

# Good essay on hazard

[Law](#), [Security](#)



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## Question 1

### PCBs

Polychlorinated Biphenyls (PCBs) are chlorinated hydrocarbons with two phenyl rings. They are stable, resistant to fire and possess good insulating properties. Hence, they were used widely before their ban in 1979, in transformers, capacitors, hydraulic machine lubricants, and oil based paints, adhesives, sealants, insulating and caulking material as well as in light ballasts. (US Environmental Protection Agency [USEPA], 2013). EH&S as well as FS personnel would have to handle PCBs when they indulge in building demolition, renovation, decontamination activities or in case of emergencies such as fire and explosion. PCBs present in electrical and building materials pose a serious health hazard to those personnel who have to handle and transport them. In case of fire and explosion, breakdown products of PCBs such as dioxin, carbon monoxide and other chlorinated compounds would also be released into the air along with soot (Jeffery, 2013).

PCBs and its by-products are carcinogenic and their exposure could lead to

chronic effects such as respiratory and gastro-intestinal disorders, immune system, reproductive system and nervous system disorders (USEPA, 2013). Acute impacts include skin pigmentation and eye irritation. EH&S and FS personnel thus need to wear appropriate personal protective equipment (PPE) including safety goggles, suit or overalls of appropriate material, respirators and face masks, gloves, etc. The personnel should be aware of the nature of PCBs and the health hazards it poses on exposure, also he should follow a suitable safe handling procedure and ensure PCB contaminated materials are disposed off as per hazardous waste disposal regulations (Health and Safety Executive [HSE], 1998).

However, in case of accidental splash of PCBs in eyes or skin, it has to be rinsed properly and the EH&S or FS personnel must be removed from the spot to safety immediately. In case of fire or explosion in a facility with sources of PCBs, the FS personnel's turnout gear could also be contaminated due to the suit's porous nature as well as stickiness of soot particles emitted. Thus the gear should be decontaminated before use or discarded appropriately (Jeffery, 2013).

## **Explosion incident in polymer plant**

On 23rd April 2004 Formosa Plastics Corporation, a Polyvinyl Chloride (PVC) manufacturing facility in Illinois exploded killing 5 workers and severely injuring 3 workers. The manufacturing process used was batch mode polymerization of Vinyl chloride monomer (VCM) to PVC resins. VCM is a highly flammable material, a known carcinogen and the explosion was fuelled by VCM (US Chemical Safety and Hazard Investigation Board [CSHIB], 2004).

In the Formosa PVC plant two operators were responsible for ensuring proper working and maintenance of each reactor. A poly operator adds the VCM raw material, initiator, water and emulsifier, and initiates as well as monitors the reaction from the top floor. After one batch process is complete, pressure is vented from the reactor and a blaster operator has to transfer the reactor contents to the stripper by opening a valve. Blaster operator has to then wash the PVC residue in the reactor and empty it through the drain valve. On the day of the incident, one of the reactors in the plant was in working condition, when the blaster operator thought the process was over and tried to open the drain valve for cleaning. He had manually overridden the automatic controls and forced open the valve, this led to pressure drop in the vessel and leakage of VCM, eventually the whole plant exploded leading to severe damage (CSHIB, 2004).

Short-term effects of exposure to air borne VCM include irritation in eyes and respiratory tract, loss of consciousness, and VCM could also inhibit blood clotting. Chronic effects of VCM exposure include damage to the nervous system, liver and kidneys. VCM is also a human carcinogen and inhalation of VCM is associated with a rare form of liver cancer (CSHIB, 2004).

In the Formosa Plastics incident the workers were not prepared for emergency release of VCM and they were not informed of standard safe operating procedures. The blaster operators working at bottom reactor level had no information about the operating condition of the reactor and in this case the operator had bypassed the closure mechanism without informing superiors. A standard safe operating procedure, emergency preparedness, training and appropriate monitoring could have averted this incident.

## **Safety issues with combustion of polymeric materials**

Polymeric compounds and materials pose very high health risk to FS as well as EH&S personnel especially in case of fires or explosions in structures that contain, process or store these materials. Polymers are substances that can undergo vigorous self-reaction and once initiated, the reaction self sustains itself compounding the temperature and pressure effects (Canadian Centre for Occupational Health and Safety [CCOHS], 2004). Explosions and fires are thus common in polymer processing plants. Polymeric materials and composites also change nature of fire and combustion byproducts from structural fires.

Byproducts of polymer combustion can be classified into 3 categories based on their hazardous nature namely irritants, asphyxiates and toxicants.

Irritants include soot, particulate matter and gases released during combustion of polymers. They could cause irritation in eyes, respiratory tract or skin on exposure. Use of protective clothing, gloves and goggles could prevent irritants from affecting the personnel. Asphyxiates such as carbon monoxide released from polymer combustion, reduces oxygen carrying capacity of blood in the exposed person, causes breathlessness and eventually leads to death. If the FS personnel are equipped with respirators, safety mask or self-contained breathing apparatus (SCBA), asphyxiation risk is reduced. However, monitoring proper usage of these PPE is essential to ensure safety of firefighters and EH&S personnel (Zurek, 2012).

Additionally, products of incomplete combustion such as hydrogen cyanide (HCN) and carcinogens such as dioxins are also released from polymer combustion. These toxicants lead to serious health impacts over a period of

time. HCN toxicity leads to brain damage and heart failure. Further, HCN secondary contamination can occur from the victim to a emergency rescuer who was not directly exposed to the fire as HCN absorbed in the body can be released later (Zurek, 2012). Decontaminating PPE and protective gear is also essential to protect FS and EH&S personnel from the secondary effects.

## **Adverse Effects of Radiation**

Radiation exposure leads to several adverse health impacts including short-term impacts such as acute radiation syndrome (ARS), cutaneous radiation injury (CRI) as well as chronic or long-term impacts including cancers, congenital defects in infants due to pre-natal radiation exposure as well as miscarriages. ARS occurs immediately within a short time of exposure to a high dose of radiation and it includes hair loss, headache, nausea and diarrhea. It is usually followed by aftereffects such as seizures and coma. CRI is caused due to skin exposure to radiation and is characterized by skin irritation, reddening and swelling (Centers for Disease Control and Prevention [CDC], 2014).

Radiation levels that cause significant biological injury to humans are measured in terms of Roentgen equivalent man (REM). Acute impacts such as hair loss occur due to exposure to 200 REM and higher levels. However, over a period of time 200 REM could even lead to sterility and completely affect the reproductive system. Rapidly dividing cells in the gastrointestinal tract also get destroyed when radiation levels exceed 200 REM. Even a minimal exposure to 100 REM reduces blood cell count and on long-term exposure it could lead to leukemia and lymphoma. Neurons in brain and heart vessels get damaged when exposure exceeds 1000 REM and beyond

this level, death could occur (Atomicarchive. com, 2015).

The nuclear reactor meltdown in Three Mile Island in 1979 was a major accident. However, radiation released from the incident was only 1/100th of the background radiation in the area. Average radiation dose a person in the nearby area had received due to the incident was only 1 millirem and the maximum dose at the site boundary was only 100 millirem. These radiation levels did not have significant health impacts (USEPA, 2012). Chernobyl nuclear reactor accident was a grave disaster and thyroid cancers are still attributed to the radiation exposure from the incident. Radioactive iodine and cesium were the chief radioactive contaminants released. Firefighters and workers at the plant received radiation dosage ranging from 70 REM to 1340 REM. About 134 people suffered from ARS and 28 of them died (US Nuclear Regulatory Commission [USNRC], 2014).

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