OHIO I.U. APPROVED

April 11, 2006
PDG Domus 060323-1

Support Document

PDG Domus Manufacturing LLC

OHIO I.U. APPROVED
BOARD OF BUILDING STANDARDS
STATE OF OHIO

April 11, 2006
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ONE SOURCE
MANY SOLUTIONS

ASHLAND RESINS FOR COMPOSITES USED IN

ARCHITECTURAL

APPLICATIONS

MODAR® RESINS

HETRON® RESINS

RESIN SYSTEMS FOR YOUR COMPOSITES OF TOMORROW ARE AVAILABLE TODAY!

Ashland Chemical

DEC Associates

FRP Planters

MODAR and HETRON resins from Ashland Chemical Company can be used to mold virtually any type of reinforced plastic composite.

Composites made with Ashland MODAR and HETRON resins have been specified by architects and engineers to replace traditional materials of construction like steel, aluminum, wood, stone and concrete.

MODAR and HETRON resins have been used to manufacture these composites:

- Baseboards
- Columns
- Doors
- Facades
- Fascia Panels
- Furniture
- Grating
- HVAC Ducting
- Light Poles
- Moldings
- Planters
- Polymer Concrete
- Railings
- Roof Slates
- Stairways
- Window Frames

MODAR® RESINS

HETRON® RESINS

Ashland Chemical Company

FRP Ceiling panels

Cover: Fascia detail

Photo courtesy of Molded Fiber Glass Company

Chemistry of MODAR & HETRON Resins

Thermosetting fire retardant MODAR resins are based on non-halogenated modified acrylic polymer chemistry.

Thermosetting fire retardant HETRON resins are based on halogenated polyester or vinyl ester chemistry.

Fillers such as alumina trihydrate or ground marble can be selectively added to the resin to improve the fire retardance, cosmetic properties or the economics of finished composites.

Molding with MODAR & HETRON Resins

MODAR and HETRON resins can be used with all composite fabrication processes:

- Hand Lay-Up
- Spray-Up
- Resin Transfer Molding (RTM)
- Compression Molding
- Pultrusion
- Filament Winding

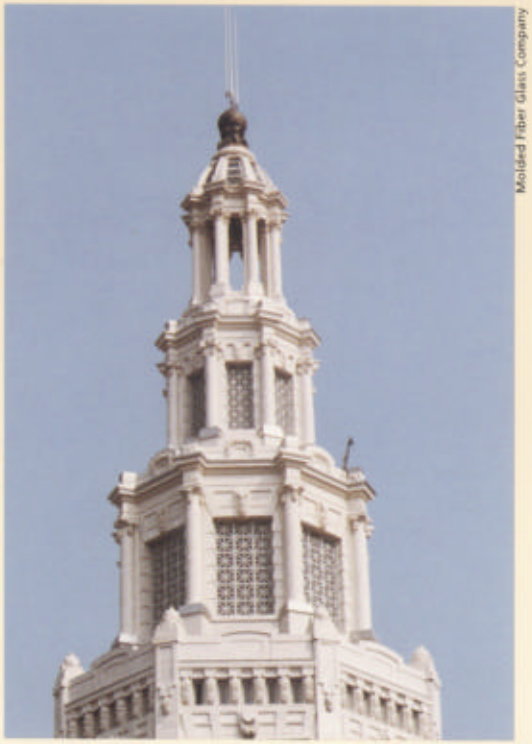
When MODAR or HETRON resins are specified for composites, low cost, light-duty tooling can be used— making MODAR or HETRON resins the choice for smaller scale production runs as well as large fabrications.

In addition to reduced tooling and start-up costs, MODAR resins offer process versatility and maximum design flexibility when compared with other resin systems.

Economics of Specifying MODAR or HETRON Resins

Composites made with MODAR or HETRON resins offer excellent life cycle costs. Including:

- **Lightweight/High Strength-to-Weight Ratios—** lightweight composites offer fast, economical installation when compared to other materials of construction.
- **Low Maintenance—** Molded-in color. Termite resistant. Easily cleaned. Composites won't chip, corrode, rot or split like metal or wood.
- **Excellent Thermal Insulation Properties.**



Molded Fiber Glass Company

Fascia panels

DEC Associates

Trellis Beams

Molded Fiber Glass Company

Gothic Column

DEC Associates

Architectural Facade

Selecting a MODAR or HETRON Resin for Your Composite Application

The ultimate performance of a composite depends on many factors including: the resin, the catalyst, the glass reinforcement, the filler loading and the fabrication techniques. These can also affect flame, smoke and toxicity performance of the composite.

The Ashland Composite Polymers Division Technical Center should be contacted to review your specific performance requirements. Our technical center will also recommend which MODAR or HETRON resin should be specified for your project.

Our Technical Center can also advise you about composite testing and the variety of industry standard tests which can be used to rate the performance or acceptability of a specific composite.

Brit Slate, Ltd.

Roofing slate/shingle

Composite Door

Permia Door

P.O. Box 2219

Columbus, Ohio

43216

614/790-4191

FAX 614/790-3735

Responsible Care*

Ashland Chemical has a strong commitment to our customers, our employees, and to the communities in which we operate and do business.

We believe in maintaining our operations in a totally safe and an environmentally responsible manner. We have focused our efforts on conserving resources and minimizing hazardous materials in both our working environment and at our customers. In addition, we also participate in the industry's Responsible Care* initiative of the Chemical Manufacturers Association.

Quality Plus℠

Ashland Chemical Company adopted a continuous improvement process called Quality Plus in the early 1980's. Ashland Chemical became a quality leader in many industries we serve; continuous improvement has become an important part of every employee's training and thinking. Driven from the top down, this process still guides all of our operations and activities, and the way we do business.

QUALITY PLUS

DEC Associates

Decorative trim

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Bulletin 2118

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COMPOSITE POLYMERS DIVISION

Ashland Chemical

Ashland Chemical Company
Division of Ashland Inc.

ONE SOURCE MANY SOLUTIONS

ASHLAND RESINS FOR COMPOSITES USED IN

MASS TRANSIT

APPLICATIONS

- *Excellent Surface Quality*
- *High Strength*
- *Corrosion resistant*
- *Fire Retardant*
- *Molded-in Color*
- *Low Maintenance*
- *Fabricate Intricate Shapes*

MODAR® RESINS **HETRON® RESINS**

RESIN SYSTEMS FOR YOUR COMPOSITES OF TOMORROW ARE AVAILABLE TODAY!

Ashland Chemical

MODAR and HETRON resins from Ashland Chemical Company can be used to mold virtually any type of reinforced plastic composite.

Composites made with Ashland MODAR and HETRON resins have been specified by architects and engineers to replace traditional materials of construction like steel, aluminum and wood.

MODAR and HETRON resins have been used to mold composites for mass transit applications including: buses, subway cars, rail passenger cars and people movers.

Composite components include:

- Interior Panels
- Exterior Panels
- Doors
- Interior Components
- Roofs
- Seating
- Sleeper Compartments
- Third Rail Cover
- Lavatory Compartments

MODAR® RESINS HETRON® RESINS

Pultrusion Engineered Products

FRP Maintenance grating

Cover: Mass transit cars
Photo courtesy of AEG Transportation, Inc.

Pultrusion Engineered Products

Third rail cover board

Trans March Link

Cable trays

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Thermosetting fire retardant MODAR resins are based on non-halogenated modified acrylic polymer chemistry.

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- **Lightweight/High Strength-to-Weight Ratios—** lightweight composites offer fast, economical installation when compared to other materials of construction.
- **Low Maintenance—** Molded-in color never needs painting. Easily cleaned. Composites won't chip, corrode, rot or split like metal or wood.
- **Excellent Thermal Insulation Properties.**

Aerotrans, Inc.

Mass transit cars

Aerotrans, Inc.

Interior panels

Selecting a MODAR or HETRON Resin for Your Composite Application

The ultimate performance of a composite depends on many factors including: the resin, the catalyst, the glass reinforcement, the filler loading and the fabrication techniques. These can also affect flame, smoke and toxicity performance of the composite.

The Ashland Composite Polymers Division Technical Center should be contacted to review your specific performance requirements. Our technical center will also recommend which MODAR or HETRON resin should be specified for your project.

Our Technical Center can also advise you about composite testing and the variety of industry standard tests which can be used to rate the performance or acceptability of a specific composite.

Ashland MODAR resins have been specified by automotive engineers to mold all types of composites used in the transportation industry.

AEG Transportation, Inc.

People mover cars

Aerotrans, Inc.

Seating and interior panels

Fibrelite Composites Ltd.

British Rail seating

P.O. Box 2219

Columbus, Ohio

43216

614/790-4191

FAX 614/790-3735

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QUALITY PLUS

Aerotrans Inc.

Mass transit cars

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Bulletin 2120

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COMPOSITE POLYMERS DIVISION

Ashland Chemical

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Division of Ashland Inc.

MODAR™

Modified Acrylic Resins

Dodge Viper RT/10

Photo Courtesy of Chrysler Corporation

Formulated Performance Resins to Meet Customer Needs

Modar Modified Acrylic Resin Series

ICI's leadership in acrylic resin technology has led to the development of unique thermoset polymers called Modar modified acrylic resin. These resins were initially developed for closed molding applications such as resin transfer molding and pultrusion. However, the end use properties of the Modar resins have encouraged their use in other molding processes.

Modar Resins Inherently Offer:

- Low Viscosity
- Rapid Cure
- Fast Cycle Times
- Superior Physical Properties
- Resistance To Cracking

Modar 814

Molding Processes: Resin Transfer Molding, Hand Lay-Up, and Filament Winding

Properties: Optimal Fire Retardancy/ Low Smoke and Low Combustion Toxicity with Hydrate Fillers

ASTM E-84 Tunnel Test (150 parts ATH): 20 Flame Spread, 40 Smoke Development

Modar 816

Molding Processes: Resin Transfer Molding, Cold Press, Hand Lay-Up, Spray-Up and Filament Winding

Properties: Resilience, Toughness, Optimal Fire Retardancy/ Low Smoke, Low Combustion Toxicity with Hydrate Fillers

ASTM E-84 Tunnel Test (100 parts ATH): 25 Flame Spread, 125 Smoke Development

Perma-Door HF704 Door
Photo Courtesy of Perma Door

Mack RD Facelift
Truck Hood
Resin Transfer Molding with Modar 824LTS
Photo Courtesy of Mack Trucks Inc

Modar 824LTS

Molding Processes: Resin Transfer Molding and Cold Press

Properties: Class A Surfaces, Low Profile, Non-Shrink

Modar 826HT

Molding Processes: Pultrusion

Properties: Low Profile, Non-Shrink, Faster Pulling Speeds, Optimal Fire Retardancy/Low Smoke, Low Combustion Toxicity, Optimum Surface Finish

Modar 835ACS

Molding Processes: Resin Transfer Molding, Cold Press, Filament Winding

Properties: High Strength, Optimal Fire Retardancy/Low Smoke, Toughness, Low Combustion Toxicity

Modar 865

Molding Processes: Resin Transfer Molding, Pultrusion, Filament Winding

Properties: High Strength, Optimal Fire Retardancy/Low Smoke, Good Temperature Resistance, High Elongation

Modar 839

Molding Processes: Designed for Closed Molding

Properties: Exceptional Toughness, High Casting Tensile Elongation, Low Viscosity, Fast Cure Reactivity

Kenworth T600 Roof
Resin Transfer Molding with Modar 824LTS
Photo Courtesy of Paccar Industries

Four Seasons Wailea Hotel, Maui
Ornamental Columns & Capitals
Chop Spray with Modar 816
Photo Courtesy of DEC Associates

For Use In Performance Applications Such As:

Truck Hoods
Architectural Facades
Automotive Body Panels
Doors
Structural Composites
Electrical Boxes
Roof Slates
Electrical Conduit
Electrical Cable Tray
Third Rail Coverboard
Ducting
Fire Retardant Panels
and Grating

For Process Economics Providing:

Fast Cycling
Process Versatility
Maximum Design Flexibility
Low Entry Costs

The Viper's smooth Class "A" exterior is achieved with Modar 824LTS in the RTM production of the car's body panels. Modar 824LTS, a low profile resin, is specifically designed for resin transfer molding. (See photo, front cover)

For additional information, please call 800-325-9577 or 314-966-3111. To place an order, contact our customer service department at extension 397.

ARCHITECTURAL

MODAR RESINS HETRON RESINS

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MODAR® Resin Opens the Door of the Future

With ever increasing public concern for the protection of the lumber resources and forests, emphasis is now focused on the use of alternative materials to replace the hardwoods traditionally used in the manufacture of products such as residential doors.

In response to this, manufacturers have been quick to demonstrate to architects, builders and the general public, the practicality and performance benefits offered by composite materials.

In the United Kingdom, a specialist molder, RMS International, Ltd., of Norfolk, has been producing FRP composite doors and frames, using MODAR® acrylic resins for several years. The rapid acceptance of these units, for both replacement and new construction has led RMS to expand its operations in the U.K. and establish manufacturing facilities in Malta. Technology transfer agreements are also in place with other EEC countries to serve continental markets.

In the United States, over 20,000 door units have been produced from MODAR acrylic resin by Design Evolution-4 (DE-4) for Permadoor.

Both companies have pioneered the use of MODAR resin in the manufacture of high quality, composite doors in their respective countries. Composite doors give better all-round performance than traditional wood doors - offering specifiers a viable alternative to the use of hardwoods. Their inherent mechanical properties also offer distinct advantages over similar products produced in uPVC or polyester resins.

Freedom from maintenance and long service life are two instantly recognizable benefits offered by the composite door. However, many other factors including impact resistance, and excellent surface finish in a number of colors/stains have all contributed to the success.

PERFORMANCE

For molders, the very fast cure times achievable with MODAR resins significantly increase production capacity and improve reliability of the press cycle - ultimately benefiting quality control for the molder and assuring specifiers and end-users of an attractive, long-life product with consistent performance and quality.

Free from swelling, warping or splitting, doors made from MODAR resins have a significantly lower coefficient of thermal expansion than comparable uPVC units, allowing doors and frames to be manufactured to tight tolerances. When filled with high density foam, the doors also have excellent thermal and sound insulation characteristics. Doors can also be manufactured with low smoke, fire retardant performance.

CONCLUSION

In the U.K. and U.S.A., composite doors are now widely specified for municipal and private housing applications because of their performance characteristics - good looks, resistance to rotting and warping and thermal insulation.

AUTOMOTIVE/TRUCK

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MODAR RESINS HETRON RESINS

MODAR® Resin Can Put A Roof Over Your Head

Rene Composite Material Ltd., of St. Ephrem Quebec, Canada, and Livingston Molded Products, of Auburn, Washington, are the two suppliers who produce the Kenworth T600A heavy duty truck roof. The Class 8 truck roof consists of a roof, mask and firewall which are adhesively bonded together to form the finished assembly. The assembly is molded in aluminum tooling and incorporates a glass fiber preform. MODAR 824LTS resin has been specified for these parts.

Product Definition:

MODAR 824LTS resin offers molders a nonshrink, low-profile resin which enables production of parts with a "Class A" surface finish. MODAR resin is an important ingredient in high quality composite parts: faster demold times allow for lower labor costs; rapid and complete cure minimizes the need for post curing; and resistance to stress cracking requires less post mold touch up and permits a lower rejection rate.

Other applications for MODAR 824LTS resin include: exterior body panels, truck hoods and fairings.

Rene Composite Material Ltd. and Livingston Molded Products, selected by Kenworth, are currently producing the T600A roofs via RTM, using MODAR 824LTS resin. With facilities in St. Ephrem, Quebec, Canada and Perisburg, Virginia, Rene supplies Kenworth's Chillicothe, Ohio and St. Therese, Canada plants at a rate of 5,500 units per year while Livingston supports the Seattle plant production with 4,000 units. Roof assemblies are completed by both molders at a rate of three per hour.

MODAR 824LTS resin offered definite advantages for production of the assembly. Norbert Grenier, General Manager of Rene agrees, "MODAR 824LTS resin offers superior painting, dimensional stability and "Class A" surface finish." This was evidenced by the low profile characteristics of MODAR resin and resulted in a roof which mirrored the mold surface and required minimum post finishing.

Tim Bare, paint engineer at Kenworth's Chillicothe plant, has been very pleased with the part's performance in the 250° F. paint oven. "The high surface quality of the MODAR 824LTS resin composite allows the roof to process through our paint line with virtually no defects and maintain their dimensional tolerances. This is very important for an appearance part and when fitting together the roof and the cab."

The Kenworth T600A roof complements other successful RTM programs using MODAR resin in the heavy truck industry such as the Mack DM600, RD Facelift and Peterbilt 357 Hoods.

AUTOMOTIVE/TRUCK

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MODAR RESINS HETRON RESINS

"Ford F150 Steps Up To RTM Composites"

Centurion Vehicles, Inc. of White Pigeon, Michigan, a large manufacturer of specialty vehicles, selected resin transfer molding (RTM) for the composites they use to transform the Ford F150 pickup into a stepside truck.

Centurion looked to Millennium Products of Elkhart, Indiana to manufacture the composite sides and tailgate using RTM. Tom Troester, Vice President of Engineering at Centurion, stated, "We wanted a higher standard of quality over traditional hand layup." Rodney Miller, President of Millennium, added "RTM allowed us to minimize our volatile emissions and utilize one set of tools to maintain the production schedule."

Both men agreed selecting the proper resin was as important as selecting the process. After evaluating resin systems that ranged from polyester to hybrids, they selected MODAR® modified acrylic resin. The low viscosity of MODAR resin allows high filler loading while still maintaining fast, thorough fiber wetout. The resin's rapid cure development results in excellent green strength which allows fast mold turnover. "Given the abuse these vehicles will take, it was also very important to select a material which offered excellent toughness. The acrylic-urethane chemistry has proven to be extremely durable" said Troester.

"Although we are well versed in RIM and open molding, this was our first experience with RTM. The program proved so successful we anticipate converting some of our existing open mold van products" said Mr. Miller.

As a result of this successful program, Troester reports new stepside models are in the development stage. The winning combination, RTM and MODAR resin, is sure to be part of the team.

MASSTRANSIT

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MODAR® RESINS HETRON® RESINS

New seating for United Airlines in Chicago

Architectural Fiberglass Inc. of Gillett, Wisconsin, has successfully met the challenge for low smoke, low toxicity, flame-retardant materials. Architectural Fiberglass were selected by United Airlines to provide 4,000 molded composite seat shells for their recently-constructed terminal at O'Hare International airport in Chicago.

The scope of the United Airlines project is typical of the large commercial contracts undertaken by Architectural Fiberglass, who produce custom-designed planters, trash receptacles, public and airport seating, contract and commercial furniture. In this application, they were required to manufacture the 4,000 seats in just 50-days. This meant selection of a production system and resin capable of giving high productivity.

After a careful search and evaluation of other resin products, Architectural Fiberglass chose MODAR 816 modified acrylic resin. The MODAR 816/alumina trihydrate dispersion provided the critical combination of low viscosity and rapid cure development with fire retardancy, low smoke and low levels of toxic combustion gas emission demanded by United Airlines.

Due to the high reactivity of MODAR resins, Architectural Fiberglass was able to complete the United Airlines order within the specified deadline. The rapid cure with freedom from exotherm cracking allowed Architectural Fiberglass to turn out one part every 12 minutes. With four molds, 80 seats per day were produced allowing the contract deadline of 50 days to be met. Since the initial contract, United has ordered an additional 1500 seats for the O'Hare Terminal.

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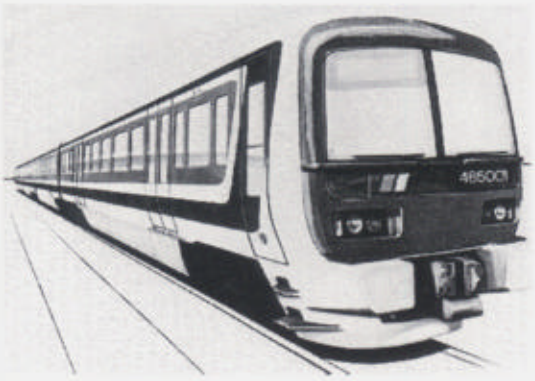
MODAR RESINS HETRON RESINS

British Rail - On The Right Track

A prime example of the fire performance advantages of MODAR® resin is in the composite-based seating produced by RGM Manufacturing, United Kingdom, which is now in service on British Rail's (BR) commuter train coaches. Class 165 coaches are fitted with steel framed seats having composite shells while Class 465 vehicles have an all composite construction, eliminating the steel frame, allowing a further weight reduction.



BR's policy is to continually improve safety so the specifications for the composite seating were particularly demanding. The finished seat had to weigh less than 25 lb yet show minimal deflection under load while demonstrating high strength and fatigue properties. In addition, the parts had to meet the requirements of British Standard #BS6853 for fire retardance in surface trains.

RGM designed and developed the seats calling on the skills of PERA International (process and materials evaluation) and PAFEC (finite element analysis). The qualities under consideration were smoke emission and fire performance in combination with optimal strength to weight ratio and the ability to maximize productivity using resin transfer molding (RTM).

Initial materials of contruction considered by RGM included phenolic, polyester, epoxy and modified acrylic resins. MODAR resin led the contenders as the resin with the best balance of properties most likely to meet end-use requirements. Positive initial molding trials and part evaluation ensued with MODAR resin allowing the decision to move to full scale production with the Ashland resin.

Fibrelite Composites Ltd. of Skipton, U.K., a producer of structural GRP composites and experienced in RTM production, undertook manufacturing development for the seat shells with technical assistance from Ashland personnel. Fibrelite used its own patented network injection technology (NIM)

with a MODAR resin dispersion formulation. The resin system allowed the shortest possible cycle time and minimized tooling required to meet production schedules. The composite seat shells produced by this method have undergone severe, fatigue cycling and loading/deflection tests and have fully met with the specification demands. Ian Milroy, the BR senior project engineer for Class 465 and 466 trains believes that MODAR resin seat shells gave the best compromise between cost and performance, particularly with regard to its low smoke abilities.

RGM supplies the finished seats to ABB Transportation (formerly BREL) and GEC Alsthom which are contracted to supply finished trains to the British Rail Board.

MASSTRANSIT

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Ashland Chemical

MODAR® RESINS HETRON® RESINS

FRP Cable Tray System Installed in New York's Metro North Railroad

The use of fiberglass reinforced plastic composites in construction for fire retardant, low smoke, low toxicity applications continues to grow, especially in New York where specifications are becoming increasingly more stringent. However, Metro North Commuter Railroad in New York, N.Y. has been able to meet their required performance with composites fabricated with MODAR resin. Metro North is currently refurbishing Grand Central Station and the electronic switching systems which control the trains to Grand Central.

To protect the electrical cables, approximately 35,000 linear feet of composite MODAR cable tray manufactured by Seasafe with pultrusions from Creative Pultrusions was installed in the tunnels beneath Grand Central Station.

The tray consists of a removable access cover, with tamper proof screw system and has proven to be tough as well as fire resistant.

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MODAR® RESINS HETRON® RESINS

"TANGARA" the New Sydney Mass Transit Train

Composite materials made with MODAR® resins are being extensively used in the "Tangara" passenger train currently being introduced to the Sydney, Australia metropolitan transit system.

Hailed as one of the most modern suburban trains in the world, the double-decked "Tangara" (from the Aboriginal word "to go") has been built to provide Sydney with a superb standard of travel comfort and security. Styled to reflect its highly sophisticated state-of-the-art technology, "Tangara" entered service in January, 1988.

The "Tangara" contract, which involves the manufacture of 450 individual rail cars over the next eight years, is being supplied by AE Goninan & Co, New South Wales, and makes extensive use of glass fiber composites for internal components.

Composites have been chosen for their light weight, excellent dimensional strength and good fire retardant properties, which makes them the ideal choice for public transport systems.

Spray Coatings Pty. Ltd. of Newcastle, Australia and other major sub contractors to AE Goninan & Co., are supplying all the internal GRP lining panels including stairs, wall lining panels, air-conditioning ducts and driver's console using resin transfer molding (RTM) with MODAR resins. Composites molded with MODAR resins have close tolerances and high impact strength.

The Australian Government Authority specified not only stringent loading specification but also a strict weight limitation of 26 lb per seat. A design was developed which utilized front and back skins connected by a 1mm thick rib corrugation. The components incorporate up to 60 percent glass fiber by weight.

Composites made with MODAR resins and alumina trihydrate dispersions gave excellent results in the Australian standard fire tests. They yielded particularly low smoke generation which was one of the principal reasons why the Government Authorities' specified MODAR resins.

A further advantage to the fabricator, Spray Coatings, is the high productivity of RTM processing using MODAR resins and MODAR-based fire-retardant gel coat. Using this process, large gel coated

composite parts exhibiting an excellent surface finish are being manufactured in less than 30 minutes-- compared to 4-5 hours for conventional polyester resin technology.

Glass fiber reinforced plastics using MODAR resins and resin transfer molding have played a major role in the "Tangara" project allowing the designers a high degree of flexibility to create a train of advanced technological design.

MASSTRANSIT

MODAR RESINS HETRON RESINS

ONE SOURCE MANY SOLUTIONS

Ashland Chemical

Pultruded Cable in the Historic Channel Tunnel

The English Channel Tunnel or "Chunnel," consists of three tunnels, 100 feet apart, 25 feet in diameter and approximately 32 miles long. The middle tunnel is the service tunnel, used for maintenance operations and is connected to the other tunnels by over six miles of interconnecting tunnels. Within this maze, there will ultimately lie approximately 1,300 km of electrical cable and hundreds of miles of fiber optics, controlling the lighting, ventilation, control and communications systems throughout the tunnel, including the 25,000 volt catenaries which supply the trains.

The environment within the tunnel is also rather severe, with temperatures ranging from 41°F to as high as 104°F, with 100 percent relative humidity. Equipment is subject to constant salt water spray or immersion. This environment, combined with the stringent safety requirements led to the choice of a unique composite cable tray routing system based on pultruded MODAR® modified acrylic resin.

Cable Tray Criteria and Material Considerations

The atmosphere within the tunnel is severe, safety requirements are stringent in such an enclosed space and operating conditions are demanding. The cable support system was required to meet the following criteria:

- Resistant to corrosion, especially saline media.
- Easy to install.
- Minimum grounding requirements.
- Minimum maintenance.
- Withstand static loadings of cables and dynamic forces induced by passing trains.
- Minimum overall cost.

The material of choice for cable support construction was between coated, galvanized mild steel and reinforced plastic composite. Reinforced plastic was eventually selected instead of steel because it more closely met the design performance specifications. Composites offered faster installation for the composite cable tray system - and the lightweight meant no special gear was necessary for handling, a big plus in the confined area of a tunnel. No welding was necessary, and the non-conducting, non-sparking features of composites provided an additional safety factor. Overall, when the lifetime of the cable support was considered, it was ultimately calculated to be less expensive than coated steel.

All materials used in the construction of the Chunnel had to meet stringent performance criteria:

- Materials must not ignite easily or propagate flame
- The material, if exposed to fire, must only produce low levels of smoke which

should not obscure visibility and hinder escape
- The decomposition products produced during combustion must not produce toxic levels of gases or corrosive vapors

Pultrusion was chosen as the manufacturing process because of its cost effectiveness for large production runs, and because pultrusion allowed the use of unique profile designed specifically for the application.

ASHLAND
ASHLAND SPECIALTY CHEMICAL COMPANY

MODAR® 814 A
Modified Acrylic Resin

Composite Polymers • Division of Ashland Specialty Chemical Co. • Division of Ashland Inc.
Box 2219, Columbus, Ohio 43216 • (614) 790-3333

FEBRUARY 2003

MODIFIED ACRYLIC RESIN

DESCRIPTION:

MODAR 814 A resin is a patented low viscosity, unpromoted, modified acrylic resin. Laminates made with MODAR 814 A resin have achieved flame spread < 25 and smoke generation < 100 (ASTM E-84) and met class A requirements per the NFPA 286 room corner burn test.

PERFORMANCE:

- Improved heat distortion temperature
- Excellent filler wet-out
- Meets the NFPA 13 requirement for non-sprinkler areas

SUGGESTED USES:

MODAR 814 A resin can be used to fabricate ductwork, architectural applications and mass transit parts when superior fire retardance and low smoke characteristics are desirable. This resin can be used for RTM (resin transfer molding), spray-up and hand lay-up applications.

ALTERNATIVE PRODUCTS:

MODAR 816 A resin can be used where improved heat distortion temperature is required. HETRON® FR 992 SB resin can be used where improved corrosion resistance is desired. For recommendations or specific services, please contact us at MODAR@ashland.com.

TYPICAL* LIQUID PROPERTIES AT 77°F

	Unfilled	Filled (150 phr[1] ATH[2])
Viscosity – Brookfield, cps LVF Spindle #2 at 60 rpm	15	400
Specific Gravity	1.05	1.41

**Typical Values: Based on material tested in our laboratories, but variable from sample to sample. Typical values should not be construed as a guaranteed analysis of any specific lot or as specification items.*

STANDARD PACKAGE: Non-returnable 55-Gallon Drums, 450 Lbs. Net.
DOT LABEL REQUIRED: Flammable Liquid
PRODUCT CODE: 563-503

[1] phr – parts per hundred resin
[2] 50/50 blend 2-4 micron and 15-16 micron alumina trihydrate (ATH) filler

ASHLAND

TYPICAL* PERFORMANCE DATA

Resin Temperature	DMA	6% Cobalt	LUPERSOL[3] DDM-9 Catalyst	Gel Time
°F	phr	phr	phr	Minutes
65	0.1	0.5	2	125
	0.2	0.5	2	44
	0.3	0.5	2	28
	0.5	0.5	2	24
77	0	0.5	2	77
	0.1	0.5	2	46
	0.2	0.5	2	27
	0.3	0.5	2	19
	0.5	0.5	2	16
85	0	0.5	2	61
	0.1	0.5	2	44
	0.2	0.5	2	25
	0.3	0.5	2	17
	0.5	0.5	2	13

TYPICAL* FIRE AND SMOKE PROPERTIES

MODAR 814 A composites, when properly formulated and manufactured, have achieved the following fire and smoke properties:

ASTM E-84, Tunnel Test (150 phr ATH and 20% Glass)	
Flame Spread Index	25 or less
Smoke Development Index	100 or less
150 phr ATH Uniform Code Standard (UBC) 26:1 – Potential Heat of Combustion, btu/lb.	< 3,500

NFPA 286 Room Corner Burn Test Results (150 phr ATH, 20% Glass)		
Test	Class A Requirement	Valves
Peak Net Heat Release Rate, MW	< 1	0.38
Peak Heat Flux at the Floor, kW/m^2	< 20	5.8
Average Upper Layer Temperature	600	533
Flame Existing Door	None	No
Auto-Ignition of Paper Target	No	No
Total Smoke Released, m^2	< 1,000	75

ASTM E-162, Radiant Panel Test (75 phr ATH and 29% Glass)	
Flame Spread Index	15 or less

[3]Registered trademark of Atofina Chemicals, Inc.

TYPICAL* FIRE AND SMOKE PROPERTIES

(Continued)

ASTM E-662, NBS Smoke Chamber (75 phr ATH and 29% Glass)		
Time	Smoke Development	
Minutes	*Flaming*	*Non-Flaming*
1.5	Less than 1	Less than 1
4	Less than 15	15 or less
Maximum	120 or less	Less than 200

Toxic Gas Analysis

Testing is done to measure levels of toxic gases generated when materials are burned. Toxic gas analysis was performed on composites made with MODAR 814 A resin, 75 phr ATH filler, and 29% weight fiberglass. The testing was set up in accordance with ASTM E-662, NBS smoke chamber guidelines. The analysis was run according to BSS 7239 toxic gas analysis protocol. The values obtained are as follows:

BSS 7239 Toxic Gas Analysis Results	
CO, ppm	53
HCL, ppm	2
HCN, ppm	Not Detected
HF, ppm	Not Detected
NO_x, ppm	12
SO_2, ppm	Not Detected

All of the proceeding fire and smoke properties have been obtained with properly manufactured composites, containing alumina trihydrate and postcured at 250_F for 4 hours. Since flame and smoke performance of filled system composites are dependent on glass content, filler type and amount, properties need to be verified on composite construction used.

Test	Method	Result
Vertical Burn	UL 94	VO

Fillers

Filler particle size affects the viscosity of filled systems. Different grades of alumina trihydrate may also have an impact on resin reactivity. The following fillers have been found acceptable for use in MODAR 814 A resin.

Alumina Trihydrate	Filler Manufacturer	
Particle Size	RJ Marshall	Huber Engineering
2-4 Micron	A-202 or A-204 Fillers	ONYX ELITE[4] 632 Filler
15-16 Micron	AH-280	SB 336

[4]Registered trademark of Huber Engineered Materials.

TYPICAL* PERFORMANCE DATA OF CURED CASTINGS[5]

1/8" Unfilled Resin Casting Properties:

Test	Casting	ASTM
Flexural Strength, psi	19,100	D-790
Flexural Modulus, 10^5 psi	4.7	D-790
Tensile Strength, psi	10,500	D-638
Tensile Modulus, 10^5 psi	4.5	D-638
Tensile Elongation, %	3.8	D-638
Heat Deflection Temperature, °C/°F	95/203	D-648
Barcol Hardness	40-45	D-2583
Specific Gravity	1.20	D-792

TYPICAL* PERFORMANCE DATA OF CURED LAMINATES[6]

Chopped Strand Mat (Hand Lay-up):

Test			ASTM
Flexural Strength, psi	24,600	14,300	D-790
Flexural Modulus, 10^5 psi	12.2	11.3	D-790
Flexural Strength (4 Point at 180°F), psi	19,500	---	D-790
Flexural Modulus (4 Point at 180°F), psi	9.7	---	D-790
Compressive Strength, psi	28,300	23,700	D-695
Tensile Strength, psi	13,800	8,900	D-638
Tensile Modulus, 10^5 psi	15.4	19.6	D-638
Izod – Notched, ft-lbs./in^2	10.3	9.5	D-256
Glass, % (wt.)	29	20	D-2583
Alumina Trihydrate, phr	75	150	D-2584
Specific Gravity	1.75	1.83	D-792

HANDLING: MODAR 814 A resin contains ingredients, which could be harmful if mishandled. Contact with skin and eyes should be avoided and necessary protective equipment and clothing should be worn.

Ashland Specialty Chemical Company maintains Material Safety Data Sheets on all of its products. Material Safety Data Sheets contain health and safety information for your development of appropriate product handling procedures to protect your employees and customers.

Our Material Safety Data Sheets should be read and understood by all of your supervisory personnel and employees before using Ashland Specialty Chemical Company's products in your facilities.

[5]Castings prepared using 1% BPO, cured 2 hours at 160°F, 1 hour at 200°F, and postcured for 2 hours at 280°F.

[6]Promoted for room temperature cure as described on the previous page and postcured for 2 hours at 250°F.

RECOMMENDED STORAGE:
Drums - Store at temperatures below 80°F. Storage life decreases with increasing storage temperature. Avoid exposure to heat sources such as direct sunlight or steam pipes. For thixed resins, mild agitation is recommended to address thixotrope settling after prolonged storage. To avoid contamination of product with water, do not store outdoors. For monomer-containing resins, keep sealed to prevent moisture pick-up and monomer loss. Rotate stock.

Bulk - See Ashland's Bulk Storage and Handling Manual for Polyesters and Vinyl Esters. A copy of this may be obtained from Ashland Specialty Chemical Company's Composite Polymers Division at (614) 790-3333.

SHELF LIFE: This product has a limited shelf life. When stored in accordance with the above conditions, this product has a minimum shelf life of three months.

ASHLAND
ASHLAND SPECIALTY CHEMICAL COMPANY

MODAR® 816 A
Modified Acrylic Resin

Composite Polymers • Division of Ashland Specialty Chemical Co. • Division of Ashland Inc.
Box 2219, Columbus, Ohio 43216 • (614) 790-3333

JANUARY 2003

MODIFIED ACRYLIC RESIN

DESCRIPTION:

MODAR 816 A resin is a patented unpromoted modified acrylic resin. Laminates made with MODAR 816 A resin meet the stringent requirements of mass transit applications.

PERFORMANCE:

- Superior heat distortion temperature
- High production rates/fast mold turnover
- Superior glass wet-out

SUGGESTED USES:

MODAR 816 A resin is used to fabricate parts for architectural and mass transit applications where fire retardance and improved high temperature properties are desired. This resin can be used for RTM (resin transfer molding), closed-molding, spray-up and hand lay-up applications.

ALTERNATIVE PRODUCTS:

Composites properly formulated and fabricated with MODAR 814 A resin can achieve ≤ 25 flame spread and ≤ 100 smoke (ASTM E-84). HETRON FR 992 SB resin provides superior corrosion resistance. For recommendations or specific services, please contact us at MODAR@ashland.com.

TYPICAL* LIQUID PROPERTIES AT 77°F

	Unfilled	Filled (100 phr[1] ATH[2])
Viscosity – Brookfield, cps LVF Spindle #2 at 30 rpm	120	900
Specific Gravity	1.10	1.38

**Typical Values: Based on material tested in our laboratories, but variable from sample to sample. Typical values should not be construed as a guaranteed analysis of any specific lot or as specification items.*

STANDARD PACKAGE: Non-returnable 55-Gallon Drums, 450 Lbs. Net.
DOT LABEL REQUIRED: Flammable Liquid
PRODUCT CODE: 563-504

®Registered trademark of Ashland Inc.

[1]phr – parts per hundred resin
[2]50/50 blend 2-4 micron and 15-16 micron alumina trihydrate (ATH) filler

TYPICAL* PERFORMANCE DATA

Includes 100 phr ATH	
MEKP (Methyl Ethyl Ketone Peroxide), %	1.5
6% Cobalt Naphthenate, %	0.3
DMA (Dimethyl Aniline), %	0.1
Approximate Gel Time, Minutes	9

Fillers

Filler particle size affects the viscosity of filled systems. Different grades of alumina trihydrate may also have an impact on resin reactivity. The following fillers have been found acceptable for use in MODAR 816 A resin.

Alumina Trihydrate Particle Size	Filler Manufacturer	
	RJ Marshall	Huber Engineering
2-4 Micron	A-202 or A-204 Fillers	ONYX ELITE[3] 632 Filler
15-16 Micron	AH-280	SB 336

TYPICAL* FIRE AND SMOKE PROPERTIES

MODAR 816 A composites combined with 75 phr ATH, when properly formulated and manufactured, have achieved the following fire and smoke properties:

ASTM E-162, Radiant Panel Test	
Flame Spread Index	25 or less

ASTM E-662, NBS Smoke Chamber		
Time	Smoke Development	
Minutes	*Flaming*	*Non-Flaming*
1.5	Less than 1	Less than 1
4	15 or less	Less than 15
Maximum	200 or less	Less than 250

Toxic Gas Analysis

Testing is done to measure levels of toxic gases generated when materials are burned. Toxic gas analysis was performed on composites made with MODAR 814 A resin, 75 phr ATH filler, and 29% weight fiberglass. The testing was set up in accordance with ASTM E-662, NBS smoke chamber guidelines. The analysis was run according to BSS 7239 toxic gas analysis protocol. The values obtained are as follows:

BSS 7239 Toxic Gas Analysis Results	
CO, ppm	60
HCL, ppm	Not Detected
HCN, ppm	Not Detected
HF, ppm	Not Detected
NO_x, ppm	10
SO_2, ppm	Not Detected

[3]Registered trademark of Huber Engineering

ASHLAND

TYPICAL* PERFORMANCE DATA OF CURED CASTINGS[4] AND LAMINATES[5]

Test	ASTM	Casting	Chop Strand Mat	Chopped Strand Mat
Flexural Strength, psi	D-790	16,700	21,400	20,600
Flexural Modulus, 10^5 psi	D-790	4.2	10.7	9.5
Flexural Strength (4 Point at 180°F), psi	D-790	---	---	18,800
Flexural Modulus (4 Point at 180°F), psi	D-790	---	---	7.9
Compressive Strength, psi	D-695	---	24,500	24,600
Tensile Strength, psi	D-638	10,600	11,100	10,400
Tensile Modulus, 10^5 psi	D-638	4.6	16.6	13.1
Elongation to Break, %	D-638	4.7	---	---
Barcol Hardness	D-2583	35	60	60
Heat Distortion Temperature, °C/°F	D-648	116/240	---	---
Glass, % (w/w)	---	0	29	30
ATH Filler[2], phr	---	0	100	75
Specific Gravity	---	1.20	1.71	---

(The mechanical properties are the average of several laminates. No gel coat was used.)

HANDLING: MODAR 816 A resin contains ingredients, which could be harmful if mishandled. Contact with skin and eyes should be avoided and necessary protective equipment and clothing should be worn.

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RECOMMENDED STORAGE:
Drums - Store at temperatures below 80°F. Storage life decreases with increasing storage temperature. Avoid exposure to heat sources such as direct sunlight or steam pipes. For thixed resins, mild agitation is recommended to address thixotrope settling after prolonged storage. To avoid contamination of product with water, do not store outdoors. For monomer-containing resins, keep sealed to prevent moisture pick-up and monomer loss. Rotate stock.

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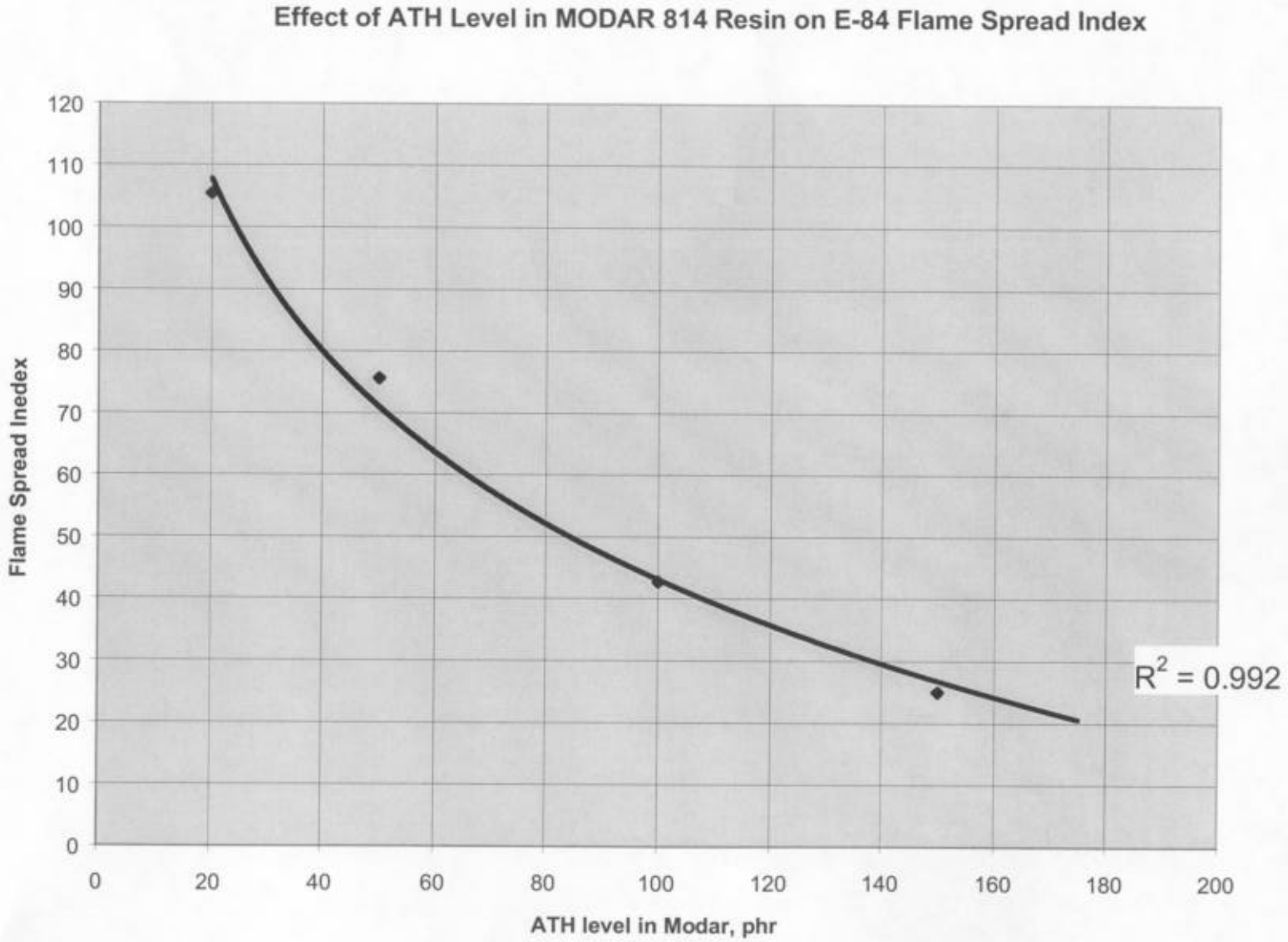
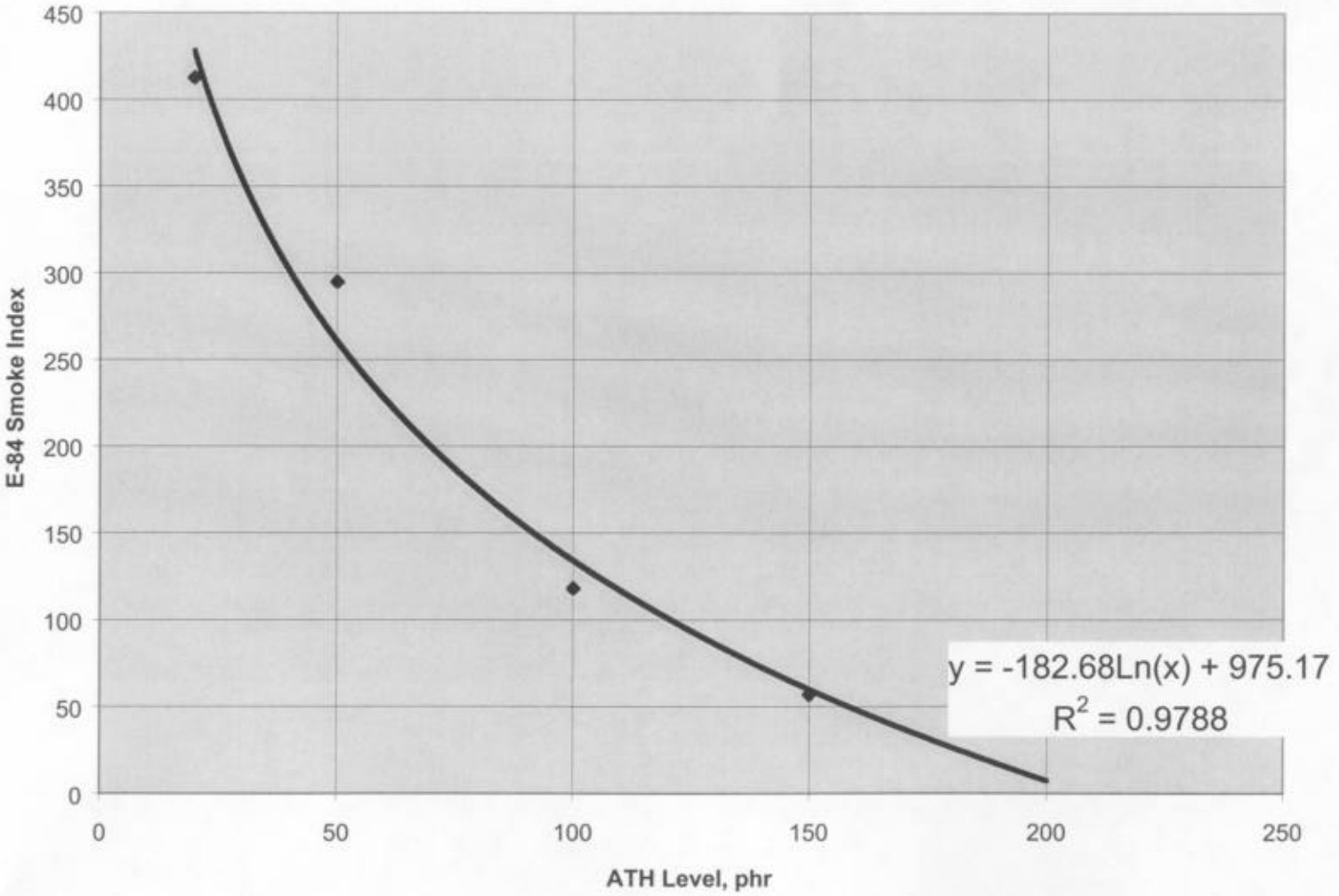
SHELF LIFE: This product has a limited shelf life. When stored in accordance with the above conditions, this product has a minimum shelf life of three months.

[4]Castings prepared using 1% BPO, cured 2 hours at 160°F, 1 hour at 200°F, and postcured for 2 hours at 280°F.
[5]Laminates prepared for room temperature cure as described on the previous page and postcured for 2 hours at 250°F.


Effect of ATH Level in MODAR 814 Resin on E-84 Flame Spread Index
Flame Spread Inedex
120
110
100
90
80
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
ATH level in Modar, phr
R2 = 0.992

Effect of ATH Level in MODAR 814 on E-84 Smoke Index



TECHNICAL DATA

MODAR® 816 A
Modified Acrylic Resin

Composite Polymers • Division of Ashland Specialty Chemical Co. • Division of Ashland Inc.
Box 2219, Columbus, Ohio 43216 • (614) 790-3333

FEBRUARY 2002

MODIFIED ACRYLIC RESIN

DESCRIPTION:

MODAR 816 A resin is a patented unpromoted modified acrylic resin. Laminates made with MODAR 816 A resin meet the stringent requirements of mass transit applications.

PERFORMANCE:

- Superior heat distortion temperature
- High production rates/fast mold turnover
- Superior glass wet-out

SUGGESTED USES:

MODAR 816 A resin is used to fabricate parts for architectural and mass transit applications where fire retardance and improved high temperature properties are desired. This resin can be used for RTM (resin transfer molding), closed-molding, spray-up and hand lay-up applications.

ALTERNATIVE PRODUCTS:

Composites properly formulated and fabricated with MODAR 814 A resin can achieve ≤ 25 flame spread and ≤ 100 smoke (ASTM E-84). HETRON FR 992 SB resin provides superior corrosion resistance. For recommendations or specific services, please contact us at MODAR@ashland.com.

TYPICAL* LIQUID PROPERTIES AT 77°F

	Unfilled	Filled (100 phr[1] ATH[2])
Viscosity – Brookfield, cps LVF Spindle #2 at 30 rpm	120	900
Specific Gravity	1.10	1.34

**Typical Values: Based on material tested in our laboratories, but variable from sample to sample. Typical values should not be construed as a guaranteed analysis of any specific lot or as specification items.*

STANDARD PACKAGE: Non-returnable 55-Gallon Drums, 450 Lbs. Net.
DOT LABEL REQUIRED: Flammable Liquid
PRODUCT CODE: 563-504

[1]phr – parts per hundred resin
[2]50/50 blend 2-4 micron and 15-16 micron alumina trihydrate (ATH) filler

TYPICAL* PERFORMANCE DATA

Includes 100 phr ATH	
MEKP (Methyl Ethyl Ketone Peroxide), %	1.5
6% Cobalt Naphthenate, %	0.3
DMA (Dimethyl Aniline), %	0.1
Approximate Gel Time, Minutes	9

Fillers

Filler particle size affects the viscosity of filled systems. Different grades of alumina trihydrate may also have an impact on resin reactivity. The following fillers have been found acceptable for use in MODAR 816 A resin.

Alumina Trihydrate Particle Size	Filler Manufacturer	
	RJ Marshall	Huber Engineering
2-4 Micron	A-202 or A-204 Fillers	ONYX ELITE[3] 632 Filler
15-16 Micron	AH-280	SB 336

TYPICAL* FIRE AND SMOKE PROPERTIES

MODAR 816 A composites combined with 75 phr ATH, when properly formulated and manufactured, have achieved the following fire and smoke properties:

ASTM E-162, Radiant Panel Test	
Flame Spread Index	25 or less

ASTM E-662, NBS Smoke Chamber		
Time	Smoke Development	
Minutes	*Flaming*	*Non-Flaming*
1.5	Less than 1	Less than 1
4	15 or less	Less than 15
Maximum	200 or less	Less than 250

Toxic Gas Analysis

Testing is done to measure levels of toxic gases generated when materials are burned. Toxic gas analysis was performed on composites made with MODAR 814 A resin, 75 phr ATH filler, and 29% weight fiberglass. The testing was set up in accordance with ASTM E-662, NBS smoke chamber guidelines. The analysis was run according to BSS 7239 toxic gas analysis protocol. The values obtained are as follows:

BSS 7239 Toxic Gas Analysis Results	
CO, ppm	60
HCL, ppm	Not Detected
HCN, ppm	Not Detected
HF, ppm	Not Detected
NO_x, ppm	10
SO_2, ppm	Not Detected

TYPICAL* PERFORMANCE DATA OF CURED CASTINGS[4] AND LAMINATES[5]

Test	ASTM	Casting	Chop Strand Mat	Chopped Strand Mat
Flexural Strength, psi	D-790	16,100	21,400	20,600
Flexural Modulus, 10^5 psi	D-790	4.2	10.7	9.5
Flexural Strength (4 Point at 180°F), psi	D-790	---	---	18,800
Flexural Modulus (4 Point at 180°F), psi	D-790	---	---	7.9
Compressive Strength, psi	D-695	---	24,500	24,600
Tensile Strength, psi	D-638	9,500	11,100	10,400
Tensile Modulus, 10^5 psi	D-638	4.1	16.6	13.1
Elongation to Break, %	D-638	3.6	---	---
Barcol Hardness	D-2583	35	60	60
Heat Distortion Temperature, °C/°F	D-648	111/231	---	---
Glass, % (w/w)	---	0	29	30
ATH Filler[2], phr	---	0	100	75

(The mechanical properties are the average of several laminates. No gel coat was used.)

HANDLING: MODAR 816 A resin contains ingredients, which could be harmful if mishandled. Contact with skin and eyes should be avoided and necessary protective equipment and clothing should be worn.

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Bulk - See Ashland's Bulk Storage and Handling Manual for Polyesters and Vinyl Esters. A copy of this may be obtained from Ashland Specialty Chemical Company's Composite Polymers Division at (614) 790-3333.

SHELF LIFE: This product has a limited shelf life. When stored in accordance with the above conditions, this product has a minimum shelf life of three months.

[4]Castings prepared using 1% BPO, cured 2 hours at 160°F, 1 hour at 200°F, and postcured for 2 hours at 280°F.
[5]Laminates prepared for room temperature cure as described on the previous page and postcured for 2 hours at 250°F.

Ashland Chemical

TECHNICAL DATA

MODAR® 839
Modified Acrylic Resin

ASHLAND CHEMICAL COMPANY • DIVISION OF ASHLAND INC.
BOX 2219, COLUMBUS, OHIO 43216 • (614) 790-3333

January 1997

MODIFIED ACRYLIC RESIN

DESCRIPTION: MODAR 839 resin is a modified acrylic resin offering the maximum in thermoset impact resistance. The resin's low viscosity and fast cure reactivity are ideal for a variety of molding processes including resin transfer molding.

TYPICAL* LIQUID PROPERTIES AT 77°F (25°C)

Specific Gravity	1.02
Viscosity, cps.	105
Shelf Life	6 months

TYPICAL* LIQUID PROPERTIES AT 77°F (25°C)

TYPICAL CURING CHARACTERISTICS AT 77°F (25°C):

		phr	
Benzoyl Peroxide - 40% Emulsion	3.0	3.0	3.0
DMA (Dimethyl Aniline)	0.5	---	---
DMPT (Dimethyl Paratoluidine)	---	0.2	0.5
Gel Time, minutes (77°F) 25°C	16-20	9-12	3-5

TYPICAL* PHYSICAL PROPERTIES

Unreinforced Casting Properties (thickness = 0.125", 3.2mm)

Flexural Strength, psi (MPa)	6,000 (41.3)
Flexural Modulus, psi x 10^5 (GPa)	1.5 (1.0)
Tensile Strength, psi (MPa)	3,400 (23.4)
Tensile Modulus, psi x 10^5 (GPa)	1.5 (1.0)
% Elongation	54
Unnotched Izod, ft-lbs/in (J/m)	16 (854)
Heat Deflection Temperature, HDT °C (°F)	50 (122)

STANDARD PACKAGE: Non-returnable 55-gallon (200 liter) drums, 450 lbs. (200Kg) net.
DOT LABEL REQUIRED: Flammable liquid
CODE: 570-332

**Typical Values: Based on material tested in our laboratories but variable from sample to sample. Typical values should not be construed as a guaranteed analysis of any specific lot or as specification items.*

MODAR® 839 RESIN (CONTINUED)

TYPICAL* MECHANICAL PROPERTIES

LAMINATE DATA - 25% W/W CHOPPED STRAND (1:1 RESIN/FILLER)[1]

Flexural Strength, psi (MPa)	20,700 (142.7)
Flexural Modulus, psi x 10^6 (GPa)	7.0 (4.8)
Tensile Strength, psi (Mpa)	14,000 (96.5)
Tensile Modulus, psi x 10^6 (GPa)	9.5 (6.5)
% Elongation	1.75
Unnotched Izod, ft-lb/in (J/m)	11.5 (614)
HDT - °C (°F)	257.5 (495)

HANDLING: MODAR 839 resin contains ingredients which could be harmful if mishandled. Contact with skin and eyes should be avoided and necessary protective equipment and clothing should be worn.

Ashland Chemical Company maintains Material Safety Data Sheets on all of its products. Material Safety Data Sheets contain health and safety information for your development of appropriate product handling procedures to protect your employees and customers.

Our Material Safety Data Sheets should be read and understood by all of your supervisory personnel and employees before using Ashland Chemical Company's products in your facilities.

RECOMMENDED STORAGE:
Drums - Store at temperatures below 80°F (26°C). Storage life decreases with increasing storage temperature. Avoid exposure to heat sources such as direct sunlight or steam pipes. Keep containers sealed to prevent moisture pickup and monomer loss. Rotate stock.

Bulk - Store in stainless steel tanks or tanks lined with epoxy or phenolic coatings. Observe precautions against heat and moisture (see above). A blanket of dry, non-contaminated air may be desirable.

SHELF LIFE: This product has a limited shelf life. When stored in accordance with the above conditions, this product has a minimum shelf life of 6 months.

[1] $CaCO_3$ Filler

Ashland Chemical

Composite Polymers Division

Ashland Chemical Company
Division of
Ashland Inc.

Address Reply:
P.O. Box 2219
Columbus, Ohio 43216
Fax: (614) 790-3735

August 19, 1999

Mr. Nathan Pingel
PDG – Domus
426 East Whittier St.
Columbus, OH 43206

Re: MODAR® in Building Applications

Dear Nate:

We are in the process of developing new literature detailing the use of MODAR in building applications. In lieu of waiting for its publication, I wanted to pen this letter detailing why we feel MODAR is the best product for composite building applications.

First of all, MODAR resins are halogen free. Many thermoset resins utilize halogens to control flame spread. While they are very effective in controlling the propagation of flame, the components of combustion can be hazardous. It is our opinion that these types of products should not be used in applications where people may need a safe, clear path to egress.

Throughout this document I will be referring to the New York City Transit Authority (NYCTA) mass transit specification. This is because it is the strictest application that I have come across (far stricter than construction codes that were written around the use of wood). This specification dictates which materials can be used in the manufacture of subway vehicles. The specification is written such that in the event of a fire the materials will perform in such a manner that people can escape a tunnel safely.

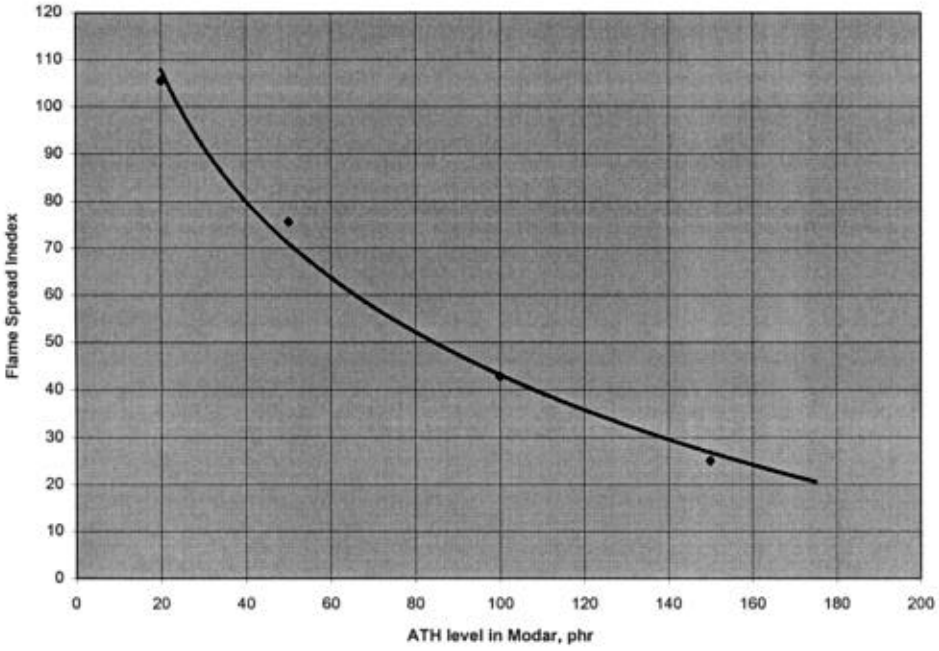
Testing

Flame Spread, Smoke Development and Smoke Toxicity are of tantamount importance to successful and safe building applications, regardless of the material of construction.

Flame Spread can measured by several testing methods, the most common of which is the ASTM E-84 tunnel test. This test is based on flame spread as compared to concrete asbestos and red oak. Concrete asbestos, which will not burn, sets the rating for 0. Red oak, which readily burns, sets the standard for 100. Materials are exposed to a fire source for time of 10 minutes and the flame propagation is compared to that of the red oak. A Flame Spread Index less than or equal to 25 is considered a class I material. Flame Spread Index of 26 to 75 is a class II material and 76 to 200 is a class III.

MODAR 814 with an appropriate amount of alumina trihydrate is capable of achieving a Class I rating.

Effect of ATH Level in MODAR 814 Resin on E-84 Flame Spread Index



Smoke Density is considered by many to be of more importance than even flame spread. This is due the fact that accidents do occur and people need to see their way to safety. Smoke Development Index (D_s) measures the amount of smoke that is generated in the event of a fire and is measured by ASTM E-662. This test measures the accumulation of smoke in a closed chamber in flaming and non-flaming modes at 90 seconds and 4 minutes. A maximum smoke density index, not related to time, is also measured . Many architectural, mass transit, and building applications set their specifications at a D_s 1.5 < 10 and D_s 4.0 < 200. As shown in the chart below, MODAR 814 with 150 parts ATH far exceeds this requirement.

Optical Smoke Density (D_s)

Time (minutes)	NYCTA Specification	MODAR 814 with 150 parts ATH
1.5		<1
4	200 max	<10
maximum		<120

Smoke toxicity is considered by many to be the most important standard in building applications. This again is driven by the fact that accidents do happen and more often than not, it is the components of the smoke that kill people and not the fire. The toxicity of smoke is measured by Mil-M-14G type MAI-60 test as per AD297 457.

MODAR 814 with 75 parts and 150 parts of alumina trihydrate has exceeded the requirements spelled out by the NYCTA specification utilizing this test method.

Smoke Toxicity

Gases	NYCTA Maximum Quantities	MODAR 814 with 75 phr ATH	MODAR 814 with 150 phr ATH
Hydrogen Chloride	10	<0.2	0
Hydrogen Bromide	10	<0.2	0
Hydrogen Cyanide	10	1	1
Hydrogen Sulfide	10	*	*
Vinyl Chloride	10	*	*
Ammonia	500		0
Aldehydes	30		6
Oxides of Nitrogen	100	10	30
Carbon Dioxide	15,000		6075
Carbon Monoxide	1,000	120	115

* We have not tested for these gases, however, as MODAR nor alumina trihydrate contain sulfur or chlorine the spontaneous generation of these chemicals during combustion is unlikely.

Another effective test comparing the toxicity of materials is the University of Pittsburgh Rodent Toxicity Test. This test was developed as a method for the assessment of acute inhalation toxicity of combustion products of materials. It provides a method for determining an LC_{50} – the concentration of combustion products which causes 50% lethality in the test animals exposed for 30 minutes and observed for 14 days following exposure. Unlike other tests, bigger numbers are better for LC_{50}. MODAR 814 with 150 parts ATH was tested to have an LC_{50} of 99.52g. Both Douglas Fir and a phenolic composite had LC_{50}'s of less than 70g.

Keep in mind that all of the samples used to generate these numbers were made in very controlled conditions in our laboratories. We insist that you verify all of the numbers with samples made within your production environment using the actual materials (glass, ATH, catalysts, etc…) that you intend on using to make your final product.

Please call me at 790-3332 if you have any questions.

Best regards-

L. Dean Doza
Product Manager – Specialty Resins

SOUTHWEST RESEARCH INSTITUTE™

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CHEMISTRY AND CHEMICAL ENGINEERING DIVISION
DEPARTMENT OF FIRE TECHNOLOGY
WWW.FIRE.SWRI.ORG
FAX (210) 522-3377

FIRE PERFORMANCE EVALUATION OF "MODAR® 814A RESIN W/150 PHR ATH" (FRP PANEL) INTERIOR FINISH MATERIAL ACCORDING TO NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) STANDARD NO. 286, "STANDARD METHODS OF FIRE TESTS FOR EVALUATING CONTRIBUTION OF WALL AND CEILING INTERIOR FINISH TO ROOM FIRE GROWTH (2000 EDITION)"

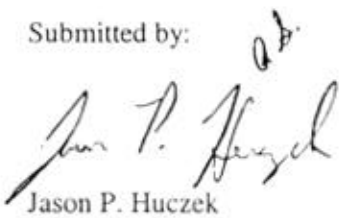
FINAL REPORT
Consisting of 25 Pages

SwRI™ Project No. 01.04917.01.406b
April 2002

Prepared for:

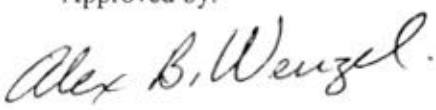
Ashland Chemical Company
5200 Blazer Parkway
Dublin, Ohio 43017

Submitted by:



Jason P. Huczek
Engineer
Material Flammability Section

Approved by:



Alex B. Wenzel
Director
Department of Fire Technology

EXECUTIVE SUMMARY

The objective of this test program was to perform a fire performance evaluation of a fiberglass reinforced plastic (FRP) panel interior finish material (MODAR® 814a Resin w/150 phr ATH) for Ashland Chemical Company, located in Dublin, Ohio. Testing was in accordance with NFPA Standard No. 286-2000, "Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth." Testing was conducted on March 14, 2002, at Southwest Research Institute's (SwRI) Department of Fire Technology, located in San Antonio, Texas.

NFPA 286 does not have any acceptance criteria for passing or failing of a product due to performance during the fire test. In general, this test is used as a tool for ranking material performance in a standard configuration. However, a major event that this test can identify is the propensity of a material to cause a standard room to "flashover." According to NFPA 286, flashover is determined to have occurred when any two of the following conditions have been attained:

- The heat release rate exceeds 1 MW.
- Heat flux at the floor exceeds 20 kW/m^2.
- The average upper layer temperature exceeds 600°C (1112°F).
  - The average upper layer temperature is determined by the average of four ceiling quadrant thermocouples in addition to the ceiling thermocouple at the center of the test room.
- Flames exit the doorway.
- Auto-ignition of a paper target on the floor occurs.

Table 1. Summary of "Flashover" Criteria Test Results.

Material ID	Peak Net Heat Release Rate (kW)	Peak Heat Flux at the Floor (kW/m^2)	Average Upper Layer Temperature (°C)	Flames Exiting Doorway	Auto-Ignition of Paper Target
MODAR® 814a Resin w/150 phr ATH FRP Panel (Beige)	382	5.8	553	No	No

Full test data can be referenced in Appendix A.

TABLE OF CONTENTS

1.0 INTRODUCTION

The objective of this test program was to perform a fire performance evaluation of a fiberglass reinforced plastic (FRP) panel interior finish material (MODAR® 814a Resin w/150 phr ATH) for Ashland Chemical Company, located in Dublin, Ohio. Testing was in accordance with NFPA Standard No. 286-2000, "Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth." Testing was conducted on March 14, 2002, at Southwest Research Institute's (SwRI) Department of Fire Technology, located in San Antonio, Texas.

This test method is intended to measure and describe the properties of materials or products in response to heat and flame under controlled laboratory conditions. The results should not be used alone to describe or appraise the fire hazard or the fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a complete fire hazard assessment or a fire risk assessment, which takes into account all the factors that are pertinent to an assessment of the fire hazard or fire risk of a particular end use. The results apply specifically to the specimens tested, in the manner tested, and not to similar materials, nor to the performance when used in combination with other materials.

2.0 NFPA 286 TEST PROCEDURE

For organic solids, liquids, and gases, a nearly constant net amount of heat is released per unit mass of oxygen consumed for complete combustion. An average value for this constant of 13.1 MJ/kg of O_2 can be used for practical applications and is accurate with very few exceptions to within ± 5%. Therefore, measurements of the oxygen consumed in a combustion system can be used to determine the net heat released. This technique, generally referred to as the "oxygen consumption technique," is now the most widely used and accurate method for measuring heat release rate in experimental fires.

The Intermediate-Scale Calorimeter is an apparatus, which measures the rate of heat release of materials and products under a wide range of conditions using the oxygen consumption technique. A schematic of the instrument as used for NFPA 286 room corner testing is shown in Figure 1.

For the NFPA 286 test procedure, specimens are mounted to fully cover both 8 x 12-ft walls, the 8 x 8-ft wall, which does not have a door in it, and the ceiling. The walls and ceiling are exposed to a propane gas burner placed 2 in. from the intersecting wall surfaces in the left corner of the room opposite from the door. The top surface of the burner through which gas is applied is 12 in. above the floor.

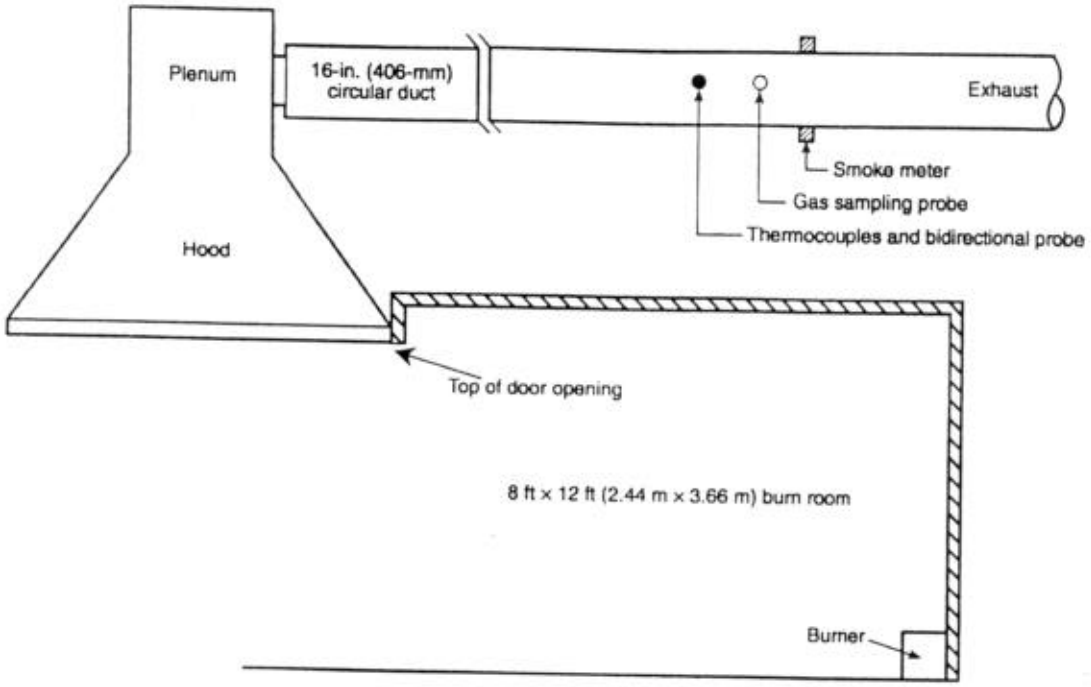


Figure 1. Schematic of the Intermediate-Scale Calorimeter Apparatus.

The interior dimensions of the test compartment are 8 ft wide by 12 ft long by 8 ft high. A doorway with dimensions of 30 in. wide by 80 in. high was constructed at the center of one of the 8-ft walls. The interior surfaces of the test room (floor, ceiling, and walls) were lined with 20-mm (.78 in.) high-density (nominally 800 kg/m^3) calcium silicate board. The test room was framed using 2 x 4-in. studs on 16-in. centers.

One total heat flux gauge is mounted 2 in. above the floor surface facing upward in the geometric center of the room. A Gardon-type gauge with a flat black surface and 180° view angle is used. While in operation, the heat flux gauge is maintained at a constant temperature above the dew point by a heated water supply. The configuration of the test room with the radiometer is illustrated in Figure 2.

Bare Type K thermocouples (0.020-in. diameter) are used at each required location. A thermocouple is located in the interior plane of the door opening on the door centerline 4 in. down from the header. Thermocouples are also located 4 in. below the ceiling at the center of the room and at the center of each of the four ceiling quadrants. The average of these five thermocouples is used to determine the upper level air temperature. A thermocouple is also located directly over the center of the burner. The thermocouples penetrate through the ceiling with their junctions 4 in. away from the surface. Spackling compound is used to fill the holes around the thermocouple wires. The thermocouple layout is shown in Figure 3.

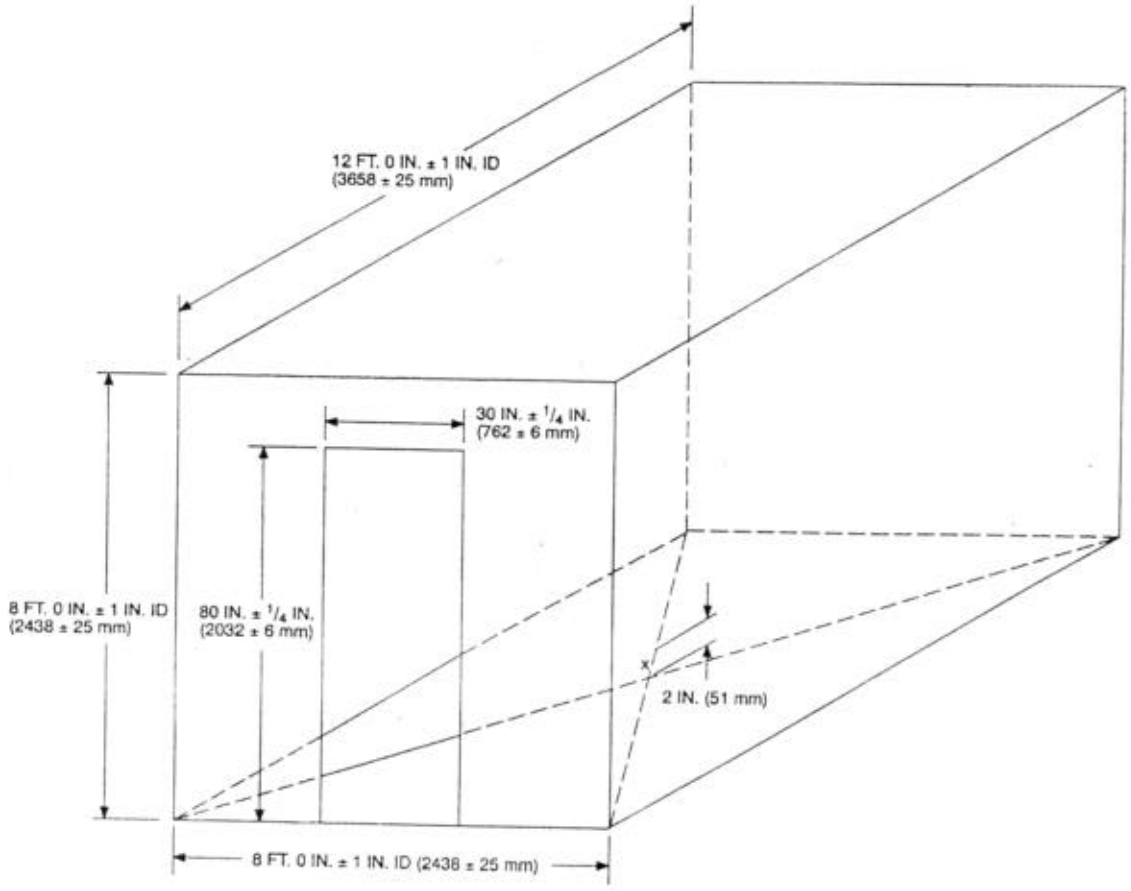


Figure 2. Schematic of the Room Test Configuration and Room Radiometer (x) Location.

At the start of a test, the propane gas burner is ignited with a remotely controlled spark igniter. The test walls are exposed to a 40-kW fire for 5 min, after which point, the gas burner is adjusted to output of 160 kW by way of a mass flow controller.

The products of combustion and entrained air are collected in a hood and extracted through an exhaust duct by a fan. A gas sample is drawn from the exhaust duct and analyzed for oxygen, carbon dioxide, and carbon monoxide concentrations. The gas temperature and differential pressure across a bi-directional probe are used for calculating the mass flow rate of the exhaust gases. Smoke production is determined based on the measured light obscuration in the duct using a white-light extinction photometer located close to the gas sampling point. The photometer is oriented vertically in the exhaust duct, and the plenum of the duct is baffled to ensure proper mixing of the exhaust gases.

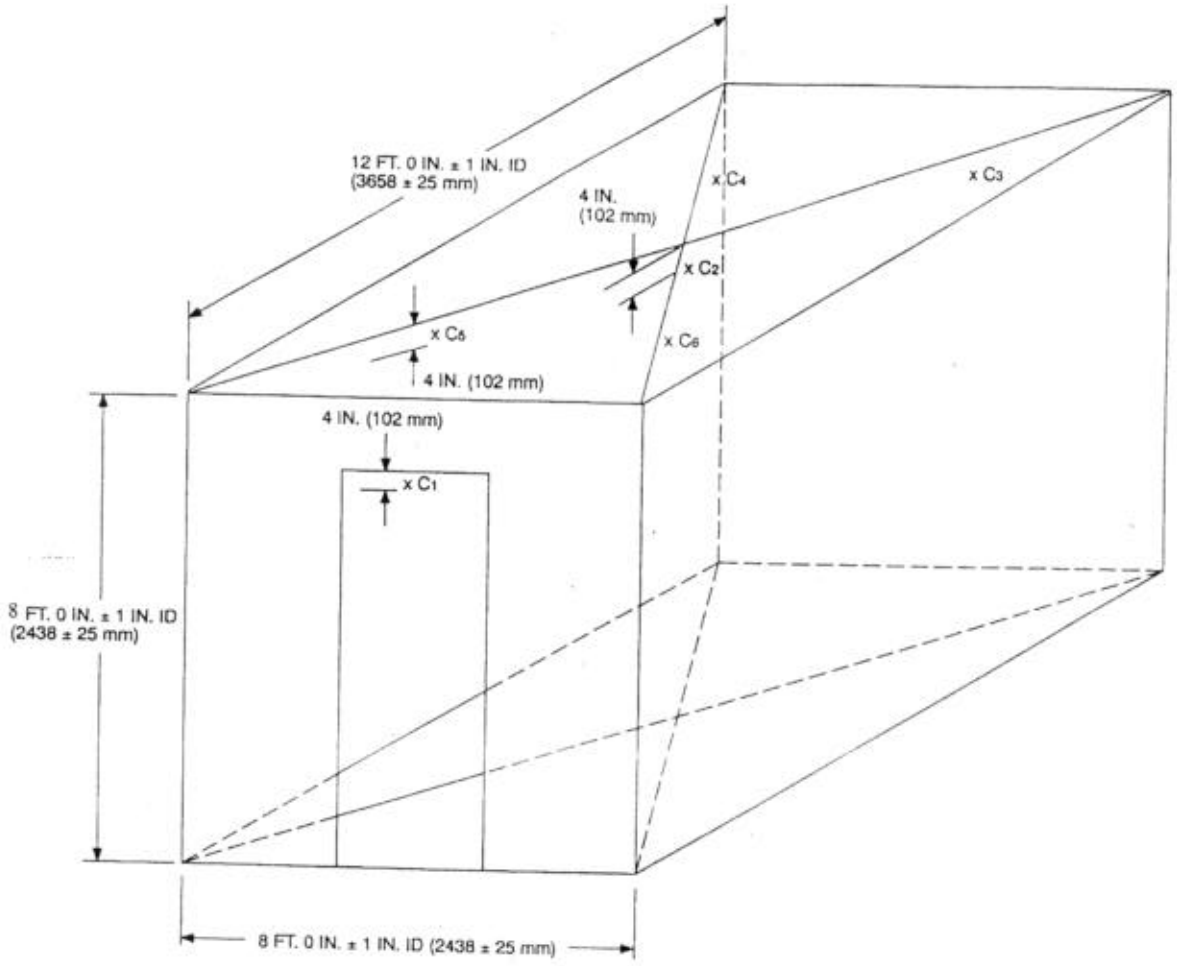


Figure 3. Schematic of the Thermocouple Layout per NFPA 286-2000.

The Intermediate-Scale Calorimeter apparatus and test protocol are standardized in the United States as NFPA 286-2000, "Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth."

3.0 DESCRIPTION OF TEST SPECIMENS

Ashland Chemical Company provided FRP panel interior finish material for testing in accordance with NFPA 286. The material identification of this material is MODAR® 814a Resin with 150 phr ATH. The test specimen was beige in color. Twelve panels measuring 52 in. wide x 96.5 in. long were received at SwRI on March 1, 2002. The specimens were trimmed to 48 in. wide x 96 in. long prior to installation into the test room. All the panels were cured at 200°F for 4 hours on March 8, 2002, at the request of the Client. After the cure time was over, the specimens were placed into conditioning (controlled

environment at 23 ± 3°C and 50 ± 5% relative humidity). The panels were installed in accordance with Section 3-3.2 and Figure 3-3.2(c) of NFPA 286-2000.

4.0 FLASHOVER CRITERIA

According to NFPA 286, flashover is determined to have occurred when any two of the following conditions have been attained:

- The heat release rate exceeds 1 MW.
- Heat flux at the floor exceeds 20 kW/m^2.
- The average upper layer temperature exceeds 600°C (1112°F).
  - The average upper layer temperature is determined by the average of four ceiling quadrant thermocouples in addition to the ceiling thermocouple at the center of the test room.
- Flames exit the doorway.
- Auto-ignition of a paper target on the floor occurs.

5.0 RESULTS AND DISCUSSION

Testing was conducted at SwRI's Department of Fire Technology located in San Antonio, Texas, on March 14, 2002. Test results are summarized in tabular and graphical form in the standard SwRI data sheets provided in Appendix A. Photographic documentation is provided in Appendix B, and visual observations can be referenced in Appendix C. A summary of the flashover criteria results is given in Table 2. The MODAR® 814a Resin with 150 phr ATH, FRP panel interior finish material **did not** cause the test room to **flashover** according to criteria per NFPA 286-2000, "Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth."

Table 2. Summary of "Flashover" Criteria Test Results.

Material ID	Peak Net Heat Release Rate (kW)	Peak Heat Flux at the Floor (kW/m^2)	Average Upper Layer Temperature (°C)	Flames Exiting Doorway	Auto-Ignition of Paper Target
MODAR® 814a Resin w/150 phr ATH FRP Panel (Beige)	382	5.8	553	No	No

Full test data can be referenced in Appendix A.

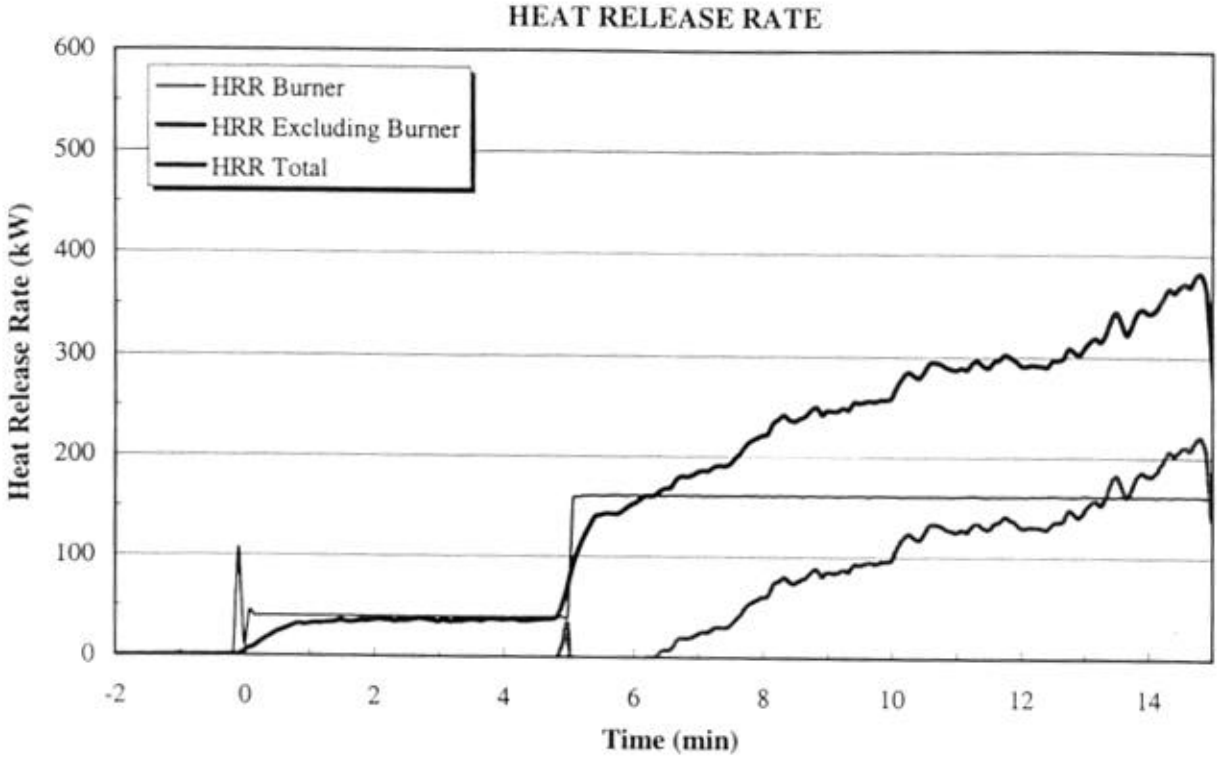
APPENDIX A

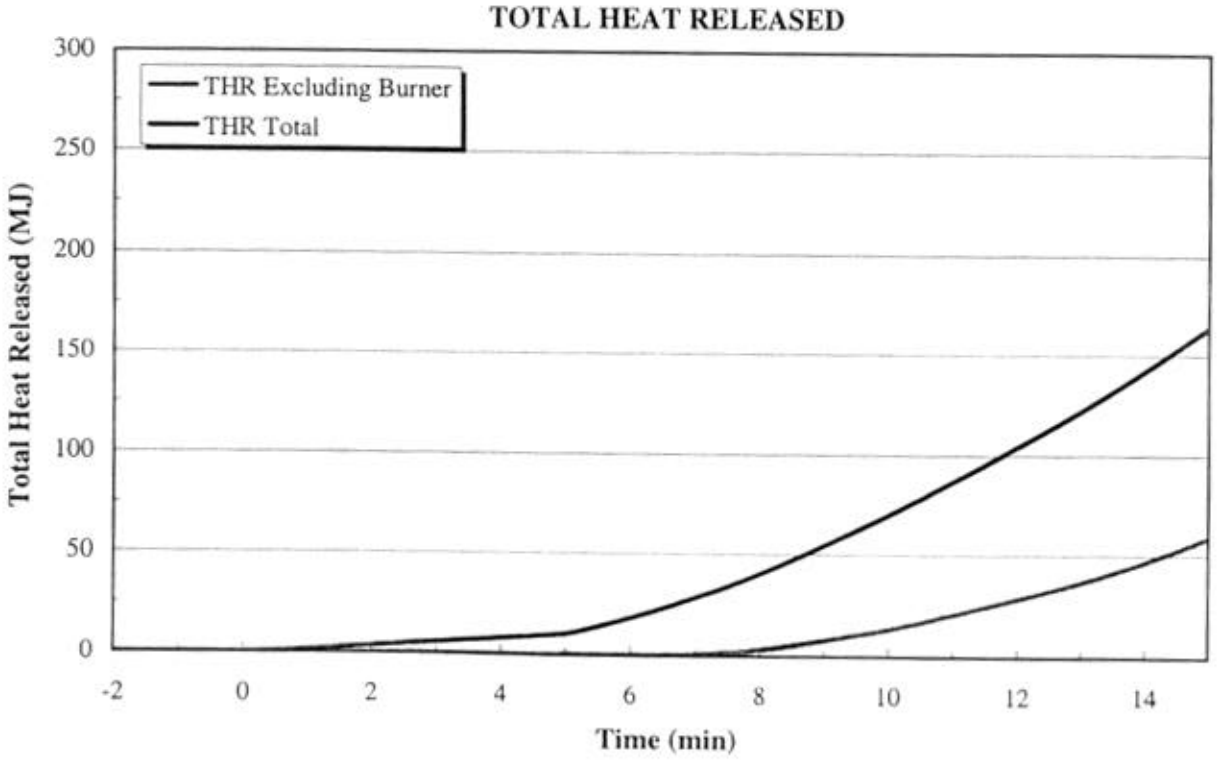
TEST DATA

(Consisting of 6 Pages)

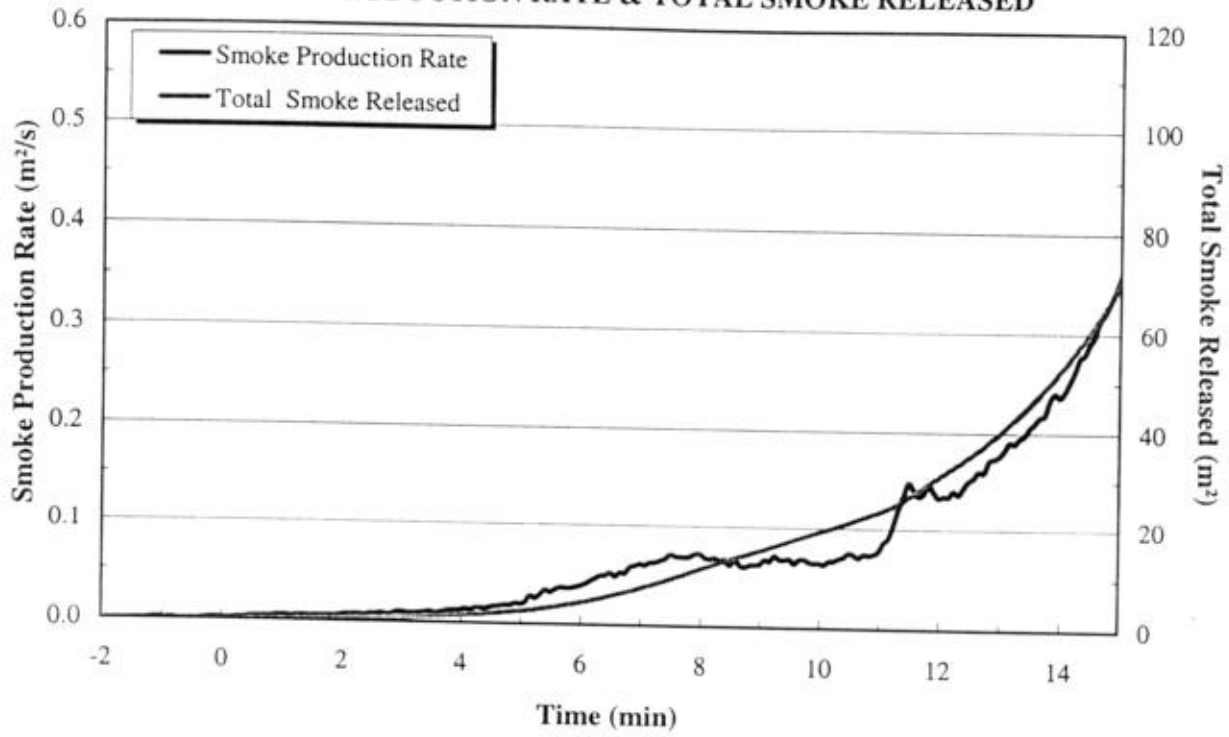
SUMMARY OF
NFPA 286 ROOM-CORNER TEST RESULTS

Peak HRR_{total}	382 kW	at	14 min 49 sec
Average HRR_{total}	185 kW		
Total Heat Released	167 MJ		
Peak $HRR_{excl.\ burner}$	220 kW	at	14 min 49 sec
Average $HRR_{excl.\ burner}$	68 kW		
Total Heat Released (Excluding Burner)	61 MJ		
Peak Smoke Production Rate	0.34 m^2/s	at	14 min 54 sec
Average Smoke Production Rate	0.08 m^2/s		
Total Smoke Released	76 m^2		
Peak Optical Density	0.13 1/m	at	14 min 54 sec
Exhaust Duct Flow at Peak O.D.	1.17 m^3/s		
Average Optical Density	0.032 1/m		
Average Volumetric Exhaust Flow	1.08 m^3/s		
Peak Heat Flux to the Floor	5.8 kW/m^2	at	14 min 54 sec
Peak Average Ceiling Temperature	553°C 1028°F	at	14 min 54 sec
Peak Doorway Temperature	447°C 837°F	at	14 min 54 sec
Peak CO Production Rate	1.35×10^{-3} m^3/s	at	14 min 54 sec
Peak CO Release Rate	1.54 g/s		
Peak CO_2 Production Rate	0.016 m^3/s	at	14 min 54 sec
Peak CO_2 Release Rate	28 g/s		

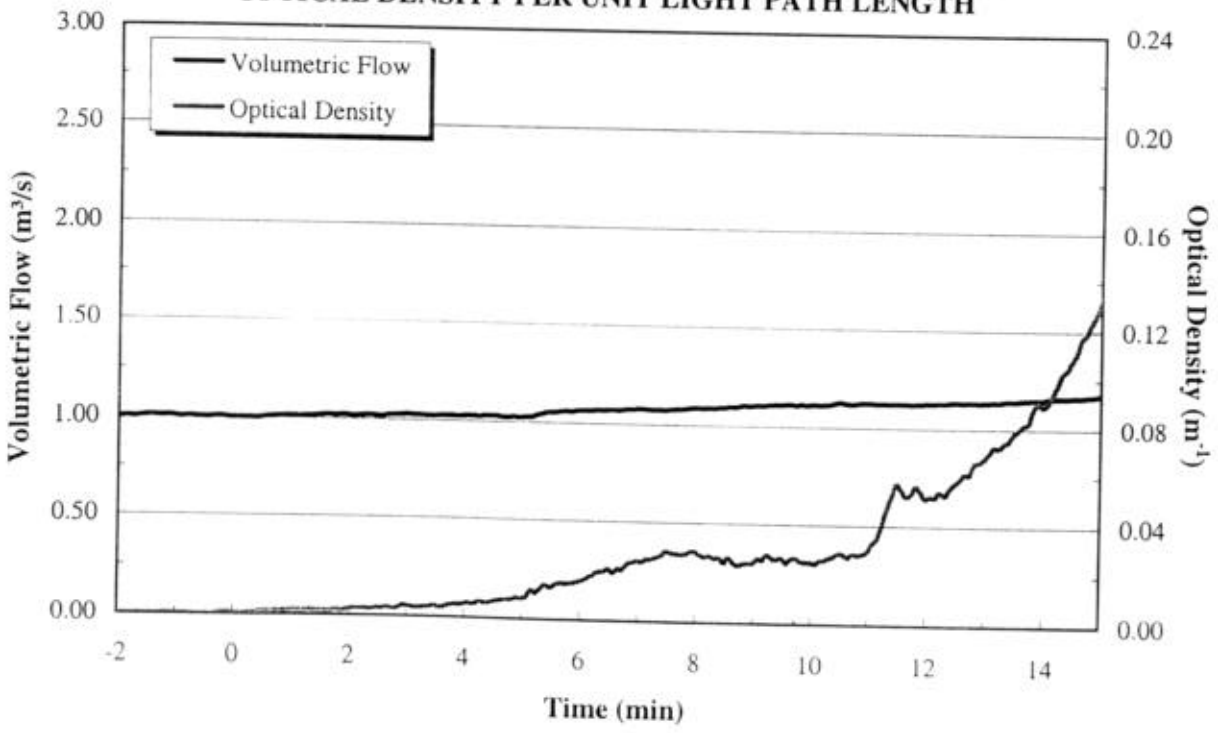

HEAT RELEASE RATE
HRR Burner
HRR Excluding Burner
HRR Total
Heat Release Rate (kW)
600
500
400
300
200
100
0
-2
0
2
4
6
8
10
12
14
Time (min)


TOTAL HEAT RELEASED
THR Excluding Burner
THR Total
Total Heat Released (MJ)
300
250
200
150
100
50
0
-2
0
2
4
6
8
10
12
14
Time (min)

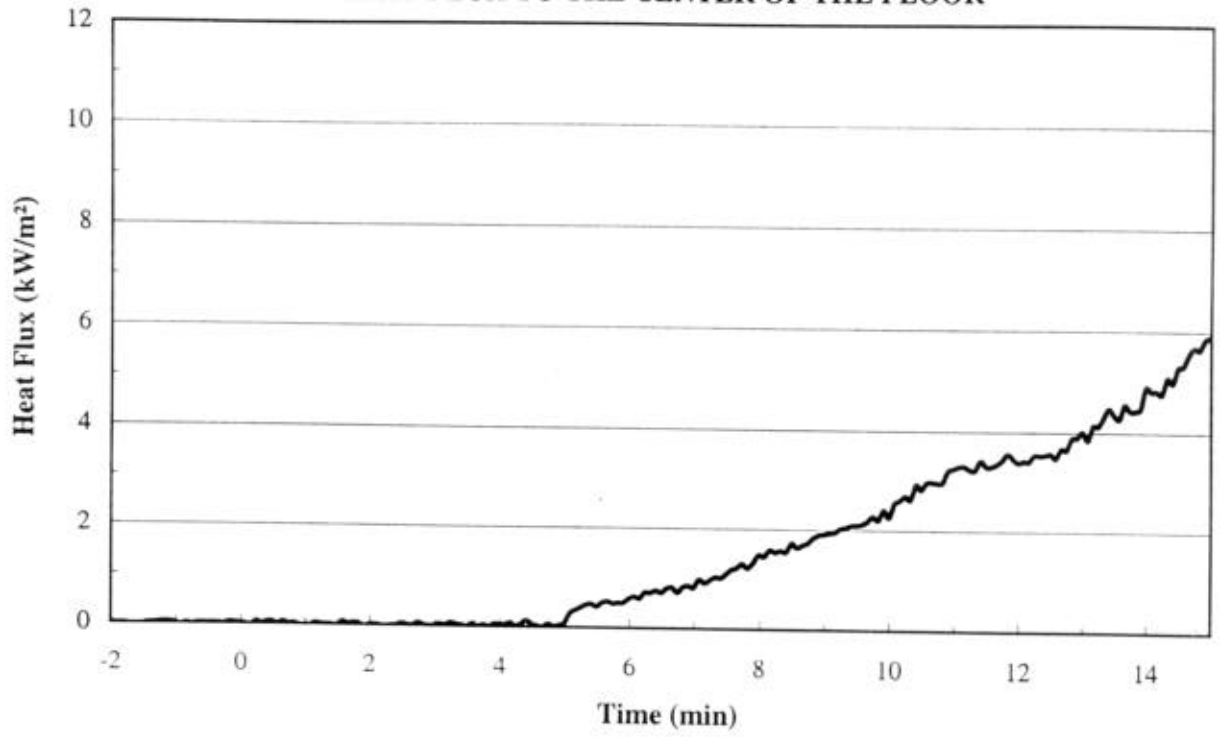
SMOKE PRODUCTION RATE & TOTAL SMOKE RELEASED



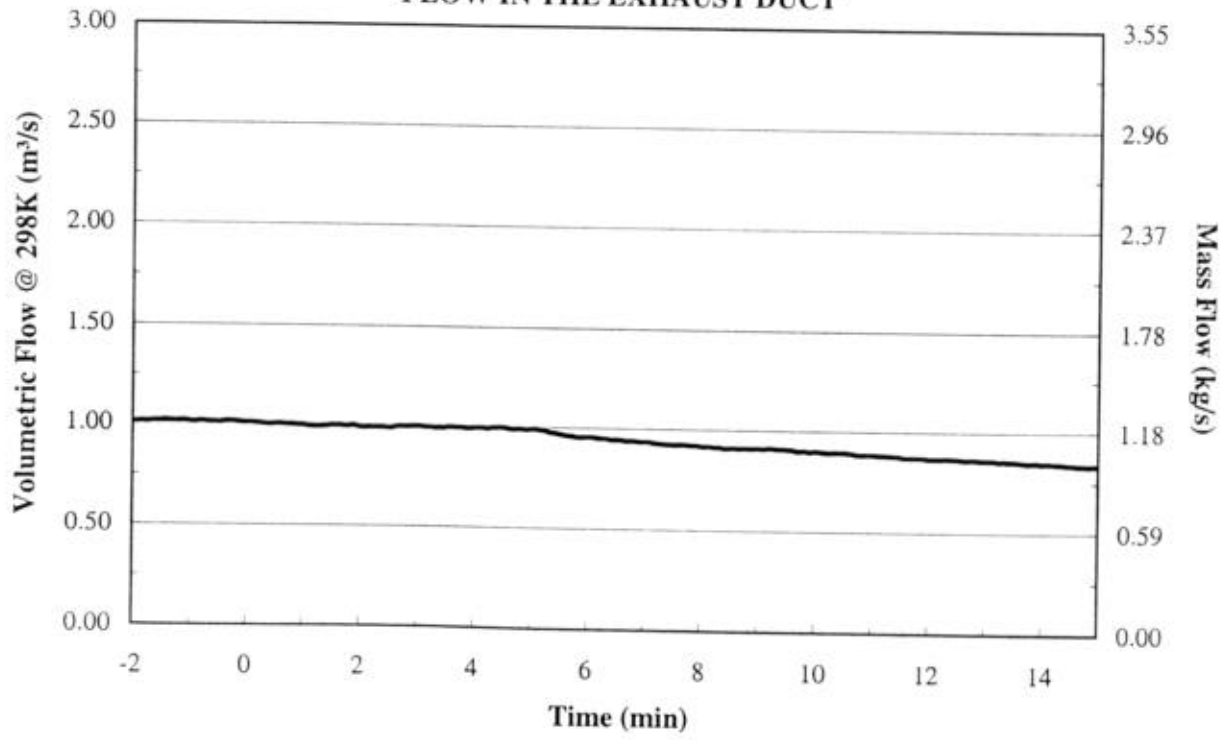
ACTUAL VOLUMETRIC FLOW IN THE EXHAUST DUCT & OPTICAL DENSITY PER UNIT LIGHT PATH LENGTH



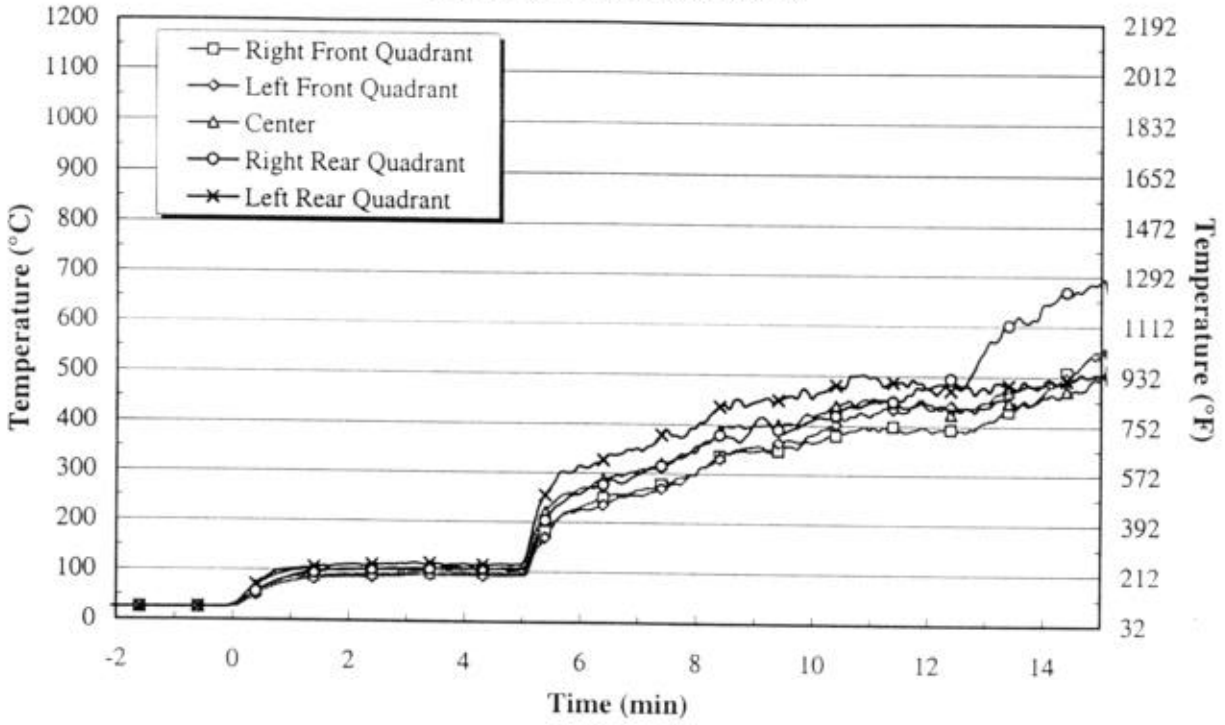
HEAT FLUX TO THE CENTER OF THE FLOOR



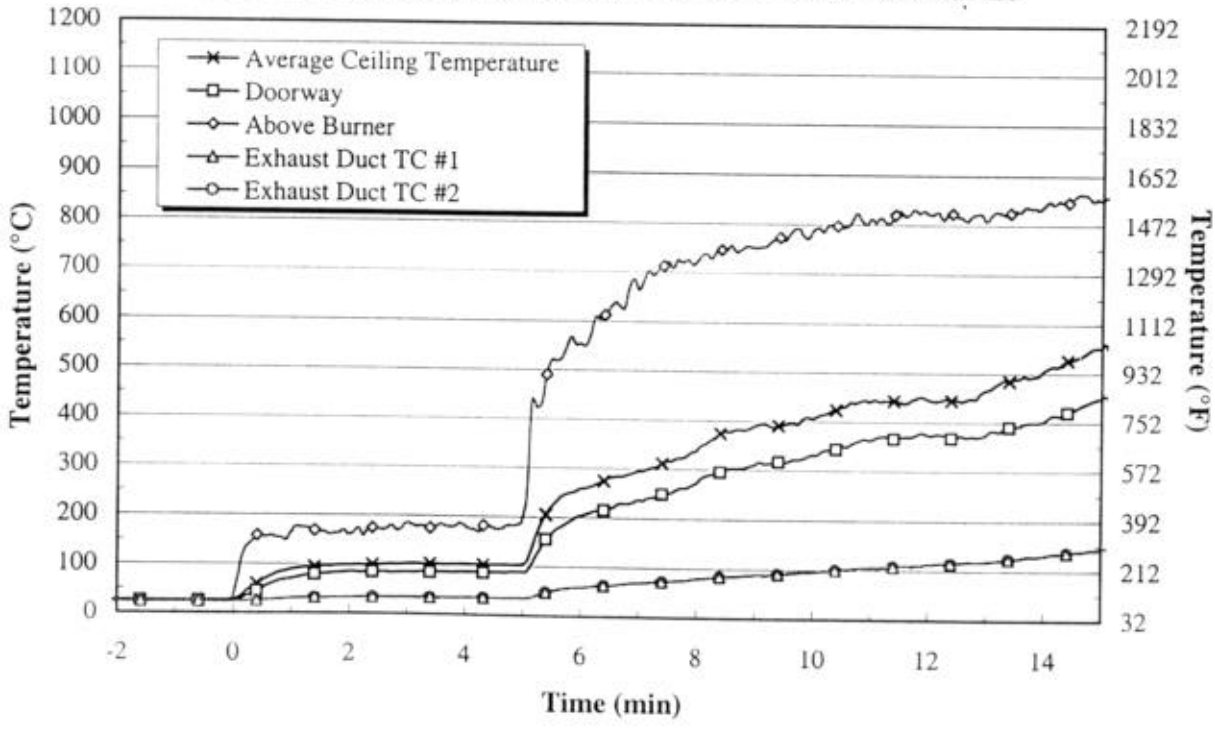
FLOW IN THE EXHAUST DUCT



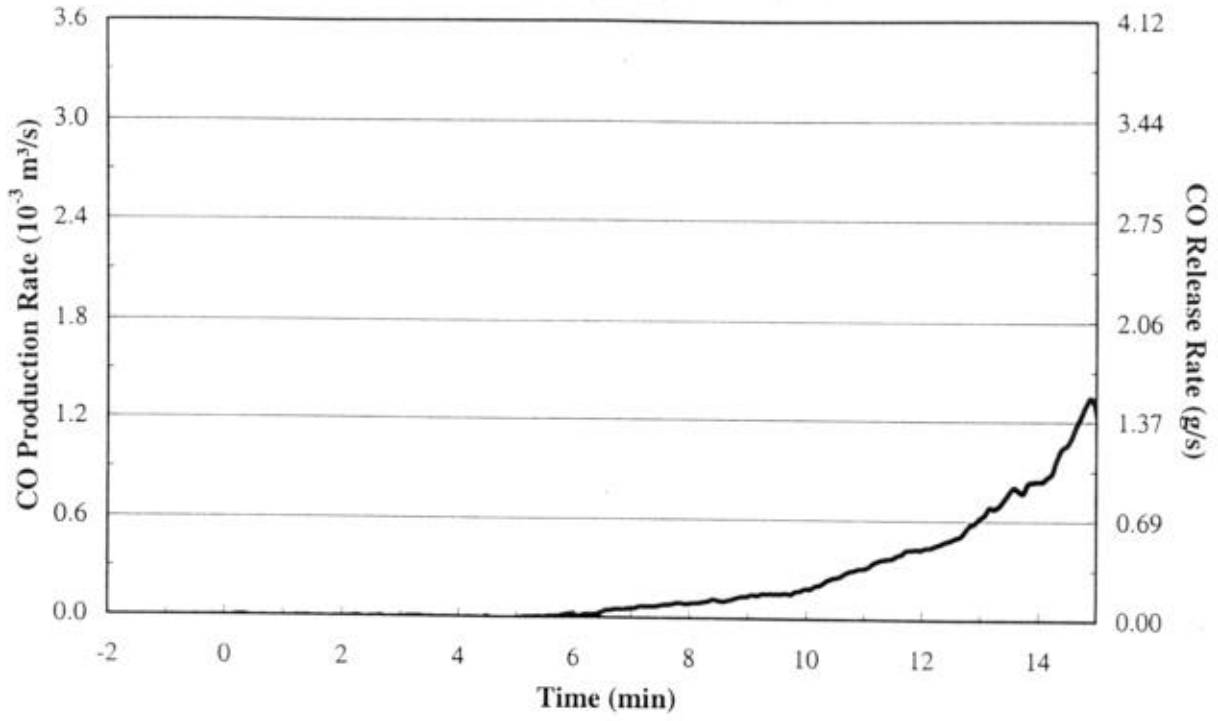
CEILING TEMPERATURES



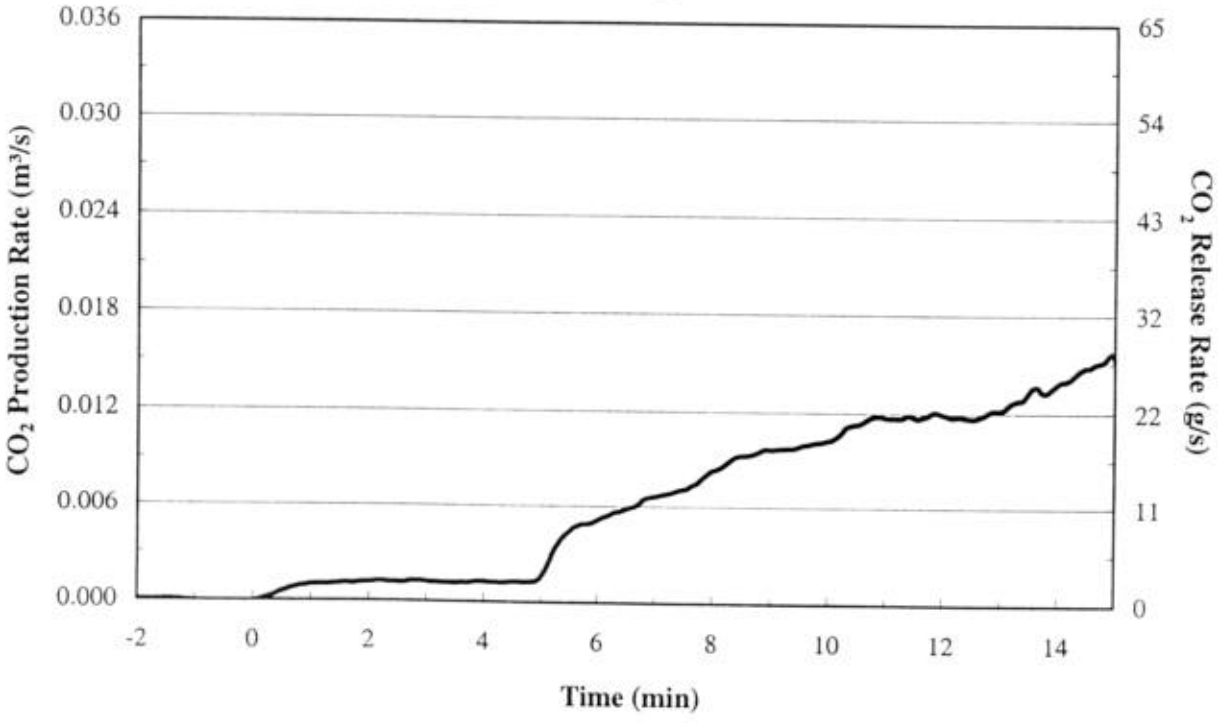
DOORWAY, ABOVE BURNER, AND DUCT TEMPERATURES



CARBON MONOXIDE (CO) PRODUCTION RATE



CARBON DIOXIDE (CO_2) PRODUCTION RATE



APPENDIX B

PHOTOGRAPHIC DOCUMENTATION

(Consisting of 6 Pages)

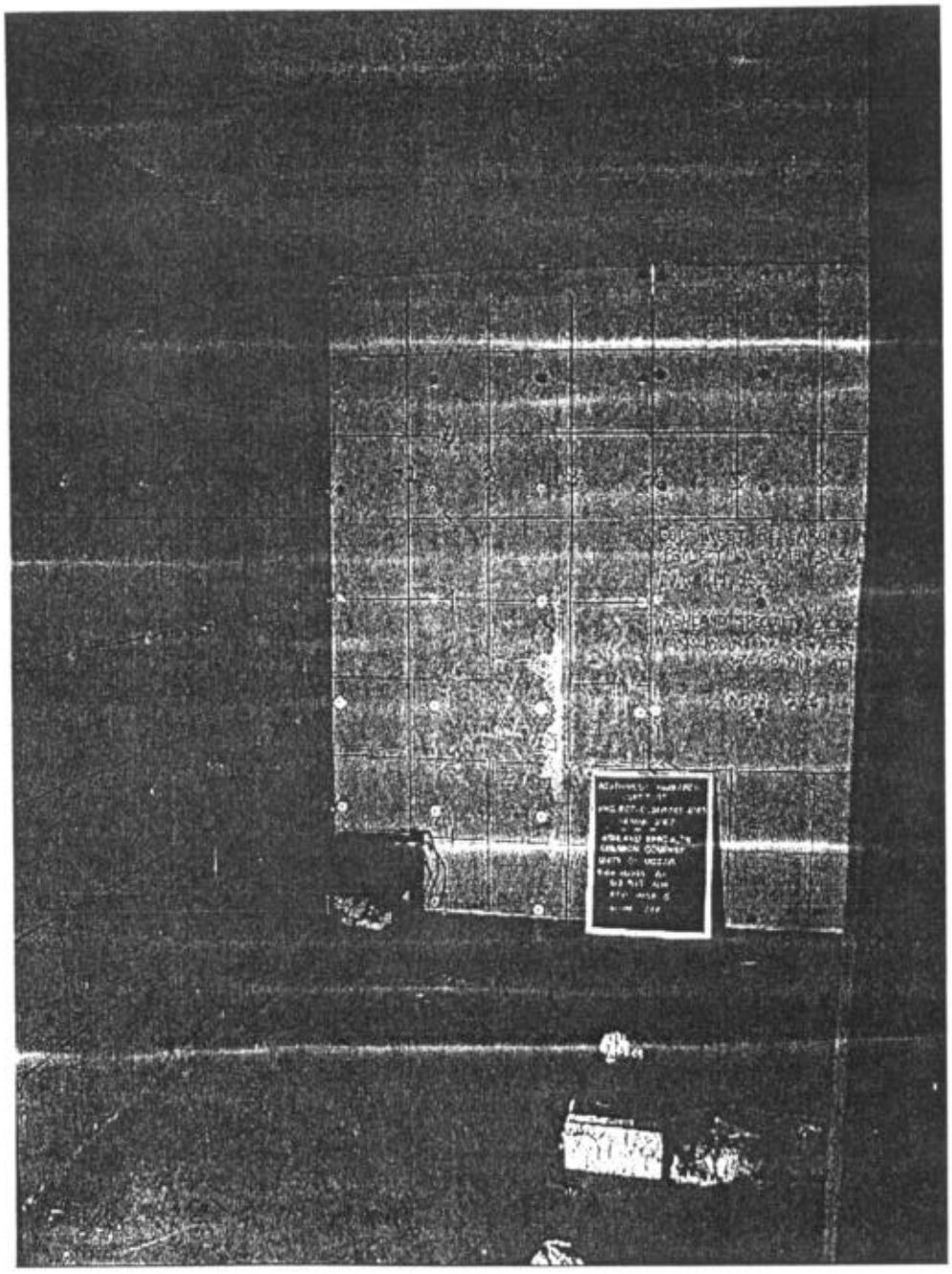


Figure B-1. Pre-Test Conditions.

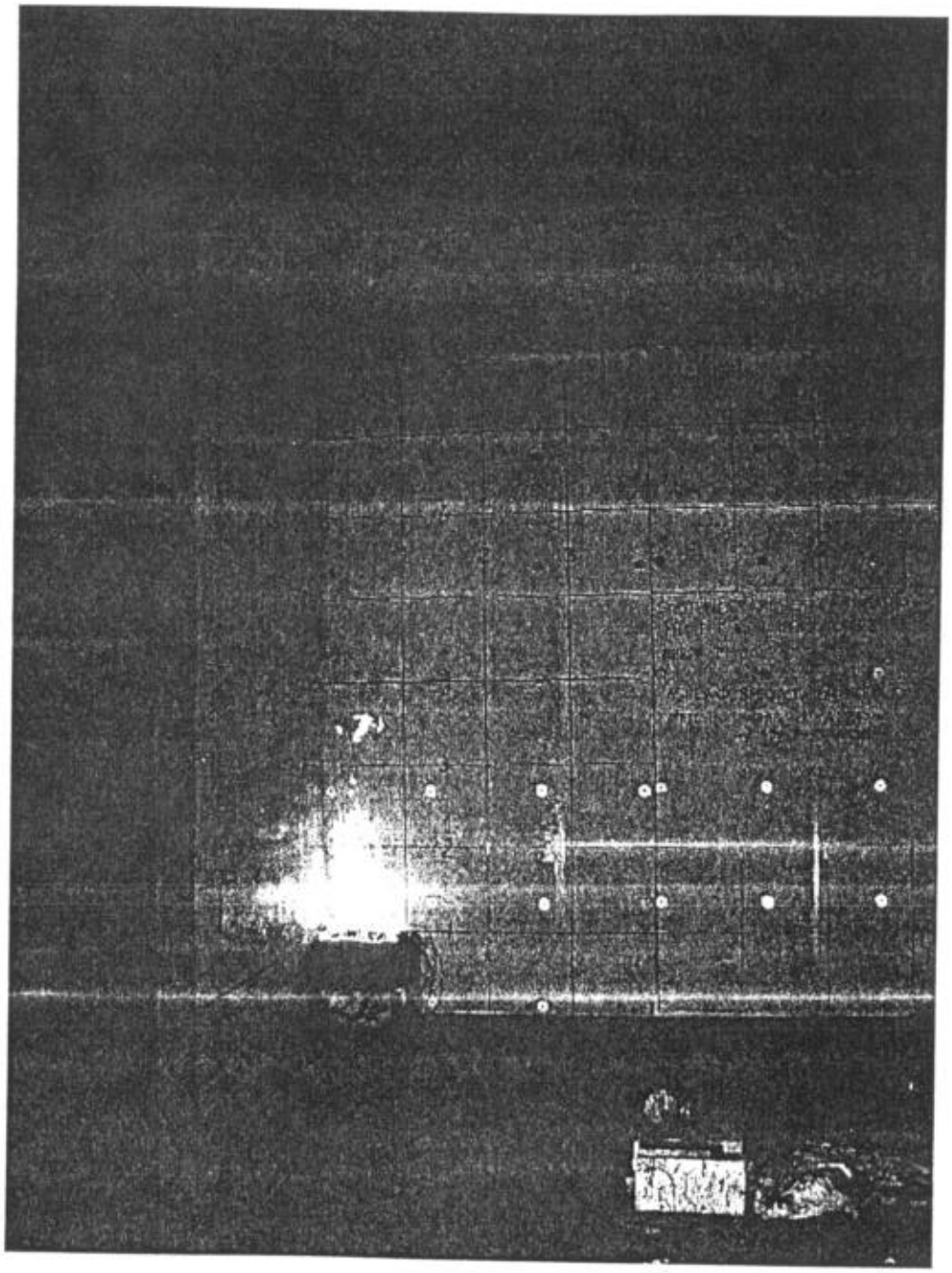


Figure B-2. Just After Ignition of Burner.

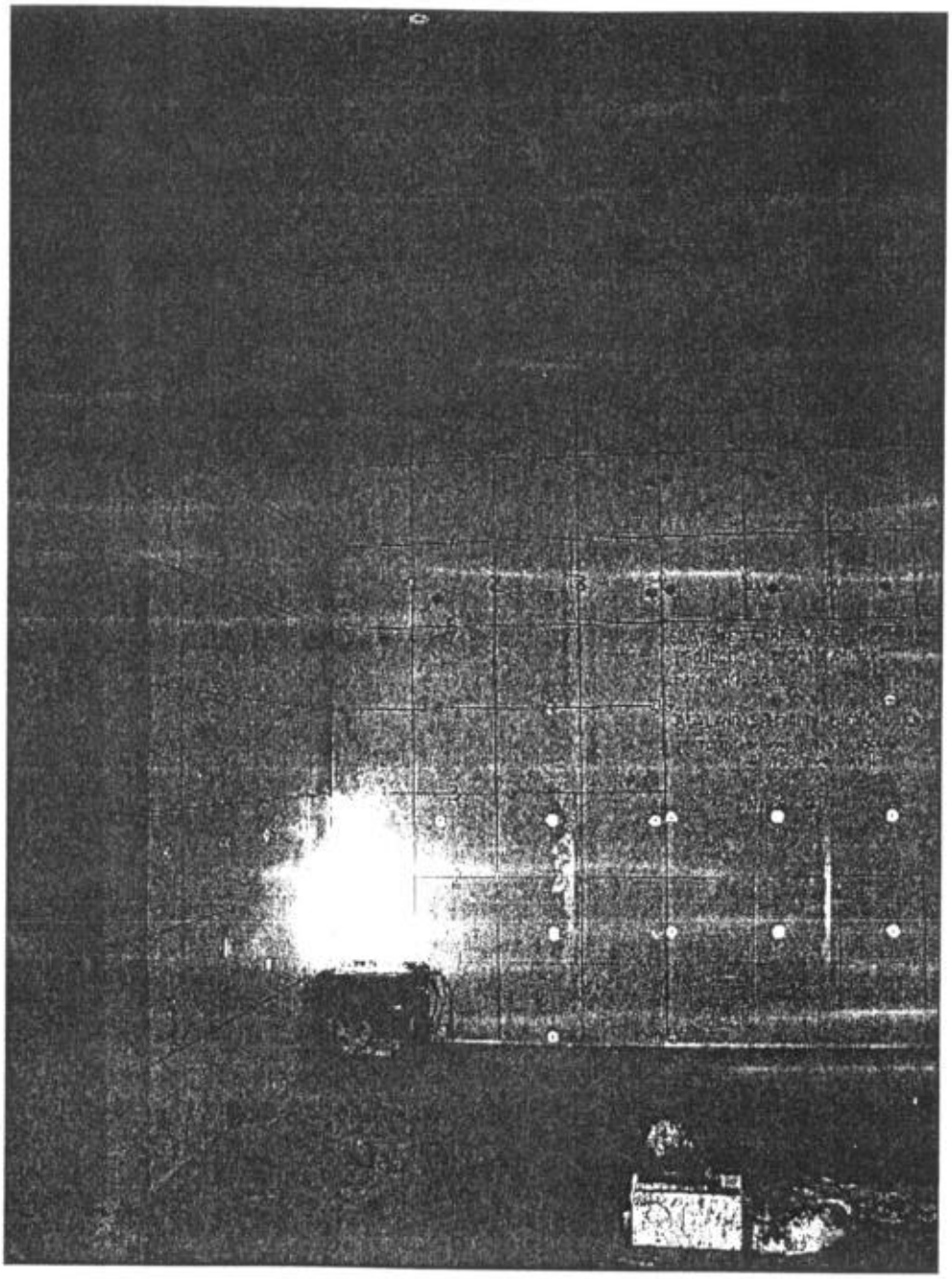


Figure B-3. Approximately 3 min into Test.

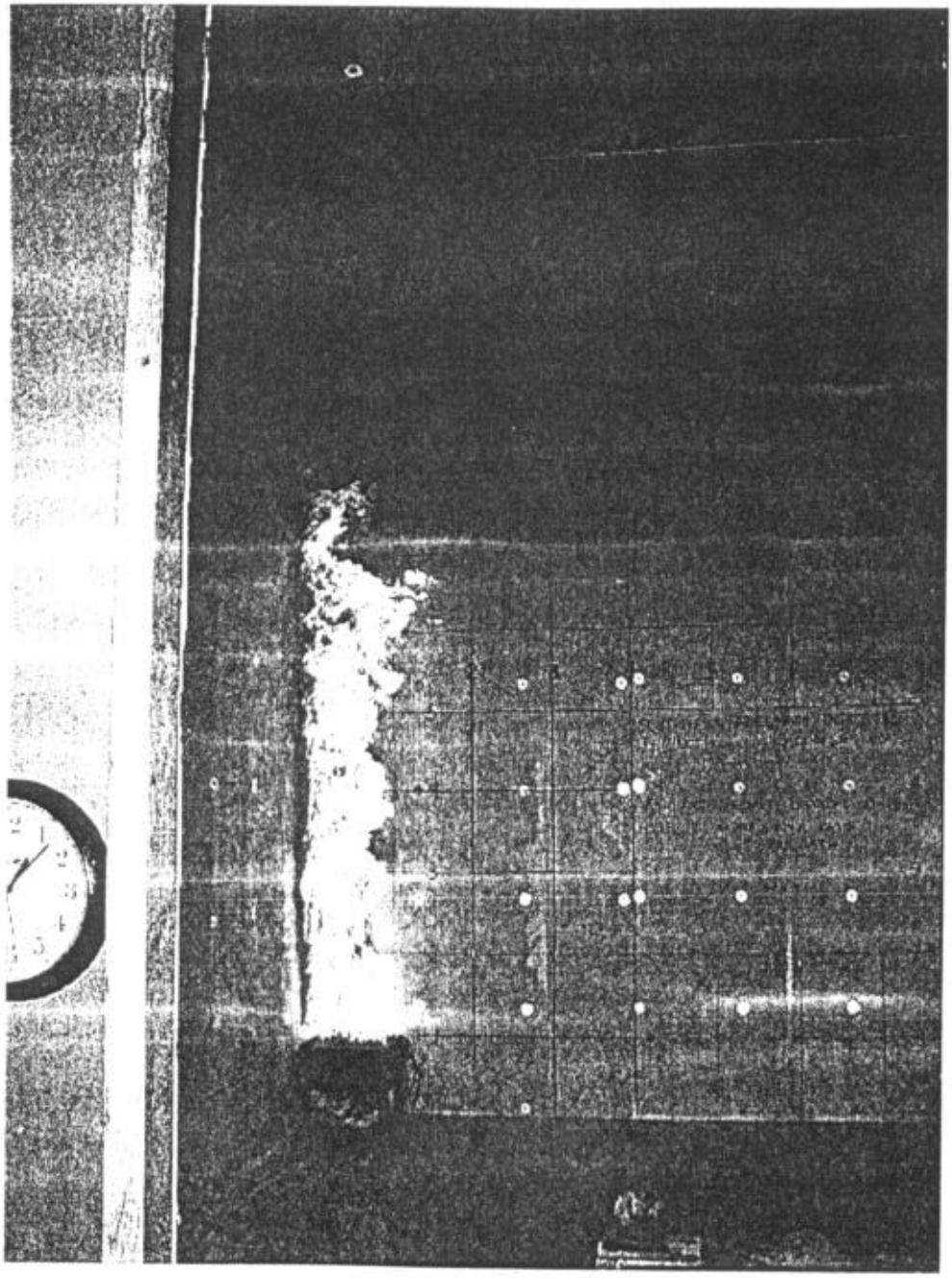


Figure B-4. Approximately 7 min into Test.

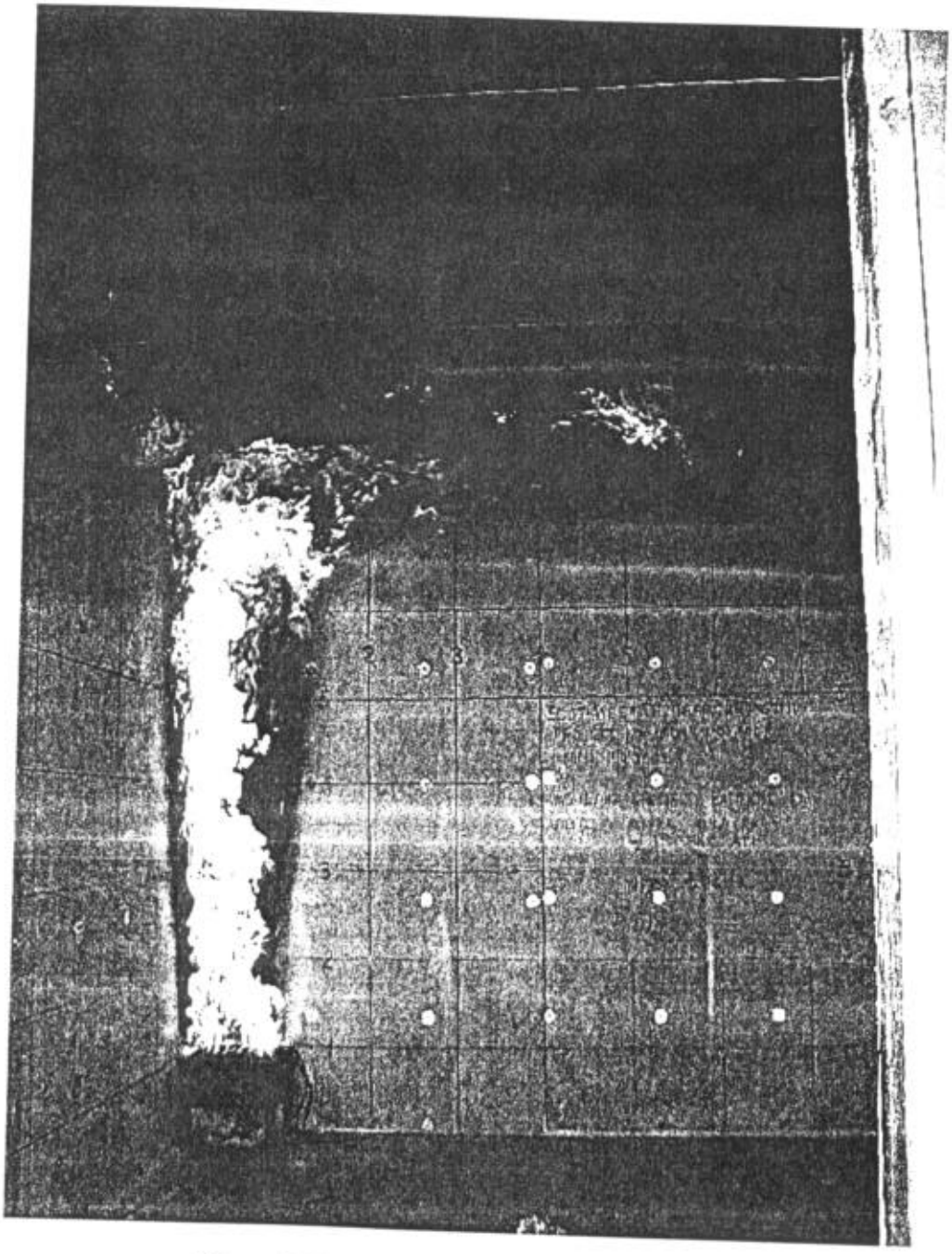


Figure B-5. Approximately 13 min into Test.

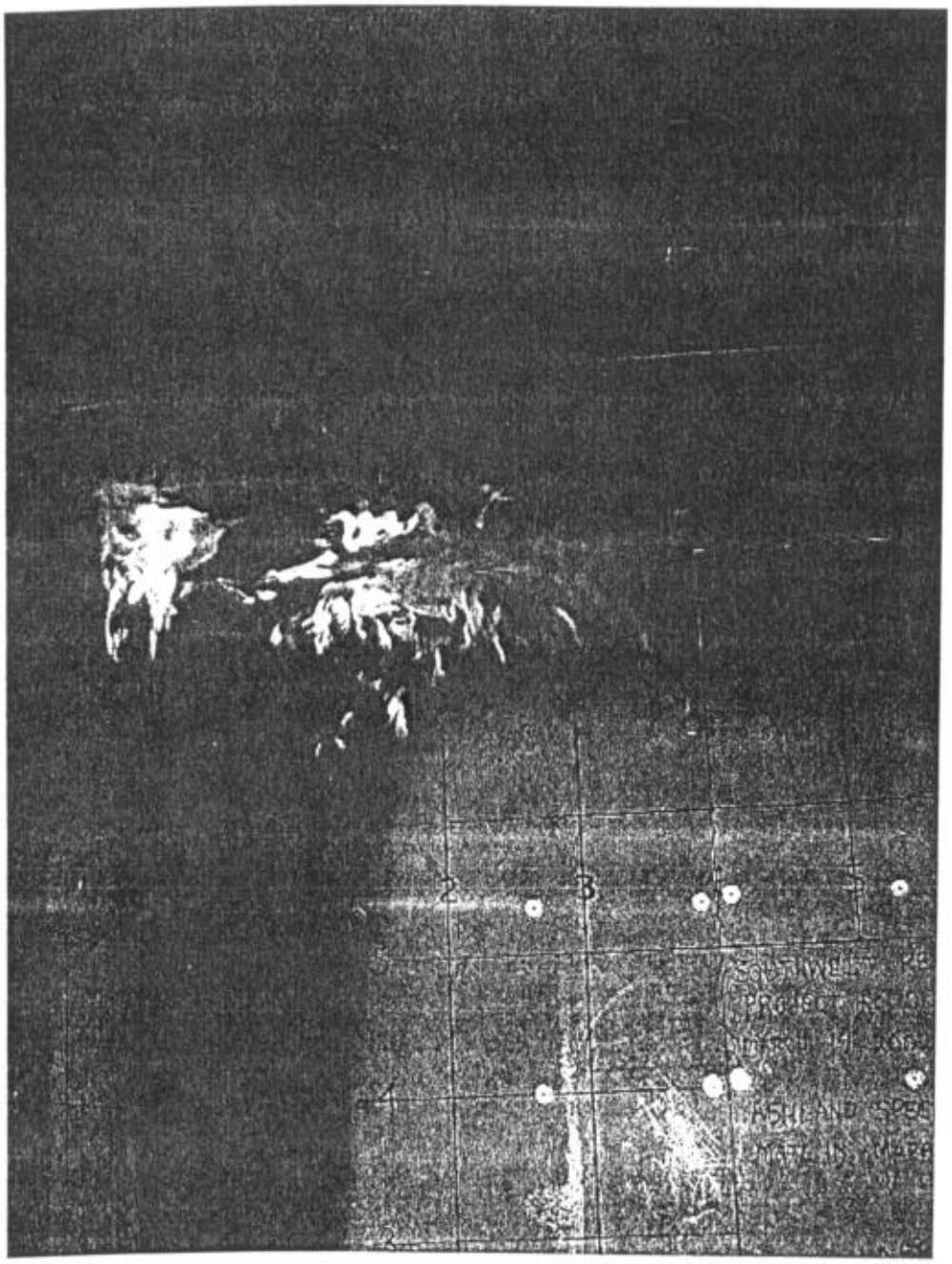


Figure B-6. Post-Test Conditions – After-flaming Observed.

APPENDIX C

VISUAL OBSERVATIONS

(Consisting of 2 Pages)

Ashland Chemical Company
SwRI Project No. 01.04917.01.406b
NFPA 286-2000 Room Corner Test
March 14, 2002
Material ID: MODAR® 814a Resin with 150 phr ATH (FRP Panels)

VISUAL OBSERVATIONS

TIME MIN:SEC	
00:00	Start of test, **burner set at 40 kW,** flames from the burner are 3 to 3½ ft in height above floor.
00:46	No change in room interior.
02:15	Slight discoloration on the wall panel in the burner corner from the top of the burner up to 2½ ft from the floor, little to no smoke in the room interior.
03:08	Slight crackling and popping off the wall panels, flames from the burner are still at 3½ ft in height with discoloration approximately 4 in. in width at direct flame impingement.
04:45	No change in the room interior.
05:00	**Fuel to burner increased to 160 kW**, flames in the burner corner are up to the ceiling.
05:14	Little to no smoke in the room interior, no ignition on the wall panels.
05:30	Flames from the burner are intermittently touching the ceiling. Scorching on the wall panels in the burner is from the top of the burner up to 3 ft from the floor.
06:12	Ignition on the wall panels from 1½ ft up to 3 ft from the floor.
06:45	Flames from the burner are up to the ceiling with intermittent flashing along both walls 1 to 2 ft away from the test corner. Light gray layer of smoke in the room interior down to 5½ ft from the floor.
07:25	Intermittent flashing of flames 2 to 4 ft along both walls at the wall/ceiling intersection.
08:00	Intermittent flashing of flames 2 to 3 ft along both walls at the ceiling.
08:12	Ignition on the ceiling panel at direct flame impingement from the burner.
08:35	Flames from the burner are up to the ceiling flashing 2 to 3 ft along both walls at the ceiling and on the ceiling.
09:30	Charring on the wall panels in the burner corner is approximately 12 in. in width along both walls up to the ceiling. Intermittent flashing along both walls at the ceiling is approximately 4 to 5 ft.
10:52	Intermittent flames are now 6 to 7 ft along both walls at the ceiling and 4 to 5 ft across the ceiling towards the doorway. Light gray layer of smoke in the room interior down to 5½ ft above the floor.
12:15	Flames are burning across the ceiling towards the doorway approximately 6 ft with flames burning 7 to 7½ ft along both walls along the ceiling.
13:00	Little to no smoke in the room interior.
13:45	Continuous burning out to 5 ft along both walls at the ceiling with continuous flashing 7 to 8 ft along both walls at the ceiling. Little to no smoke in the room interior.
15:00	**End of Test**, fuel to burner cut off, room interior extinguished.

Post Test Observations:

Left wall: Charring of wall panels vertically approximately 12-14 in. in the burner corner and 12 in. down from the ceiling towards the floor

Back wall: Charring of wall panels approximately 12-14 in. in width vertically in the burner corner and 36 in. down on the wall panels from the ceiling to the floor.

Right wall: Surface discoloration approximately 4 ft down from the ceiling to the floor.

See Appendix B, Photographic Documentation

ASTM E 136-82. Behavior of materials in a vertical tube furnace at 750 °C

The ASTM E 136-82 test for determining the combustion characteristics of building materials differs from ISO 1182 (Section 9.21) as is evident from Fig. 9.1 and the test specifications given in Table 9.2. Certain building codes (e.g. UBC Standard 4-1, Sec. 415. Noncombustible material, tests) specify this method.

Table 9.2 Test specifications for determining the combustion characteristics of building materials by ASTM E 136-82

Specimens	minimum of 4 samples 38 mm × 38 mm × 51 mm
Specimen position	vertical
Ignition source	electric furnace heated to 750 °C
Test duration	until thermocouples reach maximum temperature or specimen fails test
Conclusions	passed if at least 3 of the 4 specimens – do not cause a rise in furnace temperature of more than 30 °C – do not burn after the first 30 s – do not cause a temperature rise in the furnace or burn when weight loss exceeds 50%

ASTM E 84-84a. Surface burning characteristics of building materials

The ASTM E 84-84a test is identical to UL 723 (UL developed this method), NFPA 255 and UBC Standard 42-1. The apparatus, known as the *Steiner* tunnel is illustrated in Fig. 9.2 and the test specifications are summarised in Table 9.3.

Table 9.3 *Steiner* tunnel test specifications

Specimens	at least 1 sample 0.51 m × 7.32 m × usual thickness
Specimen position	horizontal under tunnel roof
Ignition source	2 gas burners with 5.3 MJ/min output located 190 mm below specimen at a distance of 305 mm from and parallel to the fire end of the test chamber
Test duration	10 min
Conclusion	determination of flame spread and "Flame Spread Classification" (FSC), measurement of smoke density

Two preliminary tests are carried out after calibrating the apparatus. A first run is made with standard red oak specimen to obtain numerical values of 100 for flame spread and smoke density. In the second preliminary test an asbestos cement specimen is tested in order to obtain zero values for these same parameters.

In the actual main test, the contribution of the material under test to smoke development and flame spread is measured and the material classified on the basis of the results. Details of smoke density measurement are given in Section 14.2.2.

In order to obtain the Flame Spread Classification (FSC) of the material the distance travelled by the flame front is plotted as a function of time. If the total resultant area A_T under the flame spread time – distance curve ≤ 97.5 (ft · min), then

$$FSC = 0.515 \cdot A_T$$

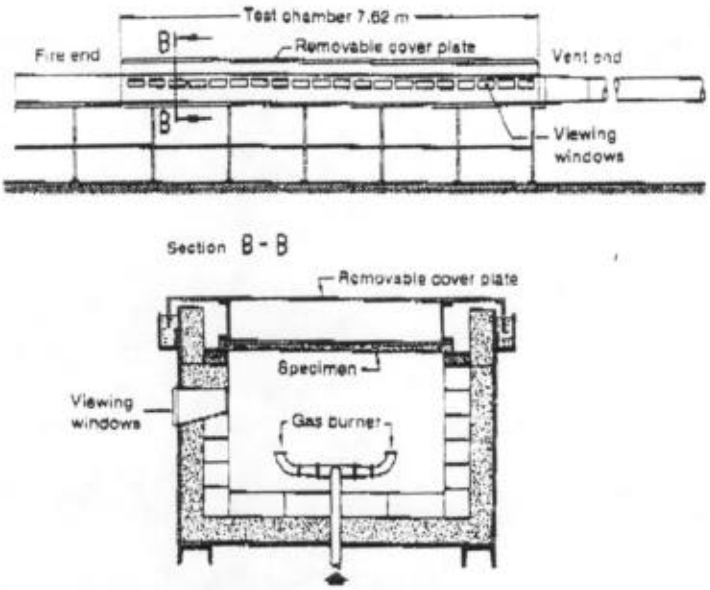


Fig. 9.2 25 ft *Steiner* tunnel

If A_T is greater than 97.5 (ft · min), then

$$FSC = \frac{4900}{195 - A_T}$$

The determination of spread of flame with the 25 ft tunnel test forms the basis of classifying "Interior Finishes" contained in all the building codes. The classification characteristics used to differ from code to code but now largely agree. The Interior Finish classifications of the principal building codes are quoted here as an example.

- Life Safety Code, NFPA 101 Section 6-5.2.1

Class	Flame spread
A	0 – 25
B	26 – 75
C	76 – 200

- Uniform Building Code (UBC) (issued by ICBO) Section 4204, Table 42-A:

Class	Flame spread
I	0 – 25
II	26 – 75
III	76 – 200

Smoke density must not exceed 450. Plastics are also covered; flame spread must not be more than 200 and smoke density is limited to 450 (or 75 by ASTM D 2843-77). In the codes

listed here, rigid foam plastics must, depending on the application, exhibit flame spread ≤ 25 or ≤ 75 and smoke density ≤ 450.

- Basic Building Code (issued by BOCA) Section 922.5.3

Class	Flame spread
I	0 – 25
II	26 – 75
III	76 – 200

- Standard Building Code (issued by SBCCI) Section 704 – Restrictions on Interior Finishes:

Class	Flame spread	Smoke density
A	0 – 25	≤ 450
B	26 – 75	
C	76 – 200	

- HUD Section 405-8.2 and -8.3 or Table 4-5.4:

  Depending on the type of building or use in particularly exposed areas, flame spread 0–25, 0–75 or 0–200. Floors as well as walls and ceilings are also included.

- HHS section 8.15: F. Interior Finishes:

  Maximum Flame Spread 25 or 75. The smoke density (max. 450) is determined by NBS TN 708 (see Section 14.2.1).

This list demonstrates the complexity of the American Building Codes and resultant difficulties in assigning the correct classification for all applications and materials despite the wide measure of agreement.

ASTM E 162-83. Test for surface flammability of materials using a radiant heat energy source

The apparatus for the ASTM E 162-83 surface flammability test is shown in Figs. 9.3 and 9.4 while the test specifications are summarised in Table 9.4.

Table 9.4 ASTM E 162-83 radiant panel flame spread test specifications

Specimens	4 specimens 150 mm × 460 mm
Specimen position	at an angle of 30° to vertical, distance from radiant panel: upper (150 mm long) edge 120 mm, lower edge 340 mm
Ignition sources	– vertical gas radiant panel 300 mm × 460 mm, operating temperature 670 °C – gas pilot burner, 230 mm long porcelain tube, 6 mm diameter, mounted horizontally at an angle of 15 to 20° to specimen; flame length 150 to 180 mm, applied to upper edge of specimen from a distance of 32 mm
Test duration	until the 360 mm reference mark is reached or maximum of 15 min
Conclusions	Flame Spread Index calculated from measured flame spread and heat evolution, measurement of smoke development

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DEPARTMENT OF FIRE TECHNOLOGY

Chemistry and Chemical Engineering Division

INVESTIGATION OF SURFACE BURNING CHARACTERISTICS OF:

A FIBERGLASS PANEL: NO. 6301-260

PROJECT NO. 01-1373-114-c[2]

FINAL REPORT

REVISED NOVEMBER 28, 1989
REVISED JUNE 22, 1987
APRIL 10, 1987

Prepared for:

ICI AMERICAS, INCORPORATED

MANTUA GROVE ROAD

WEST DEPTFORD, NEW JERSEY 08066

By:

Carl A. Hafer, P.E.
Manager
Fire Testing Services

Approved by:

Alex B. Wenzel
Director, Fire Technology for
Dr. Robert E. Lyle, Vice President
Chemistry and Chemical Engineering

San Antonio, Texas
Dallas/Ft.Worth, Texas•Detroit, Michigan•Houston, Texas•Washington, D.C.

1. INTRODUCTION

This report presents the results of a flame spread tunnel test on a fiberglass panel, submitted for evaluation by ICI Americas, Incorporated, of West Deptford, New Jersey. The report contains a description of the material tested, the preparation and conditioning of the specimen, the test procedure, and finally, the test results. Note that the results only apply to the specimen tested, in the manner tested, and not to the entire production of this or similar materials, nor to this material's performance when used in combination with other materials. All test data are on file and are available for review by authorized persons. [On November 21, 1989, the Client stated that the identification for the formula had been changed from MDR 814 to MODAR 814. The Client also stated that work on this project was done in conjunction with Miles Hill, Incorporated, of Seguin, Texas. All revised information is enclosed in brackets.]

The test was conducted in accordance with the provisions of ASTM Designation E84, "Standard Method of Test for Surface Burning Characteristics of Building Materials." This test method is similar to the test method specified in NFPA No. 255, UL No. 723 and UBC No. 42-1. ASTM E84 is a test procedure method only and does not set requirements for materials. Therefore, SwRI does not assign a classification to the material tested. Building codes, such as the Uniform Building Code, have requirements dependent on the building type, occupancy, etc. The building code having jurisdiction in the location a material is to be used will determine compliance of the test results.

The purpose of the test was to evaluate performance of the test specimen in relation to that of glass-reinforced cement board and red oak flooring under similar fire exposure. The results are expressed in terms of flame spread, fuel contribution and smoke developed during a 10-minute exposure and are recorded as a ratio with glass-reinforced cement board 0 and red oak flooring 100.

II. DESCRIPTION OF MATERIALS

On December 22, 1986, the test material was received from the Client. It is described in Table 1 below.

TABLE 1. DESCRIPTION

Type:	Fiberglass Panel
Identification No.:	6301-260
Formula:	[MODAR 814] with 150 parts ATH
Color:	Yellow/brown
Construction:	Glass reinforced polyester laminate 3 ply 1.5-oz chopped mat
No./Size Received:	2 pieces, 20.5 x 143.5 in. (0.52 x 3.65 m)
Thickness:	0.24 in. (6.10 mm)
Total Weight:	95.8 lb (43.49 kg)
Unit Weight:	2.35 lb/ft² (11.43 kg/m²)
Substrate Used:	0.25-in. (6.35-mm) glass-reinforced cement board placed between the specimen and furnace lid

III. PREPARATION AND CONDITIONING OF TEST SPECIMEN

The 21-in. x 25-ft (0.53 x 7.63-m) specimen was prepared using two panels, 20.5 x 143.5 in. (0.52 x 3.65 m), as received, from the Client. These were placed end-to-end in the tunnel with no additional support required. A 14 x 21-in. (0.36 x 0.53-m) section of 16-ga (1.6-mm) sheet metal was placed over the burner and under the leading edge of the first section to deter flame impingement on the unexposed surface in accordance with the test procedure.

The specimen was conditioned for 24 days in an atmosphere maintained between 68 and 78°F (20 and 26°C) temperature and 45- to 55-percent relative humidity.

IV. TEST PROCEDURE

The test was conducted on January 15, 1987, with Mr. W. Whitaker present representing the Client. Reference data were obtained and furnace operation checked by conducting a 10-minute test with glass-reinforced cement board on the day of the test and by periodic tests with red oak flooring. These tests provided the 0 and 100 references for

flame spread and smoke developed. Ignition over the burners was noted at 40 seconds after the start of the test in the most recent calibration with red oak flooring. Each specimen to be evaluated was tested in accordance with the standard procedure.

V. TEST RESULTS

The test results were calculated on the basis of observed flame travel and the measurement of areas under the recorder curves of furnace temperature and smoke developed (see Table 2). To allow for possible variations in results due to limitations of the test method, the numerical results were adjusted to the nearest figure divisible by 5.

Recorded data for flame spread, fuel contribution and smoke developed for the specimen are shown in the figures at the end of this report as a solid line on each graph.

TABLE 2. CLASSIFICATION

Test Specimen	Flame Spread Index E84-84a	Fuel Contribution	Smoke Developed
Glass-Reinforced Cement Board	0	0	0
Red Oak Flooring	100	100	100
A Fiberglass Panel:			
No. 6301-260	20	5	40

VI. OBSERVATIONS DURING AND AFTER TESTS

Observations made during and after the test are presented in Table 3 below.

TABLE 3. OBSERVATIONS

EVENT	
Color Change, min:s	0:58
Steady Ignition, min:s	3:20

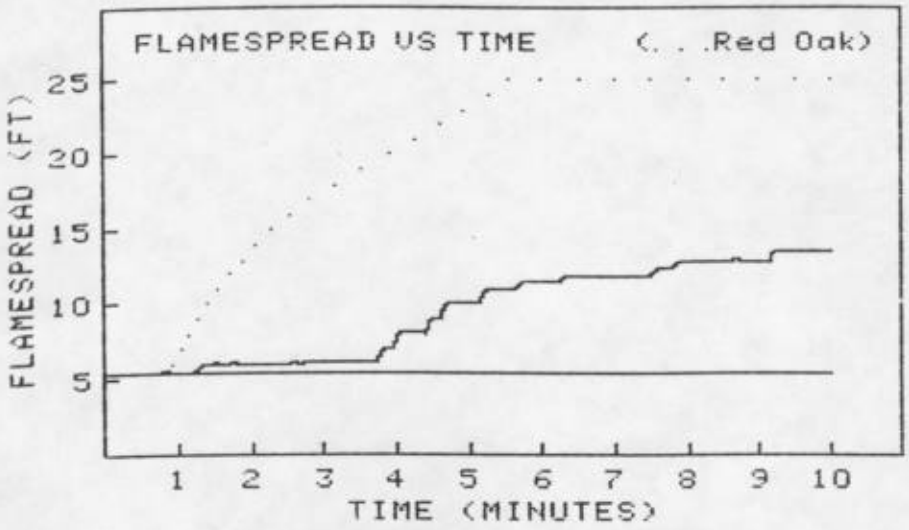
EVENT (Continued)

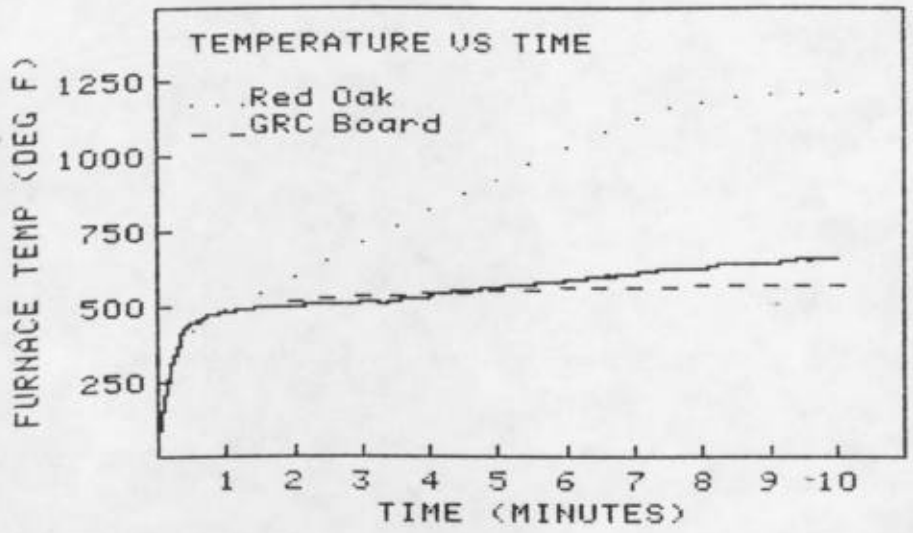
Maximum Flame Front Advance, min:s	9:15
ft	13.5
(m)	(4.12)
Afterflame Top, min:s	0:40

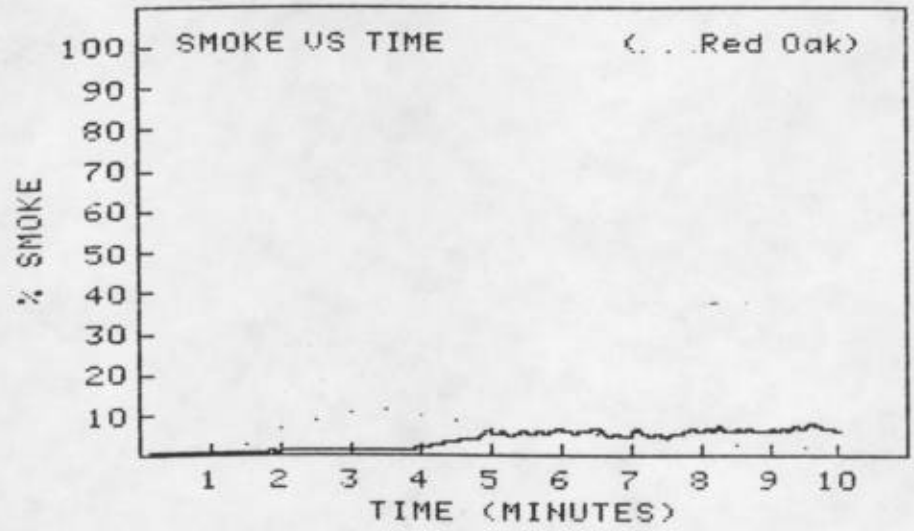
DAMAGE

Glass Exposed, ft	7.0
(m)	(2.14)
Heavy Char, ft	13.0
(m)	(3.97)
Surface Char, ft	15.0
(m)	(4.58)
Discoloration, ft	25.0
(m)	(7.63)

ICI AMERICAS
01/15/87 (TEST STARTED AT 10:13 HOURS)
PROJECT NUMBER: 01 1373 114







A FIBERGLASS PANEL: NO. 6301-260

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CHEMISTRY AND CHEMICAL ENGINEERING DIVISION
DEPARTMENT OF FIRE TECHNOLOGY
FAX (210) 522-3377

August 1, 2000

Mr. Michael Stevens
Ashland Chemical, Inc.
5200 Blazer Parkway
Dublin, Ohio 43017

Re: SwRI Project No. 01.03051.01.060a

FINAL REPORT
(Consisting of 2 pages)

Dear Mr. Stevens:

This letter constitutes our final report of tests conducted in general accordance with Boeing Specification Support Standard (BSS) 7239 on a 0.12 in. thick glass reinforced laminate with a gel coat surface identified as Modar FRP panel (Miles Panel #1), received June 6, 2000. The results apply specifically to the specimens tested, in the manner tested, and not to the entire production of these or similar materials, nor to the performance when use in combination with other materials.

The specimen was conditioned in accordance with the standard and testing was performed on June 29, 2000, at Southwest Research Institute (SwRI), located in San Antonio, Texas. Triplicate tests were performed with the pilot flame only. Toxic gas analyses were carried out using colorimetric (Dräger) tubes on the following six gases: carbon monoxide (CO), hydrogen fluoride (HF), hydrogen chloride (HCl), hydrogen cyanide (HCN), nitrogen oxides (NO_x), and sulfur dioxide (SO_2). The results are presented in Table 1 of this report.

If you should have any questions or comments or if I can be of further assistance, please contact me at 210/522-3726. I can also be reached by telefax at 210/522-3726 or electronic mail to lorvis@swri.org.

Sincerely,

A. Leigh Orvis
Research Scientist
Material Flammability Section

Approved by:

Alex B. Wenzel
Director
Department of Fire Technology

ALO/ls
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TABLE 1

BOEING SPECIFICATION STANDARD (BSS) 7239
CONCENTRATION (PPM) AT 4 MINUTES OF TESTING

Client: Ashland Chemical, Inc.
SwRI Project No.: 01.03051.01.060a

Material ID.:* Miles Panel #1
Trade Name:* Modar FRP Panel; Modar 814 resin with ATH and gel coat
Description:* Glass reinforced laminate with a gel coat surface
Color: Gray
Test Date: June 29, 2000

Exposure Mode: With Pilot Flame Only

Type of Gas	Sample No.	Concentration at 4 min (ppm)	Range of Measurement (ppm)
CO	1	100	10 - 3000
	2	100	10 - 3000
	3	100	10 - 3000
HF	1	ND*	1.5 - 15
	2	ND	1.5 - 15
	3	ND	1.5 - 15
HCl	1	1	1 - 10
	2	1	1 - 10
	3	1	1 - 10
HCN	1	ND	2 - 30
	2	ND	2 - 30
	3	ND	2 - 30
NO_x	1	2	2 - 100
	2	2	2 - 100
	3	2.5	2 - 100
SO_2	1	ND	0.5 - 25
	2	ND	0.5 - 25
	3	ND	0.5 - 25

* NOTE: ND = BELOW THE LOWER LIMIT OF THE MEASUREMENT RANGE

SAMPLE MASS:	ORIGINAL	RESIDUAL	MASS LOSS
Run 1	28.81 g	25.07 g	3.74 g
Run 2	27.29 g	22.47 g	4.82 g
Run 3	31.39 g	25.60 g	5.79 g

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DEPARTMENT OF FIRE TECHNOLOGY
FAX (210) 522-3377

ASTM E 162-98
TEST FOR SURFACE FLAMMABILITY
OF MATERIALS USING A RADIANT
ENERGY SOURCE

TEST REPORT
CONSISTING OF 4 PAGES

MATERIAL ID: MILES PANEL NO. 1

Modar 814
75 phr ATH
28% Glass
Gel Coat on Surface

SWRI PROJECT NO.: 01.03048.01.236a
TEST DATE: JUNE 20, 2000
REPORT DATE: JUNE 26, 2000

Submitted by:

A. L. Sauceda MLJ

ANTHONY L. SAUCEDA
ENGINEERING TECHNOLOGIST

Prepared for:

ASHLAND CHEMICALS, INC.
5200 BLAZER PARKWAY
DUBLIN, OHIO 43017

Approved by:

Alex B. Wenzel.

ALEX B. WENZEL
DIRECTOR
DEPARTMENT OF FIRE TECHNOLOGY

INTRODUCTION

This report presents the results of an ASTM E162 test on a specimen submitted by the Client, tested at Southwest Research Institute (SwRI), located in San Antonio, Texas. The test is conducted in accordance with the procedure outlined in ASTM E162-98, "Test for Surface Flammability of Materials Using a Radiant Energy Source."

Test specimens are preconditioned at 140°F for 24 hours followed by stabilization at 70°F and 50-percent relative humidity. The 6 x 18 in. specimen is affixed in a metal frame and the assembly is placed in front of the 12 x 19 in. radiant panel at an inclined angle (30°) --being closer, 4.75 in. at top. A 2 to 3 in. pilot flame impinges on the uppermost area of the specimen and flame propagation advances downward on the specimen. Observations such as dripping, cracking, delamination and distortion are noted and recorded. The Flame Spread Factor ($\mathbf{F_s}$), Heat Evolution Factor ($\mathbf{Q}$) and Flame Spread Index ($\mathbf{I_s}$) are calculated using incremental flame front propagation rates and predetermined radiant panel characterization formulae ($\mathbf{I_s = F_s \times Q}$).

The results apply specifically to the specimens tested, in the manner tested, and not the entire production of these or similar materials, nor to the performance when used in combination with other materials.

This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard of fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.

SUMMARY OF TEST RESULTS
ASTM E162

Client:	Ashland Chemicals, Inc.
SwRI Project No.:	01.03048.01.236a
Material ID.:*	Miles Panel No. 1
Trade Name:*	Modar FRP panel
Description:*	Glass reinforced laminate with a gel coat surface (received on June 6, 2000)
Composition:*	Modar 814 resin with ATH and gel coat
Size:	Four pieces 6.0 x 18.0 in.
Color:*	Grey gel coat surface
Thickness:	0.13 in.
Mounting:	The specimen was removed from the conditioning chamber and wrapped with aluminum foil. The specimen was retained in the holder with a 6 x 18 section of 1 in. hexagonal steel wire mesh placed against the exposed face and backed with 0.5 in. thick Marinite backer board.
Exposure Time:	15 minutes, or until the 15 in. mark and maximum temperatures were reached, whichever occurred first.

* From Client's description

RESULTS

	TEST 1	TEST 2	TEST 3	TEST 4
BASE TEMP °C	217.0	209.0	209.0	209.0
MAX TEMP °C	246.0	238.0	238.0	228.0
DELTA T °C	29.0	29.0	29.0	19.0
TIME (Min:Sec)				
IGNITION	0:09	0:11	0:09	0:14
3"	1:51	1:54	1:52	2:02
6"	3:17	3:19	3:05	3:15
9"	5:51	--	--	--
12"	--	--	--	--
15"	--	--	--	--

SUMMARY OF TEST RESULTS
ASTM E162

Client: Ashland Chemicals, Inc.
SwRI Project No.: 01.03048.01.236a

RESULTS (continued)

	TEST 1	TEST 2	TEST 3	TEST 4	AVERAGE
F_s	2.61	2.21	2.30	2.23	2.34
Q	6.05	6.05	6.05	3.97	5.53
I_s	15.79	13.36	13.91	8.85	12.98

FLAME SPREAD INDEX

AVERAGE: 13
RANGE: 9 to 16

COMMENTS AND OBSERVATIONS

In run 1, there was discoloration to the 12 in. mark and charring to the 9 in. mark. In runs 2 and 4, there was discoloration to the 11 in. mark and charring to the 8 in. mark. In run 3, there was discoloration to the 11.5 in. mark and charring to the 7.5 in. mark. There were no flaming droplets or burning pieces falling onto the floor in any run.

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TEST FOR EVALUATING THE SMOKE GENERATION CHARACTERISTICS OF SOLID MATERIALS - ASTM E662-97/NFPA 258 (FLAMING MODE ONLY)

TEST REPORT
CONSISTING OF 4 PAGES

MATERIAL ID: MILES PANEL #1

SWRI PROJECT NO.: 01.03051.01.061a
TEST DATE: JUNE 28, 2000
REPORT DATE: AUGUST 1, 2000

Submitted by:

A. LEIGH ORVIS
RESEARCH SCIENTIST

Prepared for:

ASHLAND CHEMICAL, INC.
5200 BLAZER PARKWAY
DUBLIN, OHIO 43017

Approved by:

ALEX B. WENZEL
DIRECTOR
DEPARTMENT OF FIRE TECHNOLOGY

INTRODUCTION

This report presents the results of a smoke test (flaming mode only) in accordance with ASTM E 662-97, "Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials," tested at Southwest Research Institute (SwRI), located in San Antonio, Texas. The values for the smoke generation of the material in this report were obtained in strict accordance with the standard procedure. They shall be used solely to define the properties of the described materials when exposed to heat and flames under controlled laboratory conditions. The results shall not be used as measures of smoke hazard under actual fire conditions or for toxicological assessment.

This test method is used to determine the smoke generated by solid materials using a Smoke Density Chamber. Specimens measuring 73 mm x 73 mm are tested in the vertical mode, while exposed to a radiant heat flux of 2.5 watts per square centimeter. Triplicate runs are conducted in each the flaming and nonflaming exposure modes. Results are expressed in terms of Specific Optical Density (D_s), which is defined as the measure of the amount of smoke produced per unit area by a material due to nonflaming pyrolytic decomposition and flaming combustion.

The results apply specifically to the specimens tested, in the manner tested, and not the entire production of these or similar materials, nor to the performance when used in combination with other materials.

SUMMARY OF RESULTS
EXPOSURE: FLAMING
ASTM E 662

Ashland Chemical, Inc.
SwRI Project No.: 01.03051.01.061a

MATERIAL DESCRIPTION

Material ID.:*	Miles Panel #1
Trade Name:*	Modar FRP Panel; Modar 814 resin with ATH and gel coat
Description:	Glass reinforced laminate with a gel coat surface (received June 6, 2000)
Color:	Gray
Thickness:	0.12 in.
Specimen Orientation:	Vertical
Radiant Heat Flux:	2.5 W/cm^2

* From client's material description

SPECIFIC OPTICAL DENSITY (D_s) DURING 20 MINUTES

RUN #	1.5 min	4 min	MAX D_s	Time to MAX D_s (min:sec)	MAX D_s (corrected)
1	79.2	149.3	187.5	10:35	174.7
2	1.3	121.2	177.4	16:15	168.4
3	32.6	160.6	243.1	16:40	232.2
AVERAGE	37.7	143.7	202.7		191.8

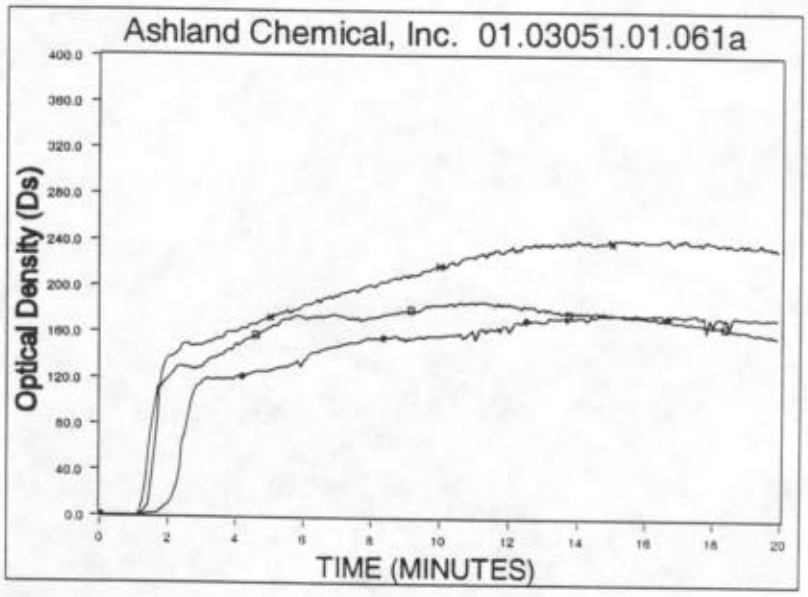
OBSERVATIONS

In run 1, there was ignition at 50 seconds and smoke at 58 seconds. Flames reached the top of the holder at 1 minute 40 seconds. Flaming ceased at 2 minutes 50 seconds, with re-ignition at 3 minutes 40 seconds. Flaming ceased at 4 minutes 10 seconds, with re-ignition at 6 minutes 10 seconds. Final flame was out at 11 minutes 55 seconds. In run 2, there was ignition at 2 minutes 10 seconds and smoke at 1 minute 46 seconds. Flames reached the top of the holder at 2 minutes 20 seconds. Flaming ceased at 16 minutes. In run 3, there was ignition at 39 seconds and smoke at 53 seconds. Flames reached the top of the holder at 1 minute 15 seconds. Flaming ceased at 4 minutes 15 seconds.

SAMPLE WEIGHTS:	ORIGINAL	RESIDUAL	WEIGHT LOSS
Run # 1:	28.29 g	18.92 g	9.37 g
Run # 2:	28.79 g	20.86 g	7.93 g
Run # 3:	28.66 g	18.87 g	9.79 g

EXPOSURE: FLAMING
ASTM E662

Ashland Chemical, Inc.
SwRI Project No.: 01.03051.01.061a



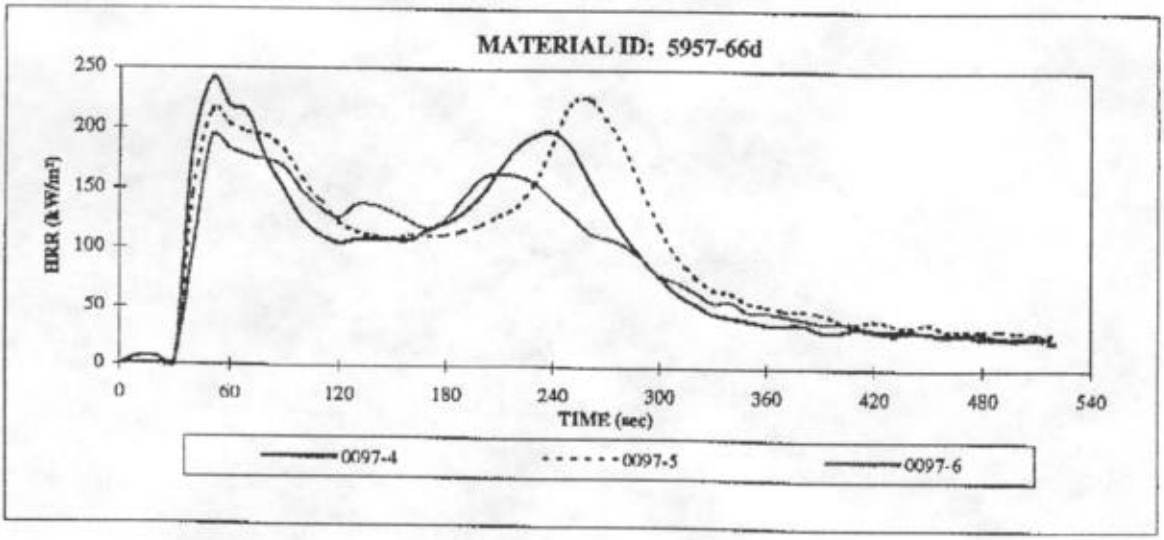
ASTM E 1354-94 CONE CALORIMETER TEST REPORT

Modar 814 with 150 phr ATH

Client:	Ashland Chemical Co.	*Test Date:*	Jan. 9, 1997	*Spark:*	Yes
Material ID:	5957-66d	*Operator:*	B. Covey	*Frame:*	Yes
Orientation:	Horizontal	*Heat Flux:*	100 kW/m²	*Grid:*	No

Test No.	Ignition Time (s)	Peak HRR (kW/m²)	Time to Peak (s)	THR (MJ/m²)	60 s HRR (kW/m²)	180 s HRR (kW/m²)	300 s HRR (kW/m²)
0097-4	40	241	50	47.7	199	152	137
0097-5	42	227	260	54.3	199	149	148
0097-6	43	193	50	46.8	180	154	132
Average	42	220	120	49.6	193	152	139

Test No.	Initial Mass (g)	Final Mass (g)	Mass Loss (g)	Mass Loss (%)	10-90 MLR (g/m²-s)	EHC (MJ/kg)	SEA (m²/kg)
0097-4	62.7	34.8	27.9	44	8.9	17.1	269
0097-5	66.8	35.0	31.8	48	9.3	17.1	327
0097-6	62.3	34.7	27.6	44	8.7	17.0	292
Average	63.9	34.8	29.1	45	9.0	17.1	296



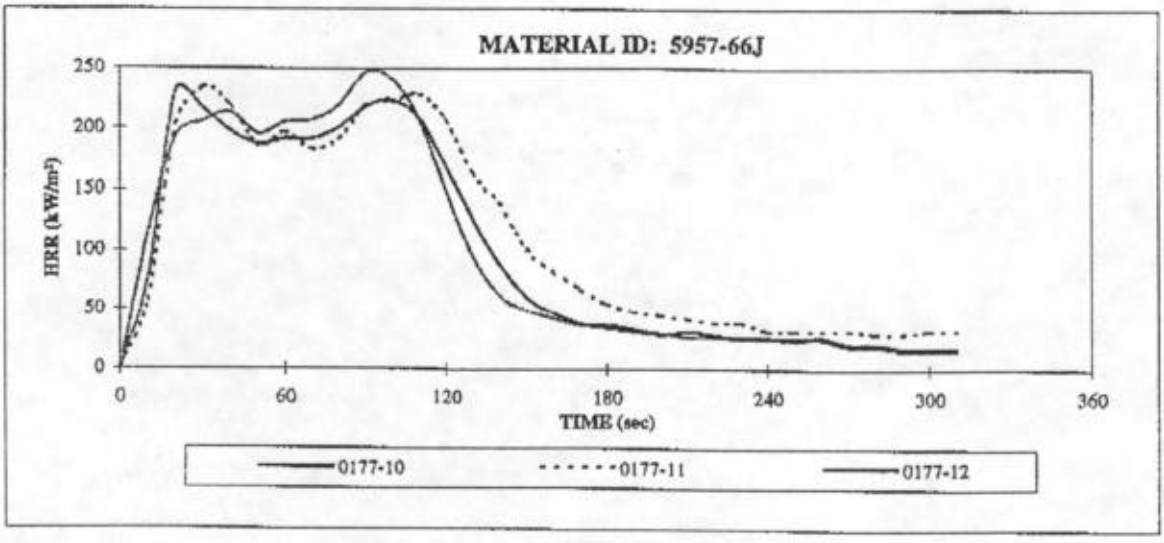
ASTM E 1354-94 CONE CALORIMETER TEST REPORT

Hetron FR992 with 3% Antimony trioxide

Client:	Ashland Chemical Co.	*Test Date:*	Jan. 17, 1997	*Spark:*	Yes
Material ID:	5957-66J	*Operator:*	B. Covey	*Frame:*	Yes
Orientation:	Horizontal	*Heat Flux:*	100 kW/m²	*Grid:*	No

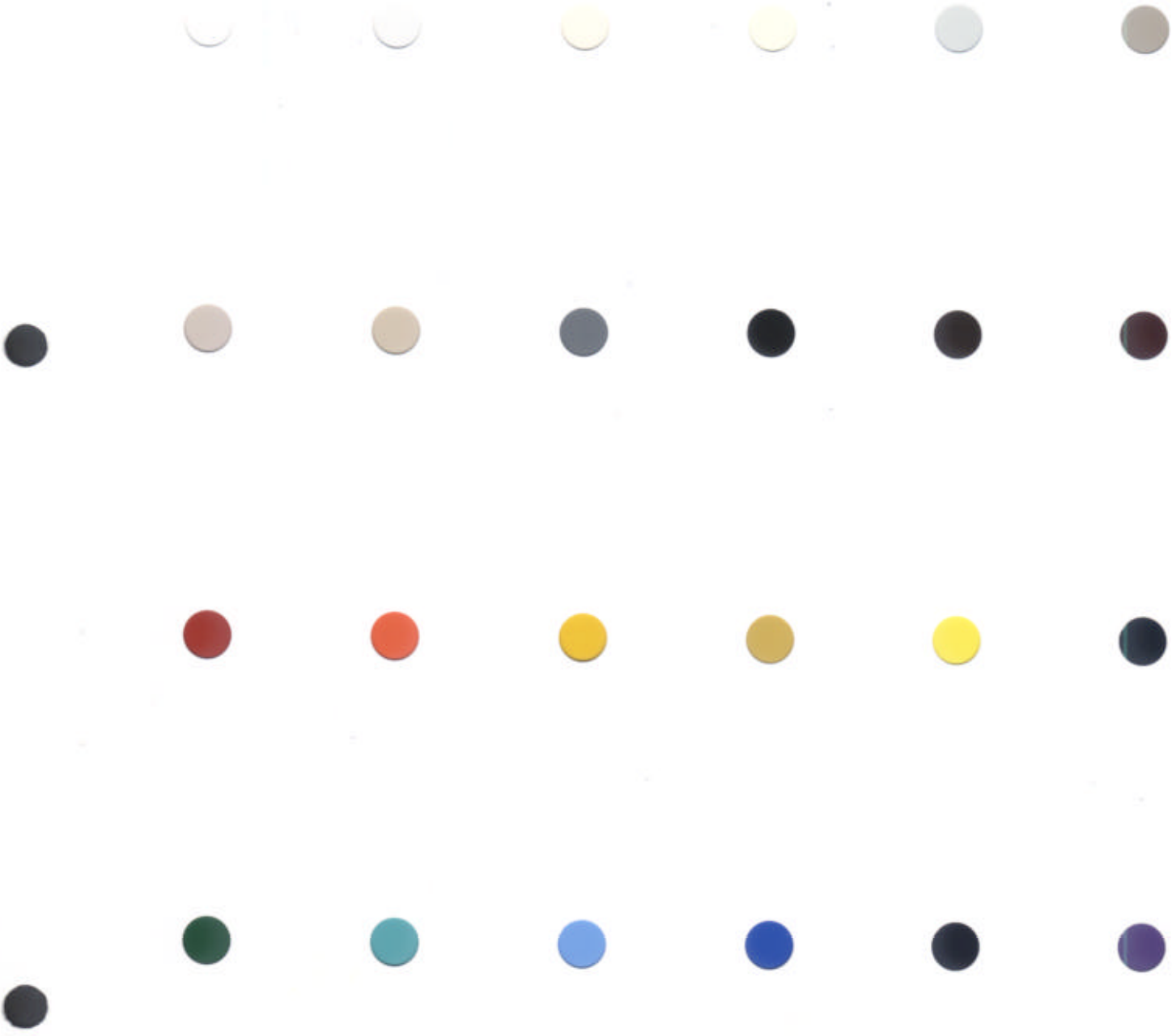
Test No.	Ignition Time (s)	Peak HRR (kW/m²)	Time to Peak (s)	THR (MJ/m²)	60 s HRR (kW/m²)	180 s HRR (kW/m²)	300 s HRR (kW/m²)
0177-10	14	231	20	30.2	206	152	100
0177-11	15	234	30	34.9	210	164	112
0177-12	13	246	90	30.4	208	152	100
Average	14	237	47	31.8	208	156	104

Test No.	Initial Mass (g)	Final Mass (g)	Mass Loss (g)	Mass Loss (%)	10-90 MLR (g/m²-s)	EHC (MJ/kg)	SEA (m²/kg)
0177-10	42.7	18.9	23.8	56	23.8	12.7	2506
0177-11	44.7	19.1	25.6	57	21.1	13.6	2429
0177-12	42.5	18.5	24.0	56	26.2	12.6	2397
Average	43.3	18.8	24.5	56	23.7	13.0	2444



Ultra™ SuperShield™

High Performance Gelcoats for Polyester Molding



FERRO

GENERAL COMPOSITION

Using special processing methods, FERRO combines high quality pigments, additives and reinforcements with unsaturated polyester and proprietary low-VOC polyester resin vehicles to create a line of gelcoats with outstanding properties. On the surface, these products provide an effective barrier to chemicals, abrasion, impact, and sunlight. Equally important is that mechanical properties of these gelcoats are virtually identical to resin/fiberglass substrates resulting in composites with the integrity of a monolithic structure.

FERRO gelcoats are available in a range of viscosities, and are engineered for easy application. Because their rheological behavior is thixotropic, viscosity varies in accordance with the rate of application; when applied at high speed, the gelcoats flow and blend readily, but return to a highly viscous state once they are allowed to remain still. As a result, the material does not sag—even on vertical surfaces—when applied at recommended thicknesses.

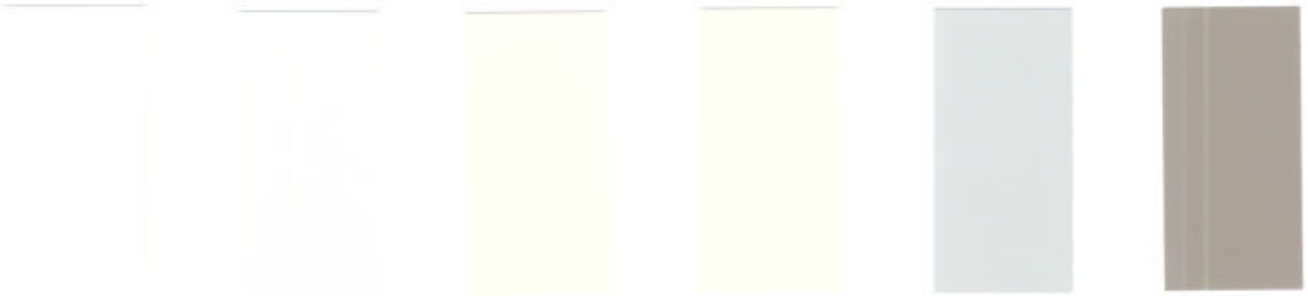
STANDARD COLORS

Standard gelcoat colors shown below are maintained in stock and are available for immediate shipment (see previous page for colors of sandable and tooling gelcoats).

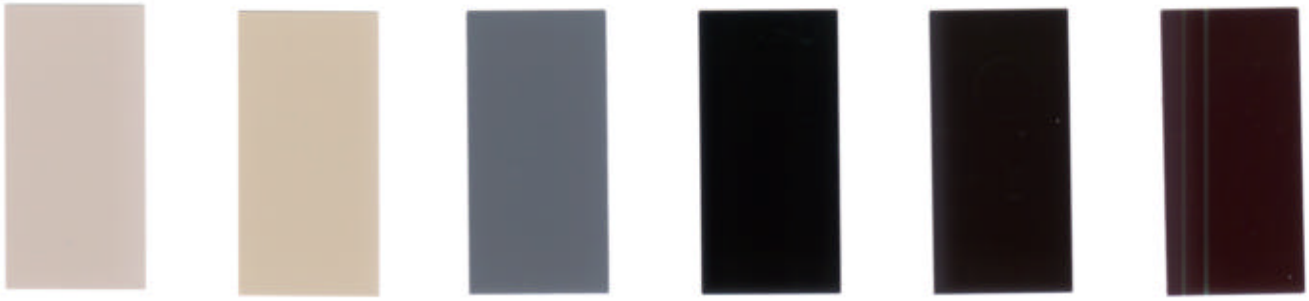
In addition, an entire spectrum of custom colors is available on short notice.

Using the latest in computerized color-matching, Ferro can duplicate your sample color, match OSHA, Munsel, Federal Standard 595 or Pantone color standards, or create special-effect gelcoats including translucent, pearlescent, and granite colors.

All orders are matched to Ferro standards, or the retain of your approved, custom gelcoat, ensuring identical reproduction from order-to-order.



WHITE | ARCTIC WHITE | OFF WHITE | LIGHT CREAM | LIGHT GRAY | DARK BEIGE



LIGHT BEIGE | BEIGE | BATTLESHIP GRAY | BLACK | DARK BROWN | MAROON

RED | ORANGE | SUNFLOWER | MUSTARD | YELLOW | DARK SEAWEED

GREEN | SEAFOAM | SKY BLUE | OCEAN BLUE | MIDNIGHT BLUE | VIOLET

Ultra™
GELCOATS

ULTRA™ 1-NPG and ULTRA™ PLUS-NPG/ISO GELCOATS

These gelcoats are suited for a broad range of high quality, open-mold lay-up applications including: boats/yachts, swimming pools, sanitaryware, sinks, recreational vehicles, commercial/ mass transit vehicles, and industrial components.

Ultra™ 1-NPG gelcoat utilizes a proprietary, low viscosity, unsaturated polyester resin vehicle containing a high level of neopentyl glycol (NPG), while **Ultra™ Plus-NPG/ISO** gelcoat utilizes an isophthalic, acid-based unsaturated polyester resin vehicle.

While the relative advantages of NPG- and ISO-based resins vary by application and molder preferences, NPG resin is considered to offer the greatest shelf stability, ease of application and ease of repair; ISO resin the greatest chemical and water/osmosis resistance. (Please note that characteristics of the base resin can differ significantly from that of the final gelcoat formulation.)

Both Ultra 1-NPG and Ultra Plus NPG/ISO gelcoat offer the complete range of features you require of a high performance gelcoat:

- Shelf stability
- Ease of application
- Color consistency
- Crack resistance
- Flexural strength
- Water/osmosis resistance
- Tear resistance
- Chemical resistance
- UV light stability
- Long term durability

UltraLowVOC™
GELCOAT

UltraLowVOC™ gelcoat incorporates the same premium ingredients as standard ULTRA gelcoat, with a proprietary polyester resin vehicle produced using an entirely new molecule patented by FERRO. This breakthrough formulation provides the same long-term, post-cure performance as standard Ultra gelcoat, while dramatically improving in-plant molding operations as follows:

- *50 PERCENT REDUCTION IN STYRENE EMISSIONS*

  Not merely a gelcoat reformulation with lower VOCs and higher viscosity, UltraLowVOC gelcoat cuts styrene emissions in half, improving worker safety and helping to comply with EPA and OSHA requirements.

- *UP TO 60 PERCENT LESS SHRINKAGE*

  UltraLowVOC gelcoat exhibits ASTM D955 shrinkage ratings of 30 to 60 percent less than gelcoats using conventional unsaturated polyester base resins. Reduced shrinkage virtually eliminates pre-release problems, while higher yield allows dramatic reductions in both spraying time and the amount of gelcoat purchased.

- *LESS OVERSPRAY AT EQUIVALENT VISCOSITIES*

  Spray patterns are more easily controlled, with less overspray waste and greater affinity to the tooling surface, while maintaining the same gelcoat viscosity to which you are accustomed.

UltraShield™
HIGH PERFORMANCE GELCOAT

UltraShield™ high performance gelcoat utilizes the same polyester resin vehicle as Ultra 1-NPG gelcoat—a proprietary, low viscosity, unsaturated polyester resin vehicle containing a high level of neopentyl glycol (NPG) offering excellent shelf stability, ease of application and ease of repair. In addition, it incorporates a new generation of high performance ingredients that set new standards for the two most important criteria by which gelcoats are judged: initial gloss and long term durability.

- *100 TO 217 PERCENT INCREASE IN GLOSS AND COLOR RETENTION*

  After 1000 hours in Xenon arc weatherometer tests, UltraShield gelcoat retains 80 to 95 percent of its original gloss—compared with 30 to 40 percent for conventional gelcoat—while demonstrating superior color retention, including greater resistance to yellowing.

SuperShield™
LOW-VOC PREMIUM GELCOAT

The very latest in FERRO's long line of gelcoat advances, SuperShield™ gelcoat utilizes the same patented polyester resin vehicle as UltraLowVOC gelcoat, offering 50 percent reductions in styrene emissions, 60 percent reductions in shrinkage, and reduced overspray at equivalent viscosities.

In addition, SuperShield gelcoat incorporates the same super-performance pigments and additives as UltraShield high performance gelcoat, increasing gloss and color retention by 100 to 217 percent over that of conventional gelcoats.

In the plant, on your mold, and in the field, SuperShield gelcoat offers you a level of performance unavailable with any other formulation available today.

UltraSandable™
GELCOAT

UltraSandable™ 1-SP gelcoat for resin transfer molding (RTM) and other applications is an ideal surface for all secondary-finishing operations. A high level of neopentyl glycol (NPG) and other high quality ingredients, together with refined processing methods, result in an easy-to-sand finish having desirable properties:

- Shelf stability
- Ease of application
- Excellent sandability
- Excellent paint adhesion
- Crack resistance
- Chemical resistance
- Long term durability

UltraSandable gelcoats are available in black and gray as standard. Please consult Ferro for product numbers, which vary by application. Custom colors are available on special order.

UltraPatch™
PATCH BOOSTER

UltraPatch™ patch booster is an additive that significantly improves the application, appearance and longevity of gelcoat patches. Not a conventional thinner or solvent, it offers:

- Faster cure
- Harder patch
- Superior gloss
- Superior color match
- Less halo
- Long-term durability

UltraPatch patch booster also eliminates the need to thin, side-promote, or add wax to gelcoat prior to patching.

UltraTooling™
GELCOAT

UltraTooling™ gelcoat for mold making offers:

- High gloss
- Excellent abrasion resistance
- Excellent solvent resistance
- Superior hardness
- Exceptional craze resistance
- Minimum distortion

To contrast with production gelcoat color(s), tooling gelcoat is offered in black, gray, green and tangerine. Available in standard and heavy-metal-free formulations.

UltraClear™
GELCOAT

For marine metal flaking and sanitaryware such as cultured marble and onyx, UltraClear™ gelcoat offers a comprehensive range of benefits:

- Extreme clarity
- Hydrolytic stability
- UV light stability
- Shelf stability
- Crack resistance
- Chemical resistance
- Long term durability

UltraClear gelcoat is used to enhance and protect the color finish as well as provide a deep, crystal-clear, non-yellowing top coat for metal flake finishes and sanitaryware. It is compatible with all FERRO gelcoats covered in this brochure. Please consult FERRO for product numbers, which vary by application.

FERRO®

TYPICAL UNCURED PROPERTIES

(based on 1.5% MEKP)

	Ultra 1-NPG	Ultra Plus-NPG/ISO	Ultra LowVOC	UltraShield NPG	SuperShield Low-VOC	Ultra Sandable 1-SP	Ultra Tooling	Ultra Clear
Gel time (minutes)*	10-14	8-12	8-14	12-16	9-16	8-12	12-16	7-9
Gel to peak (minutes)	15-20	12-18	5-12	14-22	8-14	10-18	14-22	12-18
Viscosity @ 77°F (LVF #4 @ 60 rpm-cps)	2300-2900	2300-2900	1900-3100	2300-2900	1900-3100	2300-2900	2000-2600	1900-2100
Thix index (6/60)	5.0-7.0	4.5-6.5	4.0-6.0	4.5-6.5	4.0-6.0	5.0-7.0	5.0-7.0	5.0-7.0
Weight/gal. (lbs.)	9.0-11.5	9.0-11.5	9-11	9.0-11.5	10.5-11.5	9.0-11.5	9.5-10.0	9.0-9.5
Stability @ 150°F (days minimum)	5	5	5	5	5	5	5	5
Hegman grind (minimum)	4	4	4	4	4	4	4	5
Film cure @ 77°F (minutes)	40-60	40-60	60-180	60-80	60-180	40-60	40-60	50-70
Coverage @ 20 mils, wet, (sq.ft./gal.)**	80	80	90	80	90	80	80	80
Hide @ 15 mils, wet	Complete	Complete	Complete	Complete	Complete	Complete	Complete	N/A
Patchability (Ferro UltraPatch patch booster recommended)	Good	Good	Good	Good	Excellent	N/A	Good	N/A
Sag resistance (mils)	25-30	25-30	25-30	25-30	25-30	25-30	25-30	20-25

*Gel time to your specifications within parameters required to maintain product integrity.

**Actual transfer efficiency is affected by overspray, shrinkage, and heat transfer.

M-0817

FERRO CORPORATION

Liquid Coatings and Dispersions Division

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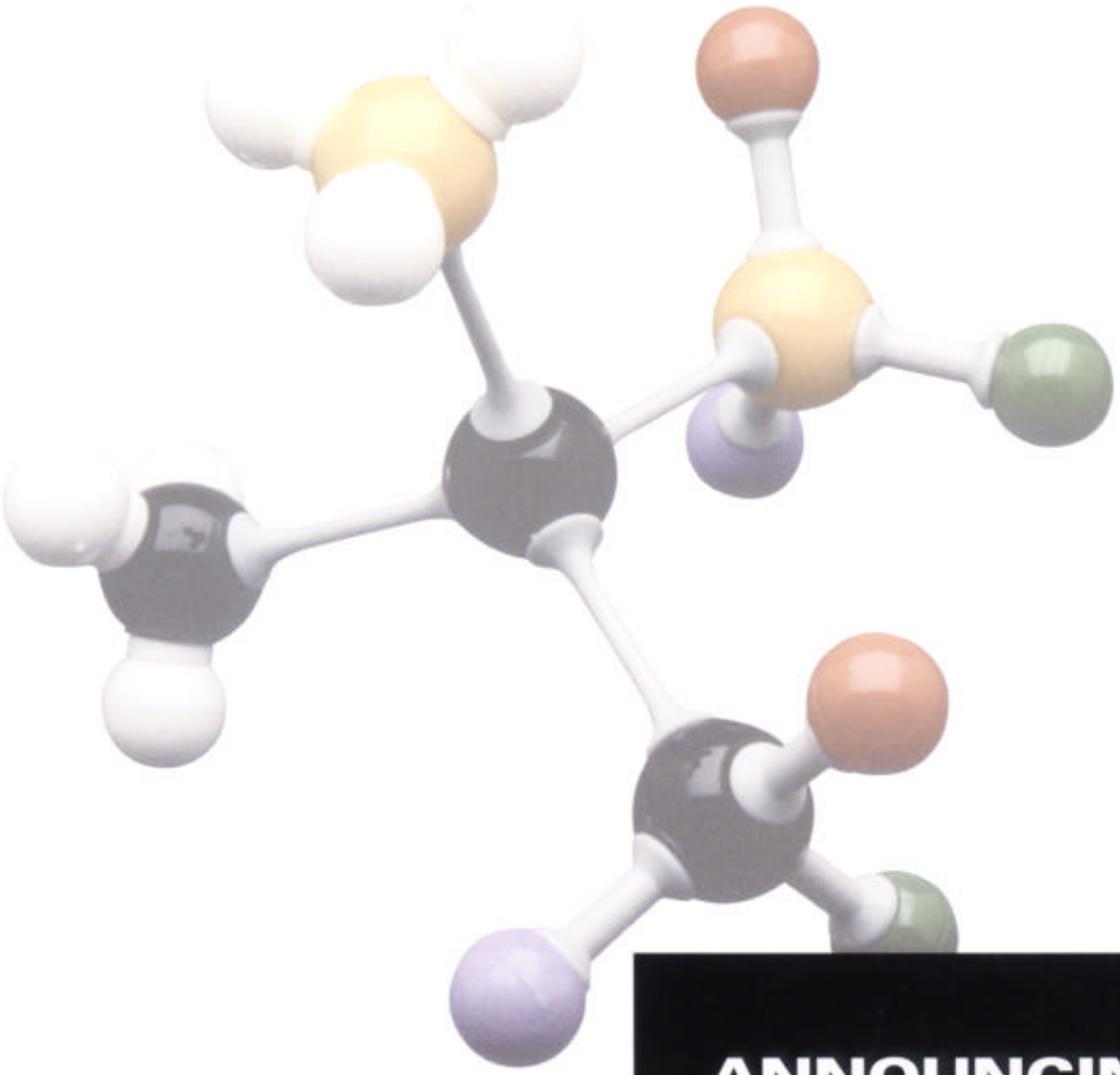
FERRO

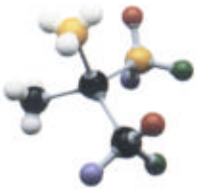


ANNOUNCING THE MOST IMPORTANT DEVELOPMENT IN THE HISTORY OF GELCOAT


From the FERRO laboratories comes a
30 mL
20
10
30 mL
20
10
©1998 Ferro Corporation

breakthrough in gelcoat technology:

SuperShield™
HIGH YIELD GELCOAT



An entirely new molecule creates a superior class of gelcoats with important advantages never before available to the reinforced processor:

UP TO 60 PERCENT LESS SHRINKAGE THAN CONVENTIONAL GELCOATS

SuperShield high yield gelcoat exhibits ASTM D955 ratings of 30 to 60 percent less shrinkage than conventional gelcoats. Such higher yields allow dramatic reductions in both spraying time and the amount of gelcoat you purchase.

SIGNIFICANTLY LESS OVERSPRAY AT EQUIVALENT VISCOSITIES

Gelcoats comprised of the new SuperShield molecule exhibit outstanding rheology for spray applications. Spray patterns are more easily controlled, with less overspray waste and greater affinity to the tooling surface—while maintaining the same gelcoat viscosity to which you are accustomed.

100 TO 217 PERCENT INCREASE IN GLOSS AND COLOR RETENTION

After 1000 hours in Xenon arc weatherometer tests, SuperShield high yield gelcoat retains 80 to 95 percent of its original gloss—compared with 30 to 40 percent for conventional gelcoats—while demonstrating superior color retention, including greater resistance to yellowing.

50 PERCENT REDUCTION IN STYRENE EMISSIONS

Not merely a gelcoat reformulation with lower VOCs and higher viscosity, SuperShield high yield gelcoat is an entirely new generation of gelcoat at the molecular level. Gone forever are approximately half of the styrene emissions that lessen the effective amount of material purchased, endanger the health of workers, and come under the increasingly intense scrutiny of the EPA and OSHA.

MECHANICAL PROPERTIES EQUIVALENT TO PREMIUM GRADES OF CONVENTIONAL GELCOAT

For all of the advantages of SuperShield high yield gelcoat, you give up nothing; it provides the same mechanical properties you would expect from the highest grades of conventional gelcoat available including: exceptional crack resistance, flexural strength, water/osmosis resistance, tear resistance, chemical resistance, long-term shelf stability, and long-term durability.

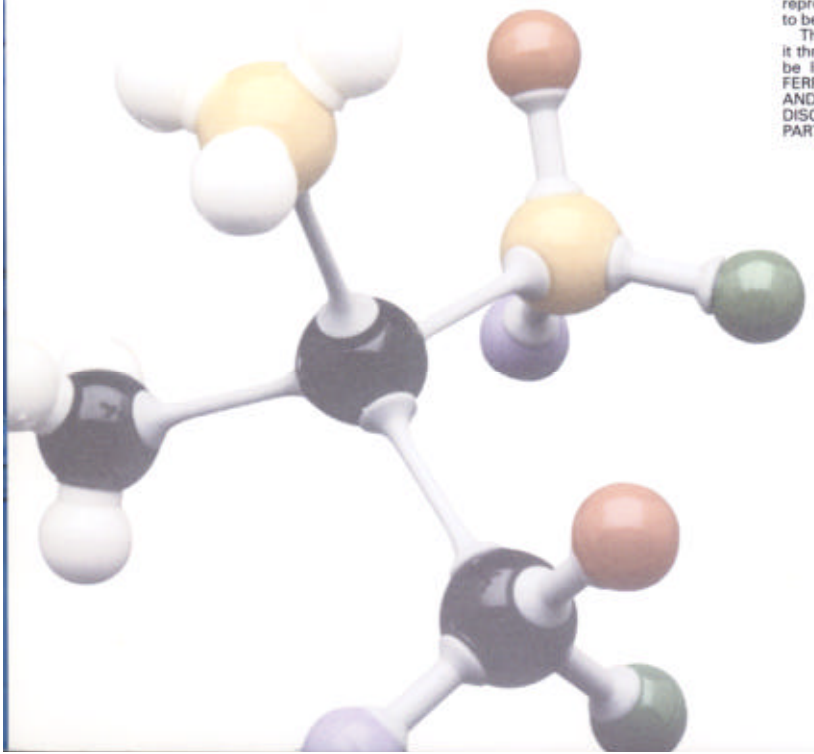
Imagine: revolutionary improvements in quality, productivity, plant hygiene, and bottom line profit—by simply switching your gelcoat. For technical data, personal assitance, and free trial information on SuperShield high yield gelcoat, contact your FERRO representative today.

FERRO®

SuperShield™
HIGH YIELD GELCOAT

SuperShield high yield gelcoat versus standard gelcoat:

specifications:			
PROPERTY	**ASTM METHOD**	**SUPERSHIELD HIGH YIELD GELCOAT**	**STANDARD GELCOAT**
Static Styrene Emission g/m²/hr	Rule 1162	57.0	110.0
Reduction of Styrene Emission	Rule 1162	53.0	Control
Gloss Retention WOM 1000 hours	ASTM G26	90.0%	35.0%
DE (CieLAB) WOM 1000 hours	ASTM G26	0.60	1.30
% Elongation (flex mode)	ASTM D790	2.25	1.46
% Elongation at break (tensile strength mode)	ASTM D638	0.90	.58
Shrinkage Reduction % of 12" Bar	ASTM D955	50.00	Control
Warpage inches on 12"Bar	ASTM D955	0.035	0.658
WVTR g/m²/day @ 28 mils	ASTM E96	6.13/3.15	6.04/3.18



For a technical literature kit contact:

FERRO CORPORATION
Liquid Coatings and
Dispersions Division
1301 North Flora Street
Plymouth, IN 46563
Tel: 219-935-5131, ext. 2508
Fax: 219-935-5278

FERRO

Premium gelcoat shields against U.V. extremes

"ULTRA SHIELD NPG" gelcoat has been developed by Ferro to withstand the most extreme weathering conditions, offering a higher level of U.V. resistance, flexural strength, and gloss retention than any gelcoat produced to date by the Company. The formulation also provides: exceptional water/osmosis resistance, crack and tear resistance, chemical resistance, shelf stability, ease of application, and ease of repair comparable to the "ULTRA 1-NPG" high performance gelcoat on which it is based.

Free videos help gelcoat professionals solve application problems

Two free videos show advanced and intermediate gelcoaters how to prevent and cure the most common gelcoat problems. Topics covered include:

- Selection of spray equipment
- Calibrating gelcoat/catalyst ratios
- Compensating for processing variables
- Mold preparation do's and don'ts
- Preventing wrinkling, porosity, crazing, cracking, runs/sags, and inconsistent thicknesses
- Spraying technique do's and don'ts
- Eliminating air voids, surface scratches, stress cracks, holes, and punctures
- Re-gelling problem spots
- Patching of textured surfaces
- Detailing of repaired surfaces

Gelcoat/ catalyst calibration

As a refresher course or a step-by-step training aid, these videos can help you and your personnel produce better looking, longer lasting gelcoats, in less time, at higher profit margins.

Fiberglass puncture repair

For free videos call: 219-935-5131 ext. 2650#

FERRO CORPORATION
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FERRO

Sandable gelcoat is easy to handle, finish

Ferro's "ULTRA 1-SP" sandable gelcoat for resin transfer molding (RTM) applications contains a high level of neopentyl glycol (NPG) and other premium additives to impart a range of desirable characteristics: extended shelf stability, easy application, excellent sandability/paintability, resistance to chemicals and cracking, and long term durability.

Tooling gelcoat resists abrasion

Specially formulated for moldmaking, Ferro's "ULTRA TOOLING GELCOAT" exhibits high gloss and minimum distortion/shrinkage together with exceptional craze resistance and hardness (Barcol Hardness: 45 min. 1/8" Casting Model 934-1 after 48 hrs.). Available in white, black, gray, and tangerine to contrast with production gelcoat colors.

Low-VOC gelcoat retains properties

A "LOW-VOC GELCOAT" introduced by Ferro reduces styrene emissions by 40 to 60 percent, improving workplace safety while retaining excellent chemical and physical properties. Based on a newly developed proprietary base resin, the low-VOC formulation offers exceptional sprayability and ease of handling, and develops a tack-free film rapidly for easier processing.

ULTRA PATCH BOOSTER

ULTRA™

GELCOATS

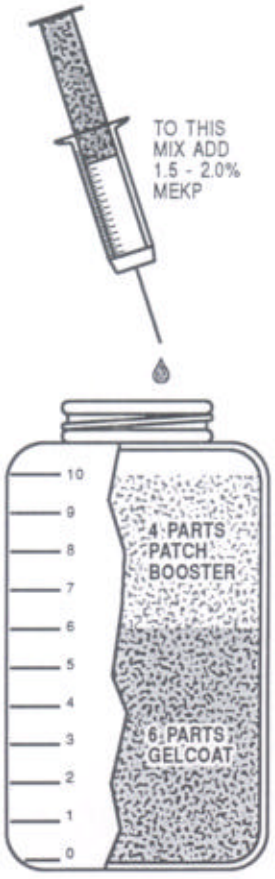
ULTRA Patch Booster is an additive for gelcoats that significantly improves the application, appearance, and longevity of gelcoat patches. Not a conventional thinner or solvent, it offers:

- *Faster cure*
- *Harder patch*
- *Superior gloss*
- *Consistent cold weather performance*
- *Superior color match*
- *Less halo*
- *Unsurpassed long term weatherability*

ULTRA Patch Booster also eliminates the need to thin, side-promote, or add wax to gelcoats prior to patching.

APPLICATION GUIDELINES

1. *Mix Patch Booster thoroughly.*
2. *The recommended ratio mix is 4 parts of Patch Booster to 6 parts of gelcoat. To this mix add 1.5% to 2% MEKP. Mix and spray.*
3. *The acceptable method for measuring small quantities of MEKP is with a syringe.*
4. *Even a thin sprayed layer will be ready to sand in approximately one hour and hard enough to buff soon thereafter.*
5. *Care must be taken not to over or under catalyze, which may affect color.*
6. *Working time is approximately 5 minutes.*



PLEASE NOTE:

This is an accelerated formulation with a limited shelf life of 30 days.

FERRO CORPORATION
Liquid Coatings and
[illegible]ersion Division

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Ferro Industrial Products Ltd.
8390-124th Street
Surrey, British Columbia
Canada V3W 3X9
Tel: 604-596-7138
Fax: 604-594-0813

FERRO

ULTRA™ GELCOATS

COLOR SELECTION GUIDE

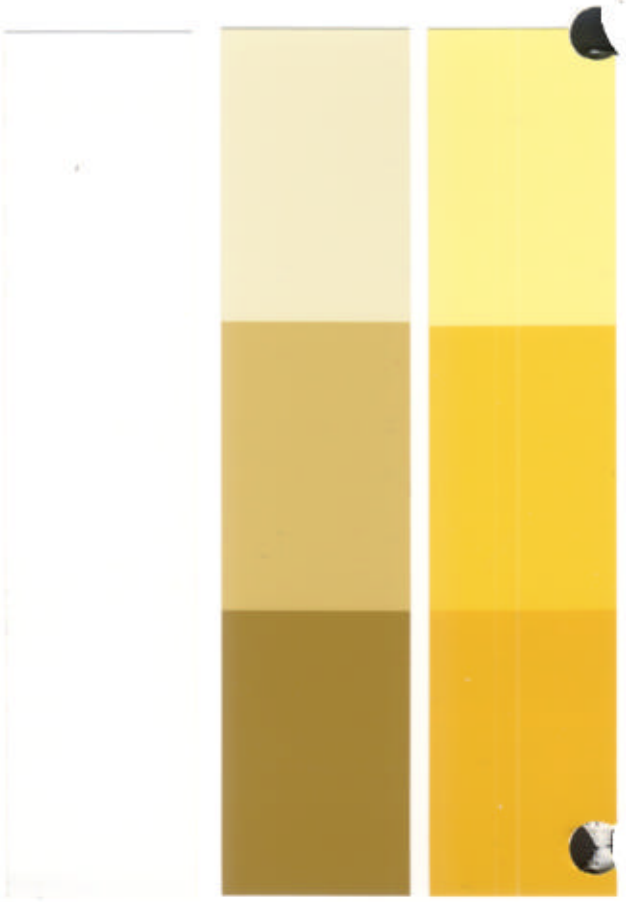
FERRO

- **ULTRA 1-NPG GELCOAT**
- **ULTRA PLUS-NPG/ISO GELCOAT**
- **ULTRA SHIELD-NPG GELCOAT**

STANDARD COLORS AT RIGHT
Standard colors are maintained in stock for ULTRA 1-NPG, ULTRA PLUS-NPG/ISO and ULTRA SHIELD-NPG gelcoats, and are available for immediate shipment.

CUSTOM COLORS
An entire spectrum of custom colors is available on short notice. Using the latest in computerized color-matching, Ferro can duplicate your sample color, match OSHA, Munsel, Federal standard 595 or Pantone color standards, or create special-effect gelcoats including translucent, pearlescent and granite colors.

All orders are matched to Ferro standards or the retain of your approved, custom gelcoat ensuring identical reproduction from order-to-order.



COLOR SHADES:	WHITE	YELLOW	YELLOW
LIGHT	N/A	998	907
MEDIUM	N/A	997	906
DARK	N/A	996	905

ULTRA 1-SP SANDABLE GELCOAT

Sandable gelcoats are available in black and gray as standard. Please consult Ferro for product numbers, which vary by application. Custom colors are available on special order.

ULTRA TOOLING GELCOAT

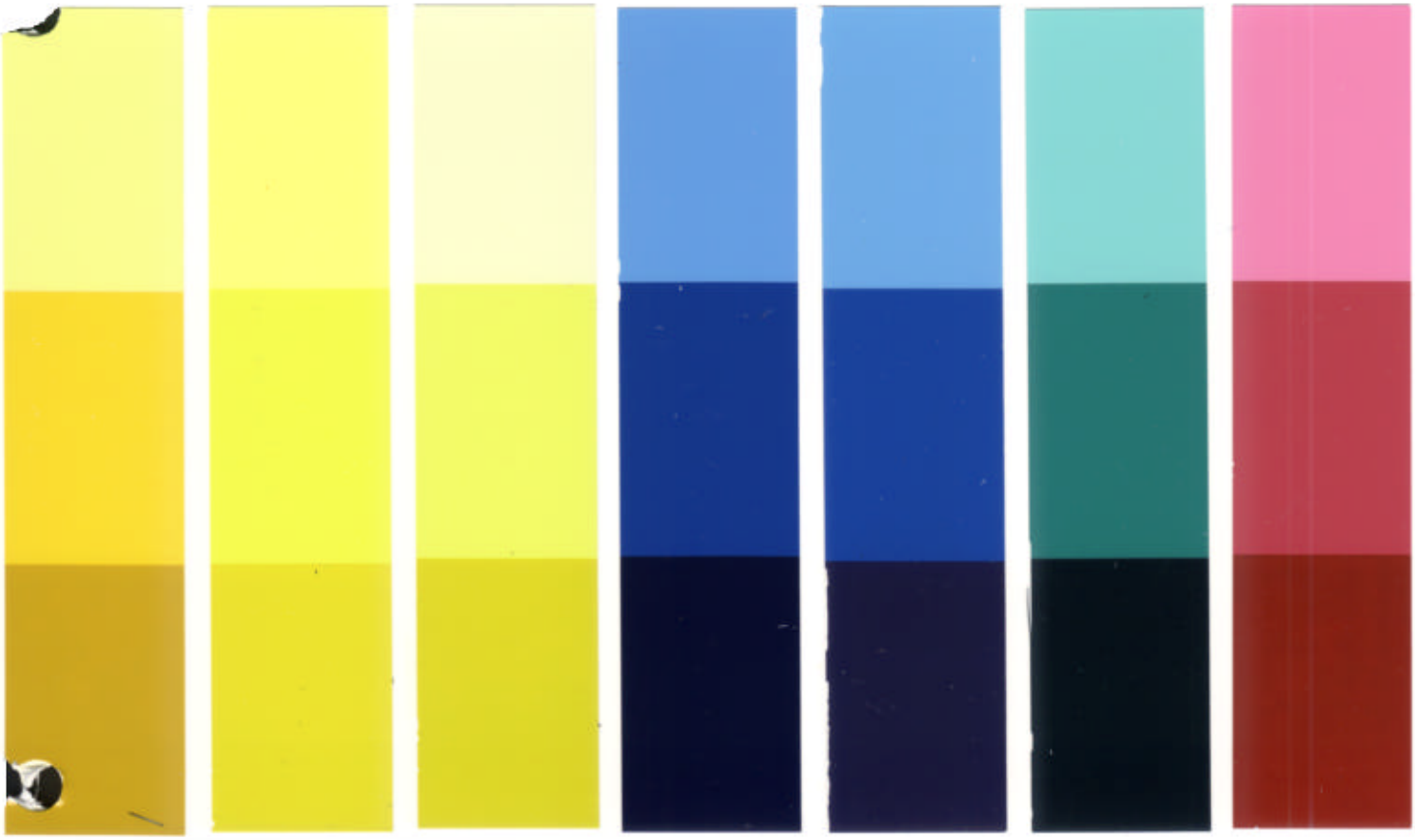
To contrast with production gelcoat color(s), tooling gelcoats are offered in black (#GV01767), gray (#GV01768), green (#GV44602) and tangerine (#GV03894).

ULTRA CLEAR GELCOAT

Clear gelcoat is compatible with ULTRA 1-NPG and ULTRA PLUS-NPG/ISO gelcoats, and is used to enhance and protect the color finish as well as provide a deep, crystal-clear, non-yellowing top coat for metal flake finishes. Please consult Ferro for product numbers, which vary by application.

GENERAL COMPOSITION

Ferro combines high quality pigments, additives and reinforcements in an unsaturated polyester resin using special processing methods to create a line of gelcoats with outstanding properties. On the surface, these products provide an effective barrier to chemicals, abrasion, impact and sunlight. Equally important, however, is that Ferro gelcoats offer mechanical properties which are virtually identical to resin/fiberglass substrates resulting in composites with the integrity of a monolithic structure.



YELLOW	YELLOW	YELLOW	BLUE	BLUE	GREEN	RED
901	904	910	274	277	613	880
900	903	909	273	276	612	879
999	902	908	272	275	611	878

Ferro gelcoats are available in a range of viscosities and are engineered for easy application. Because their rheological behavior is thixotropic, viscosity varies in accordance with the rate of application; when applied at high speed, the gelcoats flow and blend readily, but return to a highly viscous state once they are allowed to remain still. As a result, the material does not sag—even on vertical surfaces—when applied at recommended thicknesses.

RED	RED	ORANGE	BROWN	BROWN	BLACK	BLACK
886	883	877	107	104	702	704
885	882	876	106	103	701	703
884	881	875	105	102	763	757

FERRO

ULTRA 1-NPG, ULTRA PLUS-NPG/ISO AND ULTRA SHIELD-NPG GELCOATS

These three gelcoats are ideal for a wide variety of open-mold hand lay-up applications, including: boats/yachts, swimming pools, sanitaryware, sinks, recreational vehicles, commercial/mass transit vehicles and industrial components.

ULTRA 1-NPG gelcoat utilizes a proprietary low viscosity vehicle containing a high level of neopentyl glycol (NPG) resin, while ULTRA PLUS-NPG/ISO gelcoat utilizes an isophthalic acid-based NPG resin system.

While the relative advantages of NPG- and ISO-based resins vary by application and molder preferences, NPG resin is considered to offer the greatest shelf stability, ease of application and ease of repair; ISO resin the greatest chemical and water/osmosis resistance. However, please note that characterisitics of base resin can differ significantly from that of the final gelcoat formulation.

Both ULTRA 1-NPG and ULTRA PLUS-NPG/ISO gelcoats combine superior ingredients to optimize every feature you look for in gelcoat:

- Shelf stability
- Easy application
- Color consistency
- Crack resistance
- Flexural strength
- Water/osmosis resistance
- Tear resistance
- Chemical resistance
- UV light stability
- Long-term durability

For end products exposed to extreme weathering conditions, ULTRA SHIELD-NPG offers an added measure of UV resistance and flexural strength, while maintaining a high gloss finish.

For marine anti-fouling applications, Ferro also offers COPPERCLAD® anti-fouling coatings with high copper content, eliminating the need for bottom paint in many applications.

ULTRA 1-SP SANDABLE GELCOAT

ULTRA 1-SP sandable gelcoat for resin transfer molding (RTM) applications is an ideal surface for all secondary finishing operations. A high level of neopentyl glycol (NPG) and other high quality ingredients, together with refined processing methods, result in an easy-to-sand finish with ideal properties:

- Shelf stability
- Easy application
- Excellent sandability
- Excellent paint adhesion
- Crack resistance
- Chemical resistance
- Long-term durability

ULTRA TOOLING GELCOAT

ULTRA tooling gelcoat for mold-making offers:

- High gloss
- Excellent abrasion resistance
- Excellent solvent resistance
- Superior hardness
- Exceptional craze resistance
- Minimum distortion

CATALYZATION
9% active oxygen MEKP @ 23°C

CURED GELCOAT
(Barcol Hardness 1/8" Casting Model 934-1, after 48 hrs., 45 min.)

ULTRA CLEAR GELCOAT

For marine metal flaking and sanitaryware, such as cultured marble and onyx, ULTRA clear gelcoat offers a comprehensive range of benefits:

- Excellent clarity
- Hydrolytic stability
- UV light stability
- Shelf stability
- Crack resistance
- Chemical resistance
- Long-term durability

TYPICAL UNCURED PROPERTIES
(based on 1.5% MEKP)

	ULTRA 1-NPG	ULTRA PLUS-NPG/ISO	ULTRA SHIELD-NPG	ULTRA 1-SP SANDABLE	ULTRA TOOLING	ULTRA CLEAR
Gel time (minutes)*	10-14	8-12	12-16	8-12	12-16	7-9
Gel to peak (minutes)	15-20	12-18	14-22	10-18	14-22	12-18
Viscosity @ 77°F (LVF #4 @ 60 rpm-cps)	2300-2900	2300-2900	2300-2900	2300-2900	2000-2600	1900-2100
Thix index (6/60)	5.0-7.0	4.5-6.5	4.5-6.5	5.0-7.0	5.0-7.0	5.0-7.0
Weight/gal. (lbs.)	9.0-11.5	9.0-11.5	9.0-11.5	9.0-11.5	9.5-10.0	9.0-9.5
Stability @ 150°F (days minimum)	5	5	5	5	5	5
Hegman grind (minimum)	4	4	4	4	4	5
Film cure @ 77°F (minutes)	40-60	40-60	60-80	40-60	40-60	50-70
Approx. coverage (sprayed @ 20 mils, wet, sq.ft./gal.)**	80	80	80	80	80	80
Hide @ 15 mils, wet	Complete	Complete	Complete	Complete	Complete	N/A
Patchability (Ferro patch booster recommended)	Good	Good	Good	N/A	Good	N/A
Sag resistance (mils)	25-30	25-30	25-30	25-30	25-30	20-25

*Gel time to your specifications within parameters required to maintain product integrity.
**Actual transfer efficiency is affected by overspray, shrinkage, and heat transfer.

FERRO

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Plastics Manufacturing Locations Worldwide

NORTH AMERICA

UNITED STATES
Edison, New Jersey
Evansville, Indiana
S. Plainfield, New Jersey
Stryker, Ohio

EUROPE

FRANCE
Fosses
St. Dizier

HOLLAND
Rotterdam

PORTUGAL
Lisbon

SPAIN
Castellon

UNITED KINGDOM
Aldridge, England

ASIA AND PACIFIC

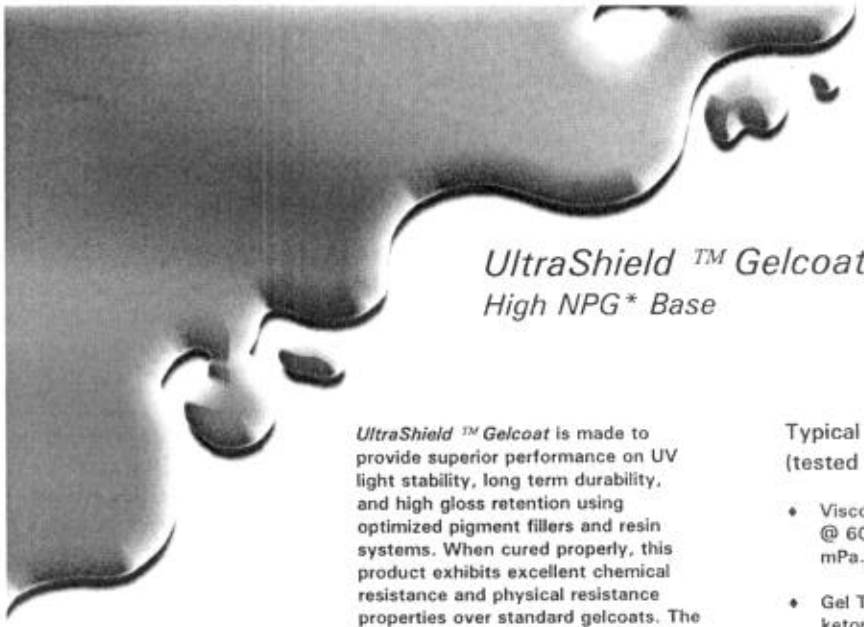
AUSTRALIA
Rockdale

LATIN AMERICA

MEXICO
Mexico, D.F.

VENEZUELA
Valencia

FERRO



UltraShield ™ Gelcoat

High NPG Base*

GELCOATS FOR REINFORCED PROCESSING

UltraShield ™ Gelcoat is made to provide superior performance on UV light stability, long term durability, and high gloss retention using optimized pigment fillers and resin systems. When cured properly, this product exhibits excellent chemical resistance and physical resistance properties over standard gelcoats. The product has excellent sprayability as well as a tack-free film cure for faster and trouble-free processing. UltraShield ™ Gelcoat is designed for application using airless spray equipment. Allow to cure for approximately 60-80 minutes prior to subsequent manufacturing steps. Elevated temperatures may permit quicker cycle times, but need to be determined in the individual operation. Please discuss your specific needs with your Ferro Sales Representative.

Typical Product Properties (tested at 25• C (77•F)

- Viscosity (Brookfield LVF#4 @ 60 RPM) – 2000-2900 mPa.s
- Gel Time (1.5% methyl ethyl ketone peroxide) – 12-16 minutes
- Cure Time – 80 minutes max.
- Specific Gravity – 1,08 – 1,38

*NPG-NEO Pentyl Glycol, a Product of Eastman Chemical

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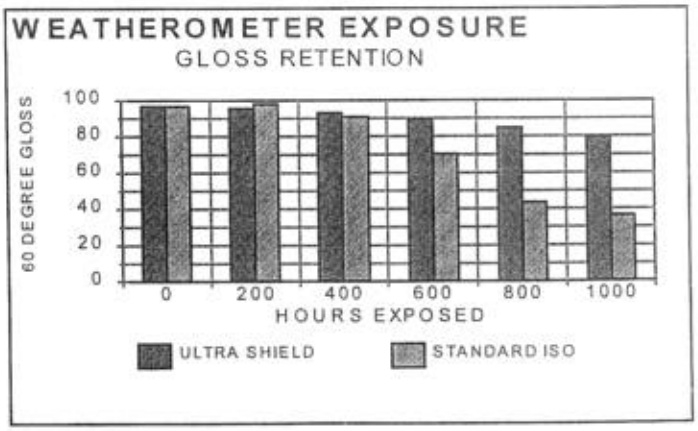

FERRO

ULTRA PLUS-NPG/ISO GELCOAT

ULTRA™

GELCOATS

ULTRA Plus-NPG/ISO gelcoat for polyester laminate applications is comprised of the finest quality pigments dispersed in an isophthalic acid-based, neopentyl glycol (NPG) resin system. Superior ingredients, together with perfected manufacturing techniques and rigid quality control standards, optimize every feature you look for in a gelcoat:

- *Shelf stability*
- *Easy application*
- *Color consistency*
- *Crack resistance*
- *Water resistance*
- *Tear resistance*
- *Chemical resistance*
- *UV light stability*
- *Long term durability*

UNCURED GELCOAT PROPERTIES

(All properties based on 1.5% M.E.K.P.)

- *Gel time @ 77°F to your specifications (within parameters required to maintain product integrity)*
- *Gel to peak: ..... 15 - 20 minutes*
- *Viscosity @ 77°F (LVF #4 @ 60 rpm): ... 2300 - 2900 cps*
- *Thix index (6/60): ..... 5.0 - 6.0*
- *Weight per gallon: ..... 9.8 - 10.8 lbs.*
- *Stability @ 150°F: ..... 5 days minimum*
- *Hegman grind: ..... 5 minimum*
- *Film cure @ 77°F: ..... 40 - 60 minutes*
- *Hide @ 15 mils (wet): . complete*
- *Coverage: ..... approx. 80 sq.ft./gal., sprayed @ 20 mils (wet)*
- *Patchability: ..... good (Ferro patch booster recommended)*

CURED GELCOAT PROPERTIES

- *Tensile test (ASTM D638 IV):*
  Elongation: ..... 2.8 - 3.5%
  Tensile strength: ..... 6000 - 8500 psi
  Modulus elast.: ..... 0.25 - 0.33 x 10^6 psi
- *Coefficient of linear expansion: ..... 5.1 x 10^{-5} in./in.°C*
- *Linear polymerization shrinkage (ASTM 2566): ..... 0.0165 - 0.0180 in./in.°C*
- *Barcol hardness: ..... 38 - 45, in 1/8" gelcoat casting*

CURED COMPOSITE PROPERTIES

(Gelcoat with laminate)

THREE POINT BEND TEST (ASTM D790)	WITH GENERAL PURPOSE (GP) RESIN	WITH DICYCLO-PENTADEINE (DCPD) MODIFIED RESIN
PERCENT ELONGATION	1.7 - 2.2	1.2 - 1.7
TENSILE STRENGTH (PSI)	12,000-16,000	10,000-13,000
MODULUS OF ELASTICITY (PSI)	.80 - 1.0 x 10^6	.80 - 1.0 x 10^6

Blister resistance:
(Boiling water exposure test, with panels evaluated according to A.N.S.I. procedures)
@ 100 hrs. ..... excellent
@ 200 hrs. ..... fair-good

TYPICAL APPLICATIONS

Marine, sanitaryware, recreational vehicles, and other open mold hand lay-up applications.

COLORS

An entire spectrum of custom colors is available on short notice. Using computer spectrophotometry, Ferro can match your color sample, or refer to complete files of OSHA, Munsel, Federal Standard 595 Series, or Pantone® matching systems.

All orders are matched to Ferro standards, or the retain of your approved, custom color, ensuring identical color reproduction from order to order.

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FERRO

ULTRA TOOLING GELCOAT

ULTRA™

GELCOATS

FERRO CORPORATION
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FERRO

ULTRA Tooling Gelcoat is specially formulated for moldmaking.

The plug to be duplicated must first be waxed to permit positive release. ULTRA Tooling Gelcoat is then applied using air atomizing spray equipment, and laminated using a tooling resin or equivalent.

The resulting surface offers a range of advantages facilitating high quality molding:

- *High gloss*
- *Excellent abrasion resistance*
- *Superior hardness*
- *Exceptional craze resistance*
- *Minimum distortion*

To contrast with your production gelcoat color(s), tooling gelcoats are offered in four colors:

- *White*
- *Black*
- *Gray*
- *Tangerine*

APPLICATIONS

Marine, sanitaryware, recreational vehicles, and other open mold hand lay-up applications.

VISCOSITY

Brookfield Model LVF, Spindle #4, @ 23°C.

1. *6 rpm: 11,000 cps to 14,000 cps.*
2. *Thix @ 6/60: 5.0 to 6.5.*

CATALYZATION

9% active oxygen MEKP @ 23°C.

1. *Do not catalyze with less than 1%, or more than 2% catalyst (by total weight of gelcoat).*

CURE DATA

1. *Gel time: 8-15 min. with 1.5%-9% active oxygen MEKP @ 23°C.*
2. *Volumetric shrinkage under 10%.*
3. *Sag resistance 25-30 mils.*

CURED GELCOAT

1. *Barcol Hardness 1/8" Casting Model 934- 1, after 48 hrs. (45 min.).*

Since Tooling Gelcoat contains solvent, all solvent must flash-off before Barcol test. Contact supplier for specific test criteria.

CAUTION

- *Do not use varnish as a sealer or finish coating when preparing a plug for moldmaking. Even if the varnish is well waxed and coated with a parting film, sufficient styrene monomer from the gelcoat can pass through the barriers to soften the varnish which will act as an adhesive between the mold and the plug.*
- *A high heat distortion tooling resin or equivalent should be applied at the coverage rate of 80 sq. ft./gal., while precisely following the resin manufacturer's recommended laminating procedures.*
- *Please note 90-day shelf life.*

APPLICATION GUIDELINES

1. *Agitate well before using.*
2. *The gel time of this product may change with aging. Check it to your specifications. If it is not within specifications, or over 90 days old, contact your Ferro sales representative.*
3. *Do not use less than 1%, or more than 2%, of MEKP catalyst.*
4. *Use only clean and properly adjusted spray equipment.*
5. *Prepare a 1/4 " thick casting with sprayed material at the time the gelcoat is sprayed into the mold. The Barcol Hardness of this casting should reach 40 within two days. Retain this casting, identified as to mold and date.*
6. *Spray catalyzed gelcoat on two small (approximately 2 ft. x 2 ft.) test panels at the same time that the tooling gelcoat is sprayed into the mold. Carefully use the same spray procedures as used on the mold. When the test panels have gelled, strip one and inspect it for porosity before proceeding further with the construction of the mold. Laminate the second panel using the same procedure used on the production mold. Retain this panel for possible future evaluation, identified as to mold and date.*

The Application Guidelines above also appear on the Tooling Gelcoat container.

LIQUID COATINGS & DISPERSIONS DIVISION
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FERRO

UltraShield ™ Gelcoat

High NPG* Base
Data Sheet - 2/96

Ultra Shield ™ Gelcoat is made to provide superior performance on UV light stability, long term durability, and high gloss retention. When cured properly, this product exhibits excellent chemical resistance and physical resistance properties over standard gelcoats. The product has excellent sprayability as well as a tack-free film cure for faster and trouble-free processing. Please discuss your specific needs with your Ferro Sales Representative.

TYPICAL PRODUCT PROPERTIES:
Tested at 25° C (77° F)

VISCOSITY (Brookfield LVF#4 @ 60 RPM)		2000-2900 mPa.s
GEL TIME	(1.5% methyl ethyl ketone peroxide)	12 - 16 minutes
CURE TIME		80 minutes max.
SPECIFIC GRAVITY		1,08 - 1,38

Ultra Shield ™ Gelcoat is designed for application using airless spray equipment. Allow to cure for approximately 60-80 minutes prior to subsequent manufacturing steps. Elevated temperatures may permit quicker cycle times, but need to be determined in the individual operation.

*NPG-Neo Pentyl Glycol, a Product of Eastman Chemical

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MATERIAL SAFETY DATA SHEET

For Coatings, Resins and Related Materials

Printed : 10/30/97

Revised : 10/16/97

SECTION I - PRODUCT IDENTIFICATION

11/6/97

Supplier: FERRO CORPORATION - PLYMOUTH
1301 N. FLORA ST.

PLYMOUTH IN 46563

Information Phone: 1-219-935-5131
Emergency Phone: 1-216-641-5324
CHEMTREC Phone: 1-800-424-9300

Product Class: Polyester Gelcoat
Trade Name : Neutral Wheat US Gelcoat
Product Code : 82-710010
C.A.S. Number: MIXTURE

HMIS Hazard Ratings: Health - 2*
none -> extreme Fire - 3
0 ---> 4 Reactivity - 2

Personal Protection - J

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	ACGIH/TLV	OSHA/PEL	VP mm HG
Unsaturated Polyester	TRADE SECRET	20-50	N.E.	N.E.	N/AP
Styrene Monomer	100-42-5	20-50	20 ppm	50 ppm	4.5
		STEL = 40	ppm	100 ppm	@ 20C
Unsaturated Polyester	68511-26-2	1-5	N.E.	N.E.	N/AP
Magnesium Ferrite	12068-86-9	1-5	N.E.	N.E.	N/AP
Titanium Dioxide	13463-67-7	5-20	10 mg/M3	10 mg/M3	N/AP
Barium Sulfate	7727-43-7	1-5	10 mg/M3	10 mg/M3	N/AP
Talc (Magnesium Silicate)	14807-96-6	5-20	2 mg/M3	2 mg/M3	N/AP
Amorphous Fumed Silica	112945-52-5	1-5	10 mg/M3	6 mg/M3	N/AP
Methyl Methacrylate Monomer	80-62-6	5-20	100 ppm	100 ppm	28 @ 20C
Silica, Crystalline Quartz	14808-60-7	< 1.	.1 mg/M3	@ mg/M3	N/AP

*** ALL Ingredients in this product are listed in the T.S.C.A. Inventory.

Effective June 28, 1994 the EPA has deleted Barium Sulfate from the category "Barium Compounds" on the list of toxic chemicals under SARA 313. See Federal Register 40 CFR Part 372.

@ The ACGIH/TLVs (listed above) and the following OSHA/PELs for Crystalline Silica (quartz and/or cristobalite) are both for respirable forms. The OSHA quartz PEL is a formula: 10mg/m3 divided by [% quartz +2]. The OSHA cristobalite PEL is a formula: 5mg/m3 divided by [% cristobalite +2]. Both are determined by respirable dust monitoring and analysis. Refer to 29 CFR 1910.1000 Table Z-3.

N.E. = Not Established

SECTION III - PHYSICAL DATA

Boiling Range: 80 - 145 Deg. C
Evap. Rate: Slower than n-Butyl Acetate
Volatiles vol % 50.8 Wgt% 34.9

Vapor Density: Heavier than Air.
Liquid Density: Heavier than Water.
Wgt per gallon: 10.99 Pounds.
Spec. Gravity: 1.31933

Appearance: Viscous Brown/Tan Liquid

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flammability Class: IC Flash Point: 29 C TCC LEL: 1.10% UEL: 12.50%

-EXTINGUISHING MEDIA:

Foam, Dry Chemical, CO2

-SPECIAL FIREFIGHTING PROCEDURES

Keep personnel removed and upwind of fire. Wear self-contained breathing apparatus. Wear full protective equipment/clothing. Treat as oil fire. Fight fire from a distance; sealed containers can rupture explosively when heated. Water may be used to keep fire-exposed containers cool until fire is out.

-UNUSUAL FIRE & EXPLOSION HAZARDS:

Flammable liquid. Vapors may form explosive mixture with air. Can polymerize when heated. Combustion can produce toxic gases. Vapors are heavier than air, can travel along the ground or through ventilation systems, and be ignited by sparks, flames or static discharge.

Combustion can produce toxic gases.

UNSATURATED POLYESTER: Fire may produce poisonous or irritating gas, fumes or vapor. Excessive heat may trigger polymerization of confined material. Containers may explode in heat of fire.

SECTION V - HEALTH HAZARD DATA

-PERMISSIBLE EXPOSURE LEVEL:

See Section II.

-EFFECTS OF OVEREXPOSURE:

Ingestion causes a burning sensation of the mouth and throat, and gastrointestinal tract irritation.

Styrene Monomer is a skin, nose and respiratory tract irritant, and may cause dermatitis. Skin permeation may occur.

It is a severe eye irritant and can cause stinging, tearing, redness and swelling, and possible corneal damage.

Inhalation can cause central nervous system (CNS) depression with nausea, headache, dizziness and other CNS effects.

High levels (1000 ppm) can cause anesthetic effects. May be fatal at 10,000 ppm Styrene.

IARC has classified Styrene as a possible carcinogen (Class 2B). There is currently not sufficient evidence to indicate that Styrene is a human carcinogen. The IARC 2B classification is based on animal data generated on Styrene Oxide. Styrene Oxide is a metabolite of Styrene.

UNSATURATED POLYESTER:

If ingested may cause gastrointestinal disturbances. Symptoms may include irritation, nausea, vomiting and diarrhea. Contact with the skin may cause skin irritation. Repeated dermal exposures can result in an eczematous dermatitis caused by primary irritation and/or sensitization. INHALATION - repeated or prolonged exposure to high vapor concentrations may be irritating to the mucous membranes and upper respiratory tract.

TITANIUM DIOXIDE: Results of a Dupont epidemiology study showed that employees who had been exposed to Titanium Dioxide pigments were at no greater risk of developing lung cancer than were employees who had not been exposed to Titanium Dioxide

(cont.)

SECTION V - HEALTH HAZARD DATA (cont.)

-EFFECTS OF OVEREXPOSURE: (cont.)

pigments. Based on the results of this study Dupont concluded that TiO2 pigments will not cause lung cancer or chronic respiratory disease in humans at concentrations experienced in the work place.

TALC (no Asbestos):

ACUTE: May cause mechanical eye irritation. Excessive exposure may cause bronchitis.

CHRONIC: Prolonged exposure to excessive quantities of Talc can result in scarring of the lungs or in the covering of the lungs.

METHYL METHACRYLATE:

Methyl Methacrylate is a skin, nose and throat irritant and can cause allergic skin rashes. Skin permeation may occur. It is a severe eye irritant and can cause discomfort, tearing, blurring of vision and possible corneal damage. Inhalation can cause headache, nausea, weakness and lung irritation with cough, discomfort and shortness of breath. Temporary sensory nervous system effects can occur, as well as abnormal kidney function tests and temporary elevation of blood pressure.

-FIRST AID:

INHALATION: If inhaled, move individual to fresh air. Make comfortably warm but not hot. Use oxygen or artificial respiration as required. See a physician if irritation is present or persists.

SKIN: In case of contact, remove contaminated clothing. Wash thoroughly with soap & plenty of water. See a physician if irritation is present or persists. Launder contaminated clothing before reuse.

EYE: Immediately flush eyes with plenty of water for at least 15 minutes and get prompt medical attention.

INGESTION: If swallowed, call a physician immediately. Induce vomiting only at the instructions of a physician. Never give anything by mouth to an unconscious person.

NOTE TO PHYSICIAN: Vomiting can cause aspiration of the liquid into the lungs, which can cause chemical pneumonitis, which can be fatal.

SECTION VI - REACTIVITY DATA

STABLITY: [ ] Unstable [x] Stable

HAZARDOUS POLYMERIZATION: [x] May occur [ ] Will not occur

-INCOMPATIBILITY:

Styrene is incompatible with strong acids & bases, peroxides, oxidizers, aluminum chloride and metallic hydrides.

POLYESTER: Strong acids, peroxides, oxidizing agents.

Methyl Methacrylate is incompatible with oxidizing and reducing agents. MMA is a strong solvent and can soften paints & rubber.

SECTION VI - REACTIVITY DATA (cont.)

-CONDITIONS TO AVOID:

Avoid excessive heat and inadvertent addition of catalyst.
POLYESTER: Avoid exposure to heat, open flame or contamination with oxidizing agents. Dissolution of material with uninhibited unsaturated monomers can result in exothermic autopolymerization.

-HAZARDOUS DECOMPOSITION PRODUCTS:

Oxides of Carbon; incompletely burned hydrocarbons.
POLYESTER: Oxides of Carbon; low molecular weight hydrocarbons; Organic Acids.

SECTION VII - SPILL OR LEAK PROCEDURES

-STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Remove all sources of ignition. Ventilate area and maintain ventilation. Use all described protective measures & equipment. Use absorbant material, such as clay or sand, to collect and contain for salvage and disposal. Prevent runoff from entering drains, sewers or waterways.
Styrene Monomer has a Reportable Quantity (RQ) = 1000 lbs.
Methyl Methacrylate has a Reportable Quantity (RQ) = 1000 lbs.

-WASTE DISPOSAL METHOD:

Follow all applicable Federal, Provincial, State and Municipal laws, regulations and by-laws. Package in U.N. approved containers and transport to an approved treatment, storage and disposal (TSD) facility.
(Also see Section X.)
Cleaned-up material may be a RCRA Harzardous Waste (D001, D003)

SECTION VIII - SPECIAL PROTECTION INFORMATION:

-RESPIRATORY PROTECTION:

In the absence of proper ventilation use NIOSH/MSHA approved organic chemical cartridge respirator. In emergency situations, or when used in confined spaces, use self-contained breathing apparatus or other air supplied full-face respirator.

-VENTILATION:

Ventilate to maintain exposure below published exposure limits. Use explosion proof motors and wiring.

-PROTECTIVE GLOVES:

Use new, impervious butyl rubber gloves. Replace every four hours, or as often as needed to maintain protection.

-EYE PROTECTION:

Use chemical safety goggles or full-face shield.

-OTHER PROTECTIVE EQUIPMENT:

Safety showers and eye wash stations within 10 seconds of work station. Where splash can occur, use an apron.

SECTION IX - SPECIAL PRECAUTIONS

-PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

Avoid contact with eyes, skin, clothing. Avoid breathing vapor, mist or spray. Use with good ventilation. Wash thoroughly after handling. Store in cool, dry area in closed containers away from incompatible materials. Store away from sunlight, heat, sparks and open flames. Do not smoke in work area. Do not store near food or feed.

DO NOT STORE ABOVE 100 degrees F (38 degrees C)!

-OTHER PRECAUTIONS:

Since emptied containers retain product residues (vapor, liquid or solid), ALL HAZARD PRECAUTIONS LISTED IN THE MSDS MUST BE OBSERVED!

Avoid improper addition of promotor and/or catalyst. Consult product bulletin. Promotors (metal organics such as Cobalt, or Analine type) and catalyst (organic peroxide type) used with this product, should always be premixed separately into the product. ** NEVER MIX PROMOTORS & CATALYST DIRECTLY TOGETHER **

SECTION X - REGULATORY INFORMATION

-SARA TITLE III SECTION 313:

This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right To Know Act of 1986 and of 40 CFR 372:

CAS#	Chemical Name	Percent by Weight
100-42-5	Styrene Monomer	28.09
71-43-2	Benzene	0.
80-62-6	Methyl Methacrylate Monomer	6.

-PROP 65 (CARCINOGEN):

WARNING: This product contains a chemical known to the state of California to cause cancer.

CAS#	Chemical Name
71-43-2	Benzene

Talc may contain up to 1.0% Quartz (Crystalline Silica) by wt.

14808-60-7	Silica, Crystalline Quartz

SECTION X - REGULATORY INFORMATION (cont.)

-PROP 65 (REPRODUCTIVE TOXICANTS):
WARNING: This product contains a chemical known to the state of California to cause birth defects or other reproductive harm.

CAS#	Chemical Name
	None

-PROP 65 (BOTH CARCINOGEN AND REPRODUCTIVE TOXICANTS):
WARNING: This product may contain a chemical known to the state of California to cause cancer or birth defects or other reproductive harm

CAS#	Chemical Name
	None

-MASSACHUSETTS SUBSTANCE LIST:
Styrene (CAS# 100-42-5) is listed.
Quartz (Crystalline Silica) is listed. The Talc in this product may contain up to 1.0% Quartz by weight.

-CERCLA - 40 CFR 302.4:
Styrene Monomer has a Reportable Quantity (RQ) = 1000 lbs.
Methyl Methacrylate has a Reportable Quantity (RQ) = 1000 lbs.

-RCRA - 40 CFR 261:
Wastes containing Styrene Monomer in a liquid form may exhibit EPA Hazardous Waste Characteristics, D001 (ignitability) and D003 (reactivity).
Wastes containing Methyl Methacrylate in a liquid form may exhibit Hazardous Waste Characteristics, D001 (ignitability) and D003 (reactivity).

-DISCLAIMER
Judgement as to the suitability of information herein or to the purchaser's purposes are the purchaser's responsiblity. Reasonable care has been taken in the preparation of this information, but FERRO EXTENDS NO WARRANTIES, MAKES NO REPRESENTATIONS AND ASSUMES NO RESPONSIBILITY OF THIS INFORMATION FOR ANY PURCHASER'S USE OR FOR ANY CONSEQUENCES OF ITS USE.
(cont.)

SECTION X - REGULATORY INFORMATION (cont.)

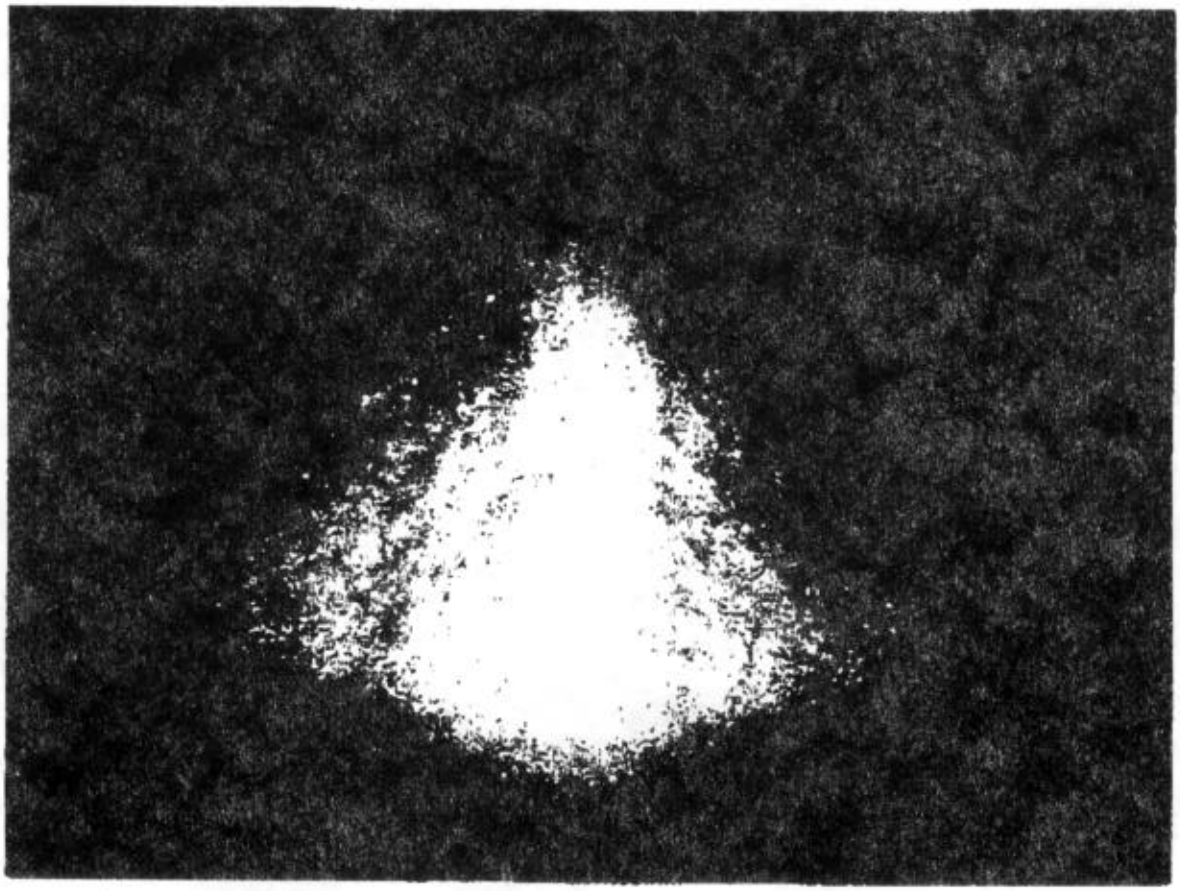
-DISCLAIMER (cont.)

STATE RIGHT-TO-KNOW FOR 82-710010

TRADE SECRET	Unsaturated Polyester
100-42-5	Styrene Monomer
13463-67-7	Titanium Dioxide
14807-96-6	Talc (Magnesium Silicate) May contain up to 1.0% Quartz (Crystalline Silica)
80-62-6	Methyl Methacrylate

MICROGLAS GLASS FLAKE

FOR CORROSION RESISTANCE RCF-No.1



General Description

MICROGLAS GLASS FLAKE (RCF) has excellent anticorrosion characteristics in the fields of paint and lining. Long time more than 15 years experience with MICROGLAS GLASS FLAKE (RCF) assures the satisfactory performance in the anticorrosion application.

NIPPON SHEET GLASS CO., LTD. NIPPON GLASS FIBER CO., LTD.

Microglas® Glass Flake

Microglas® Glass Flake is a C glass platelet, approximately 5µm thick and 10 ~ 4,000µm wide. The good chemical resistance of borosilicate C glass makes Microglas® Glass Flake ideal for use in vinyl ester, epoxy, acrylic paints and acrylic coatings as a barrier against corrosive attack by chemicals and moisture.

Manufactured by Nippon Glass Fiber Co. Ltd., Tsu, Japan.

Classification of Microglas® Glass Flake

Type	Non-Surface treatment			Surface treatment	
Product code	RCF-600	RCF-160	RCF-015	RCF-160T	RCF-160N
Glass Composition			C-glass		
Specific gravity			2.5		
Thickness (µm)			Ave. 5±2		
Particle Size Distribution >1700 µm	0	0	0	0	0
Particle Size Distribution 1700~300	80 or more	10 or less		10 or less	10 or less
Particle Size Distribution 300~150		65 or more	12 or less	65 or more	65 or more
Particle Size Distribution 150~45	20 or less				
Particle Size Distribution <45 µm		25 or less	88 or more	25 or less	25 or less
Loss on ignition(%)		-		0.15 ± 0.10	0.15 ± 0.10
Surface Treatment agent		-		Epoxysilane	Acrylsilane

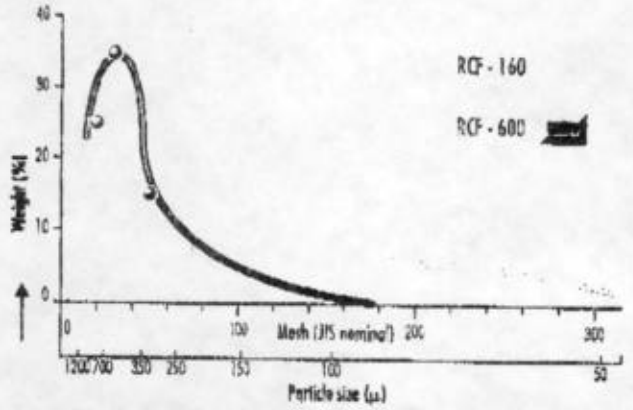
Identification of Microglas® Glass Flake

R C ——— C glass
F ——— Glass flake
600 ——— Particle size (Nominal)
N ——— Type of surface treatment

Surface Treatment	Resin
G Vinysilane	Vinyl ester
N Acrylsilane	Plastics
A Aminosilane	Acrylic
T Epoxysilane	Epoxy

Microglas® Glass Flake is available in a range of surface treatments to suit different resins.

Particle size distribution and bulk density



	Bulk density (g / cc)	Bulk density after shaking (g / cc)
RCF-600	0.20	0.30
RCF-160	0.40	0.65
RCF-015	0.75	1.15

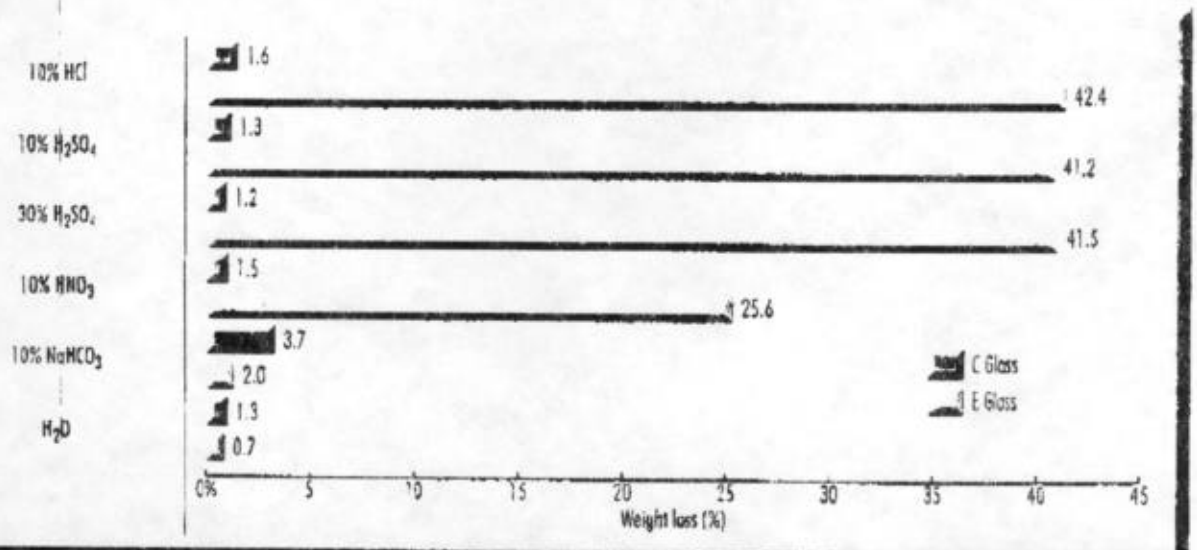
The finer the grade of Microglas® Glass Flake, the greater the bulk density.

Glass Composition

Type of glass	SiO_2	Al_2O_3	CaO	MgO	B_2O_3	Na_2O+K_2O	ZnO
C glass (%)	65–72	1–7	4–11	0–5	0–8	9–13	0–6
E glass (%)	52–56	12–16	16–25	0–6	5–13	0–0.8	---

Advantages of Microglas® Glass Flake

- ***Extended life of protective coating.*** Glass flakes dispersed through the coating prevent the ingress of water vapour and chemical solutions.
- ***Prevention of cracking and peeling.*** Glass Flakes provide a thermal stabilisation layer in the protective coating and greatly reduces the risk of cracking and peeling of the coating due to thermal shock.
- ***Improved wear resistance.*** Glass flakes increase the hardness of epoxy and polyester resin coatings, giving higher resistance to surface wear.
- ***Chemical resistance.*** C glass has greater resistance to chemical attack, compared to other types of glass, as shown below.



Comparative weight loss of C and E glass when immersed in chemical solution at 80° C for 24 hours.

Microglas® Glass Flake – in anti-corrosion coatings

The performance of an anti-corrosion coating can be altered significantly by the content and flake size of Microglas® Glass Flake and by the surface treatment.

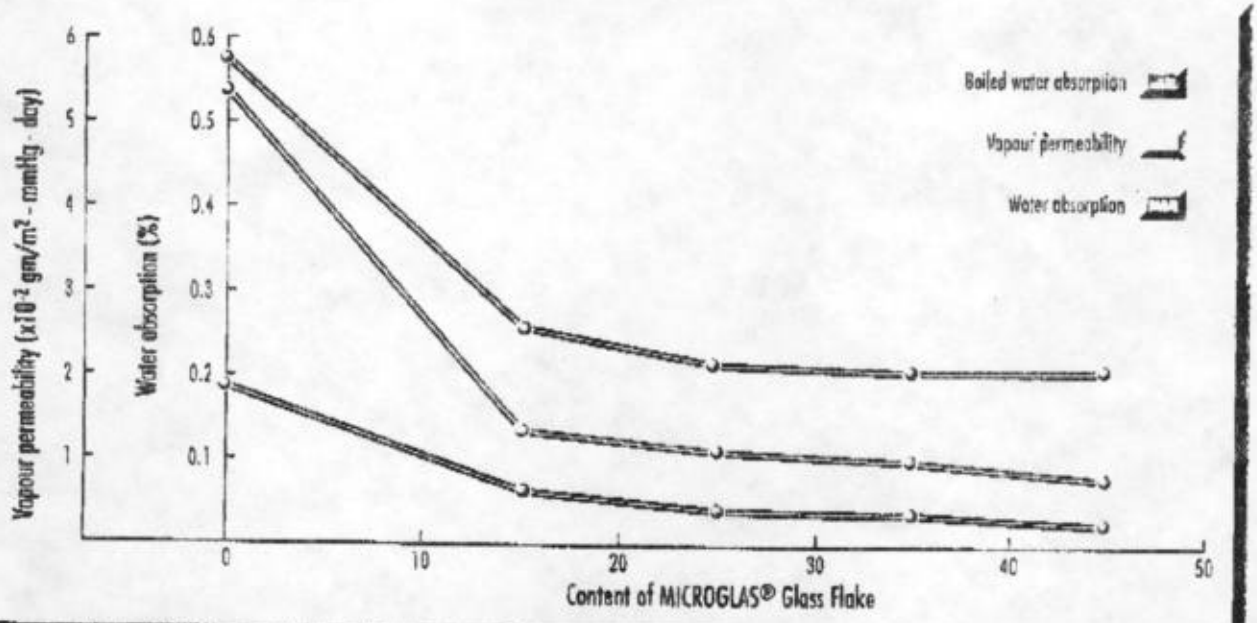
Flake Content

The ratio of Microglas® Glass Flake content in a coating is clearly correlated with corrosion resistance. Water absorption and vapour permeability of a coating decrease sharply with increasing content of Microglas® Glass Flake.

Flake ratio	Water absorption %	Vapour permeability (gm/m^2 mmHg day)	Boiled Water absorption (%)	Bulk density	Porosity (%)	Flexural strength (kg/mm^2)
0%	0.19	5.63×10^{-2}	0.57	1.14	0	10.6
25%	0.06	1.73×10^{-2}	0.23	1.30	1.5	8.3
45%	0.03	0.82×10^{-2}	0.23	1.44	5.3	11.0

Microglas® Glass Flake : RCF-600 Resin : Vinyl ester

Water Absorption

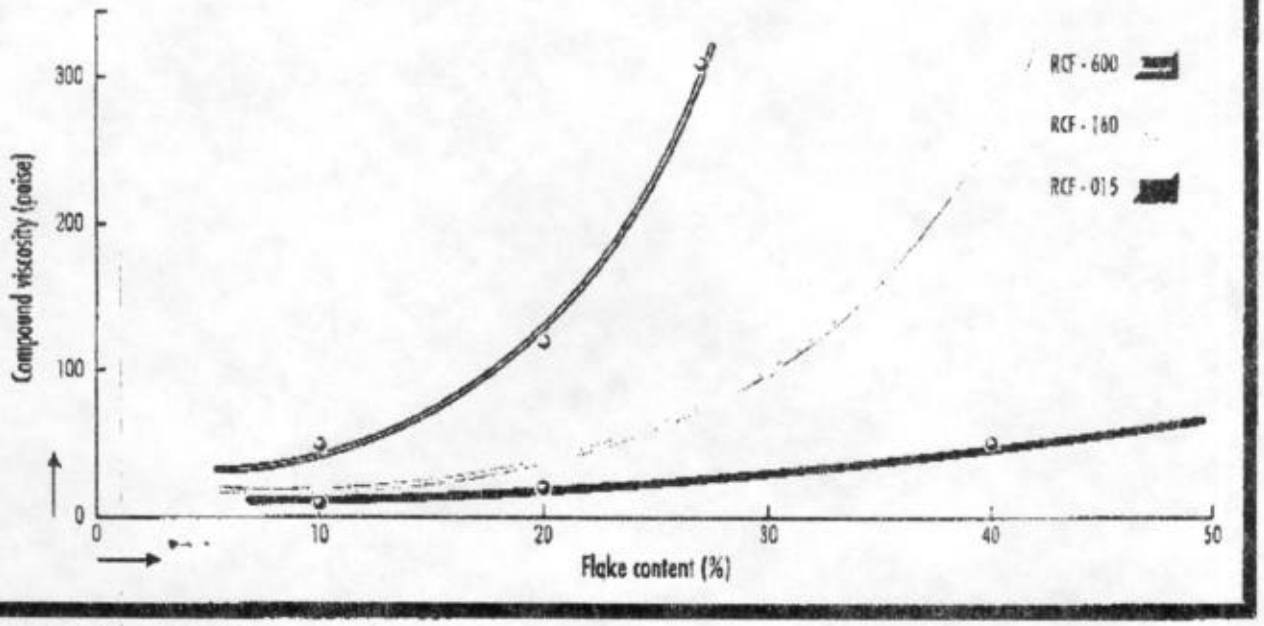


Content of MICROGLAS® Glass Flake	Barcol Hardness
Resin only	32
20 wt%	46
30 wt%	48

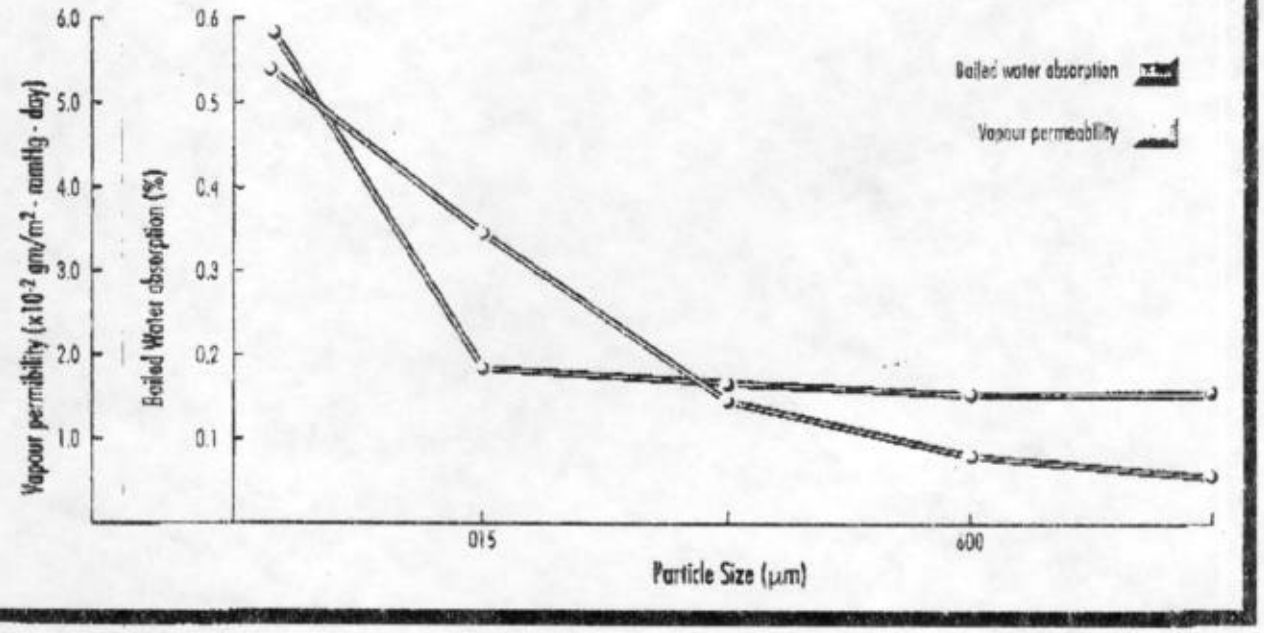
Microglas® Glass Flake improves surface hardness and gives better abrasion resistance.

Flake Size

The viscosity of resin compounds is affected by content and glass flake size. Viscosity has a direct bearing on workability of the coating, the removal of air, sag resistance, surface appearance; and ultimately, the performance of the coating. The right proportion of glass flake in the resin compound is critical. The larger the glass flake size, the more difficult it is to remove air during application of the coating. Alternatively, larger glass flakes significantly reduce vapour permeability.



Relationship between glass flake content and compound viscosity.



Relationship of glass flake size to vapour permeability and boiled water absorption.

Grade	Flake content (wt %)	Coating thickness (mm)	Ave. dispersion coefficient (sq. cm / hr)
RCF - 600	30	0.57	6.43×10^{-6}
RCF - 160	30	0.60	1.52×10^{-5}
RCF - 015	30	0.63	5.4×10^{-5}

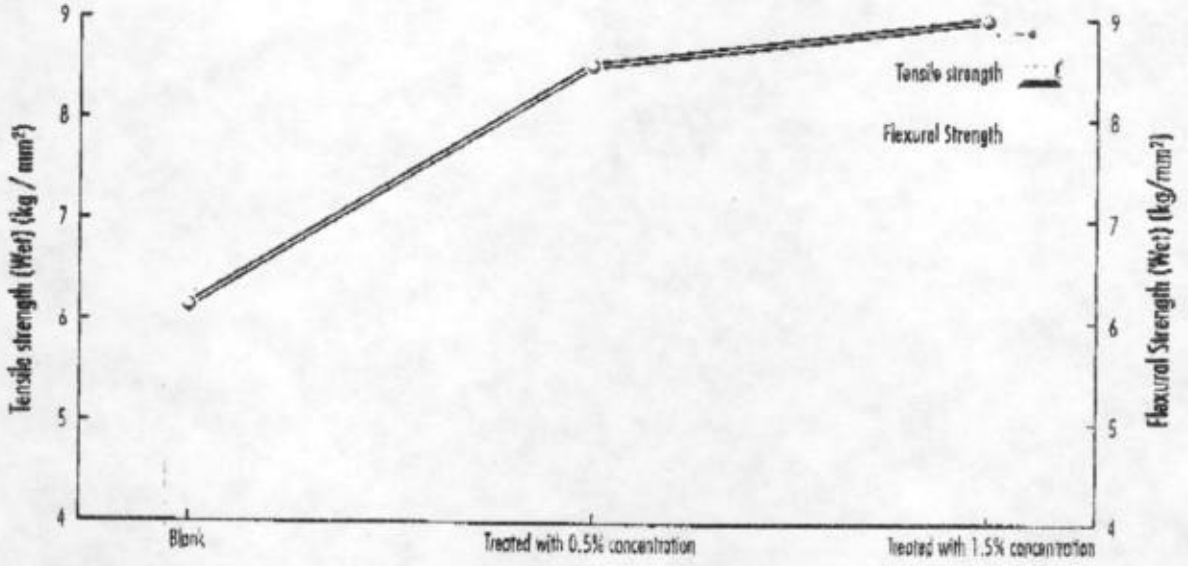
Relationship between glass flake size and average dispersion coefficient.

Test method: One-side dipping method, distilled water at 40°C

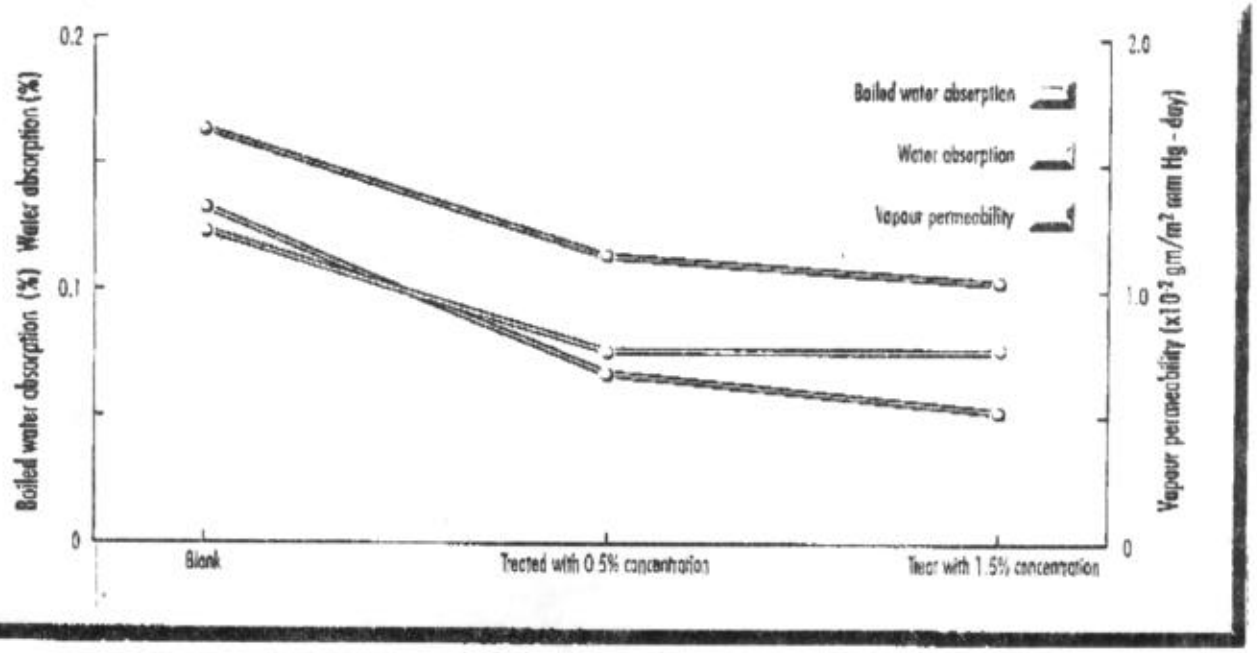
The change in weight of a steel substrate test sample, with a certain coating thickness is measured hourly by the 'one-side' dipping method; and the average dispersion coefficients of different grades of Microglas® Glass Flake are obtained. The larger the glass flake, the smaller the average dispersion coefficient. That is to say, larger glass flakes slow down the invasion of the steel substrate by chemical solutions.

Surface Treatment.

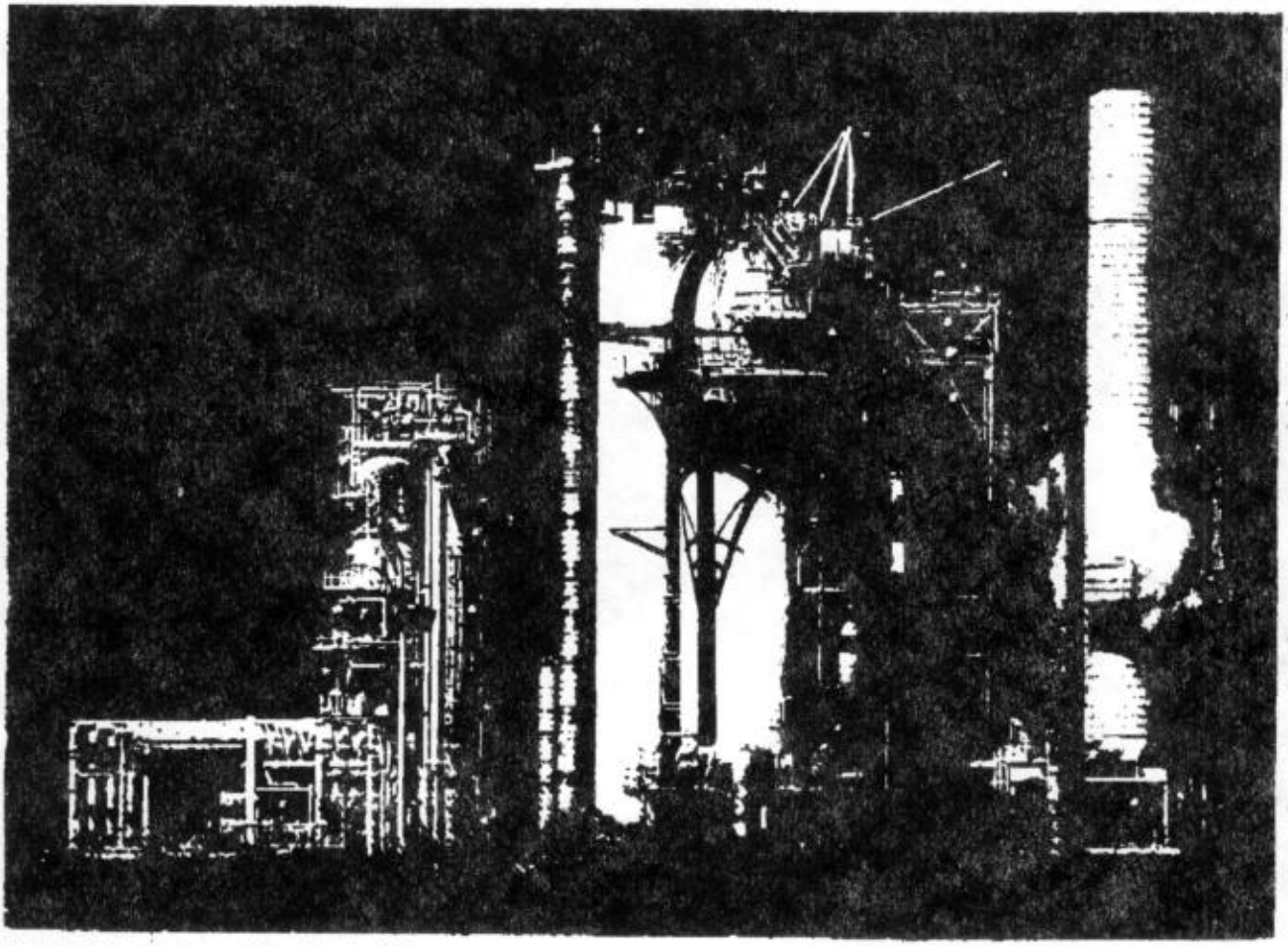
The surface treatment of Microglas® glass flake with a coupling agent, gives better bonding between the glass flakes and the resin, resulting in better corrosion resistance.



The effect of surface treatment on tensile and flexural strength
Microglas® Glass Flake, grade RCF-600, with vinylester resin. Glass flake content : 36.6 ~ 38.8%; Porosity : 2.8 ~ 3.5%.



The effect of surface treatment on water absorption and vapour permeability.



Used in Oil refineries and Petrochemical plants

Microglas® Glass Flake : The lining process

Recommended process for the application of a resin/glass flake compound:

- **Preparation of the substrate:** Any uneven joints should be ground flat and sandblasted. If sandblasting is not appropriate, any other rust removing process is sufficient.

  In the case of a concrete substrate, holes should be filled. The surface should be sandblasted or ground flat, dried thoroughly, and washed with an acid solution if necessary

  The finished surface roughness should be within the range of 50 ~ 100um.

- **Primary coating:** It is usual for the priming coat to be the same resin as that to be used for the main coating. It is recommended that the priming coat be applied with brush, roller or airless spray, to a thickness of 30 ~ 40um.

- **Secondary coating:** The secondary coating, containing the glass flake, is normally applied to a thickness of 700 ~ 1000um; however thicknesses up to 2mm should be applied in very corrosive environments. Application is normally by trowel or similar.

  A typical Microglas® Glass Flake to resin loading is 24 ~ 30% by weight. After the secondary coat has hardened, a further coat of 200 ~ 350um thickness can be applied if required.

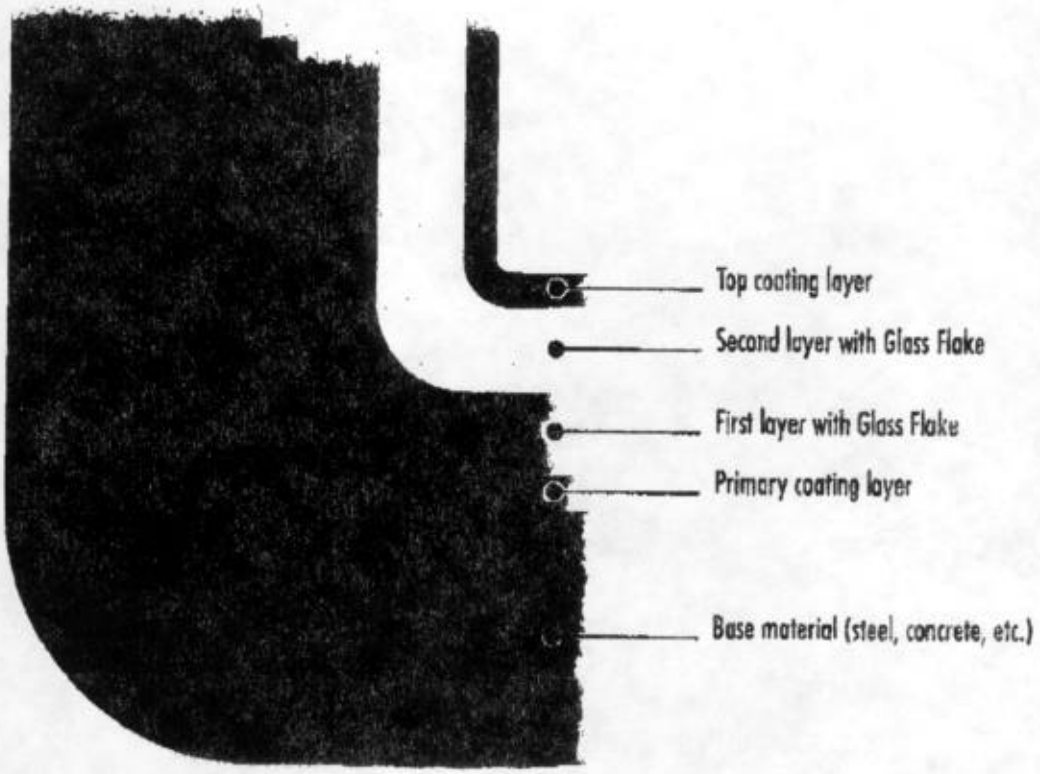
- **Top coating:** A final finishing coat is applied, if necessary.

- **Inspection:** The coating surface should be checked for the presence of surface roughness, air bubbles or any foreign matter.

  Pinhole test: The presence of pin-holes in the coating should be checked with a pin-hole detector.

  Thickness: An electronic thickness gauge should be used to check that the coating thickness is within specification.

  Hardness: Hardness of the coating surface should be checked with a Barcol hardness tester.



Microglas® Glass Flake : The lining process

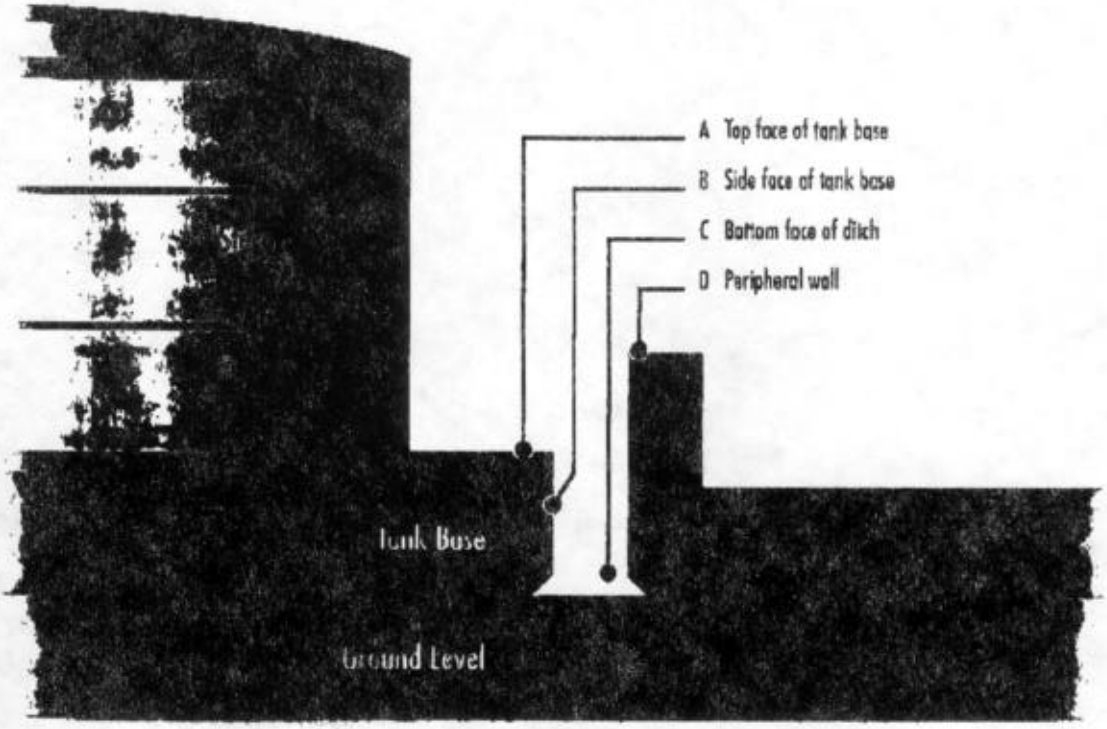
Example: A Microglas® Glass Flake coating has been proven successful in the surface treatment of the peripheral concrete works of an hydrochloric acid tank.

The coating compound was comprised of vinyl ester resin (100 parts), cobalt naphthenate (0.5 part) and hardner (1.0 part).

Microglas® Glass Flake, grade RCF-600 was mixed with the resin in different proportions, for the various concrete surfaces to be treated.

The concrete surfaces were washed and dried.

The application was by trowel and air-removal roller.

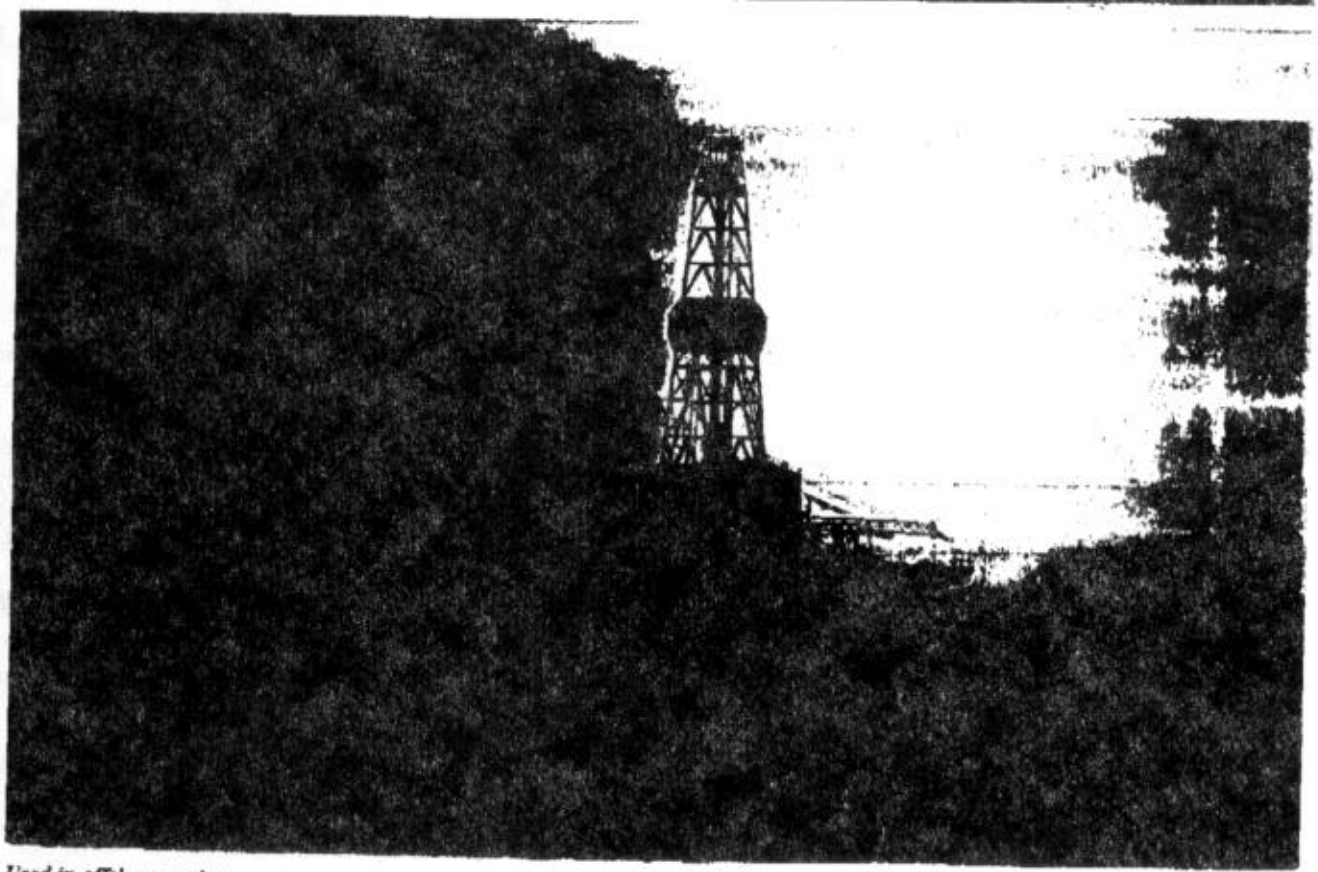


	Section	First Layer	Second Layer	Third Layer
	Top face of tank base	15wt%	35wt%	30wt%
	Side face of tank base	15	35	–
C	Bottom face of ditch	20	30	–
	Peripheral wall	20	35	–

Microglas® Glass Flake content for each surface treatment.

Applications for Microglas® Glass Flake/resin coatings

Fields	Application
Anti-corrosion apparatus in chemical plants	Dye, petroleum chemistry, pharmacy, cleaning agent, chlorine, soda, paper pulp
Marine constructions and harbour facilities	Bridge building, wharves, sluices.
Large diameter marine pipes	Inner lining of marine cooling pipes.
Petroleum tanks	Bottom plate lining (partially, welded, riveted spots) lower side walls.
Pollution control facilities	Waste gas and liquid processing, stack gas desulphurisation, water treatment, stacks and ducts
Plating metal industries	Plating and acid flushing baths.
Boilers and water tanks	Linings on tank interiors
Food industries	Fermentation tanks, reservoirs, floor linings.
Transportation	Road tankers, containers and vessels.
Fisheries	Fish tanks, storage.
Livestock	Pig and poultry farms, silos.

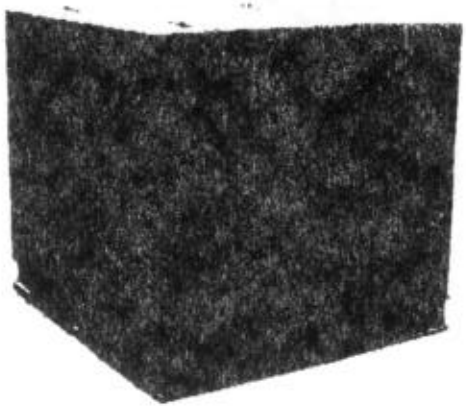


Used in offshore environments

Packaging

Microglas® Glass Flake is supplied in moisture proof paper bags, each containing 20 kgs nett weight.

For bulk shipments, the bags of glass flake are palletised and further protected by cardboard and polythene wrapping. The overall dimensions of a fully loaded pallet are 1100 x 1160 x 1020mm high

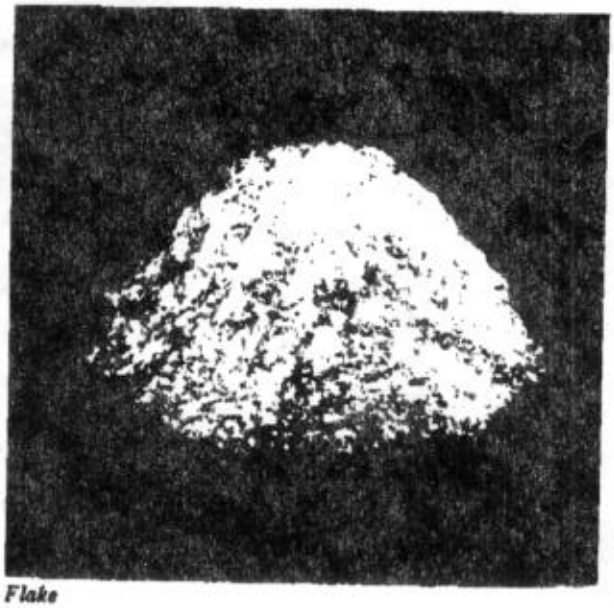


Pallet Loadings

Glass Flake RCF-160	:	30 x	20 kg bags (600 kg total nett weight)
Glass Flake RCF-600	:	14 x	20 kg bags (280 kg total nett weight)
Glass Flake RCF-015	:	48 x	20 kg bags (960 kg total nett weight)

Shipping container loadings, nett weights

	20' Container	40' Container
Glass Flake RCF-160	12 tonnes	-
Glass Flake RCF-600	5.6 tonnes	11.2 tonnes
Glass Flake RCF-015	19.2 tonnes	-



Flake

NGF EUROPE Limited

Lea Green St Helens England WA9 4PR
Tel: 01744 853065 Fax: 01744 816147

MICROGLAS® GLASS FLAKE (RCF)

MICROGLAS® GLASS FLAKE (RCF) is a C glass flake with high chemical resistance for use in anti-corrosion paints and linings.

SPECIFICATION

Product Code		RCF-600	RCF-160
Glass Composition		C glass	
Specific Gravity		2.52	
Thickness (μm)		Ave 5 ± 0.15	
Distribution of Particle Size	>1700μm	0	0
	1700~300	80 or more	10 or less
	300~150		65 or more
	150~45	20 or less	
	<45		25 or less

PACKAGING

Microglas® Glass Flake (RCF) is packed in moisture proof paper bags each containing 20 Kgs nett weight.

Manufactured by:
Nippon Glass Fiber Co Ltd., 4902 Komoricho Takachaya, Tsu, Mie 514, Japan

AKL1297/MM

NGF EUROPE Limited

Lea Green St Helens England WA9 4PR
Tel: 01744 853065 Fax: 01744 816147

MICROGLAS®FLAKE & FLEKA®

Microglas® **Flake** is an E glass flake, which has been specially developed as a reinforcing filler for thermoplastics. It reduces warpage, gives high weld strength and impact strength, and improves dimensional stability without discolouration.

SPECIFICATION

Product Code	REF-600A	REF-140A
Glass Composition	E glass	E glass
Specific Gravity	2.6	2.6
Average Thickness (μm)	5 ± 2	5 ± 2
Average Particle Size (μm)	600	140
Loss on Ignition (%)	0.15 ± 0.1	≥0.03
Surface Treatment*	Amino silane	Amino silane
Applicable Resins	PBT, PET, PC, PPE, PPS, PA66, PA6	PBT, PET, PC, PPE, PPS, FA66, PA6

*Microglas®Flake is also available untreated as a standard product. Other surface treatments for various resin types are available on request.

Fleka® is a granulated form of Microglas®Flake with improved processing characteristics. **FLEKA®** granules are made from untreated glass flakes bonded together with a special binder and a coupling agent.

SPECIFICATION

Product Code	REFG-101	REFG-301	REFG-302
Glass Composition	E glass	E glass	E glass
Base Glass Flake(untreated)	REF-600	REF-140	REF-140
Average Particle Size (mm)	1.0	0.5	0.6
Binder Type	Epoxy	Epoxy	Urethane
Coupling Agent	Amino silane/ Epoxy silane	Amino silane/ Epoxy silane	Amino silane
Loss on Ignition (%)	0.6	0 6	0.6
Applicable Resins	PPS, PET, PC, PBT	PPS, PET, PC, PBT	M-PPO, PA,PPE

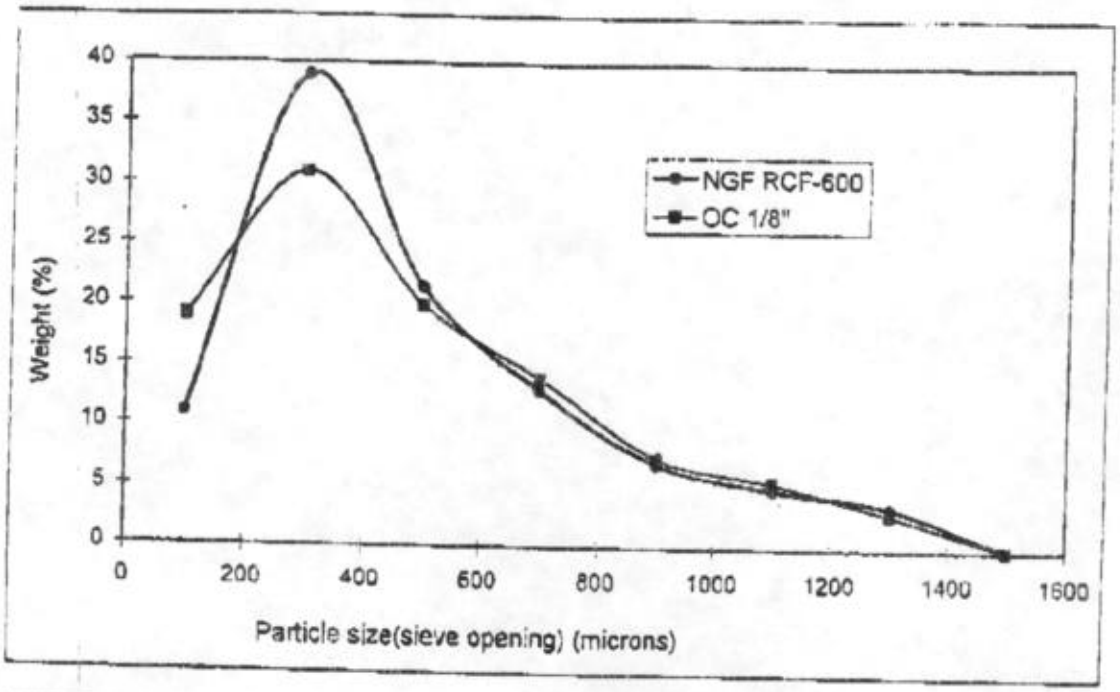
PACKAGING Microglas®Flake and Fleka® are packed in moisture proof bags each containing 20 Kgs. nett weight

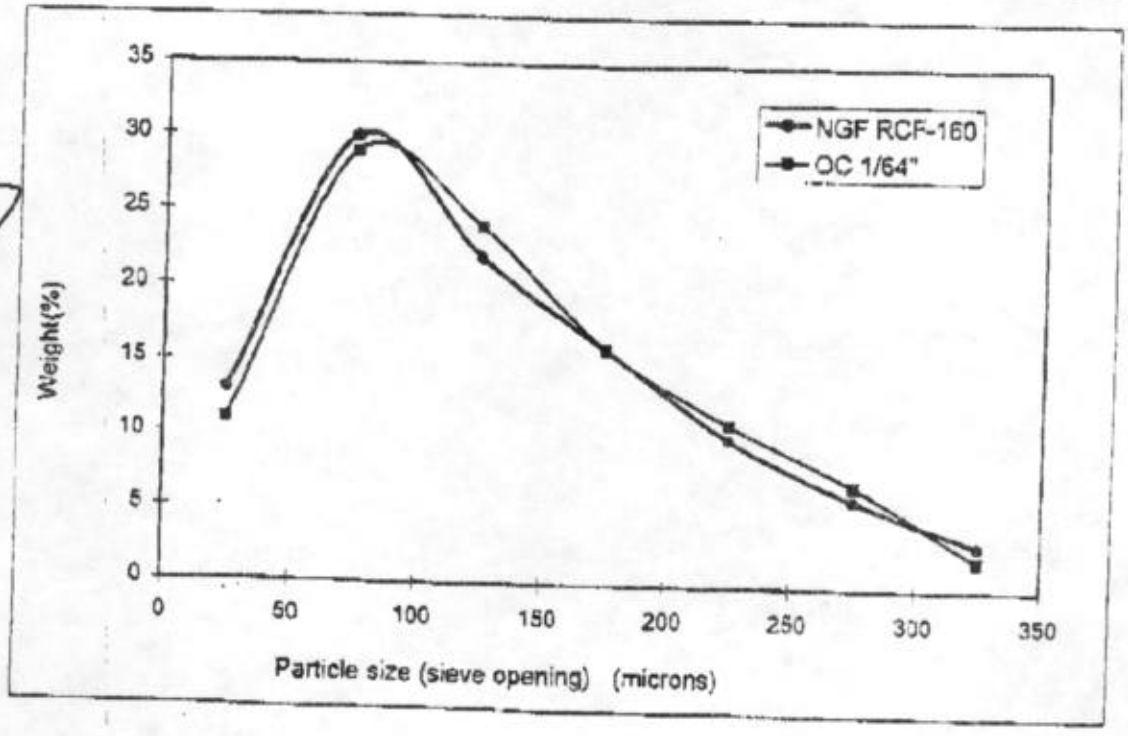
Manufactured by:
Nippon Glass Fiber Co Ltd., 4902 Komoricho Takachaya, Tsu, Mie 514, Japan

AKT 1497/0/04

GF EUROPE

Analysis of Particle Size Distribution





Reactivity Data

Quite stable, and none hazardous decomposition products.

Spill or Leak Procedures

Steps to be Taken in Case Material is Released or Spilled: No special precautions

Waste Disposal Method: Disposal procedures for solid waste in accordance with local, state, and federal regulations.

Special Protection information

Respiratory Protection: None normally required. If airborne glass flake concentrations exceed permissible exposure levels, respiratory protection for nuisance dusts in accordance with OSHA 1910. 134 should be provided.

Ventilation: If necessary to minimize nuisance dusts and housekeeping conditions.

Local Exhaust: Preferred Method

Protective Gloves: May reduce skin irritation in some operations

Protective Goggle: May reduce eye irritation in some operations.

Mesk: May reduce to inhaling glass flake in some operations.

Other Protective Equipment: Use of long sleeved shirts, buttoned to fit loosely at the neck and wrists, long pants, and good personal hygiene will maximize comfort.

Special Precautions

Precautions to be taken in storing: generally none known, however, once the package is opened, pay attention not to get wet and avoid keeping at high humidity which may occur clogging problem.

Other precautions: None known

June 20. 1991

Trade Name and Synonyms : MICROGLAS FLEKA : REFG−101
Chemical Name and Synonyms : granulated Glass Flake
Manufacturer's Name : Nippon Glass Fiber Co., Ltd.
Address : 4902 Komori−cho Takachaya, Tsu city, Mie Pref. Japan
Emergency Telephone No. : (0692−38−1111)

Ingredients

Glass Flake : ≧ 98.0%
Composition consisting principally of oxides of silicon, aluminum, calcium, boron, and magnesium fused in an amorphous vitreous state.
Surface Sizing : ≦ 2.0% Not Applicable

Physical Data

Boiling point (°F) : Not Applicable
Specific Gravity (H_2O=1) : 2.58
Vapor Pressure (mm Hg.) : Not Applicable
Percent, Volatile By Volume (%) : Not Applicable
Vapor Density (Air=1) : Not Applicable
Evaporation Rate : Not Applicable
Solubility in Water : Insoluble
Appearance and Odor : White glass flakes of thickness average 5 microns bound in granule having no odor.

Fire and Explosion Hazard Data

Flash Point : Non−burning (softening point > 800 ℃)
Flammable Limits : Not Applicable
Extinguishing Media : Not Applicable
Special fire Fighting Procedures :
In a sustained fire, self−contained breathing apparatus (SCBA) should be worn.
Unusual Fire and Explosion Hazards : Not Applicable

Health Hazard Data

Threshold Limit Value : 10 mg/m³
Effects of Overexposure :
Exposure to granulated glass flake sometimes causes irritation of the skin and, less frequently, irritation of the eyes, nose, or throat.
Emergency and First Aid Procedures :
Eye Contact : Flush eyes with clear water for at least 15 minutes−seek medical attention.

Skin Contact :

Rinse contacted areas with room temperature to cool water, then wash gently with mild soap. If glass flake becomes imbedded, seek medical attention.

Carcinogenicity Status : Not listed by IARC, NTP, or OSHA.

Reactivity Data

Stability : Stable

Incompatability (Materials to Avoid) : None Known

Hazardous Decomposition Products :

In a sustained fire, binders may decompose releasing hazardous products of combustion.

Polymerization : Will Not Occur

Spill or Leak Procedures

Steps to be Taken in Case Material is Released or Spilled : No special precautions

Waste Disposal Method : Disposal procedures for solid waste in accordance with local, state, and federal regulations.

Special Protection information

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Special Precautions

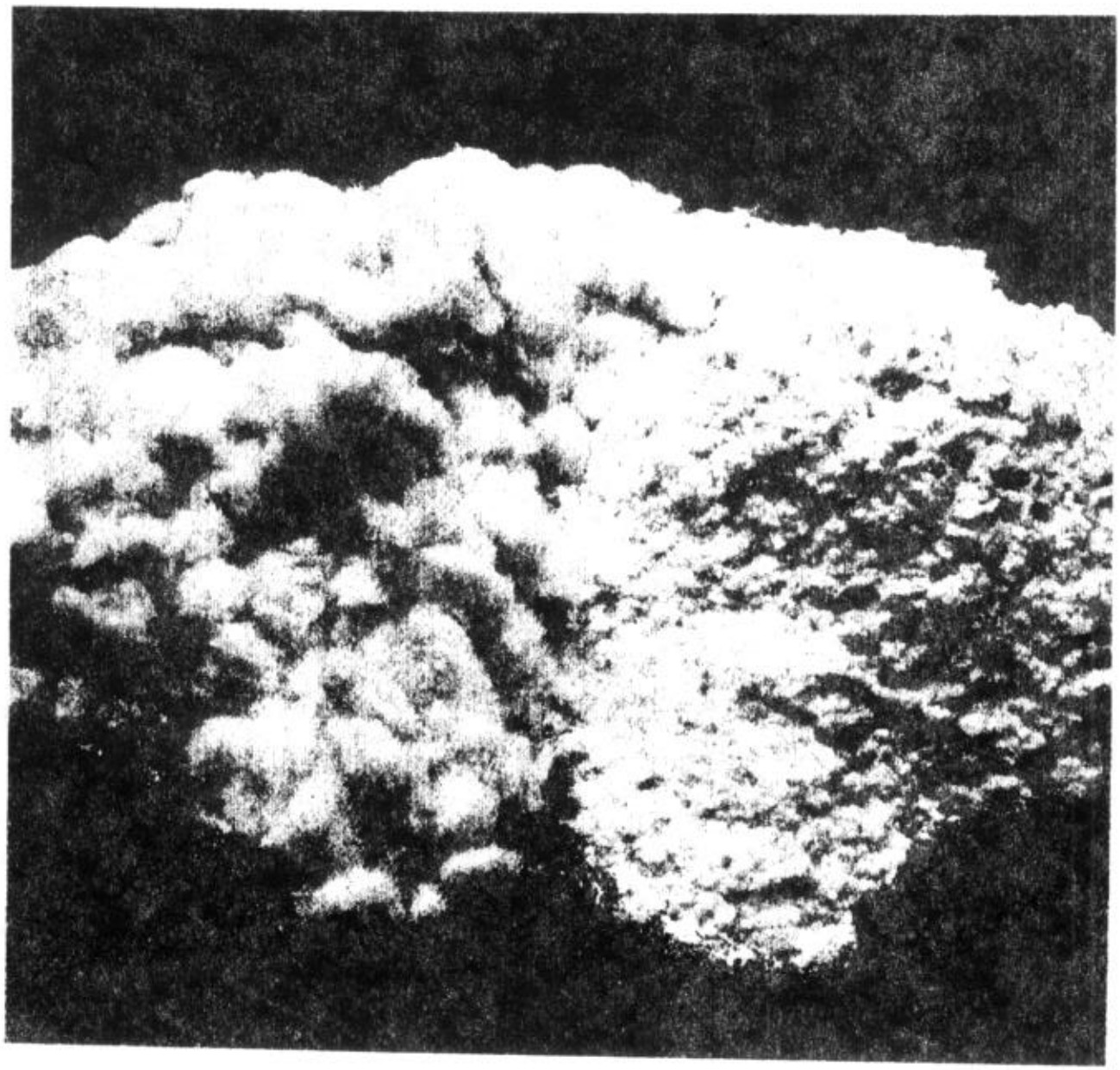
Precautions to be taken in storing : generally none known, however, once the package is opened, pay attention not to get wet and avoid keeping at high humidity which may occur clogging problem.

Other precautions : None known

June 20,1991

Owens Corning

Milled Fibers



OWENS CORNING

Milled Fibers

Introduction

The use of milled fibers in various resin systems enhances mechanical properties, dimensional stability and heat resistance. Owens Corning produces a family of milled glass fibers formulated for a variety of applications in the automotive, electrical, consumer, construction and aerospace markets. These products are manufactured from fiber input using Statistical Process Control to insure consistent quality and performance. Owens Corning is continually upgrading its processes and products to meet evolving customer needs.

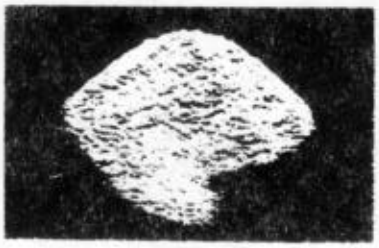
Description

Fiberglas® brand milled fibers are glass filaments coated with a specific sizing to enhance resin compatibility and hammermilled to a specified bulk density. Unlike chopped strands, which are chopped to a precise strand length, milled fibers are hammermilled to an average fiber length. Average fiber length is determined by the input glass and process conditions. These products are designed for use in a variety of thermoplastic and thermoset compounds.

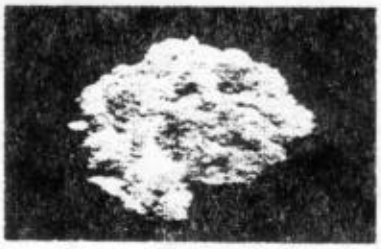
® Fiberglas is a registered trademark of Owens Corning

Characteristics

Milled fibers are produced in two general product forms: powder and floccular.



Powder: Relatively free flowing with a high bulk density. Used in formulations which require very uniform dispersions and short fibers.



Floccular: Small modules of glass filaments. Used in formulations where increased bulk or longer filaments are needed.

Product Data

The following product grid summarizes the product data:

Product Description	Sizing Type	Average Filament Diameter (Micrometers)	Nominal Bulk Density g/cm³	Appearance
731EC 1/32"	Cationic	15.8	.65	Powdery
731ED 1/32"	Cationic	15.8	.55	Floccular
731ED 1/16"	Cationic	15.8	.30	Floccular
731ED 1/8"	Cationic	15.8	.17	Floccular
737BC 1/64"	Silane	15.8	1.07	Powdery
737BD 1/16"	Silane	15.8	.45	Floccular
739DC 1/32"	*	15.8	1.08	Powdery
739EC 1/32"	*	13.3	1.08	Powdery
739DD 1/32"	*	15.8	.80	Floccular
739DD 1/16"	*	15.8	.50	Floccular

*739 contains no measureable quantity of organic sizing.

Applications

Owens Corning milled fibers are used in a variety of processes, applications, and markets.

Product	Resin Compatibility	Applications	Benefits
731	Polyester, Epoxy, Phenolic, Thermo-plastics	Electrical connectors, Automotive components Friction products Putty compounds Adhesives	Increases modulus
737	Urethanes, Thermoplastics	Automotive facia	Dimensional stability, Shrinkage control
739	PTFE, Thermoplastics	Automotive seals, gaskets & bearings, Aerospace components	Dimensional stability

Milled Fiber Mechanical Properties

Property	PTFE	Phenolic	Poly-urethane	Poly-urethane	Acetal Homo-polymer	Polyester	Epoxy
Glass Content (%)	20	20	10	30	20	56.9	33.1
Tensile Strength (Psi x 10^3)	2.4	7.0	2.7	3.3	9.0	3.7	5.7
Flexural Strength (Psi x 10^3)	4.0	15.0	2.5	4.7	16.0		
Flexural Modulus (Psi x 10^5)	2.5		0.10	0.20	7.3	.92	.66
Notched Izod Impact (ft. lb./in.)	3.2	0.5	4.1	2.7	1.0		
Elongation (%)	5	0.2	59.6	22.8	7	8.3	9.9
DTU (264 Psi, OF)	150	400		315			
Dielectric Strength (v/mil)		425		490			
Dielectric Constant (1MHZ)		5.0					
Dissipation Factor (1MHZ)		0.01					
Water Absorption (%, 24 hour)		0.1					
Recommended Reinforcement	739DC1/32"	731ED1/8"	737BD1/16"	737BD1/16"	731ED1/8"	731ED1/32"	731ED1/32"

Source: 1989-90 Modern Plastics Encyclopedia

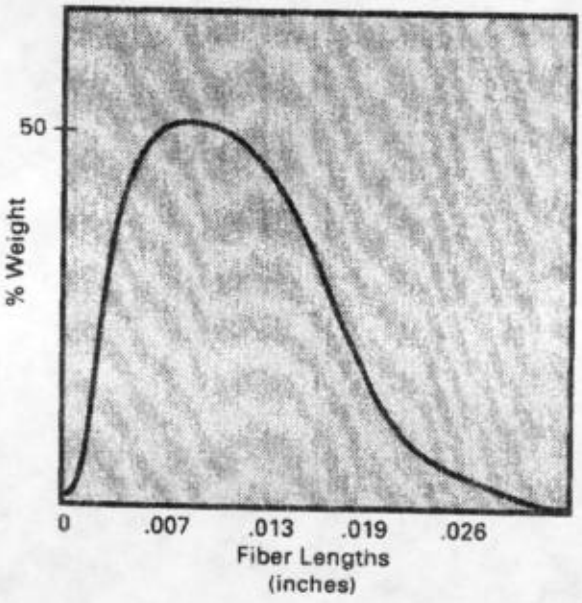
Source: Owens Corning

Processing

Milled fibers can be mixed with both wet and dry resin systems using conventional mixing equipment; however, mixing with a liquid system or liquid component is usually preferred. Higher shear mixing may be required to improve the dispersion of floccular products. Powder products in a liquid system can be pumped, sprayed, or injected using RTM, RIM, or spray equipment. Milled fibers can be dry blended with PTFE or compounded in thermoplastic resins. Powder products should be used in adhesives and surface critical applications.

Typical Fiber Length Distibution of a 1/16" Milled Fiber

The average fiber length on all milled fiber products ranges from .0021 inch to .0136 inch however, this is not a directly controlled parameter. Bulk density is the preferred control parameter.



Packaging
All products are available in polylined kraft bags, bulk cartons or fiberboard drums.

Kraft Bags
Average weight — 30 to 50 lbs.
No. per pallet — 27 to 36
Pallet dimensions — 45" x 45"
Average pallet weight — 1800 lbs.

Bulk Cartons
Average weight — 1800 lbs.
No. per pallet — 1
Pallet dimensions — 45" x 45"

Fiberboard Drums
Average weight per drum — 250 lbs.
No. per pallet — 4
Pallet dimensions — 38" x 43"
Average pallet weight — 1000 lbs.

Statement of Liability
This information is based on tests conducted by Owens Corning. We believe this information to be reliable, but do not guarantee its applicability to the user's process or assume any liability for occurrences arising out of its use. The user, by accepting the products described herein, agrees to be responsible for thoroughly testing any application before committing to production. Our recommendations should not be taken as inducements to infringe on any patent or violate any law, safety code or insurance regulation.

OWENS CORNING™
OWENS CORNING WORLD HEADQUARTERS
ONE OWENS CORNING PARKWAY
TOLEDO OHIO 43659

Pub. No. 1-PL-16058-B Litho U.S.A., September, 1996

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3/11

(6) 0277880 -005

MATERIAL SAFETY DATA SHEET

11/12/98

Section 1: Product and Company Information

Product Name(s): Cardable Fiber, Complex Reinforcements (Agimat, Aginap, Bi-Ply® Mat), CRATEC® Chopped Strand, CRATEC Plus® Chopped Strand; Chopped Strand, Cordage, Lot Glass, Mat or Veil Products, Roving, S2 Glass® Fibers, Type-30® Roving, Wax Bonded Strand, Wet Chop, Woven Roving, Yarn.

Manufacturer: Owens Corning, One Owens Corning Parkway, World Headquarters, Attn. Product Stewardship, Toledo, OH, 43659,
Telephone: 1-419-248-8234 (8am-5pm ET weekdays).

Emergency Contacts:
Emergencies ONLY (after 5pm ET and weekends): 1-419-248-5330,
CHEMTREC (24 hours everyday): 1-800-424-9300,
CANUTEC (Canada- 24 hours everyday): 1-613-996-6666.

Health and Technical Contacts:
Health Issues Information (8am-5pm ET):1-419-248-8234,
Technical Product Information (8am-5pm ET): 1-800-GET-PINK.

Section 2: Composition and Ingredient Information

Common Name	Chemical Name	CAS No.	Wt. %
Fiber Glass Continuous Filament (non respirable)*	Fibrous Glass	65997-17-3	98- 100
- Nonrespirable filaments and particulate			>98%
- Respirable particulate			<1%
- Respirable particulate with fiber-like dimensions (glass shards)			<0.002%
Size	Size	mixture	0-2%

Note: *See Section 8 of MSDS for exposure limit data for these ingredients.

Section 3: Hazards Identification

Appearance and Odor: White/off-white colored solid with no odor.

Emergency Overview

No unusual conditions are expected from this product

Primary Route(s) of Exposure: inhalation, skin, eye

Potential Health Effects:

ACUTE (short term): Fiber glass continuous filament is a mechanical irritant. Breathing dusts and fibers may cause short term irritation of the mouth, nose and throat. Skin contact with dust and fibers may cause itching and short term irritation. Eye contact with dust and fibers may cause short term mechanical irritation. Ingestion may cause short term mechanical irritation of the stomach and intestines. See Section 8 for exposure controls.

CHRONIC (long term): There is no known chronic health effects connected with long term use or contact with this product. In a laboratory test of a different product with comparable composition and durability, animals breathing very high concentrations of respirable fibers on a long-term basis developed fibrosis, lung cancer and mesothelioma. See Section 11 of MSDS for more toxicological data.

Medical Conditions Aggravated by Exposure: Respiratory or skin conditions that are aggravated by mechanical irritants may be at a increased risk for worsening from exposure to this product.

Section 4: First Aid Measures

Inhalation: Move person to fresh air. Seek medical attention if irritation persists.

Eye Contact: Flush eyes with running water for at least 15 minutes. Seek medical attention if irritation persists.

Skin Contact: Wash with mild soap and running water. Use a washcloth to help remove fibers. To avoid further irritation, do not rub or scratch affected areas. Rubbing or scratching may force fibers into skin. Seek medical attention if irritation persists.

Ingestion: Ingestion of this material is unlikely. If it does occur, watch the person for several days to make sure that intestinal blockage does not occur.

Section 5: Fire Fighting Measures

Flash Point and Method: None

Flammability Limits (%): None.

Auto Ignition Temperature: Not Applicable.

Extinguishing Media: Water, foam, CO_2 or dry chemical.

Unusual Fire and Explosion Hazards: None known.

Fire Fighting Instructions: Use self contained breathing apparatus (SCBA) and full bunker turnout gear in a sustained fire.

Hazardous Combustion Products: Primary combustion products are carbon monoxide, carbon dioxide and water. Other undetermined compounds could be released in small quantities.

Section 6: Accidental Release Measures

Releases of this product to the land, water and air may require reporting to federal, state or local authorities.

Land Spill: Scoop up material and put into suitable container for disposal as a non-hazardous waste.

Water Spill: This material will sink and disperse along the bottom of waterways and ponds. It can not easily be removed after it is waterborne; however, the material is non-hazardous in water.

Air Release: This material will settle out of the air. If concentrated on land it can then be scooped up for disposal as a non-hazardous waste.

Section 7: Handling and Storage

Storage Temperature: Not applicable.

Storage Pressure: Not applicable.

General: No special storage or handling procedures are required for this material.

Section 8: Exposure Controls and Personal Protection

Ingredient	OSHA PEL (8-hr TWA)	ACGIH TLV (8-hr TWA)
Fiber Glass Continuous Filament :		
- Nonrespirable fibers and particulate	15 mg/m^3 (total dust)	5 mg/m^3 (inhalable fraction)
- Respirable particulate	5 mg/m^3 (respirable dust)	3 mg/m^3 (PNOC)
- Respirable particulate with fiber like-dimensions (glass shards)	None Established	1 fiber/cc (respirable)
Size	None Established	None Established

PNOC = Particles not otherwise classified

As manufactured continuous filament glass fibers are not respirable. Continuous filament glass products that are chopped, crushed or severely mechanically processed during manufacturing or use may contain a very small amount of respirable particulate, some of which may be glass shards.

Ventilation: General dilution ventilation and/or local exhaust ventilation should be provided as necessary to maintain exposures below occupational exposure limits.

Personal Protection:

Respiratory Protection: A properly fitted NIOSH/MSHA approved disposable dust respirator such as the 3M model 8210 (formerly 8710) or model 8271 (formerly 9900) in high humidity environments) or equivalent should be used when: high dust levels are encountered; the level of glass fibers in the air exceeds the occupational exposure limits; or if irritation occurs. Use respiratory protection in accordance with your company's respiratory protection program, local regulations and OSHA regulations under 29 CFR1910.134.

Skin Protection: Loose fitting long sleeved shirt that covers to the base of the neck, long pants and gloves. Skin irritation is known to occur chiefly at pressure points such as around neck, wrist, waist and between fingers.

Eye Protection: Safety glasses, goggles or face shield.

Work and Hygienic Practices: Handle using good industrial hygiene and safety practices. Avoid unnecessary exposures by using adequate local exhaust ventilation. Remove material from the skin and eyes after contact. Remove material from clothing using vacuum equipment (never use compressed air). Always wash work clothes separately from other clothing. Wipe out the washer or sink to prevent loose glass fibers from getting on other clothing). Keep the work area clean of dusts and fibers released during processing or fabrication. Use vacuum equipment to clean up product Avoid dry sweeping or using compressed air as these techniques re-suspend dusts and fibers into the air. Have access to safety showers and eye wash stations.

Section 9: Physical and Chemical Properties

Vapor Pressure (mm Hg @ 20°C): Not Applicable

pH: Not Applicable

Vapor Density (Air=1): Not Applicable

Specific Gravity (Water=1): 2.60

Boiling Point: Not Applicable

Solubility in Water: Insoluble

Viscosity: Not Applicable

Appearance: Solid

Physical State: Solid

Odor Type: None

Freezing Point: Not Applicable

Evaporation Rate (n-Butyl Acetate=1): Not Applicable

Section 10: Stability and Reactivity

General: Stable

Incompatible Materials and Conditions to Avoid: None

Hazardous Decomposition Products: Sizings or binders may decompose in a fire. See Section 5 of MSDS for combustion products statement.

Hazardous Polymerization: Will not occur.

Section 11: Toxicological Information

CARCINOGENICITY: The table below indicates whether or not each agency has listed each ingredients as a carcinogen:

Ingredient	ACGIH	IARC	NTP	OSHA	97/69/EC
Fiber Glass Continuous Filament[a]	A4	3	No	No	No
Size	No	No	No	No	No

ACGIH: A4 Not Classifiable as a Human Carcinogen
IARC 3: Not Classifiable with respect to Human Carcinogenicity

[a] includes: Nonrespirable glass particulate, Respirable glass particulate, and Respirable particulate with fiber-like dimensions (glass shards)

	LD_{50} Oral (g/kg)	LD_{50} Dermal (g/kg)	LC_{50} Inhalation (ppm, 8 hrs.)
Fiber Glass Continuous Filament[(a)]	Not Available	Not Available	Not Available
Size	Not Available	Not Available	Not Available

Fiber Glass Continuous Filament: The International Agency for Research on Cancer (IARC) in June, 1987, categorized fiber glass continuous filament as not classifiable with respect to human carcinogenicity (Group 3). The evidence from human as well as animal studies was evaluated by IARC as insufficient to classify fiber glass continuous filament as a possible, probable, or confirmed cancer causing material.

The American Conference of Governmental Industrial Hygienists (ACGIH) A4 classification,, not classifiable as a human carcinogen, for respirable continuous filament glass fibers is based on inadequate data in terms of its carcinogenicity in humans and/or animals.

For respirable continuous filament glass fibers, a TLV-TWA of 1 fiber/cc was adopted to protect workers against mechanical irritation. The TLV-TWA of 5 mg/m3 was adopted for nonrespirable glass filament fiber, measured as inhalable dust, to prevent mechanical irritation of the upper respiratory tract.

Note: There are no known chronic health effects connected with long term use or contact with these products.

Products that are chopped, crushed or severely mechanically processed during manufacture or use may contain a very small amount of respirable glass fiber-like fragments. NIOSH defines "respirable fibers " as greater than 5 microns in length and less than 3 microns in diameter with an aspect ratio of $\geq$ 5:1(length-to-width ratio).

Chronic Study in Animals

A laboratory test was conducted with a different product (special application glass fiber) with comparable composition and durability. Test animals breathing very high concentrations of respirable fibers on a long-term basis developed fibrosis, lung cancer and mesothelioma.

About 23% of the rats (n=43) exposed to 1022 f/cc for 5 hrs/day, 7 days/week for 52 weeks developed lung tumors (adenoma and carcinoma). Five percent (5%) of the unexposed control group (n=38) developed lung tumors (adenoma and carcinoma).

Five percent (5%) of the rats in the exposed group developed mesothelioma and 12.5% developed advanced fibrosis. None of the rats in the unexposed control group developed mesothelioma and 0.6 % developed advanced fibrosis.

A second group of rats was exposed to a similar concentration of asbestos (respirable amosite fibers) for 5 hours/day, 7 days a week for 52 weeks. 38% of the rats developed lung tumors (adenoma and carcinoma) and 5 % developed mesothelioma. 14.5 % developed advance fibrosis.

Importantly, this result, that is similar disease rates for the special application fiber and amosite asbestos, had been predicted in a 1996 scientific paper (Inhal. Tox. 8:323-343, 1996 ref). That paper specifically stated that in rats all fibers which were durable enough to remain in a rat lung for two (2) years or more would produce the same disease rates if the exposures were the same. While the special application fiber is much less durable than asbestos, it is stable enough to remain in the rat lung for more than the two (2) year time period. The results of the current study are therefore not unexpected, and they do not indicate that similar disease rates would be seen in longer lived species or humans, exposed to these fibers.

Section 12: Ecological Information

This material is not expected to cause harm to animals, plants or fish.

Section 13: Disposal Considerations

RCRA Hazard Class: Non-hazardous.

Section 14: Transport Information

DOT Shipping Names: Not regulated

Hazard Class or Division: None

Secondary: None

Identification No.: None

Packing Group: None

Label(s) required (if not excepted): None

Special Provisions: None

Packaging Exceptions: None

Non-bulk Packaging: None

Bulk packaging: None

EPA Hazardous Substances: None

RQ: None

Quantity Limitations: **Passenger Aircraft:** None
Cargo Aircraft: None

Marine Pollutants: None

Freight Description: None

Hazardous Material Shipping Description: None

Transportation of Dangerous Goods - Canada

Proper Shipping Name: Not Regulated

TDG Hazard Classification: **(Primary):** None **(Secondary):** None

IMO Classification: None

ICAO/IATA Classification: None

Product Identification Number: None

Packing Group: None

Control Temperature: None **Emergency Temperature:** None

Schedule XII Quantity Restriction: None

Reportable Quantity for US Shipments: None

IATA Packing Instructions:

Passenger/Cargo: None
Cargo Only: None
Limited Quantity: None

Maximum Net Quantity per Package:

Passenger/Cargo: None
Cargo Only: None
Limited Quantity: None

Special Provisions: None

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MATERIAL SAFETY DATA SHEET

Section 15: Regulatory Information

TSCA Status: Each ingredient is on the Inventory.

NSR Status (Canada): Each ingredient is on the DSL.

SARA Title III:

Hazard Categories:

Acute Health:	Yes
Chronic Health:	No
Fire Hazard:	No
Pressure Hazard:	No
Reactivity Hazard:	No

Reportable Ingredients:

Sec. 302/304:	None
Sec. 313:	None

California Proposition 65: No ingredient is listed.

Clean Air Act: No ingredient is listed.

WHMIS (Canada): **Status:** Not Controlled
WHMIS Classification(s): None

Section 16: Other Information

HMIS and NFPA Hazard Rating:

Category	HMIS	NFPA
Acute Health	1	1
Flammability	0	0
Reactivity	0	0

NFPA Unusual Hazards: None.
HMIS Personal Protection: To be supplied by user depending upon use.

Revision Summary: This MSDS replaces the December 16, 1997 MSDS. The information was revised and updated in Section 2 Ingredients, Section 3 Potential health effects: chronic (long-term), Section 8: Exposure Controls and Personal Protection and Section 11- Toxicological Information

United States Testing Company, Inc.
Biological Services Division
1415 PARK AVENUE • HOBOKEN, NEW JERSEY 07030 • 201-792-2400
EST. 1880

REPORT OF TEST

Acute Inhalation Toxicity of
Thermal Degradation Products
Using The NYS Modified
Pittsburgh Protocol

on
MDR Fiberglass Reinforced Laminate
6406-150 (MDR-814)

Conducted for:

ICI Americas Inc.
General Chemicals Division
Mantua Grove Road
West Deptford, N.J. 08066

January 29, 1988

TEST REPORT NO. 060602-1

SIGNED FOR THE COMPANY

BY

Prepared by:

Charles C. Tong, Ph.D.
Director of Toxicology

Daniel Drozdowski
V.P. Biological Services Division

United States Testing Company, Inc.

Client: ICI Americas Inc.
General Chemicals Division
Mantua Grove Road
West Deptford, N.J. 08066

060602-1
1/29/88

Subject:

Sample submitted and identified by the Client as:

MDR Fiberglass Reinforced Laminate 6406-150 (MDR-814)

Sample Description: Laminate 0.16 in thickness

Project:

An inhalation test with laboratory mice was conducted in order to evaluate the acute inhalation health hazards associated with combustion products generated from certain building materials and interior finishes. The test used was based on a method developed by Dr. Yves Alarie of the University of Pittsburgh and is performed in accordance with the protocol and methodology as outlined and specified in the New York State Uniform Fire Prevention and Building Code, Article 15, Part 1120, Combustion Toxicity Testing, 9 NYCRR 1120 (2).

Summary:

When tested as specified, the "Reinforced Laminate 6406-150 (MDR-814)" has an LC_{50} of 99.52 gm (CI, 74.84-132.32). The results obtained in this study, therefore, indicate that the sample tested can be considered as not more toxic than wood according to the procedure and criteria filed by Dr. Y. Alarie for this test with the City of New York on January 22, 1987. Additional data are presented in Tables 1 and 2.

Introduction:

The purpose and intent of this safety test is to evaluate acute inhalation health hazards associated with combustion products generated from certain building materials and interior finishes. In this bioassay test procedure, laboratory mice are exposed to thermal decomposition products generated from the test article under standard conditions to evaluate the lethal potential of such thermal decomposition products (1).

This procedure is performed in accordance with the protocol and methodology as outlined and specified in the New York State Uniform Fire Prevention and Building Code, Article 15 Part 1120 Combustion Toxicity Testing, 9 NYCRR 1120 (2), and documented in United States Testing Co., Inc. Test Procedure PRO/TOX PITT/096-7.

Principals of the Test

Groups of laboratory mice are restrained in an all-glass chamber (head only exposure) and exposed for 30 minutes to thermal decomposition products generated from the test article under controlled heating conditions. By combusting different sample charge masses, a "dose"-lethality profile for the thermal decomposition products is obtained. These data can then be transformed by appropriate statistical methods to calculate a median lethal concentration (LC_{50}) for the thermal decomposition products generated from the test article. In addition to the calculated LC_{50} value, ancillary data regarding exposure conditions and the production of certain toxic gases are recorded and ammended to the report. Such information serves to validate the test procedure and is part of the data required for registering materials with the New York State Department of State, Office of Fire Prevention and Control.

Materials and Methods:

Apparatus/Equipment: Refer to Figure 1 for configuration of test apparatus.

Furnace, Programmer, Sample Holder and Mass Sensor

Lindberg Model 51894-5 special box furnace (22.9x22.9x35.6cm) with Model 59344-ES-B programmable control console. This special order furnace with access holes has a 3,500 W output with a maximum operating temperature of 1100°C.

The programmer is capable of heating the furnace at a linear rate 20°C/min from ambient temperature to 1000°C. Temperature is monitored by a Type K thermocouple. Within the furnace, a ceramic crucible sample holder is placed on a quartz pedestal. The pedestal extends through the bottom wall of the furnace and rests on a balance mass sensor. This balance, Scientech Model 3340, with a remote sensor unit, measures sample mass loss as the sample degrades in the box furnace.

Both the furnace temperature and the sample mass are recorded continuously via output to a two-channel Linseis Model L 601 flatbed strip chart recorder.

Glassware and All-glass Exposure Chamber - These custom made items were manufactured by Kontes Scientific Glassware, Vineland, N.J. to specification as directed in NYS UFPBC Article 15 and modified as shown in figure 1.

Exposure Chamber Atmosphere Monitoring - Temperature within the animal exposure chamber is monitored with a 0-60°C NBS traceable thermometer. Atmosphere concentrations of carbon monoxide (CO) and carbon dioxide (CO_2) are continuously monitored using a non-dispersive infrared analyzer, a Horiba MEXA 311-GE. These gas concentration measurements are continuously recorded with another Linseis two-channel recorder. Oxygen concentrations in the exposure chamber are monitored at defined intervals with a Beckman D-2 oxygen analyzer. Optional atmospheric analysis includes hydrocarbons measured with Horiba MEXA-224GE HC analyzer. Hydrogen cyanide (HCN), hydrogen chloride (HCL) or other toxic gases are quantitated by the use of direct sample Drager detector tubes or by taking grab samples of the atmosphere for analysis by specific ion electrode potentiometry or other suitable analytical methods.

Control of Dynamic Inhalation System - The Pittsburgh test is a dynamic inhalation system and is driven by a vacuum pump (Cole-Parmer Model DOA-P104BAA) capable of pulling a mixture of air from the furnace (11 LPM) and chilled dilutant air (9 LPM) through the exposure chamber for a total of 20 LPM. Airflows are controlled by 0-20 and 0-30 LPM flowmeters (Dwyer).

Test Animals

The animal model for the bioassay is the Swiss-Webster albino male mouse (22-30gm). Animals are housed and cared for following standard procedures (3). Test animals 5 to 7 weeks old are ordered from a registered USDA supplier. Upon receipt, animals are housed in groups of four in clear polycarbonate caging (29 x 19x 13 cm) with wood shaving bedding. Pelleted food and water are available ad libitum. Animals are held for observation for at least 7 days prior to testing to ensure healthy subjects are used in testing.

Client: ICI Americas Inc.

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1/29/88

Preparations Prior to Testing:

Sample Preparation

Prior to initiating testing, all samples evaluated by this procedure are stored for at least 48 hours in a controlled (40%-60% relative humidity) environment.

Test Apparatus

All glassware and the exposure chamber are cleaned and dried between test runs. The furnace and programmer and all electrical equipment are allowed switched on and allowed to stabilize for 15 minutes prior to adjustments or calibrations. The air chiller icebath is filled with ice and tap water. All gas concentration analyzers (O_2, CO, CO_2) are calibrated on a regular basis per our SOP using certified standard calibration gases. The test sample mass balance is also calibrated on a regular basis.

Test Procedure:

Using four test animals in the 22 to 30gm range for each run, each of the four is placed in an animal holder with the head extending through the perforated rubber dental dam seal (reinforced with duct tape) into the exposure chamber. The animals are secured and acclimated for 10 minutes with room airpulled through the system. During acclimation, air flowmeters are adjusted to allow 9 LPM of air to come through the chiller and 11 LPM from the furnace for a total air flow through the exposure system at 20 LPM.

The test sample is placed in the sample holder within the furnace. For the initial run, a sample mass of 10gm is used unless it is anticipated that 100% lethality will result. Upon verification that the sample weight sensor and recorder are correct and match, the temperature programmed furnace is activated from ambient temperature to increase at 20°C/min. The temperature at which 1% of the sample weight is lost is recorded. At this time, the exposure chamber is quickly connected to the furnace and the 30 minute exposure run is initiated.

Test Procedure: (con't)

During the 30 minute exposure, the furnace temperature, the sample ignition temperature and exposure chamber atmospheric conditions (CO_2, CO, O_2 and temperature °C) are monitored. At the end of the 30 minute exposure, the final sample weight is noted and the exposure chamber is disconnected from the furnace. Room air is drawn through the exposure chamber at 20 l/min for a 10 minute recovery period for the animals. Animals are then removed from the chamber and the eyes of the surviving are examined for corneal opacities. The number of dead animals is recorded.

After a dose-lethality relationship has been established for a test article by exposing groups of mice to at least four different sample charges, the LC_{50} value, in grams, is calculated by the method of Weil (4). Using this calculated sample charge, one additional test run, without animals, is performed to obtain representative test temperatures and gas analyses for the test article.

Experimental Results:

The results of this sample are presented in Table 1 and 2. The sample began to decompose at 333°C and decomposed throughout with 49.4 % of the sample remaining after the 30 minutes of heating. Flaming ignition occurred at 466°C.

The LC_{50} was estimated to be 99.52gm. The maximum level of CO, CO_2 are 7000 ppm and 1.9% respectively at the LC_{50} sample run. Oxygen level consistently remains above 19.0%.

Client: ICI Americas Inc.

060602-1
1/29/88

Table 1

Summary of Results

Description of Test Article: MDR Fiberglass Reinforced Laminate 6406-150 (MDR-814)

Number of Test Performed: 9

LC_{50}: 99.52gm (95% CI, 74.84-132.32)

Furnace Temperature at 1% Sample Mass Loss (°C): 333

Mean Furnace Temperature of Sample Autoignition (°C): 466

Furnace Temperature range of most rapid weight loss (°C): 340-810

Number of times and average duration exposure chamber exceed 45°C: none

Post-exposure condition of test animal eyes: all apparently normal

Mean Residue (%): 49.43

Client: ICI Americas Inc.

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1/29/88

Table 2

Test Run with LC_{50} Sample

Variables Measured	Sample: Laminate 6406-150 MDR-814
Decomposition and Exposure start at (°C)	333
LC_{50} (Grams)	99.52
(95% C.I.) =	(74.84-132.32)
LT_{50} (Minutes)	17:30
(Temp. °C)	683
Size of Sample (inches)	6.19x4.5x0.16
Max CO (ppm)	7000
Time (min)	17:30
Temp (°C)	683
Min O_2 (%)	19.0
Time (min)	9:00
Temp (°C)	539
Max CO_2 (%)	1.9
Time (min)	17:30
Temp (°C)	665
Residue After Burning (%)	46.43
Flaming Ignition (°C)	468

References:

1. Alarie, Y. and Anderson, R.C. "Toxicology and acute lethal hazard evaluation of thermal decomposition products of synthetic and natural polymers", Toxicology and Applied Pharmacology, Vol. 51, 1979, pp. 341-362.

2. Criteria and Procedures for Designation of Testing Laboratories Acceptable to the Secretary of State (In the manner set forth in 19 NYCRR 431).

3. Guide for the Care and Use of Laboratory Animals, DHHS Publications No. (NIH) 85-23.

4. Weil, C.S. "Tables for convenient calculation of median-effective dose (LD_{50} or ED_{50}) and instruction for their use", Biometrics, Vol. 8, 1952, pp. 249-261.

Preliminary Product Data

Urethane Specialties

AUTOFROTH 0035

A-side (isocyanate) component	9300A
B-side (polyol) component	101-B-0035 RESIN
Ratio by weight (A/B)	100/101 ± 5
Free-rise Density (lb/ft^3 - Using split mixer)	1.60 ± 0.1
Nominal Reactivity (minutes:seconds):	
- String Gel	2:00
- Tack-free	2:30
Component Temperatures (°F):	80 ± 3
Mold Temperatures (°F):	**95-105**
ASTM E-84 (Preliminary, max. thickness = 4"):	
Flame Spread*/Smoke Density	20/300
In-place Density (lb/ft^3)	2.25
K-factor (BTU/hr/in/ft^2/°F)	0.165
Dimensional Stability:	
-20 °F (7 days)	-1 (% Volume change)
158 °F, ambient R.H. (28 days)	-2
100 °F, 100 % R.H. (28 days)	-1
158 °F, 100 % R.H. (28 days)	-3
200 °F, ambient R.H. (28 days)	-3
Compression Strength (psi)	
Parallel	21
Perpendicular	21

* This numerical flame spread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.

BASF Corporation

13000 Levan Road
Livonia, MI 48150
(734) 591-6200
1-800-521-3820

THE DEPARTMENT OF FIRE TECHNOLOGY

INVESTIGATION OF THE SURFACE BURNING CHARACTERISTICS OF A 1.0 IN. THICK MEDIUM DENSITY POLYURETHANE FOAM, SPRAY APPLIED TO 0.25 IN. THICK GLASS REINFORCED CEMENT BOARD
MATERIAL ID: INSULSEAL FRF 190 CL1

SwRI PROJECT NO.: 01-8361-237b

FINAL REPORT

TEST DATE: 19-AUG-1997

REPORT DATE: 3-SEP-1997

Prepared for:

POLYFOAM PRODUCTS, INC.
2400 SPRING STUEBNER ROAD
SPRING, TEXAS 77389

SOUTHWEST RESEARCH INSTITUTE
Chemistry & Chemical Engineering Division

SAN ANTONIO, TEXAS
Houston, Texas • Detroit, Michigan • Washington, D.C.

FAX

Date 07/08/99

Number of pages including cover sheet 6

TO: Ron Moor
Ashland Chemical/ FRP Supply

Phone
Fax Phone 330-296-3025

FROM: Pat Donahue
Polyfoam Products, Inc.
2400 Spring Stuebner Rd.
Spring, TX 77389

Phone 281-350-8888
Fax Phone 281-288-6450

CC:

REMARKS: ☐ Urgent ☒ For your review ☐ Reply ASAP ☐ Please Comment

Following cover is the fire testing report on the material being used at PDG. Please give me a call if you need anything else. I've also mailed you a handful of copies of our new manual for operation and repair of the Foampro gun.

INTRODUCTION

This report presents the results of an ASTM E84 test on a specimen submitted by the Client. The test is conducted in accordance with the procedure outlined in ASTM E84-97, "Standard Test Method for Surface Burning Characteristics of Building Materials" (NFPA 255, ANSI/UL 723 and UBC 8-1).

This test method for the comparative surface burning behavior of building materials is applicable to exposed surfaces, such as ceilings or walls, provided that the material or assembly of materials, by its own structural quality or the manner in which it is tested and intended for use, is capable of supporting itself in position or being supported during the test period. These tests are conducted with the material in the ceiling position.

The purpose of this test method is to determine the relative burning behavior of the material by observing the flame spread along the specimen. Flame Spread and Smoke Developed index are reported. However, there is not necessarily a relationship between these two measurements.

For each test, a specimen measuring at least 21 in. wide x 24 ft long is required. The specimen may consist of a continuous, unbroken length, or of sections joined end-to-end. When requested by the Client, specimens are prepared at SwRI following the Client's instructions. Unless otherwise indicated by the Client, test specimens are conditioned as appropriate in an atmosphere maintained between 68 and 78°F and 45 to 55% relative humidity.

Immediately prior to the test, the specimen is mounted in the furnace with the side to be tested facing the test flame. Sometimes, because of the nature of the material undergoing testing, additional support (e.g. wire, wire and rods, rods, and/or bars) is used to ensure that the specimen will remain in position during the test. The use of supporting materials on the underside of the test specimen may lower the Flame Spread Index from that which might be obtained if the specimen could be tested without such support, and the test results do not necessarily relate to indices obtained by testing materials without such support.

The flame front position and light obscuration are recorded throughout the 10-minute test and used to calculate the Flame Spread and Smoke Developed indices. The temperature at 24 ft is also recorded.

The Flame Spread and Smoke Developed indices reported herein are relative to the results obtained for mineral fiber-reinforced cement board and select grade red oak (moisture content between 6 and 8%). The mineral fiber-reinforced cement board is the calibration material used to obtain 0 values for Flame Spread and Smoke; red oak decks are used to obtain 100 values for Flame Spread and Smoke.

The results apply specifically to the specimens tested, in the manner tested, and not to the entire production of these or similar materials, nor to the performance when used in combination with other materials.

This standard should be used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions and should not be used to describe or appraise the fire-hazard or fire-risk of materials, products, or assemblies under actual fire conditions. However, results of the test may be used as elements of a fire-hazard assessment or a fire-risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard or fire risk of a particular end use.

This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

TABLE 8-A---FLAME SPREAD CLASSIFICATION

Class	Flame-spread Index
I	0-25
II	26-75
III	76-200

ASTM E 84-97 REPORT

CLIENT: POLYFOAM PRODUCTS, INC.
SWRI PROJECT NO: 01-8361-237b
DAILY TEST NO: 2

DESCRIPTION OF SPECIMEN

DATE RECEIVED:	13-Aug-1997 (received ready-to-test)
MATERIAL ID:*	Insulseal FRF 190 CL1
DESCRIPTION:	Medium density polyurethane foam, with skin surface intact, spray applied to 0.25 in. thick glass reinforced cement board
THICKNESS:	1.0 in.
DENSITY:*	1.9 lbs/cu ft
COLOR:*	Dark amber
SPECIMEN SIZE:	Three sections 24.0 in. wide x 96.0 in. long
CONDITIONING TIME:	6 days at 70°F and 50% relative humidity
SUPPORT USED:	None
WITNESSED BY:	Mr. Pat Donahue and Mr. Joe Molina of Polyfoam Products, Inc.

* From Client's material description

ASTM E 84-97 REPORT

CLIENT: POLYFOAM PRODUCTS, INC.
SWRI PROJECT NO: 01-8361-237b
DAILY TEST NO: 2

TEST RESULTS (ROUNDED TO NEAREST 5)

FLAME SPREAD INDEX (FSI):	25
SMOKE DEVELOPED INDEX (SDI):	320

TEST DATA

Unrounded FSI:	25.0
Unrounded SDI:	317.7
FS*Time Area (Ft*Min):	48.6
Smoke Area (%*Min):	217.5
Fuel Area (°F*Min):	5258.5

OBSERVATIONS DURING TEST

IGNITION TIME (Min:Sec):	0:03
MAXIMUM FLAME FRONT ADVANCE (Ft):	5.0
TIME TO MAXIMUM ADVANCE (Min:Sec):	1:20
MAXIMUM TEMP. AT EXPOSED TC (°F):	575
TIME TO MAXIMUM TEMP. (Min:Sec) :	9:35
TOTAL FUEL BURNED (Cu. Ft.):	52.4
DRIPPING (Min:Sec):	None
FLAMING ON FLOOR (Min:Sec):	None
AFTERFLAME TOP (Min:Sec):	None
AFTERFLAME FLOOR (Min:Sec):	None

CALIBRATION DATA (LAST RED OAK)

RED OAK SMOKE AREA (%*Min):	47.0
RED OAK FUEL AREA (°F*Min):	8737.6
GRC BOARD FUEL AREA (°F*Min):	4937.8

Preliminary Product Data

Urethane Specialties

AUTOPOUR® 9707

DESCRIPTION: AUTOPOUR® 9707 / AUTOPOUR® 931-2113 is a two component, polymeric MDI based high density system formulated for simulated wood and decorative molding applications.

AUTOPOUR® 9707 RESIN COMPONENT

Appearence	Amber liquid
Odor	Slight Amine
Specific Gravity (@ 80°F)	1.14
Viscosity (@ 80°F)	500 cps
Flash Point	Over 200°F

AUTOPOUR® 931-2113 ISO COMPONENT

Appearence	Dark brown liquid
Odor	Slight Aromatic
Specific Gravity (@ 80°F)	1.22
Viscosity (@ 80°F)	200 cps
Flash Point	Over 400°F
Vapor Pressure	0.00016 mm Hg (@ 68°F)

PROCESSING PARAMETERS

A-side (isocyanate) Component Code	AUTOPOUR® 931-2113
B-side (polyol) Component Code	AUTOPOUR® 9707
Ratio by weight ("A"/"B")	100 / 87 ± 5
Free-Rise Density #10 Cup (pcf)	11.0 ± 0.5
Nominal Reactivity (min.-sec.)	
- String Gel	1'40"
- Tack Free	2'40"
Component Temperature (F)	85 ±5
Mold Temperatures (F)	100 - 120

** System developed on SL-317 equipment with standard mixer. Foam characteristics will vary with different equipment.*

BASF Corporation

13000 Levan Rd.
Livonia, Michigan 48150-3799
(734) 591-6200
1-800-521-3820

BASF

Preliminary Product Data

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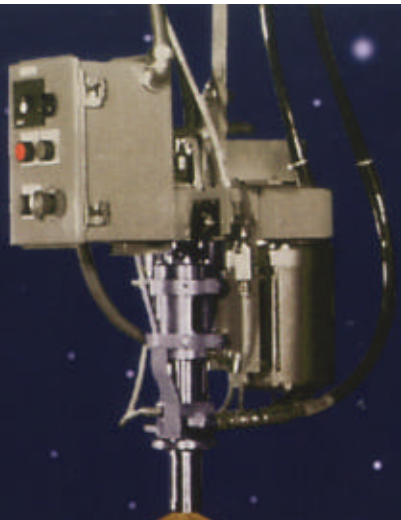
BASF



ISOFOAM®

Polyurethane Liquid Foam Systems

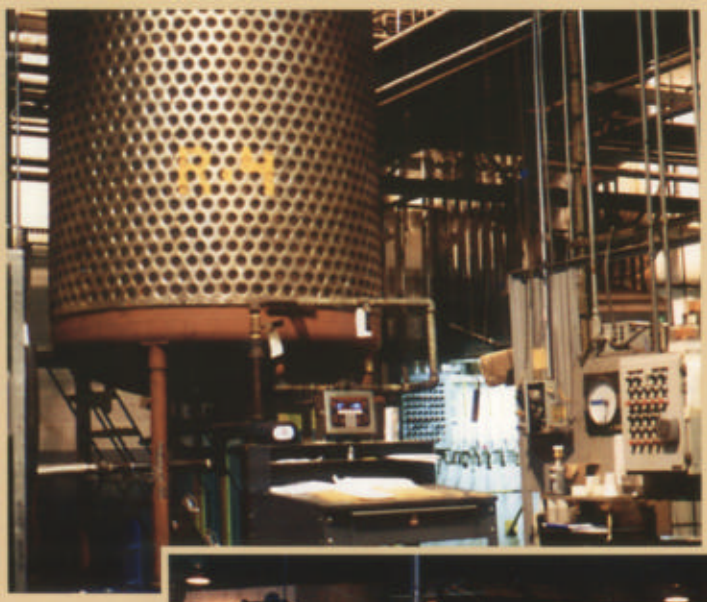
IPI INTERNATIONAL, INC.

505 Blue Ball Road · P.O. Box 70 · Elkton, Maryland 21922-0070

1-800-544-1216 · 410-392-4800 · Fax 410-398-7391

LEADERSHIP

IPI...An Industry Leader Since 1954



IPI was founded in 1954 and is the oldest supplier of liquid polyurethane foam systems in the industry. We have always been a recognized leader and consistently maintain that position.

IPI has six locations across the United States and Canada to ensure the manufacturing capabilities necessary to service our loyal customers. Our sales staff is composed of highly-trained professionals who are able to provide the technical "know-how" required to furnish our accounts with the tools they need to build their business.

IPI's laboratory staff is always utilizing their expertise to develop new products for the marketplace as well as finding innovative uses for our existing product line. They are ready to assist our sales staff in any and all situations that might arise. Their quality control program is second to none to assure consistent material each time a customer purchases.

IPI can provide a complete line of products from the system material to the coating required as well as the equipment necessary to process it. We provide product in drums, pressurized cylinders, totes and tankwagons. We ship our materials throughout North, Central and South America and export outside this area as well. We also have a distribution network set up across the United States to assist us in our marketing efforts.

IPI products are all around you in all aspects of your every-day existence. They help to keep your building warm and your food and drink cold; they're with you when you ride in a car or on a motorcycle; they are in many of the toys your children have and in the sports equipment you use; and they are even in the boat that takes you fishing or skiing. We find new places for our products every day!

CREATIVITY

Polyurethane Foam Systems

Rigid Pour-In-Place

Our rigid polyurethane foam systems are closed cell thermosetting plastics characterized by high strength to weight ratio with the primary advantage being outstanding insulation and buoyancy. They are two-component systems comprised of an isocyanate and a resin compound which typically contains polyols, catalysts, surfactants, fire retardants and blowing agents. The uses for our rigid polyurethane foams are never-ending.

The growth of the modular home industry has put more demand on rigid polyurethane foam for construction panels. Mixing and metering equipment is used to inject the proper amount of Isofoam® into the sandwiched mold. These mixed chemicals expand and fill the cavity, adhering to the metal skin as it cures to produce rigid, low density foam panels. The panels are then demolded and ready to be installed.

Our rigid polyurethane foam systems also include Coast Guard approved systems for flotation. There are uses for this material in pleasure and commercial boats as well as additional flotation devices such as buoys, floating docks, pontoons, and barge cavities.

You will also find our rigid polyurethane systems used for insulated doors, composite panels, decorative moldings, controlled atmosphere buildings, walk-in coolers, water heaters, refrigeration units, window channels and much more.

DEPEND

Isofoam Polyurethane

A GOOD ROOF SHOULD...

- Keep snow and rain out of the building
- Contribute to the comfort of the building
- Extend the life of the building
- Be easy to inspect and maintain

As important as the foam, is the proper coating to finish the roofing system. Polyurethane foam roofing systems should be covered with the proper coating for the application. IPI can provide the coating to meet your job specifications. Call us to discuss your project requirements.

Consider some of the advantages of Spray-Applied Polyurethane Foam Roofing

Conserves Energy

Light Weight

Easy To Apply

Monolithic

Self-Adhering

UL Classified

Self Flashing

Extended Building Life

Isofoam® roofing systems do this and more!

ABILITY

Foam Roofing Systems

Isofoam® Polyurethane Foam Roofing Systems

Spray-applied polyurethane foam roofing has been in use for many years. In many cases, it provides the only viable roofing system for special roofing problems. IPI is the technology leader with our Isofoam® polyurethane chemical systems. Many contractors choose IPI as their polyurethane foam supplier over all other manufacturers. The Isofoam® product line is recognized for consistency, reliability, and quality.

The Isofoam® roofing system consists of a spray applied polyurethane foam insulation base and protective elastomeric membrane. The polyurethane foam is produced by combining two liquids through high-pressure spray equipment. The mixed liquids expand and cure into a monolithic insulation that tightly adheres to the substrate. As little as half an hour later, the elastomeric membrane can be spray applied over the insulation to complete the roofing system. In the case of an aggregate roof application, a gravel covering is applied over the foam.

Detail can make the difference between a good roof and continuing roofing problems. The process begins with the selection of a contractor with the knowledge, experience, and proper equipment to ensure quality workmanship. The roofing materials should be supplied by a company with a reputation for consistency, reliability, and quality. The application equipment should be selected to meet the size of the job and be capable of handling the materials being applied.

IPI is able to provide a complete system for your roofing application, from the foam insulation to the coating to finish the job. We can also provide you with the proper equipment to give you the best possible application. We provide quality products and personal service to our accounts. Our relationship with our customers does not stop when the sale is made. We know that the service we provide to our customers is just as important as the product they receive.

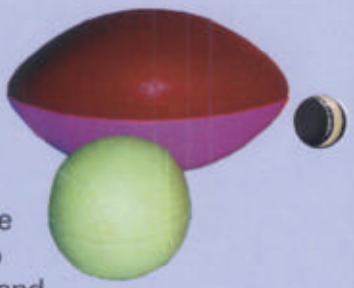
FLEXIBILITY.

Polyurethane Foam Systems

Our Isofoam® flexible products are so diversified as to boggle the imagination! They are used in automotive applications as well as motorcycle and snowmobile seating. They are also valuable as molded packaging materials to keep those precision instruments in place during shipment.

There are numerous Isofoam® products used to produce toys, balls and dolls as well as provide ballast for baseball bats and handles for tennis racquets. Golfers, it could be Isofoam® giving your favorite club just the right swing weight.

Isofoam® products are beneficial for the safety of athletes in sports activities. They protect the different body parts from injury during participation in contact sports. They also are used for shoe inserts to help provide the proper padding and avoid stress on muscles and tendons.



Other important applications for our flexible products are in medical training aides, resuscitation dummies and prosthetics. Our Castomer® elastomer products have been utilized in beds specially designed for burn victims.

VERSATILITY

Unlimited Applications

ISOFROTH® SFWF Urethane Foam Dispensing Machine

APPLICATIONS

Building Products

Insulation for entry doors, overhead doors and building panels.

Refrigeration

Insulation for walk-ins, reach-ins, ice machines, refrigerators and freezers.

Marine Flotation

Urethane foam makes a long lasting, gasoline resistant floating material for power boats, buoys and barges.

Semi-Trailers and Truck Bodies

Insulation for refrigerated trailers and dry freight vans.

Plastic Molding

Filling cavities in thermal formed or rotationally molded parts where the desired result is improved structural strength or insulation.

One day is not enough time to completely evaluate a foam dispensing machine or urethane foam chemical system. For this reason, we offer a conditional 30-day trial. Upon signing the licensing agreement, IPI will deliver an Isofroth® SF foam machine and chemicals. An invoice will be rendered covering the licensing fee and the chemicals. If, after the 30 days, you are not satisfied with the foam dispensing equipment, it can be returned for full credit. Unused chemicals may also be returned for full credit.

- Hot water and air are used to flush the foam dispensing machine.
- No toxic solvents - No solvent disposal - No employee exposure.
- Used water can generally be discharged into a sanitary sewer (Consult with local authorities).
- Incorporates a disposable mix chamber which can also be mechanically cleaned.
- Allows for hydraulic purging of sensitive pathways for overnight or long-term storage.
- One source for foam machine and chemicals, eliminating communications problems.
- Start-up and training services are provided free of charge.
- Maintenance problems are minimal since no pumps or motors are required.

The Isofroth® SF foam dispensing machine is warranted against defects in materials and workmanship for a period of one (1) year. There is no other warranty or representation made with respect to the use of Isofroth® SF equipment or Isofroth® chemicals. There is no implied warranty of merchantability or suitability for any particular purpose.

IPI International, Inc.
P.O. Box 70
505 Blue Ball Road
Elkton, Maryland 21922-0070
800-544-1216

IPI South Central
419 East Union Street
Monticello, Arkansas 71655

IPI Mid-West
1151 Atlantic Drive #5
West Chicago, Illinois 60185

IPI West Coast
12243 Branford Street
P.O. Box 1367 (91353-1367)
Sun Valley, California 91352

IPI Canada
440 Conestoga
Waterloo, OT N2L 4E2
Canada

IPI South East
7540 Fifteenth Street East
Sarasota, Florida 34243

Isofoam® 2-Component Liquid Polyurethane Rigid & Flexible Foam Systems
Castomer® Elastomer Foam Systems
Isofroth® Processing Equipment and Materials
Isofoam® Acrylic Coatings

Combining state-of-the-art technology with years of experience

The FŌM™

cavity fill insulation

the fōm company

The FŌM™ is a 40% open, 60% closed cell product comprising an outstanding thermal and acoustical insulation material.

The FŌM™ is a non-toxic environmentally friendly material that has been tested, sold and approved for use in the United States and Canada since 1969 as manufactured by Rapco Foam, Inc.

The FŌM™ is the most effective, the easiest to install, and the most economical insulation material that can be used to insulate concrete block, hollow-core concrete, precast concrete wall assemblies, pipe chases, and other enclosed wall cavity areas.

For More Information Contact:

The FŌM Company of Columbus
8724 Olde Worthington Road
Westerville, OH 43082
Ph. (614) 891-4900, fax (614) 891-8399

Manufactured By:
The FŌM Company, Ltd.
1920 S. Main Street
Akron, OH 44301
www.TheFomCompany.com

THE FŌM™ Foamed-In-Place Insulation
PRODUCT SPECIFICATIONS

I. DESCRIPTION

The FŌM™ insulation is a lightweight cellular plastic produced by the interaction of an aqueous resin solution with a catalyst and foaming agent. The finished product is a non-toxic, self-extinguishing foam with a density of no less than 0.7 lbs. per cubic foot and a thermal conductivity (k) factor of 0.19 per inch. The white, foamed-in-place, cavity fill material requires two to fourteen days for final drying, depending on weather and humidity.

II. APPLICATION

The FŌM™ is designed to be used in areas that will benefit from its high thermal and acoustical insulation values and its foamed-in-place physical characteristics. It is an ideal material for core filling concrete block walls, insulating pre-cast hollow-core concrete panels, injecting between brick veneers and block and for use in filling pipe chases, around windows, doors and other areas of limited accessibility. It is an excellent cavity fill material for stud walls when a vapor barrier is installed to prevent **The FŌM™** from drying to the interior side.

III. INSTALLATION

The FŌM™, is foamed at the job site by manufacturer-trained and certified contractors using a portable applicator gun equipped with a flexible hose for delivering the expanded wet foam to areas to be insulated. Normal drying time under average summer conditions will not exceed 14 days. Winter temperatures do not affect the foaming process providing solution temperatures are kept above 50° F during application.

A. General Notes

1. **The FŌM™** should not be applied to surfaces which will be adversely affected by moisture released during the drying process.
2. Allow 14 days for complete curing. After applications, **The FŌM™** should be protected from exposure to excess moisture or rain for a period of 24 hours.
3. **The FŌM™** should weigh between 143 and 190 grams per 6" cube. Actual specifications are 2.5 lbs. per cubic foot wet; 0.70 lbs. per cubic foot when cured or dried.
4. **The FŌM™** shall be applied at the gun with liquid ratios that comply with the manufacturer's specifications.
5. **The FŌM™** shall only be installed by manufacturer certified and trained installers who have in their possession certification ID cards.
6. Materials used for producing **The FŌM™** shall be stored at temperatures of 50° F to 85° F.
7. **The FŌM™** should only be applied using **The FŌM Company** R99 (resin) and **The FŌM Company** FA99 (foaming agent). The addition or substitution of any other materials is strictly prohibited.

B. Concrete Masonry Units

Core fill applications:

The most effective, economical and efficient method for the insulation of concrete block exterior and party walls. The foam may be pumped into the cores before the bond beams are added or it may be injected through holes drilled in the mortar joints. In addition to filling the cores, it will fill every nook, cranny and odd shaped cavity; areas that cannot be filled with core inserts or loose fill materials. When applied as a core fill, any possible shrinkage will be minimized, due to curing conditions in an enclosed cavity.

C. Pre-stressed Hollow Core Concrete Panels:

Core fill applications:

Hollow core panels are filled by inserting an applicator gun extension into the panels and extracting the tube as the cores are filled. **The FŌM™** can be applied in 15-foot increments using this method. Once filled, there is no spillage, settling or fallout of the solid foam product. Due to excellent curing conditions, shrinkage is minimized.

D. Pipe Chases, Disposal Chutes, and Other Odd-Shaped Areas:

Cavity fill applications:

The FŌM™ can be pumped into any enclosed cavity as an excellent thermal and acoustical insulation material. It performs extremely well in the prevention of sound transmission.

NOTE: It should not be applied to existing party walls where no vapor barrier is in place. When applied to stud areas in new construction projects, a vapor barrier should be used to direct moisture to the exterior during the curing stages.

NOTE: **The FŌM™** should not be applied where constant temperatures will exceed 210° F

E. Frame Construction:

2" x 4" or 2" x 6" stud application:

Filling stud areas is one of the most effective energy conservation and sound reduction uses for **The FŌM™**. Using a trowel, the product can be installed to an open stud area and then covered with polyvinyl sheeting. It can also be injected into the cavity after the poly has been applied using a flat surface to prevent any bulging. Sheetrock or paneling can then be applied. **The FŌM™** will flow around all wiring conduit and pipes while filling any odd-shaped spaces, nooks and crannies. Unlike loose fill or batted insulation, it will not settle or spill.

F. **Combination:**
Brick Veneer and Concrete Masonry Units:
Cavity fill applications:
The FōM™ can be easily applied to the cavity between the concrete block and the brick veneer by "top-filling" into the cavity during construction or by injecting the foam through a systematic series of holes in the mortar joints. This is a very effective insulating system due to excellent R-values and the prevention of air infiltration through the many nooks and crannies around doors, windows and other odd-shaped areas.

IV. LIMITATIONS:

A. **The FōM™** is a cavity fill material only; it should not be left open and exposed.

B. **The FōM™** should not be used where it will be exposed to on-going temperatures in excess of 210° F.

C. **The FōM™** should not be used for residential applications in existing buildings where a vapor barrier can not be installed.

SUMMARY

The FōM™ is a cavity fill material with high performance characteristics, low costs, and ease of installation. This formula has been used as a thermal and/or acoustical insulation material in schools, government buildings, retail centers and virtually all other facets of the construction industry.

QUALITY CONTROL

The FōM™ is installed only by trained and certified licensees of **The FōM Company**. Every installer has completed and passed a thorough and detailed training school conducted by **The FōM Company**. All application crews should be under the direct supervision of a certified installer. All certified installers should have current picture identification cards with them at the job site. If there are any questions, call **toll-free 1-877-381-1200.**

FEATURES & BENEFITS

Feature: As a foam, which is injected under modest pressure, **The FōM™** can be applied during or after the construction process filling all voids, nooks, crannies, and hard to reach areas.
Benefit: No settling, pouring out of weep holes or areas that can't be filled with loose fill materials. **The FōM™** flows around outlet boxes, electrical wiring, plumbing, masonry ties and many other obstacles that cannot be sealed with loose fill products.

Feature: The FōM™ is a 40% open, 60% closed cell product.
Benefit: Serves as an outstanding thermal and acoustical insulation. R-values exceed 5.2 per inch and a 2" thickness provides a sound transmission class (STC) of 53.7. **The FōM™** will save money on heating and cooling while providing a comfortable living and working environment.

Feature: The FōM™ is installed by manufacturer trained and certified contractors.
Benefit: Masonry contractors do not have to order, stock and handle any insulation materials; no broken bags, messy clean-up problems or lifting and pouring of dusty loose fills. The masonry contractor can get his work done fast and without delays. There are no coordination problems with other contractors; **The FōM™** can be applied after masonry contractors have left the job.

Feature: The FōM™ is not broken down due to water or water vapor exposure.
Benefits: Unlike fibrous glass and loose fill materials, exposure to moisture will not alter the shape or configuration of this material. While **The FōM™** does not provide a vapor barrier, it does maintain its shape and performance characteristics.

ACOUSTICAL PROPERTIES	
Hz.	Sound Transmission Loss*
250	27-32
500	48-50
1,000	42-44
2,000	46-50
4,000	41-46
8,000	19-25

* Based on actual field sound tests on 3-5/8" gypsum board, STC 53

PHYSICAL PROPERTIES			
Property	Test Method	Results	
Thermal Conductivity	ASTM C-177	K-Factor 0.193	R-Value 5.18/inch
Surface Burning Characteristics	ASTM E-84 (UL 723)		
Flame Spread		15	
Smoke Release		0-5	
Fire Rating	ICBO Report 3047	Class I Material	
Combustibility	ASTM E-136	non-combustible	
Water Vapor Transmission	ASTM C-355	10 Perms/inch	
Moisture Absorption 24 hours in wet cavity, % by wt.		2.0	
Linear Shrinkage normal percentage after 90 days	HUD/UMB-74	less than 2%	
Density - Standards (cured) lbs./ft³		.7	

INSULATION VALUES FOR BLOCK WALLS					
Nominal Block Width	Density (PCF)	Thermal Resistance (U)	(R)	Cores Filled with The FÔM (U)	(R)
6"	60	.32	3.125	.08	11.9
	80	.37	2.7	.10	9.8
	100	.42	2.4	.13	7.6
	120	.47	2.12	.18	5.4
	140	.59	1.7	.24	4.1
8"	60	.32	3.125	.06	15.5
	80	.34	2.94	.08	12.1
	100	.38	2.63	.10	9.9
	120	.43	2.33	.14	7.2
	140	.55	1.8	.20	4.9
12"	60	.24	4.16	.05	21.7
	80	.29	3.45	.06	18.1
	100	.34	2.84	.07	13.6
	120	.38	2.63	.09	10.8
	140	.50	2.00	.14	7.2

WELD·ON
STRUCTURAL SERIES

MEETING NEW CHALLENGES,

SETTING NEW STANDARDS.

ADHESIVES GUIDE

WELD•ON®
STRUCTURAL SERIES

DRIVES INNOVATION

WELD-ON® Structural Series Adhesives are conceived and developed by a team of chemists and engineers with unparalleled experience in methacrylate adhesives and structural composites. These experts are in the field, working with design engineers to tailor products for development in the laboratory. The end result is an adhesive that improves product performance and streamlines the production process.

WELD-ON methacrylates outperform the competition where it counts. Whether you're bonding like or dissimilar substrates, WELD-ON fuses them to produce a permanent, integral assembly. When you need the ultimate in fatigue and shock-load resistance, WELD-ON gives you the industry's highest tensile elongation.

- Fiber-tearing bonds up to 3,000 psi
- Elongation capability from 200 to 250%
- Bulk tensile strength from 2,200 to 3,500 psi

IMPROVES PROCESS

IPS WELD-ON delivers stronger bonds in less time with reduced labor costs. Reduced need for surface prep combined with controlled open time and cure speed lets you increase throughput with smaller crews. Whether you use WELD-ON'S bulk or cartridge dispensing systems, you'll get an easy to apply bonding adhesive that stays where you put it — even in inverted applications.

IPS tackled the methacrylate boil problem head-on, so now you can cure thin or thick sections in a wide range of production conditions, including high heat and humidity.

DELIVERS PERFORMANCE

Demanding users specify WELD-ON for jobs that need to be done right the first time. Our methacrylates handle the harsh pounding of high-performance marine applications and the stress of towering architectural designs. From boat builders to liquid and chemical tank designers, the growing list of WELD-ON users tells us how our new Structural Series not only meets or outperforms their specs, but lets them create new, more robust products that grow their bottom lines.

- Substrates as dissimilar as plastic and steel are permanently fused
- Bond allows maximum material performance
- New design options create product line expansion

	SS 210	SS 214	SS 218	SS 214 HV	SS 218 HV
Typical Physical Properties: (ASTM D 638 97)					
% Elongation	225 - 250	200 - 250	200 - 250	200 - 250	200 - 250
Tensile strength (psi)	3,300 - 3,500	2,250 - 2,500	2,250 - 2,500	2,250 - 2,500	2,250 - 2,500
Modulus (psi)**	90,000	140,000	140,000	140,000	140,000
Single shear strength (psi)[1]	3,000	2,000	2000	2,200	2,200
Handling Properties:					
Typical bond line thickness	.01" - .1"	.01" - .25"	.05" - .25"	.10" - .5"	.10" - 1.0"
Ratio mixing	10:1	10:1	10:1	10:1	10:1
Working time (minutes)	10 - 12	20 - 22	40 - 42	23 - 28 @ 77° F	42 - 45 @ 95° F
Fixture time (minutes)	13 - 17	30 - 35	80 - 100	25 - 30	90 - 110
Mixed viscosity (kps)	150 - 175	150 - 175	150 - 175	650 - 750	800 - 1000
Color	Beige, Gray bulk only	Off White, Gray bulk only	Off White, Gray bulk only	Gray	Gray
Packaging:					
Cartridges 470/825 mL	Yes	Yes	Yes	No	No
Bulk dispensing	5 or 50 gallons	5 or 50 gallons	5 or 50 gallons	5 or 50 gallons	5 or 50 gallons

* Both components mixed and allowed to cure at room temperature for 48 hours.
** Modulus as measured in the linear portion of the stress/strain curve.
[1] Values depend on shear strength and stiffness of the substrate when substrate failure occurs.
Working/fixture time at 75° F unless noted.

RECOMMENDED FOR:

WELD-ON Structural Series Adhesives are recommended for bonding to the following substrates:

• FRP • PVC • ABS • Acrylics • Polyester Gelcoats • Urethanes • Vinyl Esters • Styrenics

IPS WELD-ON strongly recommends you contact your local sales/technical service representative regarding your intended use and application of this and any other WELD-ON product.

WHAT USER'S SAY

Naval architect Sid Lanier builds high performance boats for rugged use in harsh environments. He relies on WELD-ON®. Exclusively.

Sid is a pioneer in bonded fiberglass stringer technology. He told us that "WELD-ON's high viscosity methacrylate lets me cut a 4-man crew in half — and get a better quality job. We shoot it on thick and don't have to worry. WELD-ON hangs on vertical surfaces, has a long open time and cures consistently. WELD-ON is tough, so I get stronger hulls that stand up to impact and resist long term fatigue without any additional weight or labor costs."

Tim Warren is General Manager of PolyTank, an international supplier of swimming pool filtration tanks. He uses WELD-ON to expand his product line and build his market share.

"WELD-ON opened a new door for us. I wanted to give my filtration customers a fiberglass liner, but couldn't bond it with our ABS tank necks, particularly in tanks with smaller size necks. WELD-ON not only bonds these dissimilar substrates, but lets me do it in our high humidity environment with a minimum of surface prep. The bond surpassed all of our pressure tests and is impervious to anything our customers will use. WELD-ON gives me design and manufacturing options I never had before."

IPS WELD-ON

Technology-driven innovation, customer-driven service. IPS has spent nearly fifty years pioneering better adhesive solutions for industrial, commercial and residential applications. Our latest innovation has created advanced, two-component methacrylate adhesives that bond metals, plastics and other materials in a broad range of demanding transportation, marine and industrial applications.

If there's a better way to join materials, IPS development teams are working on it. Whether sparked by an idea from the lab or a request from a customer, the product development process gets our experts to the field — in your plant — to be sure our products match your requirements. IPS representatives are trained to ask the right questions so we can specify the right product — or create a new one — that's right for your application.

IPS has been serving demanding customers for more than half a century. We've succeeded because we know that service means listening — and using what we hear to guide the creation of innovative technology and products for you. And that's how we help our customers succeed and lead in their industries.

Structural Adhesive Team:
IPS Corporation, P.O. Box 12729, RTP, NC 27709

Manufacturing Facilities:
600 Ellis Road, Durham, NC 27703
17109 South Main Street, Gardena, CA 90248

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Visit our website at: www.ipscorp.com
IPS Corporation, 455 West Victoria Street, Compton, CA 90220

FRP
Exclusive North American Distributor

SS208

METHACRYLATE ADHESIVE

DATA SHEET

WELD•ON®

STRUCTURAL SERIES

IPS CORPORATION

DESCRIPTION

IPS WELD-ON® SS208 methacrylate adhesive is a rapid curing, two-component, 10:1 mix ratio product for bonding composite and other plastic parts with relatively close part tolerances and bond gaps. Minimal surface preparation[1,2] combined with rapid fixture time makes WELD-ON SS 208 ideal for assembly operations requiring reduced labor and fast cycle times. Plastic materials can be cross-bonded with other plastics and metals. SS 208 is available in cartridges and bulk containers for application with meter-mix-dispensing equipment.

PERFORMANCE HIGHLIGHTS

	BENEFIT
• Rapid cure speed	8-10 Minute open working time, 15-20 minute fixture and demold time
• Minimal surface preparation[1,2]	Reduced labor cost and throughput times.
• Non-sag handling characteristics	Bead stays in place in bond gap or on vertical surfaces.
• Reduced volatility	Reduced odor, skinning, and cure shrinkage.
• Permanent toughness and elasticity	Excellent fatigue, damping, impact and shock-load resistance
• Excellent environmental resistance	Permanent bonds in harsh operating environments

TYPICAL ADHESIVE CHARACTERISTICS

	Part A Adhesive	Part B Activator	Mixed A+B
Color	Off white	White	Off white
Mix ratio by volume	10	1	
Mix ratio by weight	7.78	1	
Viscosity, cps	150-200,000	40-60,000	150-200,000
Density, grams/ml	0.92	1.04	0.94
Unit weight, lb/gallon	7.70	8.66	7.80
Working time at 75°F/24°C			8-10 minutes
Fixture time at 75°F/24°C			15-20 minutes

TYPICAL PHYSICAL PROPERTIES

Tensile strength (psi):	2000-2500
Elongation (%):	200-250
Bond strength (psi)[3]:	2500 Maximum
Modulus (psi)[4]:	90,000

RECOMMENDED SUBSTRATES

FRP & Vinyl Esters	ABS
Polyester Gelcoats	PVC
Styrenics	Acrylics
Polyurethanes	Metals[2]

Bonds are generally resistant to the effects of heat, water and moisture, aqueous chemicals and most petroleum hydrocarbons, including gasoline, motor oil and diesel fuel. Not recommended for immersion or long term exposure to concentrated acids or bases, or aggressive organic solvents such as toluene, ketones, and esters. It is the user's responsibility to determine the suitability of each adhesive for its intended use and application.

1. Most thermoplastics can be bonded with no surface preparation other than a dry wipe or air blow-off. If contamination is visible or suspected, wipe with alcohol prior to bonding. Polyolefins, thermoplastic polyesters, fluorocarbon plastics and other low surface energy plastics are generally not bondable. Testing is required on thermoset plastics because of the wide variations in compositions and bondability. See important notes 1, 2, and 3 on reverse side.
2. Light abrasion improves bond strength on steel. Acceptable bonds can be achieved with "as received" steel provided there is no rust , scale, or other surface contamination (oil). Adhesion to aluminum and stainless steel is improved by sanding. MP 100 metal primer is recommended for maximum durability. See important notes on reverse side. See important notes 1, 2, and 3 on reverse side.
3. Value will depend on shear stiffness and strength of substrate.
4. Modulus as measured in the linear portion of the stress/strain curve.

SAFETY AND HANDLING

Read Material Safety Data Sheet before handling or using this product. Adhesive (Component A) contains methyl methacrylate monomer and is flammable. Always use in a well-ventilated area. Floor-level extraction and large quantities of moving air greatly facilitate ventilation. Activator (Component B) contains peroxide. Both materials must be stored in a cool place away from sources of heat and open flames or sparks. Keep containers closed when not in use. Prevent contact with skin and eyes. In case of skin contact, wash with soap and water. In case of eye contact, flush with water for 15 minutes and seek immediate medical attention. Harmful if swallowed. Keep out of reach of children.

MIXING AND APPLICATION

EXOTHERM. The chemical curing reaction that occurs when components A and B are mixed generates heat. The amount of heat generated is controlled by the mass and thickness of the mixed product. Large masses over 1.5 inches thick can develop heat in excess of 250°F/121°C and can generate harmful, flammable vapors. Large curing masses should be carefully moved to a well-ventilated area where the chance of personal contact is minimized.

CURING. Open working time is the approximate time after mixing components A and B, depending on bonding conditions, that the adhesive remains fluid and bondable. **Fixture time** is the approximate time after mixing components A and B required for the adhesive to react the partial state of cure necessary to allow careful movement, unclamping or de-molding of assembled parts. Parts can generally be put in service when 80 percent of full strength is developed. The time to achieve 80% cure is approximately2-3 times that required for fixturing. The working and fixture times presented in this bulletin are based on laboratory tests performed at 75°F/24°C. Higher temperatures speed the curing reaction and reduce open working time. The reverse is true for lower temperatures. If significant variation in temperatures or application at very high or low temperatures is anticipated, contact your IPS representative for technical assistance.

DISPENSING EQUIPMENT. Dispensing from disposable cartridges or meter-mix-dispensing equipment is highly recommended. Both methods employ convenient static motionless mixer technology. Product supplies in pre-measured cartridges is dispensed from approved manual or pneumatic powered guns. Contact your IPS representative for information and availability.

When meter-mix dispense systems are used, care must be taken to assure compatibility between the adhesive components and the materials in the equipment that they contact. All wetted metal components should be constructed stainless steel, aluminum or a sufficient thickness of chemically resistant material that prevents contact between the adhesive components and the base metal. ***Contact with copper, brass, zinc or alloys containing these materials must be strictly avoided.*** All non-metallic seals and gaskets should be fabricated from Teflon, or polyethylene based materials. ***Natural rubber, nitrile rubber (BUNA), neoprene and Viton® are not acceptable.***

APPLICATION. Follow instructions provided or contact your IPS representative for proper preparation of dispensing equipment and substrates prior to starting the bonding process. Always dispense a quantity of adhesive at start-up to assure that the adhesive exiting the tip of the mixer is the proper color and is uniform, without streaks. If aged material is being used, allow the purged material to cure to assure quality before proceeding. Carefully dispense a sufficient quantity of adhesive on the substrate to assure that the bond gap will be completely filled when the parts are mated. Allow for squeeze-out at the edges of the bond to assure filling. Carefully secure or clamp parts to prevent joint movement while the adhesive sets. Do not apply excessive pressure that can cause excessively thin gaps and starve the bond line. If in doubt, use shims or spacers to set the gap. SS 218 and SS 218 HV adhesive should not be applied in gaps of less than 1/8 (0.125) inch. A minimum gap of 20 mils (0.02 inch) is recommended for all other adhesives. Test the curing adhesive at the edges for fingernail hardness before removing clamps or fixtures. If clean up of the adhesive from the bonded area is required, we recommend that it is carefully performed using alcohol or other preferred industrial solvent while the adhesive is still wet or soft. Partially cured adhesive can be carefully removed with a sharp knife. Cured adhesive must be sanded or scraped, using a suitable solvent to remove remaining traces.

CLEAN-UP. Adhesive components and mixed adhesive should be removed form mixing and application equipment with a suitable industrial solvent or cleaner before the mixed adhesive cures. Once the adhesive cures, soaking in a strong solvent or paint remover will be required to soften the adhesive sufficiently for removal.

STORAGE AND SHELF LIFE

The shelf life of Components A and B in unopened containers is approximately six months from the date the product is shipped from IPS facilities. Shelf life is based on steady state storage between 50°F and 80°F (10°C and 27°C). Exposure, intermittent or prolonged, above 80°F/27°C will result in a reduction of the stated shelf life. ***Exposures above 100 °F (38°C) during shipping or storage can quickly degrade Component B in cartridges or bulk containers, and must be strictly prevented.*** Shelf life of both components can be extended by air-conditioned or refrigerated storage between 50°F and 65°F (10°C and 18°C).

PACKAGING AND AVAILABILITY

SS 208, SS 214, SS 218:	470 ml. Cartridge	5 Gallon Pails	55 Gallon Drums
SS 214HV, SS 218HV:		5 Gallon Pails	55 Gallon Drums

IMPORTANT NOTES

1. **SUBSTRATE AND APPLICATION COMPATIBILITY.** The user must determine the suitability of a selected adhesive for a given substrate and application. IPS strongly recommends laboratory, shop and end-use testing that simulates the actual manufacturing and end-use environment.
2. **SURFACE PREPARATION.** The need for surface preparation must be determined by comparative testing of prepared and unprepared substrates to assure that unprepared bonding is equivalent to or acceptable for the application relative to prepared bonding. Initial bonding tests must be followed up with simulated or actual durability tests to assure that surface conditions do not lead to degradation of the bond over time under service conditions. Subsequent changes in substrates or bonding conditions will require re-testing.
3. **TECHNICAL ASSISTANCE.** Contact your IPS representative for questions or assistance with the selection of adhesives and methods for evaluating adhesives for your intended application.

This product is intended for use by skilled individuals at their own risk. Recommendations contained herein are based on information we believe to be reliable. The properties and strength values presented above are typical properties obtained under controlled conditions at the IPS laboratory. They are intended to be used only as a guide for selection for end-use evaluation. The ultimate suitability for any intended application must be verified by the end user under anticipated test conditions. Since specific use, materials and product handling are not controlled by IPS, our warranty is limited to the replacement of defective IPS products.

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MP100

METAL PRIMER

DATA SHEET

WELD•ON®

STRUCTURAL SERIES

IPS CORPORATION

DESCRIPTION

IPS WELD-ON® MP 100 metal primer is a surface treatment that is designed to clean, chemically convert and prepare stainless steel and aluminum surfaces for permanent bonding with WELD-ON methacrylate structural adhesives. It significantly improves the long-term durability of adhesive bonds that are subjected to humid or corrosive environments such as salt water or spray. Without MP 100, certain WELD-ON Structural Series adhesives can lose bond strength over time when exposed to such conditions.

MP 100 is recommended for use with the following WELD-ON structural adhesives:

SS 214	**SS 218**	**SS 505**
SS 214 HV	**SS 218 HV**	**SS 208**

APPLICATION

MP 100 is applied by simply brushing or wiping on the surface just prior to bonding.

PRODUCT HIGHLIGHTS

- Simple brush or wipe application, rapid dry
- Mild solvent action
- Aggressive etching and chemical conversion
- Blue color

BENEFITS

Minimal added time and labor input

Cleans metal surface prior to conversion

Reduces surface corrosion and chemically links adhesive to metal surface

Simplifies application

TYPICAL PRODUCT CHARACTERISTICS

Physical form:	Water-thin liquid solution
Color:	Blue
Density, grams/ml:	0.78
Unit weight, lb/gallon:	6.50
Dry time:	Five minutes or less

Contact manufacturer for test data on specific metal substrates.

SAFETY AND HANDLING

Read Material Safety Data Sheet before handling or using this product. MP 100 Metal Primer is flammable. Always use in a well-ventilated area. Floor-level extraction and large quantities of moving air greatly facilitate ventilation. Store in a cool place away from sources of heat and open flames or sparks. Keep container closed when not in use. Prevent contact with skin and eyes. In case of skin contact, wash with soap and water. In case of eye contact, flush with water for 15 minutes and seek immediate medical attention. Harmful if swallowed. Keep out of reach of children.

APPLICATION

Remove excess surface contaminants such as dust, grime, grease or oil by washing or wiping with a clean cloth. Surface should be dry before applying primer. Apply a thin coat of primer by brushing, wiping or dipping. Avoid puddling or heavy layers of primer. Remove excess primer by wiping while still wet, or remove with a clean rag dampened with alcohol. Re-apply if necessary to provide a thin, uniform layer.

STORAGE AND SHELF LIFE

The shelf life of MP 100 Metal Primer in unopened containers is approximately six months from the date the product is shipped from IPS facilities. Shelf life is based on steady state storage between 50°F and 80°F (10°C and 27°C). Exposure, intermittent or prolonged, above 80 degrees will result in a reduction of the stated shelf life.

IMPORTANT NOTES

1. **SUBSTRATE AND APPLICATION COMPATIBILITY.** The user must determine the suitability of a selected adhesive for a given substrate and application. IPS strongly recommends laboratory, shop and end-use testing that simulates the actual manufacturing and end-use environment.
2. **SURFACE PREPARATION.** The need for surface preparation must be determined by comparative testing of prepared and unprepared substrates to assure that unprepared bonding is equivalent to or acceptable for the application relative to prepared bonding. Initial bonding tests must be followed up with simulated or actual durability tests to assure that surface conditions do not lead to degradation of the bond over time under service conditions. Subsequent changes in substrates or bonding conditions will require re-testing.
3. **TECHNICAL ASSISTANCE.** Contact your IPS representative for questions or assistance with the selection of adhesives and methods for evaluating adhesives for your intended application.

This product is intended for use by skilled individuals at their own risk. Recommendations contained herein are based on information we believe to be reliable. The properties and strength values presented above are typical properties obtained under controlled conditions at the IPS laboratory. They are intended to be used only as a guide for selection for end-use evaluation. The ultimate suitability for any intended application must be verified by the end user under anticipated test conditions. Since specific use, materials and product handling are not controlled by IPS, our warranty is limited to the replacement of defective IPS products.

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WELD•ON®
STRUCTURAL SERIES
IPS CORPORATION

Structural Series SS 210

Technical Data Sheet **Beige**

Description: SS 210 methacrylate adhesive is a two component, 10:1 ratio system, 10 minute open time product. Designed for bonding refined composite parts, requiring little to no surface preparation[1]. Ideally suited for applications 20 to 120 mils thick[2], requiring fast cycle times. **WELD-ON®** SS Adhesives provide the highest combination toughness and strength available in a methacrylate adhesive.

Recommended Substrates:

FRP, PVC, ABS, Acrylics, Polyester Gelcoats, Urethanes, Vinyl Esters and Styrenics

Performance:

Features	Benefits
• High elongation over 200%.	• Ultimate fatigue and shock-load resistance (toughness).
• Low odor.	• Noticeably less odor while dispensing and negligible residual odor upon cure.
• Minimal slide and leveling.	• Adhesive stays where it is applied!
• Working time[3] 10 minutes and a fixture time[4] of 17 minutes.	• Ideal for bonding more refined close tolerance parts (up to 120 mils)[2], requiring fast bonding cycles.

Typical Adhesive Properties @ 77° F

	Adhesive Part A	Activator Part B	Mixed AB
Volumetric mix ratio:	10	1	----
Weight based mix ratio:	7.78	1	----
Working time[3]	----	----	10 - 12 min.
Fixture time[4]	----	----	16 - 20 min.
Color:	Opaque	White	Beige
Viscosity (kcp)	150 - 175	40 – 50	----
Density (g/cc)	.92	1.04	.94
Unit Weight (lb./gal.)	7.7	8.66	7.8

Excellent resistance[5]: Hydrocarbons, pH range of 3-10 and Salt Solutions.
Not recommended for: Strong Acids, Bases, and Polar Solvents.

Typical Exotherm Profile : 1/2" thick, 30 gram mass	
Time to initiation	10 min
Time to peak	17 min
Peak temp.	250° F

Packaging:
- 470 cc/825 cc Cartridges
- 5 Gallon Pails
- 55 Gallon Drums

IPS® Corporation 17109 S. Main St. P.O. Box 379 Gardena, CA 90248-0379
Phone: 1-310-898-3300
Fax: 1-310-323-4417

6/00

Typical Mechanical Properties*: Tensile Properties (ASTM D 638-97)

Tensile Strength (psi):	3,400 max.
Modulus (psi)**:	90,000
Max. Elongation (%):	225-250
Single Shear Strength (psi):	2,600#

*Both components mixed and allowed to cure at RT for 48 hours.
**Modulus as measured in the linear portion of the stress/strain curve.
Values depend on shear strength and stiffness of the substrate when substrate failure occurs.

Shelf Stability:

The shelf life of SS 210 (parts A and B) is approximately six months from the time product is shipped from IPS facilities. Shelf life is based on steady state storage between 50 degrees Fahrenheit and 80 degrees Fahrenheit. Any, or cumulative storage at temperatures above 80 degrees Fahrenheit will result in a reduction of the stated shelf life. We recommend storage of these products in a cool, dry location. These products should not be stored at temperatures below 32 degrees Fahrenheit. Shelf life can be prolonged by storage below 50 degrees Fahrenheit (do not freeze).

Exothermic and working performance:

The data presented here with regard to open, working and exotherm times and temperatures was determined in a laboratory at room temperature. Any increase or decrease in product, substrate or environmental temperatures will result in corresponding increases or decreases in handling parameters. If you have any questions or intend use of these products in different conditions, please contact IPS technical service for indications of what types of variations you might expect.

Application and handling:

Both SS 210 parts A and B are flammable. These products contain methacrylate ester. When finished using these products, keep the containers closed. Always keep away from open flames, heat and sparks. Make sure all metallic packaging (drums) and dispensing equipment are grounded when in use. Avoid contact with skin and eyes. In case of skin contact wash with soap and water. In the event of eye contact, flush with water for 15 minutes and seek immediate medical attention. These products are harmful if swallowed and should be kept out of reach of children at all times. Also note that these products cure with the development of heat (exotherm). Large masses curing can develop vapor emissions and heat in excess of 300 degrees Fahrenheit. Caution should be used to avoid contact with and the curing of large amounts of material in excess of 1.5 inches in thickness. Do not use in unventilated or enclosed areas. MMA monomer is heavier than air. Evacuation of fumes requires ground level pick up or air circulation.

Dispensing Equipment:

SS 210 can be applied through the use of either automated or manual dispensing equipment in conjunction with static mixing technology. Cartridge systems (pre-metered) with dispensing guns are also available. For information regarding the availability and/or use of such equipment, please contact IPS Technical Service or your IPS sales representative. All metallic equipment coming in contact with this adhesive should be constructed of stainless steel or coated with a sufficiently chemical resistant material to prevent contact between the base metal and the adhesive or activator components. Contact with copper, brass, zinc or any alloys containing these materials should be avoided at all times. All seals and gaskets coming in contact with these materials should be fabricated from Teflon, or Ethylene/Propylene type materials. Avoid the use of natural rubber, neoprene and Viton-type seals and gaskets. When using SS 210 make sure that enough material is used to completely fill joints with some squeeze out occurring to ensure complete joint fill when parts are joined together. Note that all materials should be dispensed and parts positioned and clamped prior to the expiration of actual working times. Allow parts to remain clamped until after the fixture time has expired. We recommend a brief test of the bond edge to assure that the material is developing hardness prior to the removal of clams or bond fixtures. Clean up of these materials while still wet is best achieved through the use of any citrus terpene or NMP (N-Methyl Pyrolidone) based cleaner. Cured adhesive is best cleaned through the use of gentle sanding or scraping in conjunction with the above cleaners or mild solvent wipe.

Notes:

1. The need for surface preparation can only be properly determined through testing to assure that the cured adhesive is achieving the desired results without preparation.. We always recommend the use of laboratory testing to address this concern. All testing should completely mimic the methods and materials intended to be used in the actual manufacturing environment.
2. We strongly recommend that you consult our technical service representatives for discussion regarding your intended use and application of this and any other IPS product.
3. The definition of working time is the time elapsed between the instant that parts A and B are combined and mixed and the time that the adhesive no longer wets the surface nor is compressible and flowable. The times represented on this sheet were determined at 75 degrees F.
4. The fixture time is defined as the time after which the bonded components can support a 2 lb. static weight on a one by one inch joint area in both the shear and normal configurations without movement.
5. Chemical resistance varies greatly depending on conditions of exposure such as: temperature, concentration, bond line thickness and length of exposure. Please contact IPS for recommendations regarding use in any chemical environment!

WELD•ON®
STRUCTURAL SERIES
IPS CORPORATION

Structural Series SS 214

Technical Data Sheet — Off-White

Description: SS 214 methacrylate adhesive is a two component, 10:1 ratio system, ideal for bonding small to medium composite assemblies, with little to no surface preparation[1]. It is formulated off-white and is UV inhibited[5]. This product offers excellent fatigue, impact, vibration damping and shock-load resistance. Ideal for bond lines up to 1/2" thick. **WELD-ON®** SS Adhesives provide the highest combination toughness and strength available in a methacrylate adhesive.

Recommended Substrates:

FRP, PVC, ABS, Acrylics, Polyester Gelcoats, Urethanes, Vinyl Esters and Styrenics

Performance:

Features	Benefits
• Off-White, UV inhibited[5].	• Consider for bonding exterior components.
• High elongation over 200%.	• Ultimate fatigue and shock-load resistance (toughness).
• Low odor.	• Noticeably less odor while dispensing and negligible residual odor upon cure.
• Minimal slide and leveling.	• Adhesive stays where it is applied!
• Working time[3] 20 minutes and a fixture time[4] of 35 minutes.	• Ideal for bonding more refined high tolerance parts (up to 1/2" bead)[2], requiring quick molding cycles.

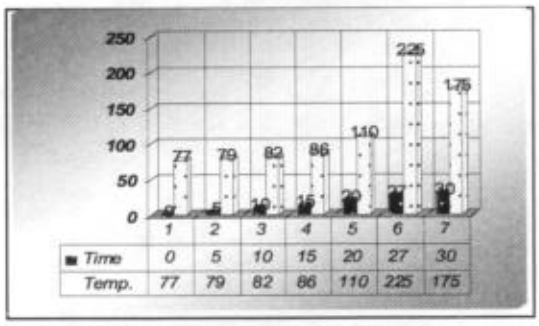
Packaging:
- 470 cc/825 cc Cartridges
- 5 Gallon Pails
- 55 Gallon Drums

Typical Adhesive Properties @ 77° F

	Adhesive Part A	Activator Part B	Mixed AB
Volumetric mix ratio:	10	1	----
Weight based mix ratio:	7.78	1	----
Working time[3]	----	----	20 - 22 min.
Fixture time[4]	----	----	30 - 35 min.
Color:	Opaque	White	Off-White
Viscosity (kcp)	150 - 175	40 – 50	----
Density (g/cc)	.92	1.26	.95
Unit Weight (lb./gal.)	7.7	10.48	7.95

Excellent resistance[6]: Hydrocarbons, pH range of 3-10 and Salt Solutions.
Not recommended for: Strong Acids, Bases, and Polar Solvents.

Typical Exotherm Profile : 1/2" thick, 30 gram mass	
Time to initiation	20 min
Time to Peak	27 min
Peak temp.	225°F



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Typical Mechanical Properties*: Tensile Properties (ASTM D 638-97)

Tensile Strength (psi):	2250 - 2500
Modulus (psi)**:	140,000
Max. Elongation (%):	200-225
Single Shear Strength (psi): (ASTM D 5868-95)	2000#

*Both components mixed and allowed to cure at RT for 48 hours.
**Modulus as measured in the linear portion of the stress/strain curve.
Values depend on shear strength and stiffness of the substrate when substrate failure occurs.

Shelf Stability:

The shelf life of SS 214 (parts A and B) is approximately six months from the time product is shipped from IPS facilities. Shelf life is based on steady state storage between 50 degrees Fahrenheit and 80 degrees Fahrenheit. Any, or cumulative storage at temperatures above 80 degrees Fahrenheit will result in a reduction of the stated shelf life. We recommend storage of these products in a cool, dry location. These products should not be stored at temperatures below 32 degrees Fahrenheit. Shelf life can be prolonged by storage below 50 degrees Fahrenheit (do not freeze).

Exothermic and working performance:

The data presented here with regard to open, working and exotherm times and temperatures was determined in a laboratory at room temperature. Any increase or decrease in product, substrate or environmental temperatures will result in corresponding increases or decreases in handling parameters. If you have any questions or intend use of these products in different conditions, please contact IPS technical service for indications of what types of variations you might expect.

Application and handling:

Both SS 214 parts A and B are flammable. These products contain methacrylate ester. When finished using these products, keep the containers closed. Always keep away from open flames, heat and sparks. Make sure all metallic packaging (drums) and dispensing equipment are grounded when in use. Avoid contact with skin and eyes. In case of skin contact wash with soap and water. In the event of eye contact, flush with water for 15 minutes and seek immediate medical attention. These products are harmful if swallowed and should be kept out of reach of children at all times. Also note that these products cure with the development of heat (exotherm). Large masses curing can develop vapor emissions and heat in excess of 300 degrees Fahrenheit. Caution should be used to avoid contact with and the curing of large amounts of material in excess of 1.5 inches in thickness. Do not use in unventilated or enclosed areas. MMA monomer is heavier than air. Evacuation of fumes requires ground level pick up or air circulation.

Dispensing Equipment:

SS 214 can be applied through the use of either automated or manual dispensing equipment in conjunction with static mixing technology. Cartridge systems (pre-metered) with dispensing guns are also available. For information regarding the availability and/or use of such equipment, please contact IPS Technical Service or your IPS sales representative. All metallic equipment coming in contact with this adhesive should be constructed of stainless steel or coated with a sufficiently chemical resistant material to prevent contact between the base metal and the adhesive or activator components. Contact with copper, brass, zinc or any alloys containing these materials should be avoided at all times. All seals and gaskets coming in contact with these materials should be fabricated from Teflon, or Ethylene/Propylene type materials. Avoid the use of natural rubber, neoprene and Viton-type seals and gaskets. When using SS 214 make sure that enough material is used to completely fill joints with some squeeze out occurring to ensure complete joint fill when parts are joined together. Note that all materials should be dispensed and parts positioned and clamped prior to the expiration of actual working times. Allow parts to remain clamped until after the fixture time has expired. We recommend a brief test of the bond edge to assure that the material is developing hardness prior to the removal of clams or bond fixtures. Clean up of these materials while still wet is best achieved through the use of any citrus terpene or NMP (N-Methyl Pyrolidone) based cleaner. Cured adhesive is best cleaned through the use of gentle sanding or scraping in conjunction with the above cleaners or mild solvent wipe.

Notes:

1. The need for surface preparation can only be properly determined through testing to assure that the cured adhesive is achieving the desired results without preparation.. We always recommend the use of laboratory testing to address this concern. All testing should completely mimic the methods and materials intended to be used in the actual manufacturing environment.
2. We strongly recommend that you consult our technical service representatives for discussion regarding your intended use and application of this and any other IPS product.
3. The definition of working time is the time elapsed between the instant that parts A and B are combined and mixed and the time that the adhesive no longer wets the surface nor is compressible and flowable. The times represented on this sheet were determined at 75 degrees Fahrenheit.
4. The fixture time is defined as the time after which the bonded components can support a 2 lb. static weight on a one by one inch joint area in both the shear and normal configurations without movement.
5. Formulated with UV resistance, however it is not recommended for direct UV exposure this product will fade to a light amber over long term UV exposure. Manufacturer should determine the suitability for their particular application.
6. Chemical resistance varies greatly depending on conditions of exposure such as: temperature, concentration, bond line thickness and length of exposure. Please contact IPS for recommendations regarding use in any chemical environment!

WELD•ON®
STRUCTURAL SERIES
IPS CORPORATION

Structural Series SS 214
Gray

Technical Data Sheet

Description: SS 214 Gray methacrylate adhesive is a two component, 10:1 ratio system, ideal for bonding small to medium composite assemblies, with little to no surface preparation[1]. This product offers excellent fatigue, impact, vibration damping and shock-load resistance. Ideal for bond lines up to 1/2" thick. **WELD-ON®** SS Adhesives provide the highest combination toughness and strength available in a methacrylate adhesive.

Recommended Substrates:

FRP, PVC, ABS, Acrylics, Polyester Gelcoats, Urethanes, Vinyl Esters and Styrenics

Performance:

Features	Benefits
• High elongation over 200%.	• Ultimate fatigue and shock-load resistance (toughness).
• Low odor.	• Noticeably less odor while dispensing and negligible residual odor upon cure.
• Minimal slide and leveling.	• Adhesive stays where it is applied!
• Working time[3] 20 minutes and a fixture time[4] of 35 minutes.	• Ideal for bonding more refined high-tolerance parts (up to 1/2" bead)[2], requiring quick-molding cycles.

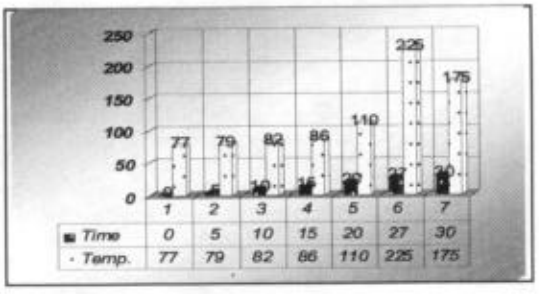
Packaging:
- 470 cc/825 cc Cartridges
- 5 Gallon Pails
- 55 Gallon Drums

Typical Adhesive Properties @ 77° F

	Adhesive Part A	Activator Part B	Mixed AB
Volumetric mix ratio:	10.00	1	----
Weight based mix ratio:	7.78	1	----
Working time[3]	----	----	20 - 22 min.
Fixture time[4]	----	----	30 - 35 min.
Color:	Opaque	Black	Gray
Viscosity (kcp)	150 - 175	40 – 50	----
Density (g/cc)	.92	1.04	.94
Unit Weight (lb./gal.)	7.70	8.66	7.80

Excellent resistance[5]: Hydrocarbons, pH range of 3-10 and Salt Solutions.
Not recommended for: Strong Acids, Bases, and Polar Solvents.

Typical Exotherm Profile : 1/2" thick, 30 gram mass	
Time to initiation	20 min
Time to peak	27 min
Peak temp.	225° F



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Typical Mechanical Properties*: Tensile Properties (ASTM D 638-97)

Tensile Strength (psi):	2250-2500
Modulus (psi)**:	140,000
Max. Elongation (%):	225-250
Single Shear Strength (psi): (ASTM D 5868-95)	2,000#

*Both components mixed and allowed to cure at RT for 48 hours.
**Modulus as measured in the linear portion of the stress/strain curve.
Values depend on shear strength and stiffness of the substrate when substrate failure occurs.

Shelf Stability:

The shelf life of SS 214 (parts A and B) is approximately six months from the time product is shipped from IPS facilities. Shelf life is based on steady state storage between 50 degrees Fahrenheit and 80 degrees Fahrenheit. Any, or cumulative storage at temperatures above 80 degrees F will result in a reduction of the stated shelf life. We recommend storage of these products in a cool, dry location. These products should not be stored at temperatures below 32 degrees Fahrenheit. Shelf life can be prolonged by storage below 50 degrees Fahrenheit (do not freeze).

Exothermic and working performance:

The data presented here with regard to open, working and exotherm times and temperatures was determined in a laboratory at room temperature. Any increase or decrease in product, substrate or environmental temperatures will result in corresponding increases or decreases in handling parameters. If you have any questions or intend use of these products in different conditions, please contact IPS technical service for indications of what types of variations you might expect.

Application and handling:

Both SS 214 parts A and B are flammable. These products contain methacrylate ester. When finished using these products, keep the containers closed. Always keep away from open flames, heat and sparks. Make sure all metallic packaging (drums) and dispensing equipment are grounded when in use. Avoid contact with skin and eyes. In case of skin contact wash with soap and water. In the event of eye contact, flush with water for 15 minutes and seek immediate medical attention. These products are harmful if swallowed and should be kept out of reach of children at all times. Also note that these products cure with the development of heat (exotherm). Large masses curing can develop vapor emissions and heat in excess of 300 degrees Fahrenheit. Caution should be used to avoid contact with and the curing of large amounts of material in excess of 1.5 inches in thickness. Do not use in unventilated or enclosed areas. MMA monomer is heavier than air. Evacuation of fumes requires ground level pick up or air circulation.

Dispensing Equipment:

SS 214 can be applied through the use of either automated or manual dispensing equipment in conjunction with static mixing technology. Cartridge systems (pre-metered) with dispensing guns are also available. For information regarding the availability and/or use of such equipment, please contact IPS Technical Service or your IPS sales representative. All metallic equipment coming in contact with this adhesive should be constructed of stainless steel or coated with a sufficiently chemical resistant material to prevent contact between the base metal and the adhesive or activator components. Contact with copper, brass, zinc or any alloys containing these materials should be avoided at all times. All seals and gaskets coming in contact with these materials should be fabricated from Teflon, or Ethylene/Propylene type materials. Avoid the use of natural rubber, neoprene and Viton-type seals and gaskets. When using SS 214 make sure that enough material is used to completely fill joints with some squeeze out occurring to ensure complete joint fill when parts are joined together. Note that all materials should be dispensed and parts positioned and clamped prior to the expiration of actual working times. Allow parts to remain clamped until after the fixture time has expired. We recommend a brief test of the bond edge to assure that the material is developing hardness prior to the removal of clams or bond fixtures. Clean up of these materials while still wet is best achieved through the use of any citrus terpene or NMP (N-Methyl Pyrolidone) based cleaner. Cured adhesive is best cleaned through the use of gentle sanding or scraping in conjunction with the above cleaners or mild solvent wipe.

Notes:

1. The need for surface preparation can only be properly determined through testing to assure that the cured adhesive is achieving the desired results without preparation.. We always recommend the use of laboratory testing to address this concern. All testing should completely mimic the methods and materials intended to be used in the actual manufacturing environment.
2. We strongly recommend that you consult our technical service representatives for discussion regarding your intended use and application of this and any other IPS product.
3. The definition of working time is the time elapsed between the instant that parts A and B are combined and mixed and the time that the adhesive no longer wets the surface nor is compressible and flowable. The times represented on this sheet were determined at 75 degrees Fahrenheit.
4. The fixture time is defined as the time after which the bonded components can support a 2 lb. static weight on a one by one inch joint area in both the shear and normal configurations without movement.
5. Chemical resistance varies greatly depending on conditions of exposure such as: temperature, concentration, bond line thickness and length of exposure. Please contact IPS for recommendations regarding use in any chemical environment!

WELD•ON®
STRUCTURAL SERIES
IPS CORPORATION

Structural Series SS 218

Technical Data Sheet — Gray

Description: SS 218 Gray methacrylate adhesive is a two component, 10:1 ratio system, ideal for large component bonding, with little to no surface preparation[1]. This product offers excellent fatigue, impact, vibration damping and shock-load resistance. This adhesive was designed for applications up to 1" thick and is uniquely formulated with mild exotherms, low shrinkage, less odor, and minimal sag on verticals. **WELD-ON®** SS Adhesives provide the highest combination toughness and strength available in a methacrylate adhesive.

Recommended Substrates:

FRP, PVC, ABS, Acrylics, Polyester Gelcoats, Urethanes, Vinyl Esters and Styrenics

Performance:

Features	Benefits
• High elongation over 200%.	• Ultimate fatigue and shock-load resistance (toughness)
• Lower exotherm and minimal leveling and slide.	• Reduces finishing in cosmetically sensitive areas. Adhesive stays where it is applied.
• Formulated forgiveness to tolerate slight off ratio mixing.	• Virtually no boil or loss of physicals (embrittlement) caused by excessive heat build-up. Seen in other systems!
• Long working time[3] 40 minutes and a fixture time[4] of 90 minutes.	• Ideal for mating large, low tolerance FRP components requiring thick bond lines and extended application time. (Stringer, liners, decks, frame components, etc.)[2]

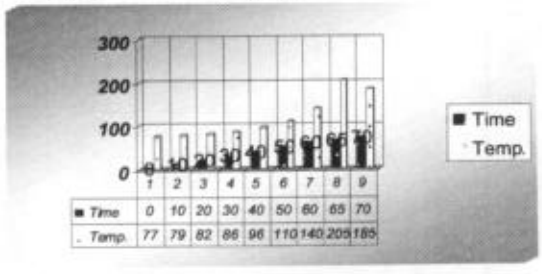
Packaging:
- 470 cc/825 cc Cartridges
- 5 Gallon Pails
- 55 Gallon Drums

Typical Adhesive Properties @ 77° F

	Adhesive Comp. A	Activator Comp. B	Mixed AB
Volumetric mix ratio:	10.00	1	----
Weight based mix ratio:	7.90	1	----
Working time[3]	----	----	40 - 42 min.
Fixture time[4]	----	----	80 – 100 min.
Color:	Opaque	Black	Gray
Viscosity (kcp)	150 - 175	40 – 50	----
Density (g/cc)	.92	1.04	.94
Unit Weight (lb./gal.)	7.70	8.66	7.80

Excellent resistance[5]: Hydrocarbons, pH range of 3-10 and Salt Solutions.
Not recommended for: Strong Acids, Bases, and Polar Solvents.

Typical Exotherm Profile : 1/2" thick, 30 gram mass	
Time to initiation	38 min
Time to Peak	65 min
Peak temp.	205° F



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6/00

Typical Mechanical Properties*: Tensile Properties (ASTM D 638-97)

Tensile Strength (psi):	2250 - 2500
Modulus (psi)**:	140,000
Max. Elongation (%):	225 - 250
Single Shear Strength (psi): (ASTM D 5868-95)	2000
*Both components mixed and allowed to cure at RT for 48 hours. **Modulus as measured in the linear portion of the stress/strain curve. # Values depend on shear strength and stiffness of the substrate when substrate failure occurs.	

Shelf Stability:

The shelf life of SS 218 (parts A and B) is approximately six months from the time product is shipped from IPS facilities. Shelf life is based on steady state storage between 50 degrees Fahrenheit and 80 degrees Fahrenheit. Any, or cumulative storage at temperatures above 80 degrees Fahrenheit will result in a reduction of the stated shelf life. We recommend storage of these products in a cool, dry location. These products should not be stored at temperatures below 32 degrees Fahrenheit. Shelf life can be prolonged by storage below 50 degrees Fahrenheit (do not freeze).

Exothermic and working performance:

The data presented here with regard to open, working and exotherm times and temperatures was determined in a laboratory at room temperature. Any increase or decrease in product, substrate or environmental temperatures will result in corresponding increases or decreases in handling parameters. If you have any questions or intend use of these products in different conditions, please contact IPS technical service for indications of what types of variations you might expect.

Application and handling:

Both SS 218 parts A and B are flammable. These products contain methacrylate ester. When finished using these products, keep the containers closed. Always keep away from open flames, heat and sparks. Make sure all metallic packaging (drums) and dispensing equipment are grounded when in use. Avoid contact with skin and eyes. In case of skin contact wash with soap and water. In the event of eye contact, flush with water for 15 minutes and seek immediate medical attention. These products are harmful if swallowed and should be kept out of reach of children at all times. Also note that these products cure with the development of heat (exotherm). Large masses curing can develop vapor emissions and heat in excess of 300 degrees Fahrenheit. Caution should be used to avoid contact with and the curing of large amounts of material in excess of 1.5 in. in thickness. Do not use in unventilated or enclosed areas. MMA monomer is heavier than air. Evacuation of fumes requires ground level pick up or air circulation.

Dispensing Equipment:

SS 218 can be applied through the use of either automated or manual dispensing equipment in conjunction with static mixing technology. Cartridge systems (pre-metered) with dispensing guns are also available. For information regarding the availability and/or use of such equipment, please contact IPS Technical Service or your IPS sales representative. All metallic equipment coming in contact with this adhesive should be constructed of stainless steel or coated with a sufficiently chemical resistant material to prevent contact between the base metal and the adhesive or activator components. Contact with copper, brass, zinc or any alloys containing these materials should be avoided at all times. All seals and gaskets coming in contact with these materials should be fabricated from Teflon, or Ethylene/Propylene type materials. Avoid the use of natural rubber, neoprene and Viton-type seals and gaskets. When using SS 218 make sure that enough material is used to completely fill joints with some squeeze out occurring to ensure complete joint fill when parts are joined together. Note that all materials should be dispensed and parts positioned and clamped prior to the expiration of actual working times. Allow parts to remain clamped until after the fixture time has expired. We recommend a brief test of the bond edge to assure that the material is developing hardness prior to the removal of clams or bond fixtures. Clean up of these materials while still wet is best achieved through the use of any citrus terpene or NMP (N-Methyl Pyrolidone) based cleaner. Cured adhesive is best cleaned through the use of gentle sanding or scraping in conjunction with the above cleaners or mild solvent wipe.

Notes:

1. The need for surface preparation can only be properly determined through testing to assure that the cured adhesive is achieving the desired results without preparation.. We always recommend the use of laboratory testing to address this concern. All testing should completely mimic the methods and materials intended to be used in the actual manufacturing environment.
2. We strongly recommend that you consult our technical service representatives for discussion regarding your intended use and application of this and any other IPS product.
3. The definition of working time is the time elapsed between the instant that parts A and B are combined and mixed and the time that the adhesive no longer wets the surface nor is compressible and flowable. The times represented on this sheet were determined at 75 degrees Fahrenheit.
4. The fixture time is defined as the time after which the bonded components can support a 2 lb. static weight on a one by one inch joint area in both the shear and normal configurations without movement.
5. Chemical resistance varies greatly depending on conditions of exposure such as: temperature, concentration, bond line thickness and length of exposure. Please contact IPS for recommendations regarding use in any chemical environment!

WELD•ON®
STRUCTURAL SERIES
IPS CORPORATION

Structural Series SS 218

Technical Data Sheet — Off-White

Description: SS 218 methacrylate adhesive is a two component, 10:1 ratio system, ideal for large component bonding, with little to no surface preparation[1]. It is formulated off-white and is UV inhibited[5]. This product offers excellent fatigue, impact, vibration damping and shock-load resistance. This adhesive was designed for applications up to 1" thick and is uniquely formulated with mild exotherms, low shrinkage, less odor, and minimal sag on verticals. SS 218 can also bond a variety of composites and thermoplastics with minimal surface preparation[2]. **WELD-ON®** SS Adhesives provide the highest combination toughness and strength available in a methacrylate adhesive.

Recommended Substrates:

FRP, PVC, ABS, Acrylics, Polyester Gelcoats, Urethanes, Vinyl Esters and Styrenics

Performance:

Features	Benefits
• Off-White, UV inhibited[5].	• Consider for bonding exterior components.
• High elongation over 200%.	• Ultimate fatigue and shock-load resistance (toughness)
• Lower exotherm and minimal leveling and slide.	• Reduces finishing in cosmetically sensitive areas. Adhesive stays where it is applied.
• Formulated forgiveness to tolerate slight off ratio mixing.	• Virtually no boil or loss of physicals (embrittlement) caused by excessive heat build-up. Seen in other systems!
• Long working time[3] 40 minutes and a fixture time[4] of 90 minutes.	• Ideal for mating large, low tolerance FRP components requiring thick bond lines and extended application time. (Stringer, liners, decks, frame components, etc.)[2]

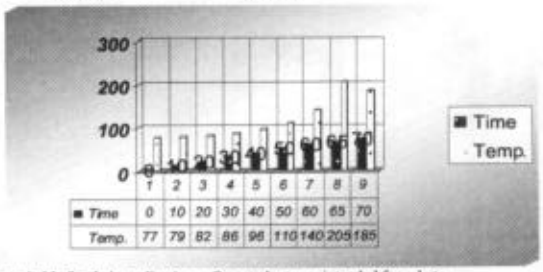
Packaging:
- 470 cc/825 cc Cartridges
- 5 Gallon Pails
- 55 Gallon Drums

Typical Adhesive Properties @ 77° F

	Adhesive Comp. A	Activator Comp. B	Mixed AB
Volumetric mix ratio:	10.00	1	----
Weight based mix ratio:	7.90	1	----
Working time[3]	----	----	40 - 42 min.
Fixture time[4]	----	----	80 - 100 min.
Color:	Opaque	White	Off-White
Viscosity (kcp)	150 - 175	40 – 50	----
Density (g/cc)	.92	1.23	.95
Unit Weight (lb./gal.)	7.70	10.25	7.93

Excellent resistance[6]: Hydrocarbons, pH range of 3-10 and Salt Solutions.
Not recommended for: Strong Acids, Bases, and Polar Solvents.

Typical Exotherm Profile : 1/2" thick, 30 gram mass	
Time to initiation	38 min
Time to peak	65 min
Peak temp.	205° F



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Fax: 1-310-323-4412

6/00

Typical Mechanical Properties*: Tensile Properties (ASTM D 638-97)

Tensile Strength (psi):	2250 - 2500
Modulus (psi)**:	140,000
Max. Elongation (%):	200-225
Single Shear Strength (psi): (ASTM D 5868-95)	2000#

*Both components mixed and allowed to cure at RT for 48 hours.
**Modulus as measured in the linear portion of the stress/strain curve.
Values depend on shear strength and stiffness of the substrate when substrate failure occurs.

Shelf Stability:

The shelf life of SS 218 (parts A and B) is approximately six months from the time product is shipped from IPS facilities. Shelf life is based on steady state storage between 50 degrees Fahrenheit and 80 degrees Fahrenheit. Any, or cumulative storage at temperatures above 80 degrees Fahrenheit will result in a reduction of the stated shelf life. We recommend storage of these products in a cool, dry location. These products should not be stored at temperatures below 32 degrees Fahrenheit. Shelf life can be prolonged by storage below 50 degrees F (do not freeze).

Exothermic and working performance:

The data presented here with regard to open, working and exotherm times and temperatures was determined in a laboratory at room temperature. Any increase or decrease in product, substrate or environmental temperatures will result in corresponding increases or decreases in handling parameters. If you have any questions or intend use of these products in different conditions, please contact IPS technical service for indications of what types of variations you might expect.

Application and handling:

Both SS 218 parts A and B are flammable. These products contain methacrylate ester. When finished using these products, keep the containers closed. Always keep away from open flames, heat and sparks. Make sure all metallic packaging (drums) and dispensing equipment are grounded when in use. Avoid contact with skin and eyes. In case of skin contact wash with soap and water. In the event of eye contact, flush with water for 15 minutes and seek immediate medical attention. These products are harmful if swallowed and should be kept out of reach of children at all times. Also note that these products cure with the development of heat (exotherm). Large masses curing can develop vapor emissions and heat in excess of 300 degrees F. Caution should be used to avoid contact with and the curing of large amounts of material in excess of 1.5 inches in thickness. Do not use in unventilated or enclosed areas. MMA monomer is heavier than air. Evacuation of fumes requires ground level pick up or air circulation.

Dispensing Equipment:

SS 218 can be applied through the use of either automated or manual dispensing equipment in conjunction with static mixing technology. Cartridge systems (pre-metered) with dispensing guns are also available. For information regarding the availability and/or use of such equipment, please contact IPS Technical Service or your IPS sales representative. All metallic equipment coming in contact with this adhesive should be constructed of stainless steel or coated with a sufficiently chemical resistant material to prevent contact between the base metal and the adhesive or activator components. Contact with copper, brass, zinc or any alloys containing these materials should be avoided at all times. All seals and gaskets coming in contact with these materials should be fabricated from Teflon, or Ethylene/Propylene type materials. Avoid the use of natural rubber, neoprene and Viton-type seals and gaskets. When using SS 218 make sure that enough material is used to completely fill joints with some squeeze out occurring to ensure complete joint fill when parts are joined together. Note that all materials should be dispensed and parts positioned and clamped prior to the expiration of actual working times. Allow parts to remain clamped until after the fixture time has expired. We recommend a brief test of the bond edge to assure that the material is developing hardness prior to the removal of clams or bond fixtures. Clean up of these materials while still wet is best achieved through the use of any citrus terpene or NMP (N-Methyl Pyrolidone) based cleaner. Cured adhesive is best cleaned through the use of gentle sanding or scraping in conjunction with the above cleaners or mild solvent wipe.

Notes:

1. The need for surface preparation can only be properly determined through testing to assure that the cured adhesive is achieving the desired results without preparation.. We always recommend the use of laboratory testing to address this concern. All testing should completely mimic the methods and materials intended to be used in the actual manufacturing environment.
2. We strongly recommend that you consult our technical service representatives for discussion regarding your intended use and application of this and any other IPS product.
3. The definition of working time is the time elapsed between the instant that parts A and B are combined and mixed and the time that the adhesive no longer wets the surface nor is compressible and flowable. The times represented on this sheet were determined at 75 degrees Fahrenheit.
4. The fixture time is defined as the time after which the bonded components can support a 2 lb. static weight on a one by one inch joint area in both the shear and normal configurations without movement.
5. Formulated with UV resistance, however it is not recommended for direct UV exposure this product will fade to a light amber over long term UV exposure. Manufacturer should determine the suitability for their particular application.
6. Chemical resistance varies greatly depending on conditions of exposure such as: temperature, concentration, bondline thickness and length of exposure. Please contact IPS for recommendations regarding use in any chemical environment!

WELD•ON®
STRUCTURAL SERIES
IPS CORPORATION

Structural Series SS 218HV

Technical Data Sheet — Gray

Description: SS 218 HV methacrylate adhesive is a two component, 10:1 ratio system, ideal for large component bonding, with little to no surface preparation[1]. This product offers excellent fatigue, impact, vibration damping and shock-load resistance. This adhesive was designed for applications up to 1" thick and is uniquely formulated with mild exotherms, low shrinkage, less odor, and minimal sag on verticals. SS 218 HV can also bond a variety of composites and thermoplastics with minimal surface preparation[2]. This product is designed for bulk dispensing equipment. **WELD-ON®** SS Adhesives provide the highest combination toughness and strength available in a methacrylate adhesive.

Recommended Substrates:

FRP, PVC, ABS, Acrylics, Polyester Gelcoats, Urethanes, Vinyl Esters and Styrenics

Performance:

Packaging:
- 5 Gallon Pails
- 55 Gallon Drums

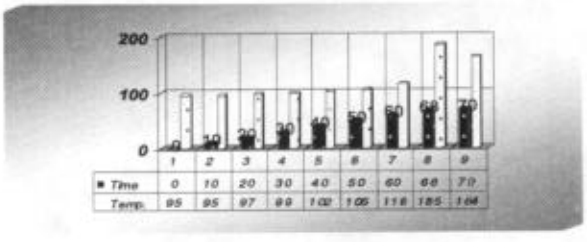
Features	Benefits
• 45 minute open time at 95° F at 1 1/2" thick 50 gram mass.	• Long open time designed for formatting large, low tolerance FRP components requiring thick bond lines and extended application time.
• High elongation over 200%.	• Ultimate fatigue and shock-load resistance (toughness).
• Lower exotherm 180° F and minimal leveling and slide.	• Reduces finishing in cosmetically sensitive areas. Adhesive stays where it is applied.
• Formulated forgiveness to tolerate slight off ratio mixing.	• Virtually no boil or loss of physicals (embrittlement) caused by excessive heat build-up. Seen in other systems!

Typical Adhesive Properties @ 77° F

	Adhesive Comp. A	Activator Comp. B	Mixed AB
Volumetric mix ratio:	10.00	1	----
Weight based mix ratio:	9.67	1	----
Working time[3]	----	----	42 - 45 min @ **95°F**
Fixture time[4]	----	----	80 - 100 min @ **95°F**
Color:	Opaque	Black	Dark Gray
Viscosity (kcp)	850 - 1,000	275 - 325	----
Density (g/cc)	1.01	1.04	1.01
Unit Weight (lb./gal.)	7.7 0	8.66	7.80

Excellent resistance[5]: Hydrocarbons, pH range of 3-10 and Salt Solutions.
Not recommended for: Strong Acids, Bases, and Polar Solvents.

Typical Exotherm Profile: 1 1/2" thick, 50 gram mass	
Time to initiation	45 min
Time to peak	68 min
Peak temp.	185° F



IPS® Corporation 17109 S. Main St. P.O. Box 379 Gardena, CA 90248-0379
Phone: 1-310-898-3300
Fax: 1-310-323-4412

6/00

Typical Mechanical Properties*: Tensile Properties (ASTM D 638-97)

Tensile Strength (psi):	2250 - 2500
Modulus (psi)**:	140,000
Max. Elongation (%):	200-250
Single Shear Strength (psi): (ASTM D 5868-95)	2,200#
*Both components mixed and allowed to cure at RT for 48 hours. **Modulus as measured in the linear portion of the stress/strain curve. # Values depend on shear strength and stiffness of the substrate when substrate failure occurs.	

Shelf Stability:

The shelf life of SS 218 HV (parts A and B) is approximately six months from the time product is shipped from IPS facilities. Shelf life is based on steady state storage between 50 degrees Fahrenheit and 80 degrees Fahrenheit. Any, or cumulative storage at temperatures above 80 degrees Fahrenheit will result in a reduction of the stated shelf life. We recommend storage of these products in a cool, dry location. These products should not be stored at temperatures below 32 degrees Fahrenheit. Shelf life can be prolonged by storage below 50 degrees Fahrenheit (do not freeze).

Exothermic and working performance:

The data presented here with regard to open, working and exotherm times and temperatures was determined in a laboratory at room temperature. Any increase or decrease in product, substrate or environmental temperatures will result in corresponding increases or decreases in handling parameters. If you have any questions or intend use of these products in different conditions, please contact IPS technical service for indications of what types of variations you might expect.

Application and handling:

Both SS 218 HV parts A and B are flammable. These products contain methacrylate ester. When finished using these products, keep the containers closed. Always keep away from open flames, heat and sparks. Make sure all metallic packaging (drums) and dispensing equipment are grounded when in use. Avoid contact with skin and eyes. In case of skin contact wash with soap and water. In the event of eye contact, flush with water for 15 minutes and seek immediate medical attention. These products are harmful if swallowed and should be kept out of reach of children at all times. Also note that these products cure with the development of heat (exotherm). Large masses curing can develop vapor emissions and heat in excess of 300 degrees Fahrenheit. Caution should be used to avoid contact with and the curing of large amounts of material in excess of 1.5 inches in thickness. Do not use in unventilated or enclosed areas. MMA monomer is heavier than air. Evacuation of fumes requires ground level pick up or air circulation.

Dispensing Equipment:

SS 218 HV can be applied through the use of either automated or manual dispensing equipment in conjunction with static mixing technology. Cartridge systems (pre-metered) with dispensing guns are also available. For information regarding the availability and/or use of such equipment, please contact IPS Technical Service or your IPS sales representative. All metallic equipment coming in contact with this adhesive should be constructed of stainless steel or coated with a sufficiently chemical resistant material to prevent contact between the base metal and the adhesive or activator components. Contact with copper, brass, zinc or any alloys containing these materials should be avoided at all times. All seals and gaskets coming in contact with these materials should be fabricated from Teflon, or Ethylene/Propylene type materials. Avoid the use of natural rubber, neoprene and Viton-type seals and gaskets. When using SS 218 HV make sure that enough material is used to completely fill joints with some squeeze out occurring to ensure complete joint fill when parts are joined together. Note that all materials should be dispensed and parts positioned and clamped prior to the expiration of actual working times. Allow parts to remain clamped until after the fixture time has expired. We recommend a brief test of the bond edge to assure that the material is developing hardness prior to the removal of clams or bond fixtures. Clean up of these materials while still wet is best achieved through the use of any citrus terpene or NMP (N-Methyl Pyrolidone) based cleaner. Cured adhesive is best cleaned through the use of gentle sanding or scraping in conjunction with the above cleaners or mild solvent wipe.

Notes:

1 The need for surface preparation can only be properly determined through testing to assure that the cured adhesive is achieving the desired results without preparation.. We always recommend the use of laboratory testing to address this concern. All testing should completely mimic the methods and materials intended to be used in the actual manufacturing environment.

2 We strongly recommend that you consult our technical service representatives for discussion regarding your intended use and application of this and any other IPS product.

3 The definition of working time is the time elapsed between the instant that parts A and B are combined and mixed and the time that the adhesive no longer wets the surface nor is compressible and flowable. The times represented on this sheet were determined at 75 degrees F.

4 The fixture time is defined as the time after which the bonded components can support a 2 lb. static weight on a one by one inch joint area in both the shear and normal configurations without movement.

5 Chemical resistance varies greatly depending on conditions of exposure such as: temperature, concentration, bond line thickness and length of exposure. Please contact IPS for recommendations regarding use in any chemical environment!

"I build high performance boats for rugged use in harsh environments. That's why I rely on Weld-On®. Exclusively."

— Sid Lanier, naval architect and fiberglass stringer pioneer

"Weld-On's high viscosity methacrylate lets me cut a 4-man crew in half — and get a better quality job. We shoot it on thick and don't have to worry. Weld-On hangs on vertical surfaces, has a long open time and cures consistently. Weld-On is tough, so I get stronger hulls that stand up to impact and resist long term fatigue without any additional weight or labor costs."

Weld-On methacrylates are engineered for the toughest composite bonding applications — and to be affordable enough for today's boat builders. Long open times, low exotherm, minimal slide and virtually no boil mean your adhesive stays where you put it — and can be worked to perfection. Call us today. See how you can build better boats faster and more efficiently.

WELD•ON®
STRUCTURAL SERIES
ADHESIVE SOLUTIONS

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SS600 SERIES

METHACRYLATE ADHESIVE DATA SHEET

SS605, SS620, SS630

WELD•ON®
STRUCTURAL SERIES
ADHESIVE SOLUTIONS

DESCRIPTION

IPS WELD-ON® SS600 Series Methacrylate Adhesives are two-component, 10:1 mix ratio products for bonding composites, metal and other plastic parts. They are designed for small-to-medium sized assemblies and accessories with relatively close part tolerances. Plastic materials can be cross-bonded with other plastics and metals. The SS600 series products are available in off-white or black through a choice of two activators. Packaging options include 470 ml cartridges and 5 & 55 gallon containers for application with meter-mix-dispensing equipment.

PERFORMANCE HIGHLIGHTS	BENEFIT
• Choice of 5, 20 and 30 minute open time	Selections for a wide variety of applications
• Minimal surface preparation[1, 2]	Reduced labor cost and throughput times
• Non-sag handling characteristics	Bead stays in place in bond gap or on vertical surfaces
• Reduced volatility	Reduced odor, skinning, and cure shrinkage
• Permanent toughness and elasticity	Excellent fatigue, impact and shock-load resistance
• Excellent hot strength[5]	Fiber tearing FRP bonds in applications up to 180°F

TYPICAL ADHESIVE CHARACTERISTICS

	Part A Adhesive	Part B Activator	Mixed A+B
Color:	Off white	Off white or black	Off white or black
Mix ratio by volume:	10	1	n/a
Mix ratio by weight:	7.78	1	n/a
Viscosity, cps:	150-200,000	60-80,000	150-200,000
Density, grams/ml:	0.92	1.04	0.94
Unit weight, lb/gallon:	7.70	8.66	7.80

TYPICAL PHYSICAL PROPERTIES

Tensile strength (psi):	2,800-3,200
Elongation (%):	100-140
Bond strength (psi)[3]:	2,800 Maximum
Modulus (psi)[4]:	90,000

RECOMMENDED SUBSTRATES

FRP & Vinyl Esters	ABS
Polyester Gelcoats	PVC
Styrenics	Acrylics
Polyurethanes	Metals[2]

Bonds are generally resistant to the effects of heat, water and moisture, aqueous chemicals and most petroleum hydrocarbons, including gasoline, motor oil and diesel fuel. Not recommended for immersion or long-term exposure to concentrated acids or bases, or aggressive organic solvents such as toluene, ketones, and esters. It is the user's responsibility to determine the suitability of each adhesive for its intended use and application.

---

1. Most thermoplastics can be bonded with no surface preparation other than a dry wipe or air blow-off. If contamination is visible or suspected, wipe with alcohol prior to bonding. Polyolefins, thermoplastic polyesters, fluorocarbon plastics and other low surface energy plastics are generally not bondable. Testing is required on thermoset plastics because of the wide variations in compositions and bondability. See important notes 1, 2, and 3 on reverse side.
2. Prepare metal for bonding by removing all dust, loose scale, rust, and other surface residue including oil or grease. Apply MP 100 Metal Primer according to directions. Heavy grinding or sanding may interfere with the chemical action of MP 100 and is not recommended, especially with aluminum and stainless steel. See important notes 1, 2, and 3 on reverse side.Value will depend on shear stiffness and strength of substrate.
3. Modulus as measured in the linear portion of the stress/strain curve.
4. Hot strength was measured on primed (MP 100) Aluminum-to-Aluminum producing 1,200 to 1,500psi lap shear strength at 180°F. These products in applications above 180°F are not recommended.

SS600 Series Products

Product	Working Time Minutes (75°F/24°C)	Fixture Time Minutes (75°F/24°C)
SS 605	4-6	10-12
SS 620	18-22	35-45
SS 630	30-35	70-90

SAFETY AND HANDLING

Read Material Safety Data Sheet before handling or using this product. Adhesive (Component A) contains methyl methacrylate monomer and is flammable. Always use in a well-ventilated area. Floor-level extraction and large quantities of moving air greatly facilitate ventilation. Activator (Component B) contains peroxide. Both materials must be stored in a cool place away from sources of heat and open flames or sparks. Keep containers closed when not in use. Prevent contact with skin and eyes. In case of skin contact, wash with soap and water. In case of eye contact, flush with water for 15 minutes and seek immediate medical attention. Harmful if swallowed. Keep out of reach of children.

MIXING AND APPLICATION

EXOTHERM. The chemical curing reaction that occurs when components A and B are mixed generates heat. The amount of heat generated is controlled by the mass and thickness of the mixed product. Large masses over 1.5 inches thick can develop heat in excess of 250°F/121°C and can generate harmful, flammable vapors. Large curing masses should be carefully moved to a well-ventilated area where the chance of personal contact is minimized.

CURING. Open working time is the approximate time after mixing components A and B, depending on bonding conditions, that the adhesive remains fluid and bondable. Fixture time is the approximate time after mixing components A and B required for the adhesive to react the partial state of cure necessary to allow careful movement, unclamping or de-molding of assembled parts. Parts can generally be put in service when 80 percent of full strength is developed. The time to achieve 80% cure is approximately2-3 times that required for fixturing. The working and fixture times presented in this bulletin are based on laboratory tests performed at 75°F/24°C. Higher temperatures speed the curing reaction and reduce open working time. The reverse is true for lower temperatures. If significant variation in temperatures or application at very high or low temperatures is anticipated, contact your IPS representative for technical assistance.

DISPENSING EQUIPMENT. Dispensing from disposable cartridges or meter-mix-dispensing equipment is highly recommended. Both methods employ convenient static motionless mixer technology. Product supplies in pre-measured cartridges is dispensed from approved manual or pneumatic powered guns. Contact your IPS representative for information and availability.

When meter-mix dispense systems are used, care must be taken to assure compatibility between the adhesive components and the materials in the equipment that they contact. All wetted metal components should be constructed stainless steel, aluminum or a sufficient thickness of chemically resistant material that prevents contact between the adhesive components and the base metal. *Contact with copper, brass, zinc or alloys containing these materials must be strictly avoided.* All non-metallic seals and gaskets should be fabricated from Teflon, or polyethylene based materials. *Natural rubber, nitrile rubber (BUNA), neoprene and Viton® are not acceptable.*

APPLICATION. Follow instructions provided or contact your IPS representative for proper preparation of dispensing equipment and substrates prior to starting the bonding process. Always dispense a quantity of adhesive at start-up to assure that the adhesive exiting the tip of the mixer is the proper color and is uniform, without streaks. If aged material is being used, allow the purged material to cure to assure quality before proceeding. Carefully dispense a sufficient quantity of adhesive on the substrate to assure that the bond gap will be completely filled when the parts are mated. Allow for squeeze-out at the edges of the bond to assure filling. Carefully secure or clamp parts to prevent joint movement while the adhesive sets. Do not apply excessive pressure that can cause excessively thin gaps and starve the bond line. If in doubt, use shims or spacers to set the gap. A minimum gap of 20 mils (0.02 inch) is recommended for all other adhesives. Test the curing adhesive at the edges for fingernail hardness before removing clamps or fixtures. If clean up of the adhesive from the bonded area is required, we recommend that it is carefully performed using alcohol or other preferred industrial solvent while the adhesive is still wet or soft. Partially cured adhesive can be carefully removed with a sharp knife. Cured adhesive must be sanded or scraped, using a suitable solvent to remove remaining traces.

CLEAN-UP. Adhesive components and mixed adhesive should be removed form mixing and application equipment with a suitable industrial solvent or cleaner before the mixed adhesive cures. Once the adhesive cures, soaking in a strong solvent or paint remover will be required to soften the adhesive sufficiently for removal.

STORAGE AND SHELF LIFE

The shelf life of Components A and B in unopened containers is approximately six months from the date the product is shipped from IPS facilities. Shelf life is based on steady state storage between 50°F and 80°F (10°C and 27°C). Exposure, intermittent or prolonged, above 80°F/27°C will result in a reduction of the stated shelf life. *Exposures above 100 °F (38°C) during shipping or storage can quickly degrade Component B in cartridges or bulk containers, and must be strictly prevented.* Shelf life of both components can be extended by air-conditioned or refrigerated storage between 50°F and 65°F (10°C and 18°C).

IMPORTANT NOTES

1. SUBSTRATE AND APPLICATION COMPATIBILITY. The user must determine the suitability of a selected adhesive for a given substrate and application. IPS strongly recommends laboratory, shop and end-use testing that simulates the actual manufacturing and end-use environment.
2. SURFACE PREPARATION. The need for surface preparation must be determined by comparative testing of prepared and unprepared substrates to assure that unprepared bonding is equivalent to or acceptable for the application relative to prepared bonding. Initial bonding tests must be followed up with simulated or actual durability tests to assure that surface conditions do not lead to degradation of the bond over time under service conditions. Subsequent changes in substrates or bonding conditions will require re-testing.
3. TECHNICAL ASSISTANCE. Contact your IPS representative for questions or assistance with the selection of adhesives and methods for evaluating adhesives for your intended application.

This product is intended for use by skilled individuals at their own risk. Recommendations contained herein are based on information we believe to be reliable. The properties and strength values presented above are typical properties obtained under controlled conditions at the IPS laboratory. They are intended to be used only as a guide for selection for end-use evaluation. The ultimate suitability for any intended application must be verified by the end user under anticipated test conditions. Since specific use, materials and product handling are not controlled by IPS, our warranty is limited to the replacement of defective IPS products.

IPS Corporation
PO Box 12729, Research Triangle Park, NC 27709 • www.ipscorp.com • Phone: (919) 598-2400 • Toll Free: 1-877-IPS GLUE • FAX (919) 598-2439

09/25/01

WELD-ON® CASE STUDY

Manufacturer: Whitewater West Industries Ltd. is the largest and most experienced builder of water parks and aquatic attractions in the world.

Problem/ Situation: Manufacturer wants to maintain its worldwide leadership position in the manufacture, design and installation of composite waterslides and aquatic attractions. The consolidation of materials used and the elimination of older technologies such as mechanical fasteners and "glass tabbing" are key factors in remaining an industry leader in all commercial markets served by the manufacturer. Creating efficiencies throughout the entire manufacturing process from initial design to final installation is critical to their long-term success.

Solution: Weld-On® Methacrylate Structural Adhesives.

- One adhesive can be used for all applications to simplify all processes – from initial design to final installation.
- An integrated solution using Weld-On adhesives with aluminum reinforcements allows the manufacturer to replace structural steel and reduce costs.
- Reduced exotherm compared with other adhesives tested reduces print-through and produces better looking parts.
- The bonding process produces fewer emissions than traditional fiberglass tabbing.
- Toughened Weld-On adhesives have the strength and durability to withstand demanding environments (i.e. Canadian winters).

Manufacturer's Statement: "Our knowledge of methacrylate adhesives over the past several years, combined with our willingness and ability to test different types of adhesives led us to a complete evaluation and subsequent approval of Weld-On products for all our applications," claims Stuart Burns-Vice President and General Manager.

What Weld-On and IPS Corporation can do for you: IPS has spent nearly fifty years pioneering better adhesive solutions for industrial, commercial and residential applications. Our latest innovation has created advanced, two-component methacrylate adhesives that bond metals, plastics and other materials in a broad range of demanding transportation, marine and industrial composite applications. If there's a better way to join materials, IPS development teams are working on it. Whether sparked by an idea from the lab or a request from a customer, the product development process gets our experts to the field (into your plant) to be sure our products match your requirements. Call us today, and we'll get busy on your unique application needs.

WELD•ON® STRUCTURAL SERIES ADHESIVE SOLUTIONS

Visit our website at: www.ipscorp.com

Call us toll-free: 1-877-IPS-GLUE (1-877-477-4583)

IPS Corporation, Structural Adhesives Division / 600 Ellis Rd., Durham, NC 27703

FRP Supplier

Exclusive North American Distributor

WELD-ON®

ADHESIVES REFERENCE GUIDE

Adhesive	Description	Color	Mix Ratio (vol)	Viscosity (cps)	Working Time[2] (min)	Fixture Time (min)	Tensile Strength (psi)	Tensile Elongation[3] (%) Post cured	Single Shear Strength[2] (psi)
SS 505	High strength. General purpose.	Amber	1:1	A:40,000-60,000 B:40,000-60,000	4-6	10-12	3,500-4,500	75-100	3,500
SS 515	High strength. General purpose.	Amber	1:1	A:40,000-60,000 B:40,000-60,000	15-18	25-30	3,500-4,500	75-100	3,500
SS 208	Toughened. General purpose.	Off white	10:1	A:150,000-200,000 B:60,000-80,000	8-10	15-20	2,000-2,500	200-250	2,000
SS 214	Toughened. General purpose.	Off white, Gray	10:1	A:150,000-200,000 B:60,000-80,000	20	40	2,000-2,500	200-250	2,000
SS 214HV	Toughened. Up to .75" gap. Medium open time. No boil/sag.	Gray	10:1	A:650,000-800,000 B:80,000-120,000	25-30 (Variable)	55-75 (Variable)	2,000-2,500	200-250	2,000
SS 218	Toughened. General purpose.	Off white, Gray	10:1	A:150,000-200,000 B:60,000-80,000	40	90	2,000-2,500	200-250	2,000
SS 218HV	Toughened. Up to 1" gap. Long open time. No boil/sag.	Gray	10:1	A:850,000-1,000,000 B:80,000-120,000	40-50@95F (Variable)	90-110@95F (Variable)	2,000-2,500	200-250	2,200
SS 605	High strength. Good hot strength.[4]	Black, White	10:1	A:150,000-200,000 B:60,000-80,000	4-6	12-14	2,900-3,300	100-150	3,000
SS 620	High strength. Good hot strength.[4]	Black, White	10:1	A:150,000-200,000 B:60,000-80,000	18-22	35-45	2,900-3,300	150-200	3,000
SS 630	High strength. Longer open time version.[4]	Black, White	10:1	A:150,000-200,000 B:60,000-80,000	30-35	70-90	2,900-3,300	150-200	3,000

Notes:
1. Values depend on shear strength and stiffness of the substrate when failure occurs.
2. Working/fixture times at 75°F unless noted.
3. All mechanical properties are based on postcure cycle, 1 hour at 87°C.
4. Hot strength was measured on primed (MP 100) Aluminum-to-Aluminum producing 1,200 to 1,500 psi lap shear strength at 180°F. For applications above 180°F please contact your IPS representative.

Read and understand both technical data sheet and MSDS before using any IPS product.

WELD•ON® STRUCTURAL SERIES ADHESIVE SOLUTIONS

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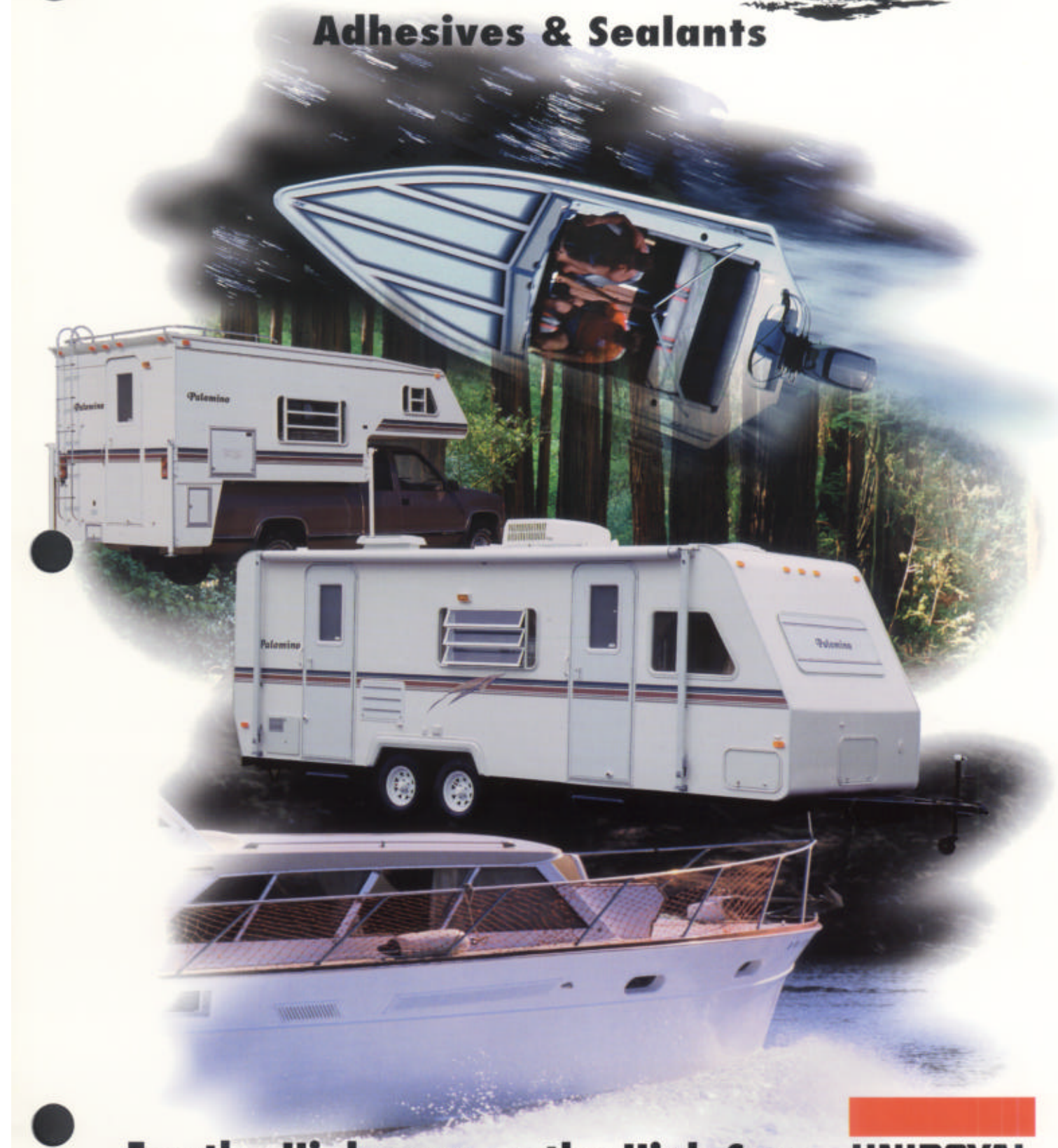
RV MARINE

Adhesives & Sealants



For the Highways or the High Seas, Count on Holding Power from

UNIROYAL

ADHESIVES & SEALANTS

High Performance Adhesives and Sealants

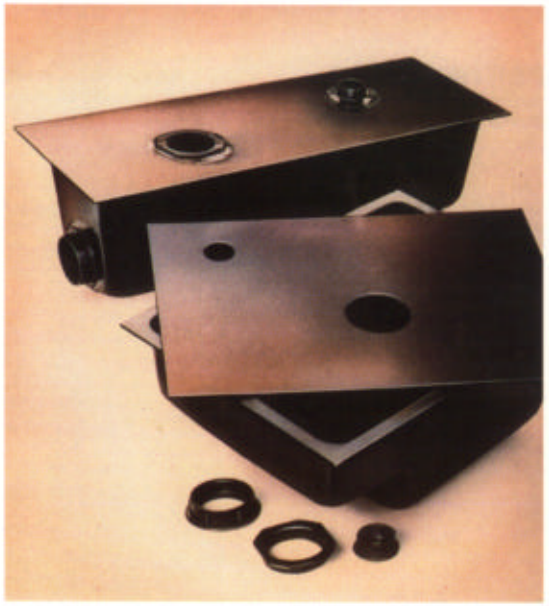
Specialty Adhesives

In addition to the Silaprene® products shown on these pages, Uniroyal Adhesives and Sealants has over 200 standard products to solve bonding and sealing problems. Our technical advisers and fully staffed laboratory are always available to develop solutions for your special applications.

PRESSURE SENSITIVE: Where quick-stick and one-way application is preferred, Silaprene PSAs can be supplied in both solvent-based and water-based formulations.

CONTACT BOND: When bonding dissimilar materials, a high strength adhesive applied to both surfaces provides a more permanent bond. Silaprene adhesive compounds are available for virtually all materials used in RV manufacturing.

SOLVENT WELD: A preferred method of joining plastic to itself. Silaprene solvent-weld adhesives provide a bond that is usually as strong as the plastic material.



All Weather Sealants

A Silaprene family of exterior sealants with exceptional weather resistance. Formulated in viscosities for general purpose, non-sagging vertical or self-leveling horizontal applications. Each sealant is paintable and available in a wide range of standard and custom colors. No tooling necessary, remains clean looking and will not peel with aging.

APPLICATIONS: Roofs of all types (especially formulated for EPDM membranes), windows, doors, trim, sidewalls, vent opening, baggage doors.

SUBSTRATES/MATERIALS: Painted or clean metal surfaces; polyethylene and other plastics; EPDM and other rubber compounds; glass, masonry and wood.

Plastic Adhesives

Silaprene M6562 and M6546 are adhesives that provide strong permanent bonds for ABS plastics. Silaprene M6562 provides a solvent-weld type bond. Silaprene M6546 is a higher viscosity adhesive/sealant extrudable manually or by machine.

APPLICATIONS: Permanent bonding for butt seaming ABS holding tanks and other applications.

SUBSTRATES/MATERIALS: ABS (including flame-retardant types such as Royalite 59), Rovel, rigid vinyl, and rigid polystyrene.

Water-Based Spray C

Hydra *FAST-EN*® sprayable c
any porous surface (such as c
porous and non-porous surfa
where using solvent-based sy
environmental concern. A wi
available to match the perfor
your application. They are co
systems. Sprayed parts can be
application of the adhesive a

APPLICATIONS: RV furniture
headliners and carpeting.

SUBSTRATES/MATERIALS: B
headliner material, metal, wo

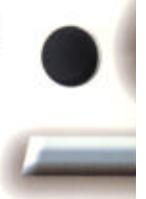
Hydra FAST-EN®

High Performance Adhesive Sealant

Silaprene Adhesive/Sealant is the premier product when high bond strength is required in a sealant. Remains resilient and grows stronger with age. Outstanding resistance to UV, heat, cold, moisture, oils, gasoline and highway chemicals. Available in a range of viscosities and colors. Paintable.

APPLICATIONS: Wherever a high bond strength sealant is required. Especially suitable for bonding dissimilar materials such as fiberglass to metal. Used for bonding metal roofs to roof bows.

SUBSTRATES/MATERIALS: Bonds and seals metals, fiberglass, wood, glass.



Rubber Roofing and Vinyl Flooring Adhesives

Silaprene DC12223 is a water-based pressure sensitive adhesive especially formulated for bonding EPDM rubber roof membranes to RV roof decks and Koroseal® vinyl floor matting to wooden floor decks. **Silaprene® M6230** is also available for flooring applications where a quick solvent based contact type adhesive is desired. These products have superior bond strength and exhibit outstanding resistance to heat, cold, and moisture. Excellent for bonding carpeting as well.

APPLICATIONS: Motorhomes, travel trailers, bus conversions, truck campers, horse trailers and specialty RV applications.

SUBSTRATES/MATERIALS: Bonds rubber, EPDM, vinyl, wood, metal, fiberglass, foam, plastics, glass, fabric and painted surfaces.

Solvent Based Contact Adhesives

Silaprene M6302 and **DC11957** are high strength solvent-based contact adhesives designed for bonding vinyl coated and other fabrics to metal, fiberglass, plastics and foam for RV furniture and marine seating applications. **M6306** can be used for bonding plastics of all types (including polyolefins) to metal, rubber, foam and wood. Both provide strong tack and quick strength build-up with flexible bonds that resist heat, cold and water.

APPLICATIONS: Interior and exterior applications including sidewalls, doors, metal and fiberglass roof panels, counter tops as well as seating applications.

SUBSTRATES/MATERIALS: Bonds almost all types of plastics, metals, wood, foam and fabric. Bonds various skin materials to honeycomb cores.

ontact Adhesives

ntact adhesives are designed to bond
en cell foam) to a wide variety of
es. They are used in applications
tems may be either a health or
e variety of formulations are
iance and processing requirements of
npatible with most standard spray
bonded within seconds after
d exhibit excellent green strength.
and Marine seating manufacturing,

nds foam, carpet, foam-backed vinyl
d, fiberglass and other plastics.

SolidSeal™

Silaprene SolidSeal™ and SolidBond™ High Solids–Low VOC Adhesive/Sealants are one-component, permanently flexible polyurethane products that cure in the presence of atmospheric moisture to produce high strength bonds that can replace rivets, welds and other fasteners. **Silaprene® SolidSeal™** is also ideal for sealing applications in a marine environment both above and below the waterline with excellent adhesion to wood and fiberglass.

APPLICATIONS: Waterproofing lap seams, bonding and sealing metal or fiberglass roofing materials to roof bows, interior and exterior sidewalls. Weather resistant seals on joints and boat hardware (not recommended for sealing wood deck seams due to possible softening by certain teak cleaners).

SUBSTRATES/MATERIALS: Excellent adhesion to metals (bare and pre-painted), plywood, glass, fiberglass, Kemlite® and other plastics.

Silaprene®

UNIROYAL
ADHESIVES & SEALANTS

RV/MARINE ADHESIVES & SEALANTS PROPERTIES GUIDE

KEY: •Flammable Solvent-Based ✦Water-Based

PRODUCT NAME OR DESCRIPTION	PRODUCT NUMBER	BASE POLYMER	SOLIDS %	COLOR (DRY)	TYPICAL VISCOSITY (CPS)	TEMP RANGE	FEATURES
Rubber Roofing &Vinyl Flooring Adhesive	✦DC12243	Acrylic	56	Clear	4500	-30°F to 220°F	Very high solids water-based PSA. High peel strength and creep resistance. Excellent weather resistance.
All Weather Sealant	•General Purpose (Non-Sag)	EPDM	63	Various	Extrudable	-65°F to 210°F	Versatile high-solids, high viscosity sealant with excellent weather resistance; fills widest range of applications. Best for vertical surfaces.
All Weather Sealant	•Self-Leveling Sealant	EPDM	50	Various	Extrudable	-65°F to 210°F	Self-leveling high solids, high viscosity sealant for horizontal seams. Excellent weather resistance.
All Weather Sealant for Oil-Milled Surfaces	•Non-Sag and Self-Leveling	EPDM	Varies By Product	Various	Extrudable	-65°F to 210°F	Specially formulated to provide weather-tight seals to oil-milled metals. Excellent weather resistance.
Contact Adhesive	•M6302	Polychloro-prene	23	Yellow	450	-40°F to 280°F	Suitable for brush, spray or roll-coat application. Non-staining, good plasticizer resistance. Superior heat resistance.
Contact Adhesive	•M6306	Polychloro-prene	22	Yellow	400	-50°F to 250°F	Very fast drying with excellent early strength, and high ultimate strength. Long open time.
Contact Adhesive	•DC11957	Urethane	15	Clear	1300	-20°F to 150°F	Especially effective on flexible vinyl substrates. Highly resistant to oils, solvents and water. Retains flexibility at low temperatures. Resistance to 200°F can be achieved by adding M6566.
Water-based Contact Adhesives	✦Hydra *FAST-EN*® Product line	Polychloro-prene or natural rubbers	Varies By Product	White (standard- can be tinted)	Varies By Product	-50°F to 240°F	Solventless -no VOC's. Environmentally friendly. Fast tack and excellent green strength. Easy clean up.
Plastic Adhesive	•M6562	ABS	42	Milky	40,000	-20°F to 400°F	Fast drying, solvent weld for permanent bond of ABS, PVC, and polystyrene. Best for flame retardant grades of ABS.
Plastic Adhesive	•M6546	ABS	47	Black	70,000	-20°F to 400°F	Adhesive/sealant for ABS and most other plastics. Fast permanent bonds. Extrudable.
Adhesive/Sealant	Silaprene® SolidSeal™	Urethane	98	Various	Extrudable	-40°F to 200°F	One-component, fast cure. Low VOC's. Bonds to most substrates. Recommended sealant for Marine applications above and below the waterline.
Adhesive/Sealant	Silaprene® SolidBond™	Urethane	98	Various	Extrudable	-40°F to 200°F	One-component, fast cure. High green strength for rivetless assemblies. Low VOC's. Bonds to most substrates.

LIMITED WARRANTY AND REMEDY

These products are warranted to the original purchaser to meet published specifications, if any, and, in the absence of published specifications, to be **MERCHANTABLE QUALITY.** Such warranty may not be assigned or otherwise transferred by purchaser. **NO OTHER WARRANTY, EXPRESSED OR IMPLIED, OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER THING IS MADE.** Purchaser's exclusive remedy for breach of this warranty shall be a refund of the price paid for the products by the purchaser. Except as stated above, Uniroyal Adhesives & Sealants shall not be liable for any defect in, or breach of obligation relating to the defects in this product, regardless of the theory that my be asserted, including, without limitation, negligence, contract, absolute liability in tort or misrepresentation. If the purchaser does not accept goods on these terms, they are to be returned at once, unopened.

RV MARINE Adhesives & Sealants

Uniroyal Adhesives & Sealants
2001 W. Washington St.
South Bend, IN 46628
800-999-GLUE

UNIROYAL ADHESIVES & SEALANTS

Silaprene®

4/6/01

TECHNICAL SALES BULLETIN

Silaprene®
HAPs Free Adhesive/Sealant

Silaprene HAPs FREE Adhesive/Sealant is an exceptional one-part product that combines ease of application, versatility of use, high ultimate strength, permanent bonds and long service life. Adhesive/Sealant is a high quality, HAPs free elastomeric sealant that provides superior adhesion to a variety of surfaces.

DESIGNED TO BOND

1. All kinds of metal, including galvanized
2. Wood, particleboard and plywood.
3. Rubber, concrete, masonry and glass
4. Thermoplastics, such as ABS, and polyolefins
5. Thermoset plastics like phenolic, polyurethane, polyesters and epoxies.
6. Fiberglass and other fiber reinforced plastics

PHYSICAL CHARACTERISTICS

1. HAPs Free
2. Fast drying with quick tack free times
3. Permanently resilient - resists vibration and stress caused by temperature cycling
4. Outstanding resistance to water, most industrial chemicals, acids and bases
5. Resists cracking, chipping and peeling
6. Requires no priming
7. Smooth, creamy texture
8. Easy to gun - colored versions can be finger tooled.
9. Paintable
10. Exceptional UV resistance and weather ability
11. Forms a tight, long-lasting seal to most surfaces
12. Shelf life: 12 months when stored below 80° F

TYPICAL PROPERTIES

(Specification ranges available upon request.)

Base: Block Co-Polymer

Colors: Gray, White, Bronze, Black, Clear (custom colors available)

	Colors	Clear
Solvents	Aliphatic Hydrocarbon Mineral Spirits	Aliphatic Hydrocarbons
Solids	70%	65%
Viscosity	Paste extrusion grade	Paste extrusion grade
Weight/gallon	9.76 pounds	7.45 pounds
Specific Gravity	1.17	0.90
Temp. range	-40°F to 200°F	-40°F to 200°F

PREPARATION OF SUBSTRATES

Surfaces to be bonded should be cleaned of all dust, oils or other contaminates. A solvent wipe is often adequate. Bonds to rigid surfaces are usually improved by a solvent wipe followed with light abrasion (180 grit), and another solvent wiping to remove abrasive residue. Dry surfaces thoroughly before applying adhesive.

METHOD OF APPLICATION

HAPs FREE Adhesive/Sealant can be applied by ordinary caulking guns or pressure pumping equipment. Pumping equipment should be of the follower-plate type and have a pump ratio of at least 40:1. Cox, Aro, Binks, DeVilbiss, Graco and Lincoln all produce suitable equipment for handling this material.

Apply a bead of Adhesive/Sealant to one surface at temperatures above 40° F. When used as an adhesive between two non-porous surfaces, solvent must escape through the edges of the bond line. Clamping, taping or use of mechanical fasteners to hold parts in place until Adhesive/Sealant develops strength is recommended. After 24 hours at room temperature, the product is considered self-holding. The use of a heat lamp at 150° F for 1 hour will speed solvent evaporation and accelerate strength build-up.

Silaprene HAPs FREE Adhesive/Sealant is formulated for room temperature curing, and curing is initiated when a majority of the solvent has been evacuated from the bond line. Strength build-up is very fast in the early stages to give high holding power, with continued strength build-up over time.

UNIROYAL ADHESIVES & SEALANTS

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CLEANER AND THINNER

Uncured material can be cleaned up with VMP Naptha, Heptane, and Mineral Spirits. Thinning is not recommended. If a thinner product is deemed necessary for your application, contact your Uniroyal Adhesives & Sealants salesman.

PRECAUTIONARY DATA

This product is flammable. Vapors may form an explosive mixture with air. Precautions should be taken to keep product away from fire, sparks, motors and other sources of heat or flame. Turn off or deactivate any electrical equipment or sources of ignition. Adequate ventilation is required to keep vapor concentrations below the Threshold Limit Value.

- For professional or industrial use only
- Read the container label and the Material Safety Data Sheet carefully before use
- Keep away from children
- Keep container closed when not in use
- Store closed container under 80° F

DISPOSAL INFORMATION

Do not reuse container or remove label. Safely dispose of container and contents in accordance with applicable Federal, State and Local regulations

TYPICAL ENVIRONMENTAL PROPERTIES

UV rating	Little to no effect, 1000 hours; QUV test ASTM G53.
Slump resistance	Good
Creep resistance	Excellent
Ozone resistance	Excellent
Elongation	400%

Silaprene®

CHEMTREC TRANSPORTATION EMERGENCY PHONE
United States: (800) 424-9300
International: (202) 483-7616 (collect)

UNIROYAL ADHESIVES & SEALANTS
2001 W. Washington Street, South Bend, IN 46628
PRODUCT INFORMATION: 1-800-999-GLUE

I. IDENTIFICATION

TRADE NAME: SILAPRENE® Clear HAP's Free Adhesive Sealant DC 12458
CAS NUMBER: Mixture
CHEMICAL NAME: Styrene-Ethylene/Butadiene-Styrene Block Polymer
CHEMICAL FAMILY: Thermoplastic Rubber

II. SPECIAL REGULATORY HAZARDS

Ingredient	% by Weight	CAS No.	Exposure Limit	OSHA (1910.1200)	EEC*	Calif.
Product	NA NA	NA	Flammable	ND	NA	
C7 - C9 Aliphatic Hydrocarbon	25.0	C4242-89-6	ND	ND	ND	NA
C8 - C 11 Aliphatic Hydrocarbon	12.4	C8553-14-0	ND	ND	ND	NA

TRANSPORTATION: Petroleum Distillates, N.O.S., UN1268, Class 3, PKG III

* European Economic Community
NA - Not applicable

ND - Not determined

III. PHYSICAL DATA

APPEARANCE AND ODOR: Clear viscous paste, aliphatic solvent odor
SOLUBILITY: Insoluble in water, soluble in organic solvents
SPECIFIC GRAVITY (H_2O=1): 0.898
VAPOR DENSITY (AIR=1): 4.4
BOILING POINT: 214° F
EVAPORATION RATE: (butyl acetate = 1): 3.8
VAPOR PRESSURE @ 100° F = 124 mm Hg
MELTING POINT: NA
VOLATILITY @ 70° F: 37.4%
VOC: 2.797 lbs/gal, 335.5 g/l

IV. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: 20° F TCC
AUTOIGNITION TEMP: ND
EXTINGUISHING MEDIA: Foam, CO_2, dry chemical
FLAMMABLE LIMITS IN AIR: LEL: 1.0; UEL: 8.0
SPECIAL FIRE FIGHTING PROCEDURES: Use water spray to cool adjacent surfaces and exposed containers only. Protect against inhalation of combustion products.
UNUSUAL HAZARDS: Flammable liquid.

V. REACTIVITY DATA

STABILITY: Stable at ambient temperatures and pressures.
INCOMPATIBILITY: Strong oxidizers, acids, and bases.
DECOMPOSITION PRODUCTS: Oxides of carbon and nitrogen.

VI. SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION: Avoid prolonged or repeated breathing of vapors. If exposure may or does exceed occupational exposure limits (sec. IV) use a NIOSH - approved respirator to prevent overexposure. In accord with 29 CFR 1910.134 use either a full face, atmosphere - supplying respirator or air - purifying respirator for organic vapors.

PROTECTIVE CLOTHING: Avoid contact with eyes. Wear safety glasses or goggles as appropriate. Avoid prolonged or repeated contact with skin. Wear chemical-resistant gloves and other clothing as required to minimize contact.

ADDITIONAL PROTECTIVE MEASURES: Use explosion-proof ventilation as required to control vapor concentrations. Air-dry contaminated clothing in a well ventilated area. Then launder before reusing.

VII. STORAGE, SPILLS, AND DISPOSAL INFORMATION

STORAGE: Store and use away from all sources of direct heat and ignition. Keep containers closed when not in use.
SPILLS: Remove ignition sources. Absorb on inert material. Use non-sparking tools. Transfer into secure containers for proper disposal. Use personal protective equipment as outlined above.
DISPOSAL: Do not reuse container or remove label. Safely dispose of containers and contents in accordance with applicable Federal, State and Local regulations.
ENVIRONMENTAL INFORMATION: Environmental effects have not been determined.

VIII. HEALTH RELATED DATA

SPECIFIC HAZARD(S): Exposure to vapor can cause irritation to eyes, lungs, and mucous membranes. Excess exposure can cause dizziness, headache, nausea and narcosis. Contact with liquid can cause eye and skin irritation.

PRIMARY ROUTE(S) OF ENTRY: Inhalation

FIRST AID PROCEDURES:

Eye Contact: Flush with water for 15 minutes.

Skin Contact: Clean with rubbing alcohol, if available, followed by soap and water.

Inhalation: Remove to fresh air. Administer oxygen or artificial respiration, if necessary. Contact physician.

Ingestion: Contact physician.

Although the information and recommendations set forth in this MSDS are presented in good faith and are believed to be correct as of the date of this MSDS, Uniroyal Adhesives & Sealants makes no representations as to the completeness or accuracy thereof. Information is supplied on the condition that the persons receiving and using it will make their own determination as to the suitability for their purpose prior to use. In no event will Uniroyal Adhesives & Sealants or any affiliate thereof be responsible for damages of any nature whatsoever resulting from the use or reliance on the information set forth in the MSDS.

Date Issued: April 26, 2000
Date Revised: September 5, 2001

Silaprene®

TECHNICAL SALES BULLETIN

SOLIDSEAL ™ POLYURETHANE ADHESIVE/SEALANT

SOLIDSEAL™ is a one component, 96% solids, fast cure, flexible, silicone free, polyurethane based, dual purpose adhesive/sealant. It is a moisture cured, non sag system. SOLIDSEAL™ provides a permanently elastic bond to most substrates without a primer.

DESIGNED TO BOND:

1. Various metals, including galvanized steel and aluminum
2. Wood, particle board and plywood
3. Glass, concrete, masonry and rubbers
4. Fiberglass (including gel-coat) and fiber reinforced plastics
5. Thermoset plastics such as polyurethane, polyester, epoxies
6. Thermoplastics, such as ABS, nylon, PVC
7. Skylight & porthole materials
8. Heating & air conditioning (HVAC) materials

FEATURES:

1. One component, ready to use, fast cure
2. Solvent free, odorless and particularly low volume shrinkage
3. Suitable for Marine applications - above and below water line
4. Silicone free; paintable with most paints
5. UV stable, heat and moisture resistant
6. Broad adhesion spectrum to most substrates without a primer
7. Non-staining characteristics on stone substrates

TYPICAL PROPERTIES:

(Specification ranges available upon request.)

Base:	Polyurethane
Colors:	White, gray & black (custom colors avail.)
Viscosity:	Paste extrusion grade
Weight/gallon:	9.8 pounds
Specific Gravity:	1.17
Temperature Range:	-40° F to 200° F
Shelf Life:	12 months when stored in original unopened container under 80° F

TYPICAL PHYSICAL CHARACTERISTICS:

(Specification ranges available upon request.)

Tensile Strength after 30 days at room temperature:	475 psi
Ultimate Elongation after 30 days at room temperature:	600%
Shore A Hardness after 30 days at room temperature:	35

UV Resistance:	Very Good
Ozone Resistance:	Excellent
Creep Resistance:	Excellent
Sag Resistance:	Excellent

PREPARATION OF SUBSTRATES:

Surfaces to be bonded should be cleaned of all dust, oils or other contaminates. A solvent wipe is often adequate. Bonds to rigid surfaces are usually improved by a solvent wipe followed with light abrasion (180 grit), and solvent wiping to remove abrasive residue. Dry surfaces thoroughly before applying adhesive.

METHOD OF APPLICATION:

SOLIDSEAL™ can be applied by ordinary caulking guns or pressure pumping equipment. Pumping equipment should be of the follower-plate type and have a pump ratio of at least 65:1. Aro, Binks, DeVilbiss, Graco and Lincoln all produce suitable equipment for handling this material. Consult Uniroyal representative or equipment supplier to ensure installation of proper equipment (including moisture-lock hoses and accessories) are in place before start-up.

Apply a bead of SOLIDSEAL™ to one surface at temperatures above 40° F. Surface skin formation will occur in 15 - 45 minutes, depending on ambient conditions. Initial set time is 4 hours, after which parts may be handled.

Clamping, taping or use of mechanical fasteners to hold parts in place until SOLIDSEAL™ develops strength is recommended. After 24 hours

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SOLIDSEAL ™ POLYURETHANE ADHESIVE/SEALANT

Method of Application (cont.):

at room temperature, the product is considered self-holding. Strength build up is very fast in the early stages to give high holding power, with continued strength build up over time.

TYPICAL LAP SHEAR STRENGTHS (PSI):

(Specification ranges available upon request.)

(Samples aged 30 days at room temperature; pulled at 2 inches per minute)

Aluminum to aluminum	486
FRP to FRP	280
Plywood to plywood	336
Galvanized steel to galvanized steel	406
Galvanized to Kemlite®	189

CLEANER AND THINNER:

Toluene, Methyl Ethyl Ketone

PRECAUTIONARY DATA:

Store in dark and cool place. Avoid excessive heat. During storage, moisture and water should be avoided. Reaction with moisture or water will cause quality deterioration, but will not be hazardous. For industrial use only.

DISPOSAL INFORMATION:

Disposal should be made by incineration or in accordance with applicable governmental regulations.

4/00

Silaprene®

CHEMTREC TRANSPORTATION EMERGENCY PHONE
United States: (800) 424-9300
International: (202) 483-7616 (collect)

UNIROYAL ADHESIVES & SEALANTS
2001 W. Washington Street, South Bend, IN 46628
PRODUCT INFORMATION: 1-800-999-GLUE

MATERIAL SAFETY DATA SHEET

GRAY

I. IDENTIFICATION

TRADE NAME: SOLIDSEAL™ DC 12154 CAS NUMBER: NA, Mixture
CHEMICAL NAME: Sealant CHEMICAL FAMILY: Polymer Solution

II. SPECIAL REGULATORY HAZARDS

Ingredient	% by Weight	CAS No.	Exposure Limit	OSHA (1910.1200)	EEC*	Calif.
Product	NA	NA	NA	NA	ND	NA

This product contains the following chemicals subject to reporting under EPCRA Section 313 (40 CFR 372).

Xylene	2 - 5	1330-20-7	100 ppm** 100 ppm***	Acute/chronic toxicity	ND	NA
Diphenyl Methane Diisocyanate	<0.6	101-68-8	0.020 ppm*** 0.005 ppm**	Acute/chronic toxicity	ND	NA

TRANSPORTATION: Not Regulated

NA = Not Applicable
*European Economic Community
***OSHA PEL

ND = Not Determined
**ACGIH TLV
****OSHA STEL

III. PHYSICAL DATA

APPEARANCE AND ODOR: Gray paste, slight xylene odor
SOLUBILITY: Nil
VAPOR PRESSURE @ 20° C.: Not Determined
VAPOR DENSITY (AIR=1): 3.66
VOLATILITY @ 70° F: 8% (Wt)
VOC: 74 g/l

SPECIFIC GRAVITY (H_2O): 1.17
MELTING POINT: NA
BOILING POINT: NA
pH: N/A

IV. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: 136° F
AUTOIGNITION TEMP: 851° F
EXTINGUISHING MEDIA: Water fog, carbon dioxide, dry chemical, foam
FLAMMABLE LIMITS IN AIR: LEL 1.0; UEL 8.0
SPECIAL FIRE FIGHTING PROCEDURES: Wear self-contained breathing apparatus with a full face mask.
UNUSUAL HAZARDS: Vapors are heavier than air and may travel along the ground. This could cause ignition by pilot light, sparks, heaters, smoking, electric motor, static discharge or other ignition sources. Never weld or cut empty drums.

V. REACTIVITY DATA

STABILITY: Stable
INCOMPATIBILITY: Amines, alcohol, water will react with this material. This reaction is not hazardous if the container can vent to the atmosphere to prevent pressure build up.
DECOMPOSITION PRODUCTS: Oxides of carbon and oxides of nitrogen, isocyanates
CONDITIONS TO AVOID: Exposure to air or moisture until ready to use
HAZARDOUS POLYMERIZATION: Will not occur

VI. SPECIAL PROTECTION INFORMATION

ENGINEERING CONTROLS: Enclosed areas should have exhaust ventilation.
PERSONAL PROTECTION EQUIPMENT: Chemical filter mask cartridge type is required if TLV is exceeded. Wear chemically resistant gloves such as neoprene rubber and OSHA approved full face mask.

VII. STORAGE, SPILLS, AND DISPOSAL INFORMATION

STORAGE: Eliminate sources of ignition
DISPOSAL: Treat as a flammable waste in compliance with EPA regulations. Dispose of in accordance with local, state and federal regulations.
ENVIRONMENTAL INFORMATION: Environmental effects have not been determined.

VIII. HEALTH RELATED DATA

PRIMARY ROUTES OF ENTRY:

Eye Contact:	Tearing, blurred vision
Skid Contact:	Dried skin, irritation possible
Inhalation:	Headache, nausea, vomiting, narcosis
Ingestion:	Nausea

CHRONIC EFFECTS OF EXPOSURE: Anemia, liver abnormalities, kidney damage, lung damage

FIRST AID PROCEDURES:

Eye Contact:	Flush with water for 15 minutes. Seek medical attention.
Skin Contact:	Wash thoroughly with soap and water. If irritation persists, seek medical attention.
Inhalation:	Remove to fresh air. If breathing is difficult, seek medical attention.
Ingestion:	Get medical attention immediately

TOXICOLOGY INFORMATION: There is no toxicity data on this product.

Date Issued: February 18, 1998
Date Revised: January 31, 2000

Silaprene®

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United States: (800) 424-9300
International: (202) 483-7616 (collect)

UNIROYAL ADHESIVES & SEALANTS
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PRODUCT INFORMATION: 1-800-999-GLUE

MATERIAL SAFETY DATA SHEET

White

I. IDENTIFICATION

TRADE NAME: SOLIDSEAL™ DC 12176 CAS NUMBER: NA, Mixture
CHEMICAL NAME: Sealant CHEMICAL FAMILY: Polymer Solution

II. SPECIAL REGULATORY HAZARDS

Ingredient	% by Weight	CAS No.	Exposure Limit	OSHA (1910.1200)	EEC*	Calif.
Product	NA	NA	NA	NA	ND	NA

This product contains the following chemicals subject to reporting under EPCRA Section 313 (40 CFR 372).

Xylene	2 - 5	1330-20-7	100 ppm** 100 ppm***	Acute/chronic toxicity	ND	NA
Diphenyl Methane Diisocyanate	<0.6	101-68-8	0.020 ppm*** 0.005 ppm**	Acute/chronic toxicity	ND	NA

TRANSPORTATION: Not Regulated

NA = Not Applicable
*European Economic Community
***OSHA PEL

ND = Not Determined
**ACGIH TLV
****OSHA STEL

III. PHYSICAL DATA

APPEARANCE AND ODOR: White paste, slight xylene odor
SOLUBILITY: Nil
VAPOR PRESSURE @ 20° C.: Not Determined
VAPOR DENSITY (AIR=1): 3.66
VOLATILITY @ 70° F: 8% (Wt)
VOC: 74 g/l

SPECIFIC GRAVITY (H_2O): 1.17
MELTING POINT: NA
BOILING POINT: NA
pH: N/A

IV. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: 136° F
AUTOIGNITION TEMP: 851° F
EXTINGUISHING MEDIA: Water fog, carbon dioxide, dry chemical, foam
FLAMMABLE LIMITS IN AIR: LEL 1.0; UEL 8.0
SPECIAL FIRE FIGHTING PROCEDURES: Wear self-contained breathing apparatus with a full face mask.
UNUSUAL HAZARDS: Vapors are heavier than air and may travel along the ground. This could cause ignition by pilot light, sparks, heaters, smoking, electric motor, static discharge or other ignition sources. Never weld or cut empty drums.

V. REACTIVITY DATA

STABILITY: Stable
INCOMPATIBILITY: Amines, alcohol, water will react with this material. This reaction is not hazardous if the container can vent to the atmosphere to prevent pressure build up.
DECOMPOSITION PRODUCTS: Oxides of carbon and oxides of nitrogen, isocyanates
CONDITIONS TO AVOID: Exposure to air or moisture until ready to use
HAZARDOUS POLYMERIZATION: Will not occur

VI. SPECIAL PROTECTION INFORMATION

ENGINEERING CONTROLS: Enclosed areas should have exhaust ventilation.
PERSONAL PROTECTION EQUIPMENT: Chemical filter mask cartridge type is required if TLV is exceeded. Wear chemically resistant gloves such as neoprene rubber and OSHA approved full face mask.

VII. STORAGE, SPILLS, AND DISPOSAL INFORMATION

STORAGE: Eliminate sources of ignition
DISPOSAL: Treat as a flammable waste in compliance with EPA regulations. Dispose of in accordance with local, state and federal regulations.
ENVIRONMENTAL INFORMATION: Environmental effects have not been determined.

VIII. HEALTH RELATED DATA

PRIMARY ROUTES OF ENTRY:

Eye Contact:	Tearing, blurred vision
Skid Contact:	Dried skin, irritation possible
Inhalation:	Headache, nausea, vomiting, narcosis
Ingestion:	Nausea

CHRONIC EFFECTS OF EXPOSURE: Anemia, liver abnormalities, kidney damage, lung damage

FIRST AID PROCEDURES:

Eye Contact:	Flush with water for 15 minutes. Seek medical attention.
Skin Contact:	Wash thoroughly with soap and water. If irritation persists, seek medical attention.
Inhalation:	Remove to fresh air. If breathing is difficult, seek medical attention.
Ingestion:	Get medical attention immediately

TOXICOLOGY INFORMATION: There is no toxicity data on this product.

TSCA Status: All components in this mixture are listed on the TSCA inventory list.

DSL: All components in this mixture are listed on the Canadian Domestic Substance List.

Date Issued: March 24, 1998
Date Revised: September 11, 2000

Silaprene®

CHEMTREC TRANSPORTATION EMERGENCY PHONE
United States: (800) 424-9300
International: (202) 483-7616 (collect)

UNIROYAL ADHESIVES & SEALANTS
2001 W. Washington Street, South Bend, IN 46628
PRODUCT INFORMATION: 1-800-999-GLUE

MATERIAL SAFETY DATA SHEET

BLACK

I. IDENTIFICATION

TRADE NAME: SOLIDSEAL™ DC 12232 CAS NUMBER: NA, Mixture
CHEMICAL NAME: Sealant CHEMICAL FAMILY: Polymer Solution

II. SPECIAL REGULATORY HAZARDS

Ingredient	% by Weight	CAS No.	Exposure Limit	OSHA (1910.1200)	EEC*	Calif.
Product	NA	NA	NA	NA	ND	NA

This product contains the following chemicals subject to reporting under EPCRA Section 313 (40 CFR 372).

Xylene	2 - 5	1330-20-7	100 ppm** 100 ppm***	Acute/chronic toxicity	ND	NA
Diphenyl Methane Diisocyanate	<0.6	101-68-8	0.020 ppm*** 0.005 ppm**	Acute/chronic toxicity	ND	NA

TRANSPORTATION: Not Regulated

NA = Not Applicable
*European Economic Community
***OSHA PEL

ND = Not Determined
**ACGIH TLV
****OSHA STEL

III. PHYSICAL DATA

APPEARANCE AND ODOR: Black paste, slight xylene odor
SOLUBILITY: Nil
VAPOR PRESSURE @ 20° C.: Not Determined
VAPOR DENSITY (AIR=1): 3.66
VOLATILITY @ 70° F: 8% (Wt)
VOC: 74 g/l

SPECIFIC GRAVITY (H_2O): 1.17
MELTING POINT: NA
BOILING POINT: NA
pH: N/A

IV. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: 136° F
AUTOIGNITION TEMP: 851° F
EXTINGUISHING MEDIA: Water fog, carbon dioxide, dry chemical, foam
FLAMMABLE LIMITS IN AIR: LEL 1.0; UEL 8.0
SPECIAL FIRE FIGHTING PROCEDURES: Wear self-contained breathing apparatus with a full face mask.
UNUSUAL HAZARDS: Vapors are heavier than air and may travel along the ground. This could cause ignition by pilot light, sparks, heaters, smoking, electric motor, static discharge or other ignition sources. Never weld or cut empty drums.

V. REACTIVITY DATA

STABILITY: Stable
INCOMPATIBILITY: Amines, alcohol, water will react with this material. This reaction is not hazardous if the container can vent to the atmosphere to prevent pressure build up.
DECOMPOSITION PRODUCTS: Oxides of carbon and oxides of nitrogen, isocyanates
CONDITIONS TO AVOID: Exposure to air or moisture until ready to use
HAZARDOUS POLYMERIZATION: Will not occur

VI. SPECIAL PROTECTION INFORMATION

ENGINEERING CONTROLS: Enclosed areas should have exhaust ventilation.
PERSONAL PROTECTION EQUIPMENT: Chemical filter mask cartridge type is required if TLV is exceeded. Wear chemically resistant gloves such as neoprene rubber and OSHA approved full face mask.

VII. STORAGE, SPILLS, AND DISPOSAL INFORMATION

STORAGE: Eliminate sources of ignition
DISPOSAL: Treat as a flammable waste in compliance with EPA regulations. Dispose of in accordance with local, state and federal regulations.
ENVIRONMENTAL INFORMATION: Environmental effects have not been determined.

VIII. HEALTH RELATED DATA

PRIMARY ROUTES OF ENTRY:

Eye Contact:	Tearing, blurred vision
Skid Contact:	Dried skin, irritation possible
Inhalation:	Headache, nausea, vomiting, narcosis
Ingestion:	Nausea

CHRONIC EFFECTS OF EXPOSURE: Anemia, liver abnormalities, kidney damage, lung damage

FIRST AID PROCEDURES:

Eye Contact:	Flush with water for 15 minutes. Seek medical attention.
Skin Contact:	Wash thoroughly with soap and water. If irritation persists, seek medical attention.
Inhalation:	Remove to fresh air. If breathing is difficult, seek medical attention.
Ingestion:	Get medical attention immediately

TOXICOLOGY INFORMATION: There is no toxicity data on this product.

TSCA Status: All components in this mixture are listed on the TSCA inventory list.

DSL: All components in this mixture are listed on the Canadian Domestic Substance List.

Although the information and recommendations set forth in this MSDS are presented in good faith and are believed to be correct as of the date of this MSDS, Uniroyal Adhesives & Sealants makes no representations as to the completeness or accuracy thereof. Information is supplied on the condition that the persons receiving and using it will make their own determination as to the suitability for their purpose prior to use. In no event will Uniroyal Adhesives & Sealants or any affiliate thereof be responsible for damages of any nature whatsoever resulting from the use or reliance on the information set forth in the MSDS.

Date Issued: February 18, 1998
Date Revised: October 12, 2001

Silaprene®

TECHNICAL SALES BULLETIN

SOLIDSEAL ™
HIGH SOLIDS - LOW VOC
ADHESIVE/SEALANT

SOLIDSEAL™ is a one component, 96% solids, fast cure, flexible, silicone free, rubber based, dual purpose adhesive/sealant. It is a moisture cured, non sag system. SOLIDSEAL™ provides a permanently elastic bond to most substrates without a primer.

DESIGNED TO BOND:

1. Various metals, including galvanized steel and aluminum
2. Wood, particle board and plywood
3. Glass, concrete, masonry and rubbers
4. Fiberglass and fiber reinforced plastics
5. Thermoset plastics such as polyurethane, polyester, epoxies
6. Thermoplastics, such as ABS, nylon, PVC

FEATURES:

1. One component, ready to use, fast cure
2. Solvent free, odorless and particularly low volume shrinkage
3. Suitable for Marine applications - above and below water line
4. Silicone free; paintable with most paints
5. UV stable, heat and moisture resistant
6. Broad adhesion spectrum to most substrates without a primer
7. Non-staining characteristics on stone substrates

TYPICAL PROPERTIES:

(Specification ranges available upon request.)

Base:	Polyurethane
Colors:	White, gray, black
Viscosity:	Paste extrusion grade
Weight/gallon:	9.8 pounds
Specific Gravity:	1.17
Temperature Range:	-40° F to 200° F
Shelf Life:	12 months when stored in original unopened container under 80° F

TYPICAL PHYSICAL CHARACTERISTICS:

(Specification ranges available upon request.)

Tensile Strength after 30 days at room temperature:	475 psi
Ultimate Elongation after 30 days at room temperature:	600%
Shore A Hardness after 30 days at room temperature:	35

UV Resistance:	Very Good
Ozone Resistance:	Excellent
Creep Resistance:	Excellent
Sag Resistance:	Excellent

PREPARATION OF SUBSTRATES:

Surfaces to be bonded should be cleaned of all dust, oils or other contaminates. A solvent wipe is often adequate. Bonds to rigid surfaces are usually improved by a solvent wipe followed with light abrasion (180 grit), and solvent wiping to remove abrasive residue. Dry surfaces thoroughly before applying adhesive.

METHOD OF APPLICATION:

SOLIDSEAL™ can be applied by ordinary caulking guns or pressure pumping equipment. Pumping equipment should be of the follower-plate type and have a pump ratio of at least 40:1. Aro, Binks, DeVilbiss, Graco and Lincoln all produce suitable equipment for handling this material.

Apply a bead of SOLIDSEAL™ to one surface at temperatures above 40° F. Surface skin formation will occur in 15 - 45 minutes, depending on ambient conditions. Initial set time is 4 hours, after which parts may be handled.

Clamping, taping or use of mechanical fasteners to hold parts in place until SOLIDSEAL™ develops strength is recommended. After 24 hours at room temperature, the product is considered self-holding.
Strength build up is very fast in the early stages to give high holding power, with continued strength build up over time.

UNIROYAL ADHESIVES & SEALANTS
Division of UNIROYAL TECHNOLOGY CORPORATION
2001 W. Washington Street, South Bend, IN 46628 • Phone: 800-999-GLUE • Fax: 219-246-5425

SOLIDSEAL™
HIGH SOLIDS - LOW VOC
ADHESIVE/SEALANT

TYPICAL LAP SHEAR STRENGTHS (PSI):

(Samples aged 30 days at room temperature; pulled at 2 inches per minute)

Aluminum to aluminum	486
FRP to FRP	280
Plywood to plywood	336
Galvanized steel to galvanized steel	406
Galvanized to Kemlite®	189

CLEANER AND THINNER:

Toluene, Methyl Ethyl Ketone

PRECAUTIONARY DATA:

Store in dark and cool place. Avoid excessive heat. During storage, moisture and water should be avoided. Reaction with moisture or water will cause quality deterioration, but will not be hazardous. For industrial use only.

DISPOSAL INFORMATION:

Disposal should be made by incineration or in accordance with applicable governmental regulations.

Silaprene SolidSeal

Competitive Analysis

Substrate	White *SolidSeal™*		White Sika-221		White Sika-252		ChemRex CX 25		Vanguard ITI-987	
	7 day	*28 day*	*7 day*	*28 day*	*7 day*	*28 day*	*7 day*	*28 day*	*7 day*	*28 day*
Al/Al	248	486	240	408	398	442	133	136		
Al/Al primed*	328	462	234	310	578	264				
ABS/ABS	175	232	138	170	130	202	226	226		
ABS/ABS primed*	367	414	290	350	470	466				
SS/SS	270	408	240	310	168	178	160	228		
SS/SS primed*	400	432	334	394	558	450				
Galv/Galv	248	406	334	354	240	292	153	192		
Galv/Galv primed*	416	456	346	398	422	456				
Galv/ Kemlite®	189	186			197	192			136	144
Totals w/primer and w/o primer	**2452**	**3296**	**2156**	**2694**	**2964**	**2750**	**----**	**----**	**----**	**----**
Totals no primer	**941**	**1532**	**952**	**1242**	**936**	**1114**	**672**	**782**	**136**	**144**

* 210T primer (Sika)

September 21, 1998

Shear data from ½" x 1" bonded specimens - 3 specimens per test
aged 7 days and 28 days at room temperature
tested at room temperature
values in PSI

Silaprene® Products Competitive Analysis

	M6325	Transportation Adhesive Sealant	Manusprene 65A	ChemRex PL2000	SolidSeal™	Sika 221
SUBSTRATE	**PSI**	**PSI**	**PSI**	**PSI**	**PSI**	**PSI**
Aluminum/Aluminum	550	373	123	49	486	408
Stainless/Stainless	424	360	127	64	406	310
Galvanized/Galvanized	432	360	149	40	406	354
ABS/ABS	307	200	142	63	232	170
Plywood/Plywood	970	687	490	336	336	275

Lap Shear Strength Test Criteria (ASTM D1002 Modified)

1. ½" x 1" lap having 10 mil dry film bond thickness
2. Samples aged at room temperature for 30 days prior to testing
3. Samples were pulled at 2"/minute
4. Above data represents the average of three test specimens

Silaprene®

PRELIMINARY TECHNICAL SALES BULLETIN

TRANSPORTATION ADHESIVE/SEALANT

Transportation Adhesive/Sealant is an exceptional one-part product that combines ease of application, versatility of use, high ultimate strength, permanent bonds and long service life. Transportation Adhesive/Sealant is a high quality, high solids elastomeric sealant that provides superior adhesion to a variety of surfaces. Bond strength improves with age.

DESIGNED TO BOND:

1. All kinds of metal, including galvanized
2. Wood, particle board and plywood
3. Rubber, concrete, masonry and glass
4. Thermoplastics, such as ABS, styrene and polyolefins
5. Thermoset plastics like phenolic, polyurethane, polyesters and epoxies
6. Fiberglass and other fiber reinforced plastics

PHYSICAL CHARACTERISTICS:

1. Extrusion or trowellable grades
2. Fast drying - tack free in less than one hour
3. Excellent early strength, gets stronger with age
4. High strength bonds to most materials (see Page 2)
5. Permanently resilient - resists vibration and stress caused by temperature cycling
6. Outstanding resistance to water, oils and greases, , industrial chemicals, acids and bases
7. Resists cracking, chipping and peeling
8. Requires no mixing, priming or heating
9. Comes in several colors and is paintable
10. Exceptional weatherability
11. Forms a tight, long-lasting seal to most surfaces
12. Shelf life: 9 months at temperatures not to exceed 80° F

TYPICAL PROPERTIES:

(Specification ranges available upon request.)

Base:	Polychloroprene
Colors:	Gray, off-white
Solvent:	Toluene
Solids:	52%
Viscosity:	Paste extrusion grade
Weight/gallon:	9.4 pounds
Specific Gravity:	1.1
Temperature Range:	-60° F to 250° F

PREPARATION OF SUBSTRATES:

Surfaces to be bonded should be cleaned of all dust, oils or other contaminates. A solvent wipe is often adequate. Bonds to rigid surfaces are usually improved by a solvent wipe followed with light abrasion (180 grit), and solvent wiping to remove abrasive residue. Dry surfaces thoroughly before applying adhesive.

METHOD OF APPLICATION:

Transportation Adhesive/Sealant can be applied by ordinary caulking guns or pressure pumping equipment. Pumping equipment should be of the follower-plate type and have a pump ratio of at least 40:1. Aro, Binks, DeVilbiss, Graco and Lincoln all produce suitable equipment for handling this material.

Apply a bead of Transportation Adhesive/Sealant to one surface at temperatures above 40° F. When used as a sealant, the applied bead will shrink approximately 50%, so no tooling is necessary for most applications. The bead surface will be tack free in 15 - 45 minutes, depending on ambient conditions. Initial set time is 4 hours, after which parts may be handled.

When used as an adhesive between two non-porous surfaces, solvent must escape through the edges of the bond line. Clamping, taping or use of mechanical fasteners to hold parts in place until Transportation Adhesive/Sealant develops strength is recommended. After 24 hours at room temperature, the product is considered self-holding. The use of a heat lamp at 150° F for 1 hour will speed solvent evaporation and accelerate strength build-up. An alternative technique is to apply product to one surface, press the two surfaces to be bonded together to ensure adhesive transfer, separate parts and allow to air dry 10 - 20 minutes, then press back together with good pressure.

UNIROYAL ADHESIVES & SEALANTS
Division of UNIROYAL TECHNOLOGY CORPORATION
2001 W. Washington Street, South Bend, IN 46628 • Phone: 800-999-GLUE • Fax: 219-246-5425

TRANSPORTATION ADHESIVE/SEALANT

Transportation Adhesive/Sealant is formulated for room temperature curing, and curing is initiated when a majority of the solvent has been evacuated from the bond line. Strength build-up is very fast in the early stages to give high holding power, with continued strength build-up over time.

CLEANER AND THINNER:

Toluene

PRECAUTIONARY DATA:

This product is extremely flammable. Vapors may form an explosive mixture with air. Precautions should be taken to keep product away from fire, sparks, motors and other sources of heat or flame. Turn off or deactivate any electrical equipment or sources of ignition. Adequate ventilation is required to keep vapor concentrations below the Threshold Limit Value.

- For professional or industrial use only
- Read the container label and the Material Safety Data Sheet carefully before use
- Keep away from children
- Keep container closed when not in use
- Store closed container under 80° F
- This product contains toxic chemicals subject to the Emergency Planning and Community Right-to-Know Act of 1986 and 40CFR 372.

DISPOSAL INFORMATION:

When discarded, this material is hazardous waste. Do no reuse container or remove label. Safely dispose of container and contents in accordance with applicable Federal, State and Local regulations.

TYPICAL PROPERTIES:

UV rating	No effect, 3000 hours with intermittent water spray every 30 minutes. ASTM 42
Flammability rating	Dried film meets MVSS 66
Slump resistance	Good
Creep resistance	Excellent
Ozone resistance	Excellent
Elongation	500%

TYPICAL LAP SHEAR STRENGTHS:

Aluminum to aluminum	373 psi
ABS to ABS	200 psi
Plywood to plywood	687 psi
Galvanized steel to galvanized steel	360 psi
Stainless steel to stainless steel	360 psi

Silaprene®

TECHNICAL SALES BULLETIN

SILAPRENE® ADHESIVE/SEALANT

SILAPRENE® Adhesive/Sealant is an exceptional one-part product that combines ease of application, versatility of use, high ultimate strength, permanent bonds and long service life. Adhesive/Sealant is a high quality, high solids elastomeric sealant that provides superior adhesion to a variety of surfaces. Bond strength improves with age.

DESIGNED TO BOND:

1. All kinds of metal, including galvanized
2. Wood, particle board and plywood
3. Rubber, concrete, masonry and glass
4. Thermoplastics, such as ABS, styrene and polyolefins
5. Thermoset plastics like phenolic, polyurethane, polyesters and epoxies
6. Fiberglass and other fiber reinforced plastics

PHYSICAL CHARACTERISTICS:

1. Extrusion or trowellable grades
2. Fast drying - tack free in less than one hour
3. Excellent early strength, gets stronger with age
4. High strength bonds to most materials (see Page 2)
5. Permanently resilient - resists vibration and stress caused by temperature cycling
6. Outstanding resistance to water, oils and greases, fuels, industrial chemicals, acids and bases
7. Resists cracking, chipping and peeling
8. Requires no mixing, priming or heating
9. Comes in several colors and is paintable
10. Exceptional weatherability
11. Forms a tight, long-lasting seal to most surfaces
12. Shelf life: 6 months at temperatures not to exceed 80° F

TYPICAL PROPERTIES:

(Specification ranges available upon request.)

Base:	Polychloroprene
Colors:	Gray, white, off-white, aluminum, black, school bus yellow
Solvent:	Toluene
Solids:	50%
Viscosity:	Paste extrusion grade
Weight/gallon:	9.2 pounds
Specific Gravity:	1.1
Temperature Range:	-60° F to 250° F

PREPARATION OF SUBSTRATES:

Surfaces to be bonded should be cleaned of all dust, oils or other contaminates. A solvent wipe is often adequate. Bonds to rigid surfaces are usually improved by a solvent wipe followed with light abrasion (180 grit), and solvent wiping to remove abrasive residue. Dry surfaces thoroughly before applying adhesive.

METHOD OF APPLICATION:

Adhesive/Sealant can be applied by ordinary caulking guns or pressure pumping equipment. Pumping equipment should be of the follower-plate type and have a pump ratio of at least 40:1. Aro, Binks, DeVilbiss, Graco and Lincoln all produce suitable equipment for handling this material.

Apply a bead of Adhesive/Sealant to one surface at temperatures above 40° F. When used as a sealant, the applied bead will shrink approximately 50%, so no tooling is necessary for most applications. The bead surface will be tack free in 15 - 45 minutes, depending on ambient conditions. Initial set time is 4 hours, after which parts may be handled.

When used as an adhesive between two non-porous surfaces, solvent must escape through the edges of the bond line. Clamping, taping or use of mechanical fasteners to hold parts in place until Adhesive/Sealant develops strength is recommended. After 24 hours at room temperature, the product is considered self-holding. The use of a heat lamp at 150° F for 1 hour will speed solvent evaporation and accelerate strength build-up. An alternative technique is to apply product to one surface, press the two surfaces to be bonded together to ensure adhesive transfer, separate parts and allow to air dry 10 - 20 minutes, then press back together with good pressure.

SILAPRENE® ADHESIVE/SEALANT

Adhesive/Sealant is formulated for room temperature curing, and curing is initiated when a majority of the solvent has been evacuated from the bond line. Strength build-up is very fast in the early stages to give high holding power, with continued strength build-up over time.

Lower solids and viscosity grades of Adhesive/Sealant are available for alternative applications where better flow characteristics are required. These versions of the product are suitable for trowelling or brushing, and can be pumped through lower power equipment, including Plews guns.

CLEANER AND THINNER:

Toluene

PRECAUTIONARY DATA:

This product is extremely flammable. Vapors may form an explosive mixture with air. Precautions should be taken to keep product away from fire, sparks, motors and other sources of heat or flame. Turn off or deactivate any electrical equipment or sources of ignition. Adequate ventilation is required to keep vapor concentrations below the Threshold Limit Value.

- For professional or industrial use only
- Read the container label and the Material Safety Data Sheet carefully before use
- Keep away from children
- Keep container closed when not in use
- Store closed container under 80° F
- This product contains toxic chemicals subject to the Emergency Planning and Community Right-to-Know Act of 1986 and 40CFR 372.

DISPOSAL INFORMATION:

When discarded, this material is hazardous waste. Do no reuse container or remove label. Safely dispose of container and contents in accordance with applicable Federal, State and Local regulations.

TYPICAL PROPERTIES:

UV rating	No effect, 3000 hours with intermittent water spray every 30 minutes. ASTM 42
Flammability rating	Dried film meets MVSS 66
Slump resistance	Good
Creep resistance	Excellent
Ozone resistance	Excellent
Elongation	500%
RES hardness	65 - 14 day cure

TYPICAL LAP SHEAR STRENGTHS:

Aluminum to aluminum	416 psi
Azdel to Azdel	200 psi
Azdel to steel	200 psi
Fiberglass to fiberglass	540 psi
Aluminum to fiberglass	475 psi
Plywood to plywood	453 psi
Plywood to fiberglass	475 psi
Galvanized steel to galvanized steel	415 psi

McGill AirSeal Corporation

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Recommended Specifications for Duct Sealants and Adhesives

1. Transverse joints, longitudinal seams, and duct wall penetrations in duct systems shall be sealed with a mastic duct sealant as specified in Section 1.1 or 1.2, or with a two-part tape sealing system as specified in Section 1.3. Longitudinal seams on rectangular duct may be sealed with a mastic seam sealant as specified in Section 1.4. Spiral lockseams are not longitudinal seams and do not require sealing. Adhesives for securing duct liner insulation to metal surfaces shall be as specified in Section 1.5. All sealants and tape sealing systems shall exceed 500 hours without degradation under accelerated aging (oxygen bomb) test conditions (ASTM-D572) and 500 hours without degradation under QUV accelerated-exterior-aging test conditions (ASTM-C732). All sealants and tape sealing systems shall perform as specified without the need for surface cleaning or solvent cleaning to remove light coatings of oil and dust before application.

   1.1 Transverse joints, longitudinal seams, and duct wall penetrations shall be sealed with **United Duct Sealer™**, **UNI-SEAL™** duct sealer, or **UNI-WEATHER™** duct sealer, which are solvent-based polymeric rubber mastics formulated to withstand temperatures from at least -20°F to +150°F. Sealant shall have a UL Classification with a flame spread of 15 or less and smoke developed of 20 or less when tested on both 18-gauge galvanized steel and inorganic reinforced cement board, at a coverage of at least 31 square feet per gallon. Sealant shall have a solids content of 71% or higher.

   1.2 Transverse joints, longitudinal seams, and duct wall penetrations shall be sealed with **United Duct Sealer™ (Water Based)**, **UNI-MASTIC™ 181** duct sealer, or **UNI-FLEX™** duct sealer, which are vinyl or acrylic copolymer mastics formulated to withstand temperatures from at least -20°F to +180°F. Sealant shall have a UL Classification with a flame spread of 5 or less and smoke developed of 0 when tested on both 18-gauge galvanized steel and inorganic reinforced cement board, at a coverage of at least 31 square feet per gallon. Sealant shall have a solids content of 69% or higher.

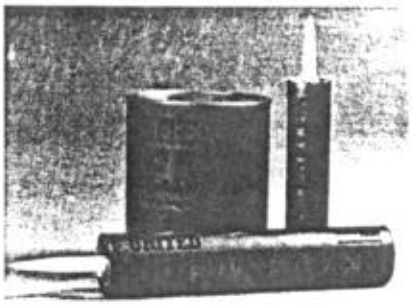
   1.3 Transverse joints, longitudinal seams, and duct wall penetrations shall be sealed with **UNI-CAST®** two-part tape sealing system, which is a combination of an adhesive activator and woven-fiber tape impregnated with a gypsum mineral compound. Sealing system shall be formulated to withstand temperatures from -40°F to +200°F. Sealing system shall have a UL Classification with a flame spread and smoke developed of 0 when tested on both 18-gauge galvanized steel and inorganic reinforced cement board, at a coverage of at least 31 square feet per gallon.

   1.4 Longitudinal seams on rectangular duct (e.g., Pittsburgh style) may be sealed with **UNI-SEAM®** sealant in lieu of a mastic duct sealant. **UNI-SEAM®** is a nonhardening, solvent-based polymeric rubber mastic formulated to withstand temperatures from -20°F to +150°F. Sealant shall have a UL Classification with a flame spread of 15 or less and smoke developed of 20 or less when tested on both 18-gauge galvanized steel and inorganic reinforced cement board, at a coverage of at least 31 square feet per gallon.

   1.5 Where insulation is to be secured to metal surfaces, the adhesive used shall be **UNI-TACK™** or **UNI-GRAB™**, which are water-based vinyl copolymer liquids. Exposed edges of insulation shall be sealed with the same adhesive. Adhesives shall be formulated to withstand temperatures from -20°F to +160°F. Adhesives shall have a UL Classification with a flame spread and smoke developed of 5 or less when tested on both 18-gauge galvanized steel and inorganic reinforced cement board, at a coverage of at least 291 square feet per gallon. Smaller applications and insulation touch-up and repair may require the use of **UNI-SPRAY™**, which is an aerosol spray adhesive.

REFILL WITH MCGILL

SOLVENT-BASED DUCT SEALANTS



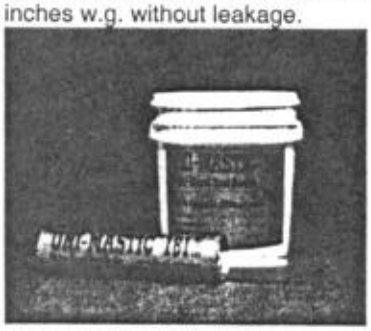
United Duct Sealer™ provides the highest quality first-time seal for low-, medium-, and high-pressure joints of any solvent-based sealant in the HVAC industry. Its high performance and reliability under the most adverse conditions is unmatched.

UNI-SEAL™ is an economical high-strength sealant for use on sheet-metal duct systems. This medium-viscosity sealant is easy to apply, dries quickly, and remains flexible to provide a sure seal.

UNI-WEATHER™ indoor/outdoor duct sealant is specifically formulated for exterior use. It resists weathering and aging, even when exposed to ultraviolet light.

WATER-BASED DUCT SEALANTS

United Duct Sealer™ (Water Based) is solvent free and nonflammable in its wet or dry state. It provides a dependable, first-time seal for low-, medium, and high-pressure joints, while having no hazardous fumes or wastes. Static pressure tested to ±40 inches w.g. without leakage.



UNI-MASTIC™ 181 is a water-based product that provides excellent adhesion to metal duct, fiberglass ductboard, and flexible duct. Because this product is fiber-reinforced, it is ideal for retrofit applications and new construction. It is nonflammable, can be used on indoor and outdoor applications, and it is UL181A-M and UL181B-M listed.

UNI-FLEX™ is an economical water-based duct sealer that is formulated for use on low-, medium-, and high-pressure duct systems. It contains antimicrobial agents and it cures to a durable flexible film that can withstand handling and mechanical vibrations.

WATER-BASED LINER ADHESIVES

UNI-TACK™ duct liner adhesive is a water-based product for bonding insulation to metal surfaces. It can be applied by brush, roller, spray gun, or coil line. This adhesive has excellent temperature and moisture resistance after curing.

UNI-GRAB™ duct liner adhesive is a premium water-based product for bonding insulation to metal surfaces. This adhesive provides instant tack to hold insulation in place. It can be applied by brush, roller, spray gun, or coil line.

McGill AirSeal Corporation

An enterprise of United McGill Corporation - Founded in 1951

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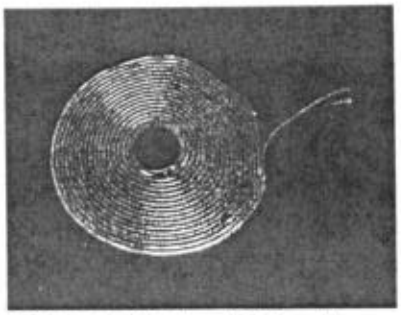
REFILL WITH MCGILL

SPECIALTY PRODUCTS

UNI-CAST™ is a two-part tape sealing system that combines a woven-fiber tape and a water-based liquid adhesive to form a hard, durable, airtight seal. It is suitable for indoor and outdoor applications on low- and high-pressure duct systems. The unique applicator is simple to use and simplifies cleanup.

UNI-SPRAY™ duct liner aerosol spray adhesive provides a transparent, high-strength bond between metal and fiberglass duct liner.



UNI-BUTYL is a 100% solids cross-linked butyl gasket tape designed for use on four bolt flange connector systems. It is non-hardening, has excellent adhesion to metal surfaces, and has outstanding resistance to extreme temperatures.

UNI-SEAM™ cold seam sealer is a non-hardening solvent-based polymeric rubber mastic. It is ideal for sealing longitudinal seams on rectangular duct (e.g. Pittsburgh style).

McGill AirSeal Corporation

An enterprise of United McGill Corporation - Founded in 1951

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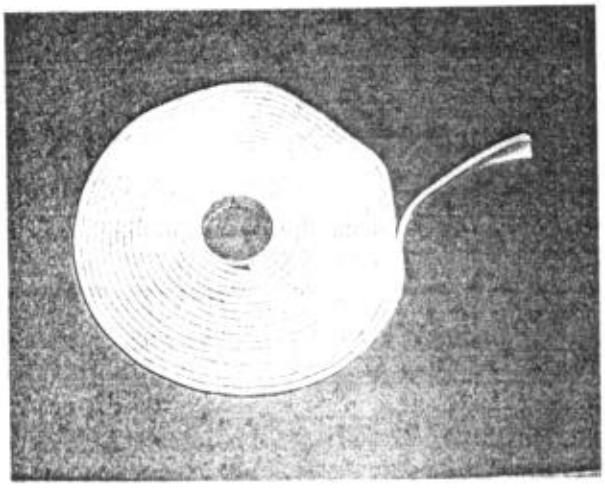
www.mcgillairseal.com

UNI-BUTYL Gasket Tape

UNI-BUTYL is a 100% solids cross-linked butyl gasket tape designed for use on four bolt flange connector systems. It is non-hardening, has excellent adhesion to metal surfaces, and has outstanding resistance to extreme temperatures.



Physical Properties

Color: Light gray
Composition: 100% Cross-linked Isobutylene Rubber
Backing: Silicone release paper
Adhesion: Excellent
Bonding Time: Immediate
Curing Time: Immediate
Water Resistance: Excellent (not for continuous water immersion)
Mildew Resistance: Mold and mildew resistant
Application Temperature: -5°F to +120°F
Operational Temperature: -60°F to +200°F
Odor: None
Paintability: Yes
Asbestos Free: Yes
U.S.D.A. Acceptable: Chemically acceptable to the U.S.D.A. for use in meat and poultry processing areas under Federal Inspection
UL Classification: UL 723 Class 1: Smoke Development 5, Flame Spread 5
Shelf Life: 2 years
Roll Size: 3/16" thick x 5/8" wide x 25' long

Instructions For Use

1. Surfaces to be sealed shall be clean and dry.
2. Cut UNI-BUTYL to the desired length and apply to the face of the flange or lap joint. With hand pressure, make sure that the UNI-BUTYL is in contact with the metal surface. Peel off the silicone release paper. Assemble the flange or joint as recommended.
3. Do not stretch the UNI-BUTYL product.

Packaging

UNI-BUTYL is available in cases that contain 20 rolls or 500 feet of product. Each skid holds 24 cases or 12,000 feet of product.

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REFILL WITH MCGILL

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e-mail: 3dinfo@3dgroup.com

January 7, 2004
pdgDOMUS - HARTFORD STYLE
ENERGY CALCULATIONS

Given:

HEAT LOSS:
Indoor air at 72 degree F, and outside air is 0 degree F. (12,000 Btu / H = 400 CFM s).

HEAT GAIN - WINTER:
LoE reflective glass facing west in Columbus (40 degree N Latitude) at 4:00 P.M. solar time on October 21, (Solar Heat Gain Factor = 173 Btu / SF / Hr). For _ heat absorbing glass, Shading Coefficient = 0.69 and U for winter conditions is 1.10 Btu / SF / Hr / F degree. Indoor air temperature is 70 degree F; outside air temperature is 40 degree F. (12,000 Btu / H = 1 ton = 400 CFM s)

HEAT GAIN - SUMMER:
For the same window area in summer, on August 21, facing west in Columbus (40 degree N Latitude) at 4:00 P.M. solar time, the SHGF = 216, and the air temperatures assumed to be 95 degrees F outdoors and 78 degrees F indoors. Coefficient = 0.69 and U for summer conditions is 1.04 Btu / SF / Hr / F degree. Indoor

HEAT LOSS / SF = Temp. Diff. of Room to Outdoors / Total Resistance (R) = Btu / hr
H.L. = (72 d — 0d) / 45 = 1.6 Btu / H / SF

Loads per Room

Room	**SF of Ext Wall x 1.6**		**= Btu s / H**	**CFM s**
Living Room	= 250 x 1.6	=	400.0 /12,000 = 0.33 x 400	= 13.2
Kitchen	= 87 x 1.6	=	139.2 / 12,000 = 0.012 x 400	= 4.8
Dining Room	= 113 x 1.6	=	180.8 / 12,000 = 0.015 x 400	= 6.0
Bath # 1	= 40 x 1.6	=	64.0 / 12,000= 0.005x 400	= 2.0
Bedroom # 1	= 93 x 1.6	=	148.8 / 12,000 = 0.012 x 400	= 4.8
Bedroom # 2	= 103 x 1.6	=	164.8 / 12,000 = 0.014 x 400	= 5.6
Bath # 2	= 66 x 1.6	=	105.6 / 12,000 = 0.009 x 4000	= 3.6
Loft	= 270 x 1.6	=	432.0 / 12,000 = 0.036 x 400 = 14.4	
	TOTAL:		1,635.2 / H =	= 54.4

January 7, 2004
pdgDOMUS - HARTFORD STYLE
ENERGY CALCULATIONS
Page Two

WINTER HEAT GAIN = Area x (SC x SHGF) + U x (Temp. Diff. of Outdoors to Indoors)
W. H.G. = Glazing Area x [(0.69 x 173) + 1.10 x (40- 70)]
= Glazing Area x (119.4 — 33.0) or area x 86.4

Loads per Room

Room	**SF of Glazing x 86.4**	**= Btu s / H divided by 12,000 x 400 = CFM s**
Living Room	= 79 x 86.4	= 6,825.6/ 12,000= 0.569 x 400 =227.6
Kitchen	= 26 x 86.4	= 2,246.4/ 12,000= 0.187 x 400 = 74.8
Dining Room	= 68 x 86.4	= 5,875.2/12,000 = 0.490 x 400 = 196.0
Bath # 1	= 15 x 86.4	= 1,296.0/12,000 = 0.108 x 400 = 43.2
Bedroom # 1	= 33 x 86.4	= 2,851.2/12,000 = 0.238 x 400 = 95.2
Bedroom # 2	= 33 x 86.4	= 2,851.2/12,000 = 0.238 x 400 = 95.2
Bath # 2	= 15 x 86.4	= 1,296.0/12,000 = 0.108 x 400 = 43.2
Loft	= 69 x 86.4	= 5,961.6/12,000 = 0.497x 400 = 198.8

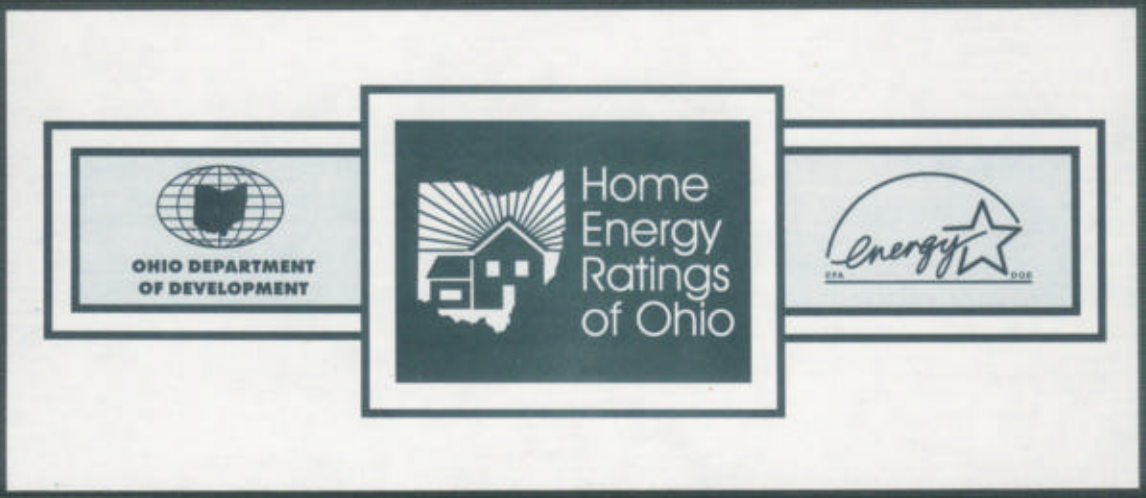
TOTAL: 29,203.2 = 2.43 Tons

SUMMER HEAT GAIN = Area x (SC x SHGF) + U x (Temp. Diff. of Outdoors to Indoors)
W. H.G. = Glazing Area x [(0.69 x 216) + 1.04 x (78- 95)]
= Glazing Area x (149.04 — 17.68) or area x 131.36

Loads per Room

Room	**SF of Glazing x 131.36 =**	**Btu s / H / 12,000 x 400 = CFM s**
Living Room	= 79 x 131.36 =	10,377.44/12,000 = 0.875 x 400 = 346.0
Kitchen	= 26 x 131.36 =	3,412.76/12,000 = 0.284 x 400 = 113.6
Dining Room	= 68 x 131.36 =	8,932.48/12,000 = 0.744 x 400 = 297.6
Bath # 1	= 15 x 131.36 =	1,970.40/12,000 = 0.164 x 400 = 65.6
Bedroom # 1	= 33 x 131.36 =	4,334.49/12,000 = 0.361 x 400 = 144.4
Bedroom # 2	= 33 x 131.36 =	4,334.49/12,000 = 0.361 x 400 = 144.4
Bath # 2	= 15 x 131.36 =	1,970.40/12,000 = 0.164 x 400 = 65.6
Loft	= 69 x 131.36 =	9,063.84/12,000 = 0.755 x 400 = 302.0

TOTAL: 44,396.3 btu s = 3.70 tons


OHIO DEPARTMENT
OF DEVELOPMENT
Home
Energy
Ratings
of Ohio
energy

OHIO DEPARTMENT OF DEVELOPMENT

Bob Taft
Governor

C. Lee Johnson
Director

October 17, 2000

Nathan Pingel, CEO
Pingel Design Group
426 East Whittier Street
Columbus, Ohio 43206

Dear Nathan:

Enclosed are copies of the Energy Rating Certificate and the Energy Star Report for the property built at 1081 Michigan Avenue, Columbus, Ohio. The home achieved a 5 Star Rating and as such is designated an Energy Star Home. I will forward the report to the U.S. EPA and they will mail you the Energy Star Home Certificate.

If you have any questions please feel free to contact your rater, Mr. Jones, at 614-784-1959 or myself at 614-466-6797 or tsmith@odod.state.oh.us. Thanks again for your hospitality on our many tours.

Sincerely;

Terrance Smith

Terrance Smith
Office of Energy Efficiency

Home Energy Ratings of Ohio

OHIO DEPARTMENT OF DEVELOPMENT

HOME ENERGY RATING

Date:	October 13, 2000	Rating No.:	2000-088
Owner's Name:	Nathan Pingle	Rating Org.:	Home Energy Ratings of Ohio
Property	1081 Michigan Ave	Phone No.:	(614) 784-1959
Address:	Columbus, OH	Rater's Name:	Don Michael Jones
		Rater's No.:	06-95
Builder's Name:	Nathan Pingel PDG Domus		
Weather Site:	Columbus, OH	Rating Type:	Based on plans
Builder's File:	DOMUS2.BLG	Rating Date:	/2000

ANNUAL ENERGY COSTS		**domus2**
Heating	$	187
Cooling	$	105
Water Heating	$	366
Lights & Appliances	$	474
Service Charges	$	135
Total	$	1267
Average Monthly	$	106

Rating

87.8
*****

Estimated Annual Energy Costs

$1267

Least Efficient	0 - 19	20 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 82	83 - 85	86 - 89	90 - 100	Most Efficient
	*	*+	**	**+	***	***+	****	****+	*****	*****+	

2000-088
Rating Certificate No.

Certified Home Energy Rater

The home's energy efficiency is rated on a zero to 100 scale using the national uniform rating method as defined in the NASEO "National Home Energy Rating Technical Guidelines", September 19, 1999. A zero rating represents the least energy efficient home possible, while a 100 rating represents the most energy efficient home possible. The rating considers heating, cooling, and hot water. The rating should be used only for comparison, since it assumes average climate and thermostat settings, quantities of hot water, and internal loads for a typical household. Energy costs are based on local energy prices at the time of rating. If energy efficiency improvements are made to the home, or energy prices change significally, the rating and annual energy costs may change. Although every effort has been made to provide accurate information, this rating does not constitute a warranty, expressed or implied, about the energy efficiency or operating costs of the house.

COMPONENT LOAD SUMMARY

Date:	October 13, 2000	Rating No.:	2000-088
Owner's Name:	Nathan Pingle	Rating Org.:	Home Energy Ratings of Ohio
Property	1081 Michigan Ave	Phone No.:	(614) 784-1959
Address:	Columbus, OH	Rater's Name:	Don Michael Jones
		Rater's No.:	06-95
Builder's Name:	Nathan Pingel PDG Domus		
Weather Site:	Columbus, OH	Rating Type:	Based on plans
Builder's File:	DOMUS2.BLG	Rating Date:	/2000

	domus2
HEATING SEASON (MMBtu/yr)	
Ceilings/Roofs	2.3
Rim/Band Joists	0.3
Above Grade Walls	5.2
Foundation Walls	0.0
Doors	0.7
Windows/Skylights	8.9
Frame Floors	0.0
Crawl Space/Unht Bsmt	-0.3
Slab Floors	0.0
Infiltration	0.0
Mechanical Ventilation	10.5
Ducts	5.3
Active Solar	0.0
Sunspace	0.0
Internal Gains	-10.0
Total	22.9
COOLING SEASON (MMBtu/yr)	
Ceilings/Roofs	0.3
Rim/Band Joists	0.0
Above Grade Walls	-0.3
Foundation Walls	0.0
Doors	-0.1
Windows/Skylights	6.6
Frame Floors	0.0
Crawl Space/Unht Bsmt	-0.2
Slab Floors	0.0
Infiltration	0.0
Mechanical Ventilation	-1.2
Ducts	1.2
Active Solar	0.0
Sunspace	0.0
Internal Gains	8.9
Whole House Ventilation	0.0
Total	15.3

ENERGY COST AND FEATURE REPORT

Date:	October 13, 2000	Rating No.:	2000-088
Owner's Name:	Nathan Pingle	Rating Org.:	Home Energy Ratings of Ohio
Property	1081 Michigan Ave	Phone No.:	(614) 784-1959
Address:	Columbus, OH	Rater's Name:	Don Michael Jones
		Rater's No.:	06-95
Builder's Name:	Nathan Pingel PDG Domus		
Weather Site:	Columbus, OH	Rating Type:	Based on plans
Builder's File:	DOMUS2.BLG	Rating Date:	/2000

ANNUAL ENERGY COSTS

		domus2
Heating	$	155
Cooling	$	124
Water Heating	$	366
Lights & Appliances	$	474
Service Charges	$	135
Total	$	1254
Average Monthly	$	105

ENERGY FEATURES

Ceiling w/Attic:	None
Vaulted Ceiling:	Pingel Ceiling U=0.022
Above Grade Walls:	Pingel U=0.027
Foundation Walls:	None
Doors:	R-2.8
Windows:	U.34 S.32 U=0.340
Window Shading:	H: Some C: Some
Frame Floors:	Pingel U=0.022
Slab Floors:	None
Infiltration:	H: 485 C: 243 CFM50
Infilt. Measure:	Blower door test
Interior Mass:	None
Heating System:	Fuel-fired air distribution
Heating Efficiency:	80.0 AFUE
Cooling System:	Air conditioner
Cooling Efficiency:	10.0 SEER
Water Heating System:	Conventional, Elec
Water Heating Efficiency:	0.91 EF
Ducts:	Uninsulated
Active Solar:	None
Sunspace:	No

Notes: Where feature level varies in home, the dominant value is shown.

ENERGY STAR HOME REPORT

Date:	October 13, 2000	Rating No.:	2000-088
Owner's Name:	Nathan Pingle	Rating Org.:	Home Energy Ratings of Ohio
Property	1081 Michigan Ave	Phone No.:	(614) 784-1959
Address:	Columbus, OH	Rater's Name:	Don Michael Jones
		Rater's No.:	06-95
Builder's Name:	Nathan Pingel PDG Domus		
Weather Site:	Columbus, OH	Rating Type:	Based on plans
Builder's File:	DOMUS2.BLG	Rating Date:	/2000

Modified End-Use Load (MMBtu/year)

	Energy Star	*As Designed*
Heating:	29.5	21.2
Cooling:	12.4	10.4
Water heating:	10.3	13.9
Total:	52.2	45.5
Rating:	**86.0**	**87.8**

This home MEETS the modified end-use load requirements for an Energy Star Home.

Pollution Prevented through Energy Star Upgrades

Type of Emissions	*Reduction (lb/year)*
Carbon Dioxide (CO2)	6803.7
Sulfur Dioxide (SO2)	30.8
Nitrogen Oxides (NOx)	16.3

The energy savings and pollution prevented are calculated by comparing the As Designed home to the Energy Efficient Reference Home as defined in the "National Home Energy Rating Technical Guidelines", September 19, 1999, prepared by the HERS Council, as amended and approved by the National Association of State Energy Officials. In accordance with these guidelines, building inputs affecting setpoints, infiltration rates, window shading and the existence of mechanical systems may have been changed prior to calculating loads.

OHIO DEPARTMENT OF DEVELOPMENT

Home Energy Ratings of Ohio

Home Energy Rating
Issued To

PDG Domus
1081 Michigan Avenue
Columbus, Ohio

Current Rating: 87.8
Estimated Annual Energy Operating Cost: $1267

Chief of the Office of Energy Efficiency

Energy Analyst

U.S. ENVIRONMENTAL PROTECTION AGENCY • U.S. DEPARTMENT OF ENERGY

WWW.ENERGYSTAR.GOV • 1-888-STAR YES (1-888-782-7937)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

OFFICE OF
AIR AND
RADIATION

Dear Builder:

Congratulations on meeting the EPA's ENERGY STAR® Guidelines for new home construction. The ENERGY STAR label is your key to market differentiation; it shows that you deliver a higher quality product for lower cost while helping to prevent air pollution. As an ENERGY STAR Homes Partner you have free access to many resources to help you increase your profits, improve sales and take advantage of the ENERGY STAR brand name. Currently, these materials include:

- **The ENERGY STAR Homes Marketing Toolkit.** Other builders claim to build energy efficient housing; you can prove it. Use your ENERGY STAR Homes Marketing Toolkit as a guide to sell your superior homes effectively using on-site displays, press releases, drop-in advertising modules and more.
- **ENERGY STAR Homes Plaque.** Mount this solid brass plaque prominently to show prospective buyers that they are getting more value for less cost when they purchase your home. For a limited time, the plaque is available free of charge by calling the hotline at 1-888-STAR-YES.
- **ENERGY STAR Homes Sales Training.** You know you have a better product, but you still have to sell its advantages. Learn how to use the benefits of ENERGY STAR Homes to close deals profitably and position your company as a market leader. Contact your account manager for details on how to arrange a sales training in your area.
- **ENERGY STAR Homes Consumer Seminars.** Fill a room with consumers or Realtors and we will present a seminar showing how home buyers get more value for less cost when they purchase ENERGY STAR Homes like yours.
- **Consumer Video**. Leave this 3 minute video running in your model home or open house and prospective buyers can learn how buying your ENERGY STAR home can save them thousands of dollars and help protect the environment. You can also customize the video to link your name with the ENERGY STAR Message.
- **Linkage to Preferred Financing.** Banks offer special mortgage terms to ENERGY STAR home buyers. Use ENERGY STAR Mortgages to qualify more customers and sell more homes at a greater profit. Our ENERGY STAR Homes Financing Partners include Chase Manhattan, Countrywide and PHH, as well as many local banks and regional lenders. Call the ENERGY STAR Hotline to find a lender in your area.

If you have any questions about these FREE materials and services, call the ENERGY STAR Hotline toll free at 1-888-STAR-YES (1-888-782-7937) or contact me directly at (202) 564-9162.

Sincerely,

Sam Rashkin

Sam Rashkin
ENERGY STAR Homes Program Manager

Certificate of Validation

The home built by

PDG Domus

at 1081 Michigan Avenue, Columbus Ohio
has been certified to be compliant with the U.S. Environmental Protection Agency's

ENERGY STAR® Homes criteria.

ENERGY STAR Homes use at least 30% less energy for heating, cooling and water

Heating than comparable homes built to the Model Energy Code.

The U.S. EPA hereby recognizes PDG Domus for its contribution
in reducing pollution through energy efficiency.

Signed:

Brian Ng
ENERGY STAR Homes
Customer Services Coordinator
www.energystar.gov/homes

Date: October 17, 2000

Home Energy Rating: 87.8 (out of 100)
Verification Organization:
Home Energy Ratings of Ohio

BRITE PRODUCTS

Español

Innovative Solutions for Metal Preservation

BRITE ZINC

FAST ORDER

For One-Step Repair or Topcoating of Galvanized Steel

- Description
- Features / Benefits
- Applications
- Product Datasheet
- MSDS

Technical | Surface Prep | Cost of Corrosion | Trade Orgs | Contact US

U.S. TOLL-FREE: 1-888-99BRITE | INTERNATIONAL: 1-313-865-4380 | FAX: 1-313-883-49

WA WELD-AID **Welding Anti-Spatter**

This site is designed for use with Internet Explorer 4.0 or higher, and Netscape Communicator 4.0 or higher

BRITE PRODUCTS

BRITE ZINC DESCRIPTION

FAST ORDER

- Features / Benefits
- Applications
- Product Datasheet
- MSDS

Home

Brite Zinc combines the proper corrosion-inhibitive properties of metallic zinc (70% in the dry film) and a corresponding high percentage of epoxy esters to assure that zinc protection stays in place. As a result, Brite Zinc can be used as a one-step process for the repair of damaged hot-dip galvanized steel or cold galvanizing without need for a primer or topcoat.

Brite Zinc provides a non-toxic and metallic finish matching the look of hot-dip galvanizing and possesses outstanding salt spray resistance conforming to the performance requirements for all. (see Technical section for more details)

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STEALTH SHIELD Technology ®

BRITE PRODUCTS

BRITE ZINC

FAST ORDER

FEATURES and BENEFITS

- Description
- Applications
- Product Datasheet
- MSDS

Home

Feature	Benefit
Reflective metallic sheen finish	Closely matches the bright look of hot-dip galvanized steel
70% high-quality (low impurities) zinc ***dust*** in the dry film (after curing)	Excellent cold galvanizing corrosion protection to inhibit rust and "rust travel" while maintaining the look of hot-dip
30% epoxy binders	Even application and long-term adhesion/flexibility to surface metal without a required primer or top coat (one-step process)
Highest-quality epoxy esters	Allows zinc dust particles to be individually encapsulated to prevent settling/nozzle clogging and improve shelf life
Best coverage in industry	570 ft^2/gal. at 1 mil dry film thickness
Available in 12 1/2 -oz. aerosol cans	Convenient and easy field application
Available in gallon cans	Easy bulk application by brush, roller, or compressed-air spray
Proven corrosion-protection performance	Meets and exceeds performance requirements of the updated ASTM-A780-93, DOD-P-21053A, and MIL-

	P-26915A, MIL-P-46105, and ASTM-B117
Quick drying and non-sagging formulation	Dries to touch in 15 minutes for second coating of Brite Zinc and can be topcoated in 24-48 hours
Safety	Low VOC (5.024 lb./gal.)

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BRITE PRODUCTS

BRITE ZINC APPLICATIONS

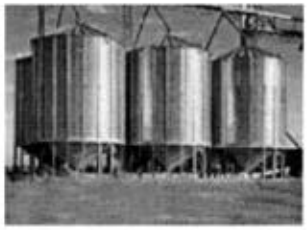
- Description
- Features / Benefits
- Product Datasheet
- MSDS

FAST ORDER

Home

Brite Zinc Common Applications

- Cold galvanizing when hot-dip is not available
- Fencing
- Galvanizing of small parts
- Touch-up of damaged hot-dip galvanizing
- Piping
- Automobile frames and exterior parts
- Iron furniture
- Steel structures
- Farming equipment
- Roofing
- Touch-up of mechanical parts & equipment
- Marine environments
- Trailers
- Galvanizing of welds
- Heating & Cooling
- Transmission Towers
- Railroad Cars
- Fabricated Metal
- And many more ....



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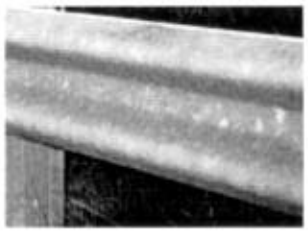
BRITE PRODUCTS

REPAIR OF HOT DIP

Home

Painting Over Touched-Up and Repaired Galvanized Steel



The following information has been reprinted from the American Galvanizers Association publication "Duplex Systems: Painting Over Hot-Dip Galvanized Steel."

Occasionally, galvanized steel is damaged during handling, fabrication, installation or welding. These damaged areas should be repaired according to ASTM-A780-93 Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings. Brite Products, Brite Zinc met and exceeded this standard. Proper repair ensures the galvanized coating provides the best corrosion resistance possible. When using a duplex system (primer and topcoat), any damaged area on the galvanized surface must be repaired prior to painting. The following steps help ensure the galvanized steel is adequately repaired and able to perform compatibly with a paint system.

- Depending on the age of the galvanized product, properly prepare and clean the surface of the material to be painted before applying the touch-up product.
- Touch-up damaged areas with a product conforming to ASTM A 780. These include paint products that are commonly known as zinc-rich paints, or cold galvanizing compounds. Zinc-rich paints can be sprayed or brushed on the damaged area.
- After touch-up, prime the surface to be painted. As a protective system, zinc-rich paints (like Brite Zinc) provide the best galvanic protection for long-term exposure.
- If required, finish with a topcoat. Follow the manufacturers guidelines for proper dry times and surface preparation between coats.

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BRITE PRODUCTS

THE GREAT % WARS

Home

For years, zinc-rich paint manufacturers have battled for marketshare by attempting to have the highest zinc content in their product. Afterall, the more zinc the better, right? This is not necessarily the case.

The fact is that the more zinc a paint product contains, the fewer adhesives it contains to hold that zinc protection in place for the long-term. The American Society for Testing and Materials (ASTM) recognized this by changing their specification for repair of damaged and uncoated areas of hot-dip galvanized coatings from 94% metallic zinc to 65% (ASTM A 780-93) in 1993. The reason being that, lacking the proper adhesives, zinc-rich paint tends to peel with time. Without an epoxy-based topcoat, there is simply not enough binders to hold the 90% or greater zinc-rich paint to the substrate long-term. In addition, there has been a historical industry-wide problem with clogging of cans with zinc of 90% or better because of the lack of epoxy inherent in these products.

This is where Brite Zinc® gives you the edge. Brite Products has developed the perfect balance of zinc dust and adhesives, Brite Zinc®. At Brite, we call this the "balanced method."

Brite Zinc® is a 70% zinc-rich coating that contains the proper amount of adhesives, to give you the best performance availableas a stand-alone system.

While meeting the industry standard for testing methods (ASTM A 780-93), Brite Zinc® is the only zinc-rich coating that:

- Best matches the look of Hot Dip Galvanizing
- Meets the ASTM industry standard for the repair of hot dip galvanizing
- Provides the perfect blend of zinc and epoxy adhesives

For more information on the level of zinc required in zinc-rich paints, see the results of a 12-year study conducted by the International Lead Zinc Research Organizatoin (ILZRO).

Technical Surface Prep Cost of Corrosion Trade Orgs Contact US

BRITE PRODUCTS

APPLICATION TIPS & TECHNIQUES

Home

This section contains tips and techniques for frequently asked questions regarding applying Brite Zinc. Email us at info@briteproducts.com if you have a topic you want addressed in this section.

Applying Brite Zinc by Brush or Roller

Currently, the Brite Zinc datasheet says that the bulk form of the product (B-200) is ready to be applied "as is" from the can by brush or roller. This is the case if you use the product up quickly (i.e., one hour or less). However, if you plan on using gallons or quarts over the course of a day, then you should thin it with Xylol or Xylene (available at most industrial paint supplies and Home Depot) to help it maintain a workable viscosity. For the gallons, use 1 quart Xylol/Xylene per gallon and use 1 pint per quart. In addition, stir the paint every 15-20 minutes while sprinkling in a little of the Xylol/Xylene. This will help allow the paint to be a little more workable while also maximizing your amount of coverage.

Paint Application and Humidity

A common-asked question at Brite is, "What's the temperature range that your product can be applied in?" Although surrounding air temperature is an important factor in successfully coating steel, humidity is equally, if not more, important. Applying a coating to steel when the relative humidity is too high can result in paint cracking, peeling, mudcracking, pinpoint rusting, and wrinkling. Those of you working outside in coastal areas are particularly susceptible to this phenomenon.

A good rule of thumb for the proper range for relative humidity developed by The Society for Protective Coatings (SSPC) is to apply the coating when the air temperature is at least 5 degrees F. above the dew point. The dew point is the highest temperature at which moisture will condense on surface and is typically listed in weather reports or can be measured using a battery-powered psychrometer. The dew point should be measured regularly throughout the day to ensure the coating is being applied in the proper range of relative humidity and avoid these failures. Another rule of thumb is to avoid painting on the days when relative humidity is >85%. This is because Brite

Zinc is an air-dry coating and the residual moisture during cure may adversely affect adhesion to the substrate.

Coating Thickness

A common concern of applicators is if a coating is being applied "thick enough." The truth is, though, applying a coating too thickly is just as harmful as applying it too thinly. Applying a coating too thickly can entrap uncured solvents, cause internal stressing, cracking, and delamination. For Brite Zinc, we recommend a dry film thickness (DFT) of 1.0 - 3.0 mils. Anything less or more runs the risk of coating failures listed above. Measure the DFT using either a magnetic dry film thickness gauge (just put on dry film and thickness will appear on screen) or banana pull-off gauge. These gauges are available through industrial paint retailers.

Surface Preparation

When using our products, a key determinant of its success is the surface preparation of the base steel. For Brite Zinc, the two areas of most concern for surface preparation are making sure that the steel is free of dirt, grease, oils, and scaled rust. To address these issues, we recommend following the SSPC standards for surface preparation in these areas:

- SSPC-SP1 solvent cleaning for removing grease and oils; and
- SSPC-SP2 hand tool cleaning for removing loose mill scale, rust, and paint.

Contact the SSPC at (877) 281-7772 if you need more information regarding these standards and be sure to check out our SURFACE PREP for more guidance.

Clearing Aerosol Nozzles

The primary cause of clogged aerosol cans is due to failing to clear the nozzle after use. Failing to clear the nozzle will allow the zinc dust to settle in the valve stem causing it to clog. Therefore, to avoid this problem, be sure to clear the nozzle after each use by turning the can upside down and spraying 2-3 seconds until the can sprays clear. This indicates that all zinc dust has been evacuated from the valve stem and will eliminate any can clogging problems you have. If you have any existing cans that are clogged, then remove the existing nozzle and replace it with the nozzle from a new can and you should be able to spray out the remaining paint in the can.

Technical Surface Prep Cost of Corrosion Trade Orgs Contact US

BRITE PRODUCTS

SURFACE PREP GENERAL GUIDELINES

Home

The following information has been reprinted from the American Galvanizers Association publication "Duplex Systems: Painting Over Hot-Dip Galvanized Steel." The SSPC standard for surface preparation (SSPC-SP 1, -SP 3, -SP 6) should be followed as well.

Surface preparation is a critical factor in achieving good paint adhesion. The two keys to surface preparation are cleaning and profiling the steel. If these two things are done correctly, a compatible paint system should have no problem adhering to the galvanized surface.

Cleaning

When cleaning a galvanized surface prior to painting, the goal is to remove any dirt, grease or oils. At the same time, care must be taken not to remove too much of the galvanized coating. Highly acidic or basic cleaning solutions remove some of the zinc coating, as does high pressure sweep blasting. The more zinc that is removed from the surface, the less corrosion protection provided. Alkaline cleaning, ammonia cleaning and solvent cleaning are the most common ways of removing dirt from a galvanized surface. As some cleaners may react differently with different paint systems, the paint manufacturer should be consulted for specific cleaning instructions.

- **Alkaline Cleaning** - Oil, grease and dirt can be removed by using an alkaline solution in the pH range of 11-12, but not greater than 13. An alkaline solution is nominally 2 to 5 percent sodium compounds with small additions of emulsifying or cheating agents. The solution can be applied through dipping, spraying or brushing. If brushing, use a soft bristle brush of nylon, not copper or steel. If dipping or spraying the alkaline solution, the temperature should range between 140 and 185 degrees F. For newly galvanized surfaces, a water-based emulsifier can be used to remove contaminants. After cleaning, thoroughly rinse the surface with hot water and allow to dry completely.

- **Solvent Cleaning** - Mineral spirits, turpentine, high flash naphtha, and other typical cleaning solvents can be used to clean galvanized surfaces provided they are applied with lint-free rags or soft bristled nylon brushes

which are frequently changed in order to avoid respreading of contaminants. After cleaning, thoroughly rinse the surface with hot water and allow to dry completely.

- **Ammonia Cleaning** - A solution of 1 to 2 percent ammonia applied with a nylon brush can also be used to clean galvanized surfaces, although this method is typically reserved for cleaning parts with ash residue. As a piece of steel is removed from the galvanizing kettle, it may pick up particles of oxidized zinc from the bath surface, otherwise known as ash. Ash residue must be removed prior to painting. After cleaning, thoroughly rinse the surface with hot water and allow to dry completely.

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Profiling

In order to provide a good adhesion profile for the paint, the galvanized surface must be flat with no protrusions and slightly roughened to provide an anchor profile for the paint system. Filing high spots, sweep blasting, phosphating, and using wash primers or acrylic passivations are the most common methods of increasing the profile of a galvanized surface. Again, care must be taken not to damage the galvanized coating.

- **High Spots** - Any high spots or rough edges should be removed and smoothed out in order to provide a level surface for paint. Use hand or power tools to grind down the high spots. Care should be taken to remove as little zinc as possible.

- **Sweep Blasting** - In order to roughen the typically smooth galvanized surface after cleaning, an abrasive sweep or brush blast may be used. Particle size for a sweep blast of galvanized steel should range between 200 and 500 microns (8 to 20 mils). Aluminum/magnesium silicate and organic media such as corncobs, walnut shells, corundum, limestone, and mineral sands with a Mohs hardness of five or less may also be used. The temperature of the galvanized part when blasting can have a significant affect on the finished surface profile. Sweep blasting while the galvanized part is still warm, 175 to 390 deg. F with less than 50% relative humidity.

- **Penetrating Sealers** - These products are two-part epoxy sealers forming a coating around 2 mils thick for use on partially weathered galvanizing. Follow manufacturer directions for applications and always use a topcoat over the sealer.

- **Zinc Phosphate Treatment** - This is a conversion coating that can increase the adherence and durability of a paint film. DO NOT USE THESE COATINGS WITH ZINC-RICH PAINTS.

- **Wash Primers** - This treatment uses a metal conditioner to neutralize surface oxides and hydroxides, as well as etch galvanized surfaces in

controlled shop conditions. These primers should be applied at a thickness of 0.3 and 0.5 mils (thickness' > 0.5 mils can cause adhesion problems).

- **Acrylic Passivations** - This treatment uses an acidic solution to passivate the galvanized surface and increase paint adhesion. The solution should be applied 0.04 mils thick to a clean surface and allowed to completely dry.

Technical Surface Prep Cost of Corrosion Trade Orgs Contact US

U.S. TOLL-FREE: 1-888-99BRITE | INTERNATIONAL: 1-313-865-4380 | FAX: 1-313-883-49

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STUC-O-FLEX®

Just because it rains in Seattle doesn't mean you have to get wet!

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Put some space between your building and the elements

Stuc-O-Flex Water Channel II:

- Secondary Moisture Barrier
- Water Evacuation Cavity
- Continuous Air Circulation
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- Standard EIFS Components
- Elastomeric Acrylic Finish

To Learn More About Stuc-O-Flex Systems, Contact Stuc-O-Flex International, Inc.
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Distributor Inquiries Welcome

STUC-O-FLEX®

ELASTOMERIC ACRYLIC FINISH

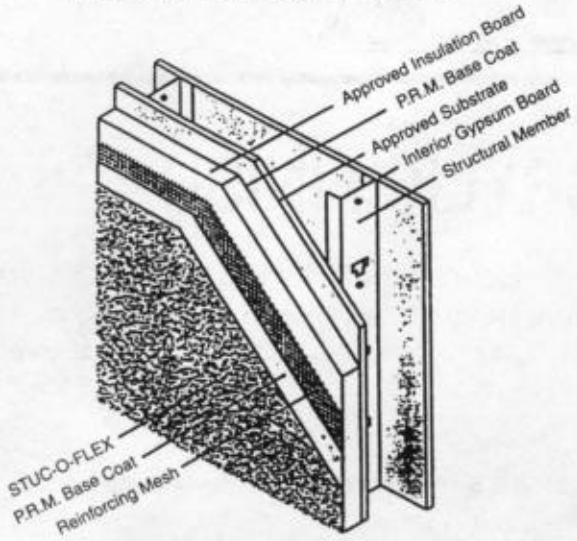
STUC-O-FLEX® is a highly resilient ACRYLIC polymer compound that looks like traditional stucco. Its elastomeric nature allows it to follow building movement without cracking like normal stucco. It's pre-mixed, pre-colored, and ready to apply. **STUC-O-FLEX®** is ideal for small accents or large interior or exterior wall applications.

FEATURES

- ☐ Applications over a variety of substrate sheathing products, cementitious materials, and a variety of sheet insulation products.
- ☐ Stretchability, up to 10 times more flexible than conventional synthetic stucco materials. **STUC-O-FLEX®** literally stretches (105% Elongation).
- ☐ Looks and feels like traditional cement stucco.
- ☐ Unlimited textures can be achieved (from a fine sand finish to a rough skip trowel, etc.).
- ☐ Easy to apply – formulated for spray or trowel application.
- ☐ Outstanding water resistance while allowing your substrate to breathe.
- ☐ Compatible with high alkali environments (i.e., cement products) while assisting in efflorescence control.
- ☐ Excellent product performance and color retention even under extreme weathering conditions.
- ☐ Limitless color selection – Twenty decorator shades available for immediate shipment as well as computer generated special colors for those unique projects.
- ☐ Performance is in the product. Cost savings is in the application.
- ☐ Normally shipped direct to your job site within 24 hours.
- ☐ FIVE year warranty on **STUC-O-FLEX®** systems.

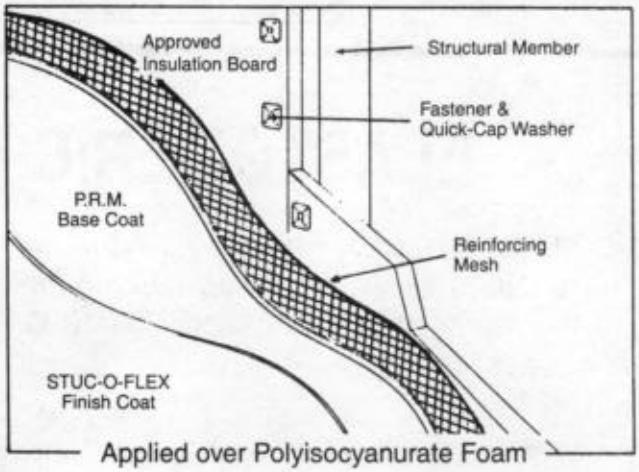
STUC-O-FLEX®

THERMAL - FLEX SYSTEM

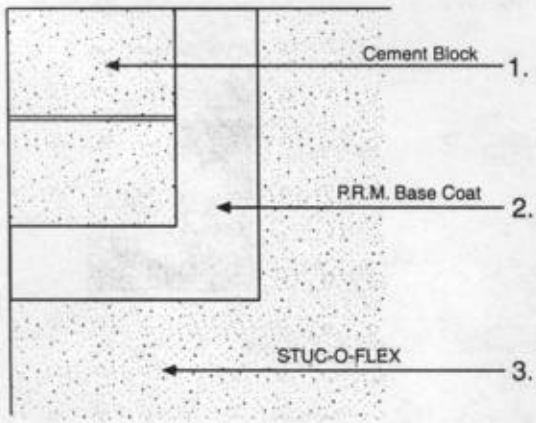


Applied over Expanded polystyrene

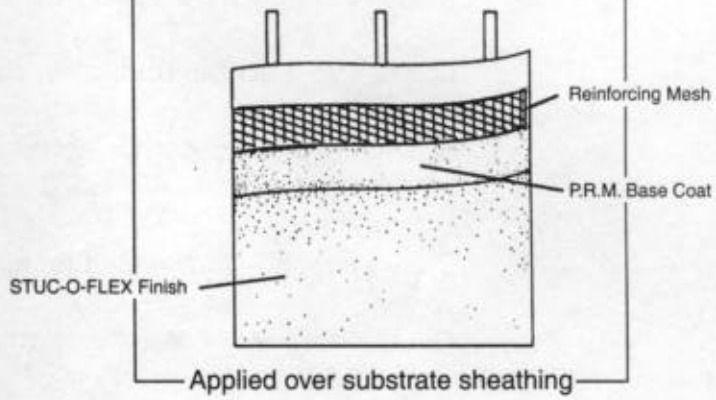
QUICK - FLEX SYSTEM



Applied over Polyisocyanurate Foam



PERM - FLEX SYSTEM



Applied over substrate sheathing

COVERAGE: Average coverage of STUC-O-FLEX® is 135 square feet per 5 gallon pail at nominal 1/16 of an inch.

Your local dealer for **STUC-O-FLEX®** is:

STUC-O-FLEX®

17639 N.E. 67th Court, Redmond, WA 98052
(425) 885-5085 • FAX (425) 869-0107 • 1 (800) 305-1045
www.stucoflex.com

PRM™

POLYMER REINFORCED MORTAR

Base Coat for STUC-O-FLEX®

PRM is a polymer reinforced mortar underlayment for use with acrylic finish coatings. PRM provides a strong bonding surface on EPS and polyisocyanuarate foam insulation materials when applied according to manufacturer's specifications.

MATERIAL PREPARATION: PRM is supplied in a 60 lb. container. Thoroughly mix at least 2 gallons of water for every 60 lbs. of PRM. If less material is required use proportionately less PRM and water. More water may be added to decrease viscosity.

SUBSTRATE PREPARATION: Substrate must be clean, dry and free from all loose or foreign materials, prior to application of PRM.

APPLICATION: PRM is usually applied with ordinary masonry trowels. It can also be spray applied with proper equipment then troweled to smooth out the surface. Material thickness must not exceed 1/4" per application. Additional applications of up to 1/4" in thickness may be applied after initial application is completely dry. Coverage rates will vary depending on substrate porosity, application method and thickness of material.

CAUTION:

- Do not take internally. If swallowed drink milk, consult physician immediately.
- Avoid prolonged contact with skin.
- Avoid direct contact with eyes, wear eye protection while handling.
- Keep out of reach of children.
- Keep container tightly sealed after each use.
- Use in well ventilated area.

STUC-O-FLEX®

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(425) 885-5085 • FAX (425) 869-0107 • 1 (800) 305-1045

PRIMESEAL®

LATEX STAIN-BLOCKING PRIMER
Moisture Resistant Sealer

- **Excellent as a primer or sealer for latex coatings**
- **Blocks water soluble tannins** • **Hides staining & bleed-thru**
- **Acts as a vapor barrier on properly prepared, approved substrates**
- **Brush, sprayer or roller applied** • **Water clean-up**

PRIMESEAL® is a specialized primer /sealer designed to block staining and bleedthru caused by tannic acid, sheathing laminates and other substrate materials. PRIMESEAL® is also an excellent sealer for retarding moisture or vapor penetration.

SURFACE PREPARATION: Surfaces must be clean, dry, and free from all dirt, dust, solvents or oils, fungi and other contaminants or foreign materials.

MATERIAL PREPARATION: Stir PRIMESEAL® thoroughly before application.

APPLICATION: PRIMESEAL® may be applied by brush, roller, paint pad or sprayer. Temperature must be above 40°F.
**PRIMESEAL® must be top-coated with final finish within 5 days.*

As A Primer: Apply 2 medium primer coats to the surface. Allow first coat to dry completely before applying second coat. Brush out runs and sags.

As A Sealer: For a moisture resistant barrier, a pin hole free film must be maintained. Three or more coats may be necessary to form a complete moisture barrier.

COVERAGE: 300 - 400 square feet per gallon depending on surface porosity and moisture content. Rough surfaces will require 25 - 50% more PRIMESEAL® than smooth surfaces.

STORAGE: Store in a cool, dry area, tightly sealed. Recommended storage temperature between 40 - 90 degrees.

STUC-O-FLEX®

17639 N.E. 67th Court, Redmond, WA 98052
(425) 885-5085 • FAX (425) 869-0107 • 1 (800) 305-1045

STUC-O-FLEX® INTERNATIONAL, INC.

17639 N.E. 67th Court
Redmond, WA 98052
(800) 305-1045
FAX (206) 869-0107

STUC-O-FLEX finishes are pre-colored at the factory, eliminating any need for on site mixing. Custom colors are available on request, see back for details.

307
Nova White

309
Soft White

311
Moonlight

312
Light Gray

313
Dove Gray

314
Whetstone

315
Sandstone

317
Autumn

318
Champagne

321
Taupe

322
Malt

325
Pate'

329
Khaki

330
Almond

332
Peaches-n-Cream

340
Light Salmon

344
Strawberry

346
Misty Mauve

351
Sunshine

357
Smoke Blue

NOTE: These color chips are to give a basic representation of standard colors. By the very nature of this product, slight color differences may occur between sample material and finished product. This is due to the method of texturing by the applicator and slight color variations of natural materials used in the STUC-O-FLEX finish coat.

STUC-O-FLEX INTERNATIONAL, INC.
SPECIAL COLOR POLICY

1. In an effort to insure excellent reproduction of your special color requirements in the most timely manner as possible, we have outlined below a list of guidelines to assist you in processing your project's material needs.
2. Job site names or numbers will be necessary for special color projects.
3. A sample chip of the desired color shall be submitted to STUC-O-FLEX International, Inc. for pigment ratio development. Preferably a 12 inch X 12 inch sample will be returned to the appropriate party for special color approval along with an approval form which should be signed and returned.
4. To provide optimum color consistancy, total square footage of wall surfaces to be coated should accompany the initial order. (Don't be conservative on square footage.)
5. There will be no additional charge for special colors of 18 pails or more; although it will be necessary to assess a one time $100.00 charge per color for product requirements less than this minimum.
6. Some special colors (i.e. deep bases, dark accent) may necessitate an additional charge because of high pigment content. This can be clarified at the time of special color approval.
7. Applicator shall be required to purchase up to 10% of the overruns from special color production (i.e., 30 pail order — 33 pail from batch production with a maximum of ten pails over.)
8. Please allow a minimum ten working days after color approval form is received for special color production and shipment.
9. Unfortunately, we can not allow any returns or refunds on special color materials.
10. A 50% deposit may be required on some custom color orders before production is sheduled.

** **NOTE:** By the very nature of this product, slight color differences may occur between sample material and finished product. This is due to the method of texturing by the applicator and slight color variations of natural materials used in the STUC-O-FLEX finish coat.

STUC-O-FLEX
"MAGIC MUD"
ELASTOMERIC ALL-PURPOSE TAPING COMPOUND

DESCRIPTION:

Stuc-O-Flex **"Magic Mud"** is a specially formulated drywall joint compound with built-in **elasticity** to minimize or eliminate cracks experienced with common drywall taping compounds. This product has been specifically designed to meet the needs of the manufactured housing industry where transportation and set-up causes extreme stress to seams and joints in drywall applications. This acrylic based polymer compound is applied identically to standard drywall products. No special tools are required.

ADVANTAGES:

- Stretchable when dry to provide maximum crack resistance
- Eliminate the need for primer prior to painting (*Review Spray-texturing Below)
- Minimal shrinkage
- Fast drying
- Easy to use with both mechanical tools or by hand
- Maximum bond strength to sheathing and tape
- Use directly from the container - No mixing required

COVERAGE:

2 Pails per 1000 Square Feet of wall board (average)

JOB CONDITIONS & CAUTIONS:

- Protect from freezing and exposure to extreme heat or direct sunlight while in container
- Apply to clean dry surface
- Temperatures above 35 degrees Fahrenheit
- Do not over thin

PACKAGING:

5 Gallon plastic pails / 50 Pounds per pail

MANUFACTURER:

Stuc-O-Flex International, Inc.
17639 NE 67th Court
Redmond, WA 98052
1-800-305-1045
1-425-885-5085
1-425-869-0107 Fax

APPLICATION INSTRUCTIONS:

Stuc-O-Flex **"Magic Mud"** is applied using the same tools and techniques as standard drywall compound. However, because of the high Acrylic Polymer content and its elastomeric characteristics this is not a product that is easy to sand. Therefore, it is recommended that you **do not** crown seams or joints to be sanded smooth later.

1. Using Magic Mud and a 6" finishing knife, fill the channel formed by the tapered edges of the drywall.

2. Embed the Joint Tape into the wet Magic Mud. Using additional Magic Mud over the tape smooth the surface using firm pressure and wipe away excess material leaving as flat as possible.

3. It may be necessary to use an 8" drywall knife and feather as much as 4" - 6 " each side to provide a smooth surface on considerably uneven joints.

4. Then using a light touch, smooth finished joint with a damp sponge to remove any extra material or high spots.

5. Butt joints without a taper will need to be feathered much wider than is the case for a regular seams.

6. In some cases it may be necessary to repeat steps 1 - 4 to achieve a perfect joint.

7. Inside and outside corners are handled in an identical fashion to standard drywall applications.

NOTE: Clean tools while Magic Mud is still wet, dry product will be difficult to remove.

**** Do not crown joints - Magic Mud is very difficult to sand ****

APPLYING SPRAY - TEXTURED FINISH

In light of the fast paced production in modular construction and limited available time to allow Magic Mud to dry, we have noticed occasional difficulties with consistency in knock-down texturing at the seams. This is a result of Magic Mud at the joints with a high moisture content and the dry paper-faced surface of the drywall. The suction over paper surfaces cause the texture compound to firm up quicker than the joint areas resulting in flatter texture at the seams. In an effort to resolve this challenge, we found good success by mixing the latex wall board primer and spray texture together. This allows for a more consistent moisture content in the spray texture which in turn results in a more consistent finished product. This is a commonly used method in the drywall

industry. This will also eliminate the need to prime your walls prior to painting. As a result, you can now use Magic Mud in all your drywall applications and reduce your cost and time needed for painting preparation.

(Example: 10 - 15 gallons of primer to 100 gallons of texture mud)

STUC-O-FLEX®
INTERNATIONAL, INC.
4709 STONEBRIAR DRIVE-OLDSMAR, FL. 34677
Phone: (727) 781-4963 Fax: (727) 786-7530
E-Mail williambattles@juno.com
From the Desk of **Bill Battles**

FAX TRANSMISSION

REFERENCE: APPLICATION OF STUC-O-FLEX
FAX: (614) 449-8968
TO: PDG DOMUS
ATT: MR. NATHAN PINGLE
FROM: WILLIAM A. BATTLES
DATE: 2 / 8 / 2001
COPIES: 1

DEAR NATE: THANKS FOR RETURNING MY CALL. STUC-O-FLEX CAN BE APPLIED BY TROWEL, HOPPER GUN SPRAY EQUIPMENT OR GRACO SPRAY EQUIPMENT. APPLICATION BY TROWEL DOES NOT REQUIRE THINNING OF THE PRODUCT, CAN BE APPLIED DIRECTLY OUT OF THE CONTAINER, AFTER SLIGHT AGITATION TO THOROUGHLY MIX THE PRODUCT. THE PUTZ (QUARTZ) FINISH CAN ONLY BE TROWELED BECAUSE THE AGGREGATE IS TOO LARGE TO PASS THROUGH SPRAY EQUIPMENT WITHOUT TEARING UP THE SPRAY TIP.

WHEN SPRAYING THE SAND FINISHES IT IS RECOMMENDED THAT THE MATERIAL BE THINNED WITH 6 TO 8 OUNCES OF CLEAN CLEAR WATER PER GALLON. SET THE COMPRESSOR AT 80 PSI AND THE MIDDLE OPENING ON THE GUN, IF USING A HOPPER GUN OR TEST THE SPRAY PATTERN WITH THE GRACO EQUIPMENT TO DEVELOP THE BEST PATTERN. IF A LOWER PSI IS USED A HEAVIER TEXTURE WILL RESULT.

UNDER SEPARATE COVER I HAVE ORDERED VARIOUS SAMPLES DEPICTING THE DIFFERENT TEXTURES THAT ARE AVAILABLE IN STUC-O-FLEX. THEY ARE; LIGHT SAND FINISH, MODIFIED SAND TEXTURE, PUTZ AND KNOCKDOWN FINISH. THE KNOCKDOWN IS ACHIEVED BY SPRAYING THE SAND TEXTURE AT 80 PSI, THEN WHEN DRY, THE SECOND COAT IS APPLIED AT 30 PSI THAT IS TROWELED ON WITH A PLASTIC TROWEL, THAT CREATES THE KNOCKDOWN TEXTURE. IN ADDITION YOU WILL BE RECEIVING A COPY OF OUR THREE RING ARCHITECTURAL BINDER FOR YOUR FILE THAT COVERS ALL THE ASPECTS OF THE PRODUCT AND VARIOUS APPLICATIONS OVER DIFFERENT SUBSTRATES.

ANY QUESTIONS CALL ME. LOOKING FORWARD TO MEETING AND WORKING WITH YOU IN THE NEAR FUTURE!

SINCERELY YOURS,

WILLIAM A. BATTLES
REGIONAL MANAGER

Stuc-O-Flex International, Inc.
17639 N.E. 67th. Court
Redmond, WA. 98052

STUC-O-FLEX, IS A HIGH BUILD ELASTOMERIC STUCCO LIKE COATING MADE WITH RESILIENT CO-POLYMER RESINS THAT PROVIDE 105% ELONGATION AND SUPERIOR WEATHERABILITY. COMES READY MIXED, READY TO USE, IN TWENTY (20) STANDARD COLORS, FOR USE ON BOTH INTERIOR & EXTERIOR SUBSTRATES. IT HAS THE ABILITY TO WITHSTAND THE INTRUSION OF WIND DRIVEN RAIN OF HURRICANE FORCES. RESISTS, SALT SPRAY. ULTRAVIOLET ATTACK AND MILDEW. BREATHES TO ALLOW BOTH VAPOR AND MOISTURE TO ESCAPE WITH LIFTING THE COATING FROM THE SUBSTRATE. HAS A CLASS "A" FIRE RATING AND CAN PROTECT EXTERIOR SURFACES FOR AS LONG AS TEN TO TWELVE YEARS, IN EVERY IMAGINABLE ENVIRONMENTAL CLIMATE. HAS BEEN SUBJECTED TO AND PASSED ALL THE REQUIRED ASTM, TESTS. (THIS INFORMATION IS DOCUMENTED ON OUR SPEC-DATA FOLDER.) CAN BE APPLIED EITHER BY TROWEL OR HOPPER GUN SPRAY EQUIPMENT. DOES NOT CONTAIN ANY TOXIC INGREDIENTS. SAND OR PORTLAND CEMENT. TEXTURE IS COMPRISED OF MARBLE CHIPS, THAT RENDERS A SAND TEXTURED FINISH, ALSO AVAILABLE IN A WORM FINISH. MANY DIFFERENT TEXTURES CAN EASILY BE ACHIEVED BY THE APPLICATOR. IT USER FRIENDLY, TOOLS AND EQUIPMENT CAN BE CLEANED-UP WITH WARM WATER. **COVERAGE IS APPROXIMATELY 150" SQ. FT. PER FIVE (5) GALLON PAIL. THIRTY (30) SQ. FT., PER GALLON.**

PRM, (POLYMER REINFORCED MORTAR) IS A POLYMER MORTAR UNDERLAYMENT FOR USE WITH ACRYLIC FINISH COATINGS. ***PRM***, PROVIDES A FLEXIBLE BONDING SURFACE ON **EPS** AND POLYISOCYANUARATE FOAM INSULATION MATERIALS WHEN APPLIED ACCORDING TO THE MANUFACTURER'S SPECIFICATION. COMES PACKAGED IN A SIX (6) GALLON CONTAINER, IN POWDER FORM. THOROUGHLY MIX AT LEAST TWO GALLONS OF WATER FOR EVERY 60 LBS., OF **PRM**. IF LESS MATERIAL IS TO BE USED USE PROPORTIONATELY LESS WATER. MORE WATER MAY BE ADDED TO DECREASE VISCOSITY. GENERALLY RECOMMENDED FOR USE ON **EPS** SYSTEMS, EXTERIOR HARDBOARDS AND DENS GLASS. CAN BE APPLIED EITHER BY TROWEL OR HOPPER GUN SPRAY EQUIPMENT. IT CAN BE SPRAYED ON WITH THE PROPER EQUIPMENT THEN TROWELED INTO THE FIBER GLASS MESH TO LEND TENSILE STRENGTH TO THE SUBSTRATE. MATERIAL THICKNESS SHOULD NOT EXCEED 1/4" PER APPLICATION. PRIOR TO APPLYING THE PRODUCT TO AN **EPS** SYSTEM, THE SURFACE SHOULD BE RASPED TO ENSURE BETTER ADHESION OF THE PRODUCT. **COVERAGE PER SIX (6) GALLON PAIL IS 130' SQ. FT.** TOOLS AND EQUIPMENT REQUIRES ONLY WARM WATER CLEAN-UP. CAN ALSO BE USED AS AN ADHESIVE TO BOND **EPS** SYSTEMS TO VARIOUS SUBSTRATES AS WELL AS QUOINS AND REVEALS, THAT ARE ADHERED TO EXTERIOR AND INTERIOR WALLS FOR DECORATIVE PURPOSES.

JOINT COMPOUND, IS A COPOLYMER ELASTOMERIC COMPRISED OF FLEXIBLE RESINS THAT HAVE EXTRAORDINARY FLEXIBILITY, IN ORDER TO WITHSTAND THERMAL SHOCK CONDITIONS. WHEN ADDRESSING PLYWOOD, OR CORNER JOINTS THE PRODUCT IS TO BE IMBEDDED INTO FIBER GLASS MESH, USING 6" JOINT MESH TAPE. THE PRODUCT SHOULD BE FEATHERED OUT AND APPLIED AS FLAT AS POSSIBLE TO COMPLETELY OBLITERATE THE JOINT.

Stuc-O-Flex International, Inc.
17639 N.E. 67th. Court
Redmond, WA. 98052

(PAGE TWO)

ONCE DRY THE PRODUCT HAS A RUBBERY EFFECT AND IS NOT EASY TO SAND, SO IT'S IMPORTANT THAT THE APPLICATOR FEATHERS IT OUT TO AVOID ANY PROBLEMS. CAN BE APPLIED WITH A BROAD DRY WALL KNIFE. CORNERS AND WALL JOINTS SHOULD BE ADDRESSED USING EITHER CORNER FIBER GLASS MESH OR PLASTIC CORNER BEAD AND PLASTIC "J" BARS, TO PREVENT WATER FROM WICKING IT'S WAY UP THE PANEL, FOLLOWED WITH THE APPLICATION OF JOINT COMPOUND AND FIBER GLASS MESH JOINT TAPE, TO TOTALLY SEAL AND WATERPROOF THE SUBSTRATE. WATER CLEAN-UP. **COVERS 350 LINEAR FEET PER FIVE GALLON PAIL.**

PRIME/SEAL, IS AN ACRYLIC LATEX WATER BASED EMULSION STAIN BLOCKING, MOISTURE RESISTANT SEALER. SERVES AS AN EXCELLENT PRIMER ON PLYWOOD, MASONRY, CONCRETE AND STUCCO SUBSTRATES. PREVENTS TANNIC ACID BLEED - THROUGH. HIDES STAINS, ACTS AS A VAPOR BARRIER. SATISFIES THE POROSITY OF THE SUBSTRATE TO PREVENT SUCTION SPOTTING OF THE FINISH COAT OF STUC-O-FLEX. **PRIME/SEAL**, SHOULD BE APPLIED OVER THE ENTIRE SUBSTRATE AFTER JOINT COMPOUND HAS BEEN APPLIED. THIS WILL EVEN THE POROSITY OF THE SUBSTRATE AND JOINT COMPOUND. APPLIED EITHER BY ROLLER OR CONVENTIONAL SPRAY EQUIPMENT. WATER CLEAN-UP. **COVERS 180 SQ. FT. PER GALLON, 900 SQ. FT. PER FIVE (5) GALLON CONTAINER**. PACKAGED IN FIVE (5) GALLON CONTAINERS. COLOR IS WHITE, CAN BE TINTED TO A LIGHTER SHADE OF THE FINISH COAT TO BE APPLIED, SO THAT IT IS EASIER TO ENSURE BETTER "ONE COAT" COVERAGE OF THE FINISH COAT.

QUICK BOND, IS AN ACRYLIC WATER BASED ADHESIVE FORMULATED TO BOND EPS (EXTRUDED POLYSTYRENE) MATERIALS TO CONCRETE, MASONRY, STUCCO, PLYWOOD AND EXTERIOR HARDBOARDS. IS VERY QUICK DRYING AND WILL STICK TO PRACTICALLY ANY SURFACE, THAT ARE CLEAN AND FREE OF DIRT , MILDEW AND FOREIGN MATTER. APPLIED BY A NOTCHED TROWEL. COMES PACKAGED IN FIVE (5) GALLON CONTAINERS. WATER CLEAN-UP. **COVERS UP TO 175 SQ. FT. PER GALLON**.

DETAIL FIBER GLASS MESH... 6" X 150 SQ. FT. PACKAGED TEN (10) ROLLS PER CASE.

STANDARD FIBER GLASS MESH... 38" X 150' PACKAGED FOUR (4) ROLLS PER CASE.

HIGH IMPACT ARMOR MESH... 38" X 85' PACKED ONE (1) ROLL PER BOX.

CORNER ARMOR TAPE... 9.5" X 150' PACKED ONE (1) ROLL PER BOX.

****

STUC-O-FLEX®
INTERNATIONAL, INC.
4709 STONEBRIAR DRIVE
OLDSMAR, FL. 34677 (727) 781-4963 - FAX (727) 786-7530
E-Mail williambattles@juno.com

"RENEW ELASTOMERIC COATING

PRODUCT DESCRIPTION:

TYPE: A HEAVY BODIED COATING DESIGNED AS A WEATHER SEAL IN NEW CONSTRUCTION AND RESTORATION SURFACE TREATMENT FOR A WIDE VARIETY OF SUBSTRATES INCLUDING E.I.F.S. STRETCHABILITY AND ELASTICITY ALLOWS FOR NORMAL BUILDING MOVEMENT WITHOUT CRACKING WHILE PROVIDING A TOUGH OUTER SHELL RESISTANT TO ENVIRONMENTAL IMPACT AND DIRT PICK UP. IT'S HIGH BUILD QUALITIES PERMIT HAIRLINE CRACKS TO BE SEALED AND BRIDGED WHILE ASSURING A UNIFORM COLOR AND APPEARANCE. TWO COATS ARE REQUIRED TO ACHIEVE MAXIMUM DRY MIL THICKNESS OF 10 MILS.

COMPOSITION: VEHICLE——73.1%
PIGMENT——26.9%

WEIGHT PER GALLON: 10.4 LBS.
VISCOSITY: 3,000 -5,000 CPS. - WET MILS 10 - MILS / DRY MILS - 5
SOLIDS WEIGHT: 48.9%

PACKAGING: FIVE (5) GALLON PLASTIC PAILS/ OTHER SIZES AVAILABLE FOR SPECIAL ORDERS.

COLORS: TWENTY (20) STANDARD COLORS. SPECIAL COLORS AVAILABLE UPON REQUEST FOR PARTICULAR APPLICATIONS.

FINISH: A SELF CLEANING, LOW SHEEN MEMBRANE (FLAT FINISH)

THINNING: NONE RECOMMENDED

COVERAGE RATE: 625 SQUARE FEET PER FIVE (5) GALLON. (APPROXIMATE)

SURFACE PREPARATION:

ALL SURFACES MUST BE CLEAN, DRY, FREE OF DIRT, GREASE, EFFLORESCES, FORM BREAKERS, MOLD, MILDEW AND ALL MATERIAL WHICH MAY COMPROMISE ADHESION.

TEMPERATURE: DO NOT APPLY TO SURFACES BELOW 40 DEGREES FAHRENHEIT.

STUC-O-FLEX JOINT COMPOUND

DESCRIPTION:

STUC-O-FLEX MODIFIED ACRYLIC JOINT COMPOUND OFFERS NEW TECHNOLOGY IN ELASTOMERIC SEALANTS. THE PRODUCT IS DESIGNED FOR TREATMENT OF BUTT JOINTS AND SEAMS IN SUBSTRATE SHEATHINGS.

USES:

STUC-O-FLEX JOINT COMPOUND IS USED TO WATERPROOF SEAMS AND BUTT JOINTS. EQUALLY IMPORTANT, IT PROVIDES AN OPPORTUNITY TO SMOOTH AND FLUSH OUT UNEVEN AREAS WITHIN SUBSTRATE SHEATHING PRIOR TO APPLY EITHER PRIME SEAL OR PANEL PRIME AND THE STUC-O-FLEX FINISH COAT APPLICATION. THIS JOINT COMPOUND INSTALLATION WHEN PROPERLY APPLIED WILL INSURE AN ATTRACTIVE EXTERIOR WALL SYSTEM IS ACHIEVED WITHOUT SHADOWING OR SEAMS SHOWING THROUGH.

SPECIFICATIONS:

RESISTANCE TO WIND DRIVEN RAIN, ACCORDING TO TT-C-555B SEC 3.3.3. NO PENETRATION. MOISTURE VAPOR PERMEABILITY, ACCORDING TO TT-C-555B SECTION 4.4.8: 10.1 PERMS, MINIMUM REQUIREMENT 0.4 EXCELLENT ADHESION, VS TENSILE STRENGTH AT BREAK, ACCORDING TO A.S.T.M. D 412-80

CHARACTERISTICS:

COLOR:	WHITE
VEHICLE:	MODIFIED ACRYLIC
VOLATILE:	WATER
ODOR:	VERY LOW
CONSISTENCY:	TEXTURED PASTE
FLASH POINT:	NONE WATER BASED
SPECIFIC GRAVITY:	1.16
TEMPERATURE RANGE	-30 DEGREES F TO 180 F
SHELF LIFE	1-YEAR MINIMUM
COVERAGE:	350 LINER FEET PER FIVE GALLON PAIL
PACKAGING:	5 - GALLON CONTAINERS

LABEL WARNING:

CLOSE CONTAINER AFTER EACH USE, DO NOT TAKE INTERNALLY. KEEP FROM FREEZING. KEEP OUT OF REACH OF CHILDREN.

BROWN
STEEL DIVISION OF LAPHAM-HICKEY STEEL CORP.

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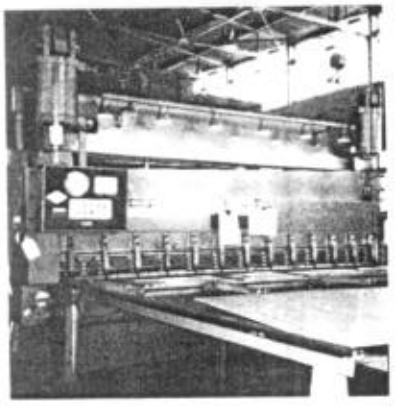
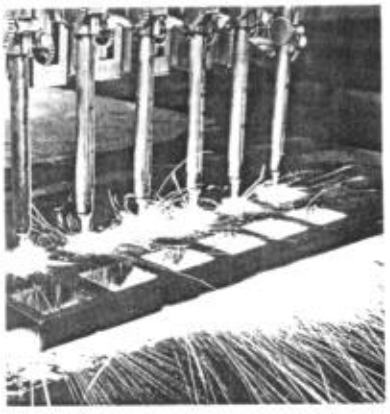
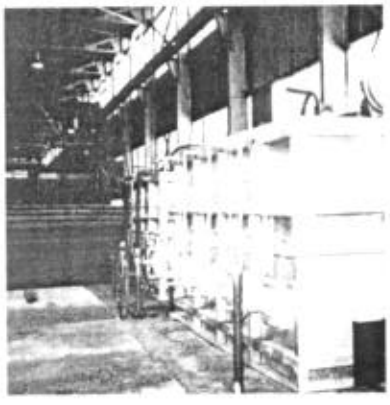
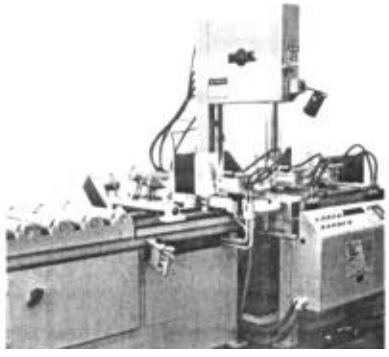
STEEL DIVISION OF LAPHAM-HICKEY STEEL CORP.

Since 1892









STEEL SERVICE CENTER INSTITUTE

Brown Steel

A History Founded Upon High Quality, Good Service and a Fair Price.

Brown Steel was founded in 1892 on three principles—High Quality, Good Service, and a Fair Price. We'll continue to serve your needs through the "bad times" and the good times.

And today, the Brown Steel Service Center adheres to these same principles. We've been supplying carbon steel in a wide variety of shapes, grades and sizes for almost 100 years. We've kept pace with the ever changing steel industry to guarantee your needs are fully served. We've added new facilities. New services. New technology. New people.

A Full-time Commitment to Your Steel Service Needs

In Brown Steel's sales department, you'll find experienced inside and outside sales people who know the steel business. They get to know the specifics of your business. They make a point to find out about your products, deadlines, supply requirements, new applications—everything it takes to guarantee that your steel supply and pre-production needs are completely fulfilled.

Our automated ordering and record keeping system system assures you of a quick turn-a-round. Often your first contact with Brown Steel—is the delivery of your order.

An inside sales desk is always open during business hours as well to provide convenient over the counter services and supplies. Whether they're in the field, in our plant, in our office, or just in a hurry, our customers soon learn to appreciate our full time commitment to their steel service needs.

Brown Supplies All Your Steel Service Needs. Quickly. Efficiently. Everytime.

Striving for the ultimate in customer service Brown Steel operates an expansive warehouse and service center in its Columbus, Ohio location. With over 100,000 square feet in the warehouse, Brown Steel stocks 2600 kinds of cold finished and hot rolled steel which include beams, plates, sheets, channels, angles, bars, structurals, expanded metals, bar grating, grip strut, pipe, reinforcing bars and much more. Our materials handling systems and equipment guarantee that you receive expedient and efficient service everytime.

Brown Guarantees Its Products and Services

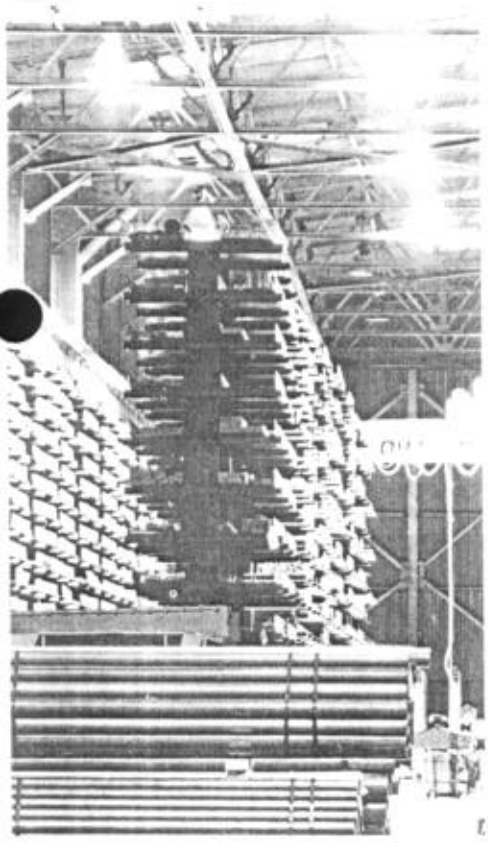
Brown Steel guarantees that our products are of the highest quality and that our services are performed to your complete satisfaction. If there is ever a question about either, Brown Steel pledges to see that it is quickly and completely resolved. We guarantee it!

The Brown Steel Service Center...

We're your inventory ...your pre-production processing ...your scrap handling...your guards...all on our payroll. Not yours.

INVENTORY

The Brown Steel Service Center stocks a complete supply of carbon steels in a variety of shapes, grades and sizes. Everything from bars to angles—plates to grip strut. In other words—we stock everything, so you don't have to! And you can count on Brown for consistent pricing of all our stock. Unlike the steel industry norms—we've always kept our prices steady even in the midst of vast market fluctuations.



Bars - Hot Rolled

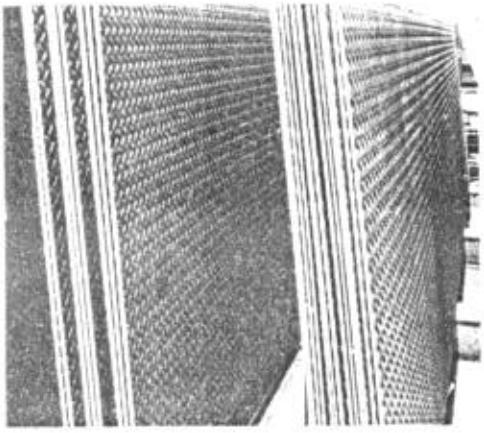
- Reinforcing Bars
- Rounds
- Square
- Flats
- Fully Threaded Rods
- Channels
- Tubing

Bars - Cold Finished

- Rounds
- Hexagons

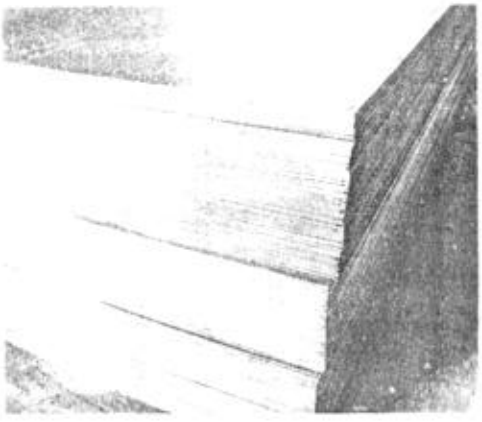
Drill Rod & Ground Flat

- Water Hardening
- Oil Hardening
- Ground Flat
- Precision Ground Flat Stock



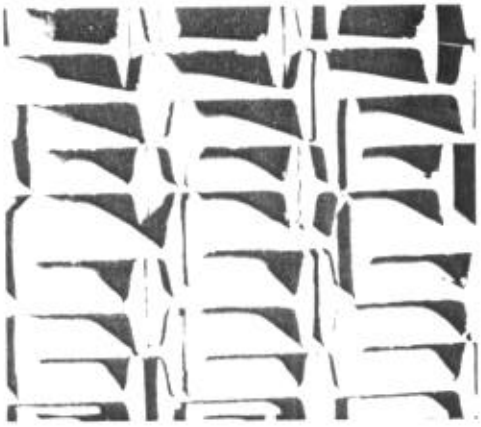
Plates

- Mild Carbon
- A 36
- Free Machining
- AR-360
- Floor Plate
- 40/50 Carbon
- A 572, Grade 50



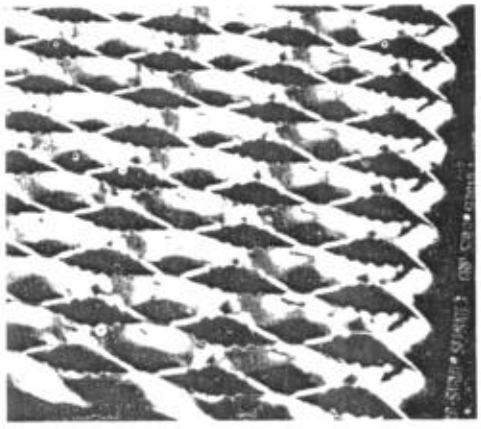
Sheets

- Hot Rolled
- Hot Rolled (Pickled and oiled)
- Cold Rolled
- Galvanized



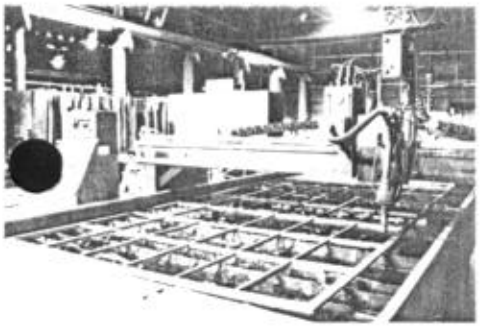
Structural Shapes/Bar Shapes/Tubing/ Pipe

- Wide Flange
- I-Beams
- Junior Beams
- Channels
- Junior, Ship and Car Channels
- Tees
- Angles
- Structural Tubing
- Structural Pipe



Grip-Strut

- Saf-T-Mesh (Non-Flattened)
- Flattened
- Expanded Metal Grating
- Grating
- Grip Strut
- Grip Strut (Aluminum and Stainless Steel)
- Welded Steel Bar Grating
- Stair Treads



PLASMA/ OXY-FUEL CUTTING

High Technology at Moderate Cost

The Plasma Arc Cutting delivers a clean, smooth cut, suitable for many applications without additional refinishing. Superior speed and quality are the result of patented Tangetial (Swirling) water injection process. The swirling water keeps the plasma arc constricted and uniform—No double arcing—Uniform construction assures consistent cut quality when making 360° shape cuts. . . . Also, the swirling water injection process can minimize plate warpage in most cases.

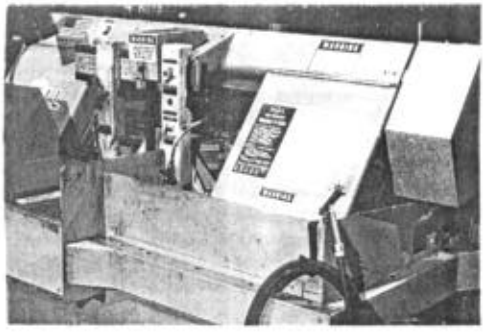
Plasma arc cutting provides high-speed shape-cutting of ferrous and non-ferrous materials, and improved cut quality through the patented water injection system.

The UCNC-8 Microprocessor numerical control for shape cutting delivers state of the art technology. Multiple input capabilities include manual and floppy disc. This specially equipped machinery protects against loss of parts program stored during a temporary power outage.

Brown Steel's Plasma and Oxy-Fuel cutting operations are tied into one centralized Cad system.

"SUPER-KERF" provides true accurate geometric kerf compensation of the part program to eliminate gouging, undercutting and corner rounding of the finished product.

We have three (3) water tables that measure 9 feet by 22 feet. This under water cutting reduces edge hardness and



NUMERICAL CONTROL CLOSE TOLERANCE CUTTING (+ or - .010)

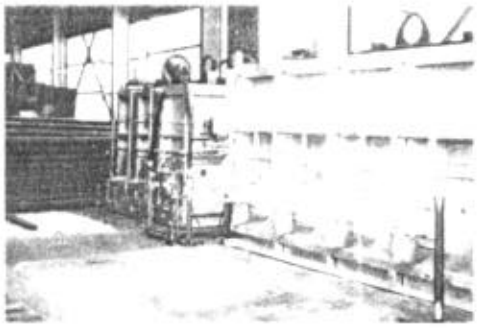
The NC control allows the pre-programming of a variety of cuts. Once set the operator enters the various job parameters such as length, number of cuts, etc. Automatic kerf compensation and initial crop cut are already preprogrammed which greatly reduces the chance for operator error. This saw will cut up to 12" square or round.

STRUCTURAL CUTTING (+ OR - 1/16")

This saw head will tilt up to 45 Degrees left or right and handle rectangular workpieces up to 20 x 21 and rounds up to 20". This saw is also NC controlled.

WORK ORDER PROCESSING—

If additional processing is required beyond those services already described, Brown Steel can fill the bill. Our Work Order department will, upon request, make all necessary arrangements to fulfill your specific fabricating needs.



HEAT TREATING—

The key word in heat treating is control. Brown Steel has years of expertise in the scientific techniques required to maintain the processes' time/temperature relationship. Our modern equipment is fully instrumented to further assure that control is always preserved.

Brown Steel's technical personnel are well versed in a variety of heat treating processes. Feel free to consult them on the need for, ease of or difficulty in, and cost of. . .

- **Stress Relieving**
- **Annealing**

BLANCHARD GRINDING—

The Brown Steel Service Center is staffed and equipped to provide precision surface grinding on both ferrous and non-ferrous metals. We provide a 63 microinch finish as a standard commercial grade and can achieve more exacting tolerances on either of our three grinders upon your request.

BROWN
STEEL 100th Anniversary
1892 - 1992

A DIVISION OF LAPHAM-HICKEY STEEL CORP.

COMMITMENT TO QUALITY

Our goal at Brown Steel is to supply products and services that meet or exceed our customers quality requirements.

The assurance of quality is accepted as the most important factor in every decision and action in our working day, by every individual within our organization.

We shall achieve our goal by actively supporting and participating in a program of continuous quality improvement. This program promotes team work, continuous employee education, total conformance to specifications, defect prevention, cost reduction and on time delivery.

We welcome suppliers who share the same goals and commitment to quality. It is our objective to create a long term relationship that promotes our mutual success.

Striving for these goals will contribute to the success of our organization and our customers.

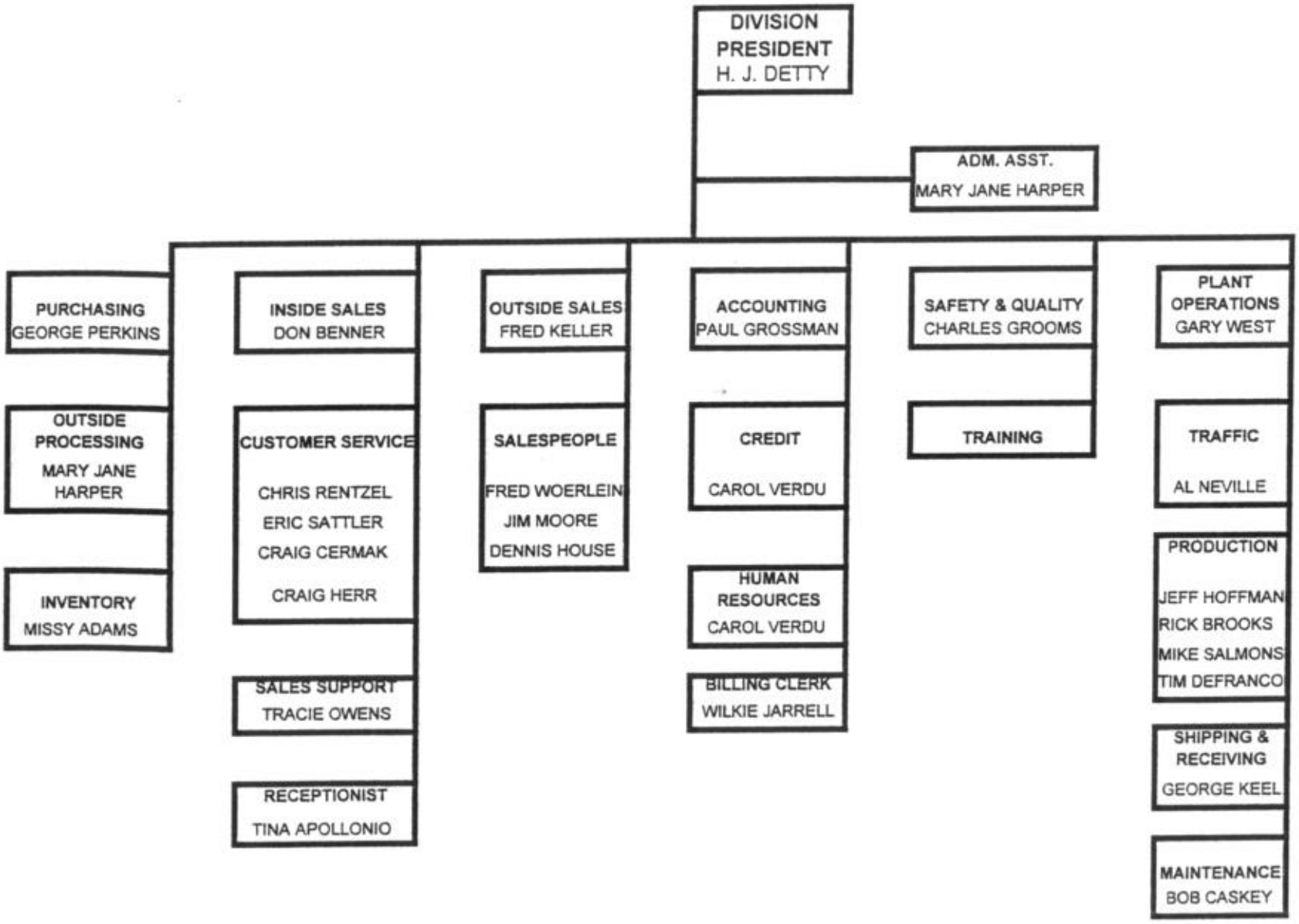
H.J. Detty
President Brown Steel Div.

OFFICE AND PLANT
753 MARION ROAD
P.O. BOX 16505
COLUMBUS, OHIO 43216

(614) 443-4881

STEEL SERVICE CENTER INSTITUTE

BROWN STEEL

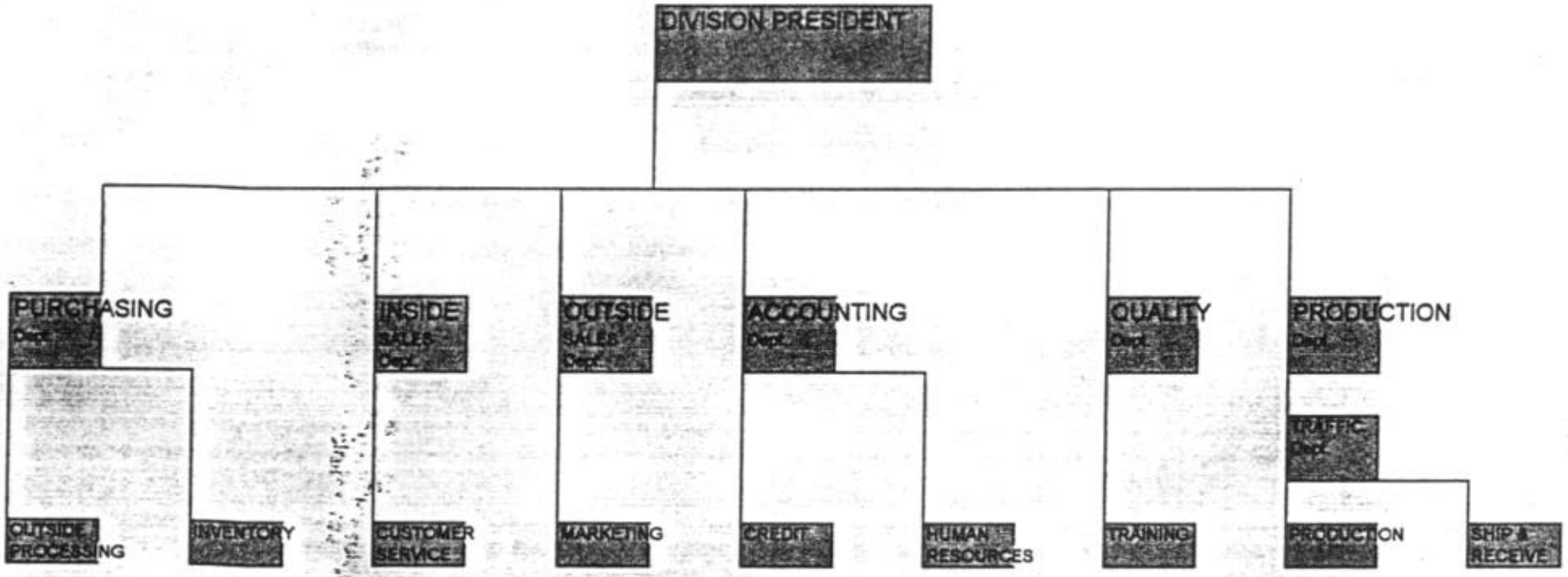

DIVISION PRESIDENT
H. J. DETTY
ADM. ASST.
MARY JANE HARPER
PURCHASING
GEORGE PERKINS
OUTSIDE PROCESSING
MARY JANE HARPER
INVENTORY
MISSY ADAMS
INSIDE SALES
DON BENNER
CUSTOMER SERVICE
CHRIS RENTZEL
ERIC SATTLER
CRAIG CERMAK
CRAIG HERR
SALES SUPPORT
TRACIE OWENS
RECEPTIONIST
TINA APOLLONIO
OUTSIDE SALES
FRED KELLER
SALESPEOPLE
FRED WOERLEIN
JIM MOORE
DENNIS HOUSE
ACCOUNTING
PAUL GROSSMAN
CREDIT
CAROL VERDU
HUMAN RESOURCES
CAROL VERDU
BILLING CLERK
WILKIE JARRELL
SAFETY & QUALITY
CHARLES GROOMS
TRAINING
PLANT OPERATIONS
GARY WEST
TRAFFIC
AL NEVILLE
PRODUCTION
JEFF HOFFMAN
RICK BROOKS
MIKE SALMONS
TIM DEFRANCO
SHIPPING & RECEIVING
GEORGE KEEL
MAINTENANCE
BOB CASKEY

PROCEDURE MANUAL DISTRIBUTION LIST

COPY #	LOCATION	NAME
MASTER COPY	QUALITY MANAGERS OFFICE	C.A. GROOMS
1	DIVISION PRESIDENTS OFFICE	JIM DETTY
2	SALES MANAGERS OFFICE	FRED KELLER
3	PLANT MANAGERS OFFICE	GARY WEST
4	SHOP OFFICE	AL NEVILLE
5	SALES OFFICE	DON BENNER
6	PURCHASING MANAGERS OFFICE	GEORGE PERKINS
7	ACCOUNTING MANAGERS OFFICE	PAUL GROSSMAN

BROWN STEEL

Division of Lapham-Hickey Steel Corporation



mail:
BROWN STEEL
PO BOX 16505
COLUMBUS OH 43216-6505

deliver:
BROWN STEEL
763 MARION ROAD
COLUMBUS OH 43207

phone:
1-800-326-0327
(614)-443-4881
FAX (614)-443-6371

ORGANIZATION CHART

QUALITY SYSTEM PROCEDURES LIST
AND
PROCEDURE MANUAL TABLE OF CONTENT

Policy Reference	QP#	NAME OF PROCEDURE	DATE ISSUED	REVISION LEVEL
1				
2	QP 2.1	QUALITY SYSTEM	04/21/97	
3	QP 3.1	CONTRACT REVIEW	11/21/95	
4				
5	QP 5.1	DOCUMENT CONTROL/REVIEW	04/21/97	
6	QP 6.1	SUPPLIER ASSESSMENT	02/19/96	
7				
8				
9	QP 9.1	PROCESS CONTROL	01/15/96	
10				
11				
12				
13				
14				
15				
16				
17	QP 17.1	INTERNAL QUALITY AUDITS	12/04/96	
18	QP 18.1	PRODUCTION OPERATOR TRAINING	06/06/95	
19				
20				

APPENDICES #1 - DISTRIBUTION LIST

PROCEDURE

QP 2.1

Subject: QUALITY SYSTEM

Issued: 04/21/97

Revision:

Approval:

1.0 Purpose: Define the organizational structure used by Brown Steel to manage the quality of products and services we provide.

2.0 Scope: This process covers implementation of ANSI/ASQC Q9002-1994. This Procedure is administered by the quality assurance manager in association with all company employees and department managers

3.0 Definitions: **APPROVED DOCUMENTS**

⇒ **Policy** Directives set forth by and approved by top management.

⇒ **Procedure** Instruction set forth by a department manager describing the steps taken by that department to carry out the management Policy.

⇒ **Work Instructions** Detailed Instructions for a specific work activity that is necessary to carry out a Procedure.

⇒ **Forms** Forms are used to record activity or list elements of quality system.

4.0 Associated Material:

1. ANSI/ASQC Q9002-1994
2. BROWN STEEL QUALITY POLICY MANUAL
3. BROWN STEEL QUALITY PROCEDURE MANUAL
4. BROWN STEEL QUALITY INSTRUCTION MANUAL
5. BROWN STEEL QUALITY FORMS MANUAL
6. DOCUMENT CONTROL/REVIEW QP 5.1
7. QUALITY RECORDS QP 16.1

5.0 Procedure:

Step1: Prepare a written Policy statement for each clause of the standard briefly describing the activities required to meet the Standard. *Note: ANSI/ASQC Q9002-1994 shall be referred to as "the standard".*

Step2: Number the Policy statement to correspond with the numbering system of the standard.(see figure 2.1-1)

Step3: Prepare a written Procedure for each department responsible for carrying out the Policy. (see QP 1.1)

Step4: Number the Procedure as described in figure 2.1-1.

PROCEDURE

Subject: QUALITY SYSTEM

QP 2.1

Issued: 04/21/97

Revision:

Approval:

Step5: Prepare written Work Instructions if the activities described in the procedure require more detailed instruction.

Step6: Prepared Forms if required to complete the Procedure or Work Instruction.

Step7: done

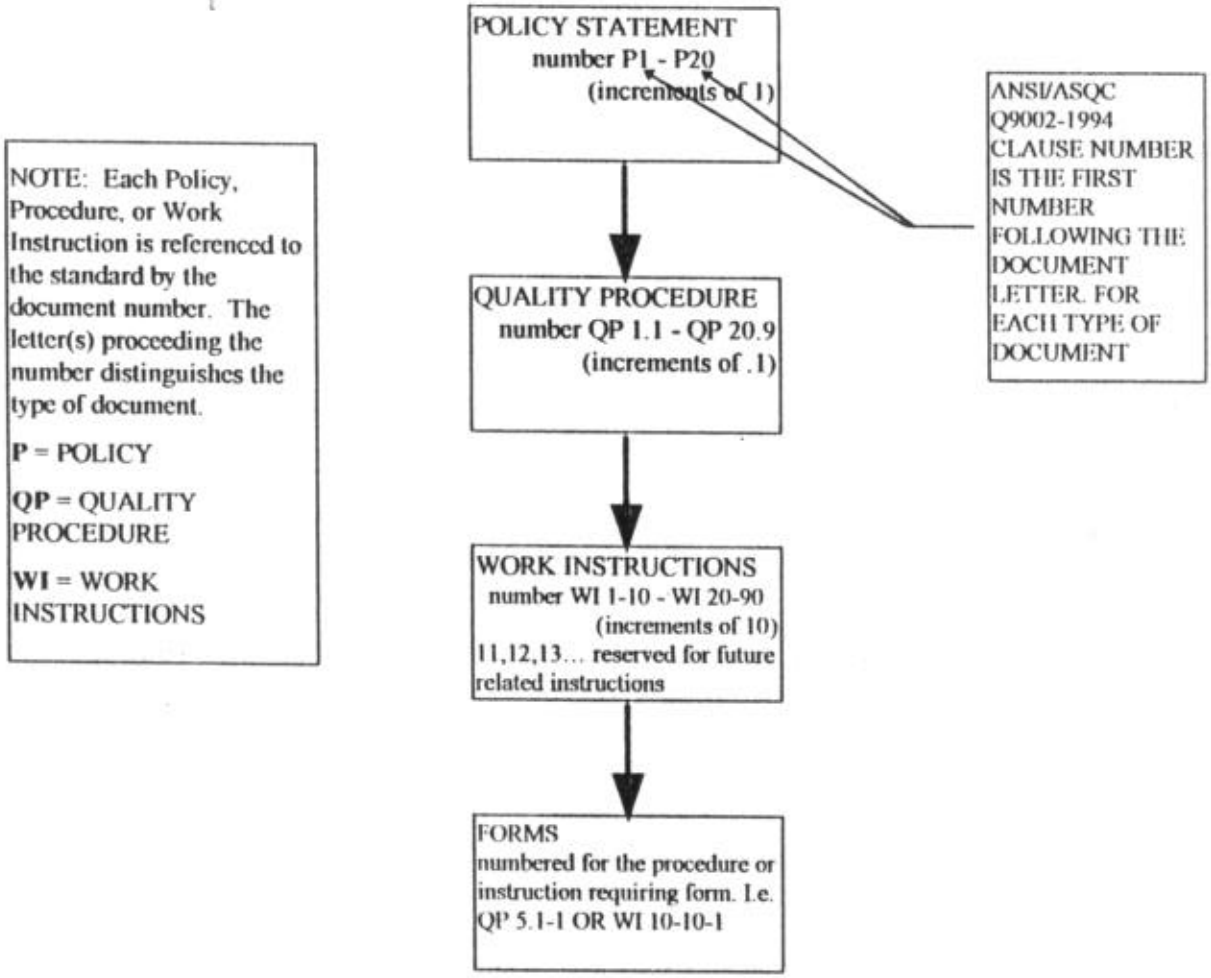


FIGURE 2.1-1

	Page: 1 of 2
PROCEDURE	QP3.1
Subject: CONTRACT REVIEW	Issued: 11/21/95
	Revision:
	Approval: Don Benner

1.0 Purpose: Describe the steps taken to review customer inquiries and orders.

2.0 Scope: Includes the review of specifications, pricing and delivery. **This process is administered by the Sales Department** and takes place prior to acceptance of order.

3.0 Definitions:

1. **"Inquiry"** - Invitation to supply a product.
2. **"No Bid"** - Inquiry that cannot be fulfilled.
3. **"Processing Requirements"** - Any value added processes.
4. **"Quotation"** - Priced inquiry.

4.0 Associated Material:

⇒ Work Instructions WI3.10 and Inquiry/Order Form 3.10-1.

5.0 Procedures:

Step1: Receive "Inquiry" in verbal or written form.

Step2: Review Specifications.

- Size
- Analysis
- Tolerances
- Quantity
- Prints

Note: If stock size inquiry or repeat order go to Step 8.

Step3: Contact customer if clarification is required.

Step4: Review Processing Requirements.

- Availability
- Capability
- Delivery

Note: If no additional review is required go to step 8.

PROCEDURE	QP3.1
Subject: CONTRACT REVIEW	Issued: 11/21/95
	Revision:
	Approval: Don Benner

Step5: Send the following

* Copy of "inquiry" to production for additional information.
* Copy of "inquiry" to purchasing for price and delivery information

Step6: Repeat steps 3 & 4, if required

Note: If no changes or review is required go to Step 8

Step7: Request or offer change in customer requirement.

Note: If change not accepted, file as "No Bid" in Quotation file

Step8: Prepare written "quotation".

* Figure weights
* Price materials
* Figure processing costs

Note: If customer does not require a quotation go to Step 11.

Step9: Send "quotation" to customer.

Step10: Place "quotation" in Quote File pending customer acceptance.

Step11: Write accepted order onto Inquiry/Order Form. (3.10-1)

* Proofread against customer "inquiry" or "quotation".

Step12: Send Inquiry/Order Form to Order Entry.

* Attach all work copies or notes to become part of permanent record.

Step13: END

PROCEDURE

Subject: DOCUMENT CONTROL/REVIEW

QP 5.1

Issued: 04/21/97

Revision:

Approval:

1.0 Purpose: Describe the steps taken to control the status and location of quality documents.

2.0 Scope: This include the approval, release, distribution, revision, and review of all quality system Documents as defined in QP2.1 Quality System. This process may be initiated by any company employee. **This Process is administered by all department managers** in association with the quality assurance manager.

3.0 Definitions:

⇒ **document center:** A specified location for all original copies of quality documents.

⇒ **distribution list:** For Draft documents this is a list of the people who are sent review copies. For approval documents this is a list showing the Department manager or department supervisor responsible for approval and storage of this document.

⇒ **Approved document:** See QP 2.1 Quality

4.0 Associated Material:

1. Document Approval Coordination cover sheet (form QP 5.1-1)
2. Document Approval Status log book and file. See WI 5-10
3. QUALITY SYSTEM QP 2.1

5.0 Procedure:

Step1: Prepare rough draft or note describing the specific purpose and description of the item to be included in the quality system.

Step2: Prepare a distribution list of effected jobs or personnel.

Step3: Send rough draft, or note, and distribution list to your supervisor and the document center for completion of formatting (typing) and status log book.

Step4: Receive typed draft with form QP5.1-1 (Approval Coordination cover sheet) attached.

Step5: Send or route Draft to all effected personnel. *Note:*  *This is a critical step. Caution must be taken to assure all distribution copies are returned to the author and then to the document control center to avoid distribution of unapproved documents.*

PROCEDURE	QP 5.1
Subject: DOCUMENT CONTROL/REVIEW	Issued: 04/21/97
	Revision:
	Approval:

Step6: Return all copies to document control center for corrections and preparation of next draft.

Step7: Repeat Step 4, 5 and 6 if significant change are required.

Step8: Receive Approval copy from document Central.

Step9: Obtain approval signature.

Step10: Return Signed original document to document central.

Step11: Receive photo copy of document and a revised table of content.

Step12: Place copy in specified Manual. *Note: Each Department manager shall maintain copies of all Approved Documents.*

Step13: Amend document when changes are required by marking a single line through the item(s) to be changed, write in the new information then initial and date new information.

Step14: Revise document when significant amendment has been made or by 2 months following an amendment. *Note:*  *Revisions are subject to the same approval process as a new document. The 1st issue has no revision level. Subsequent revisions are identified by Revision A, then B then C and so on.*

Step15: Review of quality documents are made on a continuous basis and during annual management review and during periodic internal quality audits.

Step16: done

PROCEDURE

QP 6.1

Subject: **SUPPLIER ASSESSMENT**

Issued: 02/19/96

Revision:

Approval 2/19/96

1.0 Purpose: Define the system used by Brown Steel to evaluate and select suppliers.

2.0 Scope: This procedure covers initial assessment, periodic review, and record of performance for suppliers of material or processing services to be resold by Brown Steel. **This process is administered by the Purchasing Department** in association with the Quality Assurance Department.

3.0 Definitions:

1. **Materials Supplier** - Any organization providing materials to be resold by Brown Steel.
2. **Processing Supplier** - Any organization providing processing services for resale to a customer. (ie. Welding, forming, machining)
3. **Preferred Supplier** - Status given for past performance, documented quality program and service.
4. **Approved Supplier** - Status given for past performance and service.
5. **Probationary Supplier** - Status given a new supplier or for limited use base on past performance.

4.0 Associated Material:

1. Supplier History Form and List (WI 6-10).
2. Supplier Survey Form (WI 6-20).
3. Supplier List.

5.0 Procedure:

STEP1: Initiate Supplier History Form (see WI 6-10, Form 6-10-1)

STEP2: Record Supplier status on Supplier List. *Note: A list is maintained for material supplier and a separate list is maintained for processing suppliers.*

STEP3: Send Supplier Survey Form to potential supplier. (See WI 6-20, Form 6-20-1)

STEP4: Receive completed survey Form. *Note: Form may be completed by supplier representative, by Brown Steel purchasing representative during phone interview or during visit to supplier location.*

STEP5: Update Supplier List and History Form.

PROCEDURE

Subject: **SUPPLIER ASSESSMENT**

QP 6.1

Issued: 02/19/96

Revision:

Approval 2/19/96

STEP6: Maintain an alphabetic file system containing the Survey Form and History Form. *Note: Material Supplier file is maintained by the purchasing manager. Processing Supplier file is maintained by the purchasing assistant. The Supplier list Shall serve as a table of content for these files*

STEP7: Record purchasing activity as described in WI 6-10.

STEP8: Perform annual review of performance.

a) number of line items purchased.

b) piece/tons count.

c) dollars cost.

d) piece or tons rejected.

e) rework and redelivery cost

STEP9: Record results of the review on Supplier History Form. *Note: Each Supplier is subject to continuous review and formal review of all Supplier data and activity shall be performed at least one time per year.*

STEP10: Notify Supplier of results.

STEP11: Record date of review on Supplier List

STEP12: End

PROCEDURE

	QP 9.1
Subject: **PROCESS CONTROL**	Issued: 1/15/96
	Revision:
	Approval

1.0 Purpose: To describe the steps taken to assure control of production processes.

2.0 Scope: Covers all production personnel who produce parts for our customers; covers the preparation of operator instructions. This process is administered by the Production Manager and Production Supervisors in association with the Quality Assurance Manager.

3.0 Definitions: Operator Hand Book: A **specified location** for information and instruction related to processing customer orders. This includes:

A. Work instructions
B. Job descriptions
C. Safety precautions
D. Machine maintenance
E. Work standards:
   1. Tolerances
   2. Color codes
   3. Material lists
F. Equipment or material manufacturer's literature

4.0 Associated Material:

1. Operator Hand Book (Figure 9.1-1 Check Sheet/Table of Content)
2. O.H.B. Log Sheet (Figure 9.1-2)
3. Operator Training QP 18.1

5.0 Procedures:

Step 1: Collect information on equipment, processing, and materials.

Step 2: Arrange information in a notebook:

1. Work Instruction/Job Descriptions
2. Safety
3. Maintenance
4. Work standards (tolerances, codes)
5. Forms
6. Attached (will not fit in notebook)

Step 3: Prepare a table of contents, including source of each item included (Figure 9.1-1)

Step 4: Store book in area needed

NOTE: Retain master copy in Q.C. office

PROCEDURE	QP 9.1
Subject: **PROCESS CONTROL**	Issued: 1/15/96
	Revision:
	Approval

Step 5: Record location of all notebooks (O.H.B. Log Sheet Figure9.1-2).

Step 6: Use booklet for training, per QP 18.1.

Step 7 Use book for reference.

Step 8: Review O.H.B. annually.

PROCEDURE	QP 17.1
Subject: INTERNAL QUALITY AUDITS	Issued: 12/04/96
	Revision:
	Approval: Jim Percy

1.0 Purpose: To describe the steps taken to determine if the quality system procedures and instructions (1) meet the requirements of the ISO 9002 Standard, that (2) they are being followed and that (3) they do in fact assure Quality.

2.0 Scope: This is a partial audit of the quality system. The Audit shall cover all levels of documentation (Policies, Procedure, Instructions, Forms, and records) for the processes designated by executive manager. This process is administered by the **Quality Assurance Manager** in association with executive management and all company employees. This Process shall be performed at least 2 times per year.

3.0 Definitions:

⇒ **Quality Audit** A systematic and independent examination to determine whether activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives.

⇒ **Quality system** The organizational structure, responsibilities procedures, processes and resources for implementing quality management.

⇒ **Audit team** A group of individuals, trained in auditing techniques, under the direction of the quality manager assigned to audit areas/processes outside their normal duties. The number of team member depends on the extent of the areas audited.

⇒ **Auditee** The person responsible for the areas/process being audited.

4.0 Associated Material:

1. ISO 10011-1 Guidelines for auditing quality systems.
2. BROWN STEEL QUALITY POLICY MANUAL
3. WI 17-10 AUDIT WORK SHEET INSTRUCTIONS
4. Form 17-10.1 AUDIT WORK SHEET

5.0 Procedures:

Step1: Go to Executive Management to schedule the Audit and select the processes to be audited.
Note: These shall be selected by the amount of time that has passed since the last audit of this process or due to past performance.

PROCEDURE	QP 17.1
Subject: INTERNAL QUALITY AUDITS	Issued: 12/04/96
	Revision:
	Approval: Jim Perry

Step2: Prepare a written note to the executive management to verify the scope and extent of the audit
Note: It is critical that the objective of each audit is clearly defined.

Step3: Prepare a list of all procedures and instructions to be audited.

Step4: Notify Audit team and schedule audit planning session.

Step5: Hold Audit planning meeting.
Note: This meeting is to establish a time frame and set audit assignments.

Step6: Prepare a written Audit plan showing time required and allocation of resources.

Step7: Forward Audit Plan to Auditee and to executive management.

Step8: Carry out audit per **WI 17-10 Audit Work Sheet Instructions**.

Step9: Hold a post audit meeting.
Note: This meeting is held to review audit sheets completed in Step 8 above and to schedule time to verify any unanswered questions.

Step10: Prepare final report for Executive Management summarizing audit findings.
Note: This report shall recommend corrective action to be taken.
Note: Corrective action is the responsibility of the auditee, and is to be reported to executive management and to quality control manager.

Step11: Retain audit sheets, report and corrective action in quality managers files.

PROCEDURE

QP 18.1

Subject: **Production Operator Training and Certification**

Issued: 9/6/95

Revision:

Approval

1.0 Purpose: Describe the steps taken to train, certify and re-certify production personnel.

2.0 Scope: This process covers the initial training and continued evaluation of skills of production personnel whose work directly affects the quality of products to the customer. This process determines certification and re-certification to pay grade. This process is administered by Production Management.

3.0 Associated Material:

1. Operator Hand Book (Q.P 9.1) and (Figure 9.1-1)
2. Operator Training Log Sheet (Form 18.1-1)
3. Job Assignment Category Sheet (Figure 18.1-2)
4. Production Training (WI 18.10)

4.0 Definitions:

Trainee: A person with little or no previous steel processing experience. Success completion of training is mandatory for continued employment and advancement to J2 status. Training must be completed by 180 days from hire date.

Journeyman 2: A person who has completed preliminary training and is qualified to perform all basic tasks associated with the given work area. Additional training and demonstration of skills required to achieve J1 status and pay. Subject to semi-annual review.

Journeyman 1: A person who has experience and has demonstrated proficiency in the given work area. Additional training and demonstration of skills required to achieve Master status and pay. Subject to semi-annual review.

Master: A person very skilled and able in a work area. A craftsman able to work an area independently. Subject to semi-annual review.

Work Area: See job assignment category sheet 18.1-3

Supervisors Group: A group assigned by the Production Manager, usually including Shop Supervisors and Production Managers.

5.0 Procedures:

Step 1: Assign job

Step 2: Record on log sheet (Form 18.1-1)

Step 3: Assign Trainer

Note: This must be a Shop Supervisor or Master

PROCEDURE	QP 18.1
Subject: **Production Operator Training and Certification**	Issued 9/6/95
	Revision:
	Approval:

Step 4: Hand out Operator Hand Book Check List for Job Assigned (see Figure 9.1-1)

Step 5 Wait for completion of Training

Step 6: Verify completion of check list

Step 7: Determine if person in Class 4 or 5 has previously achieved J1 status
Note: If yes, go to Step 15; if no, go to Step 8

Step 8: Record completion on Log Sheet (Form 18.1-1), and file in Shop Office file.

Step 9: Determine if person will seek next level
Note: If no, go to Step 20; if yes, go to Step 10.

Step 10: Record training start date (Form 18.1)

Step 11: Assign Trainer

Step 12: Hand out Operator Hand Book Check List

Step 13: Wait for completion of training

Step 14: Receive completed check list with Supervisor recommendation.

Step 15: Hold vote at Supervisor's group meeting

Step 16: Determine vote outcome
Note: Note outcome on Form 18.1. If no, then go to Step 13; if yes, go to Step 17.

Step 17: Record on Log Sheet

Step 18: Send copy of Log Sheet to Payroll to serve as Notice to Change Pay. File all notes from Check List in Shop Office files.

Step 19: Determine if person will seek next level
Note: If yes, repeat Step 10 - 18. If no, go to Step 20.

PROCEDURE

	QP 18.1
Subject: **Production Operator Training and Certification**	Issued 9/6/95
	Revision:
	Approval

Step 20: Monitor performance

Step 21: Perform semi-annual review
Note: This includes completion of O.H.B. Check List

Step 22: Receive Supervisor's recommendation for Recertification

Step 23: Hold vote at Supervisor's group meeting

Step 24: Determine vote outcome
Note: If yes, go to Step 26; if no, go to Step 25

Step 25: Record on Log Sheet, and send copy of review and Log Sheet to Payroll to serve as Notice to Reduce pay. Go to Step 20

Step 26: Record on log

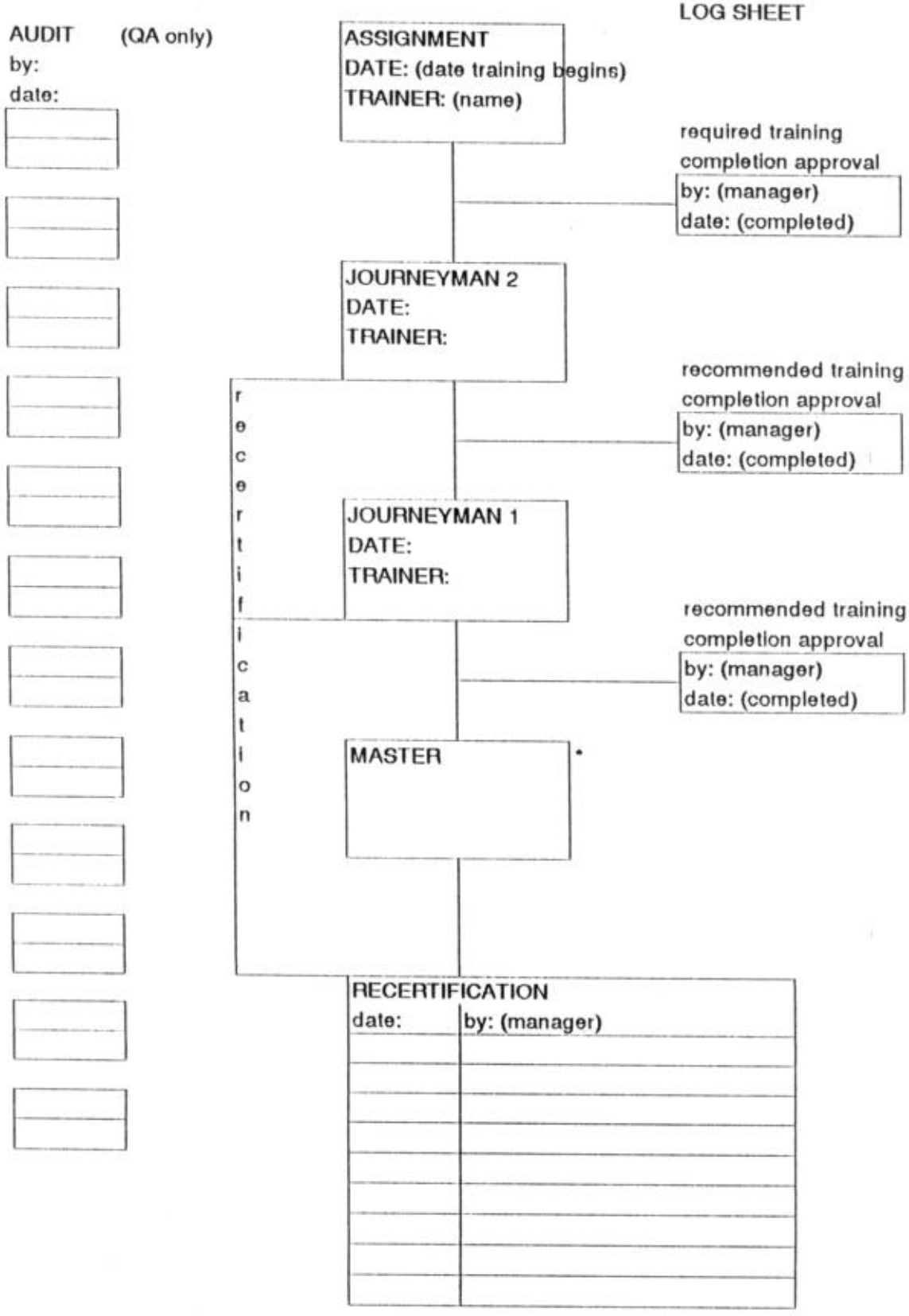
Step 27: Repeat Steps 20- 24

(Instructions for)
FORM 18.1-1
OPERATOR TRAINING
LOG SHEET

NAME (first , middle, last)

JOB FUNCTION (see figure 18.1-2)

AUDIT (QA only)
by:
date:



* Job class 4 & 5 must complete a total of 3 training cycles from 2 subgroups to acheive master status.

Columbus, Ohio 43216
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Wats: 1-800-326-0327
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BROWN STEEL DIVISION OF LAPHAM-HICKEY STEEL CORP.

P.O. BOX 16505
COLUMBUS, OHIO 43216

PRODUCT LINES

BROWN STEEL FINGERTIP STOCK GUIDE

STRUCTURAL SHAPES, BAR SHAPES, TUBING

S SHAPES
(I-Beams)
ASTM A-36
Stock Lengths 20'-40'

W SHAPES
(Wide Flange)
ASTM A-36
Stock Lengths 20'-40'

M SHAPES
(Junior Beams)
A-36
Stock Lengths 20'-40'

C SHAPES
American Standard Channels
ASTM A-36
Stock Lengths 20'-40'

MC SHAPES
A-36
Stock Lengths 20'-40'

C SHAPES
Bar Sizes
M-1020

ANGLES-L SHAPES
Equal and Unequal Legs
ASTM A-36

L-SHAPES, BAR SIZES
M-1020
All Other A-36

HOT DIP GALVANIZED ANGLE
Stock Length 20'

SQUARE/RECTANGULAR STRUCTURAL TUBING
Stock Lengths 20'-40'
Hi Y 50 and Handrail Pipe

PLATES

PLATES
A-36 & A-572
Hot Rolled

PLATES
40 - 50 Carbon

AR-360 / 415 PLATE
Heat Treated For Maximum Abrasion and Impact Resistance

FREMAX PLATES
Fremax 45
Fremax 15
Free Machining

FLOOR PLATE

SHEETS

SHEETS
Hot Rolled
Low Carbon
Gauges
7-10-11-12-14-16

SHEETS
Hot Rolled
Pickled and Oiled
Gauges
7-10-11-12-13-14-16

SHEETS
Cold Rolled
Low Carbon
Gauges 10-11-12-14-16-18-20-22-24

GALVANIZED STEEL SHEETS
Bright Spangled
Gauges 10-12-14-16-18-20-22-24-26-28

HOT ROLLED/REINFORCING BARS

ROUNDS
Hot Rolled
Stock Length 20'

SQUARE
Hot Rolled
M-1020
Stock Length 20'

HOT ROLLED STRIP
.15 Max. Carbon
Commercial Quality
Stock Length 16'

FULLY THREADED RODS
Plain Finish
National Coarse Thread
Class 2a
Stock Lengths 3'-6'-12'

REINFORCING BARS
ASTM A-615-68 Grade
40
70,000
90,000
PSI

COLD FINISHED BARS

COLD FINISHED ROUNDS
C-1018 C-1141 C-1042 C-1215 C-12L14
Random Stock Lengths 12'-24'

HEXAGONS
Cold Finished
Random Stock Lengths 10'-12'

COLD FINISHED SQUARES
Random Stock Lengths 10'-12'

COLD FINISHED FLATS
AISI — C-1018
Stock Lengths 10'-12'

FACT DATA

LAPHAM-HICKEY STEEL CORP. • NATIONWIDE SPECIALTY STEEL SERVICE

PRODUCTS

STRIP STEEL
- Cold Rolled Strip Steel - All Tempers (Coils & Straight Lengths)
- Cold Rolled Shim Steel (Coils & Straight Lengths)
- C1005 - Widely Accepted Substitute for Electromagnet Iron (Coils & Straight Lengths)

FLAT WIRE
- Cold Rolled Round Edge Flat Wire All Tempers (Coils & Straight Lengths)

TIN COATED STRIP
- Cold Rolled Electrolytic Tin Coated Bright & Matte Finish (Coils)

BAR STEEL
- Cold Finished • Alloy & Carbon Steel Rounds - Squares - Hexagons - Flats
- Centerless Ground • Turned & Polished
- Drawn Ground & Polished
- Turned Ground & Polished • Carbon Restored
- Drill Rod • Flat Ground Stock

SPRING STEEL
- Blue Tempered & Polished
- Scaleless Blue & Black Oil Tempered
- Cold Rolled Annealed - C1050, C1075, C1095
- Cold Rolled Annealed Alloy - AISI 8617 / 8620
- Hot Rolled Floor Annealed - C1095
- Hard Cold Rolled - C1075 - C1095

• Most Diversified Spring Steel Stock in the Country •

STEEL TUBING
- Cold Drawn Seamless Mechanical
- Drawn Over Mandrel
- Cold Drawn Butt Welded
- Electric Resistance Welded Rounds - Squares - Rectangles
- Structural Tubing - Squares & Rectangles
- Cold Drawn Seamless - JIC Hydraulic
- Cold Drawn Welded - JIC Hydraulic
- Bundyweld Copper Brazed - Plain & Tin Coated (Coils & Straight Lengths)
- Bundyweld Electric Resistance Welded Plain & Tin Coated (Coils & Straight Lengths)

SHEET STEEL
- Cold Rolled Sheet Steel - All Tempers (C.& S.L)
- Hot Rolled P.& O. Sheet Steel (C.& S.L.)
- Galvanized Sheet Steel

STAINLESS STEEL
- Cold Rolled Stainless Sheets
- Cold Rolled Stainless Coils - All Tempers

EQUIPMENT CAPACITY CHICAGO PLANT

	Gauge Range Inches	Width Range Inches
SLITTERS (13)	.001/.250	.062/47.000
EDGEROLLERS (4)	.030/.250	.375/6.000
SHEARS (3)	.015/.250	.375/48.000
CUT-TO-LENGTH (3) LINES	.012/.250	To 72.000
BLANKING	.020/.134	From 12"x 12"

Lapham-Hickey Steel

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BROWN STEEL CO.

EFFECTIVE DATE 1/1/92
NUMBER 5.1.6
PAGE 1 OF 3
REVISION
APPROVED J. G. Wells

SUBJECT: Receiving inspection—special or customer material

1.0 PURPOSE

This procedure describes the method used to receive special order or customer material.

2.0 APPLICATION

This procedure applies to any material received at Brown Steel for handling or value added processing. This includes material picked up or received for a specific customer. This procedure applies to all employees involved in ordering, receiving, and selling of special products.

3.0 DEFINITIONS

3.1 Value added processing consists of heat treating, surface grinding, sawing, shearing, burning or any process that increases the value of a product.

4.0 ASSOCIATED MATERIAL

4.1 Pick up order	Figure 5.1.6-2
4.2 Brown Steel Identification Tag	Figure 5.1.6-1

5.0 PROCEDURE

5.1 The sales department is responsible for issuing a pick up order from a customer.

5.2 The purchasing department is responsible for issuing a pick up order from a supplier.

5.3 A pick up order (figure 5.1.6-1) is completed as follows (1) the name of the person issuing the pickup order, (2) the date issued, (3) the shop order number, (4) purchase order or the invoice number (For material returned for credit), (5) the name and address for pickup, (6) customer name & address (not required), (7) (8) (9) accurate description of material being picked up, (10) stock, NCMR number, pick up & return, or pick up and deliver.

5.4 The receiving supervisor is responsible for assuring proper disposition of special or customer material.

5.5 The shop supervisor is responsible for receiving inspection.

5.6 Material to be resold is labeled with a Brown Steel "identification tag" (Figure 5.1.6-1) as follows: on front (1) customer name (2) shop order number, and on back, a neat and accurate description of the bundle content.

5.7 The shop supervisor and area personnel are responsible for assuring the accuracy of all receiving documents. This includes piece counts, tag comparisons, heat numbers and color codes.

5.8 Customer material held by Brown Steel is subject to the same receiving inspection as like material received for Brown Steel stock.

5.9 Customer material is clearly marked and stored separately from regular inventory.

5.10 Special order material is placed in staging area.

BROWN STEEL DIVISION
DIVISION OF LAPHAM-HICKEY STEEL
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753 MARION ROAD
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TEL. NO. (614) 443-4881
FAX NO. (614) 443-6371

SALESPERSON: (1)

DATE : (2)

S.O. # : (3)

INVOICE # : (4)

PICK UP ORDER ONLY

PICK UP AT: _____

(5)

CUSTOMER : _____

(6)

QUANTITY	DESCRIPTION	WEIGHT	REASON FOR RETURN AND OR DISPOSITION OF MATERIAL
(7)	(8)	(9)	(10)

PICKED UP BY: _____ DATE: _____

CUSTOMER SIGNATURE: _____ DATE: _____

ALL OF THE ABOVE MATERIAL MUST BE TAGGED WITH CUSTOMER NAME AND SHOP ORDER NUMBER.

Figure 5.1.6-1 Pick Up Order

UNR-Leavitt ASTM A500 Structural Tubing "ONLY"

2

TENSILE REQUIREMENTS

	Round Structural Tubing		Shaped Structural Tubing	
	Grade B	Grade C	Grade B	Grade C
Tensil Strength, min, psi (MPa)	58,000 (400)	62,000 (427)	58,000 (400)	62,000 (427)
Yield Strength min, psi (MPa)	42,000 (290)	46,000 (317)	46,000 (317)	50,000 (345)
Elongation in 2 in. (50.8mm) min, %	23 [A]	21 [B]	23 [A]	21 [B]

[A] Applies to specified wall thicknesses 0.180 in. (4.57 mm) and over. For wall thicknesses under 0.180 in., the minimum elongation shall be calculated by the formula: percent elongation in 2 in. = $61t + 12$.

[B] Applies to specified wall thicknesses 0.120 in. (3.05 mm) and over. For lighter wall thicknesses, elongation shall be by agreement with the manufacturer.

ASTM A500 Grade Structural Tubing—O.D. sizes & wall thicknesses — ROUNDS

OUTSIDE DIAMETER		NOMINAL WALL THICKNESS																					
						1/8				3/16				1/4			5/16		3/8			1/2	
Decimal	Fraction	.072 15 Ga.	.083 14 Ga.	.095 13 Ga.	.109 12 Ga.	.120 11 Ga.	.134 10 Ga.	.148 9 Ga.	.165 8 Ga.	.188 7 Ga.	.203 6 Ga.	.220 5 Ga.	.237 4 Ga.	.250 —	.277 —	.280 —	.313 —	.322 —	.375 —	.406 —	.432 —	.500 —	O D Decimal
2.875	2⅞	2.16	2.48	2.82	3.22	3.53	3.92	4.31	4.78	5.40	5.79	6.24	6.68	7.01									2.875
3.000	3	2.25	2.59	2.95	3.37	3.69	4.10	4.51	5.00	5.65	6.06	6.53	6.99	7.34									3.000
3.500	3½	2.64	3.03	3.45	3.95	4.33	4.82	5.30	5.88	6.65	7.15	7.71	8.26	8.68									3.500
4.000	4	3.02	3.47	3.96	4.53	4.97	5.53	6.09	6.76	7.65	8.23	8.88	9.52	10.01	11.01	11.12	12.33	12.65	14.52				4.000
4.500	4½		3.92	4.47	5.11	5.61	6.25	6.88	7.64	8.66	9.32	10.06	10.79	11.35	12.49	12.62	14.00	14.37	16.52	17.75	18.77	21.36	4.500
5.000	5		4.36	4.98	5.69	6.25	6.96	7.67	8.52	9.66	10.40	11.23	12.06	12.68	13.97	14.11	15.67	16.09	18.52	19.92	21.08	24.03	5.000
5.500	5½									10.67	11.48	12.41	13.32	14.02	15.45	15.61	17.34	17.81	20.53	22.09	23.38	26.70	5.500
5.563	5 9/16									10.79	11.62	12.55	13.48	14.19	15.64	15.80	17.55	18.02	20.78	22.36	23.67	27.04	5.563
6.000	6									11.67	12.57	13.58	14.59	15.35	16.93	17.11	19.01	19.53	22.53	24.26	25.69	29.37	6.000
6.625	6⅝									12.92	13.92	15.05	16.17	17.02	18.78	18.97	21.10	21.68	25.03	26.97	28.57	32.71	6.625
7.000	7									13.68	14.74	15.93	17.12	18.02	19.89	20.10	22.35	22.97	26.53	28.59	30.30	34.71	7.000
7.625	7⅝									14.93	16.09	17.40	18.70	19.69	21.74	21.96	24.44	25.11	29.04	31.30	33.19	38.05	7.625
8.625	8⅝									16.94	18.26	19.75	21.23	22.36	24.70	24.95	27.79	28.55	33.04	35.64	37.80	43.39	8.625
9.625	9⅝									18.95	20.43	22.10	23.76	25.03	27.65	27.95	31.13	31.99	37.05	39.97	42.41	48.73	9.625
10.75	10¾									21.21	22.87	24.74	26.61	28.04	30.98	31.31	34.89	35.86	41.55	44.85	47.60	54.74	10.75
11.75	11¾									23.21	25.03	27.09	29.14	30.71	33.94	34.30	38.23	39.30	45.56	49.19	52.22	60.08	11.75
12.75	12¾									25.22	27.20	29.44	31.67	33.38	36.90	37.29	41.57	42.74	49.56	53.52	56.83	65.42	12.75

ASTM A500 Grade Structural Tubing—O.D. sizes & wall thicknesses — SQUARE & RECTANGULAR

OUTSIDE DIAMETER			NOMINAL WALL THICKNESS														
SQUARES	RECTANGLES		.072" 15 Ga.	.083" 14 Ga.	.095" 13 Ga.	.109" 12 Ga.	1/8"	.134" 10 Ga.	.148" 9 Ga.	.165" 8 Ga.	3/16"	.203" 6 Ga.	.220" 5 Ga.	1/4"	5/16"	3/8"	1/2"
1-1/2 x 1-1/2								2.33	2.53	2.76	3.04						
2 x 2	1 x 3	1-1/2 x 2-1/2	1.89	2.16	2.46	2.80	3.07	3.25	3.54	3.88	4.32	4.60	4.91	5.41			
	2-1/16 x 2-1/8		1.94	2.21	2.51	2.84	3.21	3.42	3.73	4.09	4.56	4.86	5.19	5.73			
2-1/8 x 2-1/8	1-1/4 x 3		1.97	2.25	2.55	2.89	3.27	3.47	3.79	4.16							
2.17 x 2.17			2.01	2.30	2.60	2.95	3.34	3.56	3.88	4.26	4.75	5.07	5.42	5.99			
	1-1/2 x 3		2.09	2.39	2.71	3.07	3.48	3.70	4.04	4.44	4.96	5.29	5.65	6.26			
2-1/2 x 2-1/2	1-1/2 x 3-1/2	2 x 3	2.33	2.67	3.03	3.44	3.90	4.16	4.55	5.01	5.59	5.99	6.40	7.11			
	2-1/2 x 3			2.95	3.35	3.81	4.33	4.61	5.05	5.57	6.23	6.68	7.15	7.96			
3 x 3	2 x 4	2-1/2 x 3-1/2		3.24	3.68	4.19	4.75	5.07	5.55	6.13	6.87	7.37	7.90	8.81			
	2 x 4-1/2			3.52	4.00	4.56	5.18	5.53	6.06	6.69	7.51	8.06	8.65	9.66			
3-1/2 x 3-1/2	2 x 5	3 x 4		3.80	4.32	4.93	5.61	5.98	6.56	7.25	8.15	8.75	9.40	10.51			
4 x 4	2 x 6	3 x 5		4.36	4.97	5.67	6.46	6.89	7.57	8.37	9.42	10.13	10.89	12.21	14.83	17.27	21.63
4-1/2 x 4-1/2	3 x 6										10.70	11.51	12.39	13.91	16.95	19.82	25.03
5 x 5	3 x 7	4 x 6									11.97	12.89	13.89	15.62	19.08	22.37	28.43
5-1/2 x 5-1/2	3 x 8	4 x 7									13.25	14.27	15.39	17.32	21.21	24.93	31.84
6 x 6	4 x 8	5 x 7									14.53	15.66	16.88	19.02	23.34	27.48	35.24
7 x 7	4 x 10	6 x 8									17.08	18.42	19.88	22.42	27.59	32.58	42.05
8 x 8	4 x 12	6 x 10									19.63	21.18	22.87	25.82	31.84	37.69	48.85
9 x 9	6 x 12	8 x 10									22.18	23.95	25.87	29.23	36.10	42.79	55.66
10 x 10	8 x 12										24.73	26.71	28.86	32.63	40.35	47.90	62.46

This table is based on commonly used sizes. Other sizes are within UNR-Leavitt's production capabilities. We invite your inquiry.

UNR-Leavitt

puts extra quality in Structural Tubing

Material

Carefully controlled steel, purchased directly from mill sources is used by UNR-Leavitt when manufacturing Structural Tubing. The chemical limits table, top right, indicates relatively low carbon content which offers excellent weld penetration, cold formability and excellent finish.

Slitting

Under our complete control at all times. Slitting of mill coils is accomplished on our precision in-house slitting equipment. Coils are selected from our on-hand raw steel inventory.

Forming and Welding

Flat, slit coil is gradually and progressively formed into a tubular shape as it enters the welder. The steel edges are then uniformly fused by our electric resistance high frequency welding process to produce the highest quality tube. This method provides a homogenous high strength weld.

Sizing and Shaping

With our in-line continuous system, the welded tube then moves through a cooling bath and then a set of sizing rolls which cold work it down to the desired finish diameter. For square or rectangular tubing, the sizing section is fitted with special rolls which progressively shape the round tube into the desired configuration.

End Finishing and Cutting

Tubes are cut to any practical length up to a plant maximum of 80' by either flying saw-cut or punch cutting. Ends can be finished by dedimpling and/or deburring depending on size, gauge, and customer requirements.

ASTM A500 TABLES

CHEMICAL REQUIREMENTS

Element	Composition, Percent	
	Heat Analysis	Product Analysis
Carbon, Max.	0.26	0.30
Maganese, Max.	—	—
Phosphorus, Max.	0.04	0.05
Sulfur, Max.	0.05	0.063
Copper, when copper steel is specified, min.	0.20	0.18

Specified Mill Length Tolerances for Round, Square and Rectangular Structural Tubing

	22 ft. (6.7m) and Under		Over 22 ft. to 44 ft. (6.7 to 13.4m), incl.	
	Over	Under	Over	Under
Length Tolerance for specified mill length, in.(mm)	½" (12.7)	¼" (6.4)	¾" (19.0)	¼" (6.4)

Outside Dimension Tolerances for Square and Rectangular Structural Tubing

Largest Outside Dimension, across flats, in. (mm)	Tolerance,* plus and minus in. (mm)
2½" (63.5) and under	0.020 (0.51)
Over 2½" to 3½" (63.5 to 88.9), incl.	0.025 (0.64)
Over 3½" to 5½" (88.9 to 139.7), incl.	0.030 (0.76)
Over 5½" (139.7)	± 1%

*Tolerances include allowance for convexity or concavity. For rectangular sections, the tolerance calculated for the larger flat dimension shall also apply to the smaller flat dimension. This tolerance may be increased 50 percent when applied to the smaller dimension, if the ratio of cross-sectional dimensions is between 1.5 and 3, and 100 percent when the ratio exceeds 3.

Note: Must be measured at least 2" in from either end of the tubing.

CORNER RADIUS:
Sizes: Max. = 3 x normal wall thickness

STRAIGHTNESS:
Sizes: Max. = .025" per ft.

SQUARENESS OF SIDES:
Adjacent sides may deviate from 90° by a tolerance of ± 2° max.

ELONGATION

Wall Thickness in. (mm)	Elongation in 2 in. (50.8 mm) min. %	
	Grade B	Grade C
0.180 (4.57) and over	23	21
0.165 (4.19)	22	21
0.148 (3.76)	21	21
0.134 (3.40)	20	21
0.120 (3.05)	19.5	21
0.109 (2.77)	19	*
0.095 (2.41)	18	*
0.083 (2.11)	17	*
0.072 (1.83)	16.5	*

*Inquire With Us

Twist Tolerances for Square and Rectangular Structural Tubing

Specified Dimension of Longest Side, in. (mm)	Maximum Twist in 3 ft., in.	Maximum Twist in 1 m, mm
½" (38.1) and under	0.050	1.39
Over 1½" to 2½" (38.1 to 63.5), incl.	0.062	1.72
Over 2½" to 4" (63.5 to 101.6), incl.	0.075	2.09
Over 4" to 6" (101.6 to 152.4), incl.	0.087	2.42
Over 6" to 8" (152.4 to 203.2), incl.	0.100	2.78
Over 8" (203)	0.112	3.11

Outside Dimension Tolerances for Round Structural Tubing

O.D. Range	Tolerance in % of Specified O.D.
1.900" and Smaller	± .5%
2.000" and Larger	± .75%

Note: Outside diameter measurements must be made at least 2" in from either end of the tubing.

SPECIFICATION (AASHTO)	A36 (M183) (M270-36) (A709-36)	A36 (M183) (M270-36) (A709-36)	A36 (M183) (M270-36) (A709-36)	A36 (M183) (M270-36) (A709-36)	A36 (M183) (M270-36) (A709-36)	A131† Grade A	A131† Grade B
Type of Steel	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon
Requirements for Delivery	A6	A6	A6	A6	A6	A6	A6
Tensile Strength (ksi)	58/80	58/80	58/80	58/80	58/80	58/71 55/65 when ordered for cold flanging	58/71 55/65 when ordered for cold flanging
Yield Strength (Min. ksi) (Yield Point if designated YP)	36 YP	36 YP	36 YP	36 YP	36 YP over 4-8" incl.; 32 over 8" incl.	34 YP 1" and under; 32 YP over 1"; 30 when ordered for cold flanging	34 YP 30 when ordered for cold flanging
Spec. Thickness (Max. in.)	3/4	1 1/2	2 1/2	4	over 4	2	2
Lukens Thickness (Max. in.)	3/4	1 1/2	2 1/2	4	18	2	2
Chemical Composition (%) Carbon (Max.)	.25	.25	.26	.27	.29	.26 to 1/2" incl.; .23 over 1 1/2-2"	.21
Manganese	-	.80/1.20	.80/1.20	.85/1.20	.85/1.20	2 1/2 x C	.80/1.10; May be .60/1.10 when cold flanged or Si is .10 Min.*
Phosphorus (Max.)	.04	.04	.04	.04	.04	.05	.04
Sulfur (Max.)	.05	.05	.05	.05	.05	.05	.04
Silicon	-	-	.15/.40	.15/.40	.15/.40	-	.35 Max.
Chromium	-	-	-	-	-	-	-
Nickel	-	-	-	-	-	-	-
Molybdenum	-	-	-	-	-	-	-
Copper	.20 Min. when specified	.20 Min. when specified	.20 Min. when specified	.20 Min. when specified	.20 Min. when specified	-	-
Other Elements	-	-	-	-	-	-	-
Heat Treatment Required	-	-	-	-	-	-	-

*The upper limit of manganese may be exceeded up to 1.65 provided carbon plus 1/6 of manganese content does not exceed .40.

†Equivalent to ABS Grades.

SPECIFICATION (AASHTO)	A36 (M183) (M270-36) (A709-36)	A36 (M183) (M270-36) (A709-36)	A36 (M183) (M270-36) (A709-36)	A36 (M183) (M270-36) (A709-36)	A36 (M183) (M270-36) (A709-36)	A131† Grade A	A131† Grade B
Type of Steel	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon
Requirements for Delivery	A6	A6	A6	A6	A6	A6	A6
Tensile Strength (ksi)	58/80	58/80	58/80	58/80	58/80	58/71 55/65 when ordered for cold flanging	58/71 55/65 when ordered for cold flanging
Yield Strength (Min. ksi) (Yield Point if designated YP)	36 YP	36 YP	36 YP	36 YP	36 YP over 4-8" incl.; 32 over 8" incl.	34 YP 1" and under; 32 YP over 1"; 30 when ordered for cold flanging	34 YP 30 when ordered for cold flanging
Spec. Thickness (Max. in.)	3/4	1 1/2	2 1/2	4	over 4	2	2
Lukens Thickness (Max. in.)	3/4	1 1/2	2 1/2	4	18	2	2
Chemical Composition (%) Carbon (Max.)	.25	.25	.26	.27	.29	.26 to 1/2" incl.; .23 over 1 1/2-2"	.21
Manganese	-	.80/1.20	.80/1.20	.85/1.20	.85/1.20	2 1/2 x C	.80/1.10; May be .60/1.10 when cold flanged or Si is .10 Min.*
Phosphorus (Max.)	.04	.04	.04	.04	.04	.05	.04
Sulfur (Max.)	.05	.05	.05	.05	.05	.05	.04
Silicon	-	-	.15/.40	.15/.40	.15/.40	-	.35 Max.
Chromium	-	-	-	-	-	-	-
Nickel	-	-	-	-	-	-	-
Molybdenum	-	-	-	-	-	-	-
Copper	.20 Min. when specified	.20 Min. when specified	.20 Min. when specified	.20 Min. when specified	.20 Min. when specified	-	-
Other Elements	-	-	-	-	-	-	-
Heat Treatment Required	-	-	-	-	-	-	-

*The upper limit of manganese may be exceeded up to 1.65 provided carbon plus 1/6 of manganese content does not exceed .40.

†Equivalent to ABS Grades.

PINGEL DESIGN GROUP

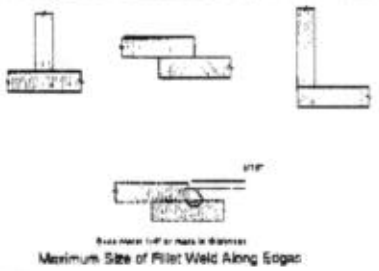
Welding Procedure Specification

PDG-2

WPS No. PDG-2 Date 10/22/2002 By MJC Type Manual ☐ Machine ☐
Authorized By _____ Date 10/22/2002 Revision 0 Semi-Auto ☒ Auto ☐
Welding Process(es) FCAW _____ Prequalified ☒
Supporting PQR(s) _____

JOINT

Type Lap, Corner and T-Joint
Backing Yes ☐ No ☐ Single Weld ☒ Double Weld ☐
Backing Material _____
Root Opening _____ Root Face Dimension _____
Groove Angle _____ Radius (J-U) _____
Back Gouge Yes ☐ No ☐
Method _____



BASE METALS

Material Spec. ASTM A36 to ASTM A36
Type or Grade _____ to _____
Thickness: Groove ( ) _____ - _____
Fillet (in) 0.125 - Unlimited
Diameter (Pipe,) _____ - _____

FILLER METALS

AWS Specification A5.20 _____
AWS Classification E71T-1 _____
_____ _____

SHIELDING

Flux _____
Electrode-Flux (Class) _____
Gas Argon/C02
Composition 75%/25%
Flow Rate 30 CFH
Gas Cup Size 5/8"

PREHEAT

Preheat Temp., Min. see table
Thickness Up to 3/4" Temperature 32 F
Over 3/4" to 1-1/2" 60 F
Over 1-1/2" to 2-1/2" 150 F
Over 2-1/2" 225 F
Interpass Temp., Min. see table Max. 450 F

POSITION

Position of Groove _____ Fillet All
Vertical Progression: ☒ Up ☐ Down

ELECTRICAL CHARACTERISTICS

Transfer Mode (GMAW):
Short-Circuiting ☐ Globular ☐ Spray ☐
Current: AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐
Other _____
Tungsten Electrode (GTAW):
Size _____ Type _____

TECHNIQUE

Stringer or Weave Bead Stringer
Multi-pass or Single Pass (per side) Single
Number of Electrodes 1
Electrode Spacing: Longitudinal _____
Lateral _____
Angle _____
Contact Tube to Work Distance 3/4"
Peening NONE
Interpass Cleaning N/A

POSTWELD HEAT TREATMENT PWHT Required ☐
Temp. _____ Time _____

WELDING PROCEDURE

Layer/Pass	Process	Filler Metal Class	Diameter	Cur. Type	Amps or WFS	Volts	Travel Speed	Other Notes
1	FCAW	E71T-1	0.045"	DCEP	165-195	27-31	6-9 ipm	5/16" fillet weld

PINGEL DESIGN GROUP

Welding Procedure Specification

PDG-3

WPS No. PDG-3 Date 10/22/2002 By MJC Type Manual ☐ Machine ☐

Authorized By _____ Date _____ Revision 0 Semi-Auto ☒ Auto ☐

Welding Process(es) FCAW _____ Prequalified ☒

Supporting PQR(s) _____

JOINT

Type Butt

Backing Yes ☒ No ☐ Single Weld ☒ Double Weld ☐

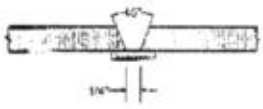
Backing Material ASTM A36

Root Opening 1/4 " Root Face Dimension 0

Groove Angle 45 DEG Radius (J-U) _____

Back Gouge Yes ☐ No ☒

Method _____



BASE METALS

Material Spec. ASTM A36 to ASTM A36

Type or Grade _____ to _____

Thickness: Groove (in) 0.125 - 0.75

Fillet ( ) _____ - _____

Diameter (Pipe,) _____ - _____

FILLER METALS

AWS Specification A5.20 _____

AWS Classification E71T-1 _____

_____ _____

SHIELDING

Flux _____

Electrode-Flux (Class) _____

Gas Argon/CO2

Composition 75%/25%

Flow Rate 30 CFH

Gas Cup Size 5/8 "

PREHEAT

Preheat Temp., Min. 32 F

Thickness Up to 3/4" Temperature 32 F

Over 3/4" to 1-1/2" _____

Over 1-1/2" to 2-1/2" _____

Over 2-1/2" _____

Interpass Temp., Min. 32 F Max. 450 F

POSITION

Position of Groove ALL Fillet _____

Vertical Progression: ☒ Up ☐ Down

ELECTRICAL CHARACTERISTICS

Transfer Mode (GMAW):

Short-Circuiting ☐ Globular ☐ Spray ☐

Current: AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐

Other _____

Tungsten Electrode (GTAW):

Size _____ Type _____

TECHNIQUE

Stringer or Weave Bead Stringer

Multi-pass or Single Pass (per side) Multiple

Number of Electrodes 1

Electrode Spacing: Longitudinal _____

Lateral _____

Angle _____

Contact Tube to Work Distance 3/4"

Peening NONE

Interpass Cleaning GRINDER &/OR WIRE BRUSH

POSTWELD HEAT TREATMENT PWHT Required ☐

Temp. _____ Time _____

WELDING PROCEDURE

Layer/Pass	Process	Filler Metal Class	Diameter	Cur. Type	Amps or WFS	Volts	Travel Speed	Other Notes
ALL	FCAW	E71T-1	0.045"	DCEP	165-195	27-31	5-12 ipm	

PINGEL DESIGN GROUP

Welding Procedure Specification

PDG-4

WPS No. PDG-4 Date 10/22/2002 By MJC Type Manual ☐ Machine ☐

Authorized By _____ Date _____ Revision 0 Semi-Auto ☒ Auto ☐

Welding Process(es) FCAW _____ _____ Prequalified ☒

Supporting PQR(s) _____ _____ _____ _____

JOINT

Type Butt,Corner, or T-Joint

Backing Yes ☐ No ☐ Single Weld ☒ Double Weld ☐

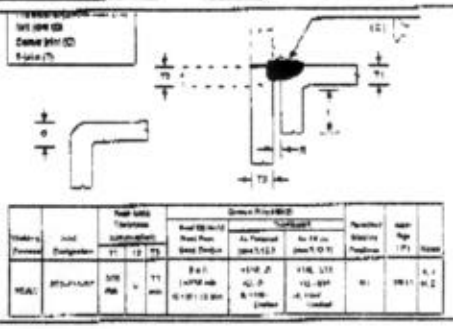
Backing Material _____

Root Opening 0 Root Face Dimension 3/16" MIN

Groove Angle _____ Radius (J-U) _____

Back Gouge Yes ☐ No ☒

Method _____



BASE METALS

Material Spec. ASTM A36 to ASTM A36

Type or Grade _____ to _____

Thickness: Groove (In) 0.1875 - 0.75

Fillet ( ) _____ - _____

Diameter (Pipe,) _____ - _____

FILLER METALS

AWS Specification A5.20 _____

AWS Classification E71T-1 _____

_____ _____

SHIELDING

Flux _____

Electrode-Flux (Class) _____

Gas Argon/CO2

Composition 75%/25%

Flow Rate 30 CFH

Gas Cup Size 5/8"

PREHEAT

Preheat Temp., Min. 32 F

Thickness Up to 3/4" Temperature 32 F

Over 3/4" to 1-1/2" _____

Over 1-1/2" to 2-1/2" _____

Over 2-1/2" _____

Interpass Temp., Min. 32 F Max. 450 F

POSITION

Position of Groove ALL Fillet _____

Vertical Progression: ☒ Up ☐ Down

ELECTRICAL CHARACTERISTICS

Transfer Mode (GMAW):

Short-Circuiting ☐ Globular ☐ Spray ☐

Current AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐

Other _____

Tungsten Electrode (GTAW):

Size _____ Type _____

TECHNIQUE

Stringer or Weave Bead Stringer

Multi-pass or Single Pass (per side) Multiple

Number of Electrodes 1

Electrode Spacing: Longitudinal _____

Lateral _____

Angle _____

Contact Tube to Work Distance 3/4"

Peening NONE

Interpass Cleaning GRINDER &/OR WIRE BRUSH

POSTWELD HEAT TREATMENT

PWHT Required ☐

Temp. _____ Time _____

WELDING PROCEDURE

Layer/Pass	Process	Filler Metal Class	Diameter	Cur. Type	Amps or WFS	Volts	Travel Speed	Other Notes
ALL	FCAW	E71T-1	0.045"	DCEP	165-195	27-31	5-12 ipm	

PINGEL DESIGN GROUP

Welding Procedure Specification

PDG-1

WPS No. PDG-1 Date 1/29/2002 By MJC Type Manual ☐ Machine ☐

Authorized By _____ Date _____ Revision 0 Semi-Auto ☒ Auto ☐

Welding Process(es) GMAW _____ Prequalified ☒

Supporting PQR(s) N/A-PREQUALIFIED _____ _____ _____

JOINT

Type Butt

Backing Yes ☒ No ☐ Single Weld ☒ Double Weld ☐

Backing Material ASTM A36

Root Opening 1/4 " Root Face Dimension 0

Groove Angle 45 DEG Radius (J-U) _____

Back Gouge Yes ☐ No ☒

Method _____

BASE METALS

Material Spec. ASTM A36 to ASTM A36

Type or Grade _____ to _____

Thickness: Groove (in) 0.375 - 0.375

Fillet ( ) _____ - _____

Diameter (Pipe,) _____ - _____

FILLER METALS

AWS Specification A5.18 _____

AWS Classification ER70S-3 _____

_____ _____

SHIELDING

Flux _____

Electrode-Flux (Class) _____

Gas Argon/CO2

Composition 75%/25%

Flow Rate 25 CFH

Gas Cup Size 5/8 "

PREHEAT

Preheat Temp., Min. 50 F

Thickness Up to 3/4" Temperature 50 F

Over 3/4" to 1-1/2" _____

Over 1-1/2" to 2-1/2" _____

Over 2-1/2" _____

Interpass Temp., Min. 50 F Max. 450 F

POSITION

Position of Groove Flat Fillet _____

Vertical Progression: ☐ Up ☐ Down

ELECTRICAL CHARACTERISTICS

Transfer Mode (GMAW):

Short-Circuiting ☐ Globular ☐ Spray ☒

Current: AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐

Other _____

Tungsten Electrode (GTAW):

Size _____ Type _____

TECHNIQUE

Stringer or Weave Bead Stringer

Multi-pass or Single Pass (per side) Multiple

Number of Electrodes 1

Electrode Spacing: Longitudinal _____

Lateral _____

Angle _____

Contact Tube to Work Distance 3/4"

Peening NONE

Interpass Cleaning GRINDER &/OR WIRE BRUSH

POSTWELD HEAT TREATMENT

PWHT Required ☐

Temp. _____ Time _____

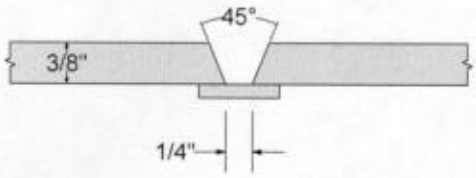
WELDING PROCEDURE

Layer/Pass	Process	Filler Metal Class	Diameter	Cur. Type	Amps or WFS	Volts	Travel Speed	Other Notes
ALL	GMAW	ER70S-3	0.030	DCEP	160/420	27	7-14 IPM	
OR								
ALL	GMAW	ER70S-3	0.035	DCEP	175/310	27	7-14 IPM	

PINGEL DESIGN GROUP

Welding Procedure Specification

PDG-1



MEMO

1) MAXIMUM ROOT PASS THICKNESS: 5/16 ".
2) MAXIMUM FILL PASS THICKNESS: 1/4".

PINGEL DESIGN GROUP

Welder Qualification Test Record

SS# 283-72-7594

WQTR No. SS# 283-72-7594 Welder Name BRIAN SCOTT Welder Id 283-72-7594

WPS No. PDG-3 Revision 0 Date 10/28/2002

Variables	Record Actual Values Used In Qualification	Qualification Range
Process (Table 4.10, Item (1))	FCAW	FCAW
Transfer Mode (GMAW):	Short-Cir. ☐ Globular ☐ Spray ☐	Short-Circuiting ☐ Globular ☐ Spray ☐
Type	Manual ☐ Machine ☐ Semi-Auto ☒ Auto ☐	Manual ☐ Machine ☐ Semi-Auto ☒ Auto ☐
Number of Electrodes	Single ☐ Multiple ☐	Single ☐ Multiple ☐
Current/Polarity	AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐	AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐
Position (Table 4.10, Item (4))	Overhead	Flat, Overhead
Weld Progression: (Table 4.10, Item (6))	Up ☐ Down ☒	Up ☐ Down ☒
Backing [Table 4.10, Item (7)]	Use Backing ☒	With Backing ☒ Without Backing ☐
Consumable Insert (GTAW)	Use Insert ☐	With Insert ☐ Without Insert ☐
Material/Spec.	ASTM A36 to ASTM A36	
Thickness (Plate): Groove (in)	0.375	0.125 - 0.75 in
Fillet ( )		0.125 - Unlimited in
Thickness (Pipe/tube): Groove ( )		-
Fillet ( )		-
Diameter(Pipe): Groove ( )		-
Fillet ( )		-
Notes		
Filler Metal (Table 10, Item (2))		
Spec.	A5.20	
Class.	E71T-1	
F-No.		
Gas/Flux Type (Table 4.10, Item (3))	Argon/CO2	
Other		

VISUAL INSPECTION (4.8.1) Acceptable Yes

AWS QC 1 ANDREW J. Mc GOLDRICK 09110711 CWI

GUIDED BEND TEST RESULTS (4.30.5)

Type	Result	Type	Result
FACE	ACCEPTABLE	ROOT	ACCEPTABLE

Fillet Test Results (4.30.2.3 and 4.30.4.1)

Appearance Fillet Size Macroetch

Fracture Test Root Penetration Description

Inspected By Andrew J. McGoldrick Test No. 61238.003 Organization MJC Date 1/27/2003

RADIOGRAPHIC TEST RESULTS (4.30.3.1)

Film Identification No.	Result	Remark

Interpreted By

Organization

Test No.

Date

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of section 4 of ANSI/AWS D1.1, (02) Structural Welding Code-Steel.

Manufacturer PINGEL DESIGN GROUP Authorized By Date

PINGEL DESIGN GROUP

Welder Qualification Test Record

SS# 283-72-7594

WQTR No. SS# 283-72-7594 Welder Name BRIAN SCOTT Welder Id 283-72-7594

WPS No. PDG-3 Revision 0 Date 10/28/2002

Variables	Record Actual Values Used In Qualification	Qualification Range
Process (Table 4.10, Item (1))	FCAW	FCAW
Transfer Mode (GMAW):	Short-Cir. ☐ Globular ☐ Spray ☐	Short-Circuiting ☐ Globular ☐ Spray ☐
Type	Manual ☐ Machine ☐ Semi-Auto ☒ Auto ☐	Manual ☐ Machine ☐ Semi-Auto ☐ Auto ☐
Number of Electrodes	Single ☐ Multiple ☐	Single ☐ Multiple ☐
Current/Polarity	AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐	AC ☐ DCEP ☐ DCEN ☐ Pulsed ☐
Position (Table 4.10, Item (4))	Vertical	Flat, Vertical, Horizontal
Weld Progression: (Table 4.10, Item (6))	Up ☒ Down ☐	Up ☒ Down ☐
Backing [Table 4.10, Item (7)]	Use Backing ☒	With Backing ☒ Without Backing ☐
Consumable Insert (GTAW)	Use Insert ☐	With Insert ☐ Without Insert ☐
Material/Spec.	ASTM A36 to ASTM A36	
Thickness (Plate): Groove (in)	0.375	0.125 - 0.75 in
Fillet ( )		0.125 - Unlimited in
Thickness (Pipe/tube): Groove ( )		-
Fillet ( )		-
Diameter(Pipe): Groove ( )		-
Fillet ( )		-
Notes		-
Filler Metal (Table 10, Item (2))		
Spec.	A5.20	
Class.	E71T-1	
F-No.		
Gas/Flux Type (Table 4.10, Item (3))	Argon/CO2	
Other		

VISUAL INSPECTION (4.8.1) Acceptable Yes

GUIDED BEND TEST RESULTS (4.30.5)

Type	Result	Type	Result
FACE	ACCEPTABLE	ROOT	ACCEPTABLE

Fillet Test Results (4.30.2.3 and 4.30.4.1)

Appearance Fillet Size Macroetch

Fracture Test Root Penetration Description

Inspected By Andrew J. McGoldrick Test No. 61238.002 Organization MJC Date 10/28/2002

RADIOGRAPHIC TEST RESULTS (4.30.3.1)

Film Identification No.	Result	Remark

Interpreted By

Organization

Test No.

Date

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of section 4 of ANSI/AWS D1.1, (02) Structural Welding Code-Steel.

Manufacturer PINGEL DESIGN GROUP Authorized By Date

PINGEL DESIGN GROUP

Welder Qualification Test Record

283-72-7594

WQTR No. 283-72-7594 Welder Name BRIAN SCOTT Welder Id 283-72-7594

WPS No. PDG-1 Revision 0 Date 1/29/2002

Variables	Record Actual Values Used In Qualification	Qualification Range
Process (Table 4.10, Item (1))	GMAW	GMAW
Transfer Mode (GMAW):	Short-Cir. ☐ Globular ☐ Spray ☒	Short-Circuiting ☐ Globular ☐ Spray ☒
Type	Manual ☐ Machine ☐ Semi-Auto ☒ Auto ☐	Manual ☐ Machine ☐ Semi-Auto ☐ Auto ☐
Number of Electrodes	Single ☒ Multiple ☐	Single ☒ Multiple ☐
Current/Polarity	AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐	AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐
Position (Table 4.10, Item (4))	Flat	
Weld Progression: (Table 4.10, Item (6))	Up ☐ Down ☐	Up ☐ Down ☐
Backing [Table 4.10, Item (7)]	Use Backing ☒	With Backing ☐ Without Backing ☐
Consumable Insert (GTAW)	Use Insert ☐	With Insert ☐ Without Insert ☐
Material/Spec.	ASTM A36 to ASTM A36	
Thickness (Plate): Groove (in)	3/8	1/8 - Unlimited in
Fillet ( )		1/8 - Unlimited in
Thickness (Pipe/tube): Groove ( )		-
Fillet ( )		-
Diameter(Pipe): Groove ( )		-
Fillet ( )		-
Notes		
Filler Metal (Table 10, Item (2))		
Spec.	A5.18	
Class.	ER70S-3	
F-No.		
Gas/Flux Type (Table 4.10, Item (3))	Argon/CO2	
Other		

VISUAL INSPECTION (4.8.1) Acceptable Yes

GUIDED BEND TEST RESULTS (4.30.5)

Type	Result	Type	Result
FACE	ACCEPTABLE		
ROOT	ACCEPTABLE		

Fillet Test Results (4.30.2.3 and 4.30.4.1)

Appearance _____ Fillet Size _____ Macroetch _____

Fracture Test Root Penetration _____ Description _____

Inspected By HOWARD SAGER Test No. 61238.001 Organization MJC Date 2/7/2002

RADIOGRAPHIC TEST RESULTS (4.30.3.1)

Film Identification No.	Result	Remark

Interpreted By _____

Organization _____

Test No. _____

Date _____

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of section 4 of ANSI/AWS D1.1, (02) Structural Welding Code-Steel.

Manufacturer PINGEL DESIGN GROUP Authorized By _____ Date _____

PINGEL DESIGN GROUP

Welder Qualification Test Record

SS# 274-50-9124

WQTR No. SS# 274-50-9124 Welder Name DOUG CRESS Welder Id 274-50-9124

WPS No. PDG-3 Revision 0 Date 10/28/2002

Variables	Record Actual Values Used In Qualification	Qualification Range
Process (Table 4.10, Item (1))	FCAW	FCAW
Transfer Mode (GMAW): Short-Cir. ☐ Globular ☐ Spray ☐		Short-Circuiting ☐ Globular ☐ Spray ☐
Type Manual ☐ Machine ☐ Semi-Auto ☒ Auto ☐		Manual ☐ Machine ☐ Semi-Auto ☒ Auto ☐
Number of Electrodes Single ☐ Multiple ☐		Single ☐ Multiple ☐
Current/Polarity AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐		AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐
Position (Table 4.10, Item (4))	Overhead	Flat, Overhead
Weld Progression: (Table 4.10, Item (6)) Up ☐ Down ☒		Up ☐ Down ☒
Backing [Table 4.10, Item (7)] Use Backing ☒		With Backing ☒ Without Backing ☐
Consumable Insert (GTAW) Use Insert ☐		With Insert ☐ Without Insert ☐
Material/Spec.	ASTM A36 to ASTM A36	
Thickness (Plate): Groove (in)	0.375	0.125 - 0.75 in
Fillet ( )		0.125 - Unlimited in
Thickness (Pipe/tube): Groove ( )		-
Fillet ( )		-
Diameter(Pipe): Groove ( )		-
Fillet ( )		-
Notes		
Filler Metal (Table 10, Item (2))		
Spec.	A5.20	
Class.	E71T-1	
F-No.		
Gas/Flux Type (Table 4.10, Item (3))	Argon/CO2	
Other		

VISUAL INSPECTION (4.8.1) Acceptable Yes

GUIDED BEND TEST RESULTS (4.30.5)

Type	Result	Type	Result
FACE	ACCEPTABLE	ROOT	ACCEPTABLE

AWS QC 1 ANDREW J. Mc GOLDRICK 99110711 CWI

Fillet Test Results (4.30.2.3 and 4.30.4.1)

Appearance Fillet Size Macroetch

Fracture Test Root Penetration Description

Inspected By Andrew J. McGoldrick Test No. 61238.003 Organization MJC Date 2/6/2003

RADIOGRAPHIC TEST RESULTS (4.30.3.1)

Film Identification No.	Result	Remark

Interpreted By

Organization

Test No.

Date

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of section 4 of ANSI/AWS D1.1, (02) Structural Welding Code-Steel.

Manufacturer PINGEL DESIGN GROUP Authorized By Date

PINGEL DESIGN GROUP

Welder Qualification Test Record

SS# 274-50-9124

WQTR No. SS# 274-50-9124 Welder Name DOUG CRESS Welder Id 274-50-9124

WPS No. PDG-3 Revision 0 Date 10/28/2002

Variables	Record Actual Values Used In Qualification	Qualification Range
Process (Table 4.10, Item (1))	FCAW	FCAW
Transfer Mode (GMAW):	Short-Cir. ☐ Globular ☐ Spray ☐	Short-Circuiting ☐ Globular ☐ Spray ☐
Type	Manual ☐ Machine ☐ Semi-Auto ☒ Auto ☐	Manual ☐ Machine ☐ Semi-Auto ☐ Auto ☐
Number of Electrodes	Single ☐ Multiple ☐	Single ☐ Multiple ☐
Current/Polarity	AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐	AC ☐ DCEP ☐ DCEN ☐ Pulsed ☐
Position (Table 4.10, Item (4))	Vertical	Flat, Vertical, Horizontal
Weld Progression: (Table 4.10, Item (6))	Up ☒ Down ☐	Up ☒ Down ☐
Backing [Table 4.10, Item (7)]	Use Backing ☒	With Backing ☒ Without Backing ☐
Consumable Insert (GTAW)	Use Insert ☐	With Insert ☐ Without Insert ☐
Material/Spec.	ASTM A36 to ASTM A36	
Thickness (Plate): Groove (in)	0.375	0.125 - 0.75 in
Fillet ( )		0.125 - Unlimited in
Thickness (Pipe/tube): Groove ( )		-
Fillet ( )		-
Diameter(Pipe): Groove ( )		-
Fillet ( )		-
Notes		-
Filler Metal (Table 10, Item (2))		
Spec.	A5.20	
Class.	E71T-1	
F-No.		
Gas/Flux Type (Table 4.10, Item (3))	Argon/CO2	
Other		

VISUAL INSPECTION (4.8.1) Acceptable Yes

GUIDED BEND TEST RESULTS (4.30.5)

Type	Result	Type	Result
FACE	ACCEPTABLE	ROOT	ACCEPTABLE

Fillet Test Results (4.30.2.3 and 4.30.4.1)

Appearance Fillet Size Macroetch

Fracture Test Root Penetration Description

Inspected By Andrew J. McGoldrick Test No. 61238.002 Organization MJC Date 10/28/2002

RADIOGRAPHIC TEST RESULTS (4.30.3.1)

Film Identification No.	Result	Remark

Interpreted By

Organization

Test No.

Date

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of section 4 of ANSI/AWS D1.1, (02) Structural Welding Code-Steel.

Manufacturer PINGEL DESIGN GROUP Authorized By Date

PINGEL DESIGN GROUP

Welder Qualification Test Record

274-50-9124

WQTR No. 274-50-9124 Welder Name DOUG CRESS Welder Id 274-50-9124

WPS No. PDG-1 Revision 0 Date 1/29/2002

Variables	Record Actual Values Used In Qualification	Qualification Range
Process (Table 4.10, Item (1))	GMAW	GMAW
Transfer Mode (GMAW):	Short-Cir. ☐ Globular ☐ Spray ☒	Short-Circuiting ☐ Globular ☐ Spray ☒
Type	Manual ☐ Machine ☐ Semi-Auto ☒ Auto ☐	Manual ☐ Machine ☐ Semi-Auto ☐ Auto ☐
Number of Electrodes	Single ☒ Multiple ☐	Single ☒ Multiple ☐
Current/Polarity	AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐	AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐
Position (Table 4.10, Item (4))	Flat	
Weld Progression: (Table 4.10, Item (6))	Up ☐ Down ☐	Up ☐ Down ☐
Backing [Table 4.10, Item (7)]	Use Backing ☒	With Backing ☐ Without Backing ☐
Consumable Insert (GTAW)	Use Insert ☐	With Insert ☐ Without Insert ☐
Material/Spec.	ASTM A36 to ASTM A36	
Thickness (Plate): Groove (in)	3/8	1/8 - Unlimited in
Fillet ( )		1/8 - Unlimited in
Thickness (Pipe/tube): Groove ( )		-
Fillet ( )		-
Diameter(Pipe): Groove ( )		-
Fillet ( )		-
Notes		-
Filler Metal (Table 10, Item (2))		
Spec.	A5.18	
Class.	ER70S-3	
F-No.		
Gas/Flux Type (Table 4.10, Item (3))	Argon/CO2	
Other		

VISUAL INSPECTION (4.8.1) Acceptable Yes

GUIDED BEND TEST RESULTS (4.30.5)

Type	Result	Type	Result
FACE	ACCEPTABLE		
ROOT	ACCEPTABLE		

Fillet Test Results (4.30.2.3 and 4.30.4.1)

Appearance _____ Fillet Size _____ Macroetch _____

Fracture Test Root Penetration _____ Description _____

Inspected By HOWARD SAGER Test No. 61238.001 Organization MJC Date 1/29/2002

RADIOGRAPHIC TEST RESULTS (4.30.3.1)

Film Identification No.	Result	Remark

Interpreted By _____

Organization _____

Test No. _____

Date _____

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of section 4 of ANSI/AWS D1.1, (02) Structural Welding Code-Steel.

Manufacturer PINGEL DESIGN GROUP Authorized By _____ Date _____

PINGEL DESIGN GROUP

Welder Qualification Test Record

SS# 283-72-7594

WQTR No. SS# 283-72-7594 Welder Name NATE PINGEL Welder Id 286-58-2193

WPS No. PDG-3 Revision 0 Date 10/28/2002

Variables	Record Actual Values Used In Qualification	Qualification Range
Process (Table 4.10, Item (1))	FCAW	FCAW
Transfer Mode (GMAW):	Short-Cir. ☐ Globular ☐ Spray ☐	Short-Circuiting ☐ Globular ☐ Spray ☐
Type	Manual ☐ Machine ☐ Semi-Auto ☒ Auto ☐	Manual ☐ Machine ☐ Semi-Auto ☒ Auto ☐
Number of Electrodes	Single ☐ Multiple ☐	Single ☐ Multiple ☐
Current/Polarity	AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐	AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐
Position (Table 4.10, Item (4))	Overhead	Flat, Overhead
Weld Progression: (Table 4.10, Item (6))	Up ☐ Down ☒	Up ☐ Down ☒
Backing [Table 4.10, Item (7)]	Use Backing ☒	With Backing ☒ Without Backing ☐
Consumable Insert (GTAW)	Use Insert ☐	With Insert ☐ Without Insert ☐
Material/Spec.	ASTM A36 to ASTM A36	
Thickness (Plate): Groove (in)	0.375	0.125 - 0.75 in
Fillet ( )		0.125 - Unlimited in
Thickness (Pipe/tube): Groove ( )		-
Fillet ( )		-
Diameter(Pipe): Groove ( )		-
Fillet ( )		-
Notes		-
Filler Metal (Table 10, Item (2))		
Spec.	A5.20	
Class.	E71T-1	
F-No.		
Gas/Flux Type (Table 4.10, Item (3))	Argon/CO2	
Other		

AWS QC 1 ANDREW J. Mc GOLDRICK 99110711 CWI

VISUAL INSPECTION (4.8.1) Acceptable Yes

GUIDED BEND TEST RESULTS (4.30.5)

Type	Result	Type	Result
FACE	ACCEPTABLE	ROOT	ACCEPTABLE

Fillet Test Results (4.30.2.3 and 4.30.4.1)

Appearance Fillet Size Macroetch

Fracture Test Root Penetration Description

Inspected By Andrew J. McGoldrick Test No. 61238.003 Organization MJC Date 1/27/2003

RADIOGRAPHIC TEST RESULTS (4.30.3.1)

Film Identification No.	Result	Remark

Interpreted By

Organization

Test No.

Date

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of section 4 of ANSI/AWS D1.1, (02) Structural Welding Code-Steel.

Manufacturer PINGEL DESIGN GROUP Authorized By Date

PINGEL DESIGN GROUP

Welder Qualification Test Record

SS# 286-58-2193

WQTR No. SS# 286-58-2193 Welder Name NATE PINGEL Welder Id 286-58-2193

WPS No. PDG-3 Revision 0 Date 10/28/2002

Variables	Record Actual Values Used In Qualification	Qualification Range
Process (Table 4.10, Item (1))	FCAW	FCAW
Transfer Mode (GMAW):	Short-Cir. ☐ Globular ☐ Spray ☐	Short-Circuiting ☐ Globular ☐ Spray ☐
Type	Manual ☐ Machine ☐ Semi-Auto ☒ Auto ☐	Manual ☐ Machine ☐ Semi-Auto ☐ Auto ☐
Number of Electrodes	Single ☐ Multiple ☐	Single ☐ Multiple ☐
Current/Polarity	AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐	AC ☐ DCEP ☐ DCEN ☐ Pulsed ☐
Position (Table 4.10, Item (4))	Vertical	Flat, Vertical, Horizontal
Weld Progression: (Table 4.10, Item (6))	Up ☒ Down ☐	Up ☒ Down ☐
Backing [Table 4.10, Item (7)]	Use Backing ☒	With Backing ☒ Without Backing ☐
Consumable Insert (GTAW)	Use Insert ☐	With Insert ☐ Without Insert ☐
Material/Spec.	ASTM A36 to ASTM A36	
Thickness (Plate): Groove (in)	0.375	0.125 - 0.75 in
Fillet ( )		0.125 - Unlimited in
Thickness (Pipe/tube): Groove ( )		-
Fillet ( )		-
Diameter(Pipe): Groove ( )		-
Fillet ( )		-
Notes		-
Filler Metal (Table 10, Item (2))		
Spec.	A5.20	
Class.	E71T-1	
F-No.		
Gas/Flux Type (Table 4.10, Item (3))	Argon/CO2	
Other		

VISUAL INSPECTION (4.8.1) Acceptable Yes

GUIDED BEND TEST RESULTS (4.30.5)

Type	Result	Type	Result
FACE	ACCEPTABLE	ROOT	ACCEPTABLE

Fillet Test Results (4.30.2.3 and 4.30.4.1)

Appearance Fillet Size Macroetch

Fracture Test Root Penetration Description

Inspected By Andrew J. McGoldrick Test No. 61238.002 Organization MJC Date 10/28/2002

RADIOGRAPHIC TEST RESULTS (4.30.3.1)

Film Identification No.	Result	Remark

Interpreted By

Organization

Test No.

Date

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of section 4 of ANSI/AWS D1.1, (02) Structural Welding Code-Steel.

Manufacturer PINGEL DESIGN GROUP Authorized By Date

PINGEL DESIGN GROUP

Welder Qualification Test Record

286-58-2193

WQTR No. 286-58-2193 Welder Name NATHAN PINGEL Welder Id 286-58-2193

WPS No. PDG-1 Revision 0 Date 1/29/2002

Variables	Record Actual Values Used In Qualification	Qualification Range
Process (Table 4.10, Item (1))	GMAW	GMAW
Transfer Mode (GMAW):	Short-Cir. ☐ Globular ☐ Spray ☒	Short-Circuiting ☐ Globular ☐ Spray ☒
Type	Manual ☐ Machine ☐ Semi-Auto ☒ Auto ☐	Manual ☐ Machine ☐ Semi-Auto ☐ Auto ☐
Number of Electrodes	Single ☒ Multiple ☐	Single ☒ Multiple ☐
Current/Polarity	AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐	AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐
Position (Table 4.10, Item (4))	Flat	
Weld Progression: (Table 4.10, Item (6))	Up ☐ Down ☐	Up ☐ Down ☐
Backing [Table 4.10, Item (7)]	Use Backing ☒	With Backing ☐ Without Backing ☐
Consumable Insert (GTAW)	Use Insert ☐	With Insert ☐ Without Insert ☐
Material/Spec.	ASTM A36 to ASTM A36	
Thickness (Plate): Groove (in)	3/8	1/8 - Unlimited in
Fillet ( )		1/8 - Unlimited in
Thickness (Pipe/tube): Groove ( )		-
Fillet ( )		-
Diameter(Pipe): Groove ( )		-
Fillet ( )		-
Notes		-
Filler Metal (Table 10, Item (2))		
Spec.	A5.18	
Class.	ER70S-3	
F-No.		
Gas/Flux Type (Table 4.10, Item (3))	Argon/CO2	
Other		

VISUAL INSPECTION (4.8.1) Acceptable Yes

GUIDED BEND TEST RESULTS (4.30.5)

Type	Result	Type	Result
FACE	ACCEPTABLE		
ROOT	ACCEPTABLE		

Fillet Test Results (4.30.2.3 and 4.30.4.1)

Appearance _____ Fillet Size _____ Macroetch _____

Fracture Test Root Penetration _____ Description _____

Inspected By HOWARD SAGER Test No. 61238.001 Organization MJC Date 2/7/2002

RADIOGRAPHIC TEST RESULTS (4.30.3.1)

Film Identification No.	Result	Remark

Interpreted By _____

Organization _____

Test No. _____

Date _____

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of section 4 of ANSI/AWS D1.1, (02) Structural Welding Code-Steel.

Manufacturer PINGEL DESIGN GROUP Authorized By _____ Date _____

SPECIFICATION FOR CARBON STEEL FILLER METALS FOR GAS SHIELDED ARC WELDING

SFA-5.18

(Identical with AWS Specification A5.18-79)

Scope: This specification prescribes requirements for bare carbon steel electrodes and rods for use with the gas metal arc (GMAW), gas tungsten arc (GTAW), and plasma arc (PAW) welding processes.

Note: The values stated in U.S. customary units are to be regarded as the standard. The SI units are given as equivalent values to the U.S. customary units. The published sizes and dimensions in the two systems are not identical and for this reason conversion from a published size or dimension in one system will not always coincide with the published size or dimension in the other. Suitable conversions, encompassing published sizes of both, can be made, however, if appropriate tolerances are applied in each case.

1. Classification and Acceptance

1.1 Classification. Filler metals in this specification are classified on the basis of their chemical composition and the mechanical properties of their weld metal in the as-welded condition, using the gas metal arc welding process (see Tables 1, 2, 3, and 4). Optional procedures are included which may be used to assure the suitability of these filler metals for use with the gas tungsten arc and plasma arc processes. Any filler metal classified under one classification shall not be classified under any other classification of this specification.

1.2 Acceptance. At the option and expense of the purchaser, any or all of the test requirements of this specification may be used as a basis for acceptance of the products covered by this specification.

1.3 Chemical Composition Requirements. The chemical composition requirements for bare solid electrodes and welding rods are given in Table 1. The requirements are based on the chemical analysis of the as-manufactured filler metal. The details of this analysis are stipulated in 3.3.

2. Manufacture

2.1 Method of Manufacture. The filler metals may be made by any method that will yield a product conforming to the requirements of this specification.

2.2 Soundness and Mechanical Property Test Requirements. When required by Table 2, the following tests are prescribed to demonstrate the soundness and mechanical properties of weld deposits made using the electrodes classified herein:

2.2.1 Soundness Test. Radiographs of the weld test assembly shown in Fig. 1 shall reveal no cracks or zones of incomplete fusion, nor any porosity or inclusions in excess of that allowed by the acceptance standards shown in Fig. 2. The details of this test are stipulated in 3.5.

2.2.2 All-Weld-Metal Tension Test. The all-weld-metal tension test specimens in the as-welded condition shall yield results conforming to the mechanical property requirements prescribed in Table 3. The details of this test are stipulated in 3.6.

2.2.3 Charpy V-Notch Impact Test. The results of the impact tests shall conform to the as-welded impact property requirements prescribed in Table 4. The details of this test are stipulated in 3.7.

2.3 Retests. If any test fails, two additional tests of that particular test, as taken from the original test assembly or from new test assemblies, shall be performed and the results of both shall meet the requirements prescribed for that test.

2.4 Standard Sizes and Lengths

2.4.1 Welding rods shall be available in straight lengths and in continuous lengths wound into coils or onto spools.

Table 1
Chemical composition requirements

AWS Classification[a]	Chemical composition, weight percent												
	C	Mn	Si	P	S	Ni	Cr	Mo	V	Cu[b]	Ti	Zr	Al
ER70S-2	0.07	0.90 to 1.40	0.40 to 0.70	0.025	0.035	c	c	c	c	0.50	0.05 to 0.15	0.02 to 0.12	0.05 to 0.15
ER70S-3	0.06 to 0.15	0.90 to 1.40	0.45 to 0.70								----	----	----
ER70S-4	0.07 to 0.15	1.00 to 1.50	0.65 to 0.85								----	----	----
ER70S-5	0.07 to 0.19	0.90 to 1.40	0.30 to 0.60								----	----	0.50 to 0.90
ER70S-6	0.07 to 0.15	1.40 to 1.85	0.80 to 1.15								----	----	----
ER70S-7	0.07 to 0.15	1.50 to 2.00[d]	0.50 to 0.80								----	----	----
ER70S-G	No chemical requirements[e]												

Note: Single values shown are maximums.

a. Electrodes classified E70S-1B in the previous edition of this specification are now classified ER80S-D2 in AWS Specification A5.28, Low Alloy Steel Filler Metals for Gas Shielded Arc Welding.

b. The maximum weight percent of copper in the rod or electrode due to any coating plus the residual copper content in the steel shall be 0.50.

c. These elements may be present but are not intentionally added.

d. In this classification, the maximum Mn may exceed 2.0 percent. If it does, the maximum C must be reduced 0.01 percent for each 0.05 percent increase in Mn or part thereof.

e. For this classification, there are no chemical requirements for the elements listed, with the exception that there shall be no intentional addition of Ni, Cr, Mo, or V.

Table 2
Mechanical and soundness tests required for classification

AWS Classification	Soundness test	All-weld-metal tension test	Charpy V-notch impact test
ER70S-2	Required	Required	Required
ER70S-3	Required	Required	Required
ER70S-4	Required	Required	Not Required
ER70S-5	Required	Required	Not Required
ER70S-6	Required	Required	Required
ER70S-7	Required	Required	Required
ER70S-G	Required	Required	Optional[a]

a. The purchaser and supplier may agree to include this test and determine jointly the impact properties for acceptance.

Table 3
Mechanical property requirements[a]

AWS Classification	Shielding gas[b]	Tensile strength[c, d] min		Yield strength[c, d] at 0.2% offset, min		Elongation in 2 in. (50 mm)* min, percent
		ksi	MPa*	ksi	MPa*	
ER70S-2, ER70S-3, ER70S-4, ER70S-5, ER70S-6, ER70S-7	CO_2	72	500	60	420	22
ER70S-G	As agreed between supplier and purchaser	72	500	60	420	22

a. As-welded mechanical properties welded in accordance with Fig. 1, electrode positive.

b. CO_2 = carbon dioxide shielding gas. The use of CO_2 for classification purposes shall not be construed to restrict the use of Argon-CO_2 or Argon-O_2 shielding gas mixtures. A filler metal classified with CO_2 will also meet the requirements of this specification when used with Argon-CO_2 or Argon-O_2 mixtures.

c. Mechanical properties as determined from an all-weld-metal tension test specimen.

d. For each increase of one percentage point in elongation over the minimum, the yield strength, or tensile strength, or both may decrease 1000 psi (10 MPa)* to a minimum of 70 000 psi (480 MPa)* for the tensile strength and 58 000 psi (400 MPa)* for the yield strength.

*See *Note* in the Scope.

Table 4
Impact properties*

AWS Classification	Minimum required impact properties[a]
ER70S-2	20 ft-lb at −20° F (27 J at −29° C)
ER70S-3	20 ft-lb at 0° F (27 J at −18° C)
ER70S-4	Not Required
ER70S-5	Not Required
ER70S-6	20 ft-lb at −20° F (27 J at −29° C)
ER70S-7	20 ft-lb at −20° F (27 J at −29° C)
ER70S-G	As agreed between supplier and purchaser

a. The lowest value obtained, together with the highest value obtained, shall be disregarded for this test. Two of the three remaining values shall be greater than the specified 20 ft-lb (27 J)* energy level; one of the three may be lower but shall not be less than 15 ft-lb (20 J).* The computed average value of the three values shall be equal to or greater than the 20 ft-lb (27 J)* energy level. (See 3.7)

*See *Note* in the Scope.

2.4.2 Bare electrodes shall be available in continuous lengths wound into coils with or without support, into drums, or onto spools.

2.4.3 Standard sizes of the rods and electrodes in all forms are shown in Table 5.

2.4.4 Standard straight lengths shall be 36 ± 1/2 in. (900 ± 20 mm).*

2.5 Finish, Temper, and Uniformity.

2.5.1 Finish. Filler metals shall have a smooth finish, free from slivers, depressions, scratches, scale, or other foreign matter that would adversely affect the welding properties or the operation of the welding equipment. Copper or other suitable coatings may be used.

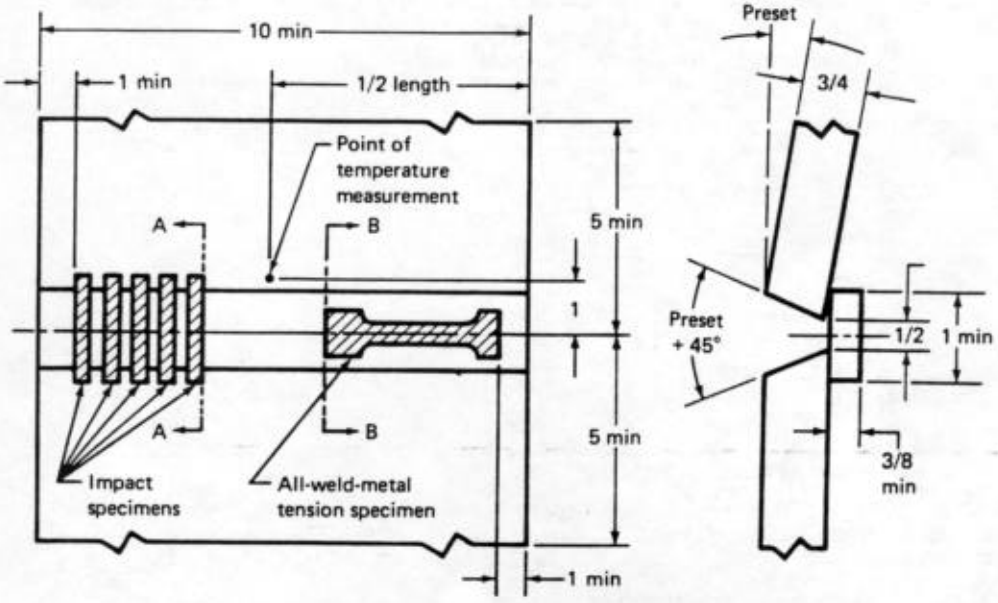
2.5.2 Temper. The temper of the filler metals shall be such that they are suitable for uninterrupted feeding on automatic or semiautomatic welding equipment. The tensile strength of as-manufactured filler metals (not weld deposit) that are wound on spools 12 in. (300 mm)* and greater in diameter as determined by ASTM Standard Methods E8, Tension Testing of Metallic Materials,[1] shall be as shown in Table 6.

2.6 Coils with and without Support, Spools, Drums, and Winding Requirements.

2.6.1 Coils without Support. Dimensions and net weights shall be as specified by the purchaser.

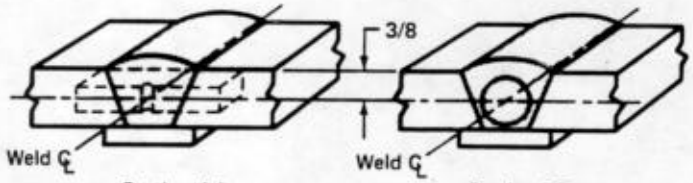
2.6.2 Coils with Support. Standard dimensions and net weight of coils with support shall be as specified in Table 7. Liners shall be of such material and design as to provide adequate protection against damage or distortion

1. ASTM standards can be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.



A. Test Plate showing location of test specimens

SI Equivalents*	
in.	mm
1/4	6.4
3/8	9.5
1/2	13
3/4	19.1
1	25
5	125
10	250



B. Orientation of impact specimen

C. Location of all-weld-metal tension specimen

Notes:

1. All dimensions (excluding angles) are in inches.
2. Prior to welding, the assembly may be preset as shown so that the welded joint will be sufficiently flat to facilitate test specimen removal. As an alternative, restraint or a combination of restraint and preset may be used.

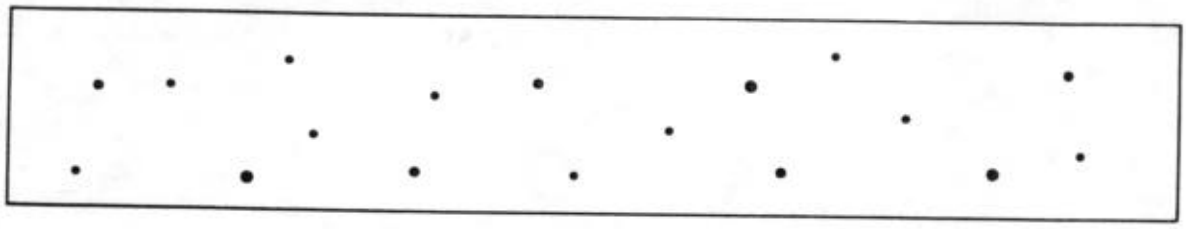
	Test conditions	
Standard size	0.045 in. (1.2 mm)*	1/16 in. (1.6 mm)*
Shielding gas	CO_2	CO_2
Electrode feed rate	450 in./min (190 mm/sec)* ± 5%	240 in./min (102 mm/sec)* ±5%
Nominal arc voltage	27 to 31 V	26 to 30 V
Resulting current, DCRP† (DCRP = electrode positive)	260 to 290 A	330 to 360 A
Tip-to-work distance††	3/4 ± 1/8 in. (19 ± 3 mm)*	3/4 ± 1/8 in. (19 ± 3 mm)*
Travel speed	13 ± 1 in./min (5.5 ± 0.5 mm/sec)*	13 ± 1 in./min (5.5 ± 0.5 mm/sec)*
Interpass temperature	300 ± 25°F (150 ± 15°C)*	300 ± 25°F (150 ± 15°C)*

*See *Note* in the Scope.

† The required combinations of electrode feed rate, arc voltage, and tip-to-work distance should produce welding currents in the ranges shown. Currents substantially outside these ranges suggest errors in feed rate, tip-to-work distance, voltage settings, or in instrumentation.

†† Distance from the contact tip to the work, not from the shielding gas cup to the work.

Fig. 1 – Details of test assembly for soundness test, all-weld-metal tension test, and impact test



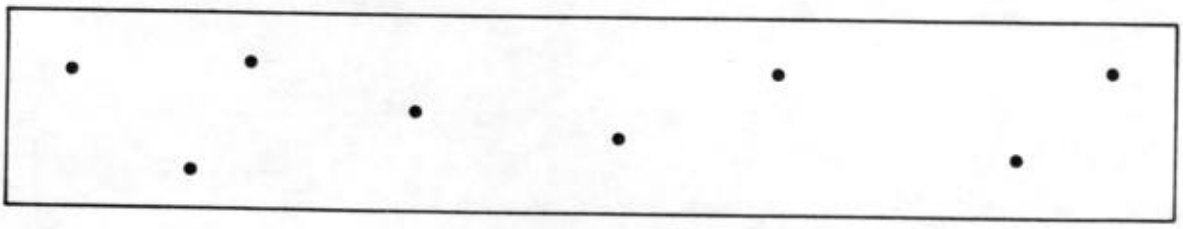
Assorted porosity and/or inclusions

Size 1/64 in. (0.4 mm) to 1/16 in. (1.6 mm) in diameter or in length. Maximum number of indications in any 6 in. (150 mm) of weld = 18, with the following restrictions:

Maximum number of large 3/64 in. (1.2 mm) to 1/16 in. (1.6 mm) diameter and/or length indications = 3.

Maximum number of medium 1/32 in. (0.8 mm) to 3/64 in. (1.2 mm) diameter and/or length indications = 5.

Maximum number of small 1/64 in. (0.4 mm) to 1/32 in. (0.8 mm) diameter and/or length indications = 10.



Large porosity and/or inclusions

Size 3/64 in. (1.2 mm) to 1/16 in. (1.6 mm) in diameter and/or length.

Maximum number of indications in any 6 in. (150 mm) of weld = 8.

Fig. 2 — Porosity and inclusion standards for soundness test

of the filler metals due to normal handling or use. Liners shall be sufficiently clean and dry to maintain the cleanliness of the filler metals.

2.6.3 Spools. Dimensions of standard 4 in. (100 mm)* spools shall be as shown in Fig. 3; dimensions of standard 8, 12, and 14 in. (200, 300, and 350 mm)* spools shall be as shown in Fig. 4; and dimensions of standard 22 and 30 in. (560 and 760 mm)* spools shall be as shown in Fig. 5. Spools shall be of such material and design as to provide adequate protection against damage or distortion of themselves or the filler metal due to normal handling or use. Spools shall be sufficiently clean and dry to maintain the cleanliness of the filler metal.

2.6.4 Drums. Outside diameters of standard drums shall be 15-1/2, 20, and 23 in. (400, 500, and 600 mm).* Drums shall be of such material and design as to provide adequate protection against damage or distortion of the filler metal due to normal handling or use. Drums shall be sufficiently clean and dry to maintain the cleanliness of the filler metal.

2.6.5 Each coil with or without support, spool, or drum shall contain one continuous length of filler metal made from a single heat or lot of materials.

2.6.6 Butt welds, when present in the filler metal, shall be suitably made so as not to interfere with the uniform uninterrupted feeding of the filler metal on automatic and semiautomatic equipment.

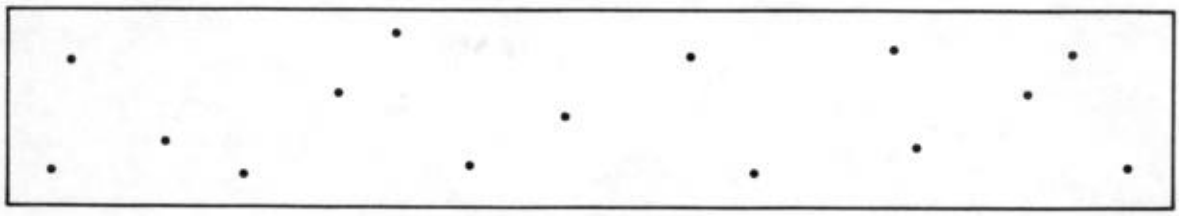
2.6.7 The filler metal shall be wound so as to avoid kinks, waves, or sharp bends which would interfere with the feeding of the filler metal and so that it is free to unwind without restriction. The starting end of the filler metal shall be identified, accessible, and secured.

2.7 Cast and Helix

2.7.1 The cast of coiled filler metals shall be such as to have imparted a curvature to the filler metal so that a specimen sufficient in length to form one loop, or a maximum of 10 ft. (3.05 meters)* when cut from the package and laid on a flat surface without restraint, shall form a circle or portion thereof of the diameter shown for cast in Table 8.

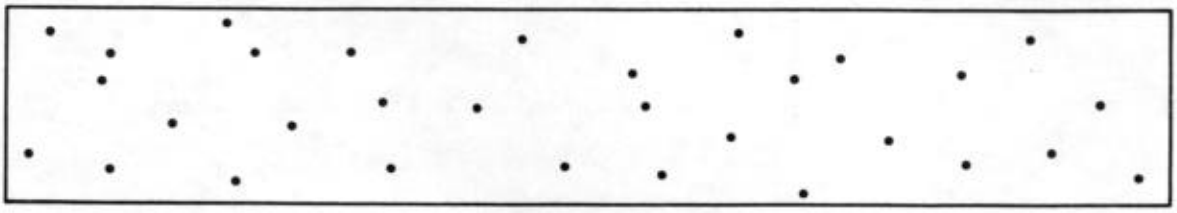
2.7.2 The helix of coiled filler metals as exhibited by the ring used to determine the cast, when placed on a flat surface without restraint, shall be such that the maximum distance from any point on the filler metal to the flat surface shall not exceed the dimension shown for helix in Table 8.

*See *Note* in the Scope.



Medium porosity and/or inclusions

Size 1/32 in. (0.8 mm) to 3/64 in. (1.2 mm) in diameter and/or length.
Maximum number of indications in any 6 in. (150 mm) of weld = 15.



Fine porosity and/or inclusions

Size 1/64 in. (0.4 mm) to 1/32 in. (0.8 mm) in diameter and/or length.
Maximum number of indications in any 6 in. (150 mm) of weld = 30.

Notes:

1. These standards are equivalent to the Grade 1 standards of AWS A5.1, Specification for Carbon Steel Covered Arc Welding Electrodes.
2. In using these standards, the chart which is most representative of the size of the porosity and/or inclusions present in the test specimen radiograph shall be used for determining conformance to these radiographic standards.
3. Since these are test welds specifically made in the laboratory for classification purposes, the radiographic requirements for these test welds are more rigid than those which may be required for general fabrication.
4. See *Note* in the Scope.

Fig. 2 (cont'd) – Porosity and inclusion standards for soundness test

2.8 Packaging. Filler metals shall be packaged in accordance with the requirements of Table 9.

2.9 Marking

2.9.1 The outside of each unit package shall be legibly marked with the following information:

2.9.1.1 Specification and classification numbers

2.9.1.2 Standard size and net weight

2.9.1.3 Lot, control, or heat number

2.9.2 Marking of any or all overpacking of unit packages with items listed in 2.9.1 shall be optional with the manufacturer.

2.9.3 Within the outer wrapping, filler metals in coils without support shall be identified by tag or otherwise on the inside end, showing the specification and the classification numbers; trade designations; size and net weight; and lot, control, or heat number. The identification shall be attached in such a manner that is not readily removable.

2.9.4 Filler metals wound on liners or into drums shall be identified by specification and classification number; trade designation; size and net weight; and lot, control, or heat number placed directly on the liners or drums in such a manner that this identification is not readily removable.

2.9.5 Filler metals wound on spools shall be identified by the specification and classification number; trade designation; size and net weight; and lot, control, or heat number placed on at least one flange of the spool in such a manner that this identification is not readily removable.

2.9.6 Each coil with support, spool, or drum shall have the following caution label, as a minimum, permanently affixed to the body of the liner, spool, or drum in a prominent position and in legible type. Coils without support shall have a tag bearing the following caution label in legible type securely attached to the inside end of the coil:

Table 5
Standard sizes*

Form	Diameter[a] in.	Diameter[a] mm*
Welding rods in straight lengths	0.045	1.2
	1/16	0.063	1.6
	5/64	0.078	2.0
	3/32	0.094	2.4
	1/8	0.125	3.2
	5/32	0.156	4.0
	3/16	0.188	4.8
Filler metal in coils with or without support	0.035	0.9
	0.045	1.2
	0.052	1.4
	1/16	0.063	1.6
	5/64	0.078	2.0
	3/32	0.094	2.4
	7/64	0.109	2.8
	1/8	0.125	3.2
Filler metal wound on standard 4, 12, 14, 22, and 30 in. (200, 300, 350, 560, and 760 mm)* spools	0.020	0.5
	0.025	0.6
	0.030	0.8
	0.035	0.9
	0.045	1.2
	0.052	1.4
	1/16	0.063	1.6
	5/64	0.078	2.0
	3/32	0.094	2.4
	7/64	0.109	2.8
Filler metal wound on light-weight 1-1/2 lb (0.7 kg)* and 2-1/2 lb (1.1 kg)* 4 in. (100 mm)* spools	0.020	0.5
	0.025	0.6
	0.030	0.8
	0.035	0.9
	0.045	1.2

a. Electrodes and welding rods of diameters up to and including 0.045 in. (1.2 mm)* shall not vary more than ± 0.001 in. (0.02 mm)* from the nominal. Diameters greater than 0.045 in. (1.2 mm)* shall not vary more than ± 0.002 in. (0.05 mm)* from the nominal.

*See *Note* in the Scope.

2.10 Rounding-Off Procedures. For purposes of determining conformance with this specification, an observed or calculated value shall be rounded off to the nearest 1000 psi tensile and yield strength, and to the nearest unit in the last right-hand place of figures used in expressing the limiting value for other values in accordance with the rounding-off method of ASTM E29, Recommended Practice for Indicating Which Places of Figures are to be Considered Significant in Specified Limiting Values.

2.11 Certification. For all material furnished under this specification, the manufacturer certifies (by meeting the requirements of 2.9) that the material, or representative material, has passed the tests required for classification by this specification. When required by the purchaser, the manufacturer shall furnish a copy of the results of those tests.

CAUTION
Welding may produce fumes and gases hazardous to health. Avoid breathing these fumes and gases. Use adequate ventilation. See American National Standard Z49.1, Safety in Welding and Cutting, published by the American Welding Society.

3. Details of Tests

3.1 Required Tests

3.1.1 The tests specified in 1.3 and 2.2 shall be conducted in accordance with this Section 3.

3.1.2 When required, chemical analysis shall be made using either 0.045 or 1/16 in. (1.2 or 1.6 mm)* diameter filler metal; test assemblies for mechanical tests shall be made using either diameter electrode with the GMAW process. If the required size is not manufactured, the size manufactured that is closest to 0.045 or 1/16 in. (1.2 or 1.6 mm)* diameter shall be used for classification purposes.

3.2 Material for Test Plates. Steel to be used for test plates for mechanical tests shall conform to one of the following ASTM specifications or their equivalent:

3.2.1 Specification A285, Low and Intermediate Tensile Strength Carbon Steel Plates of Flange and Firebox Qualities (Plate 50 mm and Under in Thickness), Grade C

3.2.2 Specification A36, Structural Steel

3.2.3 Specification A515, For Carbon Steel Plates of Intermediate Tensile Strength for Pressure Vessels for Intermediate and Higher Temperature Service, Grade 70

*See *Note* in the Scope.

Table 6
Tensile strength of as-manufactured bare solid filler metals[a]

Electrode/rod diameter[b]			Minimum required tensile strength[c] of electrodes/rods	
in.		mm*	ksi	MPa*
	0.030	0.8	135	930
	0.035	0.9		
	0.040	1.0		
	0.045	1.2		
1/16	0.063	1.6	125	860
5/64	0.078	2.0		
3/32	0.093	2.4	80	550
1/8	0.125	3.2		

a. Applicable only to filler metals wound in coils, in drums, and on spools 12 in. (300 mm)* and greater in diameter.

b. The 0.020 and 0.025 in. (0.5 and 0.6 mm)* diameter electrodes do not have minimum and maximum tensile strengths specified for them in the as-manufactured condition.

c. Strength of the electrode/rod, not the weld metal.

*See *Note* in the Scope.

3.3 Chemical Analysis

3.3.1 An adequate sample of electrode and welding rod, sufficient for retest if necessary, shall be acquired to make the prescribed chemical analysis.

3.3.2 Chemical analysis may be made by any suitable method agreed upon by the supplier and purchaser. In case of dispute, the procedure in the latest edition of ASTM E350, Standard Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron shall be the referee method.

3.4 Preparation of Test Assembly for Soundness Test, All-Weld-Metal Tension Test, and Impact Test

3.4.1 Test assemblies shall be welded in the flat position as detailed in Fig. 1, using the standard size stipulated in 3.1.2 and the test conditions shown in Fig. 1 for the classification being tested. A welded test assembly that has warped more than 5 degrees shall be discarded. Welded test assemblies shall not be straightened.

3.4.2 The test assembly shall be tack welded as prescribed in Fig. 1. The interpass temperature shall be maintained during welding. The heat input shall be as shown in Fig. 1.

3.4.3 If it is necessary to interrupt the welding procedure prescribed in 3.4.2, the assembly shall be allowed to cool in still air to room temperature. When ready to resume work, the assembly shall be preheated to the interpass temperature and the procedure used for the weld shall be as prescribed in Fig. 1.

3.4.4 No thermal treatment shall be performed on the test assembly subsequent to the welding operation.

3.5 Soundness Test

3.5.1 The assembly shall be prepared for radiographic examination in accordance with the following:

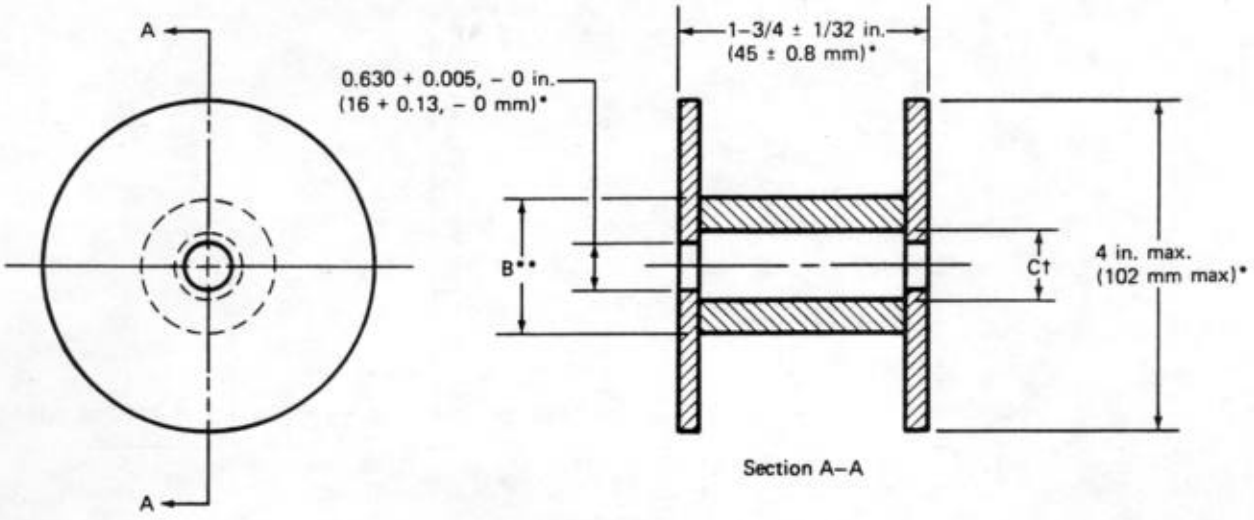
Table 7
Coil with support, standard dimensions and weights*

Standard size	Net weight of filler metal[a]		Dimensions			
			Inside diameter of liner		Width of wound filler metal, max	
in. (mm)	lb	kg	in.	mm	in.	mm
All	25	11	12 ± 1/8	305 ± 3	2-1/2	65
1/16 (1.6) and larger	50 and 60	23 and 27	12 ± 1/8	305 ± 3	4-5/8	120
0.054 (1.4) and smaller	50 and 60	23 and 27	12 ± 1/8	305 ± 3	b	b

a. Net weights shall not vary more than 10 percent.

b. As specified by purchaser.

*See *Note* in the Scope.

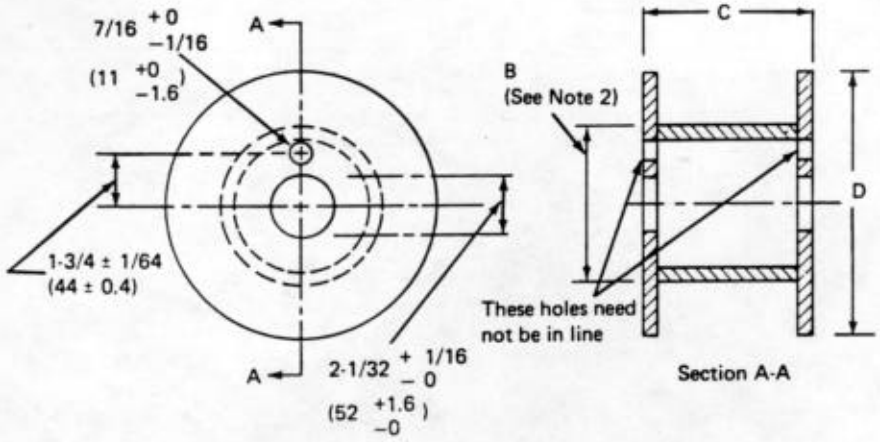


* All dimensions are in inches (millimeters). See *Note* in the Scope.

** Dimension B, outside diameter of barrel, shall be such as to permit proper feeding of the filler metals.

† Dimension C, inside diameter of barrel, shall be such that swelling of the barrel or misalignment of the barrel and flanges will not result in the inside diameter of the barrel being less than the inside diameter of the flanges.

Fig. 3 – Dimensions of 4 in. (100 mm)* spool



SI Equivalents	
in.	mm*
1/64	0.4
1/16	1.6
7/16	11
1-3/4	44
2-1/32	52

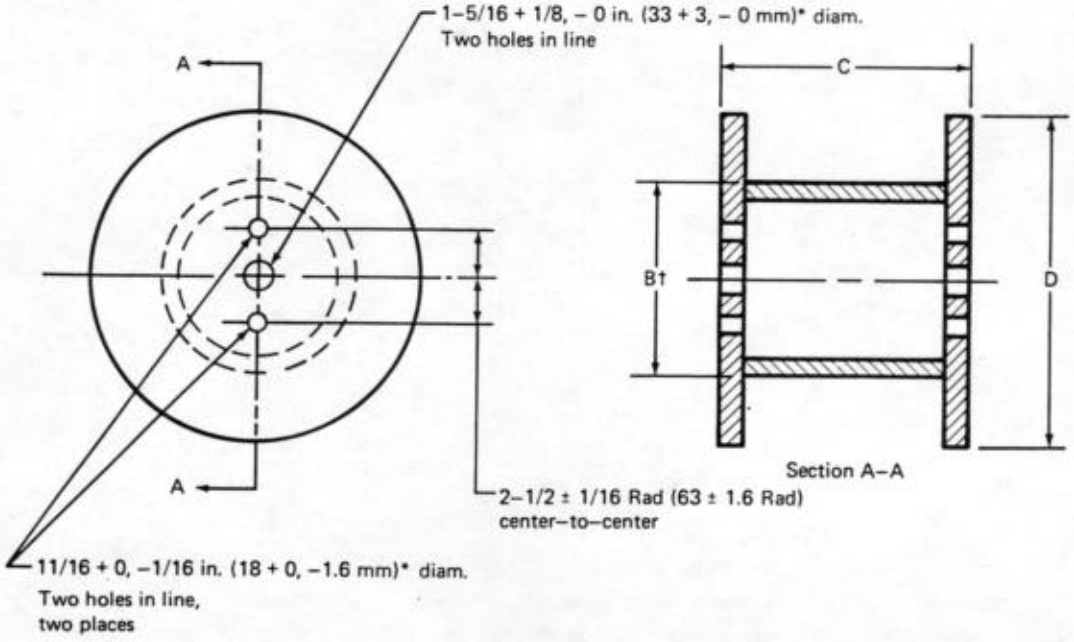
Notes:

1. All dimensions are in inches.
2. Dimension B, outside diameter of barrel, shall be such as to permit proper feeding of the filler metals.

* See *Note* in the Scope.

Dimensions					
Spool size		C		D, maximum	
in.	mm*	in.	mm*	in.	mm*
8	200	2-5/32 ± 1/32	55 ± 1	8	205
12	300	4 ± 1/16	100 ± 2	12	305
14	350	4 ± 1/16	100 ± 2	14	355

Fig. 4 – Dimensions of 8, 12, and 14 in. (200, 300, and 350 mm)* spools



All dimensions are in inches (millimeters).

† Dimension B, outside diameter of barrel, shall be such as to permit proper feeding of the filler metals.

Dimensions					
Spool Size		D		C, maximum	
in.	mm*	in.	mm*	in.	mm*
22	560	22 ± 1/2	560 ± 13	12	305
30	760	30 ± 1/2	760 ± 13	13-1/2	345

Spools of 22 and 30 in. (560 and 760 mm) are often referred to as reels.

*See *Note* in the Scope.

Fig. 5 – Dimensions of 22 and 30 in. (560 and 760 mm)* spools

Table 8
Cast and helix requirements*

AWS Classification	Type of package	Standard size	Cast		Maximum helix	
		in. (mm)	in.	mm	in.	mm
All	4 in. (100 mm) spools	0.045 (1.2)*and less	4 to 9	100 to 230	1/2	13
All	All except 4 in. (100 mm) spools	0.030 (0.8) and less	12 min	305 min	1	25
		0.035 (0.9) and larger	15 min	380 min	1	25

*See *Note* in the Scope.

Table 9
Packaging requirements[a]

Type of package	Package size in.	Package size mm*	Net weight of filler metal[b] lb	Net weight of filler metal[b] kg*
Coils without support	As specified by purchaser[c]		As specified by purchaser[c]	
Coils with support	12 ID	305 ID	25, 50, and 60	11, 23, and 27
Spools	4 OD	100 OD	1-1/2 and 2-1/2	0.7 and 1.1
	8 OD	200 OD	10 and 12	4.5 and 5.5
	12 OD	300 OD	25, 30, and 35	11, 14, and 16
	14 OD	350 OD	50 and 60	23 and 27
	22 OD	560 OD	250	110
	30 OD	760 OD	750	340
Drums	15-1/2 OD	400 OD	As specified by purchaser[c]	
	20 OD	500 OD		
	23 OD	600 OD		
Straight lengths	36 long		10 and 50	4.5 and 22.7

a. Sizes and net weights other than those specified may be available per agreement between supplier and purchaser.

b. Tolerance on net weight shall be ± 10 percent.

c. Per agreement with supplier.

*See *Note* in the Scope.

3.5.1.1 The weld ripples or weld surface irregularities on the weld face shall be removed by any suitable mechanical process to a degree such that the resulting radiographic contrast due to any remaining irregularities cannot mask or be confused with that of any objectionable defect. Also, the weld face shall merge smoothly into the plate surface. The finished surface of the reinforcement may be flush with the plate or have a reasonably uniform reinforcement, not exceeding 3/32 in. (2.5 mm).*

3.5.1.2 The backing strip shall be removed prior to performing the radiography.

3.5.2 The radiographs shall be obtained in accordance with the 2-2T level of inspection as stipulated in ASTM Method E142, Controlling Quality of Radiographic Testing.

3.5.3 When evaluating the radiographs, 1 in. (25 mm)* lengths on both ends of the test welds shall be disregarded.

3.6 All-Weld-Metal Tension Test

3.6.1 One all-weld-metal tension test specimen, as shown in Fig. 6, shall be machined from the same test assembly, as shown in Fig. 1, which was examined radiographically.

3.6.2 No thermal treatment shall be performed on the test specimen.

3.6.3 The test specimen shall be tested in accordance with the tension test section of the latest edition of AWS B4.0, Standard Methods for Mechanical Testing of Welds.

3.7 Impact Test

3.7.1 When required in Table 2, five Charpy V-notch impact test specimens, as shown in Fig. 7, shall be machined from the same test assembly, as shown in Fig. 1, which was examined radiographically.

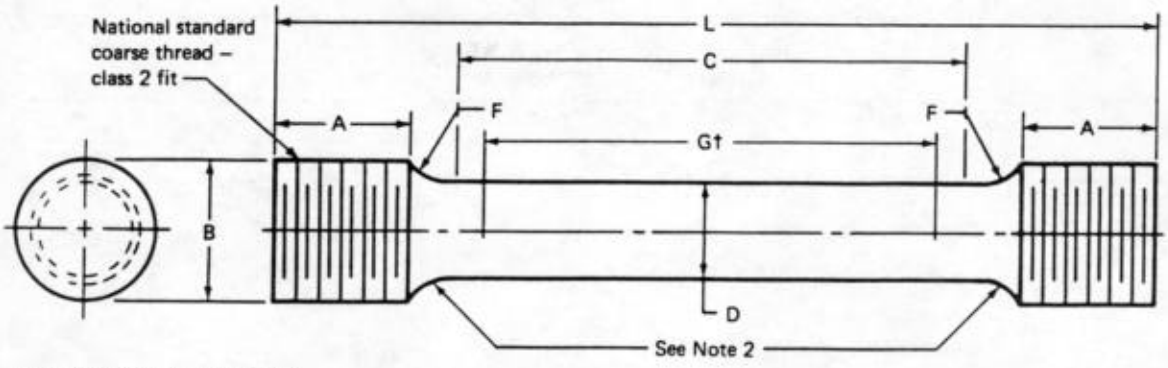
3.7.2 No thermal treatment shall be performed on the test specimens.

3.7.3 The impact specimens shall be tested in accordance with the impact test section of the latest edition of AWS B4.0, Standard Methods for Mechanical Testing of Welds.

3.7.4 The impact properties of the five specimens shall be obtained at the test temperature specified in Table 4.

3.7.5 The average value of the impact properties shall be computed in accordance with note a, Table 4.

*See *Note* in the Scope.



Gt = Gage length. See Note 2.

Dimensions of specimen, in.*								
Specimen††	D	G	C	B	L, min	A, min	F, min	Approximate area, in.^{2}
T (R) –1	0.500 ± 0.010	2.000 ± 0.005	2-1/4	3/4	5	1	0.375 (3/8)	1/5

Dimensions of specimen, mm*								
Specimen††	D	G	C	B	L,min	A,min	F, min	Approximate area, mm^2
T (R) –1	12.7 ± 0.25	50.8 ± 0.13	57.1	19.1	127.0	25.4	9.5	129

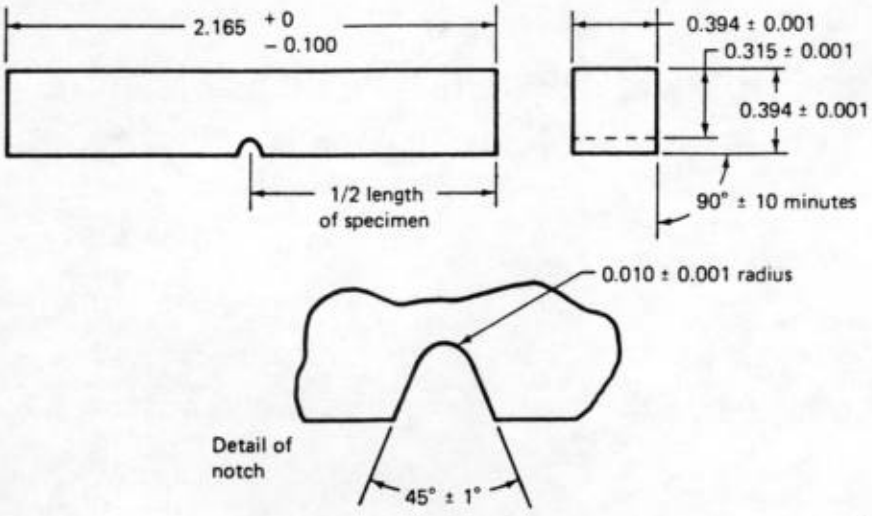
Notes:

1. Dimensions A, G, and C shall be as shown, but ends may be of any shape to fit the testing machine holders as long as the load is axial.
2. The diameter of the specimen within the gage length shall be slightly smaller at the center than at the ends. The difference shall not exceed one percent of the diameter.
3. When the extensometer is required to determine yield strength or other elastic properties, dimension C and L may be modified. However, the percent of the elongation shall be based on dimension G.
4. The surface finish within the C dimension shall be no rougher than 63 μ in. (1.6 μm)*.

††Designations from AWS B4.0-74, Standard Methods for Mechanical Testing of Welds.

*See *Note* in the Scope.

Fig. 6 – Details of all-weld-metal tension test specimen



SI Equivalents*	
in.	mm
0.010 ± 0.001	0.25 ± 0.025
0.315 ± 0.001	8 ± 0.025
0.394 ± 0.001	10 ± 0.025
2.165 +0 −0.100	55 +0 −2.5

*See *Note* in the Scope.

Note: All dimensions except angles are in inches.

Fig. 7 – Details of Charpy V-notch impact test specimen

Appendix: Guide to AWS Classification of Carbon Steel Filler Metals for Gas Shielded Arc Welding

A1. Introduction

A1.1 This guide is appended to the specification as a source of information; *it is not mandatory and does not form a part of the specification.* The purpose of this guide is to correlate the filler metal classifications with their intended applications so that this specification may be used effectively.

A1.2 Classification System

A1.2.1 The classification system used in this specification follows as closely as possible the standard pattern used in other AWS filler metal specifications. The inherent nature of the products being classified has, however, necessitated specific changes which more ably classify the product.

A1.2.2 As an example, consider ER70S-2. The prefix E designates an electrode as in other specifications. The letters ER at the beginning of a classification indicate that the bare filler metal may be used as an electrode or welding rod. The number 70 indicates the required minimum tensile strength in multiples of 1000 psi (6.9 MPa)* of the weld metal in a test weld made using the electrode in accordance with specified welding conditions. The letter S designates a bare, solid electrode or rod. The suffix 2 relates to the specific chemical composition.

A1.2.3 (Optional) At the option and expense of the purchaser, acceptance may be based on the results of any or all of the classification tests required by this specification made on a GTAW test assembly described in Fig. A1, with a tension test specimen as described in Fig. A2, and the impact specimen described in Fig. 7.

A1.3 Ventilation during Welding

A1.3.1 Three major factors in arc welding which govern the amount of contamination to which welders or welding operators may be exposed are:

A1.3.1.1 Dimensions of space in which welding is to be done (with special regard to height of ceiling)

A1.3.1.2 Number of welders or welding operators working in that space

A1.3.1.3 Possible evolution of hazardous fumes, gases, or dusts according to the metals and shielding gases involved

A1.3.2 American National Standard Z49.1, Safety in Welding and Cutting, discusses the ventilation that is required during welding and should be referred to for details. Attention is particularly drawn to Section 8, "Health Protection and Ventilation."

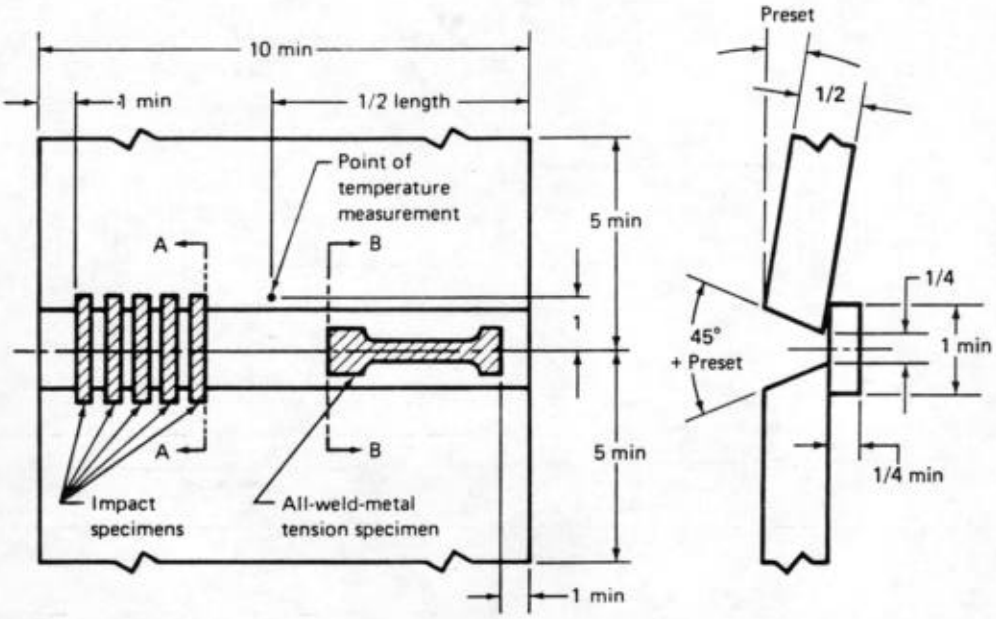
A2. Description and Intended Use

A2.1 The following is a description of the characteristics of the filler metal classifications covered by this specification and the intended uses of each classification. The designations and the chemical composition requirements for all classifications are given in Table 1 of this specification. The as-welded mechanical properties for the various filler metals will conform to the minimum requirements stated in Tables 3 and 4 of this specification and the specific classification use.

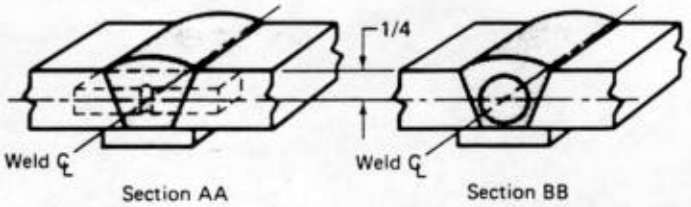
A2.2 It should be noted that weld properties may vary appreciably depending on filler metal size and current used; plate thickness; joint geometry; preheat and interpass temperatures; surface conditions; base metal composition and extent of alloying with the filler metal; and shielding gas.

A2.3 When filler metals having an analysis within the range of Table 1 are deposited, the weld metal chemical composition will not vary greatly from the as-manufactured composition when used with argon-oxygen shielding gas, but will show a considerable reduction in the content of manganese, silicon, and other deoxidizers when used with CO_2 as the shielding gas. This reduction will cause a reduction of the tensile and yield strengths of the welds made using CO_2 shielding gas but these values will not be less than the minimum values specified in Table 3.

A2.4 ER70S-2 Classification. This classification covers multiple deoxidized steel filler metals which contain a nominal combined total of 0.20 percent zirconium, titanium, and aluminum in addition to the silicon and manganese contents. These filler metals are capable of producing sound welds in semikilled and rimmed steels as well as in killed steels of various carbon levels. Because of the added deoxidants, these filler metals can be used for welding steels which have a rusty or dirty surface, with a possible sacrifice of weld quality depending on the degree of surface contamination. They can be used with a shielding gas of argon-oxygen mixtures, CO_2, or argon-CO_2 mixtures and are preferred for out-of-position welding with the short circuiting type of transfer because of their ease of operation.



A. Test plate showing location of test specimens



B. Orientation of impact specimen

C. Location of all-weld-metal tension specimen

SI Equivalents*	
in.	mm
1/4	6.4
1/2	12.7
1	25
5	125
10	250

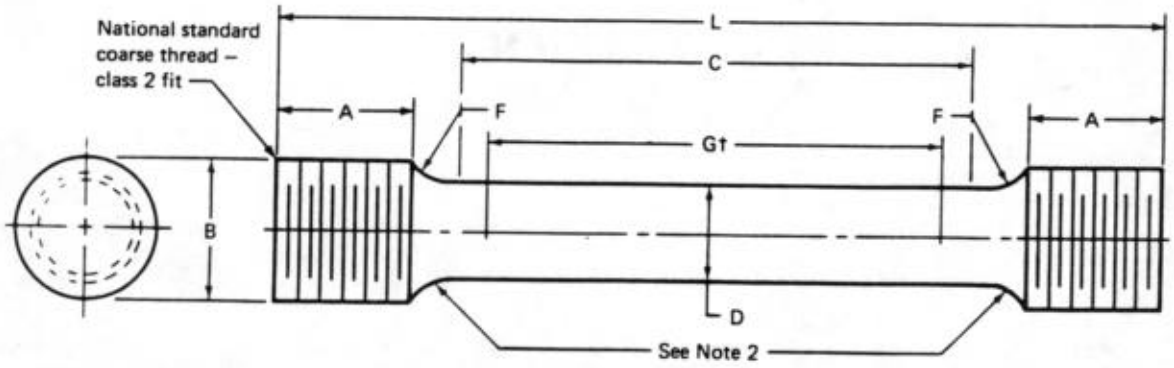
*See *Note* in the Scope.

Notes:

1. Prior to welding the assembly may be preset as shown so that the welded joint will be sufficiently flat to facilitate test specimen removal. As an alternative, restraint or a combination of restraint and preset may be used.
2. All dimensions (excluding angles) are in inches.

	Test conditions	
Standard size	3/32 in. (2.4 mm)*	1/8 in. (3.2 mm)*
Shielding gas	Argon	Argon
Travel speed	4 to 6 in./min (0.17 to 0.25 mm/sec)*	4 to 6 in./min (0.17 to 0.25 mm/sec)*
Nominal arc voltage	13 to 16 V	16 to 19 V
Nominal current, DCSP (electrode negative)	220 to 250 A	250 to 280 A
Interpass temperature	300 ± 25°F (150 ± 15°C)*	300 ± 25°F (150 ± 15°C)*

Fig. A1 — Details of optional GTAW test assembly for soundness test, all-weld-metal tension test, and impact test



G† = Gage length. See Note 2.

Dimensions of specimen, in.*								
Specimen††	D	G	C	B	L, min	A, min	F, min	Approximate area, in.²
T (R) – 2	0.350 ± 0.007	1.400 ± 0.005	1-3/4	1/2	3-1/2	5/8	0.25	1/10

Dimensions of specimen, mm*								
Specimen††	D	G	C	B	L, min	A, min	F, min	Approximate area, mm²
T (R) – 2	8.9 ± 0.18	35.6 ± 0.13	44.5	12.7	188.9	15.9	6.4	65

Notes:

1. Dimensions A, G, and C shall be as shown, but ends may be of any shape to fit the testing machine holders as long as the load is axial.
2. The diameter of the specimen within the gage length shall be slightly smaller at the center than at the ends. The difference shall not exceed one percent of the diameter.
3. When the extensometer is required to determine yield strength or other elastic properties, dimension C and L may be modified. However, the percent of the elongation shall be based on dimension G.
4. The surface finish within the C dimension shall be no rougher than 63 μ in. (1.6 μm)*.

††Designations from AWS B4.0-74, Standard Methods for Mechanical Testing of Welds.

*See *Note* in the Scope.

Fig. A2 – Details of optional all-weld-metal tension test specimen for gas tungsten arc welding

A2.5 ER70S-3 Classification. These filler metals will meet the requirements of this specification with either CO_2 or argon-oxygen as a shielding gas. They are used primarily on single-pass welds, but can be used on multiple-pass welds, especially when welding killed or semikilled steel. Small diameter electrodes can be used for out-of-position welding and for short circuiting type transfer with argon-CO_2 mixtures or CO_2 shielding gases. However, it should be noted that the use of CO_2 shielding gas in conjunction with excessively high heat inputs may result in failure to meet the minimum specified tensile and yield strength.

A2.6 ER70S-4 Classification. These filler metals contain slightly higher manganese and silicon contents than those of the ER70S-3 classification and produce a weld deposit of higher tensile strength. The primary use of these filler metals is for CO_2 shielded welding applications where a slightly longer arc or other conditions require more deoxidation than provided by the ER70S-3 filler metals. These filler metals are not required to demonstrate impact properties.

A2.7 ER70S-5 Classification. This classification covers filler metals which contain aluminum in addition to manganese and silicon as deoxidizers. These filler metals can be used when welding rimmed, killed, or semikilled steels with CO_2 shielding gas and high welding currents. The relatively large amount of aluminum assures the deposition of well deoxidized and sound weld metal. Because of the aluminum, they are not used for the short circuiting type transfer, but can be used for welding steels which have a rusty or dirty surface, with a possible sacrifice of weld quality, depending on the degree of surface contamination. These filler metals are not required to demonstrate impact properties.

A2.8 ER70S-6 Classification. Filler metals of this classification have the highest combination of manganese and silicon, permitting high current welding with CO_2 gas shielding even in rimmed steels. These filler metals may also be used to weld sheet metal where smooth weld beads are desired and steels which have moderate amounts of rust and mill scale. The quality of the weld will depend on the degree of surface impurities. This filler metal is also usable out-of-position with short circuiting transfer.

A2.9 ER70S-7 Classification. These filler metals have a substantially greater manganese content (essentially equal to that of ER70S-6) than those of the ER70S-3 classification. This provides slightly better wetting and weld appearance with slightly higher tensile and yield strengths and may permit increased speeds compared with ER70S-3 filler metals. These filler metals are generally recommended for use with argon-oxygen shielding gas mixtures, but they are usable with argon-CO_2 mixtures and CO_2 under the same general conditions as for the ER70S-3 classification. Under equivalent welding conditions, weld hardness will be lower than ER70S-6 weld metal but higher than ER70S-3 deposits.

A2.10 ER70S-G Classification. This classification includes those solid filler metals which are not included in the preceding classes. The filler metal supplier should be consulted for the characteristics and intended use. This specification does not list specific chemical composition or impact requirements. These are subject to agreement between supplier and purchaser. However, any filler metal classified ER70S-G must meet all other requirements of this specification.

A3. Welding Considerations

A3.1 Gas metal arc welding can be divided into four categories based on the mode of metal transfer employed. The methods are known as spray, pulsed spray, globular, and short circuiting type transfer. Spray, pulsed spray, and globular transfer occur as distinct droplets detached from the electrode in a fine stream or as globules. The droplets or globules transfer along the arc column into the weld puddle. In short circuiting type transfer, the electrode is deposited during frequent short circuiting of the electrode into the molten pool.

A3.2 Spray Type Transfer

A3.2.1 Spray type transfer welding of carbon steel is most commonly done with a shielding gas mixture of argon and 2 to 5 percent oxygen. A characteristic of spray type transfer welding with argon-oxygen shielding gas is the smooth arc plasma through which hundreds of droplets per second are transferred axially from the electrode to the weld puddle. With CO_2 shielding gas, however, rapid rate of transfer of droplets across the arc does not occur unless very high currents are used.

A3.2.2 Axial spray transfer in argon-oxygen shielding gas is mainly related to the magnitude and polarity of the arc current and electrical resistance heating of the electrode. The high droplet rate (approximately 250 droplets per second) develops suddenly above a critical current level, commonly referred to as the transition current. Below this current, the metal is transferred in drops generally larger in diameter than the electrode at a rate from 10 to 20 per second (globular transfer). The transition current is dependent to a great extent on electrode diameter and chemical composition. For 1/16 in. (1.6 mm)* diameter carbon steel electrodes, a transition current of 270 amperes (dc, electrode positive) is common. Alternating current is not recommended.

A3.3 Pulsed Spray Type Transfer. Metal transfer in pulsed spray arc welding is similar to the spray arc described above and occurs at lower average currents. Lower current welding is made possible by rapid pulsing of the current between a high level where metal will transfer in the spray mode and a low level where no transfer takes place. At a typical rate of 60 to 120 pulses per second, a melted drop is formed by the low current arc, then "squeezed off" by the high current pulse. This mode permits all-position welding in a manner similar to short circuiting transfer described below.

A3.4 Globular Type Transfer. The method of transfer which characterizes welding with CO_2 shielding gas is globular and non-axial in nature. Common practice with globular transfer is to use low arc voltage to cause a "buried arc" which produces deep penetration and minimizes spatter. For this type of transfer, 0.045 and 1/16 in. (1.2 and 1.6 mm)* diameter electrodes are normally used at welding currents in a range of 275-400 amperes (dc). The rate of droplets (globules) transferred ranges from 20 to 70 per second depending on the electrode, welding current, and voltage.

A3.5 Short Circuiting Type Transfer. This method of gas metal arc welding is generally done with 0.030 to 0.045 in. (0.8 to 1.2 mm)* diameter electrodes, using lower arc voltages and amperages than spray arc welding, and a power source designed for short circuiting transfer. The electrode short-circuits to the work piece, usually at a rate from 50 to 200 times per second. Metal is transferred with each short circuit and not across the arc. Short circuiting gas metal arc welding of carbon steel is most commonly done with shielding gas mixtures of argon-CO_2 or with 100 percent welding grade CO_2. Penetration of welds made with CO_2 shielding gas is greater than with argon-CO_2 mixtures. Shielding gas mixtures of 50 to 80 percent argon–remainder CO_2 result in higher short circuiting rates and lower minimum currents and voltages than with CO_2 shielding. This can be an advantage in welding thin plate.

*See *Note* in the Scope.

chapter on the specific base metal. The size of the electrode wire to be used depends upon the welding position and the variation of the gas metal arc welding process.

The basis for selecting the shielding gas involves the type of electrode, the type of base metal, the welding position, the variation of the process, and the desired weld quality. The recommended shielding gases for different metals and process variations will be covered in Chapter 13 or 14 for the particular metal to be welded.

In order to establish a basis for selection of process variation, it is necessary to know the capabilities and normal applications for each of the process variations. Figure 5-35 is a chart which shows the variations, the type of metal transfer, the base metals that can be welded, the welding position capabilities, and the recommended welding shielding gas. This will simplify the selection of materials necessary to utilize each variation of gas metal arc welding.

Deposition Rates and Weld Quality

Each of the variations has a considerable range of deposition rates based on the weld procedure employed. Figure 5-36 shows the relationship of deposition rates for the variations and the different electrode sizes that would be used. This chart is based on the utilization of carbon steel base metals and electrodes.

For welding nonferrous metals, deposition rates vary considerably due to the density of the metals being welded.

The deposition rates of gas metal arc welding are higher for the same welding currents than are obtained with shielded metal arc welding. These higher rates occur because there is no electrode coating that must be melted. The current density on the small diameter electrode wires is much higher than with covered electrodes, which contributes to the higher deposition rates for the same welding current. The tip-to-work distance

Process Variation	MIG	CO_2	Fine Wire	Spray Arc	Pulsing
Shielding Gas	Inert Gas	CO_2	CO_2 or CO_2 + Argon (C-25)	Argon + Oxygen (1 to 5%)	Inert Gas
Metal transfer	Various	Globular	Short circuiting	Spray	Discrete
Metals to be welded	Al. & Al. alloys Stainless steels nickel & nickel alloys—copper alloys, Ti, etc.	Low carbon & med. carbon steel—Low alloy high strength steels	Low carbon & medium carbon steels—low alloy high strength steels—some stainless steels.	Low carbon & med. carbon steels—Low alloy high strength steels	Alum. Nickel Steels Nickel Alloys
Metal thickness	12 gage (.109") to 3/8" without bevel preparation max. thickness—practically unlimited.	10 gage (.140") Up to 1/2" without bevel preparation	20 gage (.038"). Up to 1/4". Economical in heavier metals for vertical & overhead welding.	1/4" to 1/2" with no preparation. Max thickness practically unlimited.	Thin to unlimited thickness
Welding positions	All positions.	Flat & horizontal	All positions (also for pipe welding)	Flat & horizontal with small electrode wire all positions	All position
Major advantages	Welds most nonferrous metals—min. clean-up	Low cost gas-high travel speed deep penetration	Thin material—will bridge gaps—min. clean-up	Smooth surface—deep penetration high travel speed	Uses larger electrode
Limitations	Cost of gases	Spatter removal sometimes required	Uneconomical in heavy thickness-except out of position	Position—min. thickness	Expension power source
Appearance of weld	Fairly smooth convex surface	Relatively smooth some spatter	Smooth surface—relatively minor spatter	Smooth surface—minimum spatter	Smooth surface
Travel speeds	Up to 100 IPM	Up to 250 IPM	Max. 50 IPM-semi-auto.	Up to 150 IPM	Up to 100 IPM
Range of electrode Wire sizes—inches	Dia.-.035, .045, 1/16, 3/32	Dia.-.045, 1/16 5/64, 3/32	Dia.-.030, .035, .045	Dia.-.035, .045, 1/16, 3/32	1/16, 5/64, 3/32, 1/8

FIGURE 5-35 *Variations of the gas metal arc welding process.*

Material Thickness (1) Fraction	Decimal	mm	Electrode Dia. in.	mm	Welding Current Amps-DC	Arc Voltage Elec. Pos	Wire Feed ipm	Travel Speed ipm	Shielding Gas Flow CFH (3)
							85		
24 ga.	0.025	0.6	0.030	0.8	30-50	15-17	100	12-20	15-20
							90		
22 ga.	0.031	0.8	0.030	0.8	40-60	15-17	130	18-22	15-20
							70		
20 ga.	0.037	0.9	0.025	0.9	55-85	15-17	120	35-40	15-20
							100		
18 ga.	0.050	1.3	0.035	0.9	70-100	16-19	160	35-40	15-20
							120		
1/16	0.063	1.6	0.035	0.9	80-110	17-20	180	30-35	20-25
							160		
5/64	0.078	2.0	0.035	0.9	100-130	18-20	220	25-30	20-25
							210		
1/8	0.125	3.2	0.035	0.9	120-160	19-22	290	20-25	20-25
							210		
1/8	0.125	3.2	0.045	1.1	180-200	20-24	240	27-32	20-25
							210		
3/16	0.187	4.7	0.035	0.9	140-160	19-22	290	14-19	20-25
							210		
3/16	0.187	4.7	0.045	1.1	180-205	20-24	245	18-22	20-25
							240		
1/4	0.250	6.4	0.035	0.9	140-160	19-22	290	11-15	20-25
							210		
1/4	0.250	6.4	0.045	1.1	180-225	20-24	290	12-18	20-25

Note: Singlepass flat and horizontal fillet position. Reduce current 10 to 15% for vertical and overhead welding.

(1) For fillet and groove welds. For fillet welds size equals metal thickness. For square groove welds the root opening should equal 1/2 the metal thickness.

(3) Shielding gas is CO_2 or mixture of 75% Argon + 25% CO_2.

FIGURE 5-38 *Short circuiting transfer (fine wire) variation of gas metal arc welding.*

Material Thickness Ga.	in.	mm	Type of Weld (a)	Electrode Dia. in.	mm	Welding Current Amps-DC	Arc Voltage Elec. Pos.	Wire Feed ipm	Travel Speed ipm	CO_2 Gas Flow CFH
18	0.050	1.3	Fillet	0.045	1.1	280	26	350	190	25
			square groove	0.045	1.1	270	25	340	180	25
16	0.063	1.6	Fillet	0.045	1.1	325	26	360	150	35
			square groove	0.045	1.1	300	28	350	140	35
14	0.078	2.0	Fillet	0.045	1.1	325	27	360	130	35
			square groove	0.045	1.1	325	29	360	110	35
			square groove	0.045	1.1	330	29	350	105	35
11	0.125	3.2	Fillet	1/16	1.6	380	28	210	85	35
			square groove	0.045	1.1	350	29	380	100	35
3/16	0.188	4.8	Fillet	1/16	1.6	425	31	260	75	35
			square groove	1/16	1.6	425	30	320	75	35
			square groove	1/16	1.6	375	31	260	70	35
1/4	0.250	6.4	Fillet	5/64	2.0	500	32	185	40	35
			square groove	1/16	1.6	475	32	340	55	35
3/8	0.375	9.5	Fillet	3/32	2.4	550	34	200	25	35
			square groove	3/32	2.4	575	34	160	40	35
1/2	0.500	12.7	Fillet	3/32	2.4	625	36	160	23	35
			square groove	3/32	2.4	625	35	200	33	35

(1) For mild carbon and low alloy steels on square groove welds backing is required.

FIGURE 5-39 *Globular transfer variation (CO_2) gas metal arc welding.*

Material Thickness in. (1)	mm	Type of Weld	Number of Passes	Electrode Dia. in. (2)	mm	Welding Current Amps-DC	Arc Voltage Elec. Pos.	Wire Feed ipm	Travel Speed ipm	Shielding Gas (3) Flow CFH
1/8	3.2	Fillet or square groove	1	1/16	1.6	300	24	165	35	40-50
3/16	4.8	Fillet or square groove	1	1/16	1.6	350	25	230	32	40-50
1/4	6.4	Vee groove	2	1/16	1.6	325 375 400	24 25 26	210 260 100	30	40-50
1/4	6.4	Vee groove	2	3/32	2.4	450	29	120	35	40-50
1/4	6.4	Fillet	1	1/16	1.6	350	25	230	32	40-50
1/4	6.4	Fillet	1	3/32	2.4	400	26	100	32	40-50
3/8	9.5	Vee groove	2	1/16	1.6	325 375 400	24 25 26	210 260 100	24	40-50
3/8	9.5	Vee groove	2	3/32	2.4	450	29	120	28	40-50
3/8	9.5	Fillet	2	1/16	1.6	350	25	230	20	40-50
3/8	9.5	Fillet	1	3/32	2.4	425	27	110	20	40-50
1/2	12.7	Vee groove	3	1/16	1.6	325 375 375	24 26 26	210 260 250	24	40-50
1/2	12.7	Vee groove	3	3/32	2.4	400 450 425	26 29 27	100 120 110	30	40-50
1/2	12.7	Fillet	3	1/16	1.6	350	25	230	24	40-50
1/2	12.7	Fillet	3	3/32	2.4	425	27	105 110	26	40-50
3/4	19.1	Double Vee Groove	4	1/16	1.6	325 375 350	24 26 25	210 260 230	24	40-50
3/4	19.1	Double Vee	4	3/32	2.4	400 450 425	26 29 27	100 120 110	24	40-50
3/4	19.1	Fillet	5	1/16	1.6	350	25	230	24	40-50
3/4	19.1	Fillet	4	3/32	2.4	425	27	110	26	40-50
1	24.1	Fillet	7	1/16	1.6	350	25	230	24	40-50
1	24.1	Fillet	6	3/32	2.4	425	27	110	26	40-50

Use only in flat and horizontal fillet position.

(1) For fillet welds, material thickness indicates fillet weld size.

(3) Shielding gas is argon plus 1 to 5% oxygen.

FIGURE 5-40 *Spray arc transfer variation – gas metal arc welding.*

The interrelationship of the welding variables will be covered completely in Section 5-5.

Tips for Using the Gas Metal Arc Welding Process

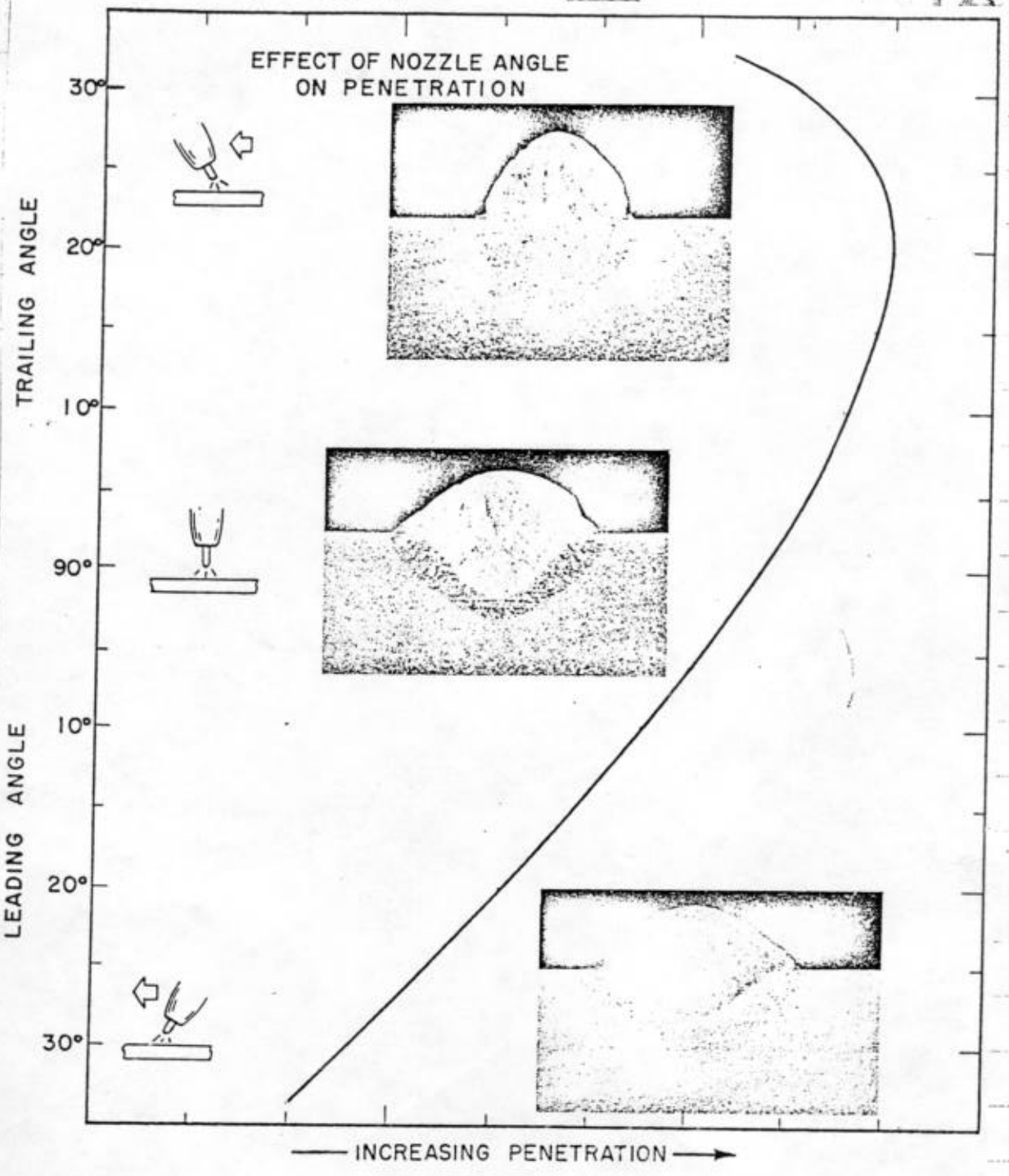
Semiautomatic welding using the short circuiting metal transfer is easy to use. Experienced shielded metal arc welders or people with no welding experience can learn this process variation in a relatively short time. Production welding can be learned in a few days, whereas pipe welding may require 80 to 120 hours of training.

It is important to use the correct welding technique when welding semiautomatically. The electrode wire should be directed to the loading edge of the puddle for optimum results. For out-of-position welding the puddle should remain small for best control.

The gun tip-to-work distance known as **stickout** must be closely controlled. If the stickout becomes too long the electrode will become overheated and will minimize penetration. Also, when the gun nozzle is too far from the arc, the shielding gas efficiency is reduced. Normal nozzle-to-work distance should be approximately one to one-and-one-half times the inside diameter of the gas nozzle being used.

Another important factor is the angle the gun nozzle makes with the work. Two angles are involved. One is known as the *travel angle,* the other is the *work angle.* The work angle is normally half the included angle

The effects produced by the leading and trailing nozzle angles are shown in the following illustration.



The secondary adjustable variable "nozzle angle" refers to the position of the welding gun with respect to the joint. This is described as shown, by two angles - Transverse and Longitudinal.
The transverse angle refers to the relationship of the welding gun and weld joint in a plane perpendicular to the direction of travel.
The longitudinal angle refers to the angle between the center line of the welding gun and a line perpendicular to the axis of the weld.
This is the angle referred to as the "nozzle angle".

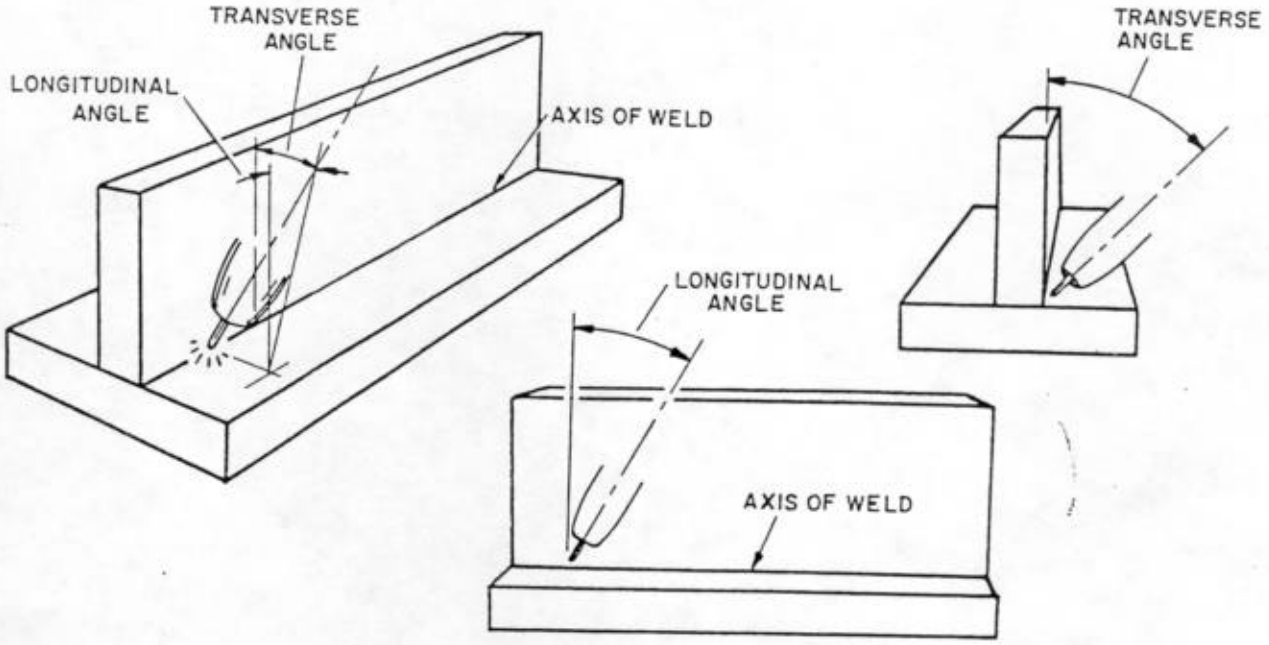
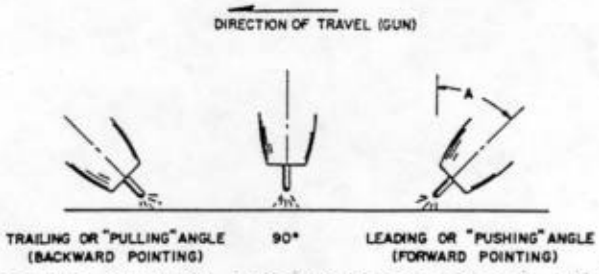


Diagram of Transverse and Longitudinal Nozzle Angles

This angle is further described as either a trailing (pulling) or a leading (pushing) angle.



WELDING CONDITIONS vs PENETRATION

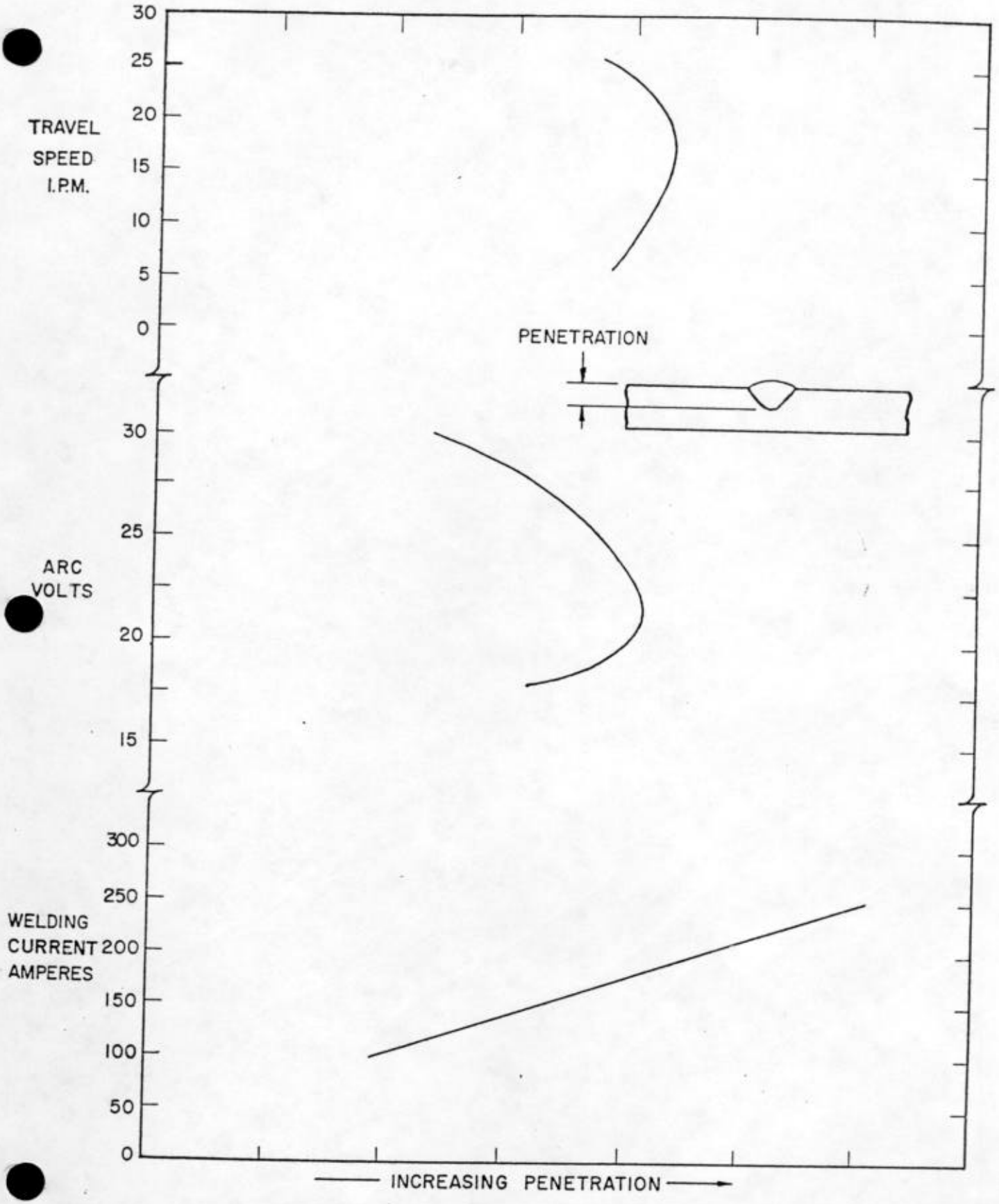


ILLUSTRATION NO. 14-5 EFFECT OF TRAVEL SPEED, ARC VOLTS, AND WELDING CURRENT ON PENETRATION.

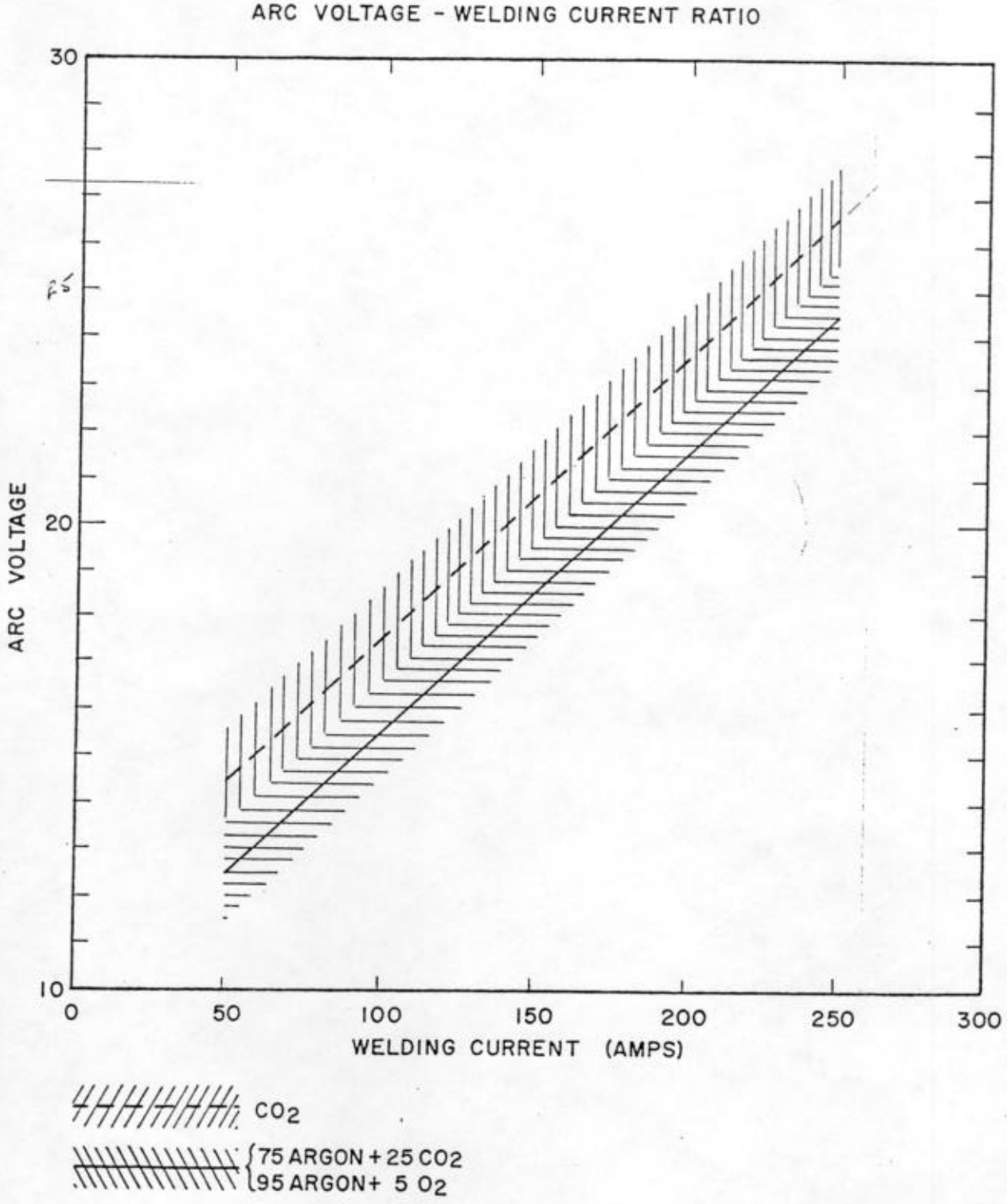
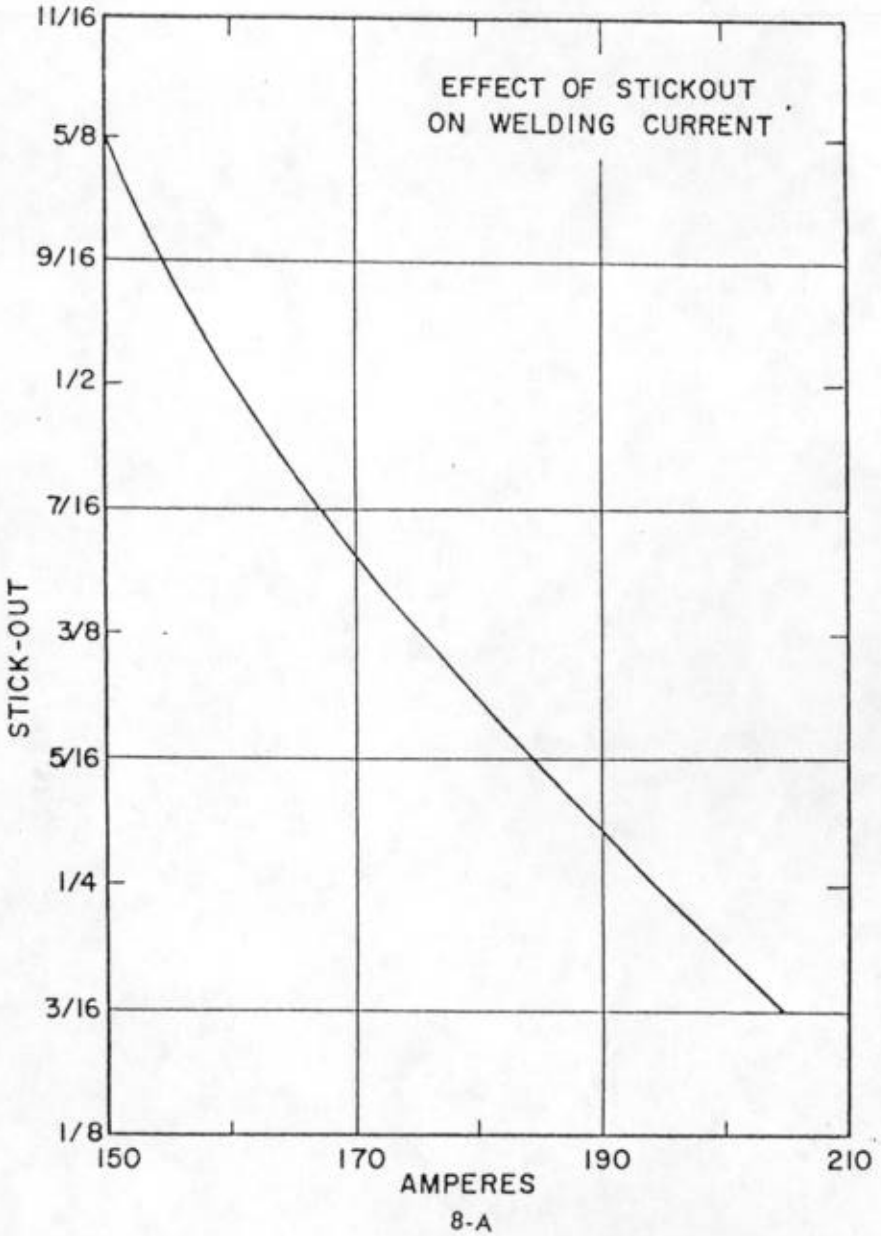
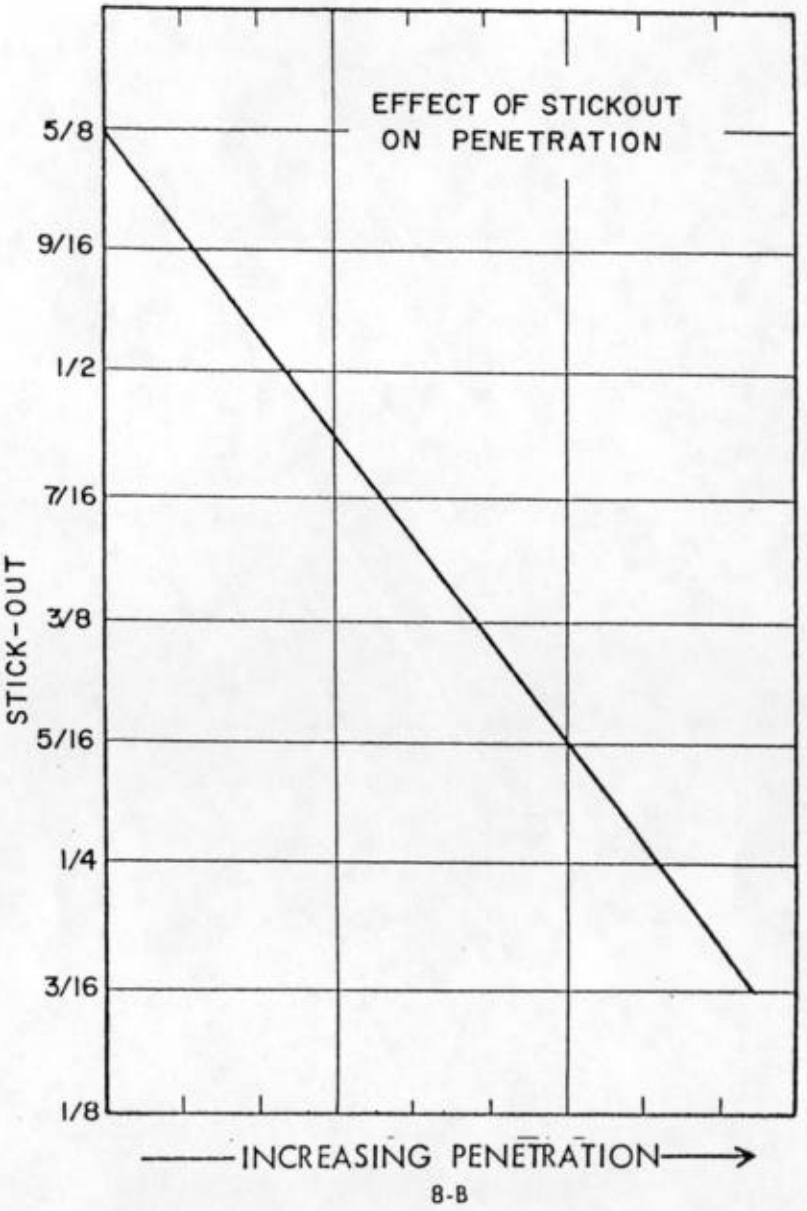


ILLUSTRATION NO. 14-7 : ARC VOLTAGE - WELDING CURRENT RATIO NECESSARY FOR ARC STABILITY.



8-A



8-B

Illustration No. 8

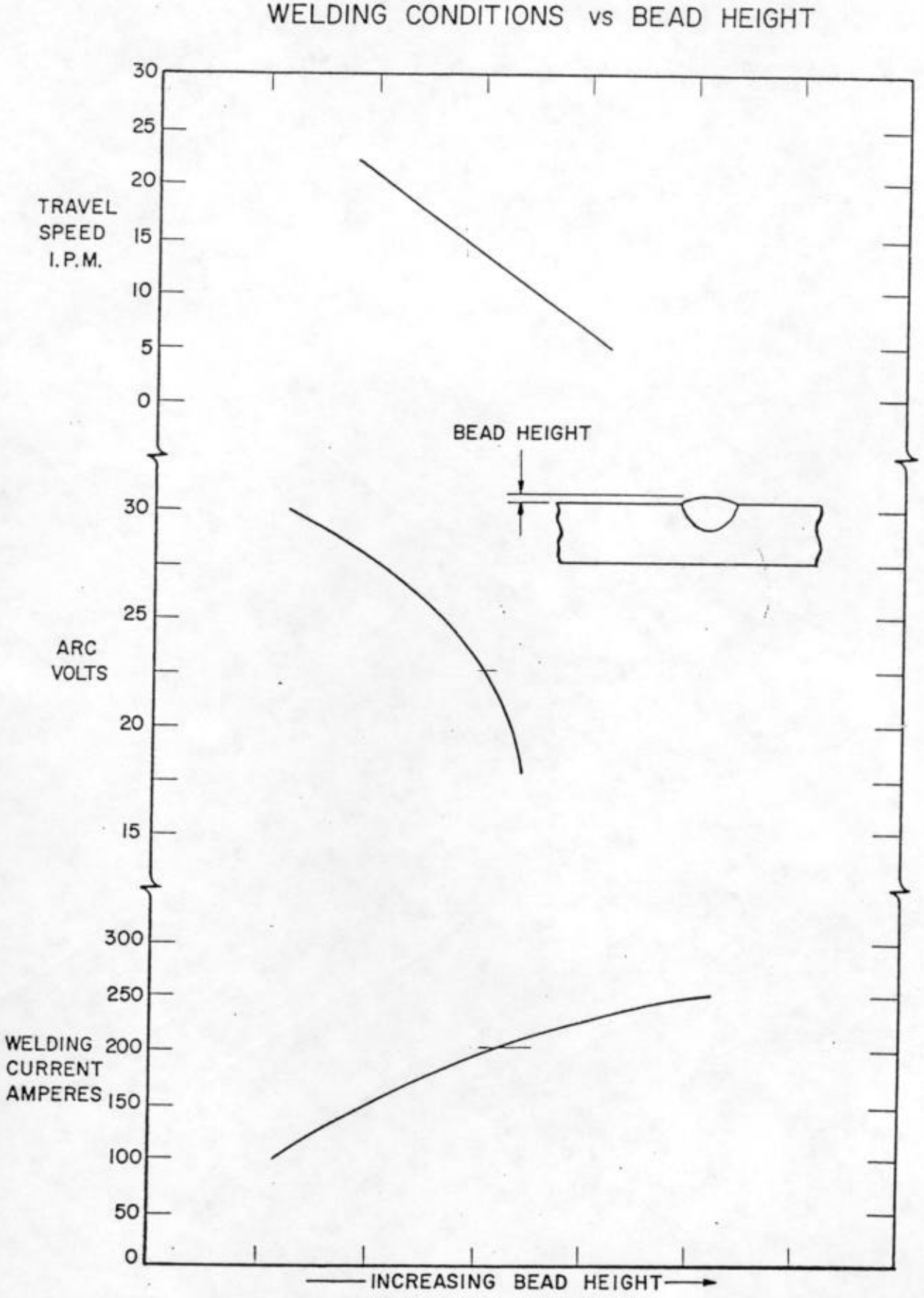


ILLUSTRATION NO. 14-11 EFFECT OF TRAVEL SPEED, ARC VOLTS, AND WELDING CURRENT ON BEAD HEIGHT.

WELDING CONDITIONS vs BEAD WIDTH

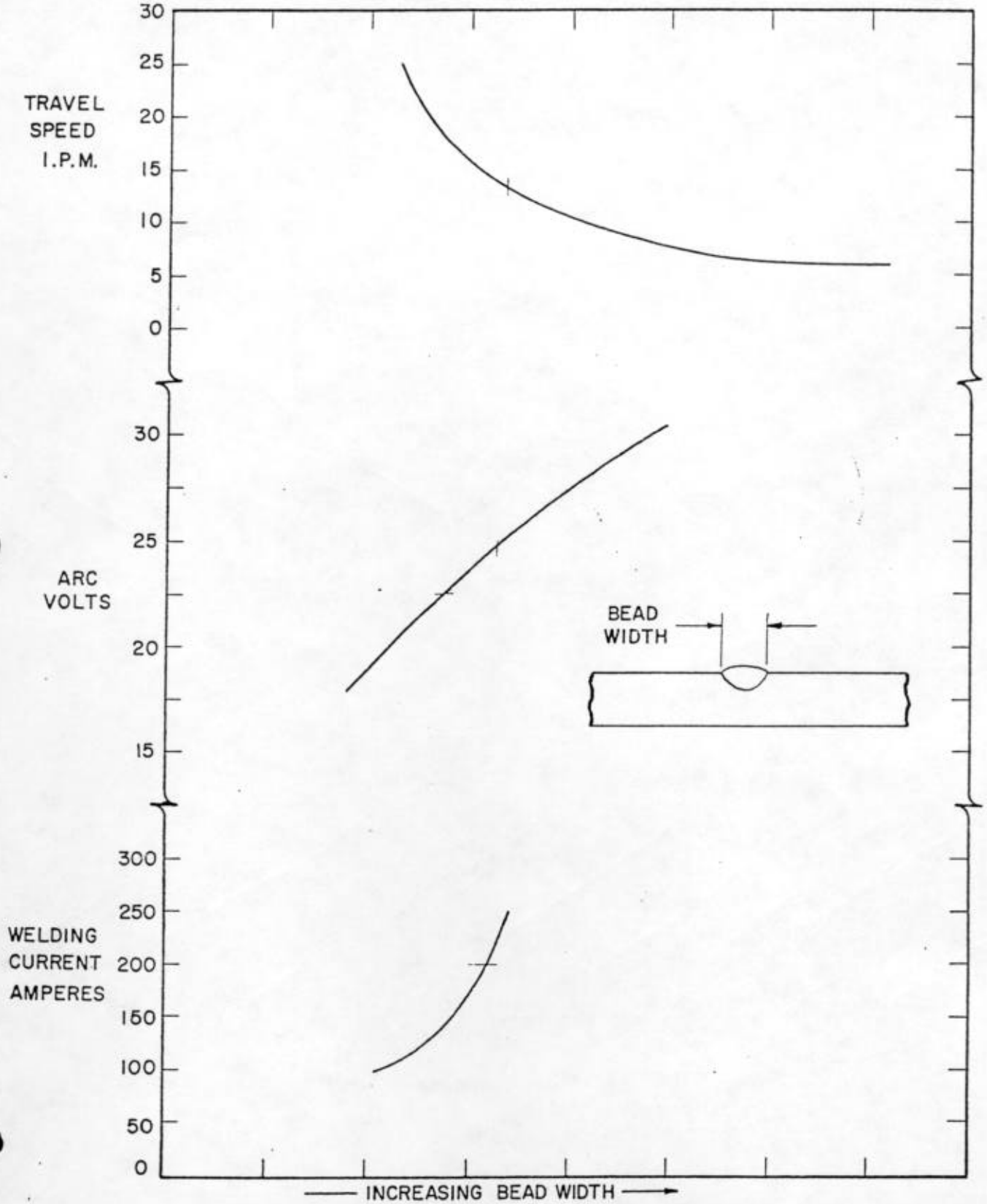
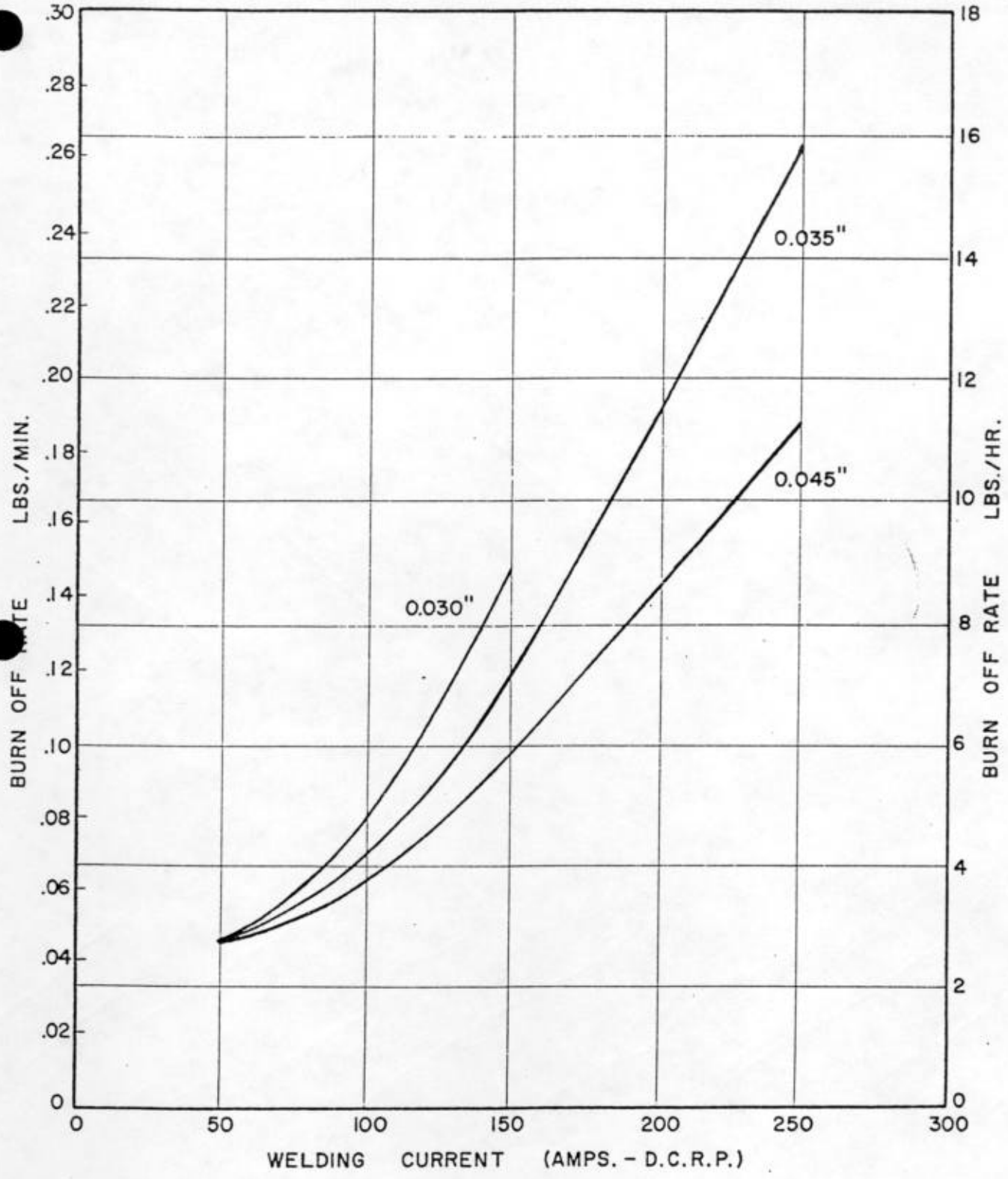


ILLUSTRATION NO. 14-12 EFFECT OF TRAVEL SPEED, ARC VOLTS, AND WELDING CURRENT ON BEAD WIDTH.

Illustration 14-15 BURN-OFF RATE vs WELDING CURRENT



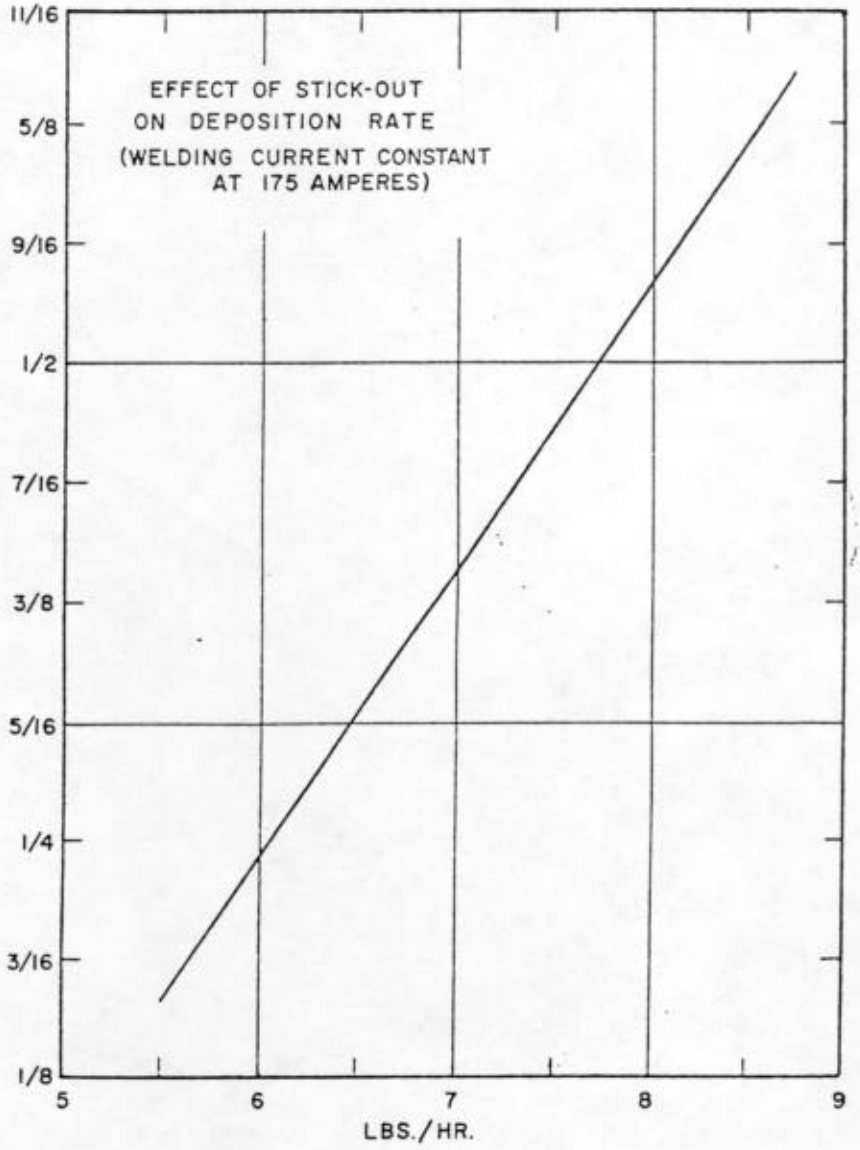


Illustration No. 14-16

Short-arc and spray transfer made simple

Teach operators fundamentals of gas metal arc welding, simple starting parameters for the wire size and the best transfer mode, and how to optimize parameters for the right heat input.

By Ed Craig

If your shop cannot justify purchase of solid-state welding machines that practically set themselves, shortening setup and adjustment time, take hope. Teaching operators how to set starting parameters for a few filler metal diameters and how to optimize those parameters for any job on your old machines can do almost as much to improve welding productivity in your shop as buying new machines.

When your operators know the fundamentals of gas metal arc welding (GMAW), and how to set up and adjust parameters, they will be able to select the best metal transfer mode and then make welds quickly. A new job with a different joint or weld position will no longer delay production.

Teach the basics

Well-trained operators understand that GMAW enjoys application throughout industry because it transfers weld metal productively in short-circuiting, globular, and spray transfer modes. Globular transfer is sensitive to current level-shielding gas combinations—at high current levels using CO_2 shielding it produces erratic contour and spatter. In contrast, short-circuiting and spray transfer produce smooth, sound welds in most applications.

Be sure that operators realize that in short-circuiting transfer the welding wire contacts the work 20 to 200 times per second, depending on current level, shorting out the arc and depositing a drop of molten filler metal at each contact. And that in spray transfer, small droplets of metal, no larger than the wire diameter, cascade across the arc gap, depositing on the work.

Short-circuiting

. . . . is a low-heat (low-current) process that uses small-diameter wires. Sheet metal fabricators and auto-body shops use 0.023- and 0.030- inch diameters; 0.035- and 0.045-inch wires join thicker material.

The typical current range for 0.023- to 0.045-inch wire is 40 to 225 A. Short circuits produce small, fast-freezing weld puddles, ideal for welding material less than 1/8 inch thick, welding out of position, making root passes, and filling gaps.

Spray transfer

. . . takes place when current is above a certain level (the level depending on wire size) and shielding gas is at least 80 percent argon. The high current induces a magnetic field around the end of the wire to pinch off the molten drops. The magnetic field produces a radial-inward force on the ionized gas in the weld zone, which keeps droplets moving straight from the end of the wire to the weld.

Using 0.045-inch wire at 190 A in short-circuiting transfer deposits 5 lb/h; with shielding gas high in argon and 300-A current, spray transfer deposits the same wire at 9 to 10 lb/h. The result is high-rate deposition, and high-quality, spatter-free welds in flat and horizontal positions. The main disadvantages of spray transfer, due to its high heat, is that it is not practical for overhead and vertical-up welds and for ferrous material thinner than 1/8 inch.

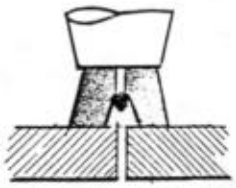
Set up for short-circuiting

Each wire size requires a specific current. For optimum welds the wire must feed at a rate just slightly faster than the melt-off rate at its

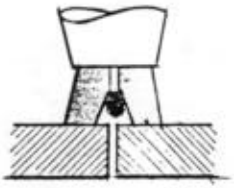
OPTIMUM CURRENTS FOR COMMON STEEL WIRES

Wire dia., in.	Short-circuiting transfer current, A	Minimum current, A, for spray transfer
0.030	50 to 150	160
0.035	75 to 175	185
0.045	100 to 225	235

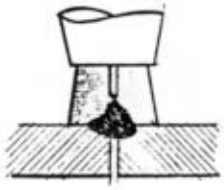
SHORT-CIRCUITING MODE



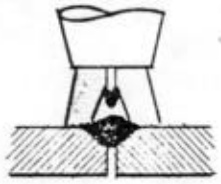
Drop begins to form in the heat of the arc.



Drop advances towards the base metal-weld puddle.

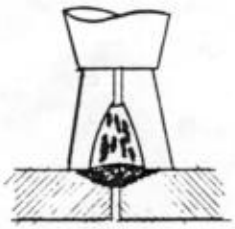


Drop touches the base metal-weld puddle, forming a short circuit; the arc goes out.

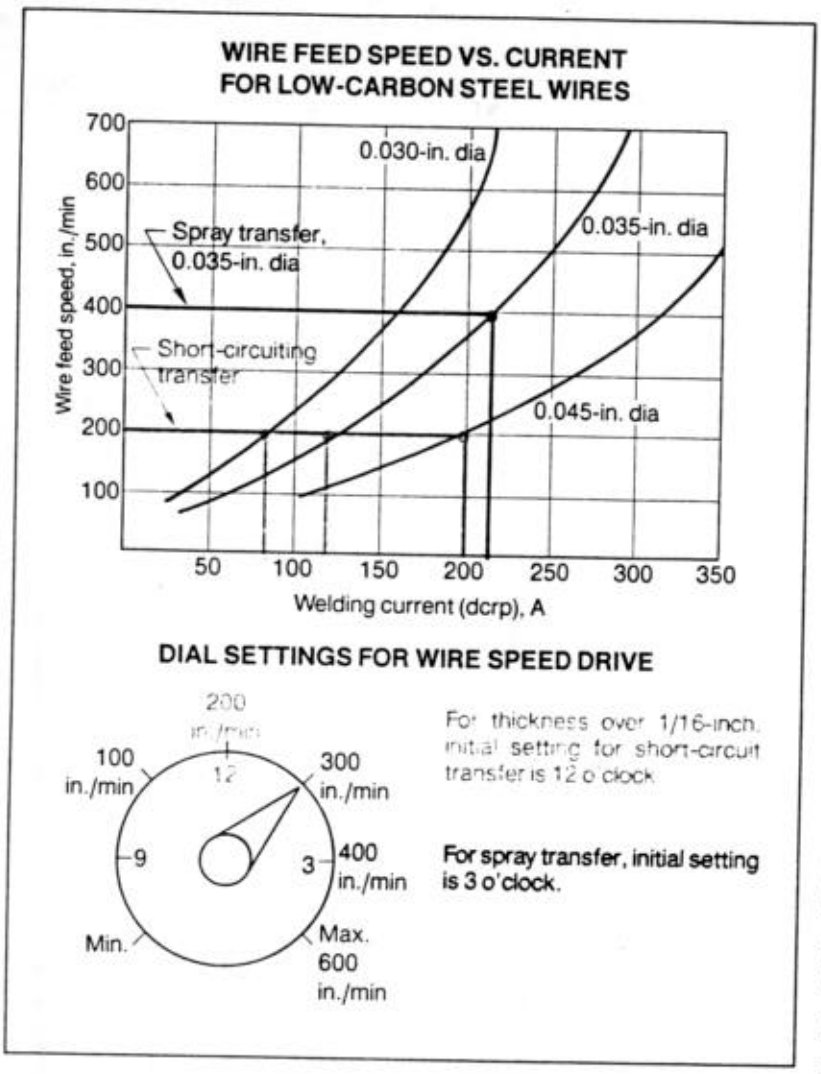


Drop transfers to the weld puddle; the arc reignites, and a new drop begins to form.

SPRAY MODE



Fine droplets melt off the end of the electrode and transfer to the base metal across the welding arc.



end; for 0.030- to 0.045-inch wires, short-circuiting uses wire feed speeds from 100 to 300 in./min. Most dial-control wire feeders for GMAW feed wire at the middle of this range, 200 in./min, when set approximately at top center—the 12 o'clock position; digital control feeders set at 200. At this setting a machine delivers 80 to 90 A for 0.030-inch wire, 120 to 130 A for 0.035-inch, and 190 to 200 A for 0.045-inch, all sound mid-range values.

Simple steps help an operator set up and optimize welding parameters for short-circuit or spray transfer.

Setting the correct voltage is critical for optimizing short-circuiting parameters. Voltage typically ranges from 13 to 23 V; the middle setting of this range, 18 V, is an ideal starting point for 0.030- to 0.045-inch wire when welding material thicker than 1/16 inch. For those thicknesses the operator will usually find that the optimized setting for 0.030-inch material is 17 V and for 0.045-inch, 19 V. For materials less than 1/16 inch thick and for welding gaps and root passes, the starting setting is 16 V. These are welding voltage settings, not open-circuit voltage (OCV) settings. Set OCV 3 to 7 volts higher, depending on power supply characteristics, to compensate for voltage drop through the welding circuit.

Optimizing the settings

Setting the machine at 16 V for thin and 18 V for thick material, and with the wire feed at 12 o'clock or 200 in./min, the operator makes a trial weld, and decides whether the weld needs more or less heat. For less heat, his first optimizing step is to reduce wire speed by turning the dial counterclockwise to the 11 o'clock position or setting the digital control at 180. If this does not produce the desired results, he returns the dial to top center (digital to 200), and reduces welding voltage by one volt. If further adjustment is needed, he repeats the first step, reducing wire feed speed. To raise heat, he reverses the steps, adjusting dials clockwise.

For final tuning, the operator listens for a consistenly smooth, crisp, crackling arc. He increases wire feed speed in small increments to increase crackle, slows it to reduce crackle.

With variable inductance

A power supply that has inductance control can add resistance that delays surges in current flow upon short-circuiting, reducing the force of the miniature explosions (the strength of the crackling sound) and increasing arc-on time, which adds heat to the weld. The added heat improves wettability and surface appearance.

If his power supply has variable inductance, the operator sets the machine at the nominal values for 0.035-inch wire—200 in./min and 18 V—and tries a weld on a clean piece of stock. Increasing inductance slightly, he makes another weld, and compares spatter of the two welds. He continues to increase inductance in small steps until spatter is minimal. Note that variable inductance has minimum impact when current is less than 120 A; benefits increase as wire size and current increase.

Spray transfer starting points

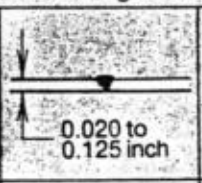
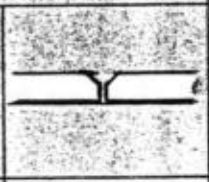
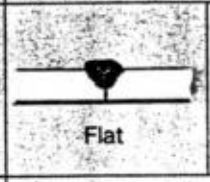
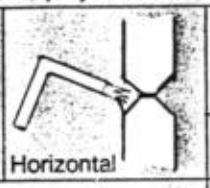
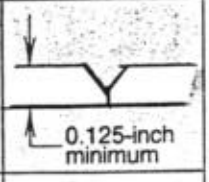
The high currents of spray transfer require high wire-feed speeds. With 0.034-inch wire, a typical spray setting would be 200 A and 400 in./min: for this wire size, the operator sets a dial-control wire feeder at the 3 o'clock position, digital control at 400 in./min.

Spray transfer voltage ranges from 23 to 33 V. The middle of this range, and the starting point for 0.035-inch wire, is 28 V, 10 V higher than for short-circuiting transfer.

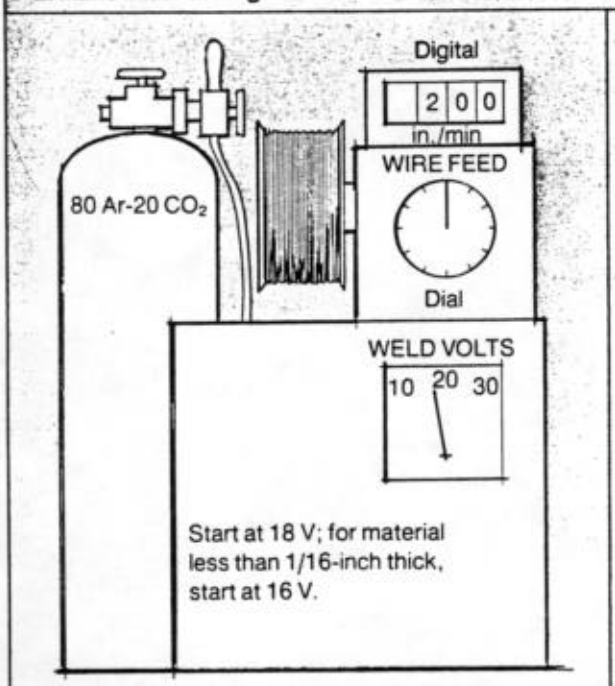
OPTIMIZING PARAMETERS FOR GAS METAL ARC WELDING OF STEEL

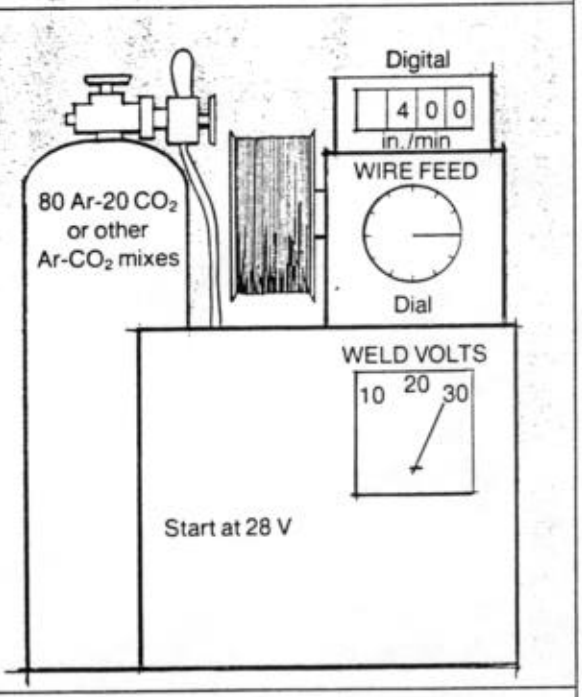
0.030-, 0.035-, 0.045-inch wire, argon-CO_2 shielding

1. Select transfer method.

Short-circuiting transfer			Spray transfer		
					
All positions	Thin materials	Root passes, gaps	Best positions		Thick material

2. Make initial settings





3. Adjust settings as indicated by results of trial welds.

1. To increase penetration, increase wire feed speed to next control number (for digital control, by 40 in./min).
2. For more penetration, increase voltage by 1 V.

Reverse the procedure for less penetration.

3. If the arc has a harsh, crackling sound, reduce wire feed speed.

1. Listen to the arc: it should have a quiet spraying sound with intermittent crackle.
2. If the crackle is almost constant, reduce wire feed speed.
3. If the arc has no crackle sound, increase wire feed speed.

Use 29 V for 0.045-inch and 27 V for 0.030-inch.

Fine-tuning spray transfer

As with short-circuiting transfer, the operator makes a trial weld and judges whether he needs less or more heat. For less heat, he reduces wire feed speed, turning the knob counterclockwise, from 3 to 1:30 o'clock (to 300 in./min on the digital meter). If that doesn't do the job, he returns wire feed to the base position, then lowers voltage by one volt. If heat is still too high, he reduces wire-feed speed as before. For more heat, he reverses the adjustments, moving the knob clockwise or increasing the digital value.

Final tuning is again by arc sound. If the arc has no crackle, he increases wire feed speed until crackle just begins. He wants an intermittent crackle that ensures a wire feed speed just high enough not to burn back the wire to the gun tip. If crackling is loud and almost continuous, he reduces wire feed speed until it is intermittent. Spray transfer is extremely hot, requiring a water-cooled torch or a torch rated

Arc crackle guides the fine tuner—smooth and crisp for short circuiting, intermittent for spray transfer.

FOR WELDING ALUMINUM USE SPRAY TRANSFER

Because aluminum has a low melting point and a high heat transfer rate that causes rapid solidification of weld metal, spray transfer is the best mode for this material.

Using typical wire diameters, 3/64 and 1/16-inch, guideline parameters are 22 V and 150 to 250 A, achieved with wirefeed speed of 300 to 400 in./min. Set dial wire-feed between 1 and 3 o'clock, digital control at 350, and voltage at 22 V (weld volts). Adjustments for optimization follow the pattern for steel: first reduce heat by lowering wire-feed speed. Reset to the starting position and lower voltage if changing speed doesn't do the job. Reverse the steps to raise heat input.

at 400 A. For operator comfort, establish optimum parameters then lower welding voltage by one or two volts and reduce arc length, reducing radiated heat.

For improved productivity

. . . at low cost, teach your operators the basics of GMAW and the simple procedures above. Relying on operator memorization of machine settings for every job can only lead to production delays and poor welds.

Understanding GMAW, your operators select the best transfer mode for the joint, material thickness, and position. Starting with the right pair of settings for the mode—18 V and wire speed set at 12 o'clock or 200 in./min for short-circuiting, or 28 V and 3 o'clock or 400 in./min for spray—and using simple incremental changes for wire diameter and adjusting heat input, your operators quickly establish optimum machine settings for each job.■

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GMAW Shielding Gases: Simplifying Selection

Fabricating shops want to simplify their inventory of gases for gas-shielded arc welding. Can they use just one or two compositions and retain weld quality?

ED CRAIG

Fabricators in North America and Europe can select from approximately 40 different shielding-gas mixes for gas-metal-arc welding (GMAW) of carbon steel, low-alloy steel, and stainless steel. The wide variety makes selection of a shielding-gas mix difficult. This article offers common-sense advice for selection of gas mixes for GMAW.

Just two shielding gases for gas-metal-arc welding, used here in a high-production environment, can serve for most welding applications, says the author of this article.

Classing the gases

The table lists 26 different shielding gases commonly used for GMAW of carbon, low-alloy, and stainless steels. Two gas mixes listed there meet all requirements for high-quality welds. The two mixes can deliver short-circuit, spray-transfer, and pulsed-GMAW metal transfer.

For carbon and low-alloy steels, an argon mix containing argon-15 percent CO_2 will produce optimum results for GMA short circuit, GMA spray and may also be used for carbon steel and stainless all-position flux-cored electrodes. For welding stainless a mix that contains 97 argon 3 CO_2 is ideal for most GMAW short-circuit and spray applications.

For welding of carbon and stainless steel, mixes that contain fractional amounts of reactive gases, like 90 helium-7.5 argon-2.5 CO_2, make no sense: half a percent CO_2 or O_2 in a gas mix has no influence on weld quality or weld chemistry.

Requirements for spray transfer

A myth of GMA welding is that "spray transfer cannot occur at CO_2 levels above 10 or 15 percent."

The fact: Shops in Europe have used 20-percent CO_2 mixes for spray transfer for decades. GMAW spray transfer is readily achieved with 0.035-inch wire with an argon mix containing up to 20-percent CO_2. Using 0.045-inch-diameter and larger wires, spray transfer can be achieved with an argon mix containing 25-percent CO_2 at a specific minimum current and voltage

Reactive gas additions and arc energy

One of the main differences among the many shielding gases used for

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SHIELDING GASES COMMONLY USED FOR GMAW OF CARBON AND LOW-ALLOY STEELS												
$Ar-O_2$		$Ar-CO_2-O_2$			$Ar-CO_2$		$Ar-He-CO_2-O_2$			
99	1	90	8	2	98	2	75	90	25	–
98	2	90	7.5	2.5	97	3	77	20	3	–
97	3	94	2	4	95	5	73	25	2	–
95	5	91	5	4	92	8	67	30	0	3
92	8	93	5	2	90	10	73	25	0	2
		90	5	5	88	12	71	25	3	1
					85	15				
					80	20				
					75	25				

Using spray transfer, welders will find differences in arc characteristics among the various gas mixes. When changing gas mixes, voltages may have to be adjusted to maintain the arc, and weld-puddle control will vary.

carbon steels is in arc-energy levels attained, influenced by the ionization potential (arc-voltage requirements) and the exothermic reactions of CO_2. The gas mixes can be divided into three groups by energy level. For GMA welding of carbon steel, maximum penetration, minimum weld porosity, and optimum impact properties result with use of medium- or high-energy mixes.

For short-circuit transfer

Short-circuit GMAW with 0.035-inch-diameter wire occurs at 40 to 200 A, 11 to 22 V, with argon mixes. Gas composition influences short-circuit frequency. For carbon-steel sheet-metal applications in the 20- to 12-gage range, a shielding gas from the medium- to high-energy group will overcome the fast-freeze characteristic of the short-circuit weld puddle to ensure consistent fusion. Welding voltage range for common argon-CO_2 mixes used for short-circuit transfer is 14 to 22 V.

For thin gages

To weld sheet metal thinner than 0.040 in. or for large gaps in sheet metal, to avoid melt-through, or to weld carbon or stainless steel by short-circuit transfer at less than 100 amps, consider an argon-oxygen gas mix from the low-energy group. These gas mixes produce a sustainable short-circuit arc at lower weld voltages than the medium- or high-energy group.

The minimum voltage for short-circuit transfer with $Ar-O_2$ mixes is 11 volts, a benefit on 20-gage sheet and thinner. With the medium- to high-energy gas mixes, the minimum weld voltage is 14 volts.

Short circuit and spray: one gas for both

For short-circuit transfer on carbon steels thicker than 20 gage, the welding decision maker selects a medium-energy mix, Ar-13-20 CO_2 or a high-energy mix, 75 Ar-25 CO_2.

Both gas mixes provide enough energy for short-circuit transfer in sheet-metal applications up to 10 gage. Most sheet-metal shops also weld material thicker than 10 gage with spray-transfer current. A medium-energy mix for spray transfer is a logical choice, as the 75 Ar-25 CO_2 mix will produce spatter when used with 0.035-inch wire.

For the sheet-metal shop that welds mostly gage carbon steels and occasionally welds material up to 1/4 inch, the optimum wire diameter is 0.035 in., which calls for a medium-energy mix of argon with 13-20-percent CO_2 for optimum spray transfer. The spray-current range for the 0.035-in. electrode is 180-350 A.

If the electrode is 0.045-in.-diameter, the welder attains spray transfer at approximately 320 A, 33-34 V, with 75 Ar-25 CO_2. Using an Ar-15-20 CO_2 mix, spatter-free spray transfer occurs at approximately 265 A, 27-28 V.

Welding steels covered with mill scale, which conducts current poorly, requires higher voltages than for clean steel and calls for a medium- or high-energy shielding gas.

Traditional $Ar-CO_2-O_2$ tri-mixes and short-circuit transfer

Three-part gas mixes fall into the low-energy gas group, using the same voltages and producing metal-transfer characteristics similar to an Ar-8 CO_2 mix. They offer no welding benefits over Ar-5-10 CO_2 mixes for spray transfer.

The low-energy tri-mix GMAW gases are well-suited to the low-energy process pulsed GMAW. In short-circuit transfer, the tri-mixes provide less energy than the high-energy Ar-CO_2 mixes. On carbon steel 14-10 gage, lack of fusion may result with short-circuit welding with tri mixes, $Ar-O_2$ mixes, and Ar-CO_2 mixes containing less than 10-percent CO_2.

The traditional tri mixes offer no benefit over standard two-component Ar-5-10 CO_2 or traditional $Ar-O_2$ mixes. For spray transfer on material thicker than 0.040 in., argon-15-20 CO_2 can give superior penetration, less porosity, better impact properties, and less sensitivity to mill scale or coated steels. The argon trimixes perform less well than the medium- and high-energy gases for most short-circuit applications thicker than 20 gage.

Argon-oxygen mixes

Gas suppliers add small amounts of oxygen to argon spray mixes to increase arc heat and stabilize electron transfer. CO_2 added to argon for spray

COMMON ARGON SHIELDING GAS MIXES GROUPED BY ARC ENERGY THEY PRODUCE		
A-Low arc energy	**B-Medium arc energy**	**C-High arc energy**
All 2-part $Ar-O_2$ mixes	All 2-part Ar-CO_2 mixes with 13-21 percent CO_2	Argon mixes with 22-30 percent CO_2
All 3-part $Ar-CO_2-O_2$ mixes containing less than 10 percent CO_2	These mixes may be used for most short circuit and spray applications with all GMAW wire diameters	Suitable for short circuit and spray. Spatter will result with wires smaller than 0.045
All argon-CO_2 mixes containing less than 8 percent CO_2	Will require higher weld voltages than Group A.	The gas mixes will require higher weld voltage than Group B.

In contrast to the argon-oxygen group, medium- and high-energy gas mixes require higher weld voltages. They give greater control of the weld pool, improved weld penetration, less porosity, and are less sensitive to mill scale or surface coatings.

transfer has the same effect, plus it can raise the arc energy with less oxidizing potential, hence less porosity. Argon-oxygen is not suitable for most carbon-steel short-circuit applications except at currents under 100 A or on work thinner than 0.060 inch.

Ar-He-CO_2

Since the medium-energy argon-CO_2 mixes produce welds that meet the most exacting standards for carbon steels, it is difficult to justify the costlier helium mixes for GMAW of these steels. All the medium-energy gas mixes in the table, when used with optimum welding parameters, will provide the energy needed for most spray-transfer applications. The argon-CO_2 mixes result in perfectly flat spatter-free fillet welds. For short-circuit and spray transfer, the medium- and high-energy gases provide the required weld wetting to produce flat fillet-weld surfaces.

Gases for welding of stainless steel

Welding austenitic stainlesses calls for 97 Ar-3 CO_2. This gas produces excellent results at 20 to 25 percent less energy input than do standard helium tri-mixes when short-circuit welding. The lower energy reduces distortion, burnthrough potential, and weld oxidation.

For spray transfer, the most common gas mix is an argon-2 oxygen mix. A problem with this mix: the oxygen oxidizes the weld leaving a black oxide surface on the weld difficult to remove. The solution is to not use an oxygen mix; try the same weld using the Ar-3 CO_2 mix. The cleaner weld surface will speak for itself. The argon CO_2 mix will use the same voltage as the argon-oxygen mix.

With the simple cost-effective two-component argon CO_2 mix for stainless the welding shop will have a single two-component multipurpose gas mix that will produce optimum quality GMAW welds on most stainless applications.

Welding steels covered with scale calls for a medium or high-energy shielding gas

In conclusion

Shops that weld carbon steels, low-alloy steels, and stainless steels can use two multipurpose gas mixes for all their applications. An argon-13-20 CO_2 mix delivers optimum weld results for all short-circuit and spray-transfer carbon and low-alloy steel applications. The optimum Ar-CO_2 mix is Ar-15 CO_2, which allows for cylinder-composition tolerance variations. This mix may also be used to shield all-position flux-cored welding of carbon, low-alloy, and stainless steels.

For welding stainless, an Ar-3 CO_2 mix works well for GMAW short-circuit and spray transfer. The Ar-3 CO_2 mix may be used for all pulsed-spray applications on carbon and stainless steels. For the welding shop that is trying to sort through the numerous available argon mixes, two simple argon-CO_2 mixes will provide ideal welds for the majority of applications. ■

Watch for responses to this article from vendors of shielding-gas mixes in the October issue of WELDING DESIGN & FABRICATION.

INSTALLATION INSTRUCTIONS
YORKVILLE 1.6 GPF TWO-PIECE PRESSURE-ASSISTED TOILETS
- Model 2320 Elongated
- Model 2325 Elongated

Thank you for selecting American Standard - the benchmark of fine quality for over 100 years. To ensure this product is installed properly, please read these instructions carefully before you begin. (Certain installations may require professional help.) Also be sure your installation conforms to local codes.

⚠ CAUTION: PRODUCT IS FRAGILE. TO AVOID BREAKAGE AND POSSIBLE INJURY HANDLE WITH CARE!

NOTE: *For proper operation these products require a minimum of 20 psi line pressure*

RECOMMENDED TOOLS AND MATERIALS

Putty Knife | Regular Screwdriver | Adjustable Wrench | Carpenters Level | Tape Measure | Hacksaw

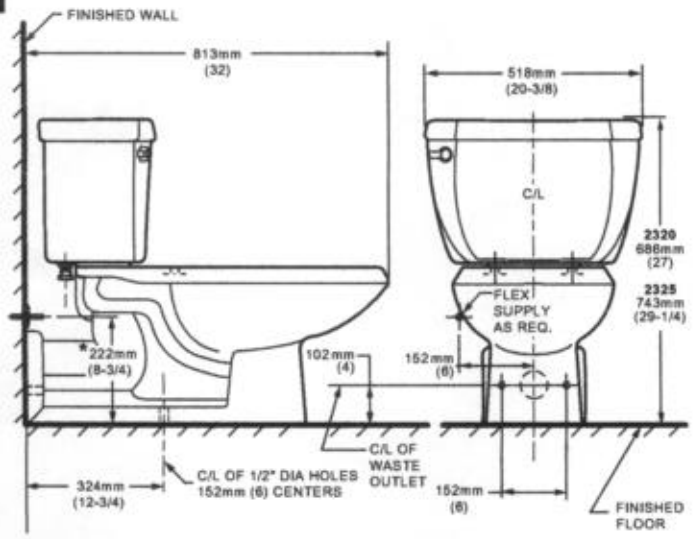
Neoprene or Graphite Felt Gasket | Closet FLange Set | Flexible Supply Tube | (2) 5/16" Lag Bolts | Sealant

1 REMOVE OLD TOILET

a. Close toilet supply valve and flush tank completely. Towel or sponge remaining water from tank and bowl.
b. Disconnect and remove supply line. NOTE: *If replacing valve, first shut off main water supply!*
c. Remove old mounting hardware, remove toilet and plug wall waste opening to prevent escaping sewer gases.
d. Remove closet bolts from flange and clean away old wax, putty, etc. from base area.
NOTE: *Mounting surface must be clean and perpendicular to the floor **before** new toilet is installed!*

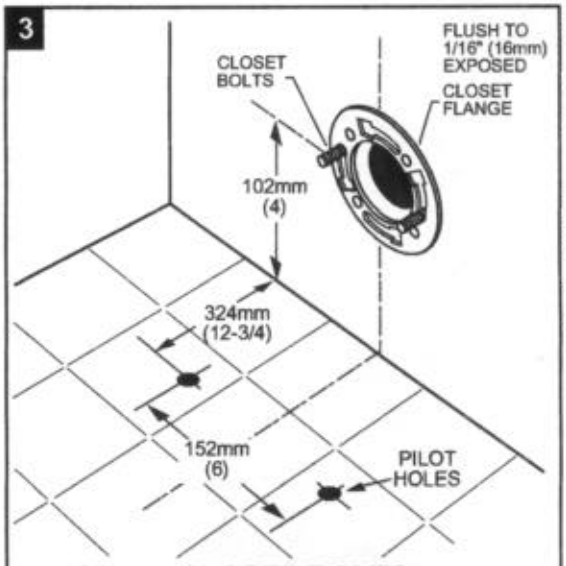
SAVE FOR FUTURE USE

2



DIMENSIONS (Nominal) NOTE: *Distance from floor to closet flange centerline (rough-in) must be 4" (102 mm) with flange surface flush to 1/16" (16mm) max. beyond finished wall.*

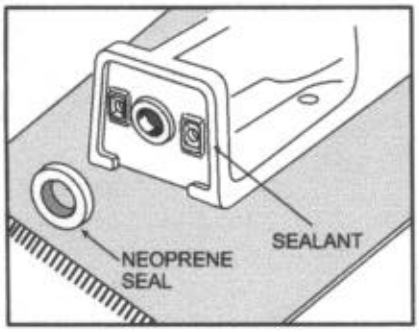
3



INSTALL CLOSET BOLTS
Install closet bolts in flange channel, turn 90°, and slide into place 6" (152 mm) apart and parallel to floor. (Use putty to hold bolts in place if necessary.) Brace under flooring as needed and drill two mounting pilot holes as shown.

American Standard | Ideal Standard | Ideal Standard | Sadosa Standard | Cedelca | Saniwares

4

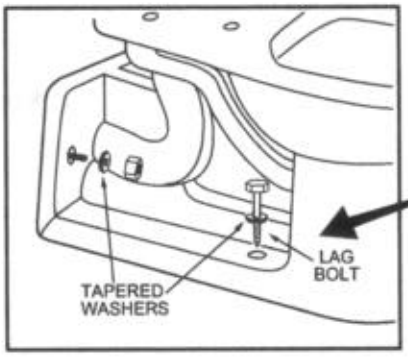


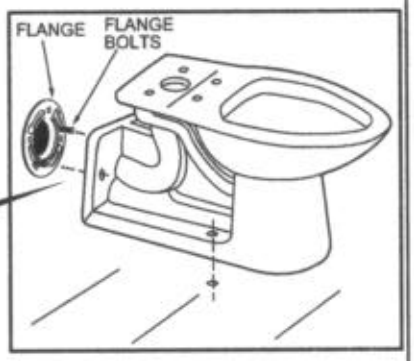
INSTALL NEOPRENE OR GRAPHITE FELT SEAL*

Install seal evenly around waste flange (horn). Apply a thin bead of sealant around base flange.

* Note: Wax seal not recommended for this application.

5

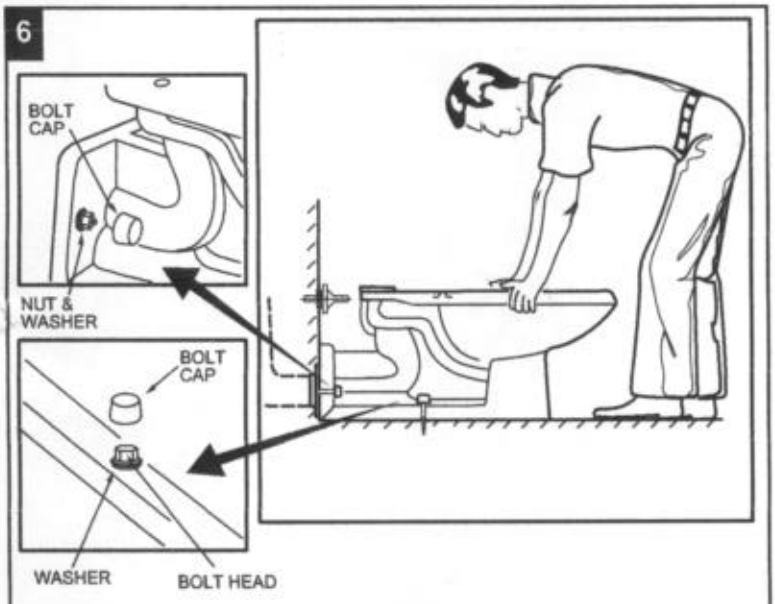




INSTALL TOILET ON FLANGE

a. Unplug wall waste opening and slide toilet towards closet flange so bolts project through mounting holes.
b. Loosely install retainer tapered washers and nuts. Side of washers marked "THIS SIDE UP" *must* face you!

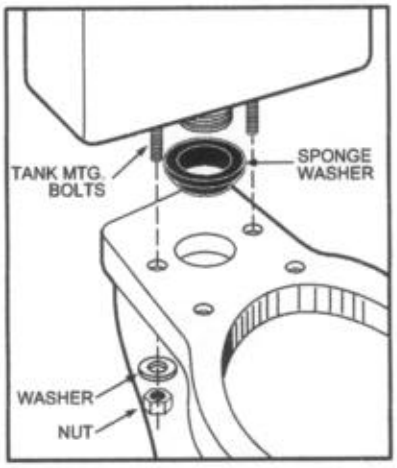
6



INSTALL TOILET

a. Position toilet squarely to wall and, with a rocking motion, push bowl against ring and flange.
Alternately tighten nuts until toilet is firmly anchored.
⚠ CAUTION: DO NOT OVERTIGHTEN NUTS OR BASE MAY BE DAMAGED!
b. Insert the tapered washers (supplied in the kit) into the lag bolts (not supplied). Insert bolts through mounting holes and tighten into pre-drilled floor openings.
c. Install the four bolt caps on tapered washers. (If necessary, cut wall bolt length to size before installing caps.)
d. Smooth off the bead of sealant around base. Remove excess sealant.

7



INSTALL TANK

a. Install large rubber gasket over threaded outlet on bottom of tank and lower tank onto bowl so that tapered end of gasket fits evenly into bowl water inlet opening, and tank mounting bolts go through mounting holes. Secure with metal washers and nuts.
b. With tank parallel to wall, alternately tighten nuts until tank is snugged down evenly against bowl's sanitary ribs.

⚠ CAUTION: DO NOT OVERTIGHTEN NUTS MORE THAN REQUIRED FOR A SNUG FIT!

8 **INSTALL TOILET SEAT** Install toilet seat in accordance with manufacturer's directions.

3D/Group, Inc.
Architecture
Engineering
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November 4, 2003
pdgDOMUS - HARTFORD STYLE
STRUCTURAL CALCULATIONS

Allowable Deflection (per able 301.6)

Floor and Ceiling Limit Live Load Deflection to l / 360
Roof, and any other structural members, Limit Live Load Deflection to l / 240
Deck and Walls Limit Live Load Deflection to l / 180

Beam Span, L = 20 ft.
Joist Spacing = 16 o.c.

Loads @ Floor Beams

Floor Plate	-	16.37 psf (200sf)	=	3,274
Beam (Tube Section)	-	12.0 plf (60 lf)	=	720
Joist	-	5.10 plf (15 @ 10 lf)	=	765
Perimeter Walls & Glass		31.3 plf (40 sf)	=	1,252
HVAC	-	200 lbs	=	200
Insulation	-	1 psf (200 sf)	=	200
Partition Load	-	5 psf (200 sf)	=	1,000
Live Load	-	40 psf (200 sf)	=	8,000
Ceiling Load	-	2 psf (200 sf)	=	400
			TOTAL:	15,811 lbs = 3.953 kips / Col

Loads @ Roof Beams

Floor Plate	-	16.37 psf (200sf)	=	3,274
Ridge Beam	-	13.61 plf (24 lf)	=	327
Rafters	-	5.10 plf (11 @ 10 lf)	=	561
Insulation	-	1 psf (200 sf)	=	200
Ceiling Load	-	2 psf (200 sf)	=	400
Snow Load	-	30 psf (290 sf)	=	8,700
			TOTAL:	13,462 lbs = 3.366 kips / Col

Loads @ Deck Beams

Floor Plate	-	16.37 psf (200sf)	=	3,274
Beam	-	12.0 plf (60)	=	720
Joist	-	5.10 plf (15 @ 10 lf)	=	765
Insulation	-	1 psf (200 sf)	=	200
Ceiling Load	-	2 psf (200 sf)	=	400
Ceramic Tiles	-	5 psf (200 sf)	=	1,000
Snow Load	-	30 psf (200 sf)	=	6,000
			TOTAL:	12,359 lbs = 3.09 kips / Col

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pdgDOMUS - HARTFORD STYLE
STRUCTURAL CALCULATIONS

ROOF — Limit Live Load to l / 240

Rafter Loads:

Rafter top plate (0.5 x5.0) x 490pcf	=	8.51 plf
Rafter (Dead Load) (2 x5)	=	5.61 plf
Live (snow) Load	=	60.0 plf
PLF (DL + LL)	=	65.6 plf
Rafter Length	=	7.70 ft (92.35 in)
SP rafter	=	24.0 in
PSF DL roof	=	3 psf

$$R\_DL = \frac{\text{dead load x rafter L}}{2} = 21.59 \text{ lbf}$$

$$R\_conn = \frac{(PLF \times L)}{2} = 252.46 \text{ lbf}$$

$$\text{PLF @ rafter edge} = \frac{(PSF\ DL\_roof) \times L}{2} + \frac{R\_DL}{\text{sp rafter}} + \text{top pl} = 31.30 \text{ plf}$$

$$\text{PLF rf\_edge\_ll} = PSF\ ll\ r \times \frac{W\ rdg}{2} = 120.00 \text{ plf}$$

$$\text{PLF rf\_edge} = \text{PLF rf\_edg\_ell} + \text{PLF rf\_ edge\_dl} = 151.30 \text{ plf}$$

Rafter Quantity = (L rdg / sp rafter)-1 = (24 ft / 24 in)-1 = 11

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pdgDOMUS - HARTFORD STYLE
STRUCTURAL CALCULATIONS

Simple Span Beam - Uniformly Distributed Load (Per Aluminum Design Manual #19)

Ridge Beam (8 x 0.50 — ASTM A36 — interior span only)

Variables:
L = 24 -0 | t = 0.50 in | d = 8.00 in | Qty = 2
a = 8 in | S = 5.33 in^3 | Fy = 36 ksi | E = 29,000,000
b = L — 2 a | I = 21.33^4 | Deflection = L / 240 | PSF$_{LLroof}$ = 35 psf

Beam Loading: W_{LL} = 280 plf
W_{DL} = 15.3 plf
$W = W_{DL} + W_{LL}$ = 295.3 plf

Allowable Stress
Fb = 0.66 x Fy = 23.8 ksi
Fv = 0.40 x Fy = 14.4 ksi

Shear & Reactions
R = w . b / 2 = V = R R = 3.35 kips
Aw = t . d = Aw = 4 in^2

Vall = Fv . Aw = 14.4 ksi x 4 in^2 = Vall = 57.60 kips

Vall = 57.60 kips $\geq$ R = 3.35 kips **CHECK = OK**

Bending
$M_{support} = \frac{w \cdot a^2}{2}$ (Moment @ supports) $M_{support}$ = 0.07 ft.kips

$M_{center} = \frac{w \cdot L}{2} \times (L - 4.a)$ (Moment @ center) M_{center} = 18.89 ft.kips

M max = Max (Msupport , Mcenter) M max = 18.89 ft.kips

M_{all} = Fb . (S. Qty) M_{all} = 21.12 ft.kips

M all = 21.12 ft.kips $\geq$ Mmax = 18.89 ft.kips **CHECK = OK**

Deflection:

def @ center = $\frac{(W_{LL} \times L) \times b}{384 \cdot E \cdot (I.Qty)} \left((5/L) \times b^2 - 24 / L \times (a^2 / b) \right)$ = deflection @ center = 1.16 in

def @ end = $\frac{(W_{LL} \times L) \times b}{24 \cdot E \cdot (I.Qty) \cdot L} \left(-1 + (6) \times (a/b)^2 + 3 (a / b)^3 \right)$ = deflection @ overhang = - 0.108 in

Max Deflection = def @ end , def @ center

Allowable Deflection = L / 240 = 24 ft x 12 / 240 = 1.20 in

Allowable Deflection = 1.20 in $\geq$ Max Deflection = 1.16 in **CHECK = OK**

November 4, 2003
pdgDOMUS - HARTFORD STYLE
STRUCTURAL CALCULATIONS

Simple Span Beam - Uniformly Distributed Load (Per Aluminum Design Manual #19)

Ridge Beam @ Gable Overhang ONLY (7 x 0.50 — ASTM A36)

Variables: L = 1 -0 | t = 0.50 in | d = 7.00 in | Qty = 2
a = 7 in | S = 5.33 in^3 | Fy = 36 ksi | E = 29,000,000
I = 21.33^4 | Deflection = L / 240 | PSF$_{LLroof}$ = 30 psf

Beam Loading: W_{LL} = 240 plf
W_{DL} = 15.3 plf
$W = W_{DL} + W_{LL}$ = 255.3 plf

Allowable Stress Fb = 0.66 x Fy = 23.8 ksi
Fv = 0.40 x Fy = 14.4 ksi

Shear & Reactions
R = w . L / 2 = V = R R = 0.128 kips
Aw = t . d = Aw = 4 in^2

Vall = Fv . Aw = 14.4 ksi x 4 in^2 = Vall = 57.60 kips

Vall = 57.60 kips $\geq$ R = 0.128 kips **CHECK = OK**

Bending
$M_{support} = \frac{w \cdot a^2}{2}$ (Moment @ supports) $M_{support}$ = 0.05 ft.kips

M_{all} = Fb . (S. Qty) M all = 0.254 ft.kips

M all = 0.254 ft.kips $\geq$ M support = 0.05 ft.kips **CHECK = OK**

Deflection:

def @ end = $\frac{(W_{LL} \times L^4)}{8 \cdot E \cdot (I.Qty)}$ = deflection @ overhang = - 0.024 in

Allowable Deflection = L / 240 = 2 x 7 / 240 = 0.058 in

Allowable Deflection = 0.058 in $\geq$ Max Deflection = 0.024 in **CHECK = OK**

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pdgDOMUS - HARTFORD STYLE
STRUCTURAL CALCULATIONS

Simple Span Beam - Uniformly Distributed Load (Per AISC Condition #1)

Roof Load ONLY (6 x 4 x 3 / 16 — ASTM A500 Gr. B)

Variables:	L = 10 -0	t = 0.1875 in	d = 6.00 in	Qty = 1
	x = 0.50 x L	S = 5.46 in^3	Fy = 46 ksi	E = 29,000,000
		I = 16.4 ^4	Deflection = L / 240	PSF_{LLroof} = 30 psf

Results:

Beam Loading: W_{LL} = 150 plf
W_{DL} = 31.3 plf
$W = W_{DL} + W_{LL}$ = 181.3 plf

Allowable Stress Fb = 0.66 x Fy = 30.36 ksi
Fv = 0.40 x Fy = 18.40 ksi

Steel Stress: Load = w x L (Total Equivalent Uniform Load) Load = 1.81 kips

Shear & Reactions:
R = w . L / 2 = V = R R = 0.905 kips
Aw = 2 x tw .(d — 2 tw) = Aw = 2.11 in^2

Vall = Fv . Aw = 18.4 ksi x 0.905 in^2 = V all = 16.65 kips

V all = 16.65 kips $\geq$ R =0.905 kips **CHECK = OK**

Bending

$$Mmax = \frac{w \cdot L^2}{8}$$ (Moment @ center) M_{center} = 2.27 ft.kips

M_{all} = Fb . (S. Qty) M all = 13.81 ft.kips

M all = 13.81 ft.kips $\geq$ Mmax = 2.27 ft.kips **CHECK = OK**

Deflection:

$$def\ @\ max = \frac{5 W_{LL} \times L^4}{384 \cdot E \cdot (I.Qty)}$$ (Live Load Deflection @ center) = 0.06 in

Allowable Deflection = L / 240 = 10 ft x 12 / 240 = 0.50 in

Allowable Deflection = 0.50 in $\geq$ Max Deflection = 0.06 in **CHECK = OK**

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pdgDOMUS - HARTFORD STYLE
STRUCTURAL CALCULATIONS

Simple Span Beam - Uniformly Distributed Load (Per AISC Condition #1)

LOFT FLOOR Load ONLY (6 x 4 x 3 / 16 — ASTM A500 Gr. B)

Variables: L = 20 -0 (*) t = 0.1875 in d = 6.00 in Qty = 1
x = 0.50 x L S = 5.46 in^3 Fy = 46 ksi E = 29,000,000
I = 16.4 ^4 Deflection = L / 240 $PSF_{LLbedroom}$ = 30 psf
(*) Because of partition framing, the longest unsupported span is 14 -0 on the first floor and 10 -0 on the second level; calculations are based on a clear span of 20 -0

Results:

Beam Loading: W_{LL} = 150 plf
W_{DL} = 31.3 plf
$W = W_{DL} + W_{LL}$ = 181.3 plf

Allowable Stress Fb = 0.66 x Fy = 30.36 ksi
Fv = 0.40 x Fy = 18.40 ksi

Steel Stress: Load = w x L (Total Equivalent Uniform Load) Load = 3.63 kips

Shear & Reactions:
R = w . L / 2 = V = R R = 1.81 kips
Aw = 2 x tw .(d — 2 tw) = Aw = 2.11 in^2

Vall = Fv . Aw = 18.4 ksi x 2.11 in^2 = V all = 38.82 kips

V all = 38.82 kips $\geq$ R = 1.81 kips **CHECK = OK**

Bending

$$Mmax = \frac{w \cdot L^2}{8}$$ (Moment @ center) M_{center} = 9.07 ft.kips

M_{all} = Fb . (S. Qty) M all = 13.81 ft.kips

M all = 13.81 ft.kips $\geq$ Mmax = 9.07 ft.kips **CHECK = OK**

Deflection:

$$\text{def @ max} = \frac{5 W_{LL} \times L^4}{384 \cdot E \cdot (I.Qty)}$$ (Live Load Deflection @ center) = 0.69 in

Allowable Deflection = L / 240 = 20 ft x 12 / 240 = 1.00 in

Allowable Deflection = 1.00 in $\geq$ Max Deflection = 0.69 in **CHECK = OK**

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STRUCTURAL CALCULATIONS

Simple Span Beam - Uniformly Distributed Load (Per AISC Condition #1)

30 psf Roof Joist Load (5 x 2 x 1 / 8 — ASTM A500 Gr. B)

Variables: L = 15 ft + 5 in; tw = 0.125 in; d = 5.00 in; Qty = 1
x = 0.50 x L; S = 1.86 in^3; Fy = 42 ksi; E = 29,000,000
I = 4.65 ^4; Deflection = L / 240; PSF$_{LLroof}$ = 30 psf

Results:

Beam Loading: W $_{LL}$ = 60 plf
W $_{DL}$ = 5.61 plf
W = W$_{DL}$ + W$_{LL}$ = 65.61 plf

Allowable Stress Fb = 0.66 x Fy = 27.7 ksi
Fv = 0.40 x Fy = 16.8 ksi

Steel Stress: Load = w x L (Total Equivalent Uniform Load) Load = 1.012kips

Shear & Reactions:
R = w .L / 2 = V = R R = 0.505 kips
Aw = 2 x tw .(d — 2 tw) = Aw = 1.19 in^2

Vall = Fv . Aw = 16.8 ksi x 1.19 in^2 = V all = 19.99 kips

V all = 19.99 kips $\geq$ R = 0.505 kips **CHECK = OK**

Bending
Mmax = $\frac{w \cdot L^2}{8}$ (Moment @ center) Mmax = 1.95 ft.kips

Mall = Fb . (S. Qty) M all = 4.29 ft.kips

M all = 4.29 ft.kips $\geq$ Mmax = 1.95 ft.kips **CHECK = OK**

Deflection:
def @ max = $\frac{5W_{LL} \times L^4}{384 \cdot E \cdot (I.Qty)}$ (Live Load Deflection @ center) = 0.674 in

Allowable Deflection = L / 240 = 15 -5 ft x 12 240 = 0.771 in

Allowable Deflection = 0.771 in $\geq$ Max Deflection = 0.674 in **CHECK = OK**

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pdgDOMUS - HARTFORD STYLE
STRUCTURAL CALCULATIONS

Simple Span Beam - Uniformly Distributed Load (Per AISC Condition #1)

Floor Joist Load ONLY (6 x _ x 10 -0 — ASTM A36)

Variables: L = 10 -0 | t = 0.25 in | d = 6.00 in | Qty = 1
x = 0.50 x L | S = 1.50 in^3 | Fy = 36 ksi | E = 29,000,000
I = 4.50 ^4 | Deflection = L / 360

Results:

Beam Loading: Joist LL = 40 PSF$_{LLf}$ x SPjst (40 psf Floor Load Dwelling @ 16 in o.c.) = 53.33 plf
Joist DL = t x d = 15.30 plf
PLF = Joist DL + Joist LL = 68.63 plf

Allowable Stress Fb = 0.66 x Fy = Fb = 23.76 ksi
Fv = 0.40 x Fy = Fv = 14.40 ksi

Shear & Reactions:

R = PLF jst x L joist / 2 = V = R R = 341.65 lbf
Aw = 2 x tw .(d — 2 tw) = Aw = 2.75 in^2

Vall = Fv . Aw = 14.40 ksi x 2.75 in^2 = V all = 39.60 kips

V all = 39.60 kips $\geq$ R = 341.65 lbf **CHECK = OK**

Bending

$M_{max} = \frac{w \cdot L^2}{8}$ (Moment @ center) M max = 0.820 ft.kips

M_{all} = Fb . (S. Qty) M_{all} = 2.97 ft.kips

M all = 2.97 ft.kips $\geq$ Mmax = 0.820 ft.kips **CHECK = OK**

Deflection:

$def\ @\ max = \frac{5W_{LL} \times L^4}{384 \cdot E \cdot (I.Qty)}$ (Live Load Deflection @ center) = 0.002 in

Allowable Deflection = L / 360 = 10 ft x 12 / 360 = 0.33 in

Allowable Deflection = 0.33 in $\geq$ Max Deflection = 0.002 in **CHECK = OK**

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pdgDOMUS - HARTFORD STYLE
STRUCTURAL CALCULATIONS

Simple Span Beam - Uniformly Distributed Load (Per AISC Condition #1)

Floor Plate Load (0.1875 x 10 -0 x 20 -0 — ASTM A36)

Variables: A = 220.4 sf

Floor Plate Dead Load:

PSF_{fL_PL}	=	(Y_{sT}) x t_{floor}		=	7.66 psf
$P_{fL\ Pl}$	=	A_{fl} x (PSF $_{fl}$Pl)	Floor Plate Total Load	+	1,687.8 lbf

CEILING FRAMING (Joists spaced at 16 inches on center)

Ceiling Joist	2 plf (15 @ 10 lf)	=	300
Drywall Ceiling	2 psf (200 sf)	=	400
	TOTAL:		700 lbs

Ceiling Joist (0.0625 x 1.75 x 1.75 x 10 -0 — ASTM A513 Type 1)

Variables: L = 10 -0 t = 0.0625 in d = 1.75 in Qty = 1
r = 0.726 S = 0.568 in^3 Fy = 46 ksi E = 29,000,000
I = 0.568 ^4 Deflection = L / 360

Joist Loading: LL = none = 0.00
DL = 4.66 p ft = 4.66 plf

Allowable Stress Fb = 0.66 x Fy = Fb = 30.36 ksi
Fv = 0.40 x Fy = Fv = 18.40 ksi

Shear & Reactions:

R = PLF jst x L joist / 2 = V = R R = 23.3 lbf
Aw = 2 x tw .(d — 2 tw) = Aw = 0.20 in^2

Vall = Fv . Aw = 18.40 ksi x 0.20 in^2 = V all = 3.68 kips

V all = 3.68 kips $\geq$ R = 0.0233 kips **CHECK = OK**

Bending

$M_{max} = \frac{w \cdot L^2}{8}$ (Moment @ center) M max = 0.699 ft.kips

M_{all} = Fb . (S. Qty) M all = 0.014 ft.kips

M all = 0.699 ft.kips $\geq$ Mmax = 0.014 ft.kips **CHECK = OK**

Deflection:

def @ max = $\frac{5W \times L^4}{384 \cdot E \cdot (I.Qty)}$ (Deflection @ center) = 0.0004 in

Allowable Deflection = L / 360 = 10 ft x 12 / 360 = 0.33 in

Allowable Deflection = 0.33 in $\geq$ Max Deflection = 0.0004 in **CHECK = OK**

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STRUCTURAL CALCULATIONS

COLUMNS UNDER NORMAL LOADING (Tube Section 4 x 4 x _ - ASTM A500 Gr B2):
Check Buckling (Slender ratio), Axial Loading — Corner Column

Variables
Weight per foot = 12.02 L = 10 - 0 P = 7.32 kips (4 x safety) = 29.28 kips/col
Allowable unit stress = 64
Fy= 46 KSI A = 3.54 in ^2 I = 8.00 in^4 B = 0.885 r = 1.50

Slenderness Ratio

$\frac{L}{r} = \frac{10 - 0 \text{ (w/ o reduction)}}{r} = \frac{120 \text{ in}}{1.50} =$ 80.0 slenderness ratio

Column Axial Load:

Table V in Steel Manual allows 64.0 kips
P = 64.00 kips
A = 3.54 in^2
Fa = P/A = 18.08 kips allowable unit stress

Second Floor Load per Exterior Column = 3.95 kips
Roof Load per Exterior Column = 3.37 kips
Total Load on First Floor Exterior Column = 7.32 kips (4 x safety factor) = 29.28 kips

P = 29.28 kips
A = 3.54 in^2
Fa = P/A = 8.27 kips actual 18.08 kips $\geq$ 8.27 kips **CHECK = OK**

Wind Resistance:

Wind = 80 MPH / 31 psf Column
P = 1/3 load increase for Wind $M = \frac{wl^2}{12} = \frac{1.33 \times 31 \times 10 (10)^2}{12} = 4.12$ Kips

From Table 3.50 = Allowable Concentrated Load = 64
Bx = 0.885
P = 29.28 kips (-25% reduction for the load) = 21.96 kips

P + P = 21.96 + (0.885 x 4.12) = 21.96 + 3.65 = 25.61 kips

64.0 kips $\geq$ 25.61 kips **CHECK = OK**

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STRUCTURAL CALCULATIONS

FOUNDATION SIZING

2000 PSF — Min. Soil Bearing Dead Load + Live Load = 29.28 K
Add 4 % superimposed Service Load = 30.45 K
f = 2,000

Concrete Area of 36 diameter pier = Ag = 3.14 x r^2 = 3.14(18 x 18) = 56.52 sq.in.

P = 0.85f (Ag — Ast) + fyAst = 0.85(2.0) (56.52) + Zero Reinforcing
= 96.08 Kips capacity > 30.45 Kips required = **OK**

Double Check:

Roof / Attic ExteriorLoad = 3.37 kips
Second Floor Exterior Load = 3.95 kips
First Floor Exterior Load = 3.95 kips
Total Exterior Footing = 11.27 kips (11,270 lbf)

Exterior Footing Diameter = The square root of [P footing @ column / (3.14 / 4) x PSF soil]

= Square Root of (7.13) = Footing Diameter = 2.67 ft
Use 36-inch diameter footing

Roof / Attic InteriorLoad = 0.00
Second Floor Interior Load = 7.90 kips
First Floor Interior Load = 7.90 kips
Total Exterior Footing = 15.80 kips

Interior Footing Diameter = The square root of P footing @ column / (3.14 / 4) x PSF soil

= Square Root of (10.0) = Footing Diameter = 3.9 ft.
Use 48-inch diameter footing

FOUNDATION ANCHORS

Framed Beam Connections — We use 3/16 full welds for 11.27kips; Table IV for 3/16 for just a 4-inch long weld has capacity for 19.7 Kips;
Base Plates :Interior piers @ 15.8 kips (AISC Tables, page 3-99), select 6 X 7 X 5/8 with capacity for 31 Kips;
Anchor bolts @ base plates:Select four (4) A325N @ _ — 16 long & 3 hooked ends = 18.6 > 15.8 **CHECK = OK**

TREATED WOOD DECK

Select 2x8WWPA Grade #3 treated cedar framing members 16-inch o.c. Fb = 400 (0.85) = 340 Fv = 75 L = 7.33 ft
E = 900,000 S = 13.141 I = 47.635
Random Floor Decking (Deflection = L / 180) = 0.4887 Dead Load (Add 15 % moisture = 25.5 lbs per CF) = 2.55 PSF
D = wL^3 / 100 E I = 0.031 Live Load (Snow Weight) = 35.0 PSF

Allow. Def. = 0.4887 in > 0.031 in **CHECK = OK**

w x L = 37.55 x 7 -4 (7.33 feet) = 275.24 plf R = WL / 2 = (275.24) / 2 = 137.6 lb-ft

Mmax = wL ^2 / 8 = 37.55 (7.33 x 7.33) / 8 = 0.252 kips M all = Fb x S = 340 x 13.141 = 4.47 kips
4.47 ft kips > 0.252 ft kips **CHECK = OK**

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STRUCTURAL CALCULATIONS

RAILING (at the 4 x 4 posts)
Based on 36 inches high, 4 -0 on center, a continuous 2 x6 top rail, and 200# / ft point load, with a 2.0 x safety factor.
Select Structural 4 x 4, Western Cedar, with Fb @ 850 (1000 x 0.85) E = 1,100,000 Iy = 14.39 Sy = 7.94

$$M = \frac{PL}{4} = \frac{(\,(\,200\text{ lb} \times 2\text{ -0 }\,) \times 2\,) \times 3\text{ -0}}{4} = \frac{2400\text{ ft-lb}}{4} = 600\text{ ft-lb}$$

Allowable Maximum Bending = Fb x S = 850 x 7.94 = 6.75 ft kips > 0.60 ftkips **CHECK = OK**

RAILING (at the 2 x 6 top railing)
Based on vertical posts atwith 4 -0 on center, a continuous 2 x6 top rail, and 2 x 2 vertical balusters @ 4 inches on center;
A 200# / ft point load, with a 2.0 x safety factor.
Select Structural 2 x6, Western Cedar, with Fb @ 850 (1000 x 0.85) E = 1,100,000 Ix = 24.10 Sx = 8.57

$$M = \frac{PL}{4} = \frac{(\,200\text{ lb} \times 2\,) \times 2\text{ -0}}{4} = \frac{800\text{ ft-lb}}{4} = 200\text{ ft-lb}$$

Allowable Maximum Bending = Fb x S = 850 x 8.57 = 7.28 ft kips > 0.20 ft kips **CHECK = OK**

ROOF HEAL CONNECTIONS —
Assume that the centroid of the tensile and compressive forces is at the center of the flanges of the rafter and the girder / beam. The mitered ends of the rafters are shop welded to the end plate that is fastened to the top cell girder of the second floor. Select _ threaded bolt.

$$M = \frac{wL^2}{8} = 2 \times \frac{74.79 \times 64}{8} = V = 585.00 \text{ @ each rafter base}$$

Determine horizontal force: T = M x 12 / d (depth of rafter) = 585. x 12 / 5 = 1,404 ft-lb
Adjust for WIND LOAD of 80 mph @ 1.33 = 1,404.00 x 1.33 = 1867 ft-lb

Length of Weld = T / 0.928D = 1.91kips / 0.928 = 2.06 (we are using continuous weld of 8

Number of bolts. Assume _ diameter A325 bearing type bolts, with threads excluded from shear planes
r = 0.125 x 0.75 x 60.8 = 5.70
(single shear governs, 9.72)
Number of bolts = 1.867 / 9.72 = 0.20 Need only one bolt between each rafter.

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ROOF RIDGE CONNECTION —
Assume that the centroid of the tensile and compressive forces is at the center of the flanges of each rafter bearing on the center ridge plate. The mitered ends of the rafters are shop welded to the end plate that is fastened to the continuous 4 x 6 beam of the cell below the roof. We have selected a _ threaded bolt.

$M = \frac{wL^2}{8} = \frac{2 \times 74.79 \times 64}{8}$ = V = 585 ft-lb @ the Ridge

Determine horizontal force: T = M x 12 / d (depth of rafter) = 1,170.00 x 12 / 5 = 2,808.00 kips
Adjust for WIND LOAD of 80 mph @ 1.33 = 2,808 x 1.33 = 3.73 kips

Length of Weld = T / 0.928D = 3.73 kips / 0.928 = 4.02 (we are using continuous weld of 5 each side

Number of bolts. Assume _ diameter A325 bearing type bolts, with threads excluded from shear planes
r = 0.125 x 0.50 x 60.8 = 3.80 kips
(single shear governs, 9.72 K)
Number of bolts = 3.73 / 9.72 kips = 0.38 Need only one bolt between each rafter.

DOOR & WINDOW HEADER FRAMING
All of the interior and exterior window and door openings are in non-load bearing walls and partitions. Thus, there are no additional loading on any headers.

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STRUCTURAL CALCULATIONS

STAIRWELL FRAMING
Simple Span Beam - Uniformly Distributed Load (Per AISC Condition #1)

Stair Tread Load ONLY (2 x 11 x 3 / 16 — ASTM A500 Gr. B)

Variables:	L = 3-6	t = 0.1875 in	d = 11.00 in	Qty = 1
	x = 0.50 x L	Sy = 3.70 in^3	Fy = 42 ksi	E = 29,000,000
		Iy = 3.70 ^4	Deflection = L / 180	

Table 301.4 Individual stair treads shall support a uniformly distributed live load or a 300 lb concentrated load over 4 square inches.

Beam Loading:
W_{LL} = 85.7 plf
W_{DL} = 16.85 plf
$W = W_{DL} + W_{LL}$ = 102.55 plf

Allowable Stress
Fb = 0.66 x Fy = 27.7 ksi
Fv = 0.40 x Fy = 16.8 ksi

Steel Stress: Load = w x L (Total Equivalent Uniform Load) Load = 0.359 kips

Shear & Reactions:
R = w . L / 2 = V = R R = 0.1795 kips
Aw = 2 x tw .(d — 2 tw) = Aw = 3.98 in^2

Vall = Fv . Aw = 16.8 ksi x 3.98 in^2 = V all = 66.86 kips

V all = 66.86 kips $\geq$ R = 0.1795 kips **CHECK = OK**

Bending
$M_{max} = \frac{w \cdot L^2}{8}$ (Moment @ center) M_{center} = 0.00055 ft.kips
M_{all} = Fb . (S. Qty) M all = 0.102.ft kips

M all = 0.102 ft.kips $\geq$ Mmax = 0.00055 ft.kips **CHECK = OK**

Also Check @ P =300 # = PL / 4 = M = 262.5 ft lb
R = P / 2 = 131.25 ft lb = 0.131 kips < 66.86 kips **CHECK = OK**

Deflection:
$def\ @\ max = \frac{5 W_{LL} \times L^4}{384 \cdot E \cdot (I.Qty)}$ (Live Load Deflection @ center) = 0.004 in

Allowable Tread Deflection = L / 240 = 3.5 ft x 12 / 240 = 0.175 in

Tread ONLY Deflection = 0.175 in $\geq$ Max Deflection = 0.004 in **CHECK = OK**

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STRUCTURAL CALCULATIONS

Stair Stringer Load ONLY (2 x 11 x 3 / 16 — ASTM A500 Gr. B)

Variables:	L = 9 -0	t = 0.1875 in	d = 11.00 in	Qty = 1
	x = 0.50 x L	Sx = 11.6 in^3	Fy = 42 ksi	E = 29,000,000
		Ix = 69.8 ^4	Deflection = L / 180	

Beam Loading:
W LL = 70.0 plf = (40 x 3.5) / 2
W DL = 16.85 plf
W = WDL + WLL = 86.85 plf per 3.5 foot longTread @ 1 -0 intervals
There are seven (7) treads each @ P = 86.55 x 3.5 , divided by 2(each bearing on each stringer
W = 151.46 per tread, or EDL = 9 x P = 1,363.14 over a 9 -0 stringer = M

Allowable Stress
Fb = 0.66 x Fy = 27.7 ksi
Fv = 0.40 x Fy = 16.8 ksi

Steel Stress: Load = w x L (Total Equivalent Uniform Load) Load = 1.36 kips

Shear & Reactions:
R = w . L / 2 = V = R R = 0.68 kips
Aw = 2 x tw .(d — 2 tw) = Aw = 3.98 in^2

Vall = Fv . Aw = 16.8 ksi x 3.98 in^2 = V all = 66.86 kips

V all = 66.86 kips $\geq$ R = 0.68 kips **CHECK = OK**

Bending
Mmax = $\frac{w \cdot L^2}{8}$ (Moment @ center) Mcenter = 0.709 ft.kips

Mall = Fb . (S. Qty) M all = 26.78 ft.kips

M all = 321.32 ft.kips $\geq$ Mmax = 26.78 ft.kips **CHECK = OK**

Deflection:
def @ max = $\frac{5W_{LL} \times L^4}{384 \cdot E \cdot (I.Qty)}$ (Live Load Deflection @ center) = 0.035 in

Allowable Deflection = L / 360 = 9 ft x 12 / 360 = 0.30 in

Allowable Deflection = 0.30 in $\geq$ Max Deflection = 0.035 in **CHECK = OK**