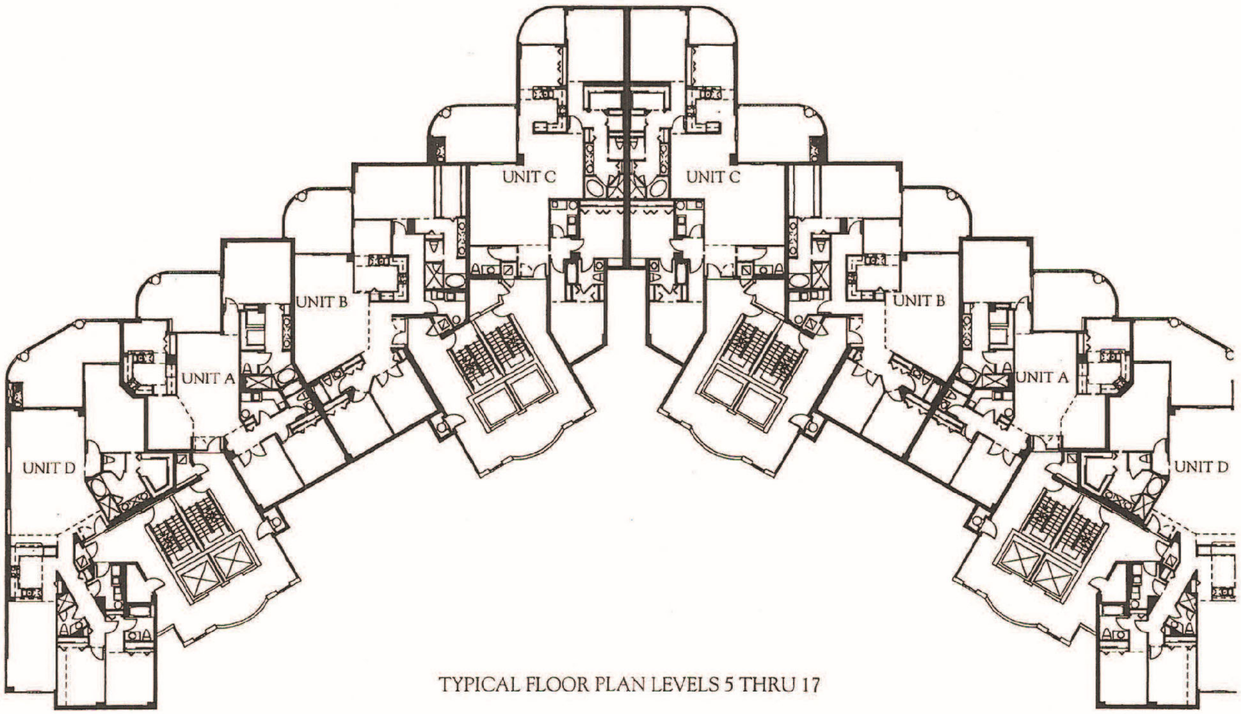
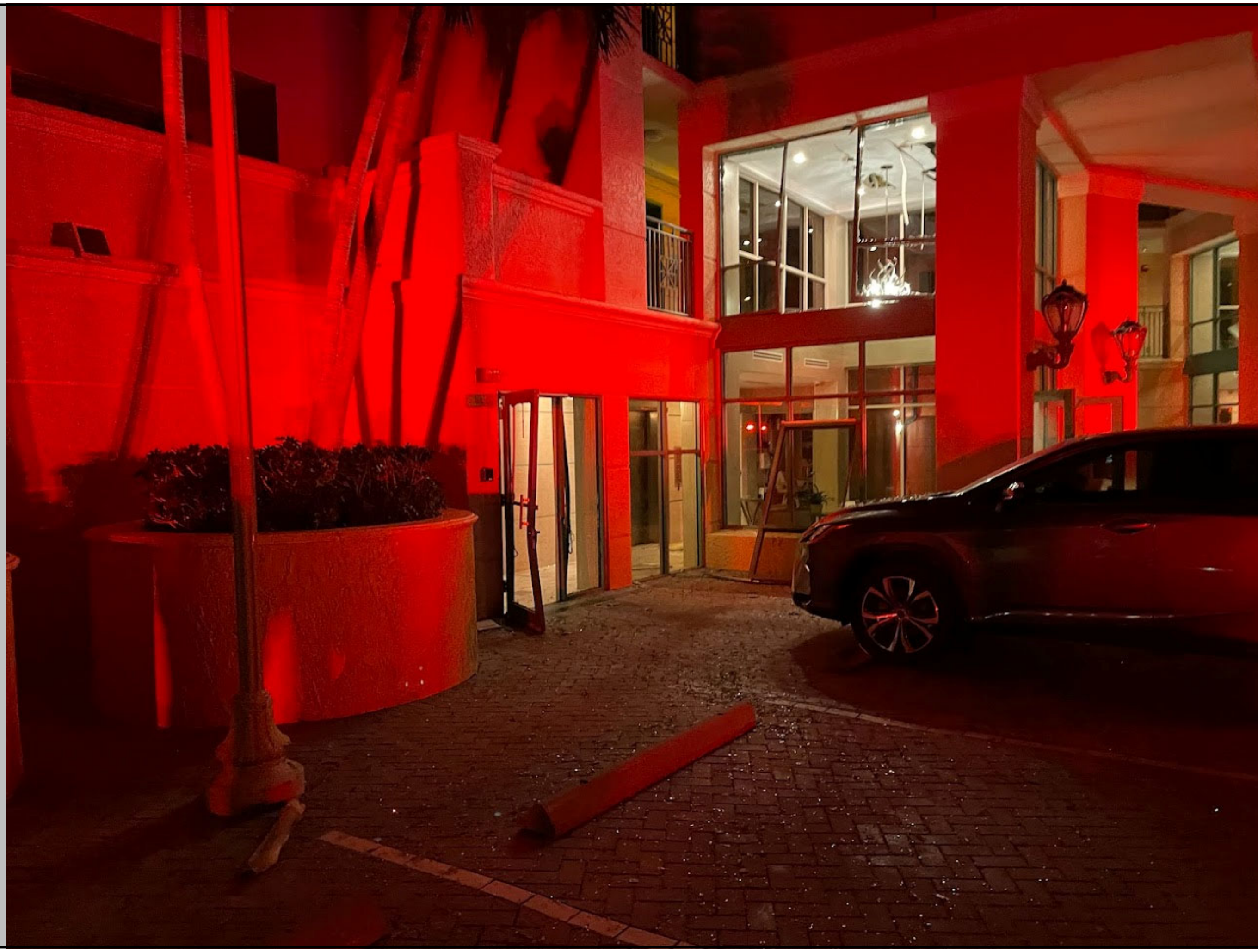
# Monterrey Condominium Incident

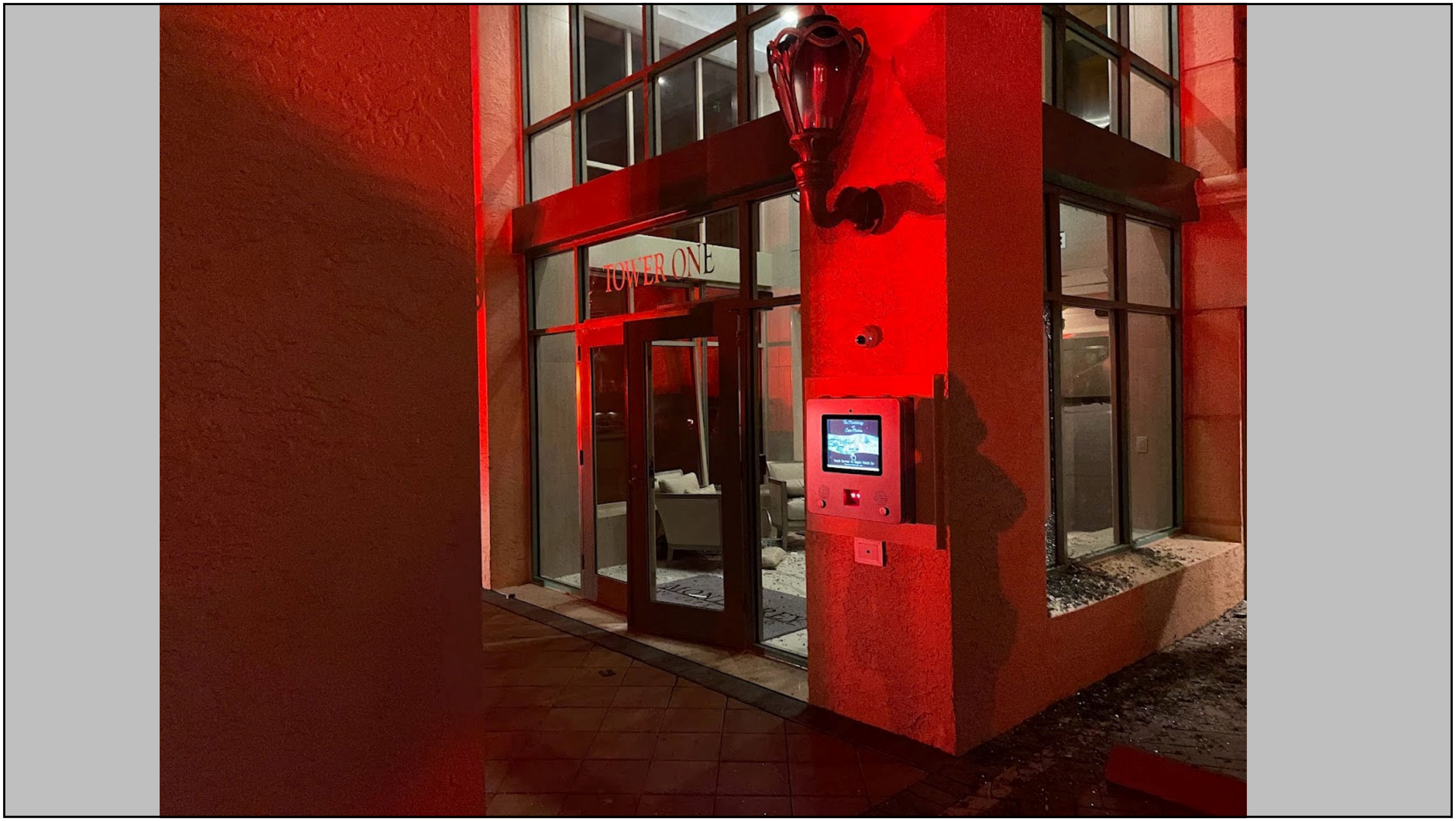
980 Cape Marco Dr.

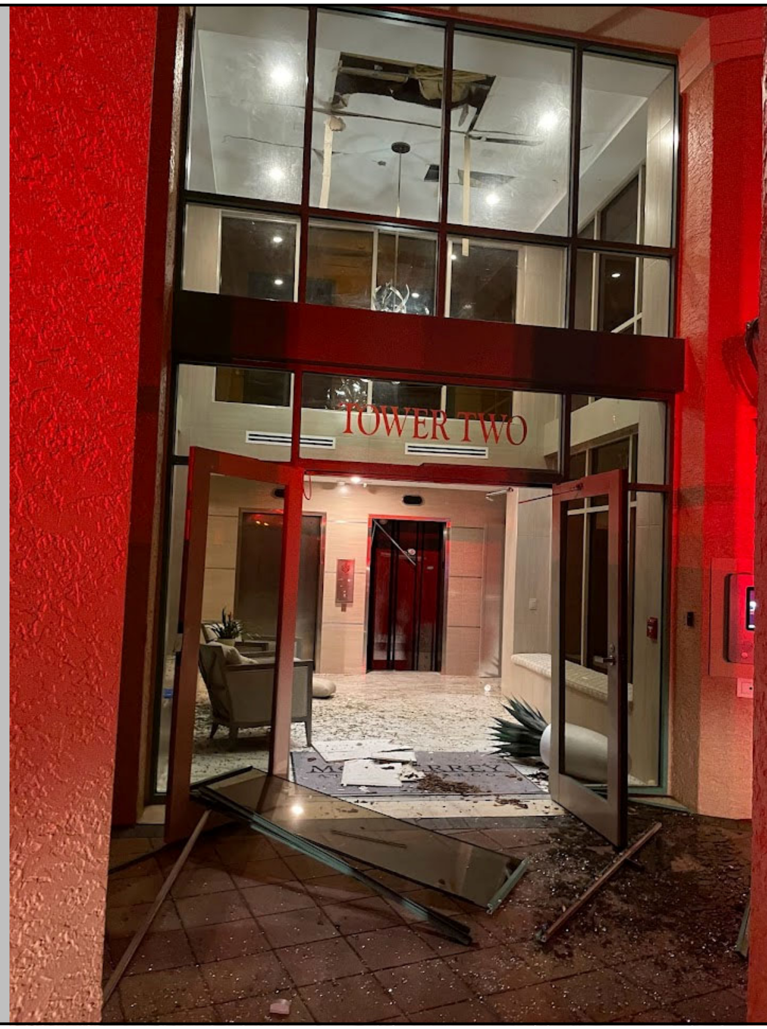
October 16, 2023




TYPICAL FLOOR PLAN LEVELS 5 THRU 17

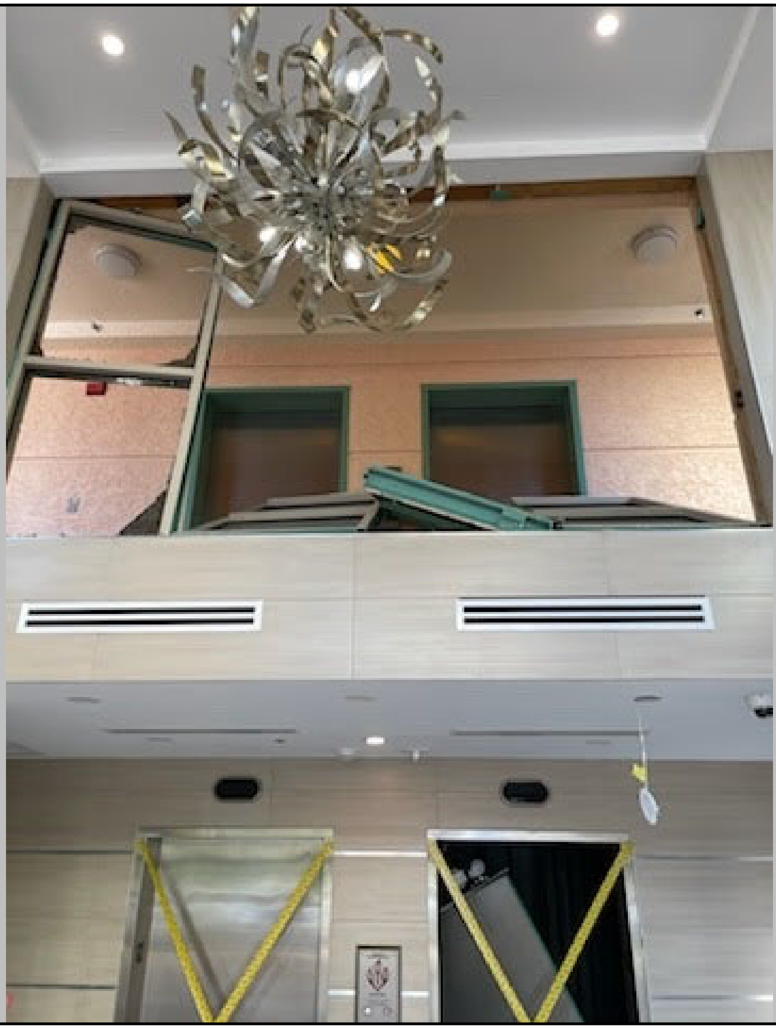



TOWER ONE


TOWER TWO


TOWER TWO


EXIT




EXIT
2
EXIT AT 2


EXIT


1601
1602
1701
1702


MAIN
ELECTRIC


MARCO
ISLAND
CHIEF


MONTERREY
TOWER 3
05 & 06
UNITS

Explosion Investigation Notes on the 10/21/2023 explosion
Monterrey Condominium Building, Marco Island, Florida
By HSM Consulting Fire Investigator Paul M. Haas CFIV

It was reported that on 10/16/2023 at about 2:59 am the Marco Island Fire Rescue and Marco Island Police responded to the Monterrey Condominiums Building for an active fire alarm and a report of an explosion. First to arrive was the Marco Island Police. On arrival the Marco Island Police found smoke in the lobby and the door and lobby window and door glass at the NE corner of the building lobby floor had been blown out. No active fire was present. The Marco Island Fire Rescue Department arrived and with police assistance began to evacuate the building. About 55 residents were present when the incident happened, and they were all evacuated from the building. Firefighters discovered fire and explosion damage in the electrical room located in the east end of the $2^{nd}$ floor lobby. This damage included extensive damage to the main disconnect panel in the electrical room with wall and ceiling explosion overpressure damage. Both state and city officials inspected the building, along with Electric Cooperative who supplied electrical service to the building. At the time of our examination of the building, the building management had obtained a local commercial electrician to come in, inspect the damage, and start repairs.

It was reported that during Hurricane Ian in October of 2022, all of Marco Island was flooded with hurricane storm surge. During Hurricane Ian, the outside transformer and the junction box located to the east of the transformer were covered in storm surge water at that time. It was reported that the building had about 18-inches of water in the building after Hurricane Ian passed. The building was built in about 1996.

Examination of the building exterior:

The Gulf of Mexico beachfront property is in a flood zone (A). The subject east-facing building is a high-rise condominium building containing approximately 20 floors with residential condo units beginning on the 3rd floor. The first floor is mostly parking with the 2nd floor containing the lobby area. The building is post-tension concrete framing. There was no obvious fire, heat, or soot damage on the exterior of the building. There is explosion overpressure damage in the form of overpressure blowout of the plate glass doors and windows on the first floor lobby area with increased outward (interior outward) overpressure door and window damage seen at the east end of the lobby area. There is plywood board-up on the damaged windows and doors. The building is fully protected by an NFPA 72 fire alarm system and an NFPA 13 Automatic fire sprinkler system. Due to the damage, the fire alarm and fire sprinkler systems are down/not functional. The FDC (fire department connection to the sprinkler system) was located at the NE corner of the building. The building receives electrical service from Lee County Electric Cooperative by underground laterals extending from a remote exterior ground pad installed transformer located streetside near the SE corner of the building. Electricians were working to repair that junction box located to the east of the exterior transformer (transformer # T42929) at the time of our examination. The exterior (outside) junction box was found with the box interior coated in carbonaceous soot and the box door warped (bent outward at the midline of the door) due to overpressure from within the box indicating and explosive overpressure even had occurred to cause the box interior soot staining and the box door deformation. No obvious electrical arc damage or signs of abnormal electrical resistance was seen inside the junction box. On the terminal buses within the junction box, there was visible corrosion and oxidation from chronic saltwater exposure. The transformer and the junction box were in close proximity to the Gulf of Mexico beach to the south.

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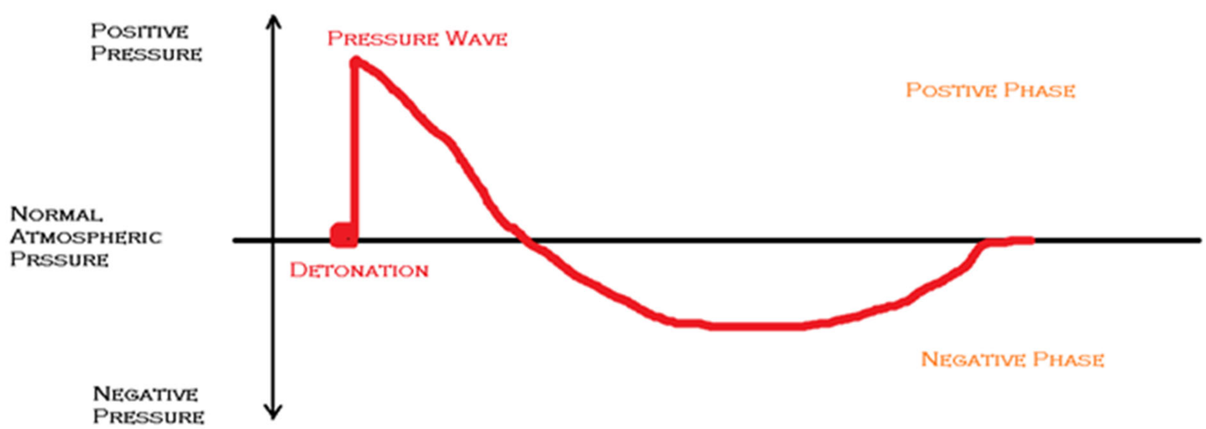
Examination of the building interior:

At the time of our examination electricians were in the 2nd floor electrical room commencing repairs to the electrical system. Examination of the building found all damage is contained to the 1st (parking garage area) and 2nd floors (lobby area) with windows and doors blown outward in the 2nd floor lobby. The drywall ceilings in the 2nd floor lobby and electrical room were displaced by an overpressure event. No obvious fire, heat, or soot damage was encountered until we reached the electrical room. The electrical room was soot-stained from floor to ceiling with soot increased at and around the main (3 of 3) disconnect panel box located on the interior west wall of the electrical room. We found the subject disconnect panel box door outside near the north entrance of the east end of the lobby. The disconnect panel door had been removed to the exterior by the initial fire investigators form the City and State.

Examination of the electrical room found all patterns of soot and overpressure damage to confidently indicate an explosion overpressure of the low order originated within and from the main (3 of 3) disconnect panel box. This included a brief flash fire as the explosive overpressure extended into and out of the panel box.

NFPA 921: 22.3.1 Low-Order Damage states: “Low-order damage is characterized by walls bulged out or laid down, virtually intact, next to the structure. Roofs may be lifted slightly and returned to their approximate original position. Windows may be dislodged, sometimes without glass being broken. Debris produced is generally large and is moved short distances. Low-order damage is produced when the blast load is sufficient to fail structural connections of large surfaces, such as walls or roof, but insufficient to break up larger surfaces and accelerate debris to significant velocities.”




Typical explosion pressure-time history

NFPA 921: 22.8.2 Interpretation of Explosion Damage states: “The explosion damage to structures (low-order and high-order) is related to a number of factors. These include the fuel-to-air ratio, specific gravity of the fuel, turbulence effects, volume of the confining space, location and magnitude of the ignition source, venting, and the characteristic strength of the structure.”

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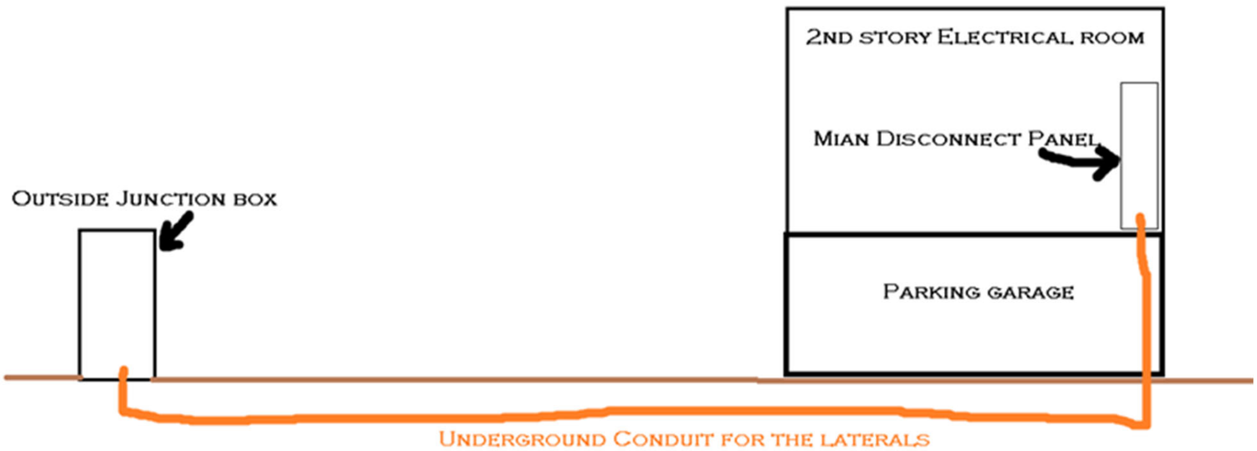
Having discovered 2 separate area of explosion damage, one at the exterior lateral junction box and the other inside the building within the 2nd story electrical room main (3 of 3) breaker panel box, we had to examine and explore if the 2 separate area of explosion damage were connected or not connected. We found the “connection” between those 2 areas was the underground conduit that carried the electrical service laterals from the outside junction box underground to the interior 2nd floor electrical room.




All collected data formulated the hypotheses that the explosive event originated within the underground conduit for the electrical service laterals. All other competing explosion origin hypotheses were confidently disproven. The next phase of the post blast investigation was to see if the cause of the explosion could be determined. Interest and attention were given to the underground lateral conduit connection between the exterior lateral junction box and the interior main disconnect panel box. Examination of the damage areas including the conduit confidently determined that an arc or arc flash event could not have generated sufficient explosive pressures to cause the overpressure and carbonaceous soot staining damage found. Examination of the damaged areas found no obvious signs or evidence that a solid or liquid fuel was involved. We then used the data collected to formulate the hypothesis that hydrogen gas was the fuel. This hypothesis included the findings of the lateral conduit at the exterior junction box were open and about a year ago that exterior junction box was flooded with Hurricane Ian storm surge water from the nearby Gulf of Mexico.

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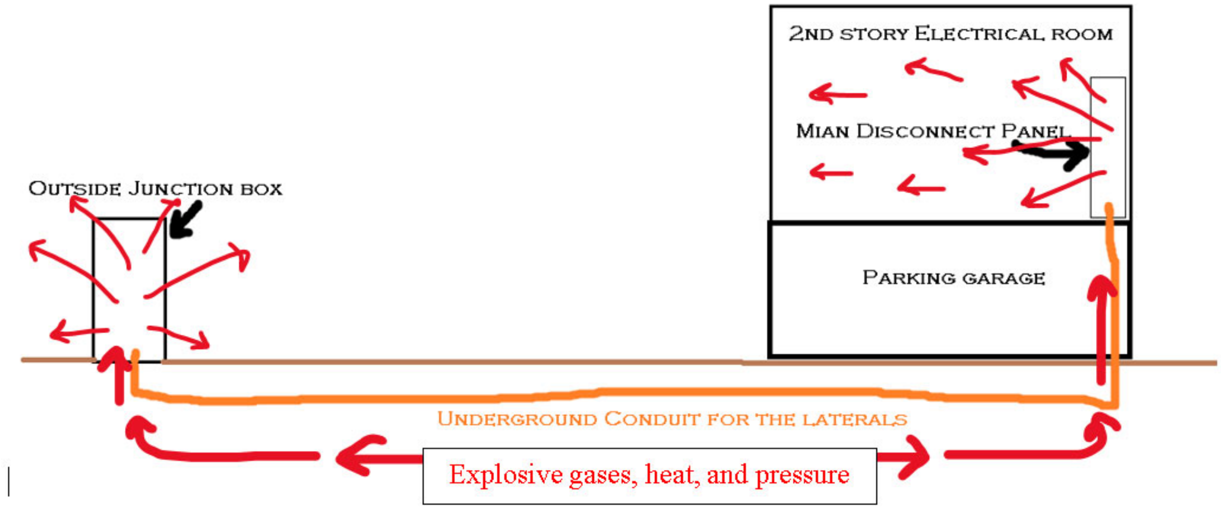


We also, included past data we had collected from a (eerily) similar electrical room fire that occurred in October 2022 in a similar high-rise 20-story condo building located some 24 miles north of the subject Monterrey Condominiums. Although this past condo electrical room arc induced fire was not an explosion, we noted that the arcing originated in the Hurricane Ian storm surge flooded underground service lateral conduit. (this event is still in coverage litigation, so the name of the building cannot be released at this time).

We tested the hypotheses that the explosion was caused by a steam explosion within the underground conduit. That hypothesis was tested and found to be disproven. Steam explosions commonly occur when cool or cold water is rapidly introduced into a superheated dry vessel. This commonly has occurred in boiler explosions when the superheated boiler runs dry, and water is added resulting on the rapid expansion of the water into steam (steam conversion) creating extremely high pressure in containment resulting in the explosive breaching of that containment. A boiler steam explosion occurred off the North Carolina Coast on June 14, 1838, when the packet steamer Polaski's starboard boiler exploded after cold water was added to that superheated dry boiler. Although a novel hypothesis, this could not have occurred here due to the preexistence of water in the lateral conduit. Any water heating would have occurred slower than the expected rapid heating of a steam explosion. Also, the byproducts of combustion (carbonaceous soot) were present in exterior junction box and in the interior main breaker panel. Steam explosions do not produce carbonaceous soot because the event is a rapid conversion of water to steam and not rapid combustion.

NFPA 921: 22.6.3 Boiler and Pressure Vessels. "A boiler explosion often creates a seated explosion because of its high energy, rapid rate of pressure release, and confined area of origin. Boiler and pressure vessel explosions will exhibit effects similar to explosives, though with lesser localized overpressure near the source."

NFPA 921: 22.7.1 Fuel Gases. "Fuel gases, such as commercial natural gas and liquefied petroleum (LP) gases, most often produce non-seated explosions. This is because these gases often are confined in large vessels, such as individual rooms or structures, and their deflagration speeds are subsonic."

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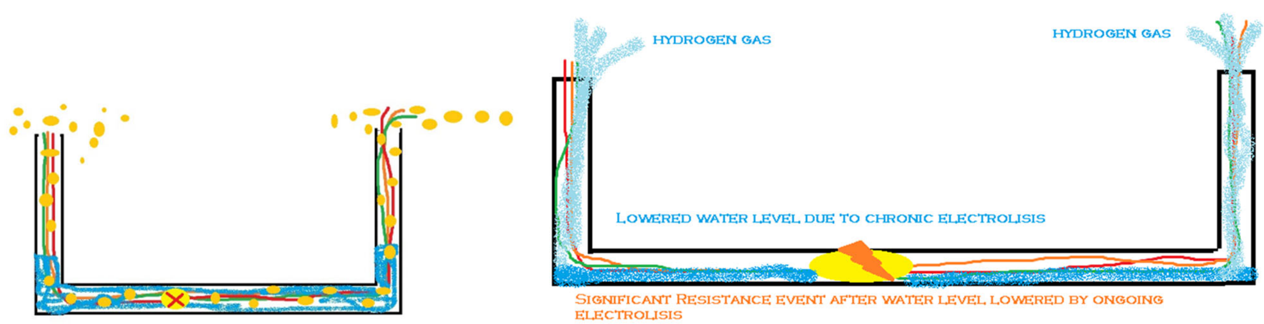
All the collected data formulated a non-disprovable hypothesis that the subject underground service lateral conduit for the Monterrey Condominiums was filled / flooded with last year's Hurricane Ian storm surge. The storm surge water remained in the underground conduit from the 2022 Hurricane Ian storm surge flooding.  The electrical current leakage from preexisting installation damage to the underground lateral cables caused scuffs and or nicks in/on the underground laterals. Those areas of preexisting lateral cable damage were bridged by the conductive salt water.  This bridging of the positive and neutral / grounds of the laterals electrically energized the water trapped in the conduit resulting in electrolysis with is the breaking of the molecular bonds between the hydrogen atoms and oxygen atoms that make up the water (H2O) molecule. Over time, as electrical resistance increased, and the volume of water decreased / reduced due to redux of electrolysis. As water is converted to separate atoms of oxygen and hydrogen the volume of water reduces. When the water level in the conduit decreased due to electrolysis redux process, electrical resistance increased, and an eventual massive electrical resistance event occurred. This also increased the electrolysis process, in turn rapidly increasing the production of hydrogen gas. Bringing together the fuel (liberated hydrogen), oxygen (liberated oxygen), and heat from the increased electrical resistance within the conduit, resulting in the ignition of the hydrogen gas. Like a shotgun or cannon with 2 open barrel ends, the explosive overpressure and explosion byproducts discharge out both open ends of the underground conduit.

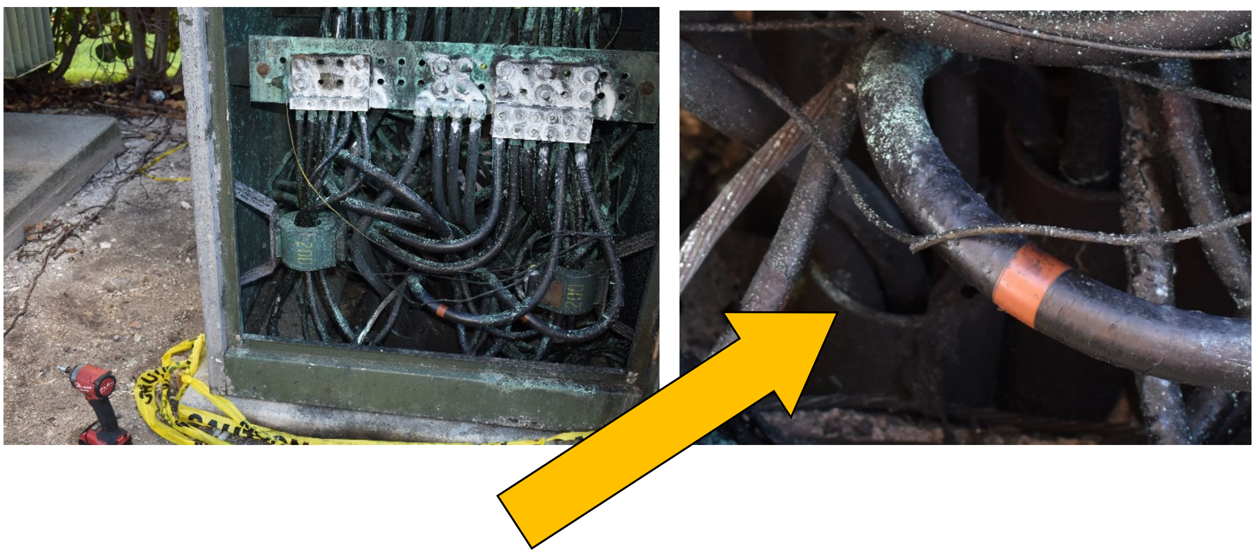



**Slow to rapid electrolysis**

The point of origin of this explosion was confidently determined to be within the underground electrical service lateral conduit.

The cause of the explosion was confidently determined to be the rapid (explosive) ignition of hydrogen gas that was liberated from the flooded underground electrical service lateral conduit after the water in the conduit was electrolyzed by electrical current leaking from the underground service laterals within that conduit.  Over time, as electrical resistance increased, and the volume of water decreased / reduced due to redux of electrolysis. As liquid water was converted to oxygen and hydrogen gas the liquid water volume was reduced. When the water level in the conduit decreased due to electrolysis, electrical resistance increased, and an eventual massive electrical resistance event occurred. The electrolysis process rapidly increased the production and emission of hydrogen gas. Bringing together the fuel (liberated lighter than air hydrogen), oxygen (liberated oxygen plus atmospheric oxygen), and heat from the increased electrical resistance event within the conduit resulted in the ignition of the hydrogen gas. Like a shotgun or cannon with 2 open barrel ends, the explosive overpressure and explosion products discharge out both open ends of the underground conduit.

**Having now encountered 2 similar combustion events, we feel it is of the highest importance to inspect and test an underground conduit that has or was flooded by water. We suggest that any underground lateral that was or has been flooded and possibly filled or contaminated with storm surge water be evaluated for hydrogen gas emission. This can be simply accomplished by using a Hydrogen Leak Detector to evaluate each conduit opening for hydrogen gas emissions.**



Open end of the conduit at the outsdie lateral junction box . This allowed storm surge water to easily enter and flood the underground conduit.

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Interior (3 of 3) Main Disconnect Panel. Note the presence of carbonaceous soot in and around the box.

Additional Notes:

*Hydrogen burns extremely quickly compared to other flammable compounds. The maximum speed of hydrogen combustion is 3.15 meters per second or 9.45 feet per second. Depending on the flammable conditions, pressure, and concentration of hydrogen, a mixture exposed to ignition sources may combust by either deflagration (low order subsonic combustion) or detonation (high order supersonic combustion). High order combustion of hydrogen does not commonly occur in open air environments.*

*Commonly Hydrogen can be explosive at concentrations of 18.3- 59% in normal atmospheric air. (Molkov V. Fundamentals of Hydrogen Safety Engineering, Part I. www.bookboon.com, 2012.)*

*Hydrogen ignited by electrical spark is often 10-times less powerful that hydrogen ignited by a detonator.*

*The chemical formula for water is $H_2O$, which means this water molecule has 3 atoms: 2 atoms of hydrogen (H) and 1 atom of oxygen (O). Using the periodic table of the elements to calculate atomic weights, the hydrogen atoms is 2, and the total weight of the oxygen atoms is 16, equaling a total $H_2O$ (water) molecule atomic weight of 18.*

*We used the term "approximant atomic weight" due to elements atomic weight are often rounded. Example: Hydrogen has an atomic weight of 1.00784 to 1.00811. Oxygen has an atomic weight of 15.99903, to 15.99977.*

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*Pure Water ($H_2O$) has a mass percent 11.11% hydrogen and 88.89% percent oxygen. Keep in mind that most “water” is not pure. Salt water contains sodium and other minor elements. Potable (treated) water often contains chlorine and other elements.*

*Generally, water contains about 11% hydrogen. 100 gallons of water has the potential to produce around 11 gallons of hydrogen.*

*A mole is the amount of a substance (in grams) that is numerically equal to its molecular weight.*

*1 gram = 0.035274 ounces or 0.00220462 pounds*

*When hydrogen is liberated from the $H_2O$ water molecule, the 2 atoms of hydrogen continue to be bonded into $H_2$ which is hydrogen (dihydrogen) gas. $H_2$ (hydrogen gas molecule) has a mass of 2.016 grams.*

*The TNT (Trinitrotoluene) equivalent of hydrogen is 28.65 grams of TNT equals 1 gram of hydrogen. Molkov V. Fundamentals of Hydrogen Safety Engineering, Part I. www.bookboon.com, 2012.*

*The standard hand grenade contained about 0.5 pounds of flaked TNT.*

*Confined Explosions: This type of explosion is seen when the blast occurs within a structure. The incident pressures of the blast wave will be very high and further amplified by reflected waves off the interior surfaces. The pressures reflected within the structure are referred to as shock pressures and are greatly reduced as venting to the outside atmosphere is increased. (TM 5-1300, 1990).*

Having now encountered 2 similar combustion events, we feel it is of the highest importance to inspect and test an underground conduit that has or was flooded by water. We suggest that any underground lateral that was or has been flooded and possibly filled or contaminated with storm surge water be evaluated for hydrogen gas emission. This can be simply accomplished by using a Hydrogen Leak Detector to evaluate each conduit opening for hydrogen gas emissions.

*10/28/2023*

*HSM Consulting*


*Paul M. Haas, IAAI CFI-V, MIAAI, MNFPA*

*Fire Investigator II (fire & post blast), Board Certified Fire Inspector II*

*Private Investigator C/G, Professional Firefighter/EMT/Paramedic*

*Wildland and Timber Consultant, Forestry Appraiser*

*And Consultant, NFPA 150 Technical Committee Member*

*Lifetime Florida Firefighter*