Buckeye Power Sales
Reliable Power Professionals Since 1947

Manufacturers offer engine-driven generator systems, from a few kWs to several MWs, in open and enclosed configurations. Open packages are usually installed inside a building or beneath a canopied structure to protect them from the elements. Enclosed generators are generally specified for applications where the generator system is to be installed outside. System designers have to consider airflow in and out of a building when installing an open package inside. For outside installations, manufacturers offer enclosures that are fixed to the base and encapsulate the engine generator package to protect it from the elements. However, when designing an enclosure, the manufacturer had to consider the same airflow requirements for indoor applications.This information sheet discusses the design requirements for generator system enclosures, the different types of enclosures, and airflow issues that can occur when an enclosed generator is installed outside.

1.0 THE INDUSTRY'S DEFINITION OF AN ENCLOSURE

All the major generator manufacturers offer enclosed generator sets for outdoor installations. The industry's definition of a basic enclosure meets the following specification.

1.1 WEATHER PROTECTIVE:

A base enclosure is termed weather protective, not weatherproof. Weather protective protects the inside components from the ingress of average weather events. Should the installation be subject to severe weather, such as snow storms and significant wind events, such as hurricanes, there are additional codes and options to meet these conditions.

Examples of Airflows for Different Enclosed Generator Applications

Figure 1 The affect of structures around generator enclosures.

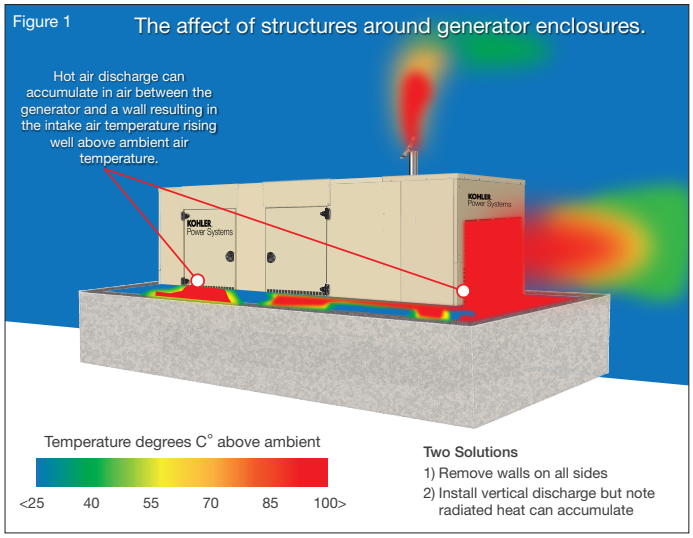


Figure 2 Adverse affect of prevailing wind with vertical discharge

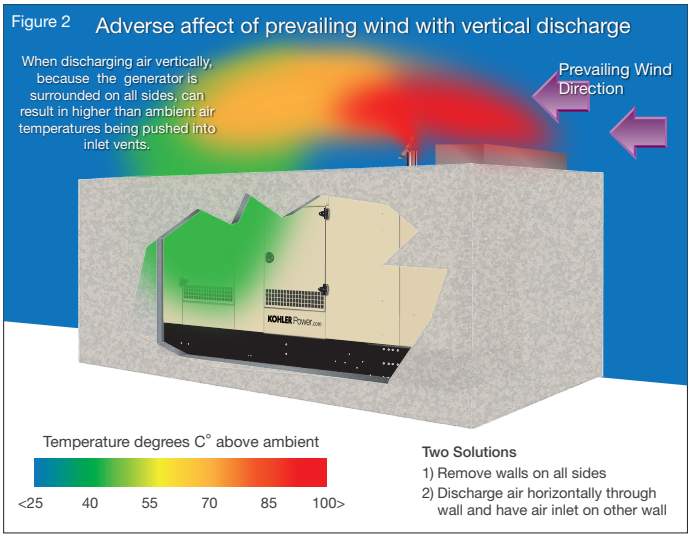
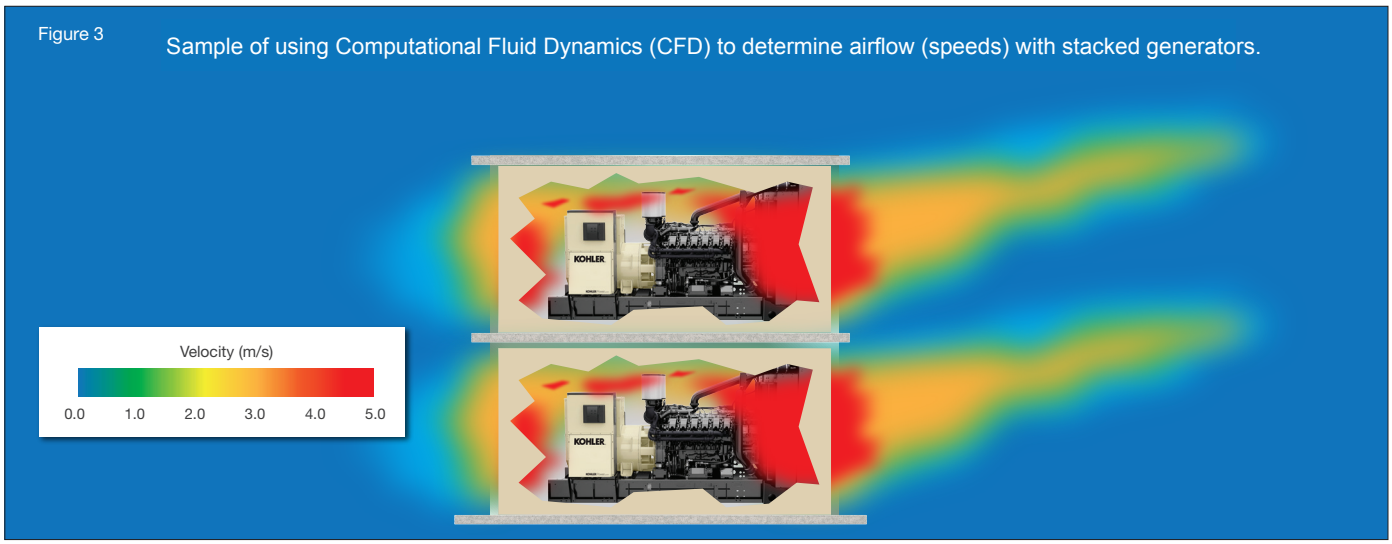


Figure 3 Sample of using Computational Fluid Dynamics (CFD) to determine airflow (speeds) with stacked generators.



1.2 ATTACHMENT AND EQUIPMENT ENCLOSED:

The enclosure is attached to the main base frame of the generator set. Usually, it encloses the engine coupled to the generator, auxiliary equipment, including an engine-mounted radiator, starter battery, generator controls, generator circuit breaker, and all fixtures that make up a complete base-spec generator.

1.3 AUTOMATIC TRANSFER SWITCH (ATS):

Usually, the ATS is mounted inside the facility adjacent to the main power inlet and distribution board.

1.4 EXHAUST AND EXHAUST AFTERTREATMENT:

Sometimes, the exhaust systems are mounted inside the enclosure, and other times above the enclosure.

1.5 SOUND ATTENUATION:

Base weather-protected enclosures usually do not include sound-attenuated material.

2.0 ENCLOSURE DESIGN AND MATERIAL

Generator systems rated to operate at full load to industry standards have engine-mounted or generator-base frame-mounted radiators. Additional features of the enclosure to ensure adequate cooling at full load are:

2.1 VENTILATION:

The canopy will have louvers to allow adequate intake air flow for engine combustion, radiator fan inflow, and alternator fan cooling. At the radiator end, a louvered exit will permit the outflow of air carrying away heat generated in operation.

2.2 MATERIAL:

The canopy is constructed of sheet metal (steel or aluminum) bolted together in sections for the six sides and roof. The panels are bolted together, and the complete assembly is painted for weather

3.0 THE DESIGN OF ENCLOSURE VENTILATION

The industry standard in the US is for a generator to pull a rated full load between 40°C (104°F) and 50°C (122°F). The cooling systems are designed to operate in these ambients, and when enclosed, the canopy design has to allow the correct amount of air in and out. While a generator's rated power output will be reduced as the ambient air temperature increases above 21°C (70°F), the airflow has to be maintained to permit the rated power at the site.

Ventilation aperture sizes our calculated to permit air flow requirements for:

3.1 RADIATOR:

Internal Combustion Engine (ICE) are fitted with radiators through which the engine block coolant water is fed. Also, on larger generator units there is additional air flow requirements for cooling the charge air driven by a turbo charge. Fans are driven mechanically by the engine or electrically.

3.2 GENERATOR:

A shaft-mounted fan that blows cooler air over the generator windings is fitted to the generator.

3.3 REJECTED HEAT:

Several components, including the engine block, exhaust system, alternator frame, and radiator frame, reject heat within a generator system. All this rejected heat has to be ventilated from the canopy

4.0 COMPUTATIONAL FLUID DYNAMICS (CFD)

CFD is a predictive software tool for determining air (or fluid) flow issues. System designers now have predicted software capable of calculating and graphically displaying air flow in multiple scenarios. One particular area CFD assists in is calculating the effect on air flow in very turbulent areas, such as around a radiator fan.

CFD can graphically depict (in color gradients) the effects walls adjacent to the enclosure have on airflow and the influence of prevailing winds (some caused by building shape, not just location) and predict if additional devices such as motorized louvers, exhaust air fans, and air discharge are required. For any generator installation requiring an enclosure, consult with your authorized generator distributor, who has access to CFD technology.

5.0 USING CFD FOR ENCLOSED GENERATOR PLACEMENT

When the manufacturer designs an enclosure to encapsulate a generator, the required ventilation points for incoming and outgoing air are calculated. However, these calculations assume a free, unobstructed area around the generator placement, but this does not always occur in the real world. Generator manufacturers and system designers now have access to CFD software that can predict, even after site deratings for altitude and ambient air intake have been taken into account, restrictions for the following:

5.1 RESTRICTED AIR INTAKE:

A wall, half the generator height, can permit hot air outflow to accumulate and raise air intake well above ambient. See ***figure 1***.

5.2 GENERATOR VERTICAL DISCHARGE WITH PREVAILING WINDS:

When the enclosed generator is surrounded by walls from top to bottom on all sides, the natural solution is to discharge the air vertically. However, using CFD, the effect of prevailing airflow can be determined to ensure hot exhaust air is not pushed down into air inlet vents. See ***figure 2***.

5.3 STACKED GENERATOR INSTALLATIONS:

Some applications, such as data centers, stack generators on top of each other where there is restricted floor space for multiple generator installations. In this situation, calculations have to be made to ensure each unit is not competing for the required airflow and that the required airflow cooling speeds are met. See ***figure 3***.

To fulfill our commitment to be the leading supplier in the power generation industry, the Buckeye Power Sales team ensures they are always up-to-date with the current power industry standards as well as industry trends. As a service, our Information Sheets are circulated on a regular basis to existing and potential power customers to maintain their awareness of changes and developments in standards, codes and technology within the power industry.

Buckeye Power Sales
Reliable Power Professionals Since 1947

CANAL WINCHESTER, OH
8155 Howe Industrial Parkway
Canal Winchester, OH 43110
(614) 751-4515
(866) 889-2628

CINCINNATI, OH
4992 Rialto Road
West Chester, OH 45069
(513) 755-2323
(800) 368-7422

CLEVELAND, OH
8465 Tower Drive
Twinsburg, OH 44087-0394
(330) 425-9165
(800) 966-2825

TOLEDO, OH
27100 Oakmead Dr.
Perrysburg, OH 43551
(855) 638-2728

CHICAGO, IL
1308 Marquette Drive
Romeoville, IL 60446
(630) 914-3000

INDIANAPOLIS, IN
1707 S. Franklin Road
Indianapolis, IN 46239
(317) 271-9661
(800) 632-0339

FORT WAYNE, IN
7525 Maplecrest Road #221
Fort Wayne, IN 46835
(855) 638-2721

USA
ULTIMATE SERVICE ASSOCIATES
A NORTH AMERICAN SITE SERVICES CO.