

GAS VAPOR MITIGATION SYSTEMS

FOR PROTECTION AGAINST VAPOR INTRUSION

- ▶ Gas Vapor Barrier System
- ▶ High-Performance VOC Barrier System
- ▶ Methane & High-Performance Waterproofing System
- ▶ Gas Venting System



With more than 60 years of experience, CETCO is an industry leader in Gas Vapor Mitigation technologies and solutions.

To speak to a technical expert about our innovative Gas Vapor Barrier and Venting Systems and how they can be custom tailored to your specific project, call 714.384.0111 or 800-527-9948.



WHAT IS VAPOR INTRUSION?

Vapor intrusion is the migration of subsurface chemical vapors into overlying structures. Vapors may include volatile organic compounds (VOCs), semi-volatile organic compounds, inorganics (i.e. mercury, hydrogen sulfide, etc.), methane or radon.

WHAT CETCO HAS TO OFFER

Vapor intrusion has become a significant environmental issue for regulators, industry leaders, and concerned residents nationwide. CETCO offers four uniquely designed vapor mitigation systems developed to meet the needs of your brownfield redevelopment project. These systems offer solutions for various site conditions, backed by a long track record and numerous case histories, and are designed with the support of our experienced technical managers.

An extensive portfolio of physical and chemical property testing is evidence of CETCO's exceptional product performance. CETCO offers technical and design assistance for our gas vapor barrier and venting systems and works with numerous environmental engineers, architects and contractors in the design of thousands of vapor mitigation systems.

OVERALL BENEFITS OF USING CETCO VAPOR MITIGATION SYSTEMS

- ▶ Chemically resistant technologies that reliably seal vapor intrusion pathways, preventing penetration by contaminated vapors
- ▶ Assurance of proper installations by a network of CETCO trained and certified installers and inspectors
- ▶ Over 50 million square feet of successful installations under hospitals, schools, libraries, high-rise commercial and residential buildings, multi-family housing developments and major public works projects throughout the world



LIQUID BOOT®



COREFLEX®



GEOVENT™

SYSTEM DESIGN AND PERFORMANCE CONSIDERATIONS

Regulations, requirements and guidance on the use of gas vapor mitigation systems vary by location. Some locales have specific action limits based on chemical concentrations and some regulations establish maximum risk criteria for indoor air quality. The U.S. EPA recommends the use of models specially designed to evaluate risk. The use of risk-based soil gas models is recommended in determining the appropriate CETCO vapor intrusion system. CETCO provides technical assistance to engineers in the evaluation of soil gas data in regards to these models.

Utilizing a model to evaluate indoor air quality assures the designer that gas vapor mitigation technologies will effectively control vapor intrusion and reduce the hazards related to indoor air quality. CETCO offers innovative gas vapor mitigation systems that will reliably provide the protection from these potentially harmful vapors that could compromise overall indoor air quality.

LIQUID BOOT® Gas Vapor Barrier System

SYSTEM DESCRIPTION

Liquid Boot® is a seamless, spray-applied, water-based membrane containing no VOCs, which provides a barrier against vapor intrusion into structures. Liquid Boot® is installed under slab and on below grade vertical walls as a gas vapor barrier to minimize vapor and nuisance water migration into buildings and is ideal for methane migration control. Liquid Boot® spray-application directly to penetrations, footings, grade beams, pile caps, etc., provides for a fully-adhered gas vapor barrier system.

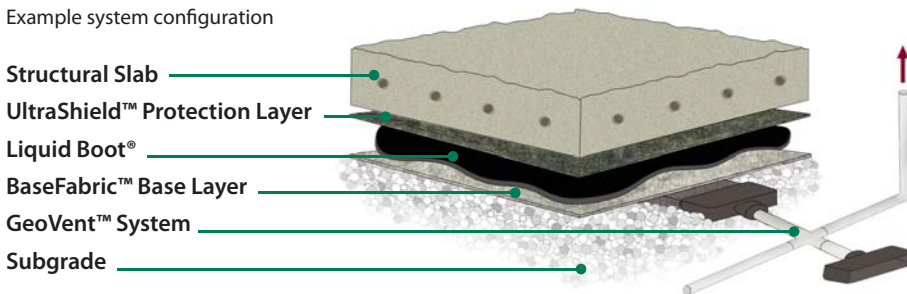
TYPICAL USES

- ▶ Underslab and below-grade vertical wall gas vapor barrier, used to minimize vapor and nuisance water (non-hydrostatic conditions) migration into buildings
- ▶ Ideal for methane migration control
- ▶ Concrete water reservoir and tank liner used to prevent water seepage into concrete

BENEFITS

- ▶ Spray application provides excellent sealing of penetrations, eliminating mechanical fastening
- ▶ Seamless, monolithic membrane eliminates seaming-related membrane failures
- ▶ Unique formulation provides superior protection from methane gases and water vapor
- ▶ Fully adhered system reduces risk of gas migration

Example system configuration



LIQUID BOOT® CHEMICAL & PHYSICAL PROPERTIES* *

CHEMICAL PROPERTY	TEST METHOD	RESULT
Acid Exposure (10% H ₂ SO ₄ for 90 days)	ASTM D543	Less than 1% weight change
Diesel (1000 mg/l), Ethylbenzene (1000 mg/l), Naphthalene (5000 mg/l) and Acetone (500 mg/l) Exposure for 7 days	ASTM D543	Less than 1% weight change; Less than 1% tensile strength change
Methane Permeability	ASTM 1434-82	Passed*
Micro Organism Resistance	ASTM D4068-88	Passed*
Oil Resistance	ASTM D543-87	Passed*
PCE Diffusion Coefficient	Tested at 6,000 mg/m ³	2.74 x 10 ⁻¹⁴ m ² /sec
Radon Permeability	Tested by US Dept. of Energy	Zero permeability to Radon (222Rn)
TCE Diffusion Coefficient	Tested at 20,000 mg/m ³	8.04 x 10 ⁻¹⁴ m ² /sec

PHYSICAL PROPERTY	TEST METHOD	RESULT
Accelerated Weathering & Ultraviolet Exposure	ASTM D822	No adverse effect after 500 hours
Bonded Seam Strength	ASTM D6392	Passed*
Dead Load Seam Strength	City of Los Angeles	Passed*
Elongation	ASTM D412	1,332% - Ø reinforcement, 90% recovery
Environmental Stress-Cracking	ASTM D1693-78	Passed*
Freeze-Thaw Resistance (100 Cycles)	ASTM A742	Meets criteria. No spalling or disbondment
Heat Aging	ASTM D4068-88	Passed*
Soil Burial	ASTM E154-88	Passed
Tensile Bond Strength to Concrete	ASTM D413	2,707 lbs/ft ² uplift force
Tensile Strength	ASTM D412	58 p.s.i. without reinforcement

*Passes all City of Los Angeles Methane Criteria

**For a complete listing of Liquid Boot® chemical and physical properties, please refer to our website at cetco.com/RTG

LIQUID BOOT® PLUS High-Performance Gas Vapor Barrier System

SYSTEM DESCRIPTION

The Liquid Boot® Plus system is a combination of the traditional Liquid Boot® spray-applied membrane and VI-20™, a 20-mil, high performance polyethylene-EVOH copolymer membrane. The system, paired with the GeoVent™ Gas Venting System, is designed to provide excellent resistance to contaminants. The Liquid Boot® membrane is spray-applied to a uniform substrate, provided by the VI-20™ geomembrane, bonding together to create a highly resistant protection barrier. Once the membrane is fully cured, UltraShield™ non-woven geotextile protection course is installed.

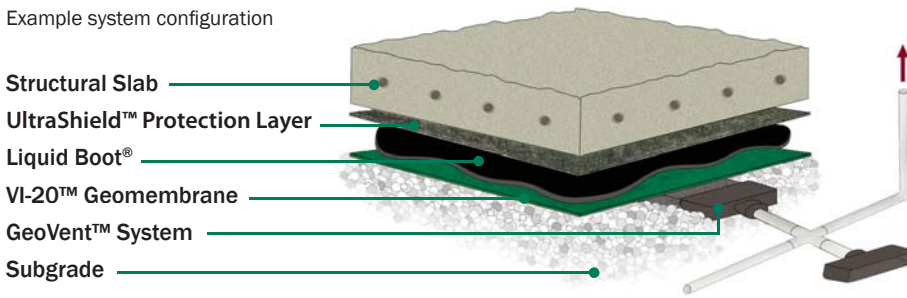
TYPICAL USES

- ▶ Installed under slab and on below grade vertical walls as a gas vapor barrier to minimize vapor and nuisance water (non-hydrostatic conditions) migration into buildings
- ▶ Ideal for applications with chlorinated solvents, BTEX and other PAHs

BENEFITS

- ▶ Combines the advantages of a spray-applied membrane with performance of a technically advanced geomembrane
- ▶ Typically 80 mil thick system provides excellent resistance to punctures and tears
- ▶ EVOH barrier technology provides superior protection against diffusion of chemicals when compared to typical HDPE geomembranes

Example system configuration



VI-20™ SUPERIOR PERFORMANCE GEOMEMBRANE WITH EVOH TECHNOLOGY

VI-20™ is a 7-layer co-extruded EVOH geomembrane made using high quality virgin-grade polyethylene and barrier resins to provide unmatched impact strength as well as superior resistance to VOC vapor transmission. EVOH technology has been shown to have VOC diffusion coefficients 20 times lower than an 80 mil HDPE geomembrane and serves as a highly resilient underslab and vertical wall barrier designed to restrict methane, radon and other harmful chemicals. EVOH is a copolymer of Polyethylene (extrudes easily and improves bonding) and Polyvinyl Alcohol and Ethylene Vinyl Alcohol (provides gas barrier). Applications for EVOH originated in the manufacturing of automotive fuel systems to control emissions of hydrocarbons, whose use was mandated by the US EPA and the CA Air Resources Board (CARB) to reduce VOC emissions.

VI-20™ CHEMICAL & PHYSICAL PROPERTIES		
CHEMICAL PROPERTY	TEST METHOD	RESULT
Benzene Diffusion Coefficient	EPA Method 8260	4.5 x 10-15 m ² /s
Ethylbenzene Diffusion Coefficient	EPA Method 8260	4.0 x 10-15 m ² /s
m&p-Xylenes Diffusion Coefficient	EPA Method 8260	3.7 x 10-15 m ² /s
Methane Permeability	ASTM 1434	< 5 x 10-10 m ² /d • atm
o-Xylene Diffusion Coefficient	EPA Method 8260	3.7 x 10-15 m ² /s
Radon Diffusion Coefficient	EPA Method 8260	2.5 x 10-14 m ² /s
Toluene Diffusion Coefficient	EPA Method 8260	4.2 x 10-15 m ² /s

PHYSICAL PROPERTY	TEST METHOD	RESULT
Membrane Composite Thickness	ASTM D5199	20 mil
Puncture Resistance	ASTM D1709	2,600 g
Tensile Strength	ASTM E154 Section. 9	58 lbs
Water Vapor Transmission	ASTM E154 & E96	.0025 US Perms

COREFLEX® Methane Barrier & High-Performance Waterproofing System

SYSTEM DESCRIPTION

CoreFlex® is a flexible membrane liner which functions as both a methane gas barrier and a high-performance waterproofing membrane. CoreFlex® features a heat welded thermoplastic membrane with the industry's heaviest reinforcement plus Active Polymer Core (APC) Technology. The CoreFlex® dual membrane system seals both gas and water breaches with reliability. CoreFlex®'s thermoplastic membrane exhibits superior puncture resistance and is integrally bonded to a proprietary APC core layer - working together to ensure superior gas vapor and waterproofing protection.

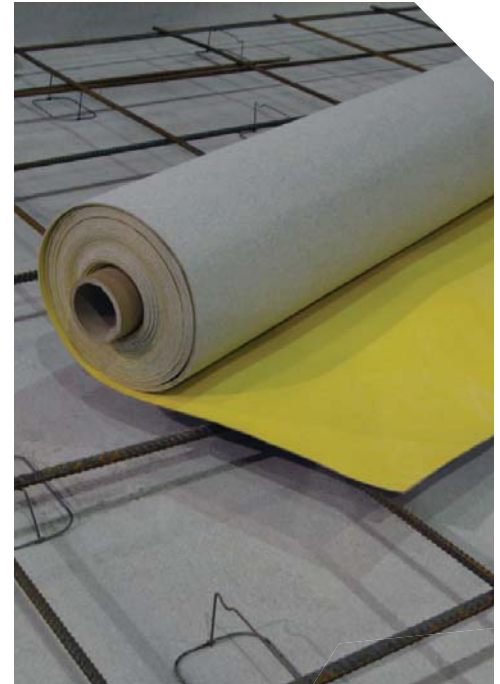
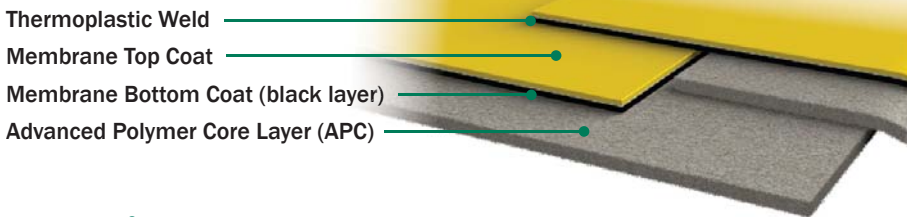
TYPICAL USES

- ▶ A fully weldable, self-healing flexible membrane liner which functions as a methane barrier and waterproofing membrane (hydrostatic conditions)
- ▶ Installed under slab and on below grade vertical walls

BENEFITS

- ▶ Fully fused, watertight, heat-welded seams
- ▶ Active sealing waterproofing membrane
- ▶ Superior puncture resistance, tensile and tear strengths
- ▶ Methane Barrier approval in Los Angeles County
- ▶ Eligible for the HydroShield Quality Assurance Program

Welded membrane overlap assembly



COREFLEX® ACTIVE POLYMER CORE TECHNOLOGY (APC)

The predominate problem with conventional thermoplastic membranes is that loose laid installations require an expensive grid anchoring system to isolate water infiltration due to an installation defect or puncture. If the CoreFlex® membrane is punctured, its Active Polymer Core activates with water contact and seals the breach preventing further water ingress into the structure. The APC geotextile layer provides protection against potential puncturing of the membrane by subsequent construction activities.

COREFLEX® CHEMICAL & PHYSICAL PROPERTIES

CHEMICAL PROPERTY	TEST METHOD	RESULT
Membrane Composite Thickness	ASTM D751	150 mil (3.8 mm)
Microorganism Resistance	ASTM D4068-88	Passed
Oil Resistance	ASTM D543	Passed

PHYSICAL PROPERTY	TEST METHOD	RESULT
Bonded Seam Strength	ASTM D751	705 lbs (3,136 N)
Environmental Stress Cracking	ASTM D1693	Passed
Hydrostatic Pressure Resistance (min 1 hr @ 100 psi)	ASTM D751	231 ft (70m)
Hydrostatic Resistance (Procedure A)	ASTM D751	754 psi (5.2 mPa)
Membrane Composite Thickness	ASTM D751	150 mil (3.8 mm)
Peel Adhesion To Concrete	ASTM D903 (mod)	10 lbs/in (1,751 N/m)
Puncture Resistance	ASTM D4833	224 lbs (996 N)
Tensile Strength	ASTM D751	549 lbs (2,442 N)
Water Vapor Retarder	ASTM E1745	Class A
<i>Water Vapor Transmission</i>	ASTM E96	0.1 perms (0.036 gr/m/hr)
<i>Tensile Strength</i>	ASTM D154	387 lbs/in (68 kN/m)
<i>Puncture Resistance</i>	ASTM D1709	12.0 lbs (5,500 grams)

GEOVENT™ Gas Venting System

SYSTEM DESCRIPTION

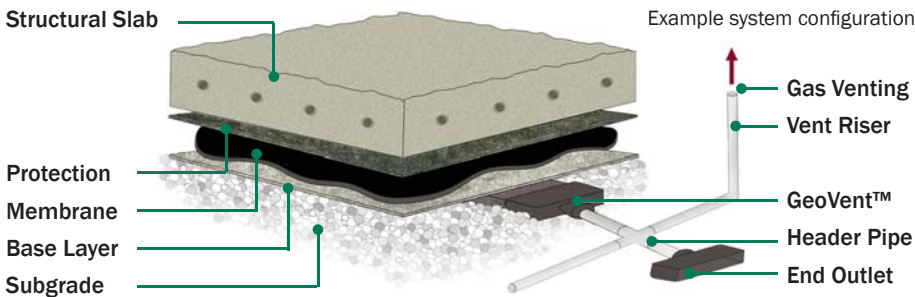
Venting systems are typically installed in conjunction with a gas vapor barrier when volatile or explosive gases are present. GeoVent™ is a low profile pressure relief, trenchless collection and venting system designed to improve venting efficiency and reduce installation costs. GeoVent™ has several advantages over trenched installations and can be used as an “Active” or “Passive” venting system depending on the specific project. Used in conjunction with Liquid Boot® or Coreflex® barrier systems, GeoVent™ can alleviate the accumulation of gas vapors under the slab.

TYPICAL USE

To provide an active or passive under slab gas venting system

BENEFITS

- ▶ Installed directly on subgrade eliminating costly trenching
- ▶ Placed in closer proximity to the gas vapor barrier allowing for more effective venting
- ▶ Greater opening area per lineal foot of pipe and integral filter fabric allowing for higher ventilation efficiency
- ▶ Installed at a higher elevation reducing susceptibility to inundation from perched groundwater that may accumulate beneath the building foundation
- ▶ Flow characteristics meet or exceed that of a typical trenched installation. The overall capacity of the system is far in excess of typical gas flux rates



DESIGN CONSIDERATIONS

- ▶ Venting systems should be properly designed to adequately relieve pressure and reduce gas concentrations from beneath the structure
- ▶ CETCO provides gas venting performance data
- ▶ CETCO provides assistance with detail drawings for these types of systems

GEOVENT™ CHEMICAL & PHYSICAL PROPERTIES

CHEMICAL PROPERTY	TEST METHOD	RESULT
Compressive Strength	ASTM D 1621	9,500 psf
Flow Rate (Hydraulic gradient = .1)	ASTM D 4716	30 gpm/ft/width
Thickness	ASTM D 1777	1.0 in.

PHYSICAL PROPERTY	TEST METHOD	RESULT
A.O.S.	ASTM D 4751	70 US Sieve
Fabric - Mass / Unit Area	ASTM D 5261	4.0 oz/yd ²
Flow Rate	ASTM D 4491	140 gpm/ft ²
Grab Tensile Strength	ASTM D 4632	100 lbs.
Permeability	ASTM D 4491	0.21 cm/sec
Puncture Strength	ASTM D 4833	65 lbs.
UV Resistance	ASTM D 4355	70%

CETCO QUALITY ASSURANCE

CERTIFIED INSTALLERS AND INSPECTORS

In any proper gas vapor barrier system installation, it is important to perform QA/QC measures to ensure successful installations. CETCO maintains a nationwide network of certified installers and inspectors that are trained in the proper installation and inspection procedures of a CETCO gas vapor barrier system. CETCO pioneered the use of a smoke test, which is currently recognized by top guidance organizations as a reliable quality control method performed on CETCO gas vapor barrier systems.

SMOKE TESTING for Gas Vapor Barrier Systems

A smoke test is a method of ensuring that a membrane is free of holes. Smoke is pumped under the membrane for a specified period of time while the surface of the membrane is observed for minute holes where the smoke is clearly visible. During the smoke test, any holes detected can immediately be repaired. This process has been completed under hundreds of structures and found to be highly successful. The smoke testing process assures engineers, developers, and owners alike that they are getting a fully tested, gas-tight membrane installation.

THE SMOKE TESTING PROCESS



A GLOBAL ENVIRONMENTAL COMPANY

CETCO, a wholly owned subsidiary of AMCOL International Corporation, is a diversified global environmental company providing innovative products and practical solutions to challenging regulatory and construction problems. CETCO delivers a complete range of services built around engineering support, technical assistance, innovative product solutions and leadership in research and development.

For more information on CETCO products and services, visit cetco.com



AMCOL® INTERNATIONAL HEADQUARTERS



Headquartered in Hoffman Estates, IL, AMCOL operates over 68 facilities in Africa, Asia, Australia, Europe, North America and South America. The company employs approximately 1,750+ employees in 26 countries. The Company, established in 1927, currently trades on the New York Stock Exchange under the symbol "ACO". AMCOL International produces and markets a wide range of specialty mineral products used for industrial, environmental and consumer-related applications. With more than 68 world-wide locations, AMCOL manages a global supply chain to deliver world-class quality. Our full range of products and services allow us to bring value to our customers, but ultimately, we believe our commitment to understanding customers' needs is what sets us apart in our industry.