Fire at a transformer plant in Vaasa

Finnish Safety and Chemicals Agency (Tukes)

Description of the event

- Large electrical transformers and reactors are manufactured and tested at Hitachi Energy Finland Oy’s plant in Vaasa, as commissioned by customers.
- Employees were testing a reactor. Similar tests are conducted a few times a month.
- The reactor being tested had been delivered to the test facility in the morning, during which the group’s checklist for the procedure had been completed.
- The test facility solutions require that the tested device is moved as testing progresses.
- In conjunction with each of these transfers, groundings must be disconnected and reconnected.
- The two employees testing the reactor completed the disconnections and reconnections belonging to the test as instructed, with the senior tester preparing a connection plan and instructing the other tester to complete the disconnections and reconnections.
- After the disconnections and reconnections, both testers were in the control room with the customers.

tukes

Description of the event

- When the voltage was increased, the senior tester paid attention to fluctuations in voltage; voltage did not seem to change according to potentiometer adjustments.
- At the same time, the senior tester heard a sound like a “faint thump” through a window that was open in the control room.
- The senior tester quickly started to lower the voltage.
- The tester saw smoke down in the test field.
- The senior tester de-energised the test field and closed the reactor’s oil valve.
- Hand-held extinguishers were insufficient to put out the fire.
- Automatic fire alarm
- When units arrived at the site, no smoke could yet be seen from the outside, which is why the first steps were taken in accordance with the expected alarm incident.

tukes

Description of the event

- When rescue units arrived at the site, no smoke could yet be seen from the outside, which is why the first steps were taken in accordance with the expected alarm incident.
- Exhaust fans fell on testing transformers, breaking their structures => more oil to fuel the fire.
- The roof collapsed, improving visibility and preventing flue gases from igniting.
- The site was guarded afterwards for several weeks; small fires started and structures this time.

tukes

Immediate cause of the accident

- The fire started because the expansion hose for transformer oil failed when its reinforcing wire heated and melted parts of the rubber hose.
- The reinforcing wire heated because one of the grounding cables was probably not connected.
- The device was grounded through the expansion oil hose, and the current heated the reinforcing wire, igniting the hose.
- Oil leaked into the fire from the expansion tank through the damaged hose, causing the fire to spread.

tukes

Technical factors behind the accident

- The device was moved several times during testing so that some groundings had to be disconnected and reconnected. This was necessary because of the test facility's spatial solutions.
- The location of any shut-off valves could not be identified during the investigation, and there was no other safety device in the line to stop the oil leak. As a result, oil leaked gravitationally on the floor from the expansion tank when the expansion hose failed.
- The test involved a reactor whose testing output required during testing is ten times higher compared to a transformer of the same size. As a result, the current flowing through the expansion hose was also higher.
- Exhaust fans falling on transformers, breaking their structures, increased the amount of oil fuelling the fire. This caused the situation to escalate into a large fire.

tukes

Organisational factors behind the accident

- The plant did not have any separate method or system to verify the success of grounding each time the tested device was moved. This allowed testing to be continued, even though grounding was not in place. **The checklist used at the plant was only used when the device was delivered to the test facility.**

- According to employees' statements, the expansion hose, which was assumed as the source of the fire, had been leaking for long. The connection had been tightened, but this only solved the problem temporarily. **Everyone had become used to the dripping oil leak**, and the policy was to empty the drip tray and wipe any oil using rags that were piled on the floor.

- **Risk assessments were mainly conducted from the perspective of occupational safety**, and the plant had no documents that could be regarded as risk assessments for process safety (industrial handling and storage of hazardous chemicals).

Organisational factors behind the accident

- **The plant had two separate maintenance systems, one of which was a system required to monitor maintenance in the group and the other was a system procured for the plant's needs.** The information contained by these systems was not synchronised. In other words, both systems could have contained the same event or repair need, but this could not be verified.

- According to the company's calculations, the ratio fluctuated on both sides of the permit limit. **The general understanding in the company was that activities were close to the limit of minor and large-scale operations and that applying for a permit was not necessary.** The exchange of information about the situation inside the company was not watertight.

Factors behind the accident: Compliance with regulatory requirements

- **Based on the operator's chemical notifications, the rescue department had stated that the amount of hazardous chemicals at the plant requires applying for a chemical safety permit from Tukes** and had notified the operator and Tukes of this situation. At the time of the fire, Tukes had not, however, received any permit application from the operator.

Recommendations

- **Recommendations for technical systems:**
  - The test facility must be designed so that the device does not need to be moved during testing.
  - A system that signals the lack of grounding/prevents testing in the absence of grounding must be deployed.
  - Shut-off valves must be added to pipelines in easily accessible locations; possibly equipped with automatic shut-off after a fire alarm/emergency stop or overflow valves.
  - The functioning of emergency stop buttons in accidents and emergencies must be consistent.
  - The purposefulness of safety-based access restrictions in accidents and emergencies must be consistent and clear.
  - Chemicals that have not been classified as flammable liquids and that may contribute to a fire and thus increase the fire load must be addressed in risk assessments and management.

Recommendations

- **Recommendations related to the organisation:**

  - Safety-critical devices and equipment must be identified, and it must be ensured that they are included in the preventive maintenance programme; a maintenance or replacement interval that prevents failures must be determined.
  - Safety-critical tasks must be identified. To ensure the success of safety-critical tasks, a set of checklists in accordance with each process must be drawn up for the plant in question and for various devices.
  - A procedure must be established for cross-checking electrical connections.
  - A single maintenance system must be used, in which all repair needs must be marked and acknowledged as completed.
  - The amount of chemicals to be handled and stored must be checked regularly, and the impact of any changes in operations must be assessed. The authorities must be notified of any significant changes, or a permit from Tukes must be applied for them.
  - A person familiar with the site must be appointed as a responsible party, who will meet rescue services when they arrive at the accident site. This person must be able to leave behind their other duties and be available to rescue services throughout the situation.

Recommendations

- **Recommendations related to the authorities' actions:**
  - Rescue services must ensure that persons qualified for different tasks are available in the case of alarms. To this end, rescue services must appoint a responsible person to supervise and develop training and management of rescue operations.
  - Rescue services must ensure the sufficiency of instructions and training in the case of severe accidents.
  - The distribution of tasks and the procedure must be specified between Tukes and rescue services if it is noticed that the scope of the handling and storage of hazardous chemicals at the plant has changed.
  - Tukes will assess and define in more detail the content of its communication in the case of an accident.
  - In addition to advice and guidance, the authorities must have straightforward procedures for written administrative decisions issued based on supervision when the authorities require

tukes