Booklet

Energy transition for first responders

Nederlands Instituut Publieke Veiligheid

Colofon

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Batteries

Risks

- Toxic and corrosive smoke.
- Risk of explosion: from the smoke / vapor cloud and from rocketering battery cells.
- Electrocution hazard.
- Polluted extinguishing water.
- Pollution of interior spaces by fluorinated substances.
- Thermal runaway.

  This is an important phenomon of incidents involving lithium-ion batteries. The thermal runaway is an uncontrollable chemical decomposition reaction. The reaction creates more heat, allowing the process to sustain itself untill all energy is drained from the battery.

Standard operating procedure

Battery between 0 and 3 kWh:

- Treat as a regular fire.
- Move the battery outside as soon as possible.
- Cool the battery in a bowl / bucket of water (incidation of time: longer than 24 hours).
- Be aware of rocketering battery cells: they can cause secundary fires.
- In case of doubt about the required action: consult the HAZMAT officer.

Battery larger than 3 kWh:

- Treat as a HAZMAT incident.
- Try to shut down the unit or system.
- Create ventilation.
- Apply cooling and consider filling / submerging the object or installation with / in water.
- Do not open doors / hatches: there is a risk of a vapor cloud explosion when opening the doors.

Biomass

Risks

Bio-combustion:

- Risk of fire due to an uncontrolled outflow out of the installation and ignition of smoke by internal or external ignition sources.
- Risk of explosion due to overpressure of hot water or steam boiler.
- Risk of poisioning due to accumulation of water vapor and CO_2.
- Leakage of hot water.

Bio-fermentation:

- Fire, explosion and poisoning hazard due to:
  - accumulation of CO_2 in the installation.
  - an uncontrolled outflow of biogas, harmful pathogens such as bacteria, viruses and parasites or components such as hydrogensulfide (H_2S), CO_2 and ammonia. This outflow can occur in the event of defect, wrong filling, failing of (piping) material of the installation or when working on the pipes.
- Hard to recognize: the smell of biogas is different from natural gas. Moreover, there is no odor component added (yet).

Standard operating procedure

Bio-combustion:

Treat as a regular incident at a combustion plant, like also exists for waste or coal.

Bio-fermentationplant:

- Start HAZMAT procedure in case of leakage of biogas.
- Be aware of a possible leakage of H_2S. This gas is, at low concentrations, recognizable by the odor of rotten eggs.
- If possible: shut down the supply of biogas.
- Try to prevent a rupture or cracking of the membrane as they can cause the uncontrolled release of biogas.
- There may be more victims because they tried to rescue each other and in the rescue attempt became intoxicated.

Electricity

Risks

Electrocution:

- Electrocution by *direct* contact.
  - Touching conductor: a person comes into direct contact with a conductor by grasping it.
  - Spark penetration or spark discharge when approaching a conductor. This occurs only in the domains Transportation and Distribution.
- Electrocution by *indirect* contact.
  - Through a medium: the electric current first flows through a medium, e.g. straight stream, a building component, a tree, etc. to the human body. This occurs particularly in the domains Transportation and Distribution.
  - Via the subsurface/soil: there is a step voltage in the subsurface. If a faulty conductor hits the ground or surface water, a hazardous area forms in the subsoil / surface water.

Pressure wave, shrapnel effect and heat:

- At electrical installations, an explosion with a pressure wave, accompanied by a strong heat development and possibly flying shrapnel can happen. The strength of the pressure wave is related to the electrical power and the nature of the installation.

Standard operating procedure

Domain Transportation (high-voltage grid and cables):

- Installation involved: staging line of 25 meters from outside fence. Do not cross staging line and do not use extinguishing agent towards building or site.
- Installation *not* involved: do not enter building/terrain without direct supervision of the administrator of the installation.
- Transmission power: staging line is fall shadow + 25 meters.
- Powerline: staging line is 25 meters from center of line.

Domain Distribution (regional distribution network):

- Plant involved: staging line of 25 meters from object. Do not cross staging line and do not use extinguishing agent towards building. In case of a rescue attempt, the maximum approach distance of installation is 2.5 meters.
- Plant not involved: do not enter building/terrain without direct supervision of the administrator of the installation.

Domain Use (in homes and buildings):

- Do not touch conductors.
- Straight stream with dry PPE.
- Straight stream is safe from 1/3 of throwing length.
- Grab rescue of energized person possible with dry and complete PPE.

Geothermal

Risks

- Potential environmental damage and personal injury during drilling or well operations and production in the event of an (uncontrolled) outflow of hot and salty water (at 4000 meters, the salty water is about 130 °C).
- Potential environmental damage and personal injury during drilling or well operations and production in the event of an (uncontrolled) outflow of gas or oil.
- Potential occupational safety hazards for employees, passersby and emergency workers due to a blowout of hot water.
- Potential environmental damage and personal injury from an uncontrolled effluent or unsafe discharge.
- Potential environmental damage and personal injury from an uncontrolled outflow of hazardous materials from storage locations (basins, tanks) containing substances intended for cleaning or the collection of wastewater.

Standard operating procedure

- Act as in regular incidents such as gas, chemical, hot water or oil spills.

Carbon dioxide

Risks

- Asphyxiation hazard due to gas formation CO_2.
  When gaseous CO_2 is released, it spreads like an invisible blanket on the ground and can suffocate small pets. At larger quantities or when CO_2 gets into basements or crawl spaces, it can also be lethal to humans.
- Choking hazard from dry ice.
  For transport through pipelines, CO_2 is compressed into supercritical CO_2. Upon release of large quantities of super-critical CO_2 the possibility exists that it may be released in solid form (as dry ice). Dry ice transitions directly at atmospheric pressure into gaseous CO_2 without without becoming liquid beforehand. At large quantities of dry ice, there is a risk of suffocation.
- Pressure wave and flying shards.
  A high-pressure CO_2-pipeline that fails will produce a pressure wave that can be lethal up to three meters from the rupture. Flying shrapnel and debris can cause injuries at 15-20 meters.
- Health damage
  At concentrations of CO_2 of more than 5 vol. % in the air, hypercapnia (excessive CO_2-level in the blood) and acidification of the blood occurs. Even higher concentrations of CO_2 (>10 vol. %) can lead to convulsions, coma and death. Also, prolonged exposure to low concentrations can cause health problems.

Standard operating procedure

- Determine the source area and area affected by the incident.
- If necessary, warn and evacuate the surrounding area.

About gas outflow

- In the event of a *horizontal* gas release following a pipe burst:
  The CO_2 is blown away over a large distance (up to approximately 60 m). Thereafter, the mixed gas disperses further under the influence of the wind.
- In the case of a *vertical* gas outflow after a pipe burst:
  The CO_2 disperses to a great height. During the expansion, it strongly dilutes so that it no longer behaves as a heavy gas.
  As a result, the concentration of CO_2 on the ground is so low that the alert limit will not be reached.
- In the case of a pressureless outflow:
  In the case of a free horizontal outflow of CO_2 it will form a narrow elongated cloud. Moisture in the air condenses; as a result, the cloud is visible as fog. Because CO_2 is heavier than air, in case of a pressureless outflow, pure CO_2 behaves as a heavy gas. As a result, accumulation of CO_2 in lower-lying areas can occur.

LNG: Liquified Natural Gas

Risks

- High Flammability:
  The Lower Explosive Limit of LNG is 5% and the Upper Explosive Limit 15%.
- LNG fire can be possibly invisible and with high heat radiation.
- Risk of explosion if released in confined space (e.g. in parking garages, workshops, gas stations).
- LNG cloud can become suffocating in high concentrations.
- Freezing injury (LNG temperature -162 ºC).
- Cold effects on structural components (becoming brittle, embrittlement).

About LNG

- When heated (> -162°C), the gas is invisible. A white cloud of water vapor is visible. This is dependent on the temperature of the LNG and environmental factors such as outside air temperature and humidity. The visible cloud is not indicative of the degree of potentially explosive atmosphere of the gas.
- The gas is heavier than air. When heated, it mixes with air and rises until the vapor-air mixture is as heavy as air.

Standard operating procedure

- When determining the area affected, take into account the chance of low hanging gas at long range, as LNG heats up and mixes with air.
- When determining the impact area, take into account that the (visible) cloud depends on
  - the temperature of the LNG
  - the temperature of the outside air
  - the humidity of the air.

A visible cloud does not always have to be LNG, but can also be condensation.

Multifuel filling station

Risks

- Domino effect:
  An accident at one installation part can lead to failure of another installation component. Think for example of an above-ground LNG storage tank in the vicinity of an above-ground hydrogen storage tank. Depending on the distance, there is a risk that an incident involving the LNG storage tank due to radiation or pressure will affect the storage tank for hydrogen.
- Interaction between a charging point (e.g. due to sparks) and a flammable gas or flammable vapor (e.g. from gasoline) in case of leakage of this gas or vapor.
- Multiple plant owners at one filling station:
  For example, the owner of an LNG installation has no knowledge of the hydrogen installation.
- The emergency shutdown facility often only works for one plant component:
  Therefore, do not automatically assume that when pressing the emergency stop, the entire installation is secured.

Standard operating procedure

- At multi-fuel filling stations, incidents with different fuel types may occur. The basic principle here is: act in a way that suits the fuel or facility involved in the incident. Please refer to the other pages in this document for the corresponding standard operating procedures.

Hydrogen

Risks

- A high probability of ignition and explosion because of the low ignition energy of hydrogen and its large flammability range.
- Hydrogen is odorless and burns with an invisible flame, which allows a hazardous situation to occur unnoticed. In addition, a hydrogen flame can be closely approached because it has a low radiant heat perpendicular to the flame.
- Hydrogen has a higher energy value per unit of weight than natural gas, so when ignited it can give a more powerful explosion.
- Hydrogen is lighter than air, allowing it to accumulate in enclosed spaces against the ceiling, which leads to a greater likelihood of ignition.

Standard operating procedure

- Start HAZMAT procedure, because it is not known how large the area affected is (consider determining a staging line and stay upwind).
- Do not extinguish a hydrogen fire, but where necessary cool (irradiated) objects.
- Always cool an irradiated hydrogen tank with sufficient water. Avoid contact of water with the Thermal Pressure Relief Device (TPRD; fuse on the relief valve). This will cause the TPRD no longer work, possibly resulting in a pressure build-up and an explosion.
- Always use an explosion hazard meter and a thermal imaging camera to visualize the leakage and/or fire.
- Keep sufficient distance from the object where hydrogen is present because of the risk of blow-off and/or escalation.
    - The distance to be used varies per scenario / installation size; please refer to the SOP of the installation.

Wind turbines

Risks

- Electricity: high voltage and medium voltage.
  This falls under the domain ‘Transport’ in the chapter ‘Electricity’.
- The presence of SF_6-gas (sulfur hexafluoride).
  This gas is present in electrical switches, both in the nacelle and downstairs.
- Working at height / danger of falling.
- Rotating parts.
- Hydraulics in pressure systems.
- Oil or coolant leaks.
- Risk of falling parts (when approaching the turbine).

Standard operating procedure

Fire:

- In case of fire *at the top* of the turbine:
  Allow the fire to burn out in a controlled manner.
- For fire *at the bottom* of the turbine:
  Regular fire fighting, with attention to high voltage.
- In case of falling parts: immediately cordon off the area in a radius of 500 meters.
- Where possible and safe, activate emergency buttons.

Accident:

- Emergency response *at the top* of the turbine:
  - Alert rope rescue team (RRT) via the dispatching center.
  - Intervention by a basic fire brigade unit is not possible: the fire department’s standard fall protection sets are not suitable for intervention in wind turbines.
- Emergency response *at the bottom* of the turbine:
  - Treat this as regular emergency assistance.
  - Have a RRT assist where necessary if the victim is in the basement or can only be reached via a manhole.
- Where possible and safe, activate emergency buttons.

Solar panels

Risks

- Deposition of combustion products from solar panels in downwind area.
- Electrocution hazard and burns.
  In a fire, the insulation of solar panel wiring can melt, putting firefighters at risk of an electric shock. This in turn results in burns, inability to release objects that are currently being held (lock-on), and cardiac arrhythmias. In addition, during offensive firefighting, even after activating the earth leakage circuit breaker, voltage may still be present on the panels.
- Structural collapse hazard during firefighting due to weighting of the roof.
- Blowing away of solar panels, for example due to poor installation or extreme weather, or the slipping of a roof due to fire, may pose hazards to persons.
- Persons or firefighters (during a deployment) falling off the roof due to slippery solar panels or sliding of panels.

Standard operating procedure

- In the event of a fire, extinguishing can always be started, even though the installation is not yet voltage-free.
  The prescribed distances:
  - at least 0.5 meters with a spray jet
  - 1 meter with a straight stream.
    An interrupted extinguishing stream does not conduct electricity: in that case, there is no risk of electrocution.
- Switch off the inverter to (partially) de-energize.
  - This can be done by switching off the relevant group or (groups) and possibly switching off the inverter itself.
  - If present, circuits in the 'string' of solar panels can be switched off.
- For large-scale installations, consult the installation manager or other expert to secure the installation.
- Provide a dry turnout gear and dry PPE when working around a PV system. In that case you are well protected against accidentally touching live parts (up to 1500V DC), even though you are slightly sweaty.

continued on next page

Solar panels (continued)

Standard operating procedure (continued)

- For deliberate actions such as the dismantling of panels or installation parts, use insulated gloves class 0 (1000V AC / 1500V DC).
- In addition, use special toos or suitable cutting pliers for disconnecting the cables. This may be necessary in some situations to create a stop line or reach a fire under the panels.
- Be alert to falling parts as a result of weakening of the installation or roof and on molten metal due to corroded mounting material. Cordon off the danger area.
- For clearing up deposition, contact the municipality and/or the insurance company.

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