-ion battery products in your personal and professional life.



Steve Kerber, Ph.D. (Vice President and Executive Director, FSRI) introduces FSRI's mission, the existing hazards in today's fire environment, and the challenges lithium-ion batteries pose for the fire service.



FDNY Google Drive

Access additional resources from the Lithium-Ion Batteries: Challenges for the Fire Service symposium hosted in partnership with FDNY, FSRI, and the [National Fire Protection Agency \(NFPA\)](#) in September 2022.

Fire and Explosion Hazards

Five Factors Contribute to Hazard Development



**Gas
Flammability**



**Propagation of
Thermal Runaway**



**Ignition
Sources**



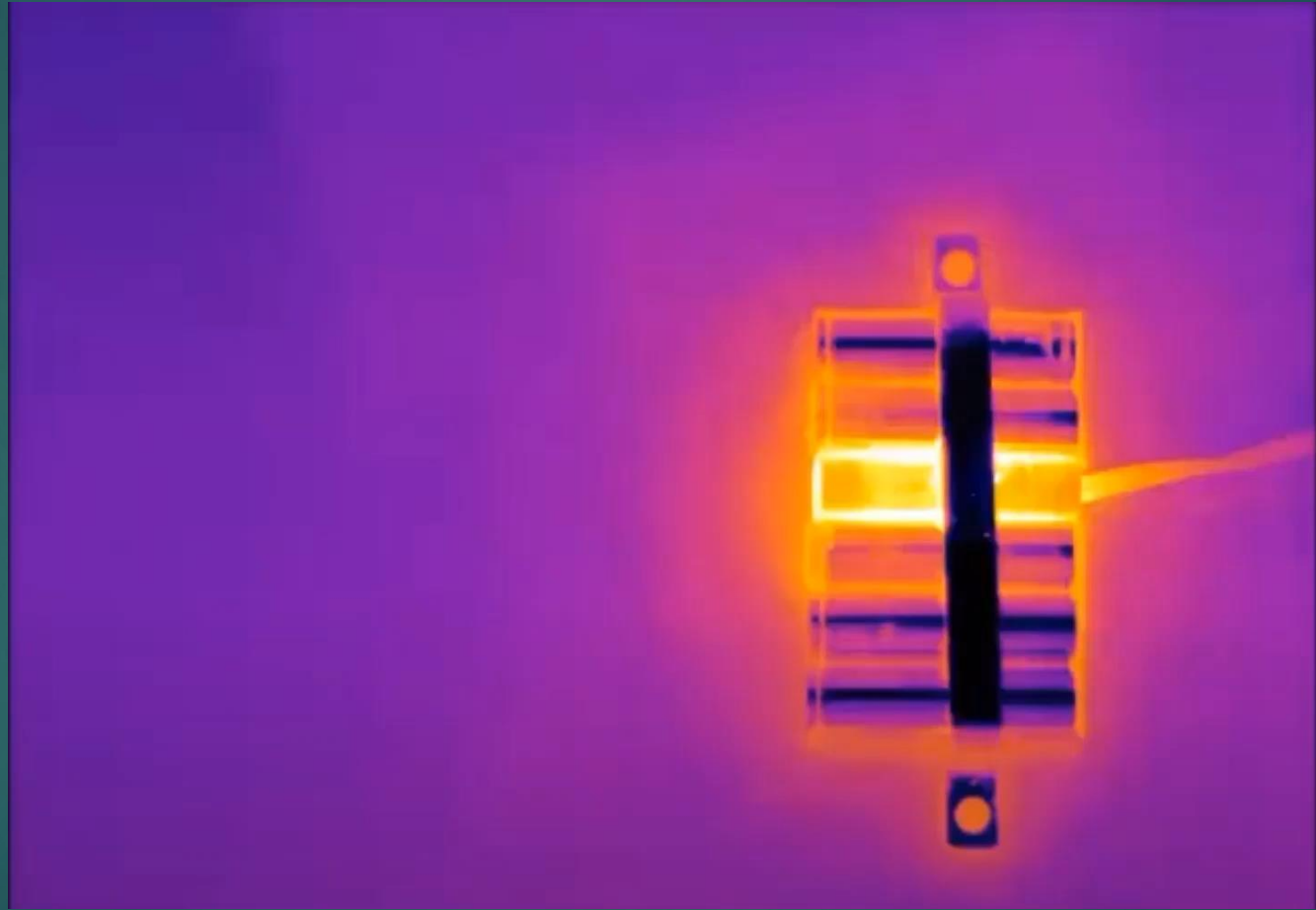
**Gas
Confinement**



**Enclosure
Strength**

OUR ASSUMPTION

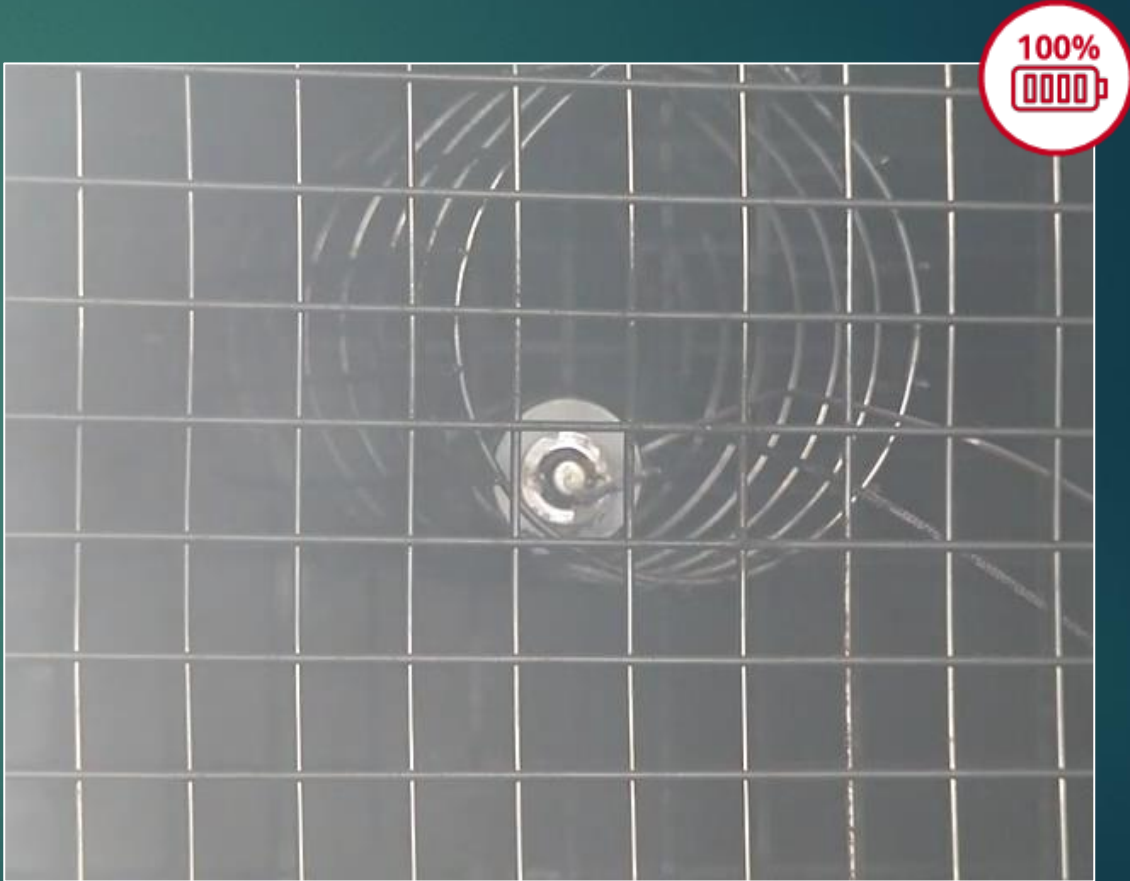
The gases produced during thermal runaway
ARE FLAMMABLE and an **IGNITION SOURCE IS PRESENT.**



Videos and Charts authorized by UL/FSRI Kerber/Baroway

Thermal Runway

UL Oven Experiments



Projects: ESS Incident Response

- Potential impact of li-ion residential ESS on incident response
- Objectives:
 - Determine whether li-ion battery gas impacts compartment fire dynamics
 - Develop size-up and tactical considerations for first responders to li-ion residential energy storage system fire incidents



U.S. DEPARTMENT OF
ENERGY



Disclaimer: The views expressed herein do not necessarily represent the views of the U.S. Department of Energy or the United States Government.



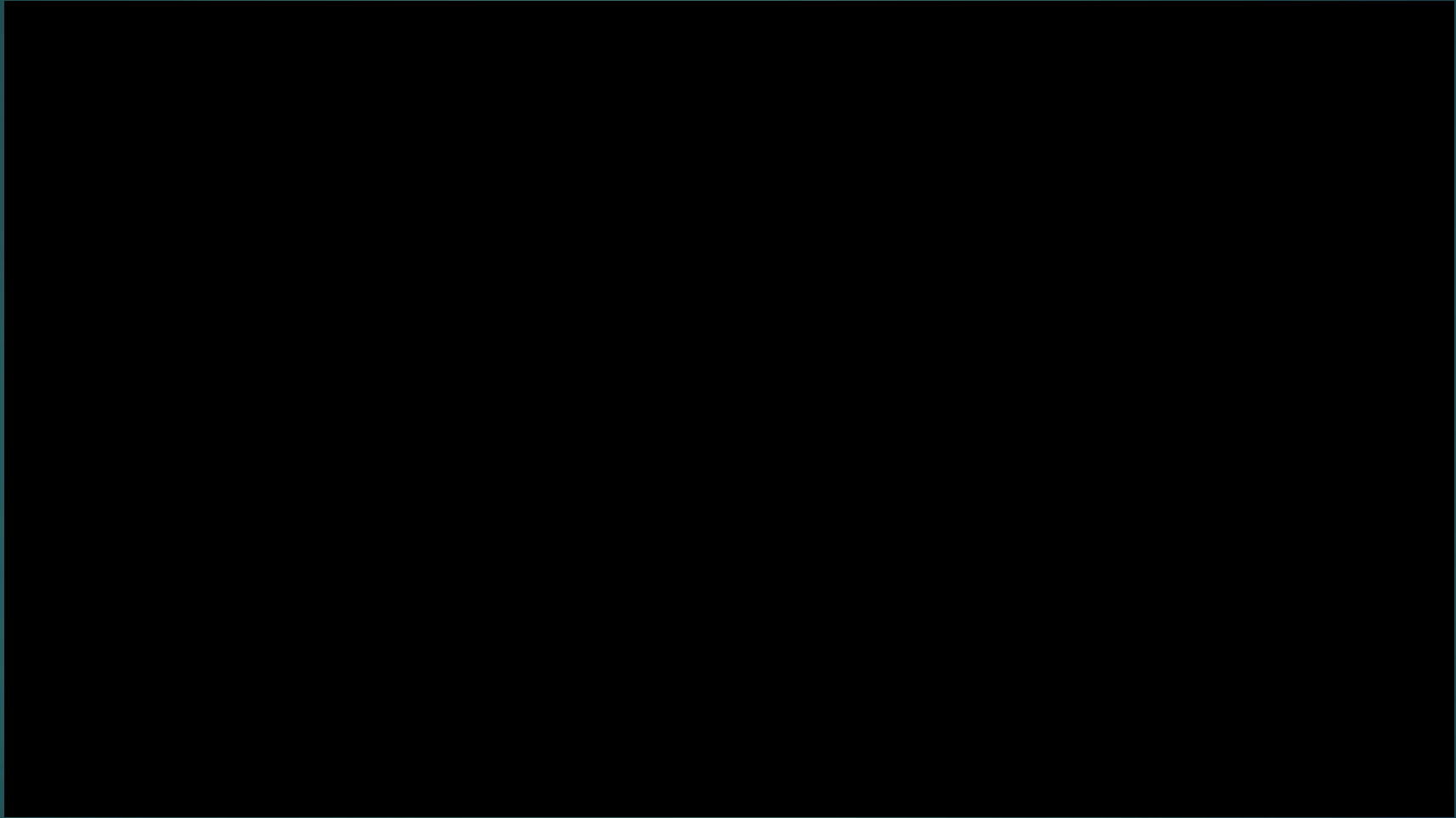
Interior view – Battery failure



Deflagration



Explosion



Slow motion explosion



CH 3



2020/06/19 10:16:33
1920x1080 30.0 S X1





2020-06-25 10:15:04









AXIS P3228-LVE

00:36:22



RESS Garage Fire Test#2_2022-06-23 11:02:56





AXIS Q6215-LE

00:36:23



RESS Garage Fire Test #2 _ 20220621

AXIS P3228-LVE

00:36:22



RESS Garage Fire Test #2 _ 20220621

Explosion

Explosion Hazards from Li-ion Battery Thermal Runaways in Residential Garages



Fire Service Size-up and Tactical Considerations

When li-ion batteries undergo thermal runaway without burning, an explosion hazard begins to develop.



Fire Service Size-up and Tactical Considerations

The timing of a battery gas explosion is unpredictable. The severity of a battery gas explosion is dependent on gas quantity.



24:01 (TR + 03:31)



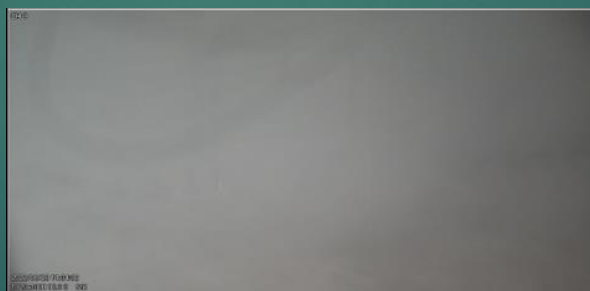
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26:22 (TR + 05:52)



29:43 (TR + 09:13)



30:50 (TR + 10:20)

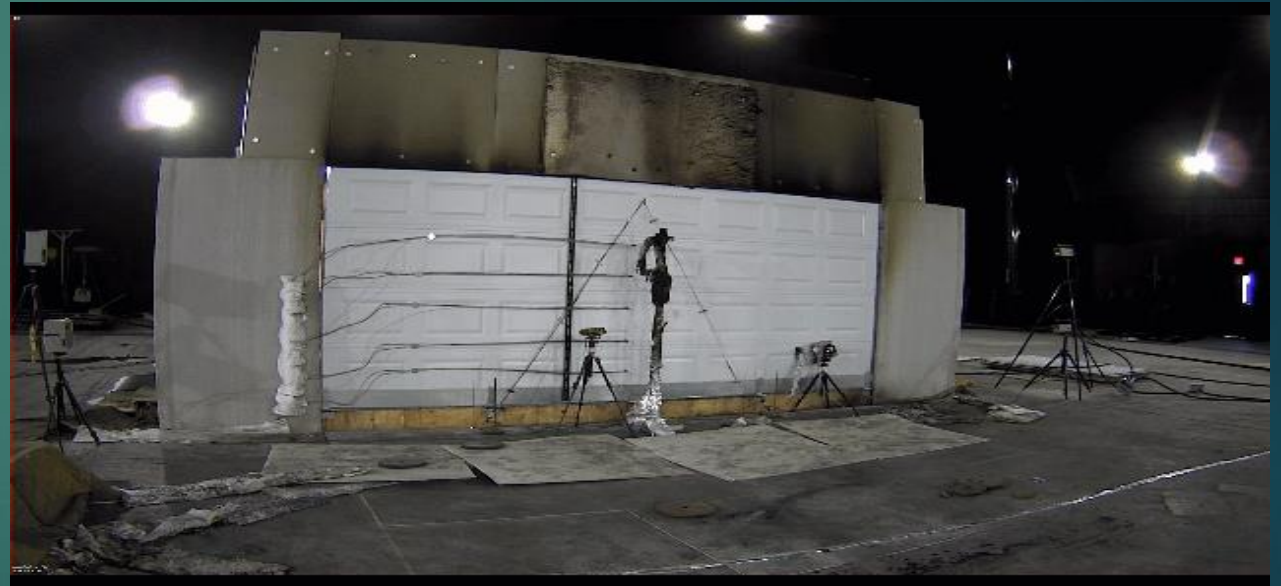


36:34 (TR + 16:04)



Fire Service Size-up and Tactical Considerations

A significant explosion hazard can develop before any exterior indicators (visual or measured) are shown.



Fire Service Size-up and Tactical Considerations

Unburned battery gas ignites readily and can increase the flammability of the smoke in a ventilation-limited fire.



Fire Service Size-up and Tactical Considerations

Without active fire, lithium-ion battery pack thermal runaways may be recognizable by white/gray battery gas leaking from the structure and forming low-hanging clouds.



DOE Test #2



Test #3 in 2020 UL Series



Surprise, AZ



Fire Service Size-up and Tactical Considerations

With or without active fire, stratification of smoke at the ceiling and at the floor indicates the thermal runaway of li-ion batteries.



Fire Service Size-up and Tactical Considerations

With an active fire, there are no reliable visual or thermal imaging indicators to confirm battery involvement from the exterior of the structure.

Before
TR



During
TR



Fire Service Size-up and Tactical Considerations

Portable gas meters are not effective for determining whether a garage fire involves lithium-ion batteries.

Gas Species	Test 1 (t=vent) [ppm]	Test 2 (t=deflagration) [ppm]	Test 3 (t=vent) [ppm]	Test 4 (t=vent) [ppm]
CO	0 (140)	60 (170)	20 (30)	0 (225)
LEL	0 (0)	0 (0)	0 (0)	0 (0) ^[1]
HCN	1.5 (9)	2 (5)	2 (2)	1 (10.5)
VOC	0 (5)	2 (24)	3 (5)	0 (8)

Source: UL Solutions



Fire Service Size-up and Tactical Considerations

During size-up, additional indicators for residential energy storage system installation should be considered beyond smoke appearance.

- Response area – Know your running district
- Presence of Photovoltaic System
- Meter altering – Additional connections
- Labeling
- Presence of EV
- Sounds and Smells
- Dispatch, interviews



Fire Service Size-up and Tactical Considerations

Fire fighters are at greatest risks for explosion hazards in the driveway and at doors, windows and other vent points. Do not park fire apparatus or stage crews in line of the front of the garage door.



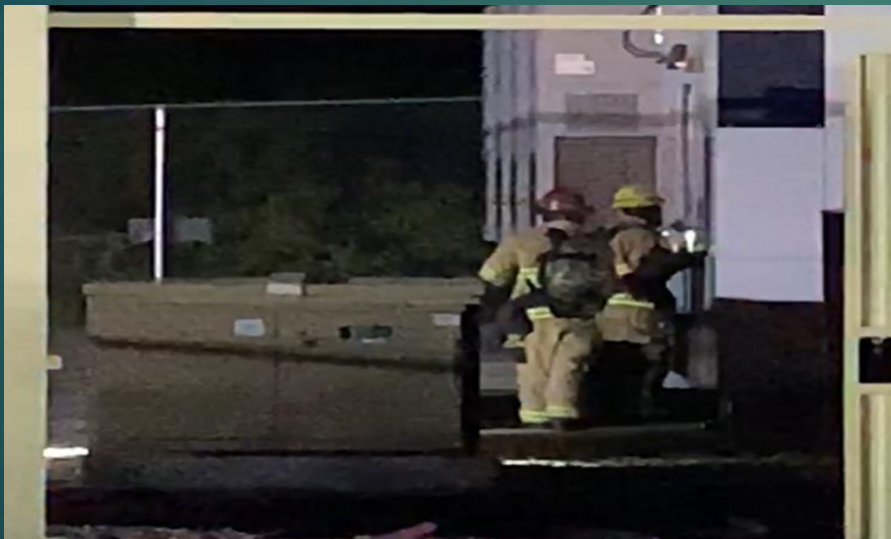
Fire Service Size-up and Tactical Considerations

Do not approach or enter to take portable gas meter measurements if there is a suspected case of batteries in thermal runaway and there are no indicators of an active fire.



Fire Service Size-up and Tactical Considerations

Because conditions can change rapidly, full structural PPE with SCBA should be donned before performing size-up. PPE should also be worn in the vicinity of heat impacted batteries until removed from the scene.



Fire Service Size-up and Tactical Considerations

Because conditions can change rapidly, hose lines should be pre-deployed, charged, and ready for operations before ventilation or entry when li-ion thermal runaways are suspected.



Fire Service Size-up and Tactical Considerations

Hose lines should remain available to manage reignition/thermal runaway of heat impacted batteries until removed from the scene.



Conclusions

- ▶ Systems that limit the oxygen to the system will preserve the batteries and reduce runaway but increase the chance of explosion.
- ▶ In all tests the systems created either a flash or explosion once the proper flammable mix was met
- ▶ Ventilation systems may help with eliminating explosions hazard but will still create a flash risk
- ▶ Thermal runaway can happen and be maintained at lower levels even in limited oxygen environments
- ▶ Don't trust the SMEs, they may know even less than you do