CHEMETRON Fire Systems™

CARDOX

CARBON DIOXIDE
FM-200®
WATER MIST
ARGONITE®

Application Bulletin

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***FIRE SUPPRESSION FOR —***

# Distributed Power Generation Facilities

## Part 1: Reciprocating Engines

The growth rate of the use of "Distributed Power" continues and is expected to reach the rate of 1500 MW per year by the end of this decade. There has been distributed power generation type equipment in use for years to provide base load power where the facilities served are isolated from a power grid. Examples would be remote locations (Cardox supplied high pressure $CO_2$ systems for several of the diesel power plants serving the various sites operated by the USA in Antarctica in the 1960s) and small islands, where the power requirements are limited.

In addition, distributed power equipment has been used for 'peaking', to provide backup power and to provide combined heat and power requirements for an associated facility.

The growth of distributed power has accelerated over the years as a result of deregulation and legislation permitting tie-in of a distributed power facility to a main power grid. While this power may be more expensive to produce than base load power, its distribution cost is less and its availability increases reliability.

This bulletin is written to give the reader information on what may be required to achieve proper automatic fixed fire protection for critical facilities .

Establishing the need for proper fire protection can involve a number of factors. Usually we have NFPA "Standards," which become a part of the Fire Codes, to establish a reasonable scope of protection. Such is not the case here. The NFPA Standards that apply to this type facility do not mandate any fire suppression requirements. (They do, however, mandate elements of the fire suppression if the decision is made to install same.)

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The determination as to whether or not fixed fire suppression should be provided and, if so, what type, requires a Fire Risk Evaluation. (This is a separate consideration from any insurance related requirements. Its purpose is to ensure continued power availability in case of a fire, not recoverability of dollars for property damage.)

A fire risk evaluation is not a perfectly defined procedure, but rather depends on input from equipment designers and fire protection professionals, operating experience, and past fire experience on similar equipment, all directed at the following factors:

- Will a fire in this equipment/facility put other facilities at risk?
- Is the equipment used a possible fire ignition source if not properly operated or maintained?
- How much and what type combustibles are present? (Flammable gases, flammable/combustible liquids, extensive electrical equipment, cabling, etc.)
- Availability of backup equipment.
- Availability of personnel for fire fighting.

Usually the key questions to be answered by this investigation are:

1. How would the loss of this equipment impact the mission for which it was provided?
2. How can we mitigate this loss?"

The critical nature of a facility generally dictates that it be adequately protected from fire. This means rapid detection, plus prompt suppression until the fire risk is completely abated, using a system that is compatible with operation and maintenance of the protected equipment and offers adequate safety features for personnel.

This bulletin is written to help the reader understand the aspects of this 'proper protection system' where such is to be provided.

National Fire Protection Association Standard #37, "Standard for the Use of Stationary Combustion Engines and Gas Turbines," covers fire related concerns of engines, fuel supplies, lubricating systems, engine exhaust and control. There is a section on fire protection features discussing requirements in general terms. Herein we will discuss potential Chemetron system approaches that meet all the requirements of this Standard and other referenced Standards and which, when properly applied, will be totally compatible with the facility and personnel, as well as meet the objective of "minimum down-time".

Figure 1, a concept drawing of a Diesel Engine Power Package, shows a typical arrangement. Literature describing this type unit indicates that engines in sizes of about 1,600 bhp to 3,800 bhp have from 160 to 300 gallons of lubricating oil. A self-contained (transportable unit) of 1,500 KW is shown to have 1,000 gallons of fuel. That fuel loading, together with a significant amount of other combustibles and obvious potential ignition sources such as malfunctioning or overloaded electrical equipment, hot manifolds or an overheated turbocharger, establishes the potential for fire.

When these key facilities operate unattended, this may in and of itself dictate the need for automatic fixed fire protection.

The proper protection system will contain

- a detection system suitable to the hazards present
- adequate fire suppressing agent in storage, with agent quantities calculated per the appropriate Standards and/or system approval
- a releasing system with manual actuation capability
- an agent distribution system within the protected enclosure(s)
- means to shut down or retard ventilation, shut off fuel flow, alarm personnel, and annunciate system operation.

The concept drawing shows such a system.

## Fire Detection

Once a decision is made to provide protection, a key first step is the selection of the proper type of fire detection required.

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➢ Gas Detection: A leak of flammable or combustible vapors can be detected with a combustible gas detection system. This system can be set to annunciate at multiple levels of gas concentration, i.e., a first level to identify the need for checking and maintenance, and a second level to initiate shutdown and possible inerting for fire prevention. ( If a gaseous agent system is used for fire suppression, see below and paragraph A.11.3.1 of NFPA #37).

➢ Flame Detection: UV/IR Flame Detectors have been used successfully to immediately respond to any open burning in the protected compartments.

➢ Smoke Detection: Where there is a desire to detect early evidence of fire involving electrical equipment, smoke detection is used. Many types of smoke detection are available, providing the opportunity to deal with various types of smoke, sensitivity, cost, etc.

➢ Heat Detection: This is the most commonly used detection type. Chemetron recommends the use of rate-compensated heat actuated detectors, with the spacing as recommended by the manufacturer when the detectors are used for suppression system actuation.

It is possible, even desirable in many cases, to use a combination of detectors. One detector can identify a problem but not necessarily trip a fire suppression system. Whereas, the operation of a second detector will release the fire suppressing agent. Or, one detection system can be used to release the gaseous agent to inert an enclosure for fire/explosion prevention by inerting, while the second detection system will release the system for fire suppression.

## Fire Suppression Agent Selection

Next comes the choice of agent to be used in the suppression system. Chemetron offers the following systems that could be used in this application. A brief discussion of the advantages/disadvantages of each is offered.

➢ Carbon Dioxide ($CO_2$): This is the agent most commonly used as it is readily available, not expensive and has a long history of successful use along with established fire suppression technology. $CO_2$, however, creates a heavier than air concentration in the protected enclosure. The $CO_2$ concentration used is also not life supporting. It is, therefore, important to deal with protecting personnel who might be in the protected space (for maintenance, etc.) and to close, upon system operation, all possible agent leak points through which the $CO_2$ fire suppressing atmosphere can be lost after a discharge. The $CO_2$ concentration is to be held until reignition sources (hot metal surfaces, etc.) have been cooled or removed, or for a minimum 'holding time' of 20 minutes, whichever is longer. See paragraph 11.4.4.1.1 of NFPA #37.

As the required $CO_2$ design concentration creates an atmosphere within the protected space that is substantially heavier than air, it will leak out, by gravity, from all uncloseable openings, making it difficult to meet a holding time requirement without designing for same. This 'holding' is accomplished by providing an extended discharge, which adds gas to make up for that lost by leakage during the required holding time period.

Example System: For an enclosure that is 10 ft wide by 30 ft long by 10 ft high with a flammable or combustible liquid hazard, the system will need 167 lbs of $CO_2$ (2 - 100 lb cylinders) for an initial 'total flooding' discharge, with perhaps 1 or maybe 2 more cylinders required for the extended discharge.

➢ FM-200: This chemical agent can suppress a fire quickly with low concentrations, thus minimizing the space required for agent storage. In spite of its high effectiveness, a drawback is that it is the most expensive agent considered here. As the FM-200 concentration is also heavier than air, its use also requires concern for eliminating potential gas leakage points after a discharge. Thus, a need for an extended discharge exists for FM-200 systems too. In concentrations used, FM-200 is normally compatible with an occupied environment. However, depending on the combustibles present, the required design concentration may come close to or exceed the NOAEL (No adverse effect level). For example: The FM-200 extinguishing concentration for diesel fuel is 6.7%, which, with the required 30% safety factor added, makes the design concentration 8.7% while the NOAEL is given as 9%.

The amount of FM-200 for an 8.7% concentration in our example enclosure (as described above in the $CO_2$ discussion) would be approximately 130 lbs at 70°F and sea level. This would require one (1) cylinder, with another of the same size or smaller for the extended discharge.

It should be noted that FM-200 storage must be kept at temperatures above 32°F in order that the system and its design meet testing laboratory approvals.

➤ Water Mist: Self-contained Water Mist Systems consist of a water tank pressurized by nitrogen to expel the very fine water mist droplets throughout the hazard protected, thus providing fire suppression. The Water Mist system is designed to meet the approval requirements for Machinery Spaces. It requires minimal concern for enclosure integrity and offers little, if any risk, to personnel in the protected space at the time of a discharge. The Water Mist system will occupy slightly more floor space than the FM-200 system and has the obvious disadvantage of wetting down the contents of the protected enclosure when it is operated. (However, the wetting is minimal and these systems have been designed in such a way as to minimize the possibility of thermal distortion of hot metal surfaces.) The Water Mist system cannot be used to inert the protected enclosure; this can only be done with gaseous agents. The Water Mist storage system must be kept from freezing.

Our example enclosure would require a Chemetron 70 gallon Water Mist system that would discharge periodically over a 10 minute time period to ensure fire suppression. (FMRC requirement - see paragraph 11.47 of NFPA #37.)

➤ Argonite (IG55): . This is a blend of 50% Argon with 50% Nitrogen that, when discharged, will suppress a fire in this type hazard with a people compatible concentration. Importantly, an Argonite discharge creates an atmosphere with almost the same density as the surrounding air thus minimizing concerns about leakage from the protected enclosure (over the required holding time.) Thus, the system required will have a single bank of cylinders all discharging at one time ( and within one minute).

The Argonite system would appear to have an edge over the other systems described above for the particular example enclosure that was arbitrarily chosen for this bulletin. It does require 3 cylinders, however. In any case, it was chosen as the system that is illustrated on the drawing herewith.

In systems of this size, the cost differential between the various systems is not great. So the decision as to agent selection is most often based on owner/operator preference, space/weight considerations, logistics of service, and refill and personnel safety concerns rather than initial cost.

Chemetron's Engineering staff is available for consultation concerning the Fire Risk Evaluation as well as evaluating options of protection for a specific type unit or individual installation.

Engineering data sheets are available on each of the system types described above.

## References


- NFPA Standard #12: Carbon Dioxide Extinguishing Systems
- NFPA Standard #2001: Clean Agent Fire Extinguishing Systems
- NFPA Standard #37: Stationary Combustion Engines and Gas Turbines
- NFPA #850: Recommended Practices... Electric Generating Plants

Applica tions Bulletins:

- 0050 - $CO_2$ Fire Protection for Diesel Power Plants
- 0780 - Water Mist Systems for Machinery Spaces
- 0025 - $CO_2$ Fire Protection for Compartmentized Gas Turbines
- 0060 - Water Mist Systems for Compartmentized Gas Turbines

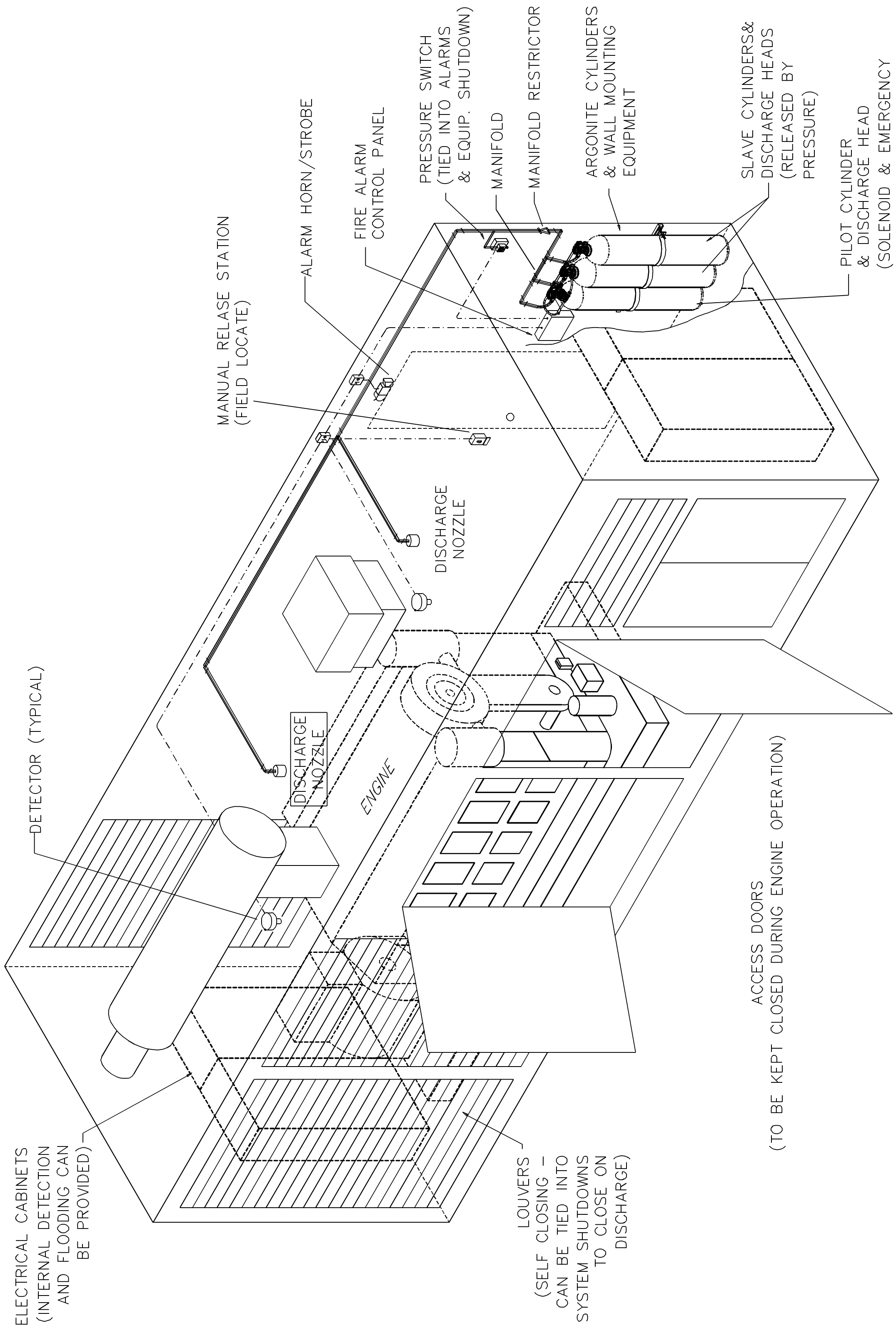


Figure #1 - Distributed Power Generation Facility
(Reciprocating Engine Typical)
ARGONITE FIRE SUPPRESSION SYSTEM