Emergency Generators and Combustion Air

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Emergency electric generators are intended to prevent hazards associated with loss of electric power. In the process, they can create a hazard of their own, specifically by robbing combustion equipment of air needed for combustion. Attention to the design of emergency generator installations can avoid this problem.

A common way to cool emergency generators is by an air-cooled radiator (see Figure 1). The most common way to design such installations is to draw outside air freely through louvers into the mechanical room where the generator is located and then to duct the air from the radiator back outdoors. This, in effect, makes the generator a large exhaust fan. Generators are often located in mechanical rooms along with natural draft (atmospheric burner) boilers and water heaters. In an informal survey of emergency generator installations we have inspected, 5 out of 8 were installed in this manner.

The reason for ducting the hot air supply from the radiator are sound. Without such ducting, the generator risks overheating the mechanical room. In one installation we inspected which was not ducted, the mechanical room consistently overheated each time the generator was run. So large signs have been placed on all doors to the mechanical room, imploring people to leave the doors open when the generator is running. (We assume that the automatic transfer switch is not able to walk over and open the doors!) However, without ductwork from the air intake to the equipment room over to the radiator itself, supply ductwork alone turns the radiator fan into a large exhaust fan as described above.

ASHRAE Standard 62 recognizes the conflict of exhaust fans in mechanical rooms with combustion equipment: "The operation of …exhaust fans may require introduction of additional makeup air to avoid interference with fuel-burning appliances." (ASHRAE Standard 62, section 5.7). As does NFPA 54: "Air requirements for the operation of exhaust fans…shall be considered in determining the adequacy of a space to provide combustion requirements." (NFPA 54, Part 5.3.1 (g)). . Generator manufacturers also know the risk. For example, Onan's Application Manual states "…it is highly recommended that combustion equipment such as the building heating boilers not be located in the same room as the generator set."
The hazards created by such generator installations are real. One client installed a carbon monoxide sensor, and routinely saw it jump from 0 to above 30 PPM when the emergency generator was run for its monthly test. We confirmed the problem using ASHRAE Standard 62's "positive combustion air supply" test (ASHRAE Standard 62, Appendix B). With the generator off, the test passed; with the generator on, it failed.

Simply enlarging the outdoor air opening will not necessarily solve the problem. In the previously described installation, the outdoor air opening was over 10 square feet, and yet the problem still occurred. Even for large openings, the strong exhaust of a generator cooling fan will typically place a mechanical room at negative pressure.

However, there are several viable solutions to this problem (see Figure 2). One option is to duct the air intake, so that the entire air flow is isolated from the indoors. This has the added benefit of avoiding cold drafts in the mechanical room, when the generator is run. Since the generator radiator is now essentially outdoors, it is important that it contain antifreeze.

Another option is to install a remote, air-cooled radiator. This can be located outdoors. It is essentially a fan and a radiator connected by two pipes to the generator located indoors. Again, antifreeze must be used. Also, due to the large amount of fluid, and the temperature extremes to which it is exposed, an expansion tank is advised. Remember that radiator fluid is hot, and so if piping is routed in exposed locations, it should be insulated.

The problem can be altogether avoided by not locating emergency generators in the same room as combustion equipment. Generators can be located outdoors in weather-proof enclosures provided by the manufacturer. Finally, it is also possible to select sealed combustion equipment, again isolating the generator airflow from combustion airflow.

An approach we have observed on one occasion in the field, but which we do not recommend, is to use a water-cooled radiator, essentially using city water to cool the generator and then reject the water to the sewer systems. The use of city water rejected to the sewer in an open system is a waste of resources and will likely be rejected by most local code officials. Also, this approach relies on city water pressure being maintained, even in the event of a power outage. For both reasons, this approach is not advised.

It is important to differentiate between the large amount of outside air required for cooling the generator (approximately 65 CFM per kw, for example 6500 CFM for a typical 100 kw generator), and the smaller amount of outside combustion air required for the generator itself (approximately 3 CFM per kw, or 300 CFM for a 100 kw generator). Our concern is the negative pressure induced by the large amount of air required for generator cooling. However, in avoiding problems relating to generator cooling, one should not forget to allow for combustion air for the generator itself.

As we become more aware of the hazards of carbon monoxide, it is important to be aware of mechanisms which contribute to carbon monoxide being generated as well as to pathways for carbon monoxide to be retained in buildings. Air-cooled emergency generators with ducted supplies to the outdoors create just a situation. Several design options can make this a hazard of the past