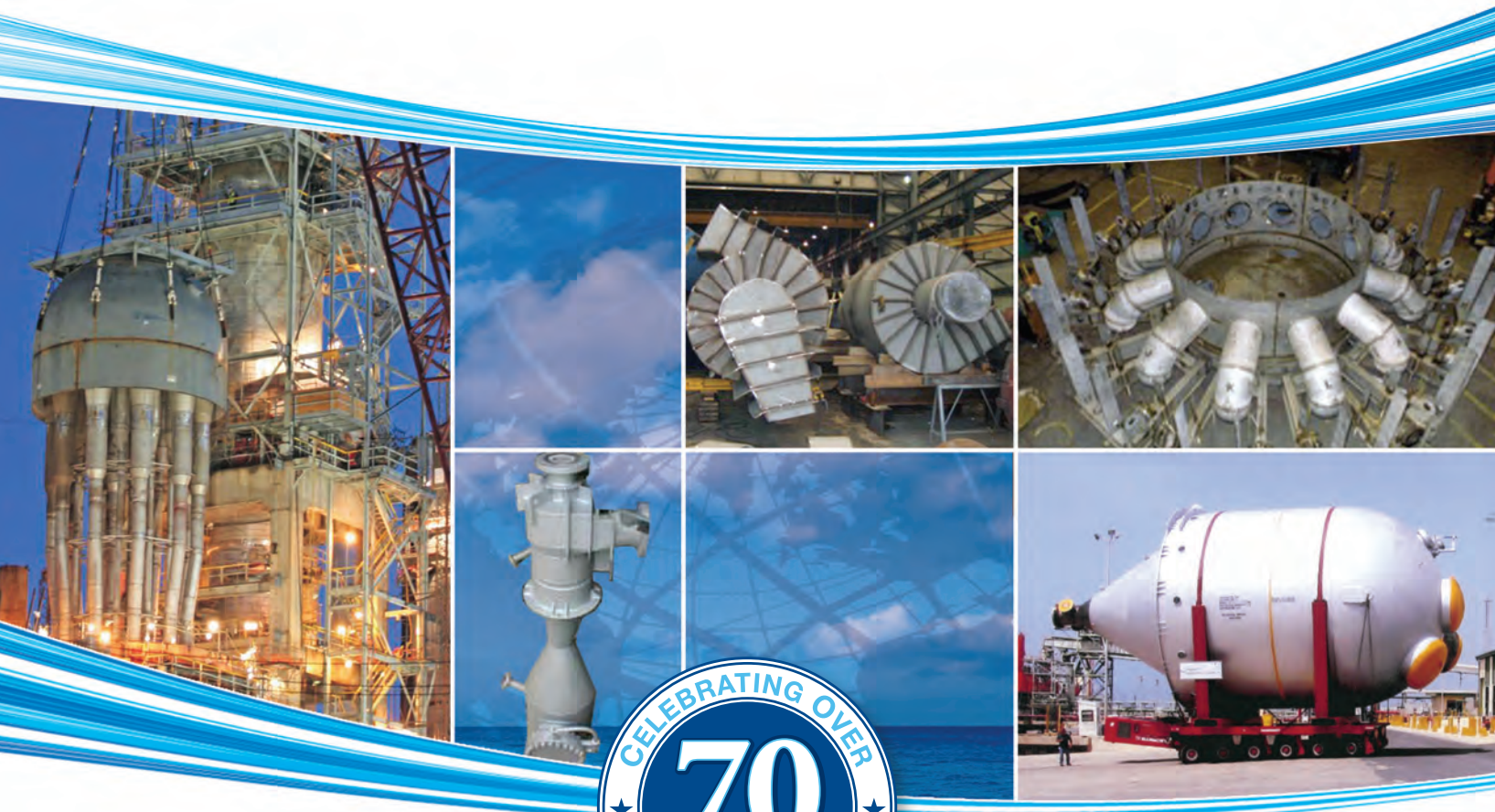


# EMTROL-BUELL

## TECHNOLOGIES

A CECO Environmental Company



*The World Leader in Cyclone Design  
& Specialists in Fluid Bed Applications*

*Global Leader For Integrated Clean Air Solutions*

We  
Are

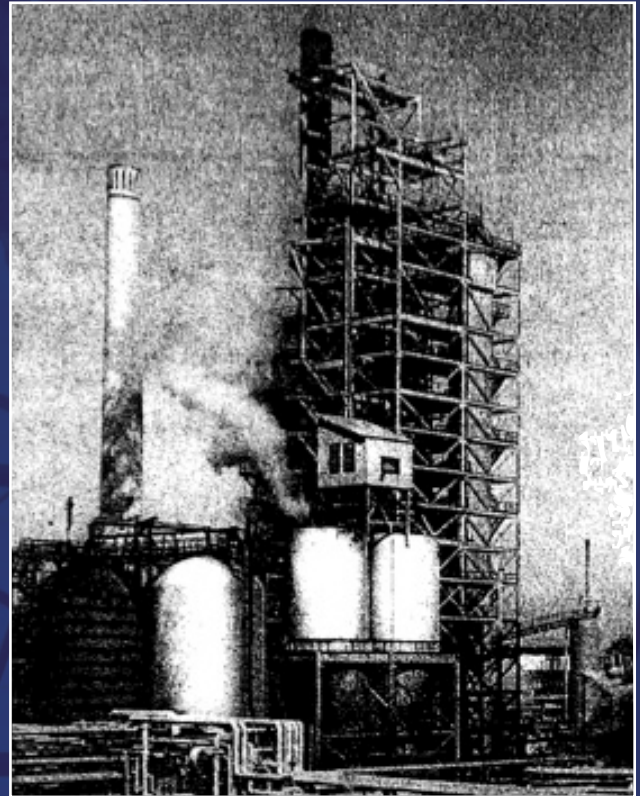
# EMTROL-BUELL TECHNOLOGIES

## History

Since its founding in 1934, Buell has been actively engaged in the study and development of cyclone technology. In the 1940's, Buell pioneered the cyclone design that was successfully used in the first commercial FCC unit located in Louisiana, USA. In the 1960's, Buell's continued development efforts in cyclone technology led to the successful entry in the newly developing petrochemical industry with cyclones that resulted in increased efficiency.

In 1973, Emtrol was established by a group of former Buell employees who successfully grew their business to also become a major equipment supplier to the same market. Throughout the next 40 years, both Buell and Emtrol continued to develop their engineering expertise including numerous patents for cyclone separation technology. As a result of their focus on proven performance, quality and reliability of cyclone equipment, that had become expected by the customer base, Buell and Emtrol became the two major suppliers of FCC cyclones and related equipment to global petroleum refining and petrochemical industries.

In 2014, CECO Environmental (parent company of Buell) purchased Emtrol and integrated the two industry leaders to form Emtrol-Buell Technologies. The merger created the largest, most experienced global market leader



*First Commercial FCC Unit (1942), Baton Rouge, LA USA*

in cyclone technology servicing fluid bed applications and third stage separators for the petroleum refining and petrochemical industries. With corporate headquarters in New York USA, combined with regional offices in Pennsylvania USA and the United Kingdom, Emtrol-Buell is well positioned to support both current and future requirements of its global customer base.



## Experience

We are the world leader in cyclone design, FCC cyclones and specialists in fluid bed applications. Our staff has over 350 years of engineering, design and technical service expertise.

We have many chemical and petrochemical applications as well, including Acrylonitrile (ACN or AN), Catoxide, Fluid™ and Flexi™ Coking (trademarks of ExxonMobil), Low Density Polypropylene (LDPP), Polypropylene, Oxy Hydrochlorination (OHCL), Polysilicon Hydrochlorination, SZORB™ (trademark of ConocoPhillips) and Vinyl Chloride Monomer (VCM) just to name a few.

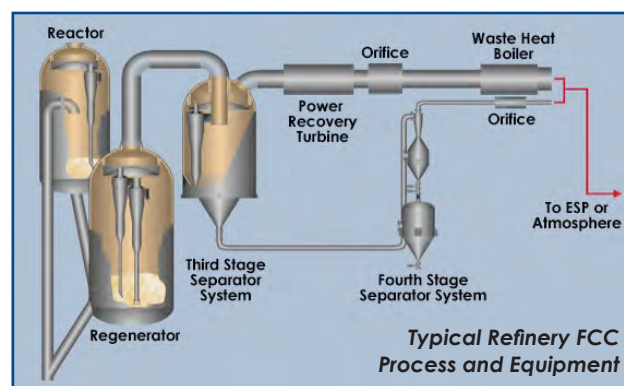
Our clientele encompasses many of the prominent oil refiners worldwide, and we have the largest installed-base of any FCC cyclone supplier in the world with over 3700 cyclones supplied since 2000.

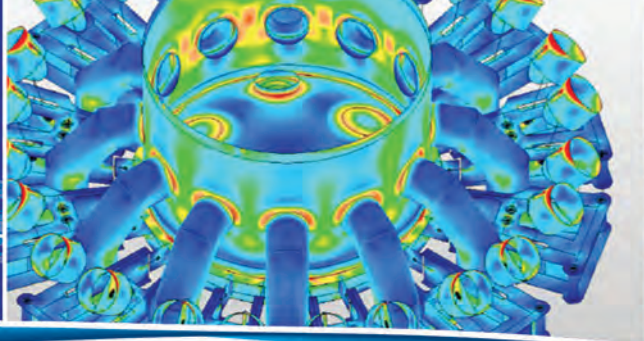
Our sound technical support, coupled with superb engineering and design support, have rendered us as a favorite among these major corporations. The continued interest and repetitive business of the established clients, and their affiliates, promote our expertise in this field – there can be no greater endorsement for our superior design than that!

## FCC Cyclone Equipment

We have supplied the following FCC equipment in accordance with Refinery, EPC and Process Licensor specifications:

- Reactor Cyclone Systems
- Regenerator Cyclone Systems
- Third Stage Separator Systems
- Fourth Stage Separator Systems, Underflow Piping, Critical Flow Orifices
- Catalyst Hopper Cyclones
- Cyclone Replacement Parts
- Cyclone Valves
- Vessel Heads and Entire Vessels
- Risers, Steam Rings, Air Grids, Spent Catalyst Distributors





## FCC Cyclone Design

We have incorporated many new features into our cyclones to enhance the separation efficiency, accommodate increased catalysts loading and to minimize wear on internal surfaces of the cyclone equipment.

Some new design features focus on:

- Aspect ratio of the cyclone inlet
- Limitations on flux rates
- Cyclone inlet to outlet criteria

## Cyclone Hanger Support Systems

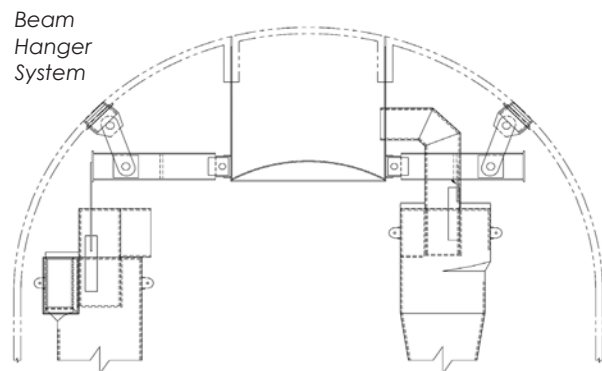
All Regenerator internal cyclone systems must be supported to accommodate the differential thermal expansion between the relatively cold vessel, which supports all vessel internals, and the cyclone system, which is exposed to a much higher temperature. This expansion problem is exacerbated by the use of rapidly expanding austenitic 304H stainless steel for the cyclone system. Although not typically an issue in smaller Regenerator units where a traditional linkage hanger system can be utilized, expansion becomes problematic in larger Regenerator units where considerable thermal movement is encountered.

Our exclusive beam hanger system utilizes an array of horizontally oriented beams, extending from the plenum skirt toward the vessel head and from which the first and second stage cyclones are supported. The ends of the beams supported by the plenum skirt are pinned to lugs fixed to the plenum skirt.

Other 'construction details' related features include:

- New crossover duct design
- Minimized use of edge bars in refractory linings throughout cyclone assembly

We have also developed a dust hopper and lined dipleg stub design that enhances the catalyst discharge from the cyclones and mitigates the effects of erosion.



Our unique configuration of pins, links, vessel lugs and beams compensates for the thermal growth difference between the high temperature of the cyclone system and the much lower temperature of the vessel. The beam remains virtually horizontal at all times and is growing in unison with the cyclones it is supporting. The desired result from our beam hanger system design is that of an expansion-balanced condition without inducing excessive stresses in any components due to thermal expansion.



## Third Stage Separator (TSS) Systems

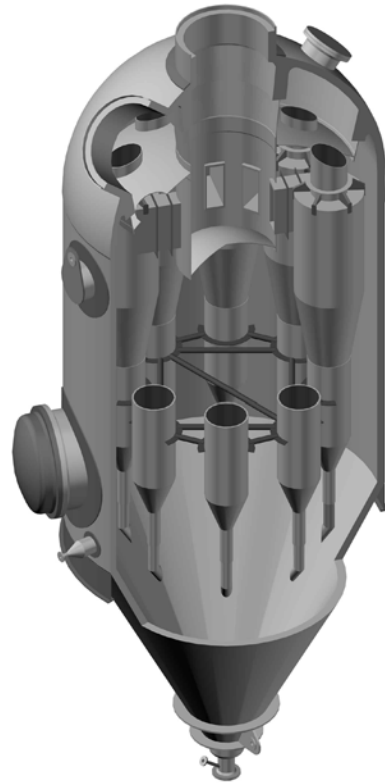
Many of our contracts have been for TSS System installations, of which about half are utilized solely for final particulate removal to meet air pollution control regulations. The balance of these units are located upstream of Power Recovery Turbines (PRT) and provide protection for the turbines, as well as reduction of catalyst emissions to the atmosphere.

All the installations upstream of a PRT are designed to handle the flue gas at the elevated Regenerator temperature and pressure, and are contained in their own pressure vessels. The units used solely for pollution control have been installed at various points in the flue gas line, resulting in a variety of configurations, metallurgy and constructions to meet specific refinery needs.

## Fourth Stage Separator (FSS) Systems & Catalyst Hoppers

FSS cyclones are installed in the underflow from the TSS and are used to collect solids that have already been separated in the TSS. Solids separated in the TSS are transported to the FSS System using a small percentage of the flue gas as a transport medium for the catalyst, which is controlled by an orifice normally located downstream of the FSS cyclone.

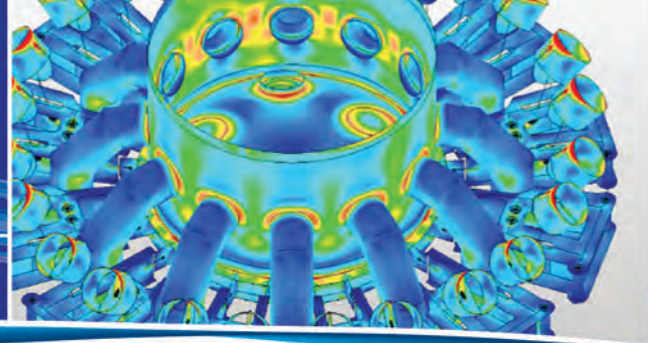
There are many different configurations for the underflow and FSS System, which must also be



*Third Stage Separator (TSS) Cutaway*

designed to accommodate unloading of the solids from the fines collection hopper. Our FSS Systems are typically designed and fabricated to pressure vessel standards, are supported by the fines hopper vessel, and have been supplied for many TSS Systems.

Our Catalyst Hopper Cyclones are easily adaptable to a variety of applications, including loading and/or unloading of Fresh and Spent Catalyst, or as auxiliary hoppers for special additives. These cyclones are typically designed to minimize catalyst loss to the atmosphere in the vent from the hopper during loading and/or unloading operations.



## Engineering Services

Since our inception, we have provided engineering services through the design of equipment for the refinery and petrochemical industries. In recent years, these industries have increased their requirements for more detailed evaluation to assure proper application and adequacy of equipment. We have met this challenge through the utilization and development of advanced technical software packages to meet or exceed expectations.

Emtrol-Buell's engineering services include a full range of design capabilities, including design of pressure vessels, piping and structural analysis. We reference the following codes and standards for which we are most familiar, but

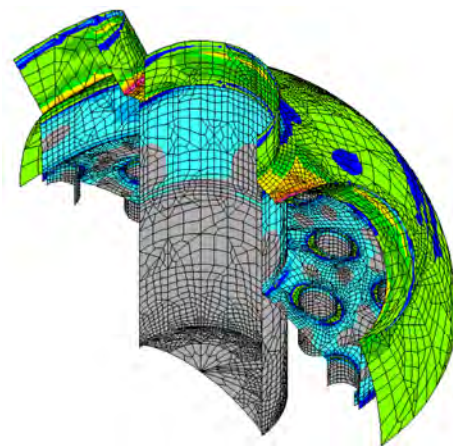
## Finite Element Analysis (FEA)

Since 1989, we have been supplying comprehensive 2D FEA models for the design of plenum chambers. In order to accommodate non-symmetric and/or non-uniform loadings, we also offer 3D modeling and analysis that is conducted in-house to ensure timely response to design changes. 3D modeling permits detailed design for unique loading conditions and depicts the effect of the non-symmetric loading. Although primarily used for analysis of the primary membrane and bending stresses due to cyclone loadings and pressure, 3D FEA models can also incorporate the secondary thermal stresses produced by the thermal gradient in the plenum skirt.

note that we can also incorporate individual specifications when requested:

- ASME Boiler and Pressure Vessel Code, Section VIII, Divisions 1 and 2
- ASME B31.3, Process Piping Code
- ASTM – American Society for Testing Materials (Materials)
- AISC – American Institute of Steel Construction (Structures)
- UBC – Uniform Building Code (Wind and Seismic)
- ANSI/ASCE – American Society of Civil Engineers (Wind and Seismic)
- WRC – Welding Research Council (Attachment Load Stresses)
- Roark's Formulas for Stress and Strain (Component Stresses)

In addition, we offer advisory and inspection services during installation or regular maintenance shutdowns from our three global locations. In 2015, we introduced a new bi-annual process review and annual mechanical review, called 'Service Pac', which offers a new, long-term approach for support to ensure that our client's FCC is operating at its maximum level of performance.



Through 2015, we have provided over 200 FEA models, many of which have been for major petroleum refining companies, and have included:

- 2D axisymmetric modeling for thermally induced stress
- 3D shell element modeling for pressure vessels
- 3D brick element models for complicated geometry

# EMTROL-BUELL TECHNOLOGIES

## **Fabrication**

Emtrol-Buell uses quality subcontractors for the manufacture of our equipment. Our subcontractors have personnel dedicated to specific tasks, including hexmesh installation, assembly and fit-up, welding and refractory installation.



*Installing Refractory Lining*

The product of our long-term affiliation with our subcontractors is their extensive experience in the fabrication and refractory lining of this specialized equipment for FCC applications. Together with Emtrol-Buell, our subcontractors in North America, Europe and Asia have developed industry-leading methods to manufacture superior quality equipment, which has become synonymous with our name.



*Heat Curing and Post Weld Heat Treating of Refractory Lined Cyclones*



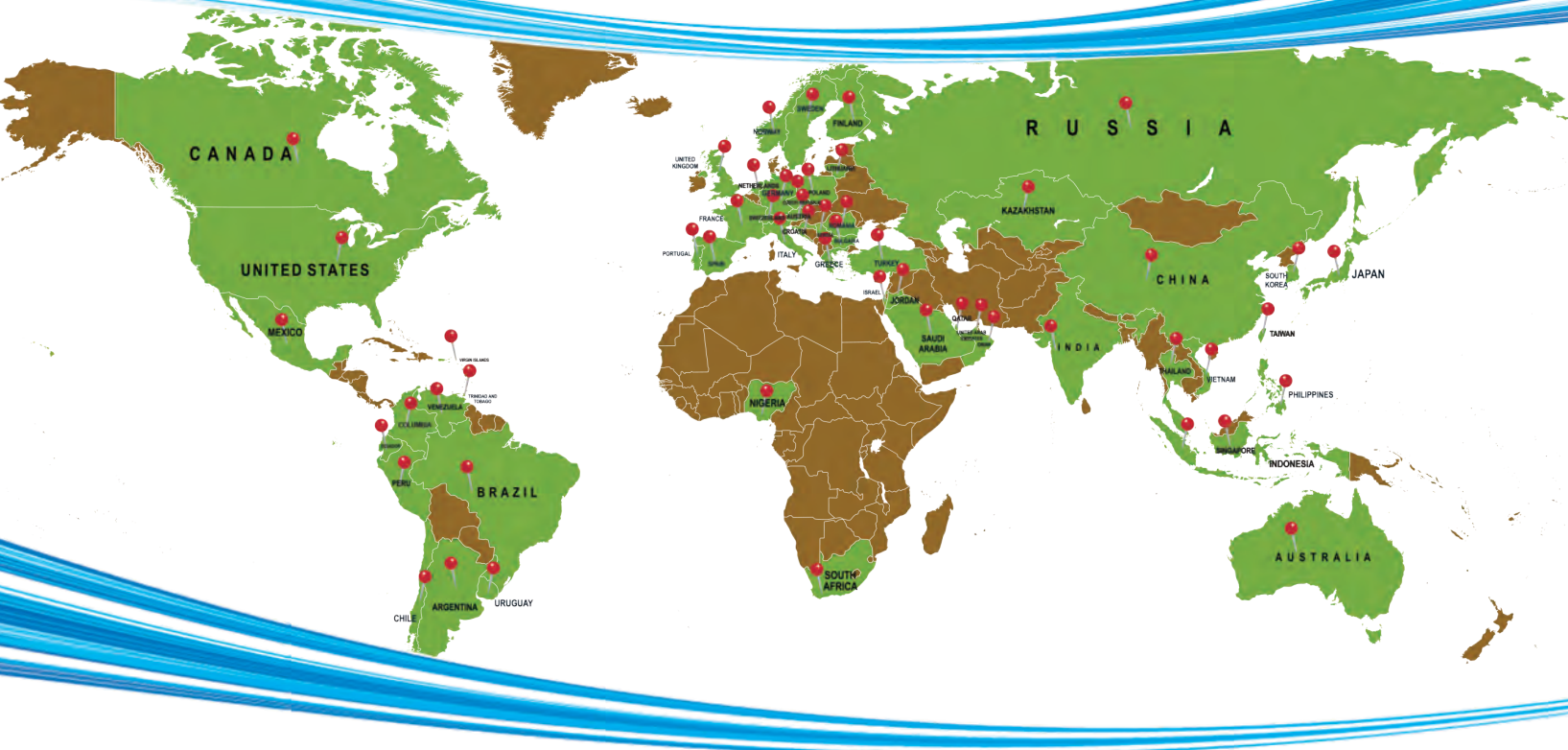
*Installing Plenum into Vessel Head*

# ENTROL-BUELL

TECHNOLOGIES

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## World Wide FCC Installations



### Entrol-Buell Technologies

USA Corporate Headquarters:

1440 Veterans Memorial Highway, Suite 100 • Islandia, NY 11749 USA  
Phone: +1.631.582.9700 • Fax: +1.631.234.8445

USA Pennsylvania Office:

102 Fairview Circle, Suite B • Lebanon, PA 17042 USA  
Phone: +1.717.274.7104 • Fax: +1.717.274.7342

United Kingdom Office:

31 St. Neots Road, Eaton Ford • Huntingdon, Cambs PE197BA England  
Phone: +44 (0) 1480 475071 • Fax: +44 (0) 1480 475046

### CECO Environmental

4625 Red Bank Road, Suite 200 • Cincinnati, Ohio 45227 USA  
Phone: +1.513.458.2600 • Toll Free: +1.800.333.5475 • Fax: +1.513.458.2647

[www.cecoenviro.com](http://www.cecoenviro.com)