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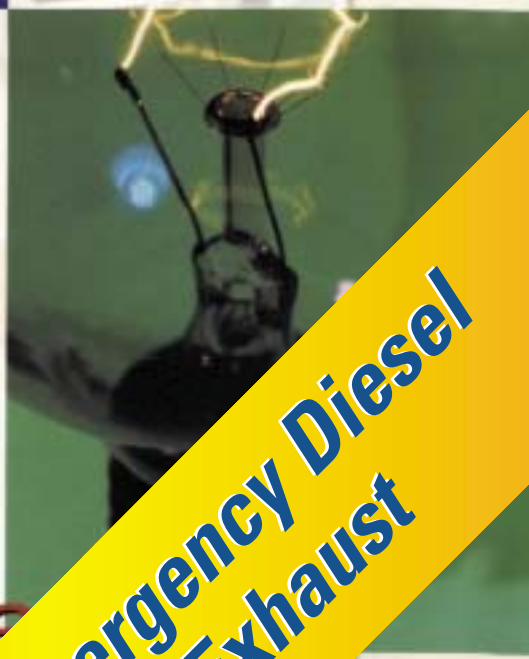

Managing Emergency Diesel Generator Exhaust

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Diesel Generator Exhaust

Managing Emergency Diesel Generator Exhaust for Re-entrainment Prevention, Air Pollution Abatement, and Odor Control

A "good neighbor" policy benefits everyone

By: Paul A. Tetley, Vice President & General Manager, Strobic Air Corp., a subsidiary of Met-Pro Corp., Harleysville, PA

Tri-Stack™ systems at Brick Hospital prevent emergency diesel generator exhaust re-entrainment and eliminate neighborhood odors

Mixed flow impeller fans can prevent diesel generator exhaust and odor from re-entering hospital buildings.

Emergency diesel generators are necessary evils at all hospitals. No one likes to have them around, but they must be available to provide immediate back-up electrical power in case of sudden power failure. Diesel/electric generators must also meet critical performance requirements, but they can also create problems when tested (generally weekly without load and monthly under load).

The two major problems caused by diesel generators include possibilities of re-entraining their exhaust into the hospital's ventilation system (or an adjacent building's), and unpleasant diesel exhaust odors in the neighborhood. To prevent these problems at the Meridian Health System for Brick Hospital in Brick Township, NJ Bill Transue, facilities manager for the hospital sought a unique solution.

The Brick Hospital consists of three linked buildings, totaling 340,000 sq.ft. The original building (South Wing at 125,000 sq.ft.) opened in 1984; the West Wing – 154,000 sq.ft. – was added in 1993; and an additional 16,000 sq.ft. sixth story was added in 2000 to accommodate 32 medical/surgical unit beds. Also in 2000 the ambulatory care building was completed. This is a two-story addition with an interconnecting atrium to the South Wing which contains 44,000 sq.ft. The hospital includes medical/surgical units, operating rooms, an expanded emergency department, radiology, physical therapy, a laboratory, pharmacy, maternity suite, same day medical, cardiology and neurology departments, all serving a growing community.

Exhaust re-entrainment and odor control

Exhaust re-entrainment and odor control at hospitals have become sensitive issues over the past few years. Often, employee complaints have culminated in lawsuits for damages claiming illnesses caused by re-entrained exhaust air from rooftop exhaust fans. Until recently, the most common method for handling diesel generator exhaust was through dedicated centrifugal-type fans with tall exhaust stacks on the building's roof. For the most part this technology did not eliminate re-entrainment or odor problems, since the exhaust stream was subject to a variety of atmospheric conditions. Depending upon wind speed and/or direction, diesel exhaust – and associated odors – went right back into the hospital or to an adjacent building.

Transue said that when the West Wing was completed in 1993, the emergency generator exhaust was being re-entrained into the fresh air intake ventilation system of the building. In an attempt to correct the problem, new ducting was constructed leading to the roof of the existing South Wing. "Even this didn't solve our problem all the time," Transue added, since during some weather conditions the air could not properly absorb or dissipate the exhaust. As a result, it was also re-entrained into the South Wing's ventilation air intakes. "As a matter of fact, when it was relo-

cated, it actually created more of a problem than if it had been left where it was," Transue said. "We were living with that problem for about seven years."

Exhaust dilution and disbursement

In addition, centrifugal fans – which are belt driven – are maintenance-intensive, and the sight of tall exhaust stacks on the roof had negative implications with regard to people in the neighborhood. As a practical alternative, use of mixed flow impeller systems that send a vertical jet plume of exhaust well above the roofline has become popular for this application. The jet plume disburses exhaust pollutants – and odors – high enough into the atmosphere to both meet applicable pollution abatement laws and eliminate odor. These systems work by mixing outside, ambient air with the exhaust gases to effectively dilute the exhaust stream thus preventing re-entrainment into the building's intake air ventilation system, doors, and windows. Exhaust re-entrainment is also prevented from entering adjacent buildings with this technology.

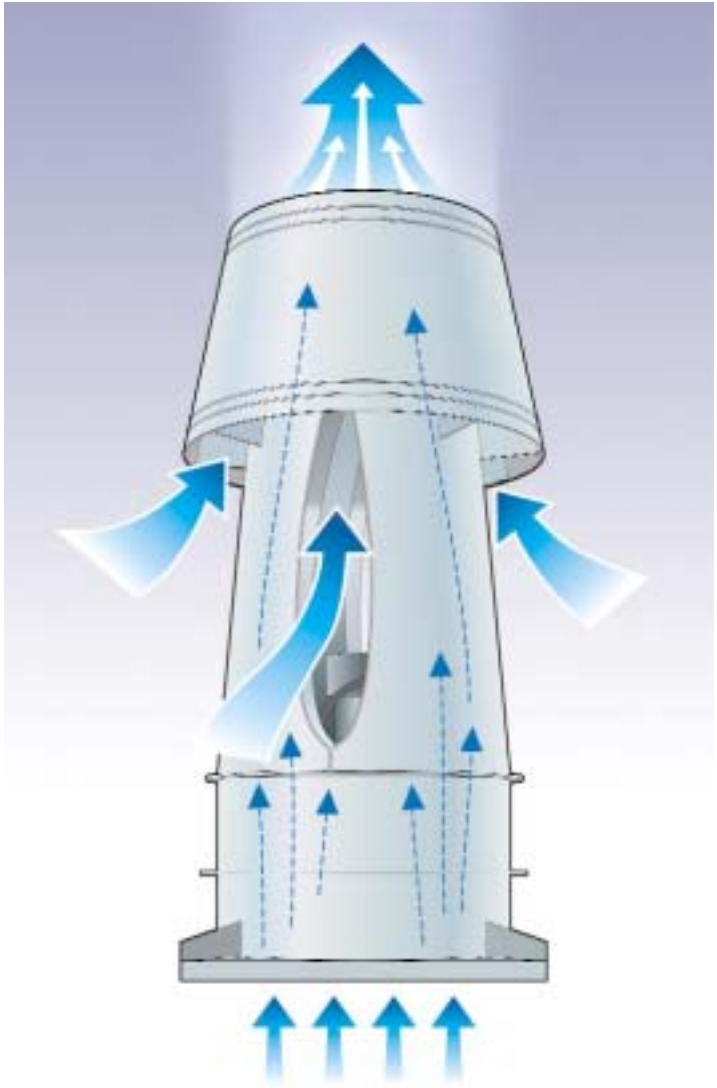
There are two diesel-powered generators at Brick Hospital, one of which is rated at 900 kW (the West Wing) and one at 635kW for the South Wing. To eliminate the re-entrainment problem, Transue contacted Steven J. DiFlora, P.E. at Kallen & Lemelson, consulting engineers in New York City. DiFlora and his associates recommended that mixed flow impeller fans be mounted on the roof to serve the two generators. The fans are rated at 20 hp and 15 hp respectively, with the 20 hp fan operating at about 7600 CFM with flue gases at 840° F which mixed with the ambient air at a 560% dilution ratio, effectively providing about 43,000 CFM total at 186° F. Even with a 10 MPH crosswind, the exhaust stream is projected at a nozzle velocity of over 4,600 FPM rising to a height of approximately 65' above the roofline, thus enabling effective dissipation and preventing possibilities for re-entrainment.

Mixed flow technology offers an efficient solution

Diesel engines are especially sensitive to changes in exhaust system back pressure, and DiFlora recommended mixed flow impeller fans because they have no effect on engine performance yet inherently pressurize engine exhaust gases for more efficient discharge. Mixed flow impeller fans incorporate an integral mixing plenum (see illustration at right) that dilutes the exhaust stream as much as 170% with ambient air. This extremely high efficiency — when combined with the mixing plenums below the roofline — resulted in the extraordinarily high 560% dilution ratio achieved. Dampers on the system also eliminate upstream pressure effects on the diesel engines, therefore preventing backpressure problems that would ordinarily reduce generator power output.

In configuring this system, Kallen & Lemelson terminated the existing flue pipes on the roofs of the South and West Wings, intercepting them and forming new transition sections to connect to the fans. A minimal amount of reinforcing steel was added to the building's roof framing structure. Each fan was bolted to its curb, and each curb was bolted through the roof to the supplementary support steel. Because the fans are precisely balanced and use direct drive motors, there was no need for additional vibration isolation. Transue said, "The fans operated smoothly with no sensation of vibration below in the occupied spaces. And from an aesthetic standpoint, these fans are barely noticeable from the surrounding area. Thanks to their capabilities, there was no need for any tall flues or stacks," he concluded. FC

Paul A. Tetley
Strobic air Corp.



Mixed flow technology offers many performance and cost advantages.

Mixed flow impeller-type roof exhaust systems operate on a unique principle of diluting outside air with plenum exhaust air at high discharge velocities, sending a powerful vertical exhaust plume up to 350' high.

Because they introduce up to 170% of free outside air into the exhaust stream, a substantially greater airflow is possible for a given amount of exhaust without additional horsepower, providing excellent dilution capabilities and greater effective stack heights over conventional centrifugal fans.

These systems also reduce noise, use less energy, and provide enhanced performance with faster payback over conventional centrifugal laboratory fume hood exhaust systems, with typical energy reduction of $.44 per cfm at $.10/kilowatt-hour, thus providing an approximate two year R.O.I. Energy consumption is about 25% lower than with conventional centrifugal fans, with substantially reduced noise levels, particularly in the lower octave bands. They conform to all applicable laboratory ventilation standards of ANSI/AIHI Z9.5 as well as ASHRAE 110 and NFPA 45, and are listed with Underwriters Laboratory under UL 705.

The systems are designed to operate continuously without maintenance for years under normal conditions; direct drive motors have lifetimes of 200,000-hours. Non-stall characteristics of the system's mixed flow wheels permit variable frequency drives to be used for added variable air volume (VAV) savings, built-in redundancy, and design flexibility.

Virtually maintenance free operation (there are no belts, elbows, flex connectors, or spring vibration isolators to maintain) eliminate the need for expensive penthouses to protect maintenance personnel under adverse conditions. Consequently, additional savings of several hundreds of thousands of dollars are realized in a typical installation.

Mixed flow impeller systems are available with a variety of accessories that add value, reduce noise, or lower energy costs substantially. For example, accessory heat exchanger glycol/water filled coils for use in 100% conditioned makeup air facilities add exhaust heat to intake ventilation air to save thousands (or hundreds of thousands) of dollars in energy costs.

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