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LPG REFILLING PLANT RESILIENCY

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Venue: DOE Merritt Road, BGC, Taguig
26 June 2018

Definition from **Merriam – Webster Dictionary**

Resiliency or **Resilience** (n.) – 1) the capability or ability to recover from or adjust easily to misfortune or change or calamity.
2) Capability to withstand shock without permanent damage, deformation or rupture

Definition from **Chambers Encyclopedic English Dictionary**

Resiliency or **Resilience** (n.) – being able to deal readily with or recover quickly from different circumstances, unexpected difficulties or conditions

How to Ensure LPG Refilling Plant is SAFE and be Resilient to Natural Calamities

Start from Basics:

1) **Safe Site Location** - Site or choose a location free from faults or unsafe location. If the Refilling Plant is already built on a location or on adjacent area considered prone to tremors or declared as "earthquake zone" be prepared, do engineering works by introducing some mitigating solutions (like if the soil where the tanks are built is soft, loose or sandy reinforced by piling or injecting the soil with mixtures that can solidify) and improved the soil. Strengthen tank foundations, check the design of anchor bolts, repair any sign of cracks or damage to concrete pedestals. If the concrete slab or floor under the tank already showed big cracks or had depressed or uneven surfaces, this mean the ground under the tank had already moved or soil under the slab had been eroded, do the necessary repair. The best alternative is still relocation to a SAFER location. Sad to say, many LPG Refilling Plants constructed many years ago were built without considering or study the geo-physical condition of the location if it is safe in the event of future seismic activity.

   Every Refilling Plant shall determine if its current location is situated on a fault line, or included in an earthquake zone or in a SAFE Zone. Coordinate with regulatory agencies.

How to Ensure the Refilling Plant is SAFE and be Resilient to Natural Calamities

3) **Double Extra Precaution for Sea Plant** -Refilling Plant near the sea or sea shore should be extra and overly cautious since it is vulnerable to "storm surge" in the event of super typhoon just like what happened in Tacloban and "tsunami" in the event of massive deep ocean floor movement or submarine volcanic eruption. Strengthen and reinforced tank foundations. Monitor and ensure anchor bolts are sufficient, not corroded, repair cracked or damaged concrete pedestals. Reinforced and strengthen the wall facing the sea. Rip-rap or concrete the soil outside the perimeter wall to arrest its erosion by tide movements and prevent the wall from collapsing. The steel re-bars of the wall is always susceptible to corrosion and decay due to salty and corrosive sea environment. If possible use galvanized re-bars. The Plant must have an Emergency Procedure and must train its personnel to response in case these calamities occurrence. Must have emergency supply of foods, medical kits and Evacuation Procedure.
4) **Caution for In-land Plant** - In-land Refilling Plant may not be as vulnerable as plant near the seashore but with tanks just installed on "saddle type concrete supports" without anchor bolts or weak anchor bolts due to poor design, is still in danger since any tremor or ground movement it can move or worst dislodge the tank resulting to pull or stress or rupture of fixed pipelines.

How to Ensure the Refilling Plant is SAFE and be Resilient to Natural Calamities

5) **Adherence to mandated National Code, Standards and Local Laws and Regulations**- Refilling Plant must always be designed, engineered and constructed by adhering to the mandatory and mandated requirements of Local and National Regulatory Agencies to National and International Accepted Codes and Standards.
   Follow the National Building Code, Electrical Code and Standard, Fire Code and Environmental Standards. If the existing plant does not conform to these Codes and Standards, make the plant conform to the mandatory requirements.
6) **Proper Design, Engineering and Use of International Accepted Code and Standards for Tanks, Pipelines, Valves, Fittings and other Equipment Sand accessories** -The LPG Storage tank must be fabricated, constructed and built in accordance to Code and Standards like ASME Code Section VIII Div. 1 and 2 for Unfired Pressure Vessels, NFPA 58 - LPGas Code and other similar codes and standards. Always consider the appropriate seismic load, wind load on top of
   other external loads to be considered in designing the tank.
7) **Correct Specification and Materials** -For bulk tank, tank appurtenances, pipelines, valve, fittings always adhere to the correct technical specifications and use the correct and right materials.

How to Ensure the Refilling Plant is SAFE, can Resist or Resilient to Natural Calamities

8) Knowledgeable and Experienced Contractors -Employ only Contractors to construct the LPG Refilling Plant possessing deep knowledge and vast experienced about LPG construction and installation. Hire only PCAB accredited Contractors and with LGU and National license.

IN A REFILLING PLANT AREAS CONSIDERED CRITICAL and HAZARDOUS DUE TO AMOUNT OF PRODUCT PRESENT ARE THE FOLLOWING:

1) LPG TANK AREA

2) LPG REFILLING HALL

3) TLF or TTLR AREA or BULK LOADING GANTRY

4) PUMPS and COMPRESSORS SHED or AREA

5) LPG PIPELINES (LIQUID and VAPOR) depending on length

6) MARINE GETTY (for LPG Import Terminals)

1) TANK AREA FOR ABOVE GROUND TANKS

Above Ground (AG) Tanks (consisting of 4 x 1000M3 or 4 x 500MT)

ABOVE GROUND (AG) TANKS

Above Ground Tanks consisting of (4) x 1000M3 or 4 x 500MT

TANK AREA

Above Ground (AG) Tank with Saddle Support on top of Concrete Pedestal

TANK AREA

Tank Concrete Pedestal (Right Side).

Foundation for bigger tanks uses matt foundation while smaller tanks uses tie-beams. Both needs soil testing prior to construction of foundations. Normally the Foundation is Design to have a Factor of Safety of 5 or more as

TANK AREA

Concrete Pedestal Support (Left Side).

Normally the Foundation of tank is designed to have a Factor of Safety of 5.0 or more as required by DOLE. In the light of possible occurrence in the future of earthquake with a magnitude in the Richter Scale of 7 or more, there is a need to re-study and re-evaluate if the FS currently being used by the Industry is still SAFE or need to be improved.

2) REFILLING HALL

Refilling Area or Hall is the next critical area in terms of product volume. It contained filled cylinders, cylinders being refilled and cylinders to be refilled.

REFILLING HALL

REFIILING HALL must be constructed of rigid strong steel structures (i.e. steel posts, girders, trusses). Refilling Hall must not be constructed of lumber, wood and hollow blocks that are weak to withstand tremors and shaking. Refilling Hall must be provided with ex-proof light and switches and must have an automatic water sprinkler system for fire protection

3) TLF or TTLR AREA or Bulk Loading/Receiving Gantry

Truck Loading Facility of Bulk Loading/ Receiving Gantry is the 3rd critical area. This will happen during product transfer when there is a tank semi-trailer or tank lorry being loaded or discharging for tank receiving.

4) PUMPS and COMPRESSORS AREA

Pumps and Compressors Shed consisting of pumps, compressors and pipe manifolds. The pipe manifolds feeds the inlet of pumps and compressors and receives from the discharge of pumps and compressors going to the refilling Hall or to the return lines back to the Storage tanks.

5) LPG PIPELINES (LIQUID, VAPOR)

The amount of LPG Liquid remaining on pipelines can be substantial especially if the pipelines have long runs from Marine Jetty to Bulk Storage Tanks to Refilling Hall to Bulk Filling Gantry

THERE ARE 3 MAJOR TYPES OF CONSTRUCTION FOR LPG REFILLING PLANT BULK STORAGE TANKS:

1) **Above-Ground Construction** – all parts and appurtenances of tank are above natural grade.

2) **Underground or Buried Construction** – all parts and appurtenances of tank except the manholes are below the natural grade line.

3) **Mounded Construction** – all parts and appurtenances of tank are above natural grade line nut ate covered with sand and soil, except the domes and manholes.

LPG MOUNDED TANK

Mounded Tank is less vulnerable compared to Above Ground Tank when subjected to super typhoon or ocean surge since it is covered under soil and of its lower profile.

ABOVE GROUND TANKS and MOUNDED TANK in one LOCATION

RECOMMENDED STEPS TO MAKE LPG REFILLING PLANT RESILIENT TO NATURAL CALAMITIES

A. **Existing and Current Operating Refilling Plant**

1) Review location of plant if its in danger zone. Refer and study the Mapped geo-physical areas or regions indicated as possible danger area and prone to seismic activities. Verify the seismic activities in area or region for the past 50 years. Do remedial actions and mitigate possible damage if natural calamity will occur.
2) Revisit the design and specifications of bulk storage tanks; cylinder refilling hall; TLF or Bulk L/R gantry; and marine jetty (for refilling plant inside import terminal). Many changes had already occurred since most of the refilling plants in the country were built. Some of the plants had not update or catch-up with current SAFE requirements and practices.
3) Replace mechanical equipment in the plant that are 20-30 years old. These equipment had already served their purpose. Retire them (all mechanical equipment are bound to FAIL, we just don't know when). These old and already obsolete equipment are vulnerable and will the first to FAIL in the event the plant is hit with natural calamity.
4) Conduct assessment, review, evaluation on present conditions of pipelines, valves and fittings and fittings and their supports. Replace corroded, pitted and damaged pipes .
5) Use welded and flanged pipe connections rather than threaded connections.

RECOMMENDED STEPS TO MAKE LPG REFILLING PLANT RESILIENT TO NATURAL CALAMITIES

A. **Existing and Current Operating Refilling Plant (continue)**

6) Strengthen and reinforced foundations of Refilling Plant storage tanks. Give close attention to conditions of anchor bolts, concrete pedestals and foundations.
7) Install ISV with remote emergency shut-down system and thermal actuation on bulk storage tank.
8) Incorporate a seismic valve on the automatic shut-down and isolation of tank in the event of earthquake.
9) Install mechanical and electrical shut-down system to close all emergency valves and electric motors to pumps, compressors and filling scales.
   and will the first to FAIL in the event the plant is hit with natural calamity.
10) Leashed and caged LPG cylinders inside the plant days before coming of typhoon in the area or region as announced by PAGASA.

RECOMMENDED STEPS TO MAKE LPG REFILLING PLANT RESILIENT TO NATURAL CALAMITIES

A. **For New Currently Being Build and Constructed Refilling Plant**

1) Choose carefully the SAFE location for construction of LPG Refilling Plant. Consider the geo-physical condition of location to build the plant. Refer, study and review the map for geo hazard locations prior to decision to build the plant.
2) Design, engineer, construct the plant in accordance to Local and National Codes and Standards, regulations and requirements (i.e. National Building Code; Electrical Code;
3) Fire Code; Environmental Laws, local zoning ordinances, etc.)
4) Fabricate and install LPG Bulk Storage tanks in accordance to International accepted Codes and Standards (such as ASME CODE Section VIII Div. 1 and 2 – Construction of Unfired Pressure Vessels; NFPA 58 –LPGas Code and similar Standards). Always consider the effect of seismic load and wind load on top of other external loads in the design of tanks.
5) Select a knowledgeable and experienced LPG Contractor in the construction and installation of LPG Refilling Plant. Use only PCAB accredited Contractors.
6) For Refilling Plant near the sea or sea shore double or triple the allowance or FS in the design of the plant, tanks and equipment.

THE END

THANK YOU

CONSTRUCTION OF 4775M3 or 500MT MOUNDED TANK

Compacting the Sand Bed For Mounded Tanks

Completed 1 x 4775M3 (2000MT) Mounded Tank with Anti-corrosion Coating

Completed Mounded Tank with Anti-Corrosion Coating

Installation Anti-Rolling Stoppers on both sides of Tank

Construction of Perimeter Wall

Steel Re-Bars for Perimeter Wall

Construction Tunnels for Tank Liquid Withdrawal

Fabrication of Shell Courses

Completed Shell Course Prior to Installation to Tank

Lifting of Completed Fabricated Shell Course

Installation of Cylindrical Shell, Course x Course

Installation of Internal Stiffeners

Installation of Internal Stiffeners

Liquid Withdrawal Nozzle @ Bottom of Tank

Tank Domes with All Nozzles

Fabrication of Hemispherical Head

Fabrication of Hemispherical Head

Installation of Hemi Head to Tank Cylindrical Shell

Completed (2) x 4773M3 or 2000MT Mounded Tanks

Compacting mounding materials between the (2) tanks

Start Mounding of (2) x 4775M3 Mounded Tanks

Compacting for every 1.5M Layer of Mounding

Cleaning and Removal Excess Mounding Sand

THE END

THANK YOU