# Coen Burners Help Reduce Energy Costs with Landfill Gas

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## ABSTRACT:

Landfill gas is collected from the White Street Municipal Sanitary Landfill in Greensboro, North Carolina. This gas is transported by pipeline to the nearby Cone Mills White Oak Plant were it is burned in a boiler retrofitted with two Coen Interzone Scroll burners to generate process and heating steam. The operation started in December, 1996 and by early 1997 sufficient gas was available to generate 30,000 lb/hr of 350 psig saturated steam on a continuous basis.

The burners can also co-fire with either natural gas or heavy fuel oil. The design capacity of the boiler is 70,000 lb/hr. All expectations have been met, and it is hoped to double the capacity of the landfill gas production in the near future.

## INTRODUCTION:

In 1995, the City of Greensboro approached Duke Power Company, the local utility company, to pursue a strategy to convert landfill gas (LFG) to energy. Duke Engineering & Services (DE&S), a division of Duke Power, now known as Duke Energy, was engaged to analyze the idea. During the course of the study, Cone Mills was looking for ways to reduce their energy costs which created an opportunity to use this LFG in their boiler house.

Since the avoided cost payable by a utility in the Southeast for electricity is low compared to other parts of the country, using LFG to generate steam in an existing boiler was quickly identified as a cost effective way to proceed. In addition, the City was happy to have LFG emissions mitigated while collecting some royalty; Cone

Mills would receive a clean source of energy that would be competitive with their cost for coal; and DE&S would build the necessary collection and pipeline equipment and sell the gas to Cone Mills for a price that would pay for the capital investment in an acceptable time period.

DE&S for financial reasons wanted to use a blower for collecting and transporting gas as opposed to using a more costly compressor arrangement. The maximum pressure from the blower was anticipated to be about 12 psig with the full flow pressure delivered upstream of the boiler control valve approximately 4 psig. Cone Mills decided to dedicate one of their four boilers to the project, a Heine boiler that was installed in 1927.

Since they no longer produce their own electricity, they normally run only one or two boilers with an additional boiler as hot back-up. The chosen boiler, originally designed for burning coal, now burns either natural gas or fuel oil. Cone Mills wanted to retain gas and oil firing capability independently or as cofiring with future LFG. Their specifications for utility support and instrumentation also had to be met.

To properly burn this low Btu fuel at low pressure, while maintaining the capability of burning natural gas and oil, a special type burner was called for. The COEN Interzone Scroll type burner was chosen because of its proven usage in this type of application. As part of the financial agreements made to move the project ahead, Cone Mills allowed DE&S to replace their existing burner at no charge in return for an agreement to burn all of the LFG that could be produced up to the capacity of the boiler.

## HISTORY:

When solid waste decomposes, it generates LFG for about 30 years, composed of approximately 50 percent methane and 50 percent carbon dioxide. Uncontrolled, this gas escapes into the environment causing ozone depletion, air quality problems, odor and other hazards. Landfills are the largest source of anthropogenic methane emissions in the U.S. constituting 40% of these emissions each year. Methane is a troublesome greenhouse gas that is 25 times more effective at trapping radiation in the atmosphere than carbon dioxide. Recovery and use of this LFG for energy projects will substantially reduce these emissions.

**Figure 1, Blower Skid**

The Environmental Protection Agency (EPA) estimates that 750 landfills could economically recover the LFG for energy. Currently, there are 150 LFG to energy sites operating in the U.S. LFG management systems can be as simple as a gas collection system, comprised of a series of vertical wells and horizontal collection pipes that collect the gas which naturally forms in landfills. This gas may then be flared, or burned, to prevent it from escaping into the atmosphere or collecting in confined spaces to form explosive pockets. More complex systems could convert the collected gas to energy through systems such as a boiler to produce steam, or a gas fired turbine or engine/generator set to produce electrical power.

## SYSTEM DESIGN:

**Collection**
Gas collection is achieved through a system of vertical wells distributed throughout the landfill, and connected together by a piping network. The wells are spaced so as to maximize their collection potential and the depth of each well varies by location. Each well is essentially a cylinder, 30 to 36 inches in diameter, containing a 6 inch diameter PVC pipe, which is incased in a layer of crushed stone, then bentonite, and finally soil back-fill material.

The wellhead consists of a tee with one leg connected to a flexible joint, one serving as the cap, and the third leg extending down into the well bore pipe through a slip joint complete with O-rings, allowing for settlement. Attached to the flexible joint is an isolation valve and from there, the well is tied into the collection header feeding the blower system. The cap holds a temperature probe and a sample port.

**Transport**
Transport of the gas from the landfill to the end user is achieved by a blower located on the landfill. Prior to entering the blower the gas passes through a condensate trap and a condensate knockout pot where most of the moisture is removed. Additional condensate traps are located throughout the system. The blower can send in excess of 2,000,000 scfd at a discharge pressure of 12 psig, through the three mile transport line.

LFG Specialties Inc. provided the blower skid which includes the blower and motor, knockout pot, connecting piping, valves, and controls, all mounted on a common base with space allowed for a future or backup blower (See Fig. No. 1). Also in LFG Specialties' scope was the flare which is ignited only when the end user is unable to use the gas.

The underground transmission line is made of high density polyethylene (HDPE) except for the first few hundred feet leaving the blower, at stream crossings, and at railroad crossings, where it is steel. Located at low points along the route are condensate traps ensuring that no significant amounts of liquid accumulate in the pipeline.

**Fuel Train and Controls**
After the fuel transport line enters the powerhouse at Cone Mills and passes through the final knockout drum, it makes a short run over to the burner elevation at the Unit 1 boiler. This section contains the fuel train components for safe operation including a Maxon main safety shutoff valve, Fisher main gas and minimum flow control valves, and ITT Skotch Trifecta burner gas safety shutoff valves. The control system was upgraded as part of the overall project to a fully metered system using Bailey unitized controllers, and are set up to allow the Coen burner to fire multiple fuel combinations.

**Burner**
Two Coen Interzone Scroll burners are mounted on a 1927 Hiene, field erected, brick set boiler (See Fig. No. 2). The existing Flame Safeguard System and fans were reused. Coen provided two registers to be mounted in a modified, existing wind box, replacing two gas/oil/pulverized coal burners. Pulverized coal had not been in service for some time on this unit although it is currently fired in all the other plant's boilers. The Coen Burners are set up to fire multiple fuel combinations with 400 °F preheated air. LFG is not available in sufficient quantities, at this time, to fire over 30,000 PPH. The remainder of boiler load is made up with natural gas or #6 oil. Turn down on LFG has been demonstrated over 8:1.

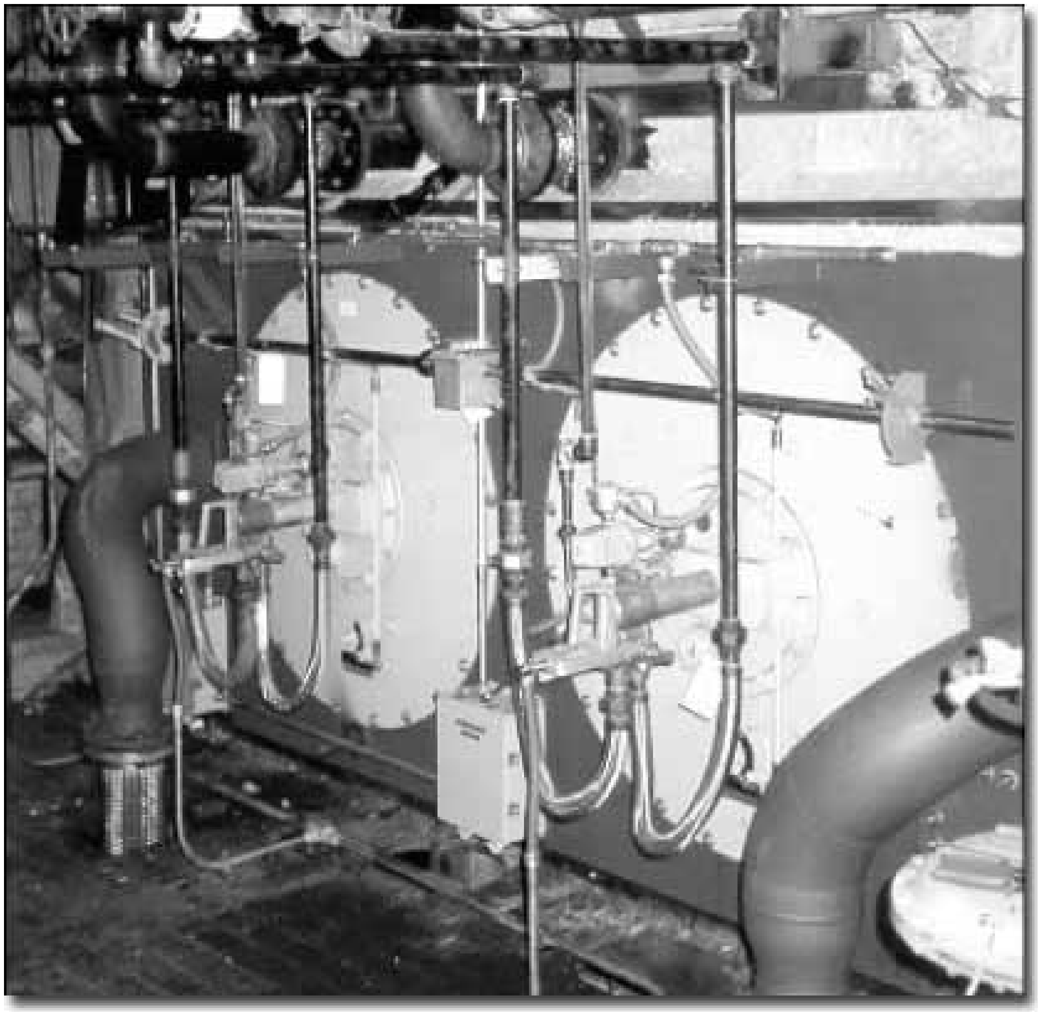

**Figure 2, Two Coen Burners on a Heine Boiler**

The Coen Interzone Scroll type burner is uniquely designed to handle problems of low Btu gas combustion. The low heating value means that higher volumes of gas are required for the same heat release as conventional fuels like natural gas. Since LFG is normally available at low supply pressures, the problem is compounded. Particulate contamination is another factor that can clog typical gas spuds or ring type burners. The LFG is introduced into a large scroll type annulus situated between two counter rotating streams of combustion air (See Fig. No. 3).

The ability of the Interzone Scroll type burner to pass large volumes of gas with a very a low pressure drop means that expensive gas boosters or compressors are not required. Not only is the capital cost of high pressure equipment and piping avoided, but the operating cost is also reduced. Typically, PVC type pipelines can be utilized for transport rather than expensive steel. The large openings in the gas scroll allow passage of particles that are sometimes found in LFG. These particles can clog normal spud or ring type burners with small orifices resulting in frequent need for shutdown and cleaning. The mixing action of the two counter rotating air streams surrounding the Interzone Scroll provides extremely stable combustion throughout a wide turndown range. This eliminates the need for any supplementary pilot fuel or sustaining burner. If the LFG supply is interrupted, however, the burner is designed to fire standby natural gas or oil to prevent any interruption in the user's process.

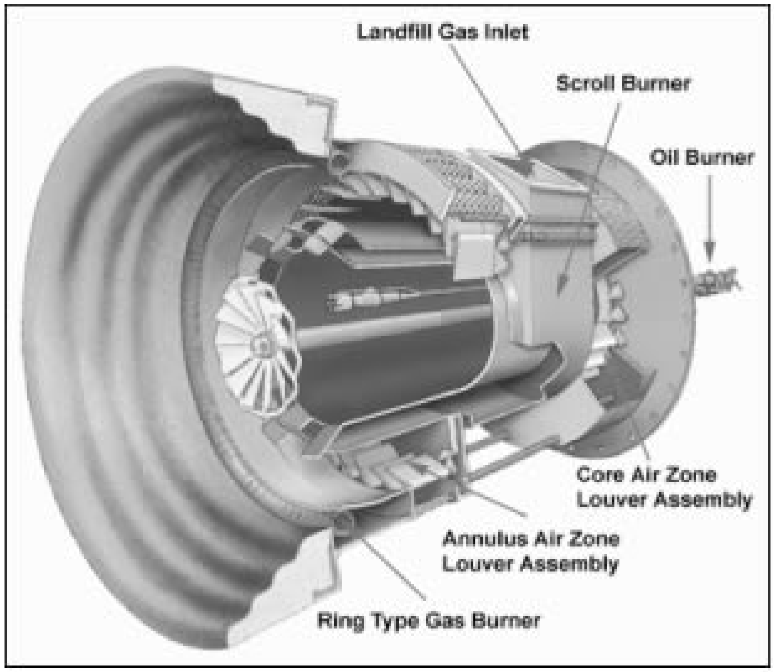


**Figure 3, Coen DAZ Scroll Burner**

## SAFETY, EMISSIONS AND REGULATIONS:

LFG is produced via biological decomposition of the organic fractions of refuse. One pound of refuse can produce about 3.6 standard cubic feet of LFG. The resultant "fuel" is classified as a medium Btu gas with a higher heating value of about 350 to 500 Btu/lb. A typical composition is 42% $CH_4$, 35% $CO_2$, 3% $O_2$, 15%$N_2$, and 5% $H_2O$. Adiabatic flame temperature is about 3000°F. Because LFG is typically called a waste fuel it has the distinction of being associated with many other waste fuels that are hazardous, polluting, and unsafe to burn. In reality, just the opposite is true.

**Safety**
LFG is a very safe fuel and can be easily burned in Coen's Interzone type scroll burner without any supporting or stabilizing fuel. The flame is very stable without any danger of flameout or instability even at very low firing rates. LFG is just as easy and safe to burn as natural gas.

LFG is inherently a low polluting fuel for NOx, CO and HC. NOx formation is aggravated by high flame temperatures. Since the flame temperature of landfill is low, the resultant NOx emissions are also low. In fact, they are approximately 70% less than natural gas. However, the flame temperature is not so low as to cause HC or CO emissions. Strict emission limits have been achieved using LFG as the primary fuel.

NOx emissions can be as low as 22 ppm. CO, and HC's have been measured at less than 5 PPM. Thermal destruction efficiency of 99.99% has been obtained. Thus, the fuel is environmentally friendly and naturally produces low NOx with low CO, HC's and VOC's.

The environmental benefits of utilizing LFG as a fuel are large. Venting of LFG is estimated to be the largest manmade emission source of methane. Methane is a greenhouse gas that has 25 times the warming effect of carbon dioxide. Industries like Cone Mills benefit the environment by utilizing LFG which would otherwise be vented to the atmosphere. The use of LFG also displaces other fuels such as natural gas and fuel oil which have much higher emissions.

**Regulations**

The Clean Air Act (CAA) regulations for municipal solid waste landfills was promulgated March 12, 1996 and will increase the number of sites that have to collect and control LFG emissions. Of the new sites being constructed over the next five years, 45 sites are estimated to be subject to the legislation. Of the existing landfills, nearly 300 are estimated to be required to install gas extraction and control systems.

While environmentally friendly, many local Air Quality Management Districts impose strict limits on emissions and treat LFG as a hazardous waste fuel. However the Code of Federal Regulations (CFR-40) part 266 subpart h, Hazardous waste burned in boilers and industrial furnaces; states "The following hazardous wastes and facilities are not subject to regulations . . . . Gas recovered from solid waste landfills when such gas is burned for energy recovery."

Pending legislation by the US Congress on the deregulation of electrical utilities should allow LFG facilities to sell electricity directly to end users. Congress is considering a law requiring large electrical utilities to purchase a specified minimum percentage of renewable power. LFG is considered a renewable fuel source. The IRS section 29 tax credits are also available to landfill owners and they help provide the economic incentive for many otherwise marginal projects.

DE&S is responding to these new regulations by helping landfill owners turn their liabilities into renewable, non-polluting energy sources. For the City of Greensboro's (NC) White Street Landfill, DE&S developed, constructed and installed a state-of-the-art gas collection system to capture LFG. DE&S operates the gas collection system and the City of Greensboro receives a percentage of the sale of the gas, which is delivered to Cone Mills' nearby textile plant. The gas provides an alternative source of fuel for the textile plant's boiler, which produces process steam. When this boiler is not operating, a flare system, serving as a backup, destroys the LFG and prevents the gases from escaping into the atmosphere.

## AWARDS:

This project has won the Duke Energy "Osprey Award for Environmental Excellence" given internally within Duke Energy for "outstanding achievement in applying the environmental leadership principles." In addition to the Osprey Award, the Greensboro project won the Duke Energy Power Partners Award, and is a candidate for the Greensboro Area Chamber of Commerce Environmental Stewardship Award.

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