CHEMETRON Fire Systems™

CARDOX

CO_2

Application Bulletin

CARBON DIOXIDE FIRE SUPPRESSION —

Diesel Electric Power Plants

The operation of diesel engine driven electric generators can provide continuous electric production for self-contained, isolated power systems; for intermittent power production to supplement other generation (peaking); for emergency power production; or for cogeneration facilities. All these important functions require reliability.

The reason diesel engines are popular for these functions is their reliability. Even so, the risk of fire exists due to the fuels, lubricants and electrics involved, combined with some obvious ignition sources.

The plant location, often isolated with equipment remotely operated, dictates a reliable self-contained fire protection system that, in and of itself, will not contribute to an interruption of power production.

Carbon dioxide (CO_2) is well suited to this purpose. It can provide fast, clean extinguishment, and due to its three-dimensional nature, it will reach a fire otherwise shielded from discharges from other types of systems, such as sprinklers. CO_2 is a nonconductor, and is nondamaging to equipment, hot metal surfaces, and sensitive components. It requires no provisions for water drainage as would be the case with sprinklers. And, if the system is properly designed, it can ensure continuity of protection during any time period required for outside response to the indication of fire.

CO_2 has proven its worth over decades in protecting diesel engines on board ships, where many, many fires have been controlled.

While operation in a ship's engine room or in a stationary power plant are somewhat different, there are enough similarities to demonstrate the need for concern with the following hazards:

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- The Fuel Oil System, when liquid fuels are used. Failure of fuel lines due to engine vibration and resultant metal fatigue can result in 130°F flash point No. 2 fuel oil coming in contact with hot exhaust manifolds. Sheathed piping can reduce, but not eliminate, the hazard.

  When heavy fuel oils are used, the centrifuges employed can be very hot. Failure results in a very smokey fire. Nozzle heaters also present a hazard. (Concern for hazards of auxiliary boilers should also be given).

- Lube Oil Systems. Good engine performance requires good lubrication (bearings and internal engine components). A large quantity of oil is often needed (one particular installation involved a 40MW plant using 12,000 gallons of lube oil.)

  A major bearing is near the turbocharger (combustion air is processed in the compressor/turbine of the turbocharger). In some machines, these turbochargers have been known to operate cherry red, thus offering a prime ignition source.

The drawing accompanying this bulletin illustrates protection at the Engines, the Fuel Oil Day Tank, and the Fuel Oil Processing area, as well as the inside Lube Oil Storage and Lube Oil Processing areas.

Not shown, but also included in a fire risk analysis, would be protection for the electric generator and the electrical switchgear/controls.

Example: At a Midwest nuclear generating station, the emergency generators were diesel-electric units, each installed in its own room. Under test, the generator itself caught fire. While the CO_2 protection system was designed to protect the oil hazards of the engine, the system contained enough CO_2 to handle the generator fire. The generator windings were open to the room, providing access for the CO_2 gas.

If the generator is totally enclosed, some units will have a fitting to allow connection to the CO_2 system to provide internal flooding.

CO_2 SYSTEM ARRANGEMENTS

In what might be called traditional CO_2 protection, the room housing the diesel electric generator would be totally flooded with CO_2 to achieve a fire extinguishing concentration: 34% CO_2 for oil fires, 50% CO_2 for electrical fires. In the many nuclear power plants where the emergency diesel generators are provided with CO_2 fire protection, each generator is in a room well designed for CO_2 flooding. Combustion air is filtered and ducted from outside. Secondary air ventilation can be shut down and ventilation openings dampered or shuttered.

However, in many power plant facilities, the engine-generators are all lined up in a row with the necessary oil equipment installed in the generator room, or mounted on a balcony. Switchgear may be along a wall, or preferably, in a separate, cut-off room. Ideally, the machines and equipment will have dikes/trenches to confine oil spills and limit the hazard.

When this is done, the local application of CO_2, rather than total room flooding, is the practical protection approach. Careful analysis is needed to ensure the entire hazard is included in the CO_2 coverage.

Provision must be included in system design to allow for simultaneous protection of adjacent (interexposing) hazards. Interestingly, some recent (1988) testing by the U.S. Coast Guard called "Localized Extinguishing Tests," bears directly on this subject.

Under USCG Regulations, many, many vessels are equipped with single shot, total flooding CO_2 systems for machinery spaces. In the event of fire at sea, the system is discharged, the fire extinguished, and then the vessel is required to sail to port with no protection. This concerned many.

Therefore, the USCG analyzed reported fires to determine which engine room equipment was most likely to be the location of a fire. This included the diesel engines used for propulsion. The Coast Guard felt a much smaller, localized, directly-applied CO_2 discharge on the machine, backed up by the engine room flooding system, would give the ship operator a good chance for handling the fire and still have protection until the ship got to port. It was established that properly designed local application of CO_2 can do the job.

In the case of a large room in a power plant with engines lined up in a row, the local application of CO_2, resulting in low level flooding, could be the answer to good, cost effective protection. This concept is described in an earlier bulletin covering protection for large nonenclosed gas turbines.

Since the hazard on the engine primarily exists due to hot metal surfaces in close proximity to combustibles, the minimum 30 second local application discharge (see NFPA Standard No. 12) may not be long enough. Extending the discharge to achieve low level flooding to an adequate CO_2 concentration level will be necessary. (Consult the Chemetron Fire Systems Engineering Department for guidance).

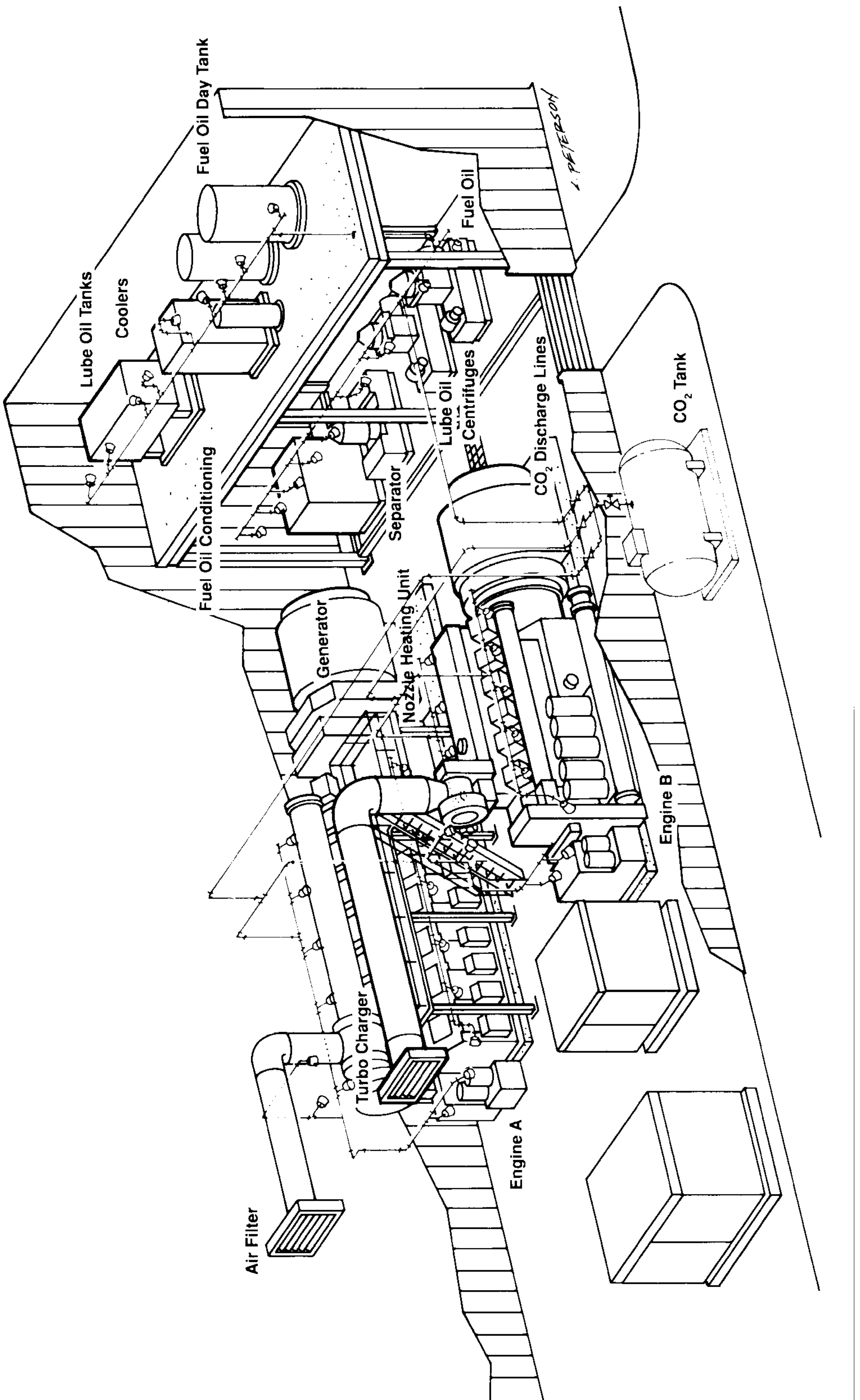
COGENERATION

During a survey period from June 1991 through May 1992, a record number of machines over 1MW capacity were ordered; 40% were for continuous duty service. Orders increased for those using diesel oil. The application to cogeneration was one reason for this growth.

In the operation of a typical engine, 38% of the input energy resulted in the output of electric power generation. 33% was exhaust heat, providing a source of high temperature heat that can be put to good use in a variety of cogeneration applications. Thus, the popularity of such facilities. As dependence grows on the cogeneration facility, so does the need for good, reliable, cost effective fire protection.

Interesting Cogeneration Application: An application story in Diesel and Gas Turbine Worldwide reported on a plant in Barcelona where 3 - 1280 KW engines, driving 1515 KVA, 6 KV, 50 hertz generators, produced exhaust gas which was scrubbed, washed, cooled, and the CO_2 separated. The CO_2 produced was sold, as 2280 Kg/H of CO_2 was recovered. 70% of the power produced went into the power grid, with the CO_2 production (compression/liquefaction) taking most of the rest. The CO_2 was sold to Coca Cola, Pepsi Cola, Cinzano, and others.

Production of your own fire extinguishant - an interesting concept!



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