FRP-Fiberglass Reinforced Plastic Products By Monoxivent

Monoxivent FRP Products, 1306 Mill St., Rock Island, IL 61201
Phone: 877-608-4383
Web: fiberglass-duct.com

Nov. 2015 Catalog

MONOXIVENT®

FRP - Fiberglass Reinforced Plastic

PRESENTS

CorrosionComposites

Corrosion Resistant Duct

VERSATILE...

CorrosionComposites
by Monoxivent®

OVERVIEW:

Corrosion Composites by Monoxivent is a source for corrosion resistant Fiberglass Fabrication Services. Fiberglass laminated composites are light weight, high strength, non conductive, and corrosion resistant. Monoxivent assists with design, engineering, drawing, manufacturing, inspection, and installation. Monoxivent brings together years of fiberglass experience and manufacturing expertise. For many industrial, Water, and Wastewater applications where corrosion is a problem, fiberglass is the material of choice.

DURABILITY:

Monoxivent's Corrosion Composites provide excellent resistance to corrosion and offer a very long service life. Laminates are designed for wind, seismic, snow, pressure, vacuum, and temperature.

STANDARDS:

Corrosion Composites adhere to ASTM, SMACNA, and other industry standards.

EXPERIENCED TEAM:

Monoxivent's design team offers engineering and layout support for custom solutions. This coupled with a manufacturing sources featuring over 40 years of experience, a 70,000-sq. foot facility, and state of the art equipment makes Corrosion Composites an excellent source for FRP products.

PRODUCTS:

For Industry, Water and Wastewater, Infrastructure:

- Duct
- Scrubbers
- Dampers
- Tank Covers
- Weirs
- Platforms
- Stacks
- Flumes
- Manholes
- Stack Liners
- Trenches
- Pressure Vessels
- Tanks
- Hoods
- Troughs
- Baffles
- Ladders
- And More!


Industrial Process - duct and vessel


Box Scrubber


Scrubber


Wastewater odor control duct system

LABORATORY FUME HOOD DUCT & HYBRID CF DUCT

Lab Duct can handle a wide variety of chemical fumes, including strong acids and caustics. Condensate formed in the duct system can concentrate these chemicals due to evaporation, making them even more corrosive. Because a Lab is considered occupied space, the structural and exterior surface of the duct requires a low smoke and flame rating per UL-181, as well as low fire-gas toxicity. This product blends the interior corrosion barrier with an exterior Class 1 duct material.


Corrosion Resistant

Applications:

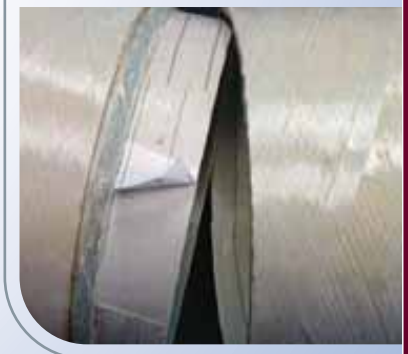
- Hospitals
- Aquariums
- Dog kennels
- Exposed Vehicle Exhaust Duct
- Swimming pools
- Laboratories

HybridCF LabDuct

Low Dust | Low VOC | LEED Driven

LOW VOC COUPLING TO JOIN MONOXIVENT FRP DUCT: THE L3 CONNECTION

To comply with LEED requirements of dust and VOC control, Monoxivent offers the L3 Connection System. A protective strip that is removed on the job site is incorporated into the duct and fittings during the fabrication process; this eliminates dust normally associated with joining fiberglass. Simply peel the strip, apply the specially designed Low VOC adhesive and grab those extra LEED points!



L3 Connector - Benefits:

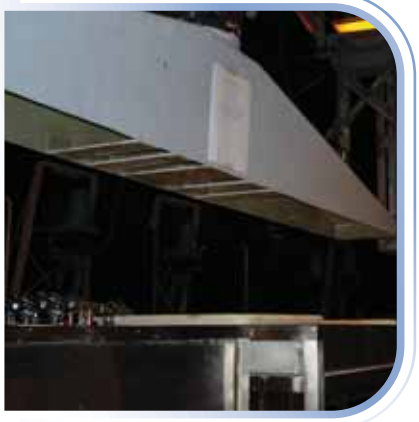
- No dust from grinding
- Low VOC in adhesive
- Tested to 15 PSI
- Meets LEED specification requirements

L3Connection by Monoxivent®

MONOXIVENT®
FRP - Fiberglass Reinforced Plastic

CASE STUDIES

CLIENT: **Ohio State University** | Columbus, OH



CHALLENGE: The photo Lab at Ohio State University required a corrosion resistant solution to capturing noxious fumes from large photo development sinks. The problem was that the students occasionally needed unlimited access to the sinks in order to flip large prints.

SOLUTION: Monoxivent designed and fabricated two 8' long custom corrosion resistant FRP hoods that were mounted on heavy duty stainless steel slides suspended from overhead stainless steel brackets. This allowed there to be the ability to capture the caustic fumes while at the same time allowing the students to easily move the hoods away from the process when needed.

CLIENT: **Owatonna Waste Water Treatment Plant** | Owatonna, MN

CHALLENGE: The City of Owatonna, MN expanded their waste water treatment facility which entailed expanding the odor control system as well.

SOLUTION: Monoxivent fabricated all of the corrosion resistant ductwork as well as the control dampers and two custom built fiberglass hoods for odor capture. This duct will be an integral part of this waste water treatment plant for years to come.

CLIENT: **Calumet Water Reclamation Plant** | Chicago, IL

CHALLENGE: The Metropolitan Water Reclamation District of Greater Chicago recently added a grit removal facility to their Calumet Waste Water Treatment plant. The process required (8) each 120' long corrosion resistant sloped flumes with an abrasion resistant surface. Flume elevations and equipment clearance without the use of cross bracing was also critical.

SOLUTION: Monoxivent designed the trough system to fit the process requirements for Metcalf & EDDY / AECOM's grit removal design. In addition to the abrasion and corrosion resistance the flumes had to resist deflection in the horizontal and vertical when full at 36" deep. Overflows, stilling wells and level devices had to be designed in close tolerance.

The flumes sections were manufactured in 20' long flanged sections with a 1% bottom slope and a level top over the 120'length. The flumes were supported every 10' with stainless steel supports. Monoxivent's grit flumes are a critical part of the grit removal system and will last for many years.

MONOXIVENT®
FRP - Fiberglass Reinforced Plastic

CorrosionComposites
Corrosion Resistant Duct

CLIENT: **Kansas City Waste Water Treatment Plant** | Kansas City, MO

CHALLENGE: Over the past 20 years the Kansas City Water Plant has replaced 38 motor and chain drives in their primary and secondary mixing tanks with one 40 horse blower. The blower supplies air to 40 fiberglass drive wheels that are directly in line with mixing paddles. Each 13' diameter Water Wheel has eight half round buckets that when filled with air will start the wheel turning. As the submerged wheels turn in the water, each wheel can generate enough torque to drive up to 400' of mixer paddles.

The first wheels were made of wood and they only held up long enough to assure the concept would work. Next they tried making the wheels from flat fiberglass plates and again the torque and weight of the water was too much.

SOLUTION: In 1988 Yankee Plastic Co. (now doing business through Crawford/Monoxivent) was asked to design a better water wheel. The resulting design has proven to be very reliable. The City of KC has installed several new water wheels each year for the last 15 years - completing a total of 40 to finish the project.

MONOXIVENT®

FRP - Fiberglass Reinforced Plastic

FRP/FIBERGLASS REINFORCED
PLASTIC DIVISION
1306 MILL STREET
ROCK ISLAND, IL 61201
877-608-4383
WWW.UNDERDUCT.COM
WWW.CORROSIONCOMPOSITES.COM

CorrosionComposites

Corrosion Resistant Duct

- Registered AIA/CES Education Provider
- U.S. Green Building Council Member since 2010

MONOXIVENT®

FRP - Fiberglass Reinforced Plastic

PRESENTS

UnderDuct

Under Slab HVAC Duct

UnderDuct

Under Slab HVAC Duct

VERSATILE.

OVERVIEW:

UnderDuct by Monoxivent provides the most versatile and cost effective Underground FRP (Fiberglass Reinforced Plastic) Duct on the market today! UnderDuct provides a wide range of solutions from the most demanding environments to standard layouts.

Monoxivent's manufacturing source has over 40 years of experience and is a leader in the Under-Slab Fiberglass Duct market. Monoxivent has a nationwide network of sales representatives and a top-tier inside support staff that provides engineering, design, sales, service, and marketing. UnderDuct is offered both in single wall and pre-insulated double wall construction to meet any ventilation needs. Monoxivent 824 Low Smoke Class 1 duct is recommended for direct burial.

MARKETS:

Supply, return, and exhaust systems include, but are not limited to: auditoriums, auto exhaust, banks, botanical centers, churches, high rise office, hospitals, libraries, parking garages, residences, restaurants, schools, super markets, swimming pools, and zoos.

DURABILITY:

Monoxivent's UnderDuct fiberglass HVAC ductwork provides excellent resistance to corrosion and leakage. The corrosion resistance qualities are maintained throughout both the inside diameter (ID) and outside diameter (OD) allowing for a wide range of applications.

EASE OF USE:

Monoxivent's UnderDuct fiberglass duct can be directly placed onto a pea gravel bed in a graded trench, then backfilled with pea gravel eliminating concrete encasement. Simple joining methods provide for easy and quick installation, which significantly lowers installation costs compared to other materials.

TESTING:

Monoxivent's UnderDuct products have met the Flame and Smoke requirements of a Class 1 duct per

Sydney Ports Corporation Terminal

Mercedes Benz Eldorado Hills

UnderDuct

by Monoxivent®

Green Building with UnderDuct:

Underground FRP Duct is environmentally sound due to the "green" aspects of our fiberglass reinforced plastic underslab duct. FRP duct is a key component of sustainable building. The quality and strength of our FRP duct means a longer life, which saves resources, and maximized airflow uses energy more efficiently.

UnderDuct's "Green" Benefits Include:

- Smooth and Improved Air Flow
- Energy Savings with Insulated FRP Duct
- Maximizes Air Flow and Efficiency
- Resistance to Mold, Corrosion, Leakage, Moisture Damage
- 824 Low Smoke and Flame Class 1 Rating
- Long-life Duct
- Energy Savings
- Allows for "Open Concept" Design in Buildings
- Laminated Joints for Complete Seal
- Promotes Displacement Ventilation Design.

Underwriter's Laboratories (UL) 181 and Uniform Mechanical Code (UMC) 10-1 for above ground installation. We are verified by an ASTM E-84 testing laboratory recognized by the following building code organizations under the Council of American Building Officials: ICBO; BOCA; SBCCI.


Davenport Library


Duncan Aviation
Lincoln, NE


Markquart Toyota
WI - UnderDuct-VE


Missouri State
Rec Center


Sydney Ports
Corporation Terminal


Raleigh Transit

UnderDuct VE
by Monoxivent®


UnderDuct-VE
System used in
service facility

UnderDuct-VE Now Available: Corrosion Resistant Underfloor Duct for Vehicle Exhaust Removal

UnderDuct, by Monoxivent, is pleased to announce our new product: UnderDuct-VE. The corrosion resistant underfloor exhausting duct is rated to 325-degrees F. The duct does not need concrete encasement. The duct's smooth bore allows for more efficient airflow and less pressure drop.

CASE STUDIES

CLIENT: **Davenport Public Library** | Davenport, IA

CHALLENGE: As part of an expansion to their district, the Davenport Library sought to build a new, eco-friendly branch to fulfill the needs of its growing community. It was decided that the new building should seek LEED Certification.

SOLUTION: UnderDuct, by Monoxivent, has played an integral role in the construction of one of Iowa's LEED green buildings: Davenport's Eastern Avenue Library. Double Wall Insulated UnderDuct is one of the sustainable components that were incorporated into the environmentally friendly design which achieved a Silver LEED Certification along with numerous other awards.

CLIENT: **Von Housen Automotive Group/ Mercedes Benz** | Eldorado Hills, CA

CHALLENGE: In an effort to achieve the Autohaus/Mercedes Benz-USA image adopted by over 80% of the country's dealerships, the luxury car store in Eldorado Hills was transformed to look like other Mercedes-Benz dealerships.

SOLUTION: The building expansion included a 2,000 square foot glass and metal showroom that emulates the Autohaus image. Monoxivent's Double Wall Insulated buried duct work was chosen for its HVAC system that enabled the creation of a large open space. This is certainly a case of a high quality installation for a customer who is quite familiar with high quality products!

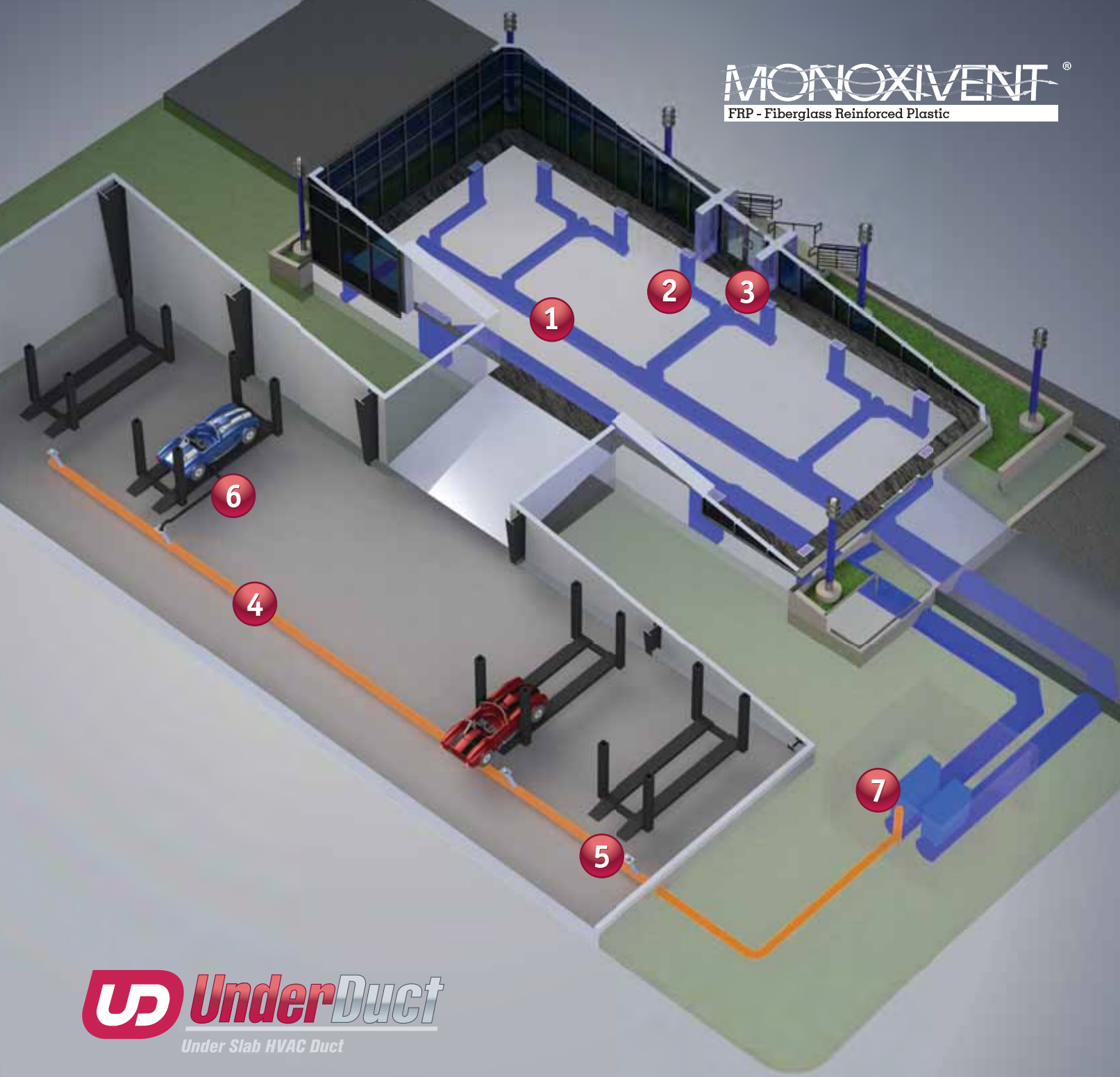
CLIENT: **Sydney Ports Corporation** | Sydney, Australia

CHALLENGE: On 20 December 2009, the Australian Premier announced that the NSW Government decided to permanently relocate the Darling Harbour No. 8 Cruise Passenger Terminal to White Bay 5, in accordance with the recommendation from the Passenger Cruise Terminal Steering Committee. The new terminal would have to service thousands of passengers in a comfortable indoor environment.

SOLUTION: The terminal construction was started in March 2012 and Monoxivent's Double Wall Insulated Buried Duct was chosen to serve as the facilities HVAC system. This required an extremely demanding solution as the buried ductwork is regularly subjected to fluctuating tide water and Monoxivent's UnderDuct provided that solution seamlessly.

MONOXIVENT®

FRP - Fiberglass Reinforced Plastic



UnderDuct

Under Slab HVAC Duct

UNDERGROUND DUCTWORK SOLUTIONS

1 Monoxivent's Double Wall Insulated UnderDuct
2 Monoxivent's Single Wall UnderDuct Register Boots
3 Floor Mounted Register Grills (by others)
4 UnderDuct-VE (Vehicle Exhaust) Ductwork
5 Monoxivent 23800 Floor Exhaust Outlets
6 Monoxivent 3000 Series No Crush Hose
7 Monoxivent Custom Mechanical Equipment Connections

MONOXIVENT®

FRP - Fiberglass Reinforced Plastic

FRP/FIBERGLASS REINFORCED
PLASTIC DIVISION
1306 MILL STREET
ROCK ISLAND, IL 61201
877-608-4383
WWW.UNDERDUCT.COM
WWW.CORROSIONCOMPOSITES.COM

UnderDuct

Under Slab HVAC Duct

- Registered AIA/CES Education Provider
- U.S. Green Building Council Member since 2010

UNDERDUCT PRODUCT INFORMATION

UnderDuct by Monoxivent provides the most versatile and cost effective Underground Fiberglass Reinforced Plastic (FRP) Duct on the market. We provide a wide range of solutions for the most demanding environments to standard layouts.

Monoxivent's manufacturing source has over 40 years of experience and is a leader in the Under-Slab Fiberglass Duct market. Monoxivent has a nationwide network of sales representatives and a top-tier inside support staff the provides: engineering, design, sales, service, and marketing. UnderDuct is offered in single wall and pre-insulated double wall construction to meet any ventilation needs. Monoxivent 824 Low Smoke Class 1 duct is approved for direct burial. UnderDuct has received Code Compliance Approval from ICC Evaluation Service.

UnderDuct markets for supply, return, and exhaust systems include, but are not limited to: auditoriums, auto exhaust, banks, botanical centers, churches, high rise office, hospitals, libraries, parking garages, residences, restaurants, schools, super markets, swimming pools, and zoos.

FEATURES & BENEFITS	UNDERDUCT	HDPE	PVC
Tested for Low Smoke & Flame Meets UL 181 & NFPA Standards for Class 1 Duct Material	✓	NO	NO
Factory Assembled Reduces Installation Cost & Improves Quality	✓	NO	NO
Low VOC Joint Option Meets LEED Specification Requirements	✓	NO	NO
Custom Shapes & Fittings Maximizes Application Potential	✓	NO	NO

CORROSION COMPOSITES PRODUCT INFORMATION

Corrosion Composites by Monoxivent is a source for corrosion resistant fiberglass fabrication services. Fiberglass laminated composites are light weight, high strength, non conductive, and corrosion resistant. Monoxivent assists with design, engineering, drawing, manufacturing, inspection, and installation. Monoxivent brings together years of fiberglass experience and manufacturing expertise. For many industrial, water, and wastewater applications where corrosion is a problem, fiberglass is the material of choice.

Corrosion Composites provides excellent resistance to corrosion and offers a long service life. Laminates are designed for wind, seismic, snow, pressure, vacuum, and temperature. Corrosion Composites adhere to ASTM, SMACNA, and other industry standards.

Product categories include: duct, scrubbers, dampers, tank covers, weirs, platforms, stacks, flumes, manholes, stack liners, trenches, pressure vessels, tanks, hoods, troughs, baffles, ladders and more.

THE UNDERDUCT ADVANTAGE

Durability:

Monoxivent's UnderDuct fiberglass HVAC ductwork provides excellent resistance to corrosion and leakage. The corrosion resistance qualities are maintained throughout both the inside diameter (ID) and outside diameter (OD) allowing for a wide range of applications.

Ease of Use:

Monoxivent's UnderDuct fiberglass duct can be directly placed onto a pea gravel bed in a graded trench, then backfilled with pea gravel eliminating concrete encasement. Simple joining methods provide for easy and quick installation, and the FRP duct is impervious to minerals or salts present in soil.

Efficiency:

Monoxivent's UnderDuct systems can be sealed to achieve a water and air tight system. A leak-free system and smooth interior surface will ensure the air reaches its destination efficiently and without contamination.

Material Integrity:

Monoxivent's UnderDuct FRP fiberglass duct is filament wound with two chemically inert materials – glass and resin. The finished product provides longer underground service life than galvanized sheet metal, stainless steel, or PVC coated sheet metal. The filament winding provides greater hoop strength resulting in a stronger duct than other methods of construction such as hand lay-up. The finished product is lighter than steel while offering superior acoustical qualities and corrosion resistance.

Testing:

Monoxivent's UnderDuct has been tested by ICC-ES and listed (PMG-1171) and shown to be compliant with the following building codes: IMC, IRC, UMC, AND CMC.

Versatility:

Monoxivent's UnderDuct FRP products are available in straight lengths, standard and custom fittings, or in shop fabricated sections. Single wall duct can be shipped in prefabricated assemblies. Pre-insulated double wall duct has many advantages, including assured uniformity of insulation, permanent protection of insulation, and all-in-one installation.

THE CORROSION COMPOSITES ADVANTAGE

Monoxivent's Corrosion Composites FRP products provide excellent resistance to corrosion and offer a longer service life compared to similar metal products. Our fiberglass reinforced plastic products are specially designed to withstand the challenges of corrosive environments such as:

Chemicals
Wind Issues
Seismic Activity
Heavy Snow
High Pressure
Vacuums
Extreme Temperatures
AND MORE!
Corrosion Composites adhere to ASTM, SMACNA, AWWA, and other industry standards.

An Experienced Team You Can Count On!

Monoxivent's design team includes engineering, layout and custom solutions. This, coupled with a manufacturing source with over 40 years of experience, a 90,000-sq. foot facility and state-of-the-art equipment makes Corrosion Composites an excellent source for FRP products.
Furthermore, all of Corrosion Composites' duct fabricators have at least five years experience in fabricating corrosion resistant duct for wastewater applications. A reference list of completed waste water projects will be provided with every quote.

Wide Range of Products Provide Versatility

The right product for a wide variety of jobs and needs, including:

Ducts
Tanks
Scrubbers
Flumes
Fume Hoods
Dampers
Manholes
Troughs
Tank Covers
Stacks
Stack Liners
Baffles
Weirs
Trenches
Ladders
Platforms
Pressure Vessels
AND MORE!

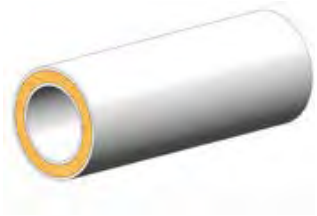
UNDERDUCT - SINGLE/DOUBLE WALL DUCT

SINGLE WALL OVERVIEW

Our Class 1 rated single wall duct, meets 25/50 flame/smoke requirements of UL 181. Monoxivent UnderDuct 824 Low Smoke has been approved for underground applications. It is an excellent choice for corrosive environments where flame and smoke development are a concern, such as laboratories and swimming pools.

Monoxivent's single wall register boot (above) is shown during installation. The corrosion resistant boots are high strength and meet the same standards as typical single wall UnderDuct. Longer boots may require temporary bracing during concrete pouring for floor.

DOUBLE WALL OVERVIEW



Double wall Monoxivent UnderDuct will eliminate any thermal losses and save time and money compared to insulating on site. When supplied with the standard 1” insulation, the duct has a k factor of 0.16 and an R value of 6. Also available in R-10, R-14 by request.

CORROSION COMPOSITES

Corrosion Composites, by Monoxivent, is the leading source for corrosion resistant fiberglass reinforced plastic (FRP) fabrication. Our FRP products are used in many industrial, water, wastewater, underground, industrial/commercial and HVAC applications where corrosion is a problem.

Fiberglass Reinforced Plastic Products Are:

Light Weight
High Strength
Non-Conductive
Corrosion Resistant

Typical FRP Applications:

Ducts
Hoods
Stacks
Pipes
Platforms
Tanks
Scrubbers
Custom Items

LAB DUCT/HYBRID CF

Corrosive Fume Duct/Hybrid

Lab Duct can handle a wide variety of chemical fumes, including strong acids and caustics. Condensate formed in the duct system can concentrate these chemicals due to evaporation, making them even more corrosive. Because a Lab is considered occupied space, the structural and exterior surface of the duct requires a low smoke and flame rating per UL-181, as well as low fire-gas toxicity.

Hybrid-CF (Corrosive Fume) duct has an interior layer of corrosion resistant vinyl ester resin while the structural and exterior layers are fabricated with Monoxivent's 824 UnderDuct Resin. The unique blend offers the required corrosion resistance often needed with the protection of a low smoke, low flame Class 1 Duct that is required for use in occupied buildings.

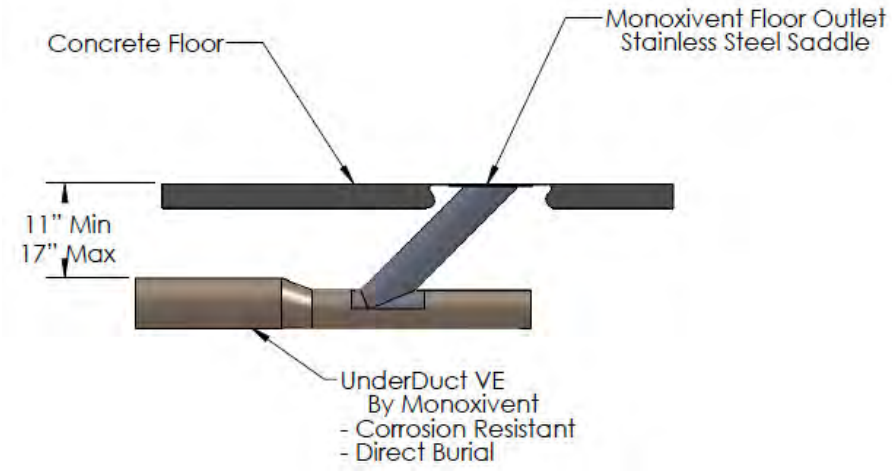
Applications:

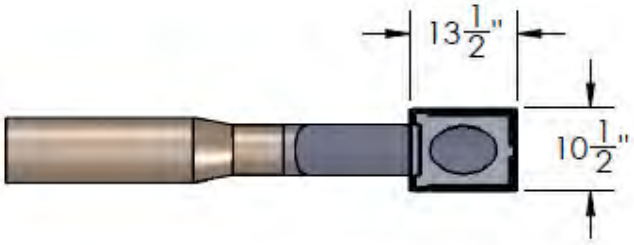
Hospitals
Aquariums
Dog Kennels
Exposed Vehicle Exhaust Duct
Swimming Pools
Laboratories

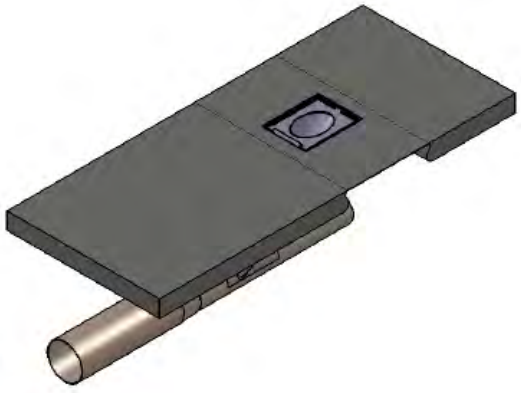
UNDERDUCT - VE, CORROSION RESISTANT UNDERFLOOR DUCT FOR VEHICLE EXHAUST REMOVAL

UnderDuct, by Monoxivent, is pleased to announce: UnderDuct-VE. The corrosion resistant underfloor exhausting duct is rated to 325-degrees F. The duct does not need concrete encasement. The duct's smooth bore allows for more efficient airflow and less pressure drop.

UNDERDUCT - VE, CORROSION RESISTANT UNDERFLOOR DUCT FOR VEHICLE EXHAUST REMOVAL







UNDERDUCT - INSTALLATION/BURIAL GUIDELINES AND PROCEDURES

Summary:

UnderDuct FRP should be laid in a graded trench with good drainage on a 4” bed of pea gravel. Minimum distance from under the slab to top of duct is 4" of compacted fill. The recommended maximum is 4' of compacted fill. Duct can be designed for deeper burial.
Encasement in concrete is not necessary. With fiberglass boots in place and sealed, cover with sand or pea gravel and pour floor slab with no delay or tie down.
Duct is manufactured with a resin rich veil on the OD to prevent water infiltration. Where ground water infiltration is possible the field joints should be made using the wet lay-up method as described in the installation instructions.
NOTE: Leak test the system before backfilling.

UNDERDUCT - INSTALLATION/BURIAL GUIDELINES AND PROCEDURES

Joining duct with a catalyzed resin and cloth and/or mat may be effectively performed by placing cloth and/or mat on a sheet of waxed film or cellophane and saturating with a resin after adding catalyst. The wet lay-up may then be applied to the ends to be joined and air pockets worked out by squeezing or rolling on the firm surface.

Duct Fitting Ends and field cuts shall be completely brush coated with catalyzed resin prior to joint wrap so no raw glass fibers are exposed. Resins used shall be the same type used in the duct and fitting filament winding. Wet field joints (mat and resin) shall be a minimum 4” in width and at lease the same thickness as the adjoining duct wall.

Joints shall be minimum three wraps for duct up to 22”Ø, four wraps for 22”Ø to 36”Ø and six wraps for duct 38”Ø to 60”Ø. Joint material shall be thoroughly saturated with the same type of resin as used in duct and fittings. Minimum joint overlap shall be 4” for all sizes

A hard roller (Paint Roller) can be used to spread the resin and to work out potential air bubbles. Additional layers of mat may be used in the same manner. Care should be taken to catalyze only the amount of resin that can be used during the pot life of the resin. A little experience can quickly determine the proper handling of the resin

The catalyst should be carefully proportioned to the amount of resin to be used, and thoroughly mixed to a uniform blend. Duct joints or repaired parts should be allowed to cure at least 24 hours before being used. If additional lamination is to be made over a cured area, surface should be broken by sanding before application.

Trench:
The surface at the bottom of the trench should be continuous, smooth and free of rocks to avoid point loading on the duct. The trench should also be graded with a slight pitch to facilitate drainage with the bedding as uniform and continuous as possible.

Trench width should not be greater than necessary to provide adequate room for joining the duct in the trench and for compaction the backfill in the bedding zone and at the sides of the duct. The minimum distance between the duct and the trench is 4 inches; maximum recommended trench width is twice the diameter of the duct.

Where the risk of flooding the trench during installation is possible, care should be taken to keep water away from the duct and the field joint areas. Keeping the water from the duct system shall continue from the time the duct is first placed in the trench, until backfill or encasement is completed. Damage can occur when the duct is floated during a water uplift event.

UNDERDUCT - INSTALLATION/BURIAL GUIDELINES AND PROCEDURES

Backfilling:
The approved backfill materials are pea gravel or dry sand. These materials will achieve 80% to 90% compaction without the use of mechanical compaction machines. Rodding and hand tamping are the only approved compaction methods over the top of the duct.

In poor soil conditions, permeable synthetic support fabric should be utilized as a trench liner to prevent migration of the gravel into native soil. The next two layers (6” cover over duct), in lifts of 6”, may be the excavated material, provided there is no organic material, frozen lumps, debris, or particles larger than ½”.

Each layer is to be compacted to the required density. Where heavy floor loads are expected, the floor slab should be either structurally reinforced over the duct area or as an alternate method, a crown of concrete could be poured over the duct in lieu of the indicated select backfill. In either case, the selection of the proper method should be determined by the structural engineer.

Concrete Encasement:
Concrete encasement is not required, but can be accommodated with provisions. If you are considering concrete encasement, it must be done in 2 to three 3 lifts depending on the diameter and trench conditions, with provisions to prevent floating. Please contact Monoxivent for specific instruction on how to do this without damaging the duct. Duct hold down systems for encasement should be designed by a Mechanical Engineer and confirmed with Monoxivent for potential pounds of floating lift per linear foot per diameter.

Tools and Supplies:
Items you are going to need to make a Field Joint will be as follows. Lamination roller, rubber gloves, paint brushes, measuring containers, utility knife or scissors, grinding disc (36 grit abrasive), heat gun (if temperatures are below 60o F), wax paper or mylar, acetone (for cleanup) and protective wear.

Precautions:
Although most polyester and vinylester resin are quite stable, extended storage at elevated temperatures above 80o F (26.7o C) can decrease the reactivity of the resin or cause it to gel even without the use of catalyst. Make sure you read the resin data sheets that come with every shipment. Temperature extremes must be avoided for proper curing of the resin. See Table 1 below for mixing ratios at varying temperatures. Work must be done in a dry, well-ventilated area. A wide flat surface should be available to wet-out the glass mat strips. The surface should be covered with a disposable covering. Anyone coming into contact with the resin and catalyst must wear rubber gloves and protective eyewear. Always review the supplied MSD Sheets, keep all joining materials away from an open flame and use an adequate amount of ventilation.

UNDERDUCT - INSTALLATION/BURIAL GUIDELINES AND PROCEDURES

Mixing:
The rate of curing of the resin is dependent on the temperature. At low temperatures, most resins have a longer working life and require longer curing periods. Working time is decreased and curing takes place more rapidly as the temperature increases. Decreasing the amount of catalyst prolongs the working time. See Table 1.

The catalyst should be carefully proportioned to the amount of resin to be used, and thoroughly mixed to a uniform blend. Duct joints or repaired parts should be allowed to cure at least 24 hours before being used.

Table 1

Amount of Resin	Amount of Hardener	Temperature	Approximate Pot Life
1 qt	2 / 3 oz	50-60°F	20 min.
1 qt	1 / 2 oz	60-70°F	20 min.
1 qt	1 / 3 oz	70-80°F	20 min.
1 qt	1 / 3 oz	80-90°F	20 min.
1 qt	1 / 6 oz	Over 90°F	20 min. or less

Joining:
Coat all raw edges with resin mix, completely filling the joint and slightly squeezing the sections together. It is often preferable to add sufficient Cab-O Sil to resin for this step to produce a paste or light putty which will fill small voids and irregularities if there is not a good fit. It is often desirable to speed-up the hardening time for this step also by increasing the MEK catalyst required by 1 to 2 cc per pound. Insure that the interior surface is relatively smooth but a light “bead” on the interior is desirable and acceptable.

Butted sections may be “hot patched” with tabs to hold the alignment until the complete joint can be made. A tab consists of 2-3” square of glass mat saturated with resin mix. Place the prepared hot patch tab across the joint to be made to form a “tack weld.” Three are usually sufficient. For this step, it is often desirable to speed-up the hardening time of the resin by increasing the MEK catalyst by 1 to 2 cc per pound.

Two lay-ups may be required to prevent sag and overheating of the resin during hardening.
Where accessible, the inside surface of the joint should be covered with 1-2 piles of fiberglass mat 4-6” wide and 1 ply of 6-8” wide surfacing veil or mat saturated with resin.

Cut the glass mat to length using Table 2 and Table 3 for the number of layers and width of glass required. Each piece of glass should be cut into manageable lengths allowing for a slight overlap. Lay the widest section of mat on a flat surface treated with release agent or covered with releasing film. Wet the entire surface with resin mix, using a paint brush and/or roller. Position the next ply of glass, staggering the pieces properly.

UNDERDUCT - INSTALLATION/BURIAL GUIDELINES AND PROCEDURES

Wet out the entire surface area of this layer with the resin mix. Remove as much air as possible with brush and/ or roller toward the edges of the laminate section. Be careful to not remove excessive resin from an area. Repeat with proper sequence of glass until all plies have been saturated with resin and formed into one integral unit.

If additional lamination is to be made over a cured area, surface should be broken by sanding before application.

Clean Up:
Preferably, acetone is used as a cleaner for your hands and tools. Soap and hot water may be used, though not as effectively as acetone. Thorough cleanup must be made before the resin cures. Care should be exercised to keep catalyst and resin from contact with skin. We recommend wearing rubber gloves when working with resins and catalyst.

Table 2

Duct Wall Thickness	Minimum Total Width of Overlays
1 / 8”	4”
3 / 16”	4”
1 / 4”	4”
5 / 16”	5”
3 / 8”	6”
7 / 16”	7”
1 / 2”	8”
9 / 16”	9”
5 / 8”	10”

UNDERDUCT - INSTALLATION/BURIAL GUIDELINES AND PROCEDURES

Table 3

Duct Wall Thickness	Number of Plies of Strapping and Sequence
1 / 8"	MRM
3 / 16"	MRM
1 / 4"	3(MR)M
5 / 16"	3(MR)M
3 / 8"	3(MR)MM
7 / 16"	3(MR)MM
1 / 2"	3(MR)M, MRM
9 / 16"	3(MR)M, 2(MR)M
5 / 8"	3(MR)M, 3(MR)M

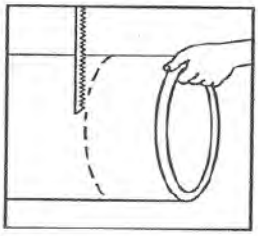
M= 1 1/2 oz. / ft²
R = 24 1/2 oz. / ft²

These tables should only be used as guides for the minimum total width of joint overlays and minimum joint thickness. Joint thickness should be at least as thick as the duct to be joined.

*** ASTM C 582 Table 2 Type 2**
*** ASTM D 3982 Table 2**

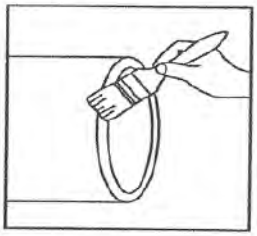
UNDERDUCT - INSTALLATION/BURIAL GUIDELINES AND PROCEDURES

Joining Procedures for Wet Lay-Up

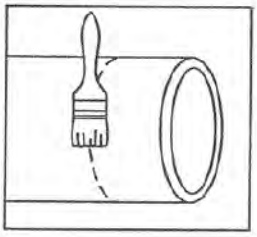


1. Firmly support duct sections. Square the ends to be welded using a saw.

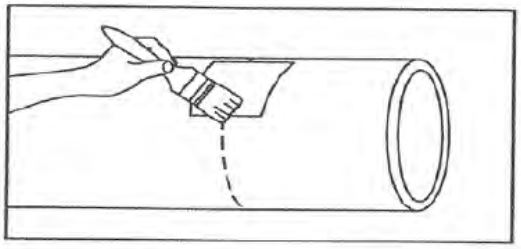
2. Rough the outer surface with sander approximately 1" farther from the ends than the finished weld surface. Where inside welds are possible, interior surfaces should be sanded prior to assembly. See Table 2 on previous page.



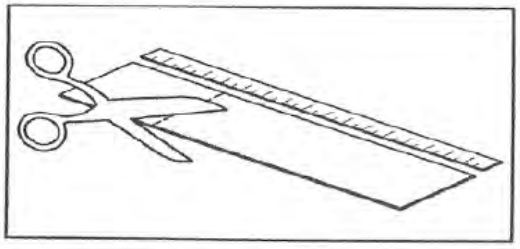
3. Coat roughened ends of duct with a small amount of catalyzed reins. Any large voids may be filled with silica-filled resin putty.



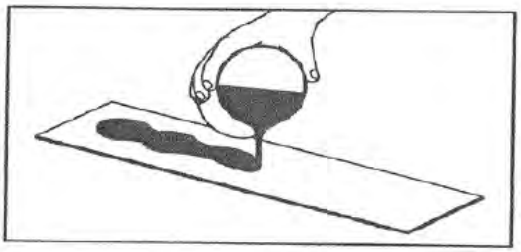
4. Support components in joint position so that no movement occurs while making the joint. Fill joint with resin.



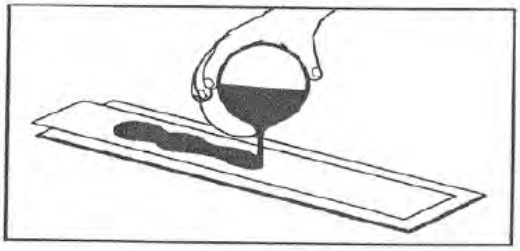
5. A "Hot Patch" technique may help prevents movement of duct during the weld-cure period. Wet 2" squares of mat with a small amount of resin using three times normal amount of catalyst. Apply "Hot patches" at intervals around joint. Curing or hardening in a matter of minutes, they secure duct sections in proper alignment. Mix resin and catalyst for "Hot Patches" in a small paper cup and discard immediately after use to avoid contaminating welding resin.



6. Lay out fiberglass mat strips on the work table. Length of each strip should be 2" longer than circumference of duct. Strips longer than 36" may be cut in half to simplify application. Mix prescribed amount of catalyst with required amount of resin in a separate clean container. Prepare only the amount of resin which can be used immediately (about 1 qt. per 6 sq. ft. of mat) the resin will harden in roughly 20-30 minutes.

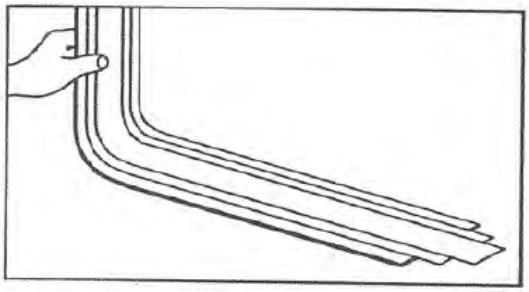


7. After mixing in the catalyst thoroughly, pour the resin onto the widest mat first. Spread it over the entire mat strip, working it into the mat fibers manually. (Neoprene gloves are recommended).

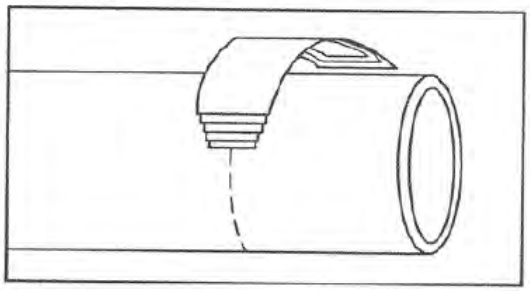


8. Place the next widest strip onto the first strip by staggering away from the first to produce a smooth weld strip joint. Add more resin and work onto the second strip.

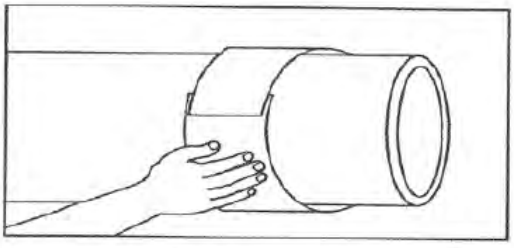
UNDERDUCT - INSTALLATION/BURIAL GUIDELINES AND PROCEDURES



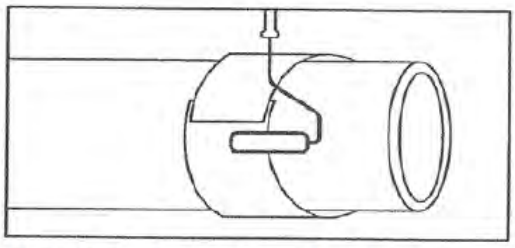
9. Add other strips in the same manner. In wetting each strip, it is best to be a little "lean" on resin at this stage rather than over-wetting. More resin may be added later if necessary. After



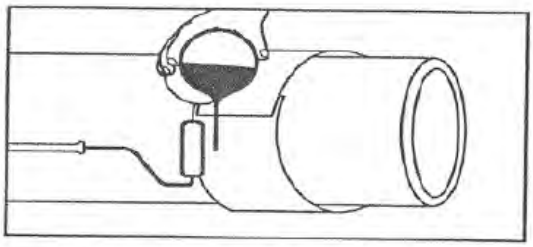
10. Pick up the completed weld strip by one end and center in carefully on the duct joint. Apply the tapered end first with the



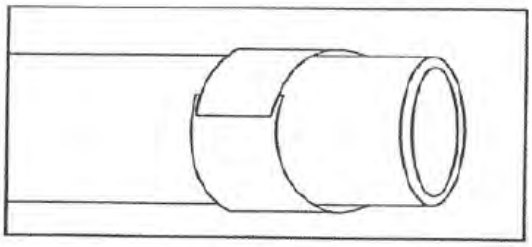
11. Be sure the weld is centered, with care taken to avoid wrinkles on the under and back side of the weld. Continue applying the strip around the joint until the free end overlaps



12. Finish the application of the weld with the roller. Any remaining air bubbles will appear as light spots. These should be rolled to the edge of the weld where they will be released and disappear. If weld is not a slight butt joint, a little extra rolling and hand work to shape mat strips to structure configuration will eliminate bumps and ridges.

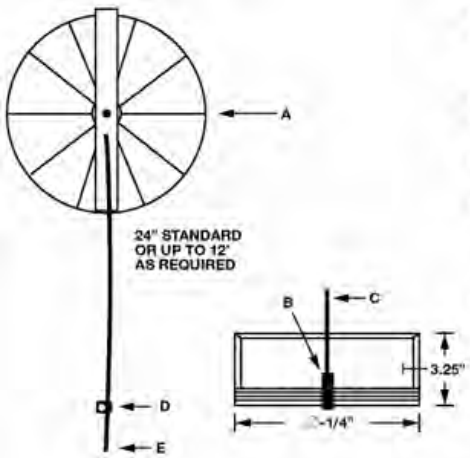


13. At this stage, resin may be added where necessary if any mat appears to be not thoroughly wetted. It is better to have too little resin on the weld strip, when initially applied, than too much. Over-wetting makes it difficult to keep the weld strips in place. Also coat the remaining sanded surface with resin.



14. Allow the completed weld to cure thoroughly tack free. Do not move or disturb weld until it is thoroughly cured. If temperature is below 55°F, keep weld area warm with heat lamps. For exterior installation, protect the weld from the weather.

CABLE OPERATED DAMPERS



Design & Materials

A. Galvanized steel radial damper velocity loaded to hold setting. Also available in aluminum and stainless steel.
B. Damper pivot accepts rotary cable.
C. Cable lengths as required up to 12'. 1/4" brass plated steel rotary cable.
D. Nylon cable clamp for field furnished with 5/16" hex self-drilling screw.
E. Male square rotary cable end adjusts with a standard hex nut driver (by others) or the MAT square nut driver. Optional: thin-blade screwdriver adjusted cable tip.

Features

- Furnished one piece for easy installation.
- Cable minimum turn radius = 4".
- Operating temperature limits = -40° to 240° F.
- Maximum recommended velocity = 1600 FPM.
- No linkages or cable to adjust.
- No small loose parts to get lost.
- Dampers may be installed in any plane.

Available Sizes

6", 8", 10", 12" & 14"

MONOXIVENT FRP WARRANTY

IMPORTANT

Representatives or their customers are responsible for all claims of freight damage regardless of carrier used. Monoxivent will not provide a replacement or compensation for any merchandise damaged in transit.

LIMITED WARRANTY

Monoxivent shall replace or repair at its discretion, any products or components manufactured which prove to be defective in workmanship or material within one (1) year from date of shipment.

The foregoing is in lieu of all warranties, expressed or implied, and all other obligations or Liabilities on behalf of the Company, regarding products it may manufacture or sell. Except as provided herein, the purchaser accepts the product "As Is."

A. In no event shall Monoxivent, be liable for consequential or special damages; nor for transportation, labor, inadequate system design by others, incorrect equipment selection by others, or other charges for adjustment, replacement, installation or other alterations, which may be performed in connection with such products. The warranty specified herein is waived in the event that the Representative or Purchaser performs any unauthorized repairs or modifications to the product. Such authorization must be obtained in writing from Monoxivent.

B. Products not manufactured by Monoxivent or not part of an assembly manufactured by Monoxivent shall be warranted only to the extent provided by the manufacturer.

LIMITATION OF WARRANTY

Monoxivent makes no other warranties, express or implied, including warranties of merchantability and fitness for a particular use if designed by others, and shall not be liable for incidental or consequential damages such as, but not limited to, lost profits, loss of use of other equipment or increases in costs or expenses.

CORROSION SPECIFICATION

Sample Specification from Monoxivent Corrosion Composites
SECTION 15800 – FIBERGLASS REINFORCED PLASTIC DUCTWORK

PART 1 – GENERAL

1.01 Reference:

A. This Section of the Contract Specifications shall be read in conjunction with Section 15000 – General Mechanical Clauses, which shall apply to and govern the work of this section.

1.02 Work Included:

A. FRP – Fiberglass Reinforced Plastic ductwork and appurtenances, complete and in place, in accordance with the requirements of the Drawings.
B. All ductwork in the Chemical Room and connecting the Hydrochloric Acid Scrubber Unit shall be FRP.

1.03 Standards:

A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
    a. ASTM C 582 – Standard specification for contact – molded reinforced thermosetting plastic laminates for corrosion resistant equipment.
    b. ASTM D 3982 – Standard specification for contact-molded fiberglass ducts and hoods.
    c. ASTM D 2996 – Standard specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Pipe.
    d. NPS 15-69 - Standards specification for Custom Contact-Molded Reinforced - Polyester Chemical - Resistant Process Equipment.
    e. SMACNA Thermoset FRP Duct Construction Manual
    f. ASTM E 84 - Test for low flame

1.04 Submittals:

A. Submit shop fabrication drawings and installation drawings of the ventilation system in accordance with Section 01300 – Submittals.

CORROSION SPECIFICATION

PART 2 – PRODUCTS

2.01 General:

A. Manufacturer:
   a. Provide FRP duct as manufactured by one of the following without exception:
      i. Corrosion Composites by Monoxivent
      ii. Yankee Plastics
      iii. Or equal

B. Service Conditions:
   a. Ductwork shall be designed for exhausting Hydrochloric Acid fumes at ambient conditions. The minimum wall thickness for above grade FRP ductwork shall conform to the following:
   b. Minimum Wall thickness will be in accordance with NPS 15-69, Table 2.
   c. Duct with inside diameter of 20" (508mm) or less shall have a wall thickness of 0.125" (3.2mm); duct with inside diameter of 22" - 36" (559mm - 914mm)shall have a wall thickness of 0.1875" (4.8mm); duct with inside diameter of 38" (965mm) or greater shall have a wall thickness of 0.25" (6.4mm).
      i. Surfacing veil shall be C glass veil with a silane finish and a soluble binder.
      ii. Chopped strand mat shall be type ECR glass minimum 1.5 oz/sq ft (458 g/sq m) with silane finish and styrene soluble binder.
      iii. Continuous roving for chopper gun spray up shall be type E glass.
      iv. Woven roving shall be type E glass minimum 24 oz/sq yd (814 g/sq m)
      v. Continuous roving for filament winding shall be type E glass with silane finish.
   d. Minimum Hanger Spacing will be in accordance with ASTM D 3982, Table 1.

C. Construction:
   a. FRP shall be of filament wound construction with a PS 15-69 corrosion barrier. Cast duct with no reinforced internal corrosion barrier or press molded fittings will not be accepted.
   b. FRP duct shall be factory assembled to the greatest possible extent, with a minimum number of field joints.
   c. Maximum allowable deflection for any size ductwork shall be 0.50" (12.7mm) between supports and for any size of duct under worst case operating conditions.
   d. FRP ductwork shall be designed using a safety factor of 10 to 1 for pressure and 5 to 1 for vacuum without exception.
   e. Out of roundness of duct shall be limited to 1% of diameter.
   f. Length of flanged duct sections shall not vary more than 0.50" (12.7mm) at 70 degrees F (21 degrees C).
   g. Un-flanged duct sections shall be square on the ends in relation to the center axis within 0.125" (3.2mm) up to and including 24" (610mm) diameter and within 0.1875" (4.8mm) for all diameters greater than 24" (610mm).

CORROSION SPECIFICATION

D. Laminates:
   a. Resin shall be a premium grade of fire retardant vinyl ester with a flame spread rating of less than 25, I.D. “Class 1” of ASTM E84 “Standard Method of Test for Surface Burning Characteristics of Building Material”. Resin shall be AOC’s #K022, Ashland’s #FR992 or Reichhold #9300.
   b. Ductwork shall have a resin rich inner surface, an interior layer, a structural layer and an exterior layer with UV resistant coating.
   c. Inner surface: Nominal 10 mils thick composed of a single ply of the “C “glass surfacing veil, having a resin content of 90%.
   d. Interior layer: Nominal 90 mils thick composed of at least two layers of 1-1/2’’ chopped strand mat. Resin content shall be 75%.
   e. Structural layer: Filament wound type E glass to meet minimum wall thickness as specified. The total wall thickness includes the inner surface.
   f. Exterior UV resistant coating: Factory applied corrosion resistant gel coat with UV inhibitors. Light gray or white shall be used as the standard colors.

E. Fittings:
   a. Fittings shall be hand lay-up construction fabricated from the same resin and have the same strength as the FRP duct.
   b. The internal diameter of fittings shall be equal to the adjacent duct.
   c. The centerline radius of all elbows shall be 1.5 times the diameter.
   d. Elbows 24" (610mm) diameter and smaller shall be smooth radius. Elbows larger than 24" (610mm) diameter shall be mitered.
   e. Elbows 45 degrees or less shall be at least two (2) miter/three (3) gore. Elbows greater than 45 degrees shall be at least four (4) miter/five (5) gore.

F. Flanges:
   a. Provide flanged connections as required to flexible connectors, expansion joints, vessels, demisters, fans, silencers and other locations as shown.
   b. Flanges shall be hand lay-up construction. Dimensions shall be in accordance with PS 15-69 – Table 2 and the duct dimension schedule.
   c. Flange faces shall be perpendicular to the axis of the duct within 0.5 degree.
   d. Flange faces shall be flat to within 0.0313" (0.8mm) up to and including 18" (457mm) diameter and within 0.0625" (1.6mm) for 20" (508mm) diameter and larger.
   e. Gaskets shall be EPDM/Neoprene, full face and minimum 0.125" (3.2mm) thickness.
   f. Bolts, nuts and washers shall be Type 316 stainless steel.

G. Joints:
   a. Provide butt and wrap joints in accordance with ASTM D 3982.
   b. Field weld materials shall be supplied by the duct manufacturer. Complete written and online video instructions shall be provided along with Material Safety Data Sheets.
   c. Resin, catalyst and fiberglass materials shall be supplied in bulk for the total number of joints plus 20% extra.

CORROSION SPECIFICATION

2.02 Expansion Joints:

A. Provide expansion joints where shown on the Drawings.
B. Type: W-design configuration with integral flanges suitable for service with FRP duct under the conditions specified.
    a. Material: EPDM
    b. Backing rings: 0.394" (10mm) thick, 2" (51mm) wide, type 316 stainless steel where flanged expansion joints or flex connectors are noted.
    c. Extensions: 3" (76mm)
    d. Compression: 2.5" (64mm)
    e. Lateral offset: 2.5" (64mm)
    f. Thickness: 0.250"(6.4mm) minimum
    g. Bolts, nuts and washers: Type 316 stainless steel.
C. Expansion joints shall be flanged where connecting ductwork to equipment, otherwise slip-type will be acceptable. Acceptable manufacturer: Mercer Rubber or equal.

2.03 Butterfly Dampers:

A. Round FRP dampers:
    a. Round FRP dampers shall be the butterfly type. FRP fabrication shall meet the corrosion requirements specified in this section for FRP ductwork.
        i. Fabrication:
            1. Frame and blade: premium vinyl ester. Blade shall fully encapsulate shaft. Blades that bolt to a single side of the shaft will not be accepted.
            2. Shaft: Pultruded vinyl ester
            3. Bearings: EPDM/Neoprene
            4. Pins and hardware: Type 316 stainless steel.
            5. Shaft seals: EPDM/Neoprene
            6. Isolation dampers will have full circumference EPDM/Neoprene seals.
            7. Dampers shall have flanged ends or plain ends. Provide Type 316 stainless steel bolts, nuts and washers for flanged connections (By Others).
            8. Balancing/Volume dampers shall have a fully adjustable slot with an extra hole drilled in the handle for contractor to “drill –and-pin in-place” once the system is balanced so handle cannot vibrate loose.

CORROSION SPECIFICATION

PART 3 – EXECUTION

3.01 Installation:

A. FRP ducts shall be installed in a neat and workmanlike manner, properly aligned and cut from measurements taken at the site to avoid interferences with structural members, architectural features, openings and equipment.
B. Supports and anchors: All ducting shall be firmly supported with fabricated or commercial hangers or supports in accordance with SMACNA requirements. Where necessary to avoid stress on equipment or structural members, the ducts shall be anchored or harnessed. Expansion joints and guides as shown on drawings shall compensate for expansion due to temperature differences.
C. Support duct risers in accordance with ASHRAE and SMACNA as indicated.

3.02 Duct Preparations:

A. Prior to installation, each duct length and all fittings shall be carefully inspected, flushed clean of any debris or dust, and straightened, if not true. All duct and fittings shall be equally cleaned before assembly.

3.03 Duct Joints:

A. Butt and Wrap Joints: Prior to joining, ends shall be ground smooth. All dust and debris must be fully removed. Ends shall be resin-coated to prevent corrosion; in duct of 24" (610mm) diameter and above an interior corrosion wrap is required. The joint should be of equal strength as the duct wall. A butt and wrap sequence and thickness chart should be shown on the fabrication drawings and supplied with the Material Safety Data Sheets.
B. Supports and Anchors: All ducting shall be firmly supported with fabricated or commercial hangers or supports in accordance with SMACNA. Where necessary to avoid stress on equipment or structural members, the ducts shall be anchored or harnessed. Expansion joints and guides shall compensate for duct expansion due to temperature differences.

CORROSION SPECIFICATION

3.04 Inspection and Field Testing:

A. Inspection: All finished installations shall be carefully inspected for proper joints and sufficient supports, anchoring, interference and damage to duct, fittings and gel coat. Damage shall be repaired to the satisfaction of the Engineer.
B. Field Testing: Prior to enclosure or buying, all ducting systems shall be pressure tested at 1-1/2 times the maximum working pressure. The contractor shall furnish all test equipment, labor, materials and devices at no extra cost to the owner.
C. Leakage may be determined by loss of pressure, soap solution, chemical indicator or other positive and accurate method. All fixtures, devices or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the test procedures.
D. Leaks shall be repaired to the satisfaction of the Engineer and the system shall be re-tested until no leaks are found.

END OF SECTION 15800

LABORATORY DUCT SPECIFICATION

Sample Specification - Monoxivent Laboratory Hybrid Duct
SECTION 15800 – FIBERGLASS REINFORCED PLASTIC DUCTWORK

PART 1 – GENERAL

1.01 Reference:

A. This Section of the Contract Specifications shall be read in conjunction with Section 15000 – General Mechanical Clauses, which shall apply to and govern the work of this section.

1.02 Work Included:

A. FRP – Fiberglass Reinforced Plastic ductwork and appurtenances, complete and in place, in accordance with the requirements of the Drawings.

B. All exhaust ductwork in the Terrace and Concourse Levels and connecting to the rooftop discharge shall be FRP.

1.03 Standards:

A. ASTM C 582 – Standard specification for contact – molded reinforced thermosetting plastic laminates for corrosion resistant equipment.

B. ASTM D 3982 – Standard specification for contact-molded fiberglass ducts and hoods.

C. ASTM D 2996 – Standard specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Pipe.

D. SMACNA's Thermoset FRP Construction Manual.

E. ASTM E 84 - Test for low smoke and low flame.

LABORATORY DUCT SPECIFICATION

1.04 Submittals:

A. Submit shop fabrication drawings and installation drawings of the ventilation system in accordance with Section 01300 – Submittals.

B. Submit test results from a certified testing laboratory that the ductwork supplied complies with UL 181, Class 1, maximum flame-spread index of 25 and maximum smoke-developed index of 50 according to ASTM E 84. Certification date must be no older than ten (10) years.

PART 2 – PRODUCTS

2.01 General:

A. Manufacturer: Provide FRP duct as manufactured by one of the following without exception:

1. Monoxivent
2. Yankee Plastics

B. Service Conditions:

1. Ductwork shall be designed for exhausting corrosive salt water laden air at ambient conditions. The minimum wall thickness for above grade FRP ductwork shall conform to the following:

a) Wall thickness an minimum hanger spacing will be in accordance with ASTM D3982, Table 1

b) Duct with inside diameter less than 22" (560mm) shall have a minimum wall thickness of 0.125” (3.2mm); duct with inside diameter of 22" - 36" (560 - 915mm) diameter shall have a minimum wall thickness of 0.1875" (4.8mm); duct with inside diameter greater than 36" (915mm) shall have a minimum wall thickness of 0.25" (6.4mm).

2. The FRP ductwork shall be designed and fabricated to carry air which is at xx” W.G. negative pressure.

LABORATORY DUCT SPECIFICATION

C. Reinforcement:

1. Surfacing veil (interior and exterior) shall be C glass veil with a silane finish and a soluble binder.

2. Chopped strand mat shall be type E glass minimum 460 gr/sq. m (1.5 oz. /sq. ft.) with silane finish and styrene soluble binder.

3. Continuous roving for chopper gun spray up shall be type E glass.

4. Woven roving shall be type E glass minimum 570 gr/sq. m (24 oz. /sq. yd.)

5. Continuous roving for filament winding shall be type E glass with silane finish.

D. Construction:

1. FRP shall be of filament wound construction with an ASTM C – 582 interior corrosion barrier. Cast duct with no reinforced internal corrosion barrier or press molded fittings will not be accepted.

2. FRP exterior shall be Monoxivent 824 modified acrylic resin that complies with UL 181, Class 1, maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL according to ASTM E 84.

3. The use of liners to achieve the indicated smoke and flame spread development will not be accepted.

4. FRP duct shall be factory assembled to the greatest possible extent, with a minimum number of field joints.

5. Maximum allowable deflection for any size ductwork shall be 12 mm (0.47”) between supports and for any size of duct under worst case operating conditions.

LABORATORY DUCT SPECIFICATION

6. FRP ductwork shall be designed using a safety factor of 10 to 1 for pressure and 5 to 1 for vacuum without exception.

7. Out of roundness of duct shall be limited to 1% of diameter.

8. Length of flanged duct sections shall not vary more than 12 mm (0.47") at 21 degrees C.

9. Un-flanged duct sections shall be square on the ends in relation to the center axis within 3 mm (0.118") up to and including 600 mm (24") diameter and within 4.76 mm (0.187") for all diameters greater than 600 mm.

E. Laminates:

1. Interior resin shall be a premium grade of fire retardant vinyl ester with a flame spread rating of less than 25, I.D. "Class 1" of ASTM E84 "Standard Method of Test for Surface Burning Characteristics of Building Material". Resin shall be AOC's #K022, Ashland's #FR992 or Riechhold #9300.
2. Exterior resin shall be Monoxivent 824 modified acrylic resin that complies with UL 181 for Class 1 duct.

3. Ductwork shall have a resin rich inner surface, an interior layer, a structural layer and a resin rich exterior surface.

4. Inner surface: Nominal 10 mils thick composed of a single ply of the "C "glass surfacing veil, having a resin content of 90%.

5. Interior layer: Nominal 90 mils thick composed of at least two layers of 1-1/2'' chopped strand mat. Resin content shall be 75%.

6. Structural layer: Filament wound type E glass to meet minimum wall thickness as specified. The total wall thickness includes the inner surface.

LABORATORY DUCT SPECIFICATION

7. Exterior layer: Single "C" veil shall be applied to duct exterior without exception.

8. Exterior coating: Factory applied corrosion resistant gel coat. Light gray or white shall be used as the standard colors.

F. Fittings:

1. Fittings shall be hand lay-up construction fabricated from the same resin and have the same strength as the FRP duct.

2. The internal diameter of fittings shall be equal to the adjacent duct.

3. The centerline of all elbows shall be 1.5 times the diameter.

4. Elbows 600 mm (24") and smaller shall be smooth radius. Elbows 750 mm and larger shall be mitered. Provide a minimum of three (3) mitered joints (s-piece) for elbows above 45 degrees.

G. Flanges:

1. Provide flanged connections as required to flexible connectors, expansion joints, vessels, demisters, fans, silencers and other locations as shown.

2. Flanges shall be hand lay-up construction. Dimensions shall be in accordance with ASTM D 3982– Table 1 and the duct dimension schedule.

3. Flange faces shall be perpendicular to the axis of the duct within 0.5 degree.

4. Flange faces shall be flat to within 0.8 mm (0.03") up to and including 450 mm (18") diameter and within 1.6 mm (0.06") for 500 mm (20") diameter and larger.

5. Gaskets shall be EPDM, full face and minimum 3.175 mm (0.125") thickness.

6. Bolts, nuts and washers shall be Type 316 stainless steel.

H. Joints:

1. Provide butt and wrap joints in accordance with ASTM D 3982.

2. Field weld materials shall be supplied by the duct manufacturer. Complete written and online video instructions shall be provided along with Material Safety Data Sheets.

3. Resin, catalyst and fiberglass materials shall be supplied in bulk for the total number of joints plus 15% extra.

2.02 Expansion Joints:

A. Provide expansion joints where shown on the Drawings.

B. Type: W-design configuration with integral flanges suitable for service with FRP duct under the conditions specified.

C. Material: EPDM

D. Backing rings: 10 mm (0.39") thick, 50 mm (2") wide, type 316 stainless steel where flanged expansion joints or flex connectors are noted.

E. Extensions: 80 mm (3")

F. Compression: 65 mm (2.5")

G. Lateral offset: 65 mm (2.5")

H. Thickness: 6 mm (0.25") minimum

I. Bolts, nuts and washers: Type 316 stainless steel.

J. Expansion joints shall be flanged where connecting ductwork to equipment, otherwise slip-type will be acceptable. Acceptable manufacturer: Mercer Rubber or equal.

2.03 Butterfly Dampers:

A. Round FRP dampers:
   a. Round FRP dampers shall be the butterfly type. FRP fabrication shall meet the corrosion requirements specified in this section for FRP ductwork.
      i. Fabrication:
         1. Frame and blade: premium vinyl ester. Blade shall fully encapsulate shaft. Blades that bolt to a single side of the shaft will not be accepted.
         2. Shaft: Pultruded vinyl ester
         3. Bearings: EPDM/Neoprene
         4. Pins and hardware: Type 316 stainless steel.
         5. Shaft seals: EPDM/Neoprene
         6. Isolation dampers will have full circumference EPDM/Neoprene seals.
         7. Dampers shall have flanged ends or plain ends. Provide Type 316 stainless steel bolts, nuts and washers for flanged connections (By Others).
         8. Balancing/Volume dampers shall have a fully adjustable slot with an extra hole drilled in the handle for contractor to "drill –and-pin in-place" once the system is balanced so handle cannot vibrate loose.

PART 3 – EXECUTION

3.01 Installation:

A. FRP ducts shall be installed in a neat and workmanlike manner, properly aligned and cut from measurements taken at the site to avoid interferences with structural members, architectural features, openings and equipment.

B. Supports and anchors: All ducting shall be firmly supported with fabricated or commercial hangers or supports in accordance with SMACNA requirements. Where necessary to avoid stress on equipment or structural members, the ducts shall be anchored or harnessed. Expansion joints and guides as shown on drawings shall compensate for expansion due to temperature differences.

C. Support duct risers in accordance with ASHRAE and SMACNA as indicated.

LABORATORY DUCT SPECIFICATION

3.02 Duct Preparations:

A. Prior to installation, each duct length and all fittings shall be carefully inspected, flushed clean of any debris or dust, and straightened, if not true. All duct and fittings shall be equally cleaned before assembly.

3.03 Duct Joints:

A. Butt and Wrap Joints: Prior to joining, ends shall be ground smooth. All dust and debris must be fully removed. Ends shall be resin-coated to prevent corrosion; in duct of 600 mm (24") diameter and above an interior corrosion wrap is required. The joint should be of equal strength as the duct wall. A butt and wrap sequence and thickness chart should be shown on the fabrication drawings and supplied with the Material Safety Data Sheets.

B. Supports and Anchors: All ducting shall be firmly supported with fabricated or commercial hangers or supports in accordance with SMACNA. Where necessary to avoid stress on equipment or structural members, the ducts shall be anchored or harnessed. Expansion joints and guides shall compensate for duct expansion due to temperature differences.

3.04 Inspection and Field Testing:

A. Inspection: All finished installations shall be carefully inspected for proper joints and sufficient supports, anchoring, interference and damage to duct, fittings and gel coat. Damage shall be repaired to the satisfaction of the Engineer.

B. Field Testing: Prior to enclosure or buying, all ducting systems shall be pressure tested at 1-1/2 times the maximum working pressure. The contractor shall furnish all test equipment, labor, materials and devices at no extra cost to the owner.

C. Leakage may be determined by loss of pressure, soap solution, chemical indicator or other positive and accurate method. All fixtures, devices or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the test procedures.

D. Leaks shall be repaired to the satisfaction of the Engineer and the system shall be re-tested until no leaks are found.

END OF SECTION 15800

UNDERDUCT LOW VOC SPECIFICATION

SECTION XXXXX – FIBERGLASS REINFORCED PLASTIC DUCTWORK (FRP)

Part 1 General

1.1 Summary:

A. Section includes:
   a. Thermoset FRP ducts and fittings
B. Related Sections:
   a. Section XXXXX "Testing, Adjusting and Balancing for HVAC" for testing, adjusting and balancing requirements for nonmetal ducts.
   b. Section XXXXX "Metal Ducts" for single and double wall, rectangular and round ducts.
   c. Section XXXXX "Air Design Accessories" for dampers, duct-mounting access doors and panels, turning vanes and flexible ducts.

1.2 References:

A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
   a. American Society for Testing Materials (ASTM):
      i. C 518
      ii. C 582
      iii. D 2412
      iv. D 2996
      v. D 3982
      vi. E 84
   b. ICC-ES (International Code Council Evaluation Service):
      i. LC 1014 PMG Listing Criteria for Underground Plastic Ducts
      ii. EG290 Evaluation Guideline for Underground Plastic Air Ducts
   c. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
      i. Thermoset FRP Duct Construction Manual
   d. United States Department of Commerce:
      i. NPS 15-69
   e. Underwriters Laboratories:
      i. UL 723 Test for Surface Burning Characteristics of Building Materials

UNDERDUCT LOW VOC SPECIFICATION

1.3 Submittals

A. Product Data:
   a. Resin
   b. Glass
   c. Gel Coat

B. Coordination Drawings: Plans drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   a. Duct installation in congested spaces, indicating coordination with general construction, building components and other building services. Indicated proposed changes to duct layout.
   b. Suspended ceiling components.
   c. Structural members to which duct will be attached.
   d. Penetrations of smoke barriers and fire-rated construction.

C. Verification that the resin to be supplied has been tested by an ASTM E84 Nationally Recognized Testing Laboratory to comply with ASTM E 84 standards of low smoke and low flame. Certification shall be current within ten (10) years of project start date.

D. Verification that the duct system is ICC approved and complies with the following Building Codes:
   a. 2012 and 2009 *International Mechanical Code*® (IMC)
   b. 2012 and 2009 *International Residential Code*® (IRC)
   c. 2012 and 2009 *Uniform Mechanical Code*® (UMC)*
   d. 2010 and 2007 *California Mechanical Code*® (CMC)

**Uniform Mechanical Code is a copyrighted publication of the International Association of Plumbing and Mechanical Officials*

Part 2-Products

2.1 Thermoset FRP Ducts and Fittings

A. Resin:
   a. Thermoset FRP Resin: Manufacture duct with Monoxivent 824 modified acrylic resin that complies with UL 181, Class 1, maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL according to ASTM E 84.
   b. The use of liners to achieve the indicated smoke and flame spread development will not be accepted.

B. Insulation:
   a. Double-Wall Insulated Duct: Inner and outer duct complying with requirements for "Round Duct" description. Closed Cell Polyurethane Foam insulation with maximum thermal conductivity of 0.14 BTU x in. / h x sq. ft. x deg F at 75 deg. F mean temperature

R6	1" THK
R10	1.5" THK

UNDERDUCT LOW VOC SPECIFICATION

C. Reinforcement:
   a. Surfacing Veil shall be "C" glass veil with a silane finish and a styrene soluble binder.
   b. Chopped Strand Mat shall be Type E Glass with a minimum 1-1/2 ounce per square foot with silane finish and styrene soluble binder.
   c. Woven Roving shall be Type E glass minimum 24 ounces per square yard.
   d. Continuous Roving for a filament binding shall be Type E glass with a silane finish.

D. Construction:
   a. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, and access doors and panels, according to SMACNA's "Thermoset FRP Duct Construction Manual" Chapter 7, "Requirements".
   b. FRP ductwork shall be design safety factor of 10 to 1 for pressure and 5 to 1 for vacuum
   c. Out of roundness of duct shall be limited to ±1/4"
   d. Round Duct: Filament wound minimum Thickness:

2" to 20" diameter	0.125" THK
22" to 36" diameter	0.1875" THK
38" to 96" diameter	0.25" THK

E. Lamination:
   a. All ductwork shall have any interior and exterior "C" veil liner 10 mil thick.
   b. Structural layer shall be fabricated toward Winding or Hand lay-up Standard.
   c. Exterior:
      i. Below ground to have a "C" veil layer.
      ii. Above ground to have a "C" veil layer and White paraffinated gel coat with UV inhibitors

F. Fittings:
   a. All fittings shall be made out of the same resin and having the same strength as the FRP ductwork
   b. The internal diameter of all fittings shall be equal to the adjacent duct
   c. The tolerance on angles of all fittings shall be ± 1° up to and including 24" diameter and ± ½° for 30" diameter and above.

G. Elbows:
   a. Elbows Centerline radius shall be 1-1/2 times the diameter.
   b. Fabricate 45-degree elbows with a minimum of two (2) segments and 90-degree round elbows with a minimum of three (3) segments.

H. Drains:
   a. When required, formed drain pockets with a minimum of NPS 1" threaded pipe connections

I. Joints:
   a. Field Joints are to be Slip Type Insert with Adhesive Bonding. Joint design is based on L3 Connection System by Monoxivent.
   b. All Field joints are to incorporate factory supplied peel ply on ducts to be joined as well as on joint insert for dust control during installation.

UNDERDUCT LOW VOC SPECIFICATION

c. Fiberglass adhesive shall have a VOC content of 80 g/l or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24)
b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

Part 3-Execution

3.1 Duct Installation

A. General
   a. Store Resin, glass reinforcing and curing agent in a cool, dry area to maximize shelf life.
   b. Upon arrival at the installation site the customer shall examine the duct for any damage that may have occurred in transit.
   c. Follow ASTM D 3982 Table 1 for recommended hanger spacing.
   d. Use flexible connections to isolate ductwork from vibration caused by air-moving equipment (By Others).
   e. Unload the duct system with care and store in a location where it will be free of damage. Impact of a tool or other heavy object may result in a fracture of the inner lining and may affect the service life of the duct.
   f. Support large sub-assemblies during unloading and transportation to prevent excessive deflection and over stressing.
   g. Use full-face gaskets to eliminate any cantilever effect caused from bolting.
   h. Tighten bolts on flange connections following torque values given in Table1 per ASTM D 3982.
   i. Follow manufactures Field Jointing instructions for bonding ductwork together.

B. Burial
   a. Ductwork Trench shall be dug so that it will be 1.5 times wider than then diameter of the duct.
   b. Fill bottom of trench with a minimum of 6" of back fill (sand or pea gravel) compacted to 80%-90%.
   c. Grade Trench with a 1% pitch back to the largest diameter duct.
   d. Backfill in 6" lift increments compacting 80%90%.
   e. A minimum of 4" of backfill overtop the duct system is required.

C. During construction, meet or exceed the recommended dust control measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 2nd Edition 2007, ANSI/SMACNA 008-2008 (Chapter 3).

UNDERDUCT LOW VOC SPECIFICATION

3.2 Field Quality Control

A. Leakage Test:
   a. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual". Submit a test report for each test.
   b. Test the following systems:
      i. Supply Ducts with a Pressure Class of 2-inch w.g. or higher: Test representative duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.
      ii. Return Ducts with a Pressure Class of 2-inch w.g. or higher: Test representative duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.
   c. Disassemble, reassemble and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   d. Test for leaks before burial of ducts.
   e. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.

B. All duct shipped to the jobsite shall have open ends sealed with shrink wrap for transport to eliminate contaminant infiltration.

C. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 – "Ventilation System Start-up."

END OF SECTION XXXXX

UNDERDUCT SPECIFICATION

Sample Specification from Monoxivent UnderDuct -- Revised 10/30/15

SECTION 23310 – FIBERGLASS REINFORCED PLASTIC DUCTWORK (FRP)

PART 1 - GENERAL

1.01 Summary:

A. This section of the Contract Specifications shall be read in conjunction with Section 15000 – General Mechanical Clauses, which governs the work of this section.
Related Sections:
   a. Section XXXXX "Testing, Adjusting and Balancing for HVAC" for testing, adjusting and balancing requirements for nonmetal ducts.
   b. Section XXXXX "Metal Ducts" for single and double wall, rectangular and round ducts.
   c. Section XXXXX "Air Design Accessories" for dampers, duct-mounting access doors and panels, turning vanes and flexible ducts.

1.02 References:

A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
   a. C 518 - Standard Test Method for Steady-State Thermal Transmission Transmission Properties by Means of the Heat Flow Meter Apparatus
   b. ASTM D 3982 – Standard specification for contact-molded fiberglass ducts and hoods.
   c. ASTM D 2996 – Standard specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Pipe
   d. NPS 15-69 - Standards specification for Custom Contact-Molded Reinforced - Polyester Chemical - Resistant Process Equipment.
   e. SMACNA Thermoset FRP Duct Construction Manual
   f. ASTM E 84 - Test for flame spread and smoke development
   g. UL 723 - Test for Surface Burning Characteristics of Building Materials
   h. ICC-ES (International Code Council Evaluation Service):
      i. LC 1014PMG-Listing Criteria for Underground Plastic Ducts
      ii. ICC-ES Listing # PMG-1171 for Underground Plastic Air Ducts

UNDERDUCT SPECIFICATION

1.03 Submittals

A. Submit electronic layout and shop fabrication drawings in accordance with Section 01300 – Submittals.
B. Provide a description of manufacturing materials and process.
C. Submit burial instructions and field joining procedures.
D. Verification that the resin to be supplied has been tested by an ASTM E84 Nationally Recognized Testing Laboratory to comply with UL 181 Class 1 standards of low smoke (>50) and low flame (>25). Certification shall be current within ten (10) years of project start date.
E. Verification that the duct system is ICC approved and complies with the following Building Codes:

2015, 2012 and 2009 International Mechanical Code® (IMC)
2015, 2012 and 2009 International Residential Code® (IRC)
2015, 2012 and 2009 Uniform Mechanical Code® (UMC)*
2015, 2010 and 2007 California Mechanical Code® (CMC)
2010 National Building Code of Canada (NBC)

*Uniform Mechanical Code is a copyrighted publication of the International Association of Plumbing and Mechanical Officials

PART 2 - PRODUCTS

2.01 Thermoset FRP Ducts and Fittings

A. Manufacturer: Provide FRP duct as manufactured by one of the following:
   a. UnderDuct by Monoxivent
   b. Or equal
B. Conditions:
   a. Ductwork shall be designed for underground HVAC exhaust and supply.
   b. Top of duct must be a minimum of 4'' under the bottom of slab. When the top of duct is deeper than 48'' from bottom of slab the duct wall thickness shall be confirmed by calculation.
   c. Duct shall be corrosion resistant in all soil conditions.
   d. The FRP ductwork shall be designed for plus 10'', minus 5'' water column.
   e. Duct shall be designed for an operating temperature range of 45° F to 175 ° F while maintaining strength requirements per ASTM 2412.
C. Resin:
   a. Thermoset FRP Resin: Manufacture duct with Monoxivent 824 modified acrylic resin that complies with ASTM E84, Class 1, maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL.
   b. The use of liners to achieve the indicated smoke and flame spread development will not be accepted.

UNDERDUCT SPECIFICATION

D. Insulation: --When Required
   a. Double-Wall Insulated Duct: Inner and outer duct complying with requirements for "Round Duct" description. Closed Cell Polyurethane Foam insulation with maximum thermal conductivity of 0.14 BTU x in. / h x sq. ft. x deg F at 75 deg. F mean temperature (R-Value of 6).

E. Reinforcement:
   a. Surfacing Veil shall be "C" glass veil with a silane finish and a styrene soluble binder.
   b. Chopped Strand Mat shall be Type E Glass with a minimum 1-1/2 ounce per square foot with silane finish and styrene soluble binder.
   c. Woven Roving shall be Type E glass minimum 24 ounces per square yard.
   d. Continuous Roving for a filament binding shall be Type E glass with a silane finish.

F. Construction:
   a. FRP shall be of filament wound construction with a smooth resin rich "C" veil interior and exterior layer.
   b. FRP duct shall be factory assembled to the greatest possible extent, with a minimum number of field joints.
   c. FRP ductwork shall be designed using a safety factor of 10 to 1 for pressure and 5 to 1 for vacuum without exception.
   d. Out of roundness of duct shall be limited to 1% of diameter.
   e. Length of duct sections shall not vary more than 0.50" (12.7mm) at 70 degrees F (21 degrees C).
   f. Duct sections shall be square on the ends in relation to the center axis within 0.125" (3.2mm) up to and including 24" (610mm) diameter and within 0.1875" (4.8mm) for all diameters greater than 24" (610mm).
   g. Round Duct: Filament wound minimum Thickness:
      i. Minimum Wall thickness will be in accordance with NPS 15-69, Table 2.
      ii. Duct with inside diameter of 20" (508mm) or less shall have a wall thickness of 0.125" (3.2mm); duct with inside diameter of 22" - 36" (559mm - 914mm) shall have a wall thickness of 0.1875" (4.8mm); duct with inside diameter of 38" (965mm) or greater shall have a wall thickness of 0.25" (6.4mm).

G. Lamination:
   a. All ductwork shall have an exterior "C" veil liner 10 mil thick.
   b. Structural layer shall be filament wound or Hand laid up.

UNDERDUCT SPECIFICATION

H. Exterior:
   a. Below ground to have a "C" veil layer.
   b. Above ground to have a "C" veil layer and White or Light Gray paraffinated gel coat with UV inhibitors

I. Fittings:
   a. All fittings shall be made out of the same resin and having the same strength as the FRP ductwork
   b. The internal diameter of all fittings shall be equal to the adjacent duct
   c. The tolerance on angles of all fittings shall be ± 1° up to and including 24" diameter and ± ½° for 30" diameter and above.

   d. Elbows Centerline radius shall be 1-1/2 times the diameter.
   a. Elbows 45 degrees or less shall be at least one (1) miter/two (2) gore. Elbows greater than 45 degrees shall be at least two (2) miter/three (3) gore.
   e.

J. Drains:
   a. When required, formed drain pockets with a minimum of NPS 1" threaded pipe connections

K. Joints:
   a. Field Joints to be Butt & Wrap type for wet lay-up method.
   b. Field joint kits sent out with an extra 20% material

PART 3 - EXECUTION

3.01 Duct Installation

A. General
   a. Store Resin, glass reinforcing and during agent in a cool, dry area to maximize shelf life.
   b. Upon arrival at the installation site, the customer shall examine the duct for any damage that may have occurred in transit.
   c. Follow ASTM D 3982 Table 1 for recommended hanger spacing.
   d. Use flexible connections to isolate ductwork form vibration caused by air-moving equipment (By Others).
   e. Unload the duct system with care and store in a location where it will be free of damage. Impact of a tool or other heavy object may results in a fracture of the inner lining and may affect the service life.

UNDERDUCT SPECIFICATION

f. Support large sub-assemblies during unloading and transportation to prevent excessive deflection and over stressing.
g. Follow manufacturer's Field Jointing instructions for bonding ductwork together.

B. Burial
   a. Grade Trench so it will be 1.5 times wider than then diameter of the duct.
   b. Fill bottom of trench with a minimum of 6” of back fill (sand or pea gravel).
   c. Slope Trench with a 1/8" per foot pitch back to the start of the system.
   d. Backfill in 6” lift increments compacting 80-90%.
   e. A minimum of 4” of backfill overtop the duct system is required.
   f. Follow manufacturer's burial procedures.

3.02 Field Connections

A. Butt and Wrap Joints: Prior to joining, ends shall be ground smooth. All dust and debris must be fully removed. The joint shall be of equal strength to the duct sections being joined. A butt and wrap sequence and thickness chart shall be provided with written instructions as well as Material Safety Data Sheets.
B. For L-3 joints follow field instructions provided.
C. Double wall insulated duct joints shall include a fiberglass alignment sleeve in the foam layer with a standard butt and wrap overlay.

3.03 Field Quality Control

A. Inspection: All finished installations shall be carefully inspected for properly made joints and damage to duct and fittings. Damage found shall be repaired to the satisfaction of the Engineer.
B. Field Testing: Prior to enclosure or buying, all ducting systems shall be pressure tested at 1-1/2 times the maximum working pressure. The contractor shall furnish all test equipment, labor, materials and devices at no extra cost to the owner.
C. Leakage may be determined by loss of pressure, soap solution, chemical indicator or other positive and accurate method. All fixtures, devices or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the test procedures.
D. Leaks shall be repaired to the satisfaction of the Engineer and the system shall be re-tested until no leaks are found.

END OF SECTION 23310

UNDERDUCT-VE SPECIFICATION

SECTION XXXXX – FIBERGLASS REINFORCED PLASTIC DUCTWORK (FRP)

Part 1 General

1.1 Summary:

A. Section includes:
   a. Thermoset FRP ducts and fittings
B. Related Sections:
   a. Section XXXXX "Testing, Adjusting and Balancing for HVAC" for testing, adjusting and balancing requirements for nonmetal ducts.
   b. Section XXXXX "Metal Ducts" for single and double wall, rectangular and round ducts.
   c. Section XXXXX "Air Design Accessories" for dampers, duct-mounting access doors and panels, turning vanes and flexible ducts.

1.2 References:

A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
   a. American Society for Testing Materials (ASTM0:
      i. C 582 Contact-Molded reinforced Thermosetting Plastic (RTP) Laminated for Corrosion-Residence Equipment
      ii. D 2412
      iii. D 2996 Filament-Wound "Fiberglass" (Glass Fiber Reinforced Thermosetting Resin) Pipe and Fittings.
      iv. D 3982 Contact-Molded "Fiberglass" (Glass Fiber Reinforced Thermosetting Resin) Duct and Hoods
      v. E 84 Standard Test Method for Surface Burning Characteristic of Building Materials
   b. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
      i. Thermoset FRP Duct Construction Manual
   c. United States Department of Commerce:
      i. NPS 15-69

1.3 Submittals

A. Product Data:
   a. Resin
   b. Glass
   c. Gel Coat

UNDERDUCT-VE SPECIFICATION

B. Coordination Drawings: Plans drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   a. Duct installation in congested spaces, indicating coordination with general construction, building components and other building services. Indicated proposed changes to duct layout.
   b. Suspended ceiling components.
   c. Structural members to which duct will be attached.
   d. Penetrations of smoke barriers and fire-rated construction.

Part 2-Products

2.1 Thermoset FRP Ducts and Fittings

A. Resin:
   a. Thermoset FRP Resin: Duct and fittings shall be made with a fire retardant vinyl ester resin that is corrosion resistant to carbon monoxide gas and engine exhaust at 350 dg F.

B. Reinforcement:
   a. Surfacing Veil shall be “C” glass veil with a silane finish and a styrene soluble binder.
   b. Chopped Strand Mat shall be Type E Glass with a minimum 1-1/2 ounce per square foot with silane finish and styrene soluble binder.
   c. Woven Roving shall be Type E glass minimum 24 ounces per square yard.
   d. Continuous Roving for a filament binding shall be Type E glass with a silane finish.

C. Construction:
   a. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, and access doors and panels, according to SMACNA’s “Thermoset FRP Duct Construction Manual” Chapter 7, “Requirements”.
   b. FRP ductwork shall be design safety factor of 10 to 1 for pressure and 5 to 1 for vacuum
   c. Out of roundness of duct shall be limited to ±1/4”
   d. Round Duct: Filament wound minimum Thickness:

2” to 20” diameter	0.125” THK
22” to 36” diameter	0.1875” THK
38” to 96” diameter	0.25” THK

D. Lamination:
   a. All ductwork shall have any interior and exterior “C” veil liner 10 mil thick.
   b. Structural layer shall be fabricated toward Winding or Hand lay-up Standard.
   c. Exterior:
      i. Below ground to have a “C” veil layer.

UNDERDUCT-VE SPECIFICATION

E. Fittings:
   a. All fittings shall be made out of the same resin and having the same strength as the FRP ductwork
   b. The internal diameter of all fittings shall be equal to the adjacent duct
   c. The tolerance on angles of all fittings shall be ± 1° up to and including 24" diameter and ± ½° for 30" diameter and above.

F. Elbows:
   a. Elbows Centerline radius shall be 1-1/2 times the diameter.
   b. Fabricate 45-degree elbows with a minimum of two (2) segments and 90-degree round elbows with a minimum of three (3) segments.

G. Drains:
   a. When required, formed drain pockets with a minimum of NPS 1" threaded pipe connections

H. Joints:
   a. Field Joints to be Butt & Wrap type for wet lay-up method.
   b. Field joint kits sent out in bulk form with an extra 20% material for waste
   c. Resin to be same as duct

Part 3-Execution

3.1 Duct Installation

A. General
   a. Store Resin, glass reinforcing and curing agent in a cool, dry area to maximize shelf life.
   b. Upon arrival at the installation site the customer shall examine the duct for any damage that may have occurred in transit.
   c. Follow ASTM D 3982 Table 1 for recommended hanger spacing.
   d. Use flexible connections to isolate ductwork from vibration caused by air-moving equipment (By Others).
   e. Unload the duct system with care and store in a location where it will be free of damage. Impact of a tool or other heavy object may result in a fracture of the inner lining and may affect the service life of the duct.
   f. Support large sub-assemblies during unloading and transportation to prevent excessive deflection and over stressing.
   g. Use full-face gaskets to eliminate any cantilever effect caused from bolting.
   h. Tighten bolts on flange connections following torque values given in Table1 per ASTM D 3982.
   i. Follow manufactures Field Jointing instructions for bonding ductwork together.

UNDERDUCT-VE SPECIFICATION

B. Burial

a. Ductwork Trench shall be dug so that it will be 1.5 times wider than then diameter of the duct.
b. Fill bottom of trench with a minimum of 6” of back fill (sand or pea gravel) compacted to 80%-90%.
c. Grade Trench with a 1% pitch back to the largest diameter duct.
d. Backfill in 6” lift increments compacting 80%90%.
e. A minimum of 4” of backfill overtop the duct system is required.

END OF SECTION XXXXX

ICC CODE APPROVAL SUMMARY

Monoxivent has received confirmation from ICC Evaluation Service, LLC (ICC-ES), that its UnderDuct Fiberglass Reinforced Plastic duct is approved with the provisions of the:

2012 and 2009 International Mechanical Code (IMC)

2012 and 2009 International Residential Code (IRC)

2012 and 2009 Uniform Mechanical Code (UMC)*

2010 and 2007 California Mechanical Code (CMC)

*Uniform Mechanical Code is a copyrighted publication of the International Association of plumbing and Mechanical Officials.

This confirmation, as evidenced in ICC-ES listing PMG-1171, provides guidance to code officials faced with approving the use of UnderDuct under these codes.

The listing is available online at www.icc-es-pmg.org.

Monoxivent's summary is available online at http://www.icc-es-pmg.org/Listing_Directory/pdf/PMG-1171.pdf.

ICC-ES PMG Listing

PMG-1171

Effective Date: November 2015

This listing is subject to re-examination in one year.

CSI: DIVISION: 23 00 00—HEATING, VENTILATION AND AIR CONDITIONING (HVAC)
Section: 23 31 00—HVAC Ducts and Casings

Product certification system:

The ICC-ES product certification system includes testing samples taken from the market or supplier's stock, or a combination of both, to verify compliance with applicable codes and standards. The system also involves factory inspections, and assessment and surveillance of the supplier's quality system.

Product: Underground Single Wall & Double Wall Insulated Duct for HVAC Direct Burial Applications
Underground Single Wall Duct for Under Ground Vehicle Exhaust Direct Burial Applications

Listee: Monoxivent
1306 Mill Street
Rock Island, IL 61201
www.monoxivent.com

Additional Listee:

Appalachian Plastics Inc.
34001 Glove Road
Glade Spring, VA 24340

Compliance with the following codes:

2015, 2012 and 2009 *International Mechanical Code*® (IMC)
2015, 2012 and 2009 *International Residential Code*® (IRC)
2015, 2012 and 2009 *Uniform Mechanical Code*® (UMC)*
2013, 2010 and 2007 *California Mechanical Code*® (CMC)
2010 National Building Code of Canada® (NBC)**

**Uniform Mechanical Code is a copyrighted publication of the International Association of Plumbing and Mechanical Officials.*
*** National Building Code of Canada is a copyrighted publication of the National Research Council Canada*

Compliance with the following standards:

ICC-ES LC1014-2015, PMG Listing Criteria for Underground Plastic Air Ducts
ICC-ES EG290, Evaluation Guideline for Underground Plastic Air Ducts
ASTM D2412-2011, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM E84-2015a, Standard Test Method for Surface Burning Characteristics of Building Materials
UL 723 10th Edition Sept 2008, Test for Surface Burning Characteristics of Building Materials
ASTM C518-2010, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

Identification:

The Monoxivent underground duct and fittings described in this listing are identified by a permanent label bearing the manufacturer's name (Monoxivent) and/or trademark, the product name, model number and the ICC-ES PMG listing mark.

Installation:

Installation of Monoxivent underground HVAC Duct and fittings must comply with the manufacturer's published installation instructions and the applicable codes.

Flood Plain Elevation: Product was tested to withstand a pressure equivalent to 12 feet water column pressure for 7 days with no leakage. Product may be installed right on the sub-grade of excavation without any further sub material being required except when it is bedrock then a sub soil such as sand or construction grade fill or pea gravel may be used under the duct.

Models:

Underground HVAC Duct and Fittings:
The Monoxivent underground HVAC duct and fittings are an underground air duct and fitting system for use in forced-air heating and cooling systems in accordance with Section 603.8 of the IMC, Section M1601.1.2 of the IRC, or Section 602.0 of both the CMC and the UMC, as applicable. See Table 1, below.

Single wall ducts and fittings are made of fiberglass reinforced thermoset resin. Double wall ducts and fittings are made of fiberglass reinforced thermoset resin as inner and outer layers, with closed cell polyurethane foam inserted in-between as the insulation material. Both single wall and double wall straight ducts have a minimum pipe stiffness of 8 psi (55kPa) at 5 percent deflection when tested in accordance with ASTM D2412. See Table 2, below.

Surface Burning Characteristics: Fiberglass reinforced thermoset resin has a flame spread index of 25 or less and a smoke development index of 50 or less when tested in accordance with ASTM E84. Closed cell polyurethane foam complies with section 2603.3 of the *International Building Code*® and has a flame spread index of 25 or less and a smoke development index of 450 or less when tested in accordance with ASTM E84.

Thermal Resistance: when tested in accordance with ASTM C518, single wall with a total thickness of 0.125 inch has a thermal resistance value of R1; double wall with a total thickness of 1.25 inches (1 inch polyurethane foam enclosed by a 0.125 inch of fiberglass inner and a 0.125 inch fiberglass outer layer) has a thermal resistance value of R6.

The Monoxivent underground HVAC duct and fittings are designed for use in systems with a maximum rated positive pressure equivalent to 10 inch water column and a maximum rated negative pressure of 5 inch water column in accordance with Section 603.3 of the IMC.

Underground Vehicle Exhaust Duct and Fittings
Single wall ducts and fittings made of fiberglass reinforced thermoset resin having a flame spread index of 25 or less and a smoke development index of 50 or less when tested in accordance with ASTM E84 by an accredited third party testing lab, are suitable for use to convey vehicle exhaust gases in accordance with section 510.8 of IMC. Material compatibility and suitability are subject to evaluation and approval by authority having jurisdiction.

The Monoxivent underground Vehicle Exhaust duct and fittings are designed for use in systems with a maximum rated negative pressure of 10 inch water column.

Conditions of Listing:

1. Designs using Monoxivent underground HVAC duct and fittings must be limited to systems with a maximum air temperature of 150˚F (66˚C) at the discharge of the unit entering the duct system. Sizing must be in accordance with Section 603.2 of the IMC, Section M1601.1 of the IRC, or Section 601.2 of both the CMC and the UMC.
2. For the purposes of this evaluation, Monoxivent underground HVAC and Vehicle Exhaust duct and fittings must be installed underground or embedded. Above ground applications are outside scope of this report.
3. The design of concrete slabs with an embedded air duct is beyond the scope of this evaluation.
4. Underground air duct pipes located below the design flood elevation must be designed and installed to resist hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the design flood elevation, in accordance with Section 603.13 of the IMC, Section M1601.3.8 of the IRC, or Section 604.6 of both the CMC and the UMC, as applicable.
5. The maximum depth below Base Flood Elevation (BFE) in which the duct can be installed flat on grade based on testing per LC1014 Section 4.3.2 is 6 feet (1829 mm). For installation beyond 6 feet below BFE, Monoxivent underground HVAC Duct shall have a minimum slope of 1/8 inch per foot (10.4mm/m) to allow drainage to a point provided with access.
6. The Monoxivent underground HVAC and Vehicle Exhaust duct and fittings are manufactured by Appalachian Plastics Inc. in Glade Spring, Virginia under a quality control program with annual surveillance inspections by ICC-ES.

TABLE 1—SYSTEM COMPONENTS

Item Description	Model Number	I.D. (inches)	Thickness (inches)	Item Description	Model Number	I.D. (inches)	Overall Thickness (inches)
Single-Wall 45º Elbow	S064	6	0.125	Double-Wall 45º Elbow	D064	6	1.25
Single-Wall 45º Elbow	S084	8	0.125	Double-Wall 45º Elbow	D084	8	1.25
Single-Wall 45º Elbow	S104	10	0.125	Double-Wall 45º Elbow	D104	10	1.25
Single-Wall 45º Elbow	S124	12	0.125	Double-Wall 45º Elbow	D124	12	1.25
Single-Wall 45º Elbow	S144	14	0.125	Double-Wall 45º Elbow	D144	14	1.25
Single-Wall 45º Elbow	S164	16	0.125	Double-Wall 45º Elbow	D164	16	1.25
Single-Wall 45º Elbow	S184	18	0.125	Double-Wall 45º Elbow	D184	18	1.25
Single-Wall 45º Elbow	S204	20	0.1875	Double-Wall 45º Elbow	D204	20	1.25
Single-Wall 45º Elbow	S224	22	0.1875	Double-Wall 45º Elbow	D224	22	1.375
Single-Wall 45º Elbow	S244	24	0.1875	Double-Wall 45º Elbow	D244	24	1.375
Single-Wall 45º Elbow	S264	26	0.1875	Double-Wall 45º Elbow	D264	26	1.375
Single-Wall 45º Elbow	S284	28	0.1875	Double-Wall 45º Elbow	D284	28	1.375
Single-Wall 45º Elbow	S304	30	0.1875	Double-Wall 45º Elbow	D304	30	1.375
Single-Wall 45º Elbow	S324	32	0.1875	Double-Wall 45º Elbow	D324	32	1.375
Single-Wall 45º Elbow	S344	34	0.1875	Double-Wall 45º Elbow	D344	34	1.375
Single-Wall 45º Elbow	S364	36	0.1875	Double-Wall 45º Elbow	D364	36	1.375
Single-Wall 45º Elbow	S384	38	0.25	Double-Wall 45º Elbow	D384	38	1.5
Single-Wall 45º Elbow	S404	40	0.25	Double-Wall 45º Elbow	D404	40	1.5
Single-Wall 45º Elbow	S424	42	0.25	Double-Wall 45º Elbow	D424	42	1.5
Single-Wall 45º Elbow	S444	44	0.25	Double-Wall 45º Elbow	D444	44	1.5
Single-Wall 45º Elbow	S464	46	0.25	Double-Wall 45º Elbow	D464	46	1.5
Single-Wall 45º Elbow	S484	48	0.25	Double-Wall 45º Elbow	D484	48	1.5
Single-Wall 45º Elbow	S504	50	0.25	Double-Wall 45º Elbow	D504	50	1.5
Single-Wall 45º Elbow	S524	52	0.25	Double-Wall 45º Elbow	D524	52	1.5
Single-Wall 45º Elbow	S544	54	0.25	Double-Wall 45º Elbow	D544	54	1.5
Single-Wall 45º Elbow	S564	56	0.25	Double-Wall 45º Elbow	D564	56	1.5
Single-Wall 45º Elbow	S584	58	0.25	Double-Wall 45º Elbow	D584	58	1.5
Single-Wall 45º Elbow	S604	60	0.25	Double-Wall 45º Elbow	D604	60	1.5
Single-Wall 90º Elbow	S069	6	0.125	Double-Wall 90º Elbow	D069	6	1.25
Single-Wall 90º Elbow	S089	8	0.125	Double-Wall 90º Elbow	D089	8	1.25
Single-Wall 90º Elbow	S109	10	0.125	Double-Wall 90º Elbow	D109	10	1.25
Single-Wall 90º Elbow	S129	12	0.125	Double-Wall 90º Elbow	D129	12	1.25
Single-Wall 90º Elbow	S149	14	0.125	Double-Wall 90º Elbow	D149	14	1.25
Single-Wall 90º Elbow	S169	16	0.125	Double-Wall 90º Elbow	D169	16	1.25
Single-Wall 90º Elbow	S189	18	0.125	Double-Wall 90º Elbow	D189	18	1.25
Single-Wall 90º Elbow	S209	20	0.125	Double-Wall 90º Elbow	D209	20	1.25
Single-Wall 90º Elbow	S229	22	0.1875	Double-Wall 90º Elbow	D229	22	1.375
Single-Wall 90º Elbow	S249	24	0.1875	Double-Wall 90º Elbow	D249	24	1.375
Single-Wall 90º Elbow	S269	26	0.1875	Double-Wall 90º Elbow	D269	26	1.375
Single-Wall 90º Elbow	S289	28	0.1875	Double-Wall 90º Elbow	D289	28	1.375
Single-Wall 90º Elbow	S309	30	0.1875	Double-Wall 90º Elbow	D309	30	1.375
Single-Wall 90º Elbow	S329	32	0.1875	Double-Wall 90º Elbow	D329	32	1.375
Single-Wall 90º Elbow	S349	34	0.1875	Double-Wall 90º Elbow	D349	34	1.375
Single-Wall 90º Elbow	S369	36	0.1875	Double-Wall 90º Elbow	D369	36	1.375
Single-Wall 90º Elbow	S389	38	0.25	Double-Wall 90º Elbow	D389	38	1.5
Single-Wall 90º Elbow	S409	40	0.25	Double-Wall 90º Elbow	D409	40	1.5
Single-Wall 90º Elbow	S429	42	0.25	Double-Wall 90º Elbow	D429	42	1.5
Single-Wall 90º Elbow	S449	44	0.25	Double-Wall 90º Elbow	D449	44	1.5
Single-Wall 90º Elbow	S469	46	0.25	Double-Wall 90º Elbow	D469	46	1.5
Single-Wall 90º Elbow	S489	48	0.25	Double-Wall 90º Elbow	D489	48	1.5
Single-Wall 90º Elbow	S509	50	0.25	Double-Wall 90º Elbow	D509	50	1.5
Single-Wall 90º Elbow	S529	52	0.25	Double-Wall 90º Elbow	D529	52	1.5
Single-Wall 90º Elbow	S549	54	0.25	Double-Wall 90º Elbow	D549	54	1.5
Single-Wall 90º Elbow	S569	56	0.25	Double-Wall 90º Elbow	D569	56	1.5
Single-Wall 90º Elbow	S589	58	0.25	Double-Wall 90º Elbow	D589	58	1.5
Single-Wall 90º Elbow	S609	60	0.25	Double-Wall 90º Elbow	D609	60	1.5
Single-Wall Endcap	S06E	6	0.125	Double-Wall Endcap	D06E	6	1.25
Single-Wall Endcap	S08E	8	0.125	Double-Wall Endcap	D08E	8	1.25
Single-Wall Endcap	S10E	10	0.125	Double-Wall Endcap	D10E	10	1.25
Single-Wall Endcap	S12E	12	0.125	Double-Wall Endcap	D12E	12	1.25
Single-Wall Endcap	S14E	14	0.125	Double-Wall Endcap	D14E	14	1.25
Single-Wall Endcap	S16E	16	0.125	Double-Wall Endcap	D16E	16	1.25
Single-Wall Endcap	S18E	18	0.125	Double-Wall Endcap	D18E	18	1.25
Single-Wall Endcap	S20E	20	0.125	Double-Wall Endcap	D20E	20	1.25
Single-Wall Endcap	S22E	22	0.1875	Double-Wall Endcap	D22E	22	1.375

Single-Wall Endcap	S24E	24	0.1875	Double-Wall Endcap	D24E	24	1.375
Single-Wall Endcap	S26E	26	0.1875	Double-Wall Endcap	D26E	26	1.375
Single-Wall Endcap	S28E	28	0.1875	Double-Wall Endcap	D28E	28	1.375
Single-Wall Endcap	S30E	30	0.1875	Double-Wall Endcap	D30E	30	1.375
Single-Wall Endcap	S32E	32	0.1875	Double-Wall Endcap	D32E	32	1.375
Single-Wall Endcap	S34E	34	0.1875	Double-Wall Endcap	D34E	34	1.375
Single-Wall Endcap	S36E	36	0.1875	Double-Wall Endcap	D36E	36	1.375
Single-Wall Endcap	S38E	38	0.25	Double-Wall Endcap	D38E	38	1.5
Single-Wall Endcap	S40E	40	0.25	Double-Wall Endcap	D40E	40	1.5
Single-Wall Endcap	S42E	42	0.25	Double-Wall Endcap	D42E	42	1.5
Single-Wall Endcap	S44E	44	0.25	Double-Wall Endcap	D44E	44	1.5
Single-Wall Endcap	S46E	46	0.25	Double-Wall Endcap	D46E	46	1.5
Single-Wall Endcap	S48E	48	0.25	Double-Wall Endcap	D48E	48	1.5
Single-Wall Endcap	S50E	50	0.25	Double-Wall Endcap	D50E	50	1.5
Single-Wall Endcap	S52E	52	0.25	Double-Wall Endcap	D52E	52	1.5
Single-Wall Endcap	S54E	54	0.25	Double-Wall Endcap	D54E	54	1.5
Single-Wall Endcap	S56E	56	0.25	Double-Wall Endcap	D56E	56	1.5
Single-Wall Endcap	S58E	58	0.25	Double-Wall Endcap	D58E	58	1.5
Single-Wall Endcap	S60E	60	0.25	Double-Wall Endcap	D60E	60	1.5
Single-Wall Lateral	S06L	6	0.125	Double-Wall Lateral	D06L	6	1.25
Single-Wall Lateral	S08L	8	0.125	Double-Wall Lateral	D08L	8	1.25
Single-Wall Lateral	S10L	10	0.125	Double-Wall Lateral	D10L	10	1.25
Single-Wall Lateral	S12L	12	0.125	Double-Wall Lateral	D12L	12	1.25
Single-Wall Lateral	S14L	14	0.125	Double-Wall Lateral	D14L	14	1.25
Single-Wall Lateral	S16L	16	0.125	Double-Wall Lateral	D16L	16	1.25
Single-Wall Lateral	S18L	18	0.125	Double-Wall Lateral	D18L	18	1.25
Single-Wall Lateral	S20L	20	0.125	Double-Wall Lateral	D20L	20	1.25
Single-Wall Lateral	S22L	22	0.1875	Double-Wall Lateral	D22L	22	1.375
Single-Wall Lateral	S24L	24	0.1875	Double-Wall Lateral	D24L	24	1.375
Single-Wall Lateral	S26L	26	0.1875	Double-Wall Lateral	D26L	26	1.375
Single-Wall Lateral	S28L	28	0.1875	Double-Wall Lateral	D28L	28	1.375
Single-Wall Lateral	S30L	30	0.1875	Double-Wall Lateral	D30L	30	1.375
Single-Wall Lateral	S32L	32	0.1875	Double-Wall Lateral	D32L	32	1.375
Single-Wall Lateral	S34L	34	0.1875	Double-Wall Lateral	D34L	34	1.375
Single-Wall Lateral	S36L	36	0.1875	Double-Wall Lateral	D36L	36	1.375
Single-Wall Lateral	S38L	38	0.25	Double-Wall Lateral	D38L	38	1.5
Single-Wall Lateral	S40L	40	0.25	Double-Wall Lateral	D40L	40	1.5
Single-Wall Lateral	S42L	42	0.25	Double-Wall Lateral	D42L	42	1.5
Single-Wall Lateral	S44L	44	0.25	Double-Wall Lateral	D44L	44	1.5
Single-Wall Lateral	S46L	46	0.25	Double-Wall Lateral	D46L	46	1.5
Single-Wall Lateral	S48L	48	0.25	Double-Wall Lateral	D48L	48	1.5
Single-Wall Lateral	S50L	50	0.25	Double-Wall Lateral	D50L	50	1.5
Single-Wall Lateral	S52L	52	0.25	Double-Wall Lateral	D52L	52	1.5
Single-Wall Lateral	S54L	54	0.25	Double-Wall Lateral	D54L	54	1.5
Single-Wall Lateral	S56L	56	0.25	Double-Wall Lateral	D56L	56	1.5
Single-Wall Lateral	S58L	58	0.25	Double-Wall Lateral	D58L	58	1.5
Single-Wall Lateral	S60L	60	0.25	Double-Wall Lateral	D60L	60	1.5
Single-Wall Reducer	S06R	6	0.125	Double-Wall Reducer	D06R	6	1.25
Single-Wall Reducer	S08R	8	0.125	Double-Wall Reducer	D08R	8	1.25
Single-Wall Reducer	S10R	10	0.125	Double-Wall Reducer	D10R	10	1.25
Single-Wall Reducer	S12R	12	0.125	Double-Wall Reducer	D12R	12	1.25
Single-Wall Reducer	S14R	14	0.125	Double-Wall Reducer	D14R	14	1.25
Single-Wall Reducer	S16R	16	0.125	Double-Wall Reducer	D16R	16	1.25
Single-Wall Reducer	S18R	18	0.125	Double-Wall Reducer	D18R	18	1.25
Single-Wall Reducer	S20R	20	0.125	Double-Wall Reducer	D20R	20	1.25
Single-Wall Reducer	S22R	22	0.1875	Double-Wall Reducer	D22R	22	1.375
Single-Wall Reducer	S24R	24	0.1875	Double-Wall Reducer	D24R	24	1.375
Single-Wall Reducer	S26R	26	0.1875	Double-Wall Reducer	D26R	26	1.375
Single-Wall Reducer	S28R	28	0.1875	Double-Wall Reducer	D28R	28	1.375
Single-Wall Reducer	S30R	30	0.1875	Double-Wall Reducer	D30R	30	1.375
Single-Wall Reducer	S32R	32	0.1875	Double-Wall Reducer	D32R	32	1.375
Single-Wall Reducer	S34R	34	0.1875	Double-Wall Reducer	D34R	34	1.375
Single-Wall Reducer	S36R	36	0.1875	Double-Wall Reducer	D36R	36	1.375
Single-Wall Reducer	S38R	38	0.25	Double-Wall Reducer	D38R	38	1.5
Single-Wall Reducer	S40R	40	0.25	Double-Wall Reducer	D40R	40	1.5
Single-Wall Reducer	S42R	42	0.25	Double-Wall Reducer	D42R	42	1.5
Single-Wall Reducer	S44R	44	0.25	Double-Wall Reducer	D44R	44	1.5
Single-Wall Reducer	S46R	46	0.25	Double-Wall Reducer	D46R	46	1.5
Single-Wall Reducer	S48R	48	0.25	Double-Wall Reducer	D48R	48	1.5
Single-Wall Reducer	S50R	50	0.25	Double-Wall Reducer	D50R	50	1.5
Single-Wall Reducer	S52R	52	0.25	Double-Wall Reducer	D52R	52	1.5
Single-Wall Reducer	S54R	54	0.25	Double-Wall Reducer	D54R	54	1.5
Single-Wall Reducer	S56R	56	0.25	Double-Wall Reducer	D56R	56	1.5
Single-Wall Reducer	S58R	58	0.25	Double-Wall Reducer	D58R	58	1.5
Single-Wall Reducer	S60R	60	0.25	Double-Wall Reducer	D60R	60	1.5

Single-Wall Tee	S06T	6	0.125	Double-Wall Tee	D06T	6	1.25
Single-Wall Tee	S08T	8	0.125	Double-Wall Tee	D08T	8	1.25
Single-Wall Tee	S10T	10	0.125	Double-Wall Tee	D10T	10	1.25
Single-Wall Tee	S12T	12	0.125	Double-Wall Tee	D12T	12	1.25
Single-Wall Tee	S14T	14	0.125	Double-Wall Tee	D14T	14	1.25
Single-Wall Tee	S16T	16	0.125	Double-Wall Tee	D16T	16	1.25
Single-Wall Tee	S18T	18	0.125	Double-Wall Tee	D18T	18	1.25
Single-Wall Tee	S20T	20	0.125	Double-Wall Tee	D20T	20	1.25
Single-Wall Tee	S22T	22	0.1875	Double-Wall Tee	D22T	22	1.375
Single-Wall Tee	S24T	24	0.1875	Double-Wall Tee	D24T	24	1.375
Single-Wall Tee	S26T	26	0.1875	Double-Wall Tee	D26T	26	1.375
Single-Wall Tee	S28T	28	0.1875	Double-Wall Tee	D28T	28	1.375
Single-Wall Tee	S30T	30	0.1875	Double-Wall Tee	D30T	30	1.375
Single-Wall Tee	S32T	32	0.1875	Double-Wall Tee	D32T	32	1.375
Single-Wall Tee	S34T	34	0.1875	Double-Wall Tee	D34T	34	1.375
Single-Wall Tee	S36T	36	0.1875	Double-Wall Tee	D36T	36	1.375
Single-Wall Tee	S38T	38	0.25	Double-Wall Tee	D38T	38	1.5
Single-Wall Tee	S40T	40	0.25	Double-Wall Tee	D40T	40	1.5
Single-Wall Tee	S42T	42	0.25	Double-Wall Tee	D42T	42	1.5
Single-Wall Tee	S44T	44	0.25	Double-Wall Tee	D44T	44	1.5
Single-Wall Tee	S46T	46	0.25	Double-Wall Tee	D46T	46	1.5
Single-Wall Tee	S48T	48	0.25	Double-Wall Tee	D48T	48	1.5
Single-Wall Tee	S50T	50	0.25	Double-Wall Tee	D50T	50	1.5
Single-Wall Tee	S52T	52	0.25	Double-Wall Tee	D52T	52	1.5
Single-Wall Tee	S54T	54	0.25	Double-Wall Tee	D54T	54	1.5
Single-Wall Tee	S56T	56	0.25	Double-Wall Tee	D56T	56	1.5
Single-Wall Tee	S58T	58	0.25	Double-Wall Tee	D58T	58	1.5
Single-Wall Tee	S60T	60	0.25	Double-Wall Tee	D60T	60	1.5
Single-Wall Wye	S06W	6	0.125	Double-Wall Wye	D06W	6	1.25
Single-Wall Wye	S08W	8	0.125	Double-Wall Wye	D08W	8	1.25
Single-Wall Wye	S10W	10	0.125	Double-Wall Wye	D10W	10	1.25
Single-Wall Wye	S12W	12	0.125	Double-Wall Wye	D12W	12	1.25
Single-Wall Wye	S14W	14	0.125	Double-Wall Wye	D14W	14	1.25
Single-Wall Wye	S16W	16	0.125	Double-Wall Wye	D16W	16	1.25
Single-Wall Wye	S18W	18	0.125	Double-Wall Wye	D18W	18	1.25
Single-Wall Wye	S20W	20	0.125	Double-Wall Wye	D20W	20	1.25
Single-Wall Wye	S22W	22	0.1875	Double-Wall Wye	D22W	22	1.375
Single-Wall Wye	S24W	24	0.1875	Double-Wall Wye	D24W	24	1.375
Single-Wall Wye	S26W	26	0.1875	Double-Wall Wye	D26W	26	1.375
Single-Wall Wye	S28W	28	0.1875	Double-Wall Wye	D28W	28	1.375
Single-Wall Wye	S30W	30	0.1875	Double-Wall Wye	D30W	30	1.375
Single-Wall Wye	S32W	32	0.1875	Double-Wall Wye	D32W	32	1.375
Single-Wall Wye	S34W	34	0.1875	Double-Wall Wye	D34W	34	1.375
Single-Wall Wye	S36W	36	0.1875	Double-Wall Wye	D36W	36	1.375
Single-Wall Wye	S38W	38	0.25	Double-Wall Wye	D38W	38	1.5
Single-Wall Wye	S40W	40	0.25	Double-Wall Wye	D40W	40	1.5
Single-Wall Wye	S42W	42	0.25	Double-Wall Wye	D42W	42	1.5
Single-Wall Wye	S44W	44	0.25	Double-Wall Wye	D44W	44	1.5
Single-Wall Wye	S46W	46	0.25	Double-Wall Wye	D46W	46	1.5
Single-Wall Wye	S48W	48	0.25	Double-Wall Wye	D48W	48	1.5
Single-Wall Wye	S50W	50	0.25	Double-Wall Wye	D50W	50	1.5
Single-Wall Wye	S52W	52	0.25	Double-Wall Wye	D52W	52	1.5
Single-Wall Wye	S54W	54	0.25	Double-Wall Wye	D54W	54	1.5
Single-Wall Wye	S56W	56	0.25	Double-Wall Wye	D56W	56	1.5
Single-Wall Wye	S58W	58	0.25	Double-Wall Wye	D58W	58	1.5
Single-Wall Wye	S60W	60	0.25	Double-Wall Wye	D60W	60	1.5
Single-Wall Straight	S06S	6	0.125	Double-Wall Straight	D06S	6	1.25
Single-Wall Straight	S08S	8	0.125	Double-Wall Straight	D08S	8	1.25
Single-Wall Straight	S10S	10	0.125	Double-Wall Straight	D10S	10	1.25
Single-Wall Straight	S12S	12	0.125	Double-Wall Straight	D12S	12	1.25
Single-Wall Straight	S14S	14	0.125	Double-Wall Straight	D14S	14	1.25
Single-Wall Straight	S16S	16	0.125	Double-Wall Straight	D16S	16	1.25
Single-Wall Straight	S18S	18	0.125	Double-Wall Straight	D18S	18	1.25
Single-Wall Straight	S20S	20	0.125	Double-Wall Straight	D20S	20	1.25
Single-Wall Straight	S22S	22	0.1875	Double-Wall Straight	D22S	22	1.375
Single-Wall Straight	S24S	24	0.1875	Double-Wall Straight	D24S	24	1.375
Single-Wall Straight	S26S	26	0.1875	Double-Wall Straight	D26S	26	1.375
Single-Wall Straight	S28S	28	0.1875	Double-Wall Straight	D28S	28	1.375
Single-Wall Straight	S30S	30	0.1875	Double-Wall Straight	D30S	30	1.375
Single-Wall Straight	S32S	32	0.1875	Double-Wall Straight	D32S	32	1.375
Single-Wall Straight	S34S	34	0.1875	Double-Wall Straight	D34S	34	1.375
Single-Wall Straight	S36S	36	0.1875	Double-Wall Straight	D36S	36	1.375
Single-Wall Straight	S38S	38	0.25	Double-Wall Straight	D38S	38	1.5
Single-Wall Straight	S40S	40	0.25	Double-Wall Straight	D40S	40	1.5
Single-Wall Straight	S42S	42	0.25	Double-Wall Straight	D42S	42	1.5

Single-Wall Straight	S44S	44	0.25	Double-Wall Straight	D44S	44	1.5
Single-Wall Straight	S46S	46	0.25	Double-Wall Straight	D46S	46	1.5
Single-Wall Straight	S48S	48	0.25	Double-Wall Straight	D48S	48	1.5
Single-Wall Straight	S50S	50	0.25	Double-Wall Straight	D50S	50	1.5
Single-Wall Straight	S52S	52	0.25	Double-Wall Straight	D52S	52	1.5
Single-Wall Straight	S54S	54	0.25	Double-Wall Straight	D54S	54	1.5
Single-Wall Straight	S56S	56	0.25	Double-Wall Straight	D56S	56	1.5
Single-Wall Straight	S58S	58	0.25	Double-Wall Straight	D58S	58	1.5
Single-Wall Straight	S60S	60	0.25	Double-Wall Straight	D60S	60	1.5

TABLE 2—LOADING[1]

DUCT DIAMETER (inches)	DUCT CONSTRUCTION	LOAD at 5% DEFLECTION (lbs)	Stiffness at 5% Deflection (psi)
6	Single Wall	986	274
6	Double Wall	828	230
20	Single Wall	148	12.3
20	Double Wall	434	36.2

For **SI:** 1 inch = 25.4 mm, 1 lb = 14.59 N/m.

[1] Loads are the results of ASTM 2412 testing without safety factors yielding a 5% deflection based on inside diameter. Duct specimen tested were non-ribbed or none-reinforced sections of straight duct.

CORROSION COMPOSITES - STANDARDS

Corrosion Composites by Monoxivent offers a full line of corrosion resistant fiberglass products.Our products are designed and fabricated in accordance with industry standards providing the end user with dependable quality solutions, and the right material of choice for a variety of applications. Monoxivent's manufacturing source provides over 90,000-sq. feet of production space, modern equipment, and over 40 years of experience within the FRP industry.

ASTM and SMACNA standards are the benchmark for fabrication of our FRP products, including:

ASTM (American Society of Testing and Materials):

ASTM D3299, Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks

ASTM D3982, Standard Specification for Contact Molded Fiberglass (Glass Fiber Reinforced Thermosetting Resin) Ducts

ASTM D4097, Standard Specification for Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks

ASTM D6041, Standard Specification for Contact-Molded "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Corrosion Resistant Pipe and Fittings

ASTM C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment

SMACNA (Sheet Metal and Air Conditioning Contractors' National Association): www.smacna.org

SMACNA, Thermoset FRP Duct Construction Manual

FRP CONFIGURATION

SHAPE
Round, rectangular, and oval are the typical filament wound construction shapes. Upon requests, shapes such as triangular and others are available. Qualified Monoxivent staff is available for designing projects requiring non-standard construction.

^ From Top:
Rectangular Duct,
Round Duct, Oval Duct

DIAMETER
Duct diameters are available from 2"-144", and rectangular sizes as required for your projects. Monoxivent's 824-API pre-insulated double wall duct is also available in the above ranges.

WALL THICKNESS
Duct wall thickness ranges from 1/8" to 1" (increasing in increments of 1/16"). Wall thicknesses are available for abnormal burial depths or other special loading requirements. Standard ductwork is furnished with the following minimum wall thickness as set forth in ASTM D 3982,PS 15-69 and SMACNA Fiberglass standard:
Diameter Wall Thickness
2" to 18" 0.125 inches
20" to 36" 0.187 inches
38" to 60" 0.250 inches

LENGTHS
Duct sections will be shop fabricated to minimize the number of field joints.

FITTINGS
Standard fittings included:
Elbows, Tees, Laterals, Y's, Reducers, Dampers, Registers, Boxes, Square-to-Rounds, Crosses, Flanges.

^ From Top:
Single Wall FRP,
Double Wall FRP

COLORS
A wide range of colors is available for overhead exposed applications. Please refer to the supplemental color chart for complete details: call factory

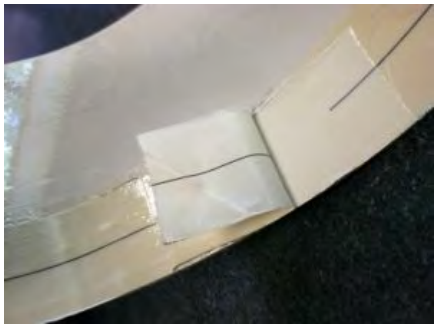
SINGLE WALL (any configuration available)
Our Class 1 rated single wall duct, meets 25/50 flame/smoke requirements of UL 181. Monoxivent UnderDuct 824 Low Smoke has been accepted for HVAC and occupied Industrial areas. It is an excellent choice for corrosive environments where flame and smoke development are a concern, such as laboratories and swimming pools.

DOUBLE WALL (any configuration available)
Double wall Monoxivent UnderDuct will eliminate any thermal losses and save time and money compared to insulating on site. When supplied with the standard 1" insulation, the duct has a k factor of 0.16 and an R value of 6. Also available in R-10, R-14 by request.

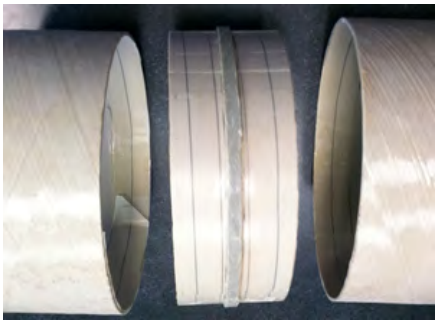
L3 CONNECTION

Low Dust
Low VOC
LEED Driven
by Monoxivent

Low Dust, Low VOC, LEED Driven

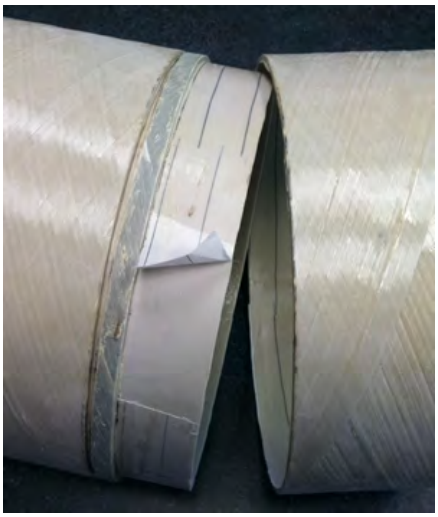


LOW VOC COUPLING TO JOIN MONOXIVENT FRP DUCT



To comply with LEED requirements of dust and VOC control, Monoxivent offers the L3 Connection System. A protective strip that is removed on the job site is incorporated into the duct and fittings during the fabrication process. Simply peel the strip, apply the specially designed Low VOC adhesive and grab those extra LEED points!

L3 Benefits:



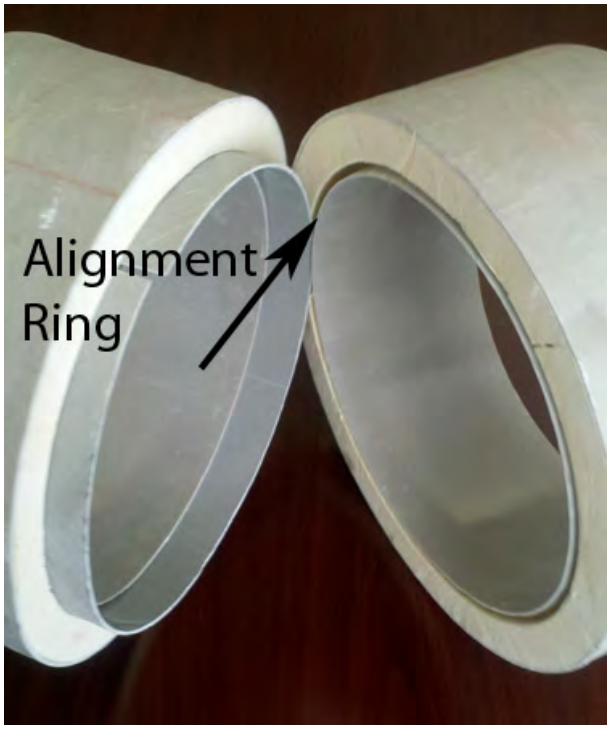
No dust from grinding
Low VOC in adhesive
Tested to 15 PSI
Meets LEED specification requirements

DOUBLE WALL INSULATED DUCT CONNECTION

Double Wall Insulated Duct Connection

DWIDC

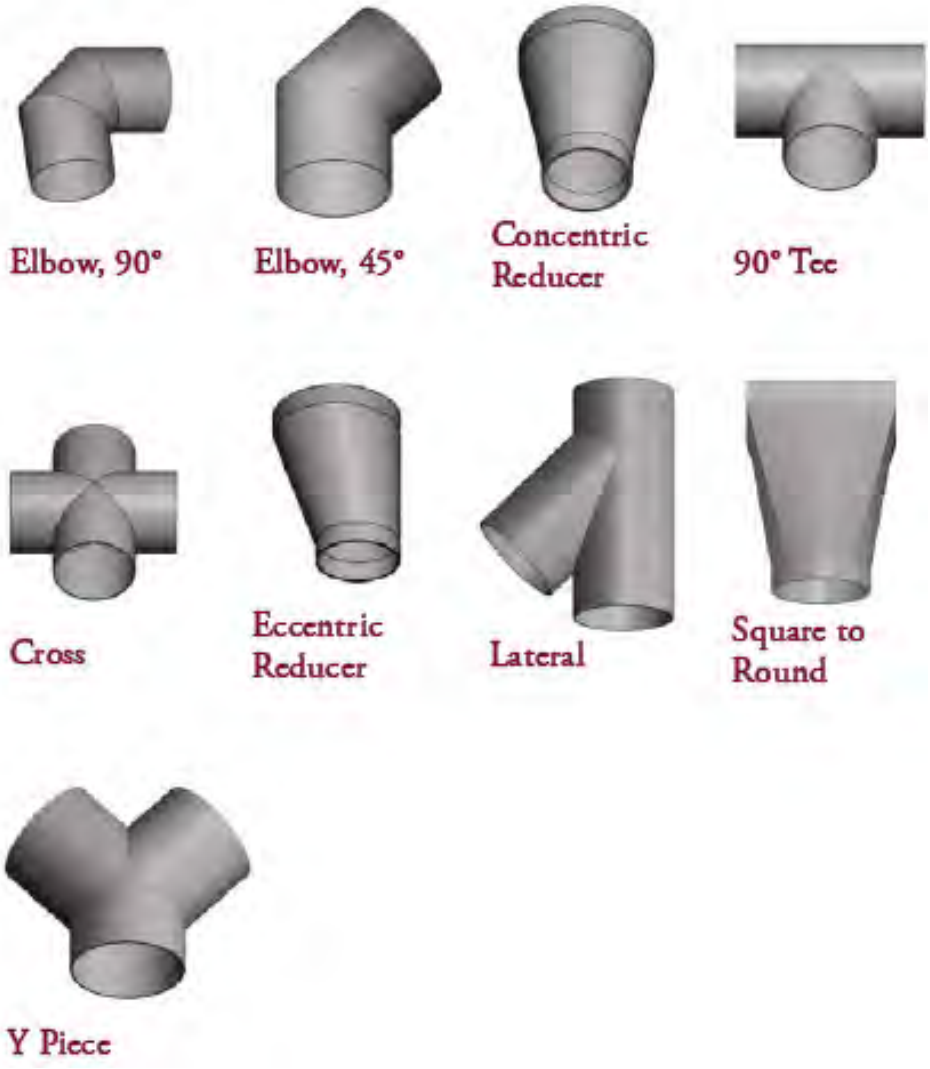
Monoxivent now supplies a standard double wall duct connection that incorporates an FRP alignment sleeve with every field joint. Installation is made easier with the added benefit of eliminating gaps for a higher quality finished duct system.



FRP FITTINGS AND JOINTS

Monoxivent FRP offers a complete line of fiberglass fittings to complete your FRP Duct system. These quality fittings made from fiberglass composite materials are designed and manufactured to the highest standards. Field joints within the corrosion resistant product line are made using the wet lay-up method using a glass, resin wrap (see below).

Fittings



JOINING PROCEDURES
FIELD INSTALLATION: WET LAY-UP, L3 JOINT, SOCKET JOINTS

Installation photos:

Edges to be joined are prepared and "roughed up."

UnderDuct aligned and temporarily connected.

Installers prepare fiberglass and resin mix at jobsite.

Installer places hot patch around UnderDuct.

Installer welds strip to duct.

Installers roll out air bubbles.

UNDERDUCT, FIELD INSTALLATION INSTRUCTIONS

Overview:

Joining duct with a catalyzed resin and cloth and/or mat may be effectively performed by placing cloth and/or mat on a sheet of waxed film or cellophane and saturating with a resin after adding catalyst. The wet lay-up may then be applied to the ends to be joined and air pockets worked out by squeezing or rolling on the firm surface.

Duct Fitting Ends and field cuts shall be completely brush coated with catalyzed resin prior to joint wrap so no raw glass fibers are exposed. Resins used shall be the same type used in the duct and fitting filament winding. Wet field joints (mat and resin) shall be a minimum 4” in width and at lease the same thickness as the adjoining duct wall. Joints shall be minimum three wraps for duct up to 22”Ø, four wraps for 22”Ø to 36”Ø and six wraps for duct 38”Ø to 60”Ø. Joint material shall be thoroughly saturated with the same type of resin as used in duct and fittings. Minimum joint overlap shall be 4” for all sizes.

A hard roller (Paint Roller) can be used to spread the resin and to work out potential air bubbles. Additional layers of mat may be used in the same manner. Care should be taken to catalyze only the amount of resin that can be used during the pot life of the resin. A little experience can quickly determine the proper handling of the resin.

The catalyst should be carefully proportioned to the amount of resin to be used, and thoroughly mixed to a uniform blend. Duct joints or repaired parts should be allowed to cure at least 24 hours before being used.

If additional lamination is to be made over a cured area, surface should be broken by sanding before application.

Trench:

The surface at the bottom of the trench should be continuous, smooth and free of rocks to avoid point loading on the duct. The trench should also be graded with a slight pitch to facilitate drainage with the bedding as uniform and continuous as possible.

Trench width should not be greater than necessary to provide adequate room for joining the duct in the trench and for compaction the backfill in the bedding zone and at the sides of the duct. The minimum distance between the duct and the trench is 4 inches; maximum recommended trench width is twice the diameter of the duct.

Where the risk of flooding the trench during installation is possible, care should be taken to keep water away from the duct and the field joint areas. Keeping the water from the duct system shall continue from the time the duct is first placed in the trench, until backfill or encasement is completed. Damage can occur when the duct is floated during a water uplift event.

UNDERDUCT, FIELD INSTALLATION INSTRUCTIONS

Backfilling:

The approved backfill materials are pea gravel or dry sand. These materials will achieve 80% to 90% compaction without the use of mechanical compaction machines. Rodding and hand tamping are the only approved compaction methods over the top of the duct.

In poor soil conditions, permeable synthetic support fabric should be utilized as a trench liner to prevent migration of the gravel into native soil. The next two layers (6" cover over duct), in lifts of 6", may be the excavated material, provided there is no organic material, frozen lumps, debris, or particles larger than ½". Each layer is to be compacted to the required density. Where heavy floor loads are expected, the floor slab should be either structurally reinforced over the duct area or as an alternate method, a crown of concrete could be poured over the duct in lieu of the indicated select backfill. In either case, the selection of the proper method should be determined by the structural engineer.

Concrete Encasement:

Concrete encasement is not required, but can be accommodated with provisions. If you are considering concrete encasement, it must be done in 2 to three 3 lifts depending on the diameter and trench conditions, with provisions to prevent floating. Please contact Monoxivent for specific instruction on how to do this without damaging the duct. Duct hold down systems for encasement should be designed by a Mechanical Engineer and confirmed with Monoxivent for potential pounds of floating lift per linear foot per diameter.

Tools and Supplies:

Items you are going to need to make a Field Joint will be as follows. Lamination roller, rubber gloves, paint brushes, measuring containers, utility knife or scissors, grinding disc (36 grit abrasive), heat gun (if temperatures are below 60^{o} F), wax paper or mylar, acetone (for cleanup) and protective wear.

Precautions:

Although most polyester and vinylester resin are quite stable, extended storage at elevated temperatures above 80^{o} F (26.7^{o} C) can decrease the reactivity of the resin or cause it to gel even without the use of catalyst. Make sure you read the resin data sheets that come with every shipment. Temperature extremes must be avoided for proper curing of the resin. See Table 1 below for mixing ratios at varying temperatures. Work must be done in a dry, well-ventilated area. A wide flat surface should be available to wet-out the glass mat strips. The surface should be covered with a disposable covering. Anyone coming into contact with the resin and catalyst must wear rubber gloves and protective eyewear. Always review the supplied MSD Sheets, keep all joining materials away from an open flame and use an adequate amount of ventilation.

UNDERDUCT, FIELD INSTALLATION INSTRUCTIONS

Mixing:

The rate of curing of the resin is dependent on the temperature. At low temperatures, most resins have a longer working life and require longer curing periods. Working time is decreased and curing takes place more rapidly as the temperature increases. Decreasing the amount of catalyst prolongs the working time. See Table 1.

The catalyst should be carefully proportioned to the amount of resin to be used, and thoroughly mixed to a uniform blend. Duct joints or repaired parts should be allowed to cure at least 24 hours before being used.

Table 1

Amount of Resin	Amount of Hardener	Temperature	Approximate Pot Life
1 qt	2 / 3 oz	50-60°F	20 min.
1 qt	1 / 2 oz	60-70°F	20 min.
1 qt	1 / 3 oz	70-80°F	20 min.
1 qt	1 / 3 oz	80-90°F	20 min.
1 qt	1 / 6 oz	Over 90°F	20 min. or less

Joining:

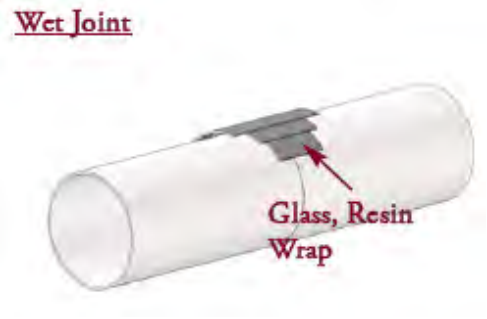
Coat all raw edges with resin mix, completely filling the joint and slightly squeezing the sections together. It is often preferable to add sufficient Cab-O Sil to resin for this step to produce a paste or light putty which will fill small voids and irregularities if there is not a good fit. It is often desirable to speed-up the hardening time for this step also by increasing the MEK catalyst required by 1 to 2 cc per pound. Insure that the interior surface is relatively smooth but a light “bead” on the interior is desirable and acceptable.

Butted sections may be “hot patched” with tabs to hold the alignment until the complete joint can be made. A tab consists of 2-3” square of glass mat saturated with resin mix. Place the prepared hot patch tab across the joint to be made to form a “tack weld.” Three are usually sufficient. For this step, it is often desirable to speed-up the hardening time of the resin by increasing the MEK catalyst by 1 to 2 cc per pound.

Two lay-ups may be required to prevent sag and overheating of the resin during hardening.
Where accessible, the inside surface of the joint should be covered with 1-2 piles of fiberglass mat 4-6” wide and 1 ply of 6-8” wide surfacing veil or mat saturated with resin.

Cut the glass mat to length using Table 2 and Table 3 for the number of layers and width of glass required. Each piece of glass should be cut into manageable lengths allowing for a slight overlap. Lay the widest section of mat on a flat surface treated with release agent or covered with releasing film. Wet the entire surface with resin mix, using a paint brush and/or roller. Position the next ply of glass, staggering the pieces properly.

Wet out the entire surface area of this layer with the resin mix. Remove as much air as possible with brush and/or roller toward the edges of the laminate section. Be careful to not remove excessive resin from an area.
Repeat with proper sequence of glass until all plies have been saturated with resin and formed into one integral unit.



If additional lamination is to be made over a cured area, surface should be broken by sanding before application.

Clean Up:

Preferably, acetone is used as a cleaner for your hands and tools. Soap and hot water may be used, though not as effectively as acetone. Thorough cleanup must be made before the resin cures. Care should be exercised to keep catalyst and resin from contact with skin. We recommend wearing rubber gloves when working with resins and catalyst.

Table 2

Duct Wall Thickness	Minimum Total Width of Overlays
1 / 8”	4”
3 / 16”	4”
1 / 4”	4”
5 / 16”	5”
3 / 8”	6”
7 / 16”	7”
1 / 2”	8”
9 / 16”	9”
5 / 8”	10”

UNDERDUCT, FIELD INSTALLATION INSTRUCTIONS

Table 3

Duct Wall Thickness	Number of Plies of Strapping and Sequence
1 / 8”	MRM
3 / 16”	MRM
1 / 4”	3(MR)M
5 / 16”	3(MR)M
3 / 8”	3(MR)MM
7 / 16”	3(MR)MM
1 / 2”	3(MR)M, MRM
9 / 16”	3(MR)M, 2(MR)M
5 / 8”	3(MR)M, 3(MR)M

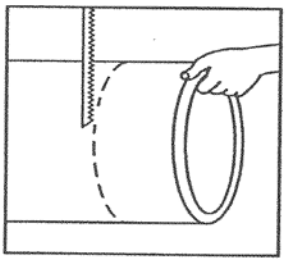
M= 1 1/2 oz. / ft²
R = 24 1/2 oz. / ft²

These tables should only be used as guides for the minimum total width of joint overlays and minimum joint thickness. Joint thickness should be at least as thick as the duct to be joined.

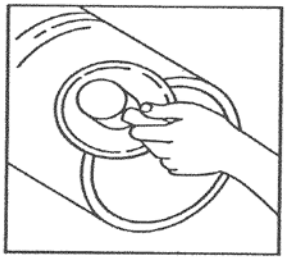
* **STM C 582 Table 2 Type 2**
* **STM D 3982 Table 2**

UNDERDUCT, FIELD INSTALLATION INSTRUCTIONS

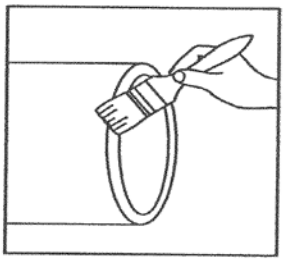
Joining Procedures for Wet Lay-Up



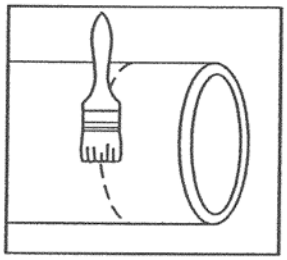
1. Firmly support duct sections. Square the ends to be welded using a saw.



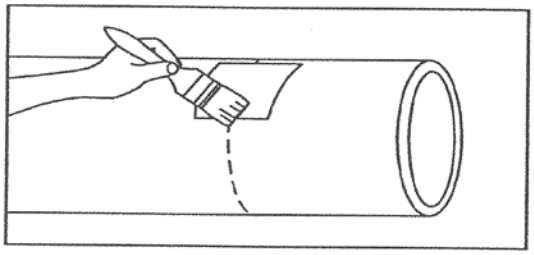
2. Rough the outer surface with sander approximately 1" farther from the ends than the finished weld surface. Where inside welds are possible, interior surfaces should be sanded prior to assembly. See Table 2 on previous page.



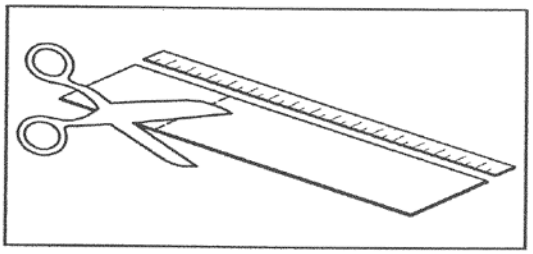
3. Coat roughened ends of duct with a small amount of catalyzed reins. Any large voids may be filled with silica-filled resin putty.



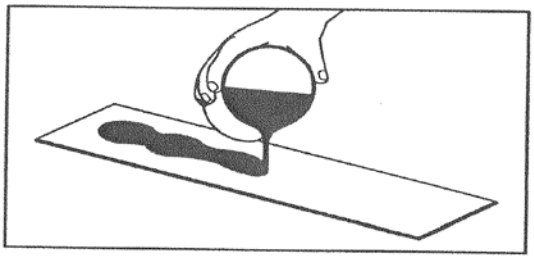
4. Support components in joint position so that no movement occurs while making the joint. Fill joint with resin.



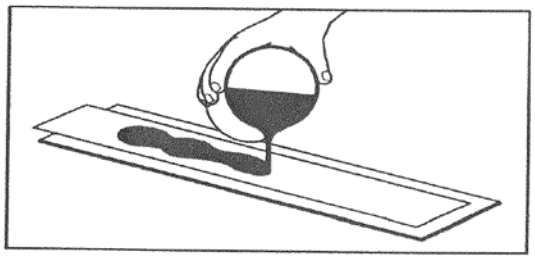
5. A "Hot Patch" technique may help prevents movement of duct during the weld-cure period. Wet 2" squares of mat with a small amount of resin using three times normal amount of catalyst. Apply "Hot patches" at intervals around joint. Curing or hardening in a matter of minutes, they secure duct sections in proper alignment. Mix resin and catalyst for "Hot Patches" in a small paper cup and discard immediately after use to avoid contaminating welding resin.



6. Lay out fiberglass mat strips on the work table. Length of each strip should be 2" longer than circumference of duct. Strips longer than 36" may be cut in half to simplify application. Mix prescribed amount of catalyst with required amount of resin in a separate clean container. Prepare only the amount of resin which can be used immediately (about 1 qt. per 6 sq. ft. of mat) the resin will harden in roughly 20-30 minutes.

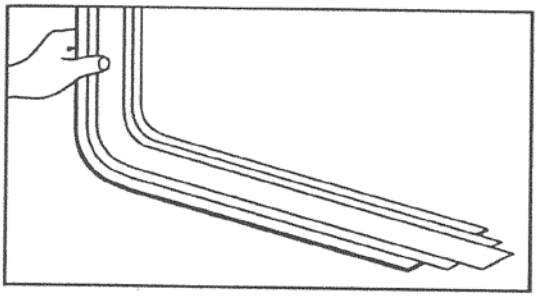


7. After mixing in the catalyst thoroughly, pour the resin onto the widest mat first. Spread it over the entire mat strip, working it into the mat fibers manually. (Neoprene gloves are recommended).

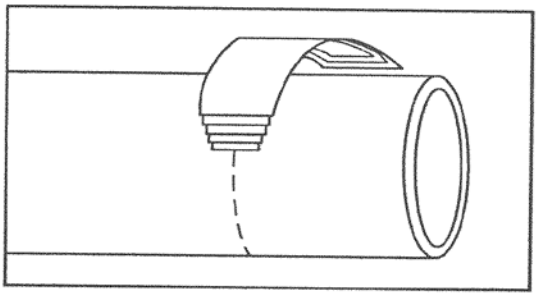


8. Place the next widest strip onto the first strip by staggering away from the first to produce a smooth weld strip joint. Add more resin and work onto the second strip.

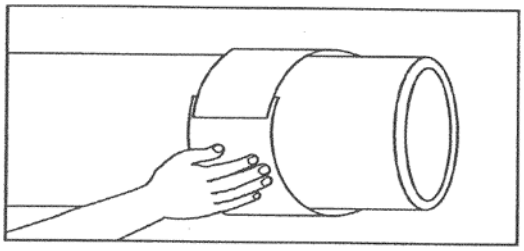
UNDERDUCT, FIELD INSTALLATION INSTRUCTIONS



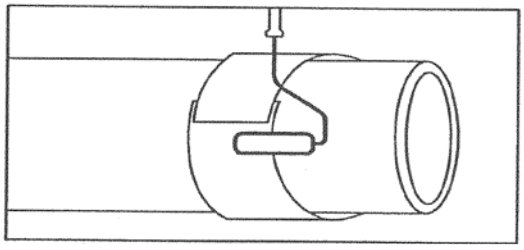
9. Add other strips in the same manner. In wetting each strip, it is best to be a little “lean” on resin at this stage rather than over-wetting. More resin may be added later if necessary. After



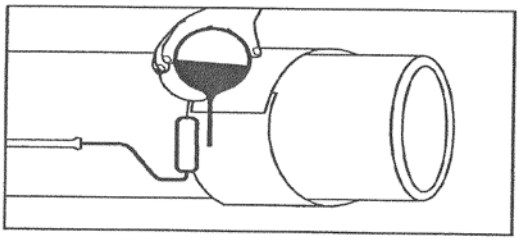
10. Pick up the completed weld strip by one end and center in carefully on the duct joint. Apply the tapered end first with the



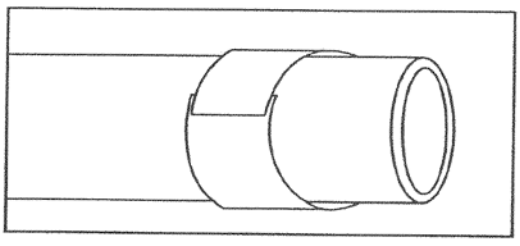
11. Be sure the weld is centered, with care taken to avoid wrinkles on the under and back side of the weld. Continue applying the strip around the joint until the free end overlaps



12. Finish the application of the weld with the roller. Any remaining air bubbles will appear as light spots. These should be rolled to the edge of the weld where they will be released and disappear. If weld is not a slight butt joint, a little extra rolling and hand work to shape mat strips to structure configuration will eliminate bumps and ridges.



13. At this stage, resin may be added where necessary if any mat appears to be not thoroughly wetted. It is better to have too little resin on the weld strip, when initially applied, than too much. Over-wetting makes it difficult to keep the weld strips in place. Also coat the remaining sanded surface with resin.



14. Allow the completed weld to cure thoroughly tack free. Do not move or disturb weld until it is thoroughly cured. If temperature is below 55°F, keep weld area warm with heat lamps. For exterior installation, protect the weld from the weather.

WHAT IS FRP?

Fiberglass Reinforced Plastic Explained

Fiberglass Reinforced Plastic (sometimes referred to as Fiberglass Reinforced Poylmer) products are a composite of fiberglass and a plastic or polymer resin that when combined, offer a stronger, more durable, more corrosion and heat-resistant product than is found anywhere else.

Using a mold to create the finished product, fiberglass is generally thermoset with a type of plastic or epoxy resin. When cured, the end product will hold its shape because of the resin, while the fiberglass will provide strength and stiffness. Just as important, the resin has additional corrosion- and heat-resistant properties not found in any type of metal products. This technology has led to increased durability and strength in hostile and corrosive environments such as chemical processing plants, food processing, waste water treatment and sewage centers, HVAC, semiconductor plants, power generator facilities, fuel storage tanks and more.

BENEFITS OF FRP:
UNDERDUCT - THE BETTER CHOICE FOR UNDERGROUND HVAC APPLICATIONS

Corrosion Resistant
UnderDuct's Fiberglass Reinforced Duct is specifically designed to withstand the harsh underground environment. Our FRP duct stands up to water, temperature changes and acidic soil conditions. In very wet or corrosive environments, UnderDuct is the clear choice over stainless steel, galvanized, PVC, or PVC coated galvanized.

High Strength yet Light Weight
Filament wound FRP Composites have a higher strength-to-weight ratio than steel. Being a structural material, large lightweight fiberglass duct sections can be shop fabricated and shipped to the jobsite for easy installation. Light weight components also save on transportation and installation costs. UnderDuct does not require concrete encasement. When buried in compacted sand or pea gravel UnderDuct does not require hold downs.

Sustainable, Green Building
UnderDuct is a sustainable alternative to metal duct and is an excellent choice for green building and design. UnderDuct is resistant to mold, corrosion, leakage and moisture damage. Smooth interior walls provide improved air flow for maximum efficiency and energy savings. UnderDuct buried duct systems allow for more open design concepts.

Shop Fabrication
Underduct assemblies are built to approved shop drawings . Shop assembled sections can be in the range of 20' long allowing as few field joints as possible. Not only does this lessen shipping costs, it also assures better quality control and cuts expensive field installation costs.

Non-Conductive
Unlike metal, UnderDuct is inherently non-conductive.

Minimal Maintenance
UnderDuct is built to last the life of the building. Even after a flood or a sprinkler system release UnderDuct can be pumped out with no ill effects.

Fire Resistant
All surfaces of UnderDuct and fittings, as a finished composite, meet the Flame and Smoke requirements of the Class 1 duct per UL 181 and UMC 10-1. Verifications of performance are done by an ASTM E-84 testing laboratory, recognized by the following building code organizations under the Council of American Building Officials: ICBO; BOCA; SBCCI.

UNDERDUCT PRODUCTION PROCESS

Monoxivent's manufacturing source has over 40 years of experience and is a leader in the Underslab Fiberglass Ductwork market. Monoxivent has a nation-wide network of sales representatives and a top-tier inside support crew, which provides engineering, design, sales, service, and marketing. UnderDuct is offered both as single wall and pre-insulated double wall duct to meet any ventilation needs. Monoxivent 824 Low Smoke Class 1 duct is recommended for direct burial.

< UnderDuct Staging Area

< UnderDuct, filament winding on mandrel

< UnderDuct, curing before heading to staging area

GREEN BUILDING WITH UNDERDUCT: UNDERGROUND FRP DUCT IS ENVIRONMENTALLY SOUND

Due to the 'green' aspects of our fibergalss reinforced plastic underslab duct, FRP duct is a key component of sustainable building. The quality and strength of our FRP duct means a longer life, which saves resources, and maximized airflow uses energy more efficiently.

UnderDuct - Green Benefits:

Smooth and improved air flow
Energy savings with insulated FRP duct
Maximizes air flow and efficiency
Resistance to mold, corrosion, leakage, moisture damage
824 low smoke and flame - Class 1 Rating
Long-life duct
Energy savings through Displacement Ventilation Design
Allows for "open concept" design in buildings
Laminated joints for complete seal

MADE IN THE USA, BUY AMERICAN ACT

UnderDuct, by Monoxivent, is in compliance of the Buy American Act, Sec. 1605. Please contact Monoxivent staff with any questions pertaining to this act: 877-608-4383.

The act language follows:

Sec. 1605. USE OF AMERICAN IRON, STEEL, AND MANUFACTURED GOODS.

(a) None of the funds appropriated or otherwise made available by this Act may be used for a project for the construction, alteration, maintenance, or repair of a public building or public work unless all of the iron, steel, and manufactured goods used in the project are produced in the United States.

(b) Subsection (a) shall not apply in case or category of cases in which the head of the Federal department or agency involved finds that -

(1) applying subsection (a) would be inconsistent with the public interest;

(2) iron, steel, and the relevant manufactured goods are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality; or

(3) inclusion of iron, steel, and manufactured goods produced in the United States will increase the cost of the overall project by more than 25 percent.

(c) If the head of a Federal department or agency determines that it is necessary to waive the application of subsection (a) based on a finding under subsection (b), the head of the department or agency shall publish in the Federal Register a detailed written justification as to why the provision is being waived.

(d) This section shall be applied in a mnner consistent with United States obligations under international agreements.

COMPLETED PROJECTS LIST, MONOXIVENT FRP
Updated - Mar. 2014

3M, Cottage Grove, MN

3M Domes, Cordova, IL

Aberdeen, MD, Waste Water Treatment

ACO Building 2, Bettendorf, IA

Allegheny Ludlum, PA

Apex United Methodist, Raleigh, NC

Art and Design, Millstadt, IL

Ashland Chemical, Columbus, OH

Bailey Residence, SC

Beaver Run Pump, Lawrenceville, GA

Bergan Mercy Hospital, NE

Bethel Baptist, Tuscaloosa, AL

Blanco, TX, Elementary

Boeing, Ridley Park, PA

Brookwood, AL, High School

Brown Road, Southfield, MI

Calumet Grit Flumes, Chicago, IL

Chesapeake Terrace, Baltimore, MD

Christenson Chevrolet, Portage, IN

Christopher Newport University, VA

Climax Molybdenum, IA

Coburg Water, Milwaukie, OR

Converse College, SC

Dakota City, NE, Tannery

Danisco USA, Thomson, IL

DMV, WI

Dublin Performing Arts Center, CA

Duncan Aviation, Lincoln, NE

Dundalk Waste Water Treatment, Baltimore, MD

East Pinson Rec Center, Birmingham, AL

Eastern Avenue Library, Davenport, IA

Edmond, OK, Rec and Aquatic Center

Efrain Duran Water Treatment, Rio Grande City, TX

Fairmont Pool, Richmond, VA

Fanshawe College, ON

Four Seasons, DC

Ft. Sill, Wichita Falls, TX

GEA Process Engineering, Columbia, MD

Gillette Sr. Center, WY

Goodyear, Akron, OH

Hauppauge H.S., NY

Holy Land, FL

ICBC Driver's License, BC

Indoor Sports Court, Windham, NH

INDSPEC, Petrolia, PA

Ivey School of Business, ON

Kalamazoo, MI, Airport

Kankakee, IL, Environmental

Kansas City, MO, Water Treatment

Kennedy Space Center, Cocoa, FL

Kirkland AFB, NM

KPI Kennel, FL

Lake Itasca, MN, Headwaters

Lake Lewisville, Denton, TX

Lakewood Mausoleum, Minneapolis, MN

Lowell Waste Water, Gary, IN

Mamaroneck, NY, Waste Water

Markquart Motors, Chippewa Falls, WI

Mascoutah, IL, High School

McEwen Treatment Plant, Batavia, OH

Mercedes-Benz, El Dorado, CA

Minera Yanacocha, Peru

Missouri State University, Springfield, MO

MSC Winona, MN, SE Tech

MST-Billess Waste Water, St. Louis, MO

MTA East Operations, Beltsville, MD

Myriad Botanical Center, OK

Navistar, Chicago, IL

Newburgh, DE, Aquaduct

North Carolina A&T Cherry Hall

North Georgia College, Dahlonega, GA

Northwestern University, Chicago, IL

NU Tech, Willow Springs, IL

Oakland Foods, IA

Ohio State Unversity Photo Lab, Columbus, OH

Orton Ceramics, Columbus, OH

Our Lady of Guadalupe, PA

Owatonna, MN, Waste Water

Passaic Waste Water, Newark, NJ

PCS Phosphate, IL

Pfizer, Kalamazoo, MI

Plant Scherer, Carrollton, GA

COMPLETED PROJECTS LIST, MONOXIVENT FRP
Updated - Mar. 2014

Puetz Road, Franklin, WI

R&L Carriers, Syracuse, NY

Ransom Everglades School, FL

River City Shrouds, Gary, IN

Rock Island Arsenal, IL, Canopy

Rockwell Collins, Cedar Rapids, IA

San Mateo, CA, High School

Sapheon Lab, Morrisville, NC

Science and Technology Bldg., Santa Monica, CA

Severndale WTP, Beltsville, MD

Southern Elementary, Tuscaloosa, AL

Southern Environmental, Pensacola, FL

Spring Creek WWTP, Springfiled, IL

St. Francis Tech, Tulsa, OK

Superior, WI, WWTP

TBW Cypress Creek, Land O' Lakes, FL

Three Rivers Jr./Sr. High School, TX

Transit Operations, Raleigh, NC

Tulsa, OK, Paper

U of Florida, Gainesville, FL

Virginia, MN, WTP

West Inverness WWTP, Baltimore, MD

White Bay Passenger Terminal, Sydney, Australia

Youngblood Nissan, Springfield, MO

MONOXIVENT FRP CASE STUDY
CALUMET: CORROSION/ABRASION RESISTANT GRIT FLUMES

Application Spotlight Location:
Calumet Water Reclamation Plant, Chicago, IL

Challenge:
The Metropolitan Water Reclamation District of Greater Chicago recently added a grit removal facility to their Calumet Waste Water Treatment plant. The process required (8) each 120' long corrosion resistant sloped flumes with an abrasion resistant surface. Flume elevations and equipment clearance without the use of cross bracing was also critical.

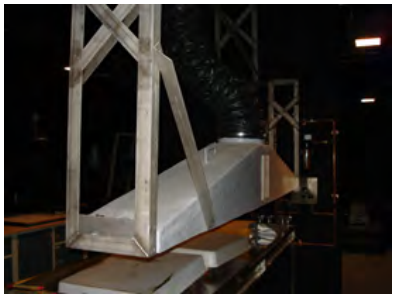
Solution:
Monoxivent designed the trough system to fit the process requirements for Metcalf & EDDY / AECOM's grit removal design. In addition to the abrasion and corrosion resistance the flumes had to resist deflection in the horizontal and vertical when full at 36" deep. Overflows, stilling wells and level devices had to be designed in close tolerance. The flumes sections were manufactured in 20' long flanged sections with a 1% bottom slope and a level top over the 120'length. The flumes were supported every 10' with stainless steel supports. Monoxivent's grit flumes are a critical part of the grit removal system and will last for many years.

MONOXIVENT FRP CASE STUDY
OHIO STATE: CORROSION RESISTANT EXHAUST HOODS

Application Spotlight Location:
OSU Photo Lab, Columbus, OH

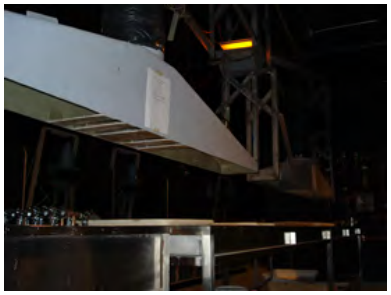
Details:
Custom FRP (Fiberglass) Exhaust Hoods, 8' x 1'

Summary:
During a normal weekly visit to a large mechanical engineering firm in Columbus, OH, Air Control Products was asked to assist in designing a custom FRP exhaust hood. The engineer needed the hood to be 8' long and 1' wide to span the length of a photo development sink. It was important for the end user to be able to "slide" the hood off to the side of the sink so that the large photos being developed could be flipped for proper development processing.



Monoxivent was contacted and a "napkin" drawing was provided. The resources available from Monoxivent provided Air Control Products with several design renditions to review with the mechanical engineer. After several changes and design improvements we were able to provide the engineer with a completed CAD drawing to present to the end user. Once a couple of simple changes were made Air Control Products was named as basis of design for the project.

When the contract was awarded to Air Control Products the order was placed with Monoxivent for not one but two hoods. Monoxivent worked their custom fabrication magic to create the FRP hoods that provided the end user with exactly what they envisioned. Monoxivent incorporated stainless steel, heavy duty drawer slides to provide the hood with the lateral "sliding" movement necessary to move the hood aside for development procedures. Monoxivent called up its' parent company, Crawford, and their metal fabrication shop to provide the stainless work. One of the stipulations from the engineer was that the hood performance be tested and confirmed. Monoxivent performed the test and provide the data showing the correct ventilation for removing the development chemical fumes. In turn the hoods also protected the students from the chemical fumes created by the development process.



MONOXIVENT FRP CASE STUDY
OWATONNA: ODOR CONTROL VENTILATION

Application Spotlight Location:
Owatonna Waste Water Plant, Minnesota

Midwest Mechanical Solutions - Monoxivent Sales Representative

Summary:
Owatonna is a city in southern Minnesota with a population of approximately 25,000 located about an hour south of Minneapolis. Legend has it that Princess Owatonna, the sickly daughter of Chief Wabena of the Dakota Indians, was brought to the waters of the mineral springs of Maple Creek which supposedly had magical healing powers.

In March of 2010, the City of Owatonna expanded their waste water treatment plant which is situated on the Straight River, just upstream from Maple Creek. The Mechanical Engineering firm of Wentz Associates, Inc. designed an odor control ventilation system that was to be installed by Forte Mechanical under the supervision of Magne Construction, the General Contractor on the project.

Midwest Mechanical Solutions, Monoxivent's representative in Minnesota, got the approval to supply Monoxivent's Corrosion Composite duct work in accordance with the written specifications for this project. Monoxivent manufactured all of the 14", 24" and 30"odor control fiberglass duct work along with the dampers and two custom built fiberglass hoods for odor capture.

Corrosion Composites by Monoxivent; an integral and vital part of a project designed to help safeguard the healing waters that aided in the recovery of the City's namesake.

MONOXIVENT FRP CASE STUDY
KANSAS CITY: FIBERGLASS WATER WHEELS

Fiberglass Water Wheels Save Energy and Maintenance Costs at Water Treatment Plant

City of Kansas City, MO

Over the past 20 years the Kansas City Water Plant has replaced 38 motor and chain drives in their primary and secondary mixing tanks with one 40 horse blower. The blower supplies air to 40 fiberglass drive wheels that are directly in line with mixing paddles. Each 13' diameter Water Wheel has eight half round buckets that when filled with air will start the wheel turning. As the submerged wheels turn in the water, each wheel can generate enough torque to drive up to 400' of mixer paddles.

The first wheels were made of wood and they only held up long enough to assure the concept would work. Next they tried making the wheels from flat fiberglass plates and again the torque and weight of the water was too much. In 1988 Yankee Plastic Co. (now doing business through Crawford/ Monoxivent) was asked to design a better water wheel. The resulting design has proven to be very reliable. The City of KC has installed several new water wheels each year for the last 15 years - completing a total of 40 to finish the project.

MONOXIVENT FRP CASE STUDY
SYDNEY: UNDERDUCT

Application Spotlight Location:
Sydney Ports Corporation, Australia

Challenge:
On 20 December 2009, the Australian Premier announced that the NSW Government decided to permanently relocate the Darling Harbour No. 8 Cruise Passenger Terminal to White Bay 5, in accordance with the recommendation from the Passenger Cruise Terminal Steering Committee. The new terminal would have to service thousands of passengers in a comfortable indoor environment.

Solution:
The terminal construction was started in March 2012 and Monoxivent's Double Wall Insulated Buried Duct was chosen to serve as the facilities HVAC system. This required an extremely demanding solution as the buried ductwork is regularly subjected to fluctuating tide water and Monoxivent's UnderDuct provided that solution seamlessly.

MONOXIVENT FRP CASE STUDY, MISSOURI STATE: UNDERDUCT AT UNIVERSITY

Application Spotlight Location:
Missouri State University Rec Center, Springfield, MO
Sales Representative:
Triangle Sales
Details:
88' of 20" Diameter UnderDuct; 84' of 6" Diameter UnderDuct; 28 Volume Dampers
Summary:
Over 170' of Monoxivent's Single Wall UnderDuct, along with 28 volume dampers have been installed at the new Missouri State University Rec Center. The facility is seeking LEED certification. Since its founding in 1905 as the Fourth District Normal School, then as Southwest Missouri State Teacher's College in 1919, Southwest Missouri State College in 1945, and Southwest Missouri State University in 1972 and finally to Missouri State University in 2005 as it is known today, Missouri State has continually evolved to meet the needs of her clients, the students. Located in Springfield, MO, MSU boasted an official system enrollment in 2011 of 22,866 students; up from its first year enrollment of 573 in 1905! Throughout its rich history, MSU has turned out such notable attendees such as John Goodman, George C. Scott and Tennessee Williams. In 2006, the students of Missouri State demanded a new evolution: the creation of a new Recreation Center. The project was initiated by student leaders, designed with the help of students, and funded through a dedicated student fee and private contributions, making this facility one that fits their needs, meets their standards, and is solely theirs.

This new steel structured 100,000 SF facility includes an aquatics area, locker rooms, a climbing wall, 3 basketball courts, weight and fitness areas, multipurpose rooms and support areas. With the interior designed by Cannon Design of St. Louis, MO, the aquatics area designed by Counsilman-Hunsaker of St. Louis, MO and the project managed by DeWitt & Associates, Inc. of Springfield, MO, the project is pursuing LEED Silver certification. The center has already received two design awards, one through the American Institute of Architects (AIA) St. Louis Chapter; the other is from AIA Central Region.

Many of the facility innovations that are now standard in the swimming pool design industry leapt to life from the minds and drawing boards at Counsilman-Hunsaker. Their unique understanding of swimming and insights into swimming kinetics led them to new solutions in both facility design and operational efficiency. The engineers at Counsilman-Hunsaker chose Monoxivent's single wall UnderDuct as the product of choice for the supply duct in the aquatics area and was supplied by Monoxivent's representative Triangle Sales of Lenexa, KS. This was an exceptional choice of a cutting edge product for a cutting edge design.

MONOXIVENT FRP CASE STUDY
DUNCAN: UNDERDUCT AT AVIATION SITE

Application Spotlight Location: Duncan Aviation, Lincoln, NE, Airport
Sales Representative: Air-Side Components
Details: 400' of UnderDuct, mostly 48" Diameter

Summary: The Lincoln Municipal Airport, located 4 miles outside of Lincoln, NE has gone through many changes over the years. During World War II, the airfield was named Lincoln Army Air Field until December 1945. In 1952 the facility was re-opened as Lincoln Air Force Base and the U.S. Air Force closed the installation in 1966. It is the second-largest airport in the state of Nebraska and its long landing strip was designated as an emergency landing site for the Space Shuttle, though it was never used in this way. Currently, it is owned by the Lincoln Airport Authority and is “Gate 1” to Central and Southeast Nebraska. Today, a portion of Lincoln Airport hosts the Nebraska Air National Guard's 155th Air Refueling Wing and the airport is also home to Duncan Aviation, a large family-owned aircraft maintenance and refurbishing company.

Duncan Aviation has been in operation since 1956, and has a long history of doing right by their customers. Duncan Aviation is a premier aircraft maintenance, modification and refurbishment service provider headquartered in Lincoln and they needed to have a larger paint hangar to provide full exterior paint services to customers who fly larger business aircraft. This need was met by Tectonic Management Group, Inc. of Wheat Ridge, CO, a Design/Build General Contractor.

The word “Architect”, derived from the Latin “Architectus” and the Greek “Arkhitekton”, literally means “Master Builder.” Tectonic Management Group embodies this definition of “Architects that Build” by leading the design process as an Architect and the construction process as the General Contractor. The company vision is to be a Premier Design and Construction company that does what it promises, which is totally in line with Duncan’s history of doing right by their customers.

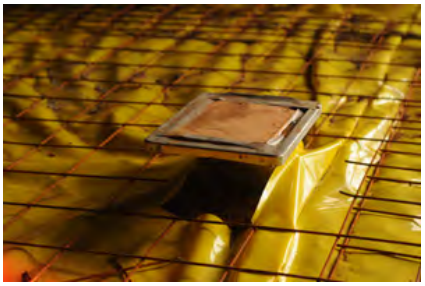
Tectonic Management designed a new 45,000 square foot aircraft paint facility which will allow the input of some of the largest business aircraft in use today. The planned hangar has the latest down-draft air flow technology, utilizing a two-zone airflow system to provide the best paint environment possible for aircraft. To accomplish this, Monoxivent’s UnderDuct FRP duct was selected as the material of choice to bury below the hangar floor and connect the various concrete down-draft trenches. Supplied to the project by Monoxivent’s representative Air-Side Components of La Vista, NE, the project required approximately 400’ of Monoxivent’s Single Wall UnderDuct with the majority of it comprised of 48” diameter duct. As a Class 1 duct, UnderDuct was the perfect choice for the design and construction of this airflow system and will be part of this historic airport for years to come.

MONOXIVENT FRP CASE STUDY
UNDERDUCT-VE AT WISCONSIN DEALERSHIP

Application Spotlight Location:
Markquart Motors, Chippewa Falls, WI
Sales Reprsentative:
Midwest Mechanical Solutions
Details:
UnderDuct VE installation included: FRP duct underfloor with Monoxivent floor outlet assembly, including lay-flat door, and no crush 3000 Series hose

Summary:
Chippewa Falls, Wisconsin: Famous for being the home of the 140-year old Jacob Leinenkugel Brewing Company, the seventh-oldest brewing company in the United States. The city's name originated because of its location on the Chippewa River, which was named by the Ojibwa Native Americans. Early settlers misheard the word "Ojibwa" as "Chippewa." Chippewa Falls is also the address of Markquart Toyota, a division of Markquart Motors which is owned by LDJLLC, a partnership of Lee, Dave and John Markquart.

The Markquart brothers followed their vision of “Offering the Best Automotive Solutions for Life!” when they decided to add on to their Toyota dealership. Designed by SDS Architects of Eau Claire, WI and engineered by Karges-Faulconbridge, Inc. of St. Paul, MN, their new state of the art service facility incorporated several of Monoxivent’s product lines for capturing and removing vehicle exhaust from the service area of 20 work stations.
Midwest Mechanical Solutions of Minneapolis, MN teamed up with Monoxivent to supply over 200’ of underground Fiberglass Reinforced Plastic duct incorporating 20 stainless steel covered floor outlets, stainless steel saddles with 3” crush proof hoses and neoprene tailpipe adapters . (2) 5 HP Monoxivent Backward Inclined BI-150 belt drive Blowers were also supplied for connection to the specialty FRP duct with debris cleanout ports. This duct system, which can handle the high heat and corrosive nature of vehicle exhaust, also provided an excellent alternative and lasting solution to the problem of corroding metal ducts installed underground. To the Ojibwa, the name Wisconsin means “gathering of the waters” and to Markquart Toyota, the “gathering” of Monoxivent’s diverse products has certainly proven to be the “Best Automotive Exhaust Solution for their Life.”



- Sean Hartnett/photos

MONOXIVENT FRP CASE STUDY
MERCEDES: UNDERDUCT AT CALIFORNIA DEALERSHIP

Application Spotlight Location:
Mercedes-Benz, El Dorado, CA

Air Tech Sales - Monoxivent Sales Representative, Marcelo Carino

Summary:
The modern history of El Dorado Hills dates back to the early 1960s when original developer Alan Lindsey began its development as a master planned community. Since its inception as a group of residential "villages", this once small collection of neighborhoods has grown into the third highest income communities of its size range in the nation. It boasts such notable residents as Austin Collie - NFL Wide Receiver, Indianapolis Colts and Ryan Anderson - NBA power forward, Orlando Magic. It is also home for the Mercedes Benz of El Dorado Hills, a dealership owned by the Von Housen Automotive Group.
Mercedes-Benz has a rich history of environmental sensitivity, with more than a century of ongoing research that drives changes in their technology. They constructed the first green luxury dealership in the world to be U.S. Green Building Council-certified in Peoria, AZ. When it came time for the Von Housen Automotive Group to expand their showroom in El Dorado Hills, they followed the Mercedes Benz theme of responsible building. Fashandi & Associates Engineering of San Diego, CA designed a showroom with the concept of using insulated buried duct work for its HVAC system that enabled the creation of a large open space. While Monoxivent's UnderDuct was not the specified product for this project, Air Tech Sales of Roseville, CA who is Monoxivent's representative in the area, teamed up with DKM Heating & Air Conditioning of Loomis, CA to win the job and install over 300 feet of double-wall Underduct that is factory insulated for an insulation value of R-7. This is certainly a case of a high quality installation for a customer who is quite familiar with high quality products!

MONOXIVENT FRP CASE STUDY, LEED LIBRARY: UNDERDUCT IN DAVENPORT

Application Spotlight Location: Eastern Avenue Library, Davenport, IA; UnderDuct Details: Over 1500-linear feet of UnderDuct from 36" diameter down to 8" diameter

Project Details (from Davenport Library Press Release): A successful public and private collaboration raised $8.2-million toward construction of Eastern Avenue Branch Library (Davenport, IA). The new library is scheduled to open in summer 2010.

"As one of the few LEED-certified public libraries in Iowa, the Eastern Avenue Branch will be an important contribution to Davenport in many ways," said LaWanda Roudebush, Director of the Davenport Public Library. "This will truly be a multi-purpose Branch that will not only provide education, recreation, and opportunity but also will be an environmentally friendly gathering place for the community. We will be better able to serve the public with expanded library services and technology." The Eastern Avenue Branch Library will seek certification as a Leadership in Energy and Environmental Design (LEED) building. The LEED rating system of various levels encourages and accelerates global adoption of sustainable green building and development practices through the creation and implementation of universally understood and accepted tools and performance criteria. "Green" features of the Eastern Avenue Branch Library include geothermal heating and cooling, energy efficient design, storm water management to reduce runoff and pollution, day lighting to reduce the use of electric lighting and indoor environmental quality to reduce exposure to chemicals. Joe Huberty of Engberg Anderson, Milwaukee, WI, is the primary architect of the project. Bush Construction, of Davenport, is the general contractor. Both companies employ LEED-accredited professionals.

UnderDuct Summary: UnderDuct, by Monoxivent, is playing an integral role in the construction of Iowa's latest LEED green building: Davenport's Eastern Avenue Library. UnderDuct is one of the sustainable components being incorporated into the environmentally friendly design. UnderDuct was installed with an insulated double-wall design that features 824 Low Smoke and Flame Class 1 duct rating, which is approved for direct burial. UnderDuct provides excellent resistance to corrosion and leakage. The duct is being used in conjunction with a geothermal HVAC design. "Having the LEED design has major cost savings after the building is built," Roudebush said. "The design also assists with the health and comfort levels for employees and visitors. We are excited about the underfloor duct; our Commissioning Agent, Mark Blackwood, of River Place Technologies in East Moline (IL) informed us that it has increased the lifespan, compared to metal duct, from 20- to 70-years."

River Place Technologies is a certified commissioning authority for LEED and other projects and has a custom balancing division. "The duct is a nice heavy walled product that fits well for the underground application," Blackwood said. "This is the most viable option over the life of the building. I was impressed by UnderDuct. I really do not see any reason to go with any other product underground."

UnderDuct was specified by Henneman Engineering's Eric Granzow. Henneman, from Iowa City (IA), was the lead engineer on the library project. "The UnderDuct provides a better overall finished product by ensuring that the insulation stays with the duct for the life of the system and minimizes concerns for moisture damage, both inside and out, by the inherent non-corrosive nature of the product," Granzow said. "These features maximize the energy saved over the life by eliminating two ot the largest causes of energy loss in duct systems; loss of insulation and leakage." UnderDuct was installed after the foundation walls were put into place, prior to the floor being poured. Once the soil was compacted around the UnderDuct slab preparations were made for pouring. The duct was laid with a 1% slope to allow for drainage. With the laminated field joints the system is water and air tight. Another advantage of having the HVAC duct underfloor is to create open space in the occupied areas. Terry Cahill, UnderDuct Division Manager, met with the mechanical design engineers to stress the LEED benefits of the product, including: energy savings from the insulated duct, the corrosion resistance of the duct, a better airflow with a smooth interior, and laminated joints for a sealed system. Roudebush added that the fiberglass design, without seams or crevices, enables the duct to be mold and rust free. She said this component was discussed with the project manager, as well as Debra Sider of Engberg Anderson.

MONOXIVENT FRP CASE STUDY
TRANSIT OPERATIONS: UNDERDUCT INSTALLED AT NC FACILITY

Application Spotlight Location:
Transit Operation Facility, Raleigh, NC
(LR Gorrell - Monoxivent Sales Representative)

UnderDuct Details:
Double Wall UnderDuct, 28" down to 12" diameter duct

Summary:
The Transit Operations Center consists of a 27,400-square-foot, two-story operations administration building; a single-story bus maintenance facility of 56,000 square feet; a 7,500-square-foot bus wash building; and a two-lane fueling depot building. The project also includes a bus shelter on Poole Road for CAT (Capital Area Transit) riders. The transit operations center will accommodate 125 buses, with the ability for expansion to 200 buses.

The double wall duct provides the most efficient method for transferring the heating and cooling throughout the facility. The double wall duct is sustainable and environmentally friendly.

Goals and Objectives:
Replace 30+ year old facility with a new state of the art, environmentally sustainable facility to serve the City's transit system.

MONOXIVENT FRP CASE STUDY
LAKEWOOD: UNDERDUCT AT MAUSOLEUM PROJECT

Application Spotlight Location:
Lakewood Mausoleum, Minneapolis, MN
Midwest Mechanical Solutions - Monoxivent Sales Representative
UnderDuct Details:
8" up to 38" Diameter, Double Wall Duct

Summary: Lakewood Mausoleum, made famous as the final resting place of Tiny Tim, is located in Minneapolis, MN. During the design phase of the Mausoleum expansion, Hammel, Green and Abrahamson, Inc., the architect for this project wanted to create an above ground repository that had the comfort and convenience of indoor visitation. Being a place of solace however, it was neither desirable nor fitting for traditional methods of delivering heating and cooling.

With this in mind, Monoxivent's double walled insulated Underduct was the perfect answer. Having the ability to bury the HVAC duct work in the ground instead of the age old visible approach of hanging duct, enabled the Architect to focus more on the aesthetics of the building interior. Unencumbered by problems with corrosion and material degradation from direct burial, Monoxivent's Fiberglass Reinforced UnderDuct has helped to construct a "Green" minded building that has the grandeur and year round comfort that a place of reflection demands. Midwest Mechanical Solutions, who is Monoxivent's representative in the area, has teamed up with Egan Company to install approximately 1200 feet of Underduct that is factory insulated for an insulation value of R-7. Underduct will be a timeless addition for the millennia to come!

MONOXIVENT FRP CASE STUDY
LAKE ITASCA: UNDERDUCT FRP AT HEADWATERS, U OF MINNESOTA LAB

Application Spotlight Location/Sales Rep:

Lake Itasca, MN
Headwaters - Mississippi River

University of Minnesota Biological Station/ Laboratories

Midwest Mechanical - Monoxivent Sales Representative

About Itasca/Project:
Three ecosystems converge at Itasca: coniferous forest, eastern deciduous forest and tall grass prairie. Plants and animals native to each are abundant in the 50 square miles of Itasca State Park. The spectacular variety of undisturbed habitats makes Itasca an outstanding site for field research and training.
Itasca Biological Station and Laboratories is a University of Minnesota field station dedicated to research and teaching on how ecosystems work, with an eye to cultivating an appreciation of their value and preservation for future generations.

Over the past century, the station has attracted tens of thousands of students, teachers and scientists.

Monoxivent's UnderDuct has been installed at a new $4.1 million campus center at Itasca Biological Station and Laboratories. The center, which replaces three obsolete buildings, will provide 12,000 square feet of technology-enabled laboratories, classrooms and offices, a multipurpose room that accommodates 150 people, a library/computer room, and three administrative offices.

MONOXIVENT FRP CASE STUDY
WASTE WATER TREATMENT PLANT, CITY OF DETROIT

Application Spotlight Location:
City of Detroit Wastewater Treatment Plant
Detroit, MI

Challenge:
In December of 2010 Monoxivent received a request from Applied Science Engineering, Detroit, MI. They needed to design a corrosion resistant, insulated containment tray for 8" scum pipe and two 4" hot water pipes. The total length being 1,600 feet running between 7 buildings and they needed an easy access cover system.

Solution:
Monoxivent worked through many concept changes, with the final design completed and ready for bid in June of 2013. Monoxivent was awarded the contract in January of 2014 and the final project completed the following November. The tray and cover sections are double wall urethane foam insulated (R-7), and the 36" x 18" deep tray sections are incased in reinforced concrete. The embedment angles, cross supports and the building wall pass through sleeves are all 1/4" thick #316 stainless steel. Monoxivent also designed and supplied 220 each fiberglass pipe support brackets. From start to finish Monoxivent was an integral part of this project from concept, design, manufacturing and on site assistance.

MONOXIVENT FRP CASE STUDY
UNIVERSTIY OF ILLINOIS NATURAL HISTORY BUILDING

Application Spotlight Location:
University of Illinois
Champaign/Urbana, IL

Monoxivent Sales Rep:
Langendorf Supply
Peoria, IL

Project Summary:

Designed by Nathan C. Ricker, the Natural History Building is an example of the High Victorian Gothic style. The original building was completed in 1892, and the departments of botany, zoology, and geology moved in that fall. A lecture hall and museum were added in 1909 and 1910 (W.C. Zimmerman, architect), with another addition in 1923 (J.M. White, architect).

The building is undergoing a $70 million renovation begun 2012. UnderDuct is being used for a new displacement ventilation system for the first floor. They have faced many challenges in bringing the building up to modern standards. One example the contractor discovered are the unusual corbelled brick foundation walls under the old concrete floors. They easily modified the prefabricated UnderDuct components to fit the building's sub structure.

UnderDuct is ideally suited for this type of restoration project. The light weight, prefabricated sections were easily carried into the building and set in the trenches then assembled with as few field joints as possible.

UnderDuct is a Class 1 duct material per NFPA 90 and is in compliance with the following Building Codes:

- IMC, International Mechanical Code
- IRC, International Residential Code
- UMC, Uniform Mechanical Code
- CMC, California Mechanical Code