## FastFusion Poly Pipe Field Fusion Welding

Not many two-year old companies can claim to have revolutionized their industry, but that's exactly what Fast Fusion of Grand Junction, CO, is in the process of doing. Starting from scratch, Fast Fusion designed, developed, and produced an entirely new system for fusion welding polyethylene pipe in the field, a system that dramatically increases the productivity, efficiency, and profitability of pipeline contractors who use it.

Polyethylene pipe is widely used for a variety of applications including water and sewer lines, chemical transfer, food processing, irrigation, mining and dredging, geothermal power generation, telecommunications, and oil and natural gas collection and transport. The primary advantage of polyethylene pipe over its metallic and PVC competitors is the fact that it can be joined by fusion as it is installed, creating what is effectively a joint-free pipe of virtually any length required.

Fusion joining is a mature and well-proven technology, and there are a number of equipment suppliers in the industry. The traditional approach is to create a "welding station" at some convenient point along the right of way, and then move the pipe through the welding system. This is not as simple as it sounds, however, because the joint must be protected from environmental contaminants while it's being made, which means the "welding station" is typically housed in a protective structure of some kind.

"Considering that polyethylene pipe is used everywhere from the Canadian Arctic to the deserts of the American Southwest, placing, moving, and maintaining a ‘welding station' structure can be a big job," explains Fast Fusion President Dick McKinley. "It also takes a lot of people and equipment to move the pipe through the ‘welding station,' and you inevitably put a lot of strain on the newly-welded joints in the process.

"Our approach is to turn this model completely around and bring the welding equipment to the joint. The Fast Fusion Trac20 is a self-contained fusion welding system on tracks that moves along the right of way and makes the joints in place. Once it's joined, the pipe experiences only minimal movement.

"A Trac20 can be equipped with any welding system the customer prefers," McKinley continued, "and it incorporates our patented cooling technology that significantly cuts the cycle time for a weld. The net result is that a Trac20 effectively doubles the number of joints that can be assembled in a day and reduces the cost per foot by 50% while simultaneously improving joint quality.

The Fast Fusion Trac20 is powered by a Cat 3054C, a four-cylinder, turbocharged and after-cooled diesel engine that meets Tier II/Stage II emission requirements. It is directly coupled to the hydraulic pump that powers the Trac20's hydrostatic track drive, and also powers a 6,000-watt generator and an air compressor via an auxiliary belt drive. The generator provides current to the fusion welding system's heating elements, and the compressor is part of Fast Fusion's patented joint cooling system. The engine also supplies power for the cab air-conditioning system, as well as the usual complement of engine accessories.

Since announcing the availability of the Trac20 in North America in January of 2005, Fast Fusion has sold 22 and has already received orders for a second machine from three of the original customers. All of these machines were sold through ISCO Industries of Louisville, KY, which has exclusive North American distribution rights. Fast Fusion anticipates a similar response from European customers as soon as negotiations with an international distributor are completed. Five Star Industries of Knoxville, IA, is the preferred manufacturer of the Fast Fusion product.

Fast Fusion is not resting on its laurels. It has already produced a version of the Trac20 intended for the offshore oil industry. The MFT21 is essentially a barge-mounted version of the Trac20, minus the tracks and hydrostatic drive system. The first unit is now at work laying pipe in the Gulf of Mexico. Also on the horizon is a bigger version of the Trac20, the MFT 36 and the MFT 48 will be the size of a Cat D8 bulldozer and will be able to handle pipe in the 18 to 48 in. dia. range, will also be powered by Caterpillar . (Updated March 2006)

**Contact: Fast Fusion • P. O. Box 55264 • Grand Junction, CO 81505**
**866-295-9757 • www.fastfusion.com**








**Side By Side Comparison of Fusion Methods**

| Size | Conventional Cost / Foot | Fast Fusion Cost / Foot | $ Savings | % Savings |
|---|---|---|---|---|
| 2" | $0.27 | $0.22 | $0.04 | 16% |
| 3" | $0.32 | $0.25 | $0.07 | 23% |
| 4" | $0.40 | $0.26 | $0.14 | 36% |
| 6" | $0.50 | $0.30 | $0.20 | 41% |
| 8" | $0.58 | $0.35 | $0.23 | 39% |
| 10" | $0.75 | $0.41 | $0.34 | 45% |
| 12" | $0.82 | $0.50 | $0.32 | 39% |
| 14" | $1.06 | $0.51 | $0.54 | 51% |
| 16" | $1.19 | $0.58 | $0.61 | 51% |
| 18" | $1.19 | $0.69 | $0.50 | 42% |
| 20" | $2.57 | $1.12 | $1.44 | 56% |

- Average Savings 40%
- **Average Savings 6"-20" - 46%**

**Irrigation Project**
MobileFusion Trac 20 in an environmentally sensitive area in California fusing 4" through 20" HDPE. Minimal environmental impact and double efficiency were hallmarks of this PE fusion operation.

**Insertion Project Florida**
MobileFusion Trac 20 in Florida, thirty six miles of perforated polyethylene 8 inch and 12 inch diameters. Minimal environmental impact and a reduction in cost per ft. of 47%

**Natural Gas Project**
Mobile Fusion Trac20 in Alberta Canada. Fifty percent production increase per shift allowed this project to be operational in less time than using conventional fusion methods.

**Mining Project**
Mobile Fusion Trac20 in New Mexico. Operation provided minimal environmental impact and eliminated the need to drag the pipe resulting in better efficiency and project quality control.

**Natural Gas Project**
Mobile Fusion Trac20 fusing medium density polyethylene pipe in Western Colorado. Minimal environmental impact and increased production over conventional pipe fusing methods.

**Highway Irrigation Project**
Pipe fused for a bore project under an Interstate. Pipe ramming, pipe bursting and directional drilling technologies have a new partner in efficiency, productivity and profitability, the Mobile Fusion Trac technology by Fast Fusion.

**Natural Gas Project**
Mobile Fusion Trac20: Fast Fusion versus conventional HDPE fusion methods is to ONE PERSON versus FOUR! Efficiency! Productivity! Profitability!

**Natural Gas Project**
Mobile Fusion Trac20 in Western Colorado/ Fusing pipe in all weather conditions with a fifty percent increase in production.

**All Weather Cab of MFT 20**:
View inside the cab of the MFT 20. This ergonomic environment is designed as a safe operator work platform for maximizing operator efficiencies inside the all weather cab.

# INVESTIGATOR'S SUMMARY[1]

Nomination 2006-10

Investigator: Robert I. Carr, P.E., Ph.D.[2]

# FIELD WELDING POLYETHYLENE PIPE

## The Innovation

Fast Fusion (FF) is a self-propelled polyethylene pipe fusing machine that allows an operator, within a specially designed cab, to control the machine's travel, operate the handling of the poly pipe sections (through a patented hydraulic and air driven work station platform), and complete the fusion weld process concurrently. Most important, Fast Fusion machines incorporate a patented enhanced cooling system that has dramatically increased the number of fusion welds per hour and, correspondingly, the production capacity of the operator over any other machine offered in the industry. Fast Fusion equipment is designed to operate in all conditions world wide to fuse pipe from 2" OD up to 48" OD. It has low impact on the environment and a safe work environment.

Fast Fusion, LLC purchased and developed a number of patents all related to the welding of plastic pipe. Known under the trade name / trade mark, "Fast Fusion" our innovative designed equipment dramatically increased the welding production per day by 50% to 80% over existing conventional equipment available in the industry and also reduced the cost per ft of the welding of plastic pipe by 47% to 67%.

Fast Fusion systems incorporate three major innovations:

(1) The primary innovation is the technology to remove the heat from the weld – allowing for 50% to 80% higher productivity per shift, with better quality, than conventional fusion.
(2) The innovation of the all weather cab – allowing for the welding of polyethylene pipe in all weather conditions and protecting the pipe from contamination that interferes with the welding of the pipe and quality of the weld. This reduces costg and improves quality.
(3) The innovation of the handling of the pipe material – allowing for the material to be handled in an efficient manner with a net result of less labor & equipment required than conventional fusion, which reduces cost, and less stress on the pipe, which improves quality.

The first and current machine, MobileFusion Trac 20, welds pipe from 2"OD to 20" OD with MSRP = $300,000. Thirty-one (31) Trac 20 machines have been sold, of which 16 have been delivered. Two parties purchased a second machine, both within six months of the first: ISCO Industries and Big Country Pipeline. Four other current owners are considering purchasing additional machines.

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[1] September 29, 2006

[2] Professor Emeritus of Civil Engineering, University of Michigan, Ann Arbor, MI 48109.

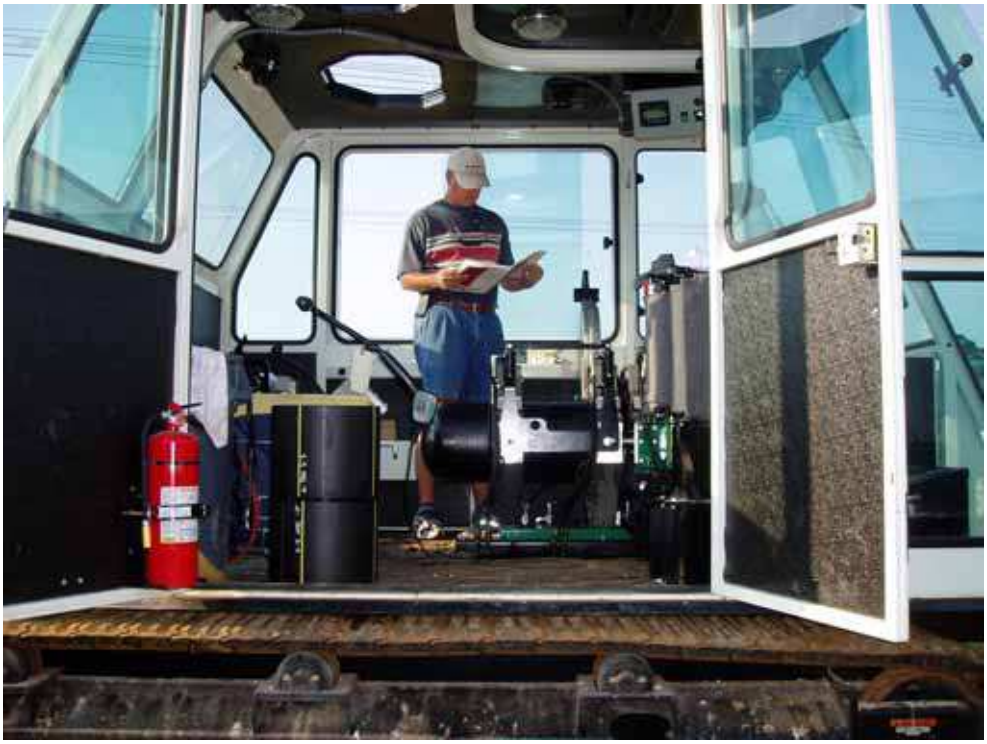
The MobileFusion Trac system was engineered and designed to reduce the labor and support equipment needed to weld plastic pipe, reduce the amount of time it took to complete a fusion weld and to create a mobile working platform that was safer to operator that is efficient in the welding of plastic pipe. Our equipment eliminated the most common causes of failed welds such as weather conditions from wind, dust, rain, snow and conditions that could not be controlled by the person welding the pipe.

Fast Fusion is a technology advancement that also incorporated equipment that was already known and accepted within the industry. We do not replace the equipment that does the actual welding of the pipe such as the McElroy or Connectra fusion machines but simply made our equipment the add value by the use of MobileFusion Trac and our welding procedure.



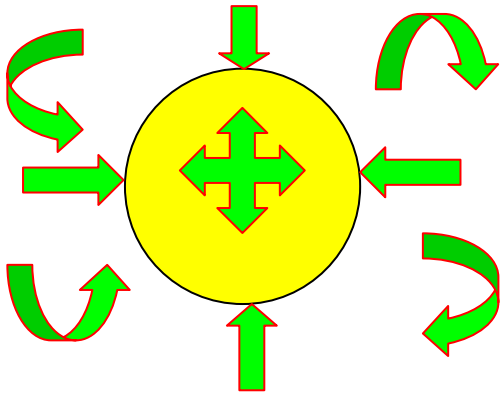
**Conventional Fusion Equipment**

This was the key in bringing acceptance to an industry that has not been receptive to change or for innovation especially for one that has never been achieved in the history of polyethylene pipe and from someone that has never been involved in the industry and certainly not technically credible.



**Fast Fusion machine**





**Circulating air after fusion**

**Application of the Innovation**

**Machines:** Currently available machines and machines under development include the following:

- MobileFusion Trac 20 welds pipe from 2" OD to 20" OD, MSRP = $300,000. 31 have been sold, of which 16 have been delivered.
- MobileFusion Trac 21 welds pipe from 2" OD to 20" OD and is skid mounted and not on tracks, to be used on a barge or directional drilling project that does not require mobility. MSRP = $225,000
- MobileFusion 21F. This package allows the weld cooling technology to be installed in a manufacturing plant that builds polyethylene welded footings, MSRP = $80,700
- MobileFusion Trac 36 welds pipe 20" OD through 36" OD, MSRP = $750,000. It is out of design and going into production, with expected delivery 1st qtr. 2007. One has been sold, and a commitment has been received for another.
- MobileFusion Trac 48 Welds Pipe from 36" OD through 48" OD, with MSRP = $1.2M. It is in design, with production 2nd qtr 2007. A commitment for one has been received.

Pipeline owners now only allow Fast Fusion equipment on their project because they see a significant improvement in weld quality and project completion, which allows them to move product to market sooner than expected. A contractor on a federal project ran the equipment two 10-hr shifts, followed by a machine maintenance break, and finished the project three months earlier than with conventional fusion. On a recent project, one operator owning a Fast Fusion machine hired two other companies that owned Fast Fusion equipment, to have three Fast Fusion machines on the project.

**Cost Effectiveness:** MFT 20 average gross margin per day = $3,000 per 8 hour shift versus conventional fusion gross margin = $1,800, because cost reduction per weld = 47% to 67%. If additional conventional fusion machines were added to meet MFT 20 daily production,

costs per weld would increase two to three times. This demonstrates the big advantage of innovation.

ROI for Fast Fusion machine owners:

| | | |
|---|---|---|
| Gross Margin | ($3000/day) (180 days) = | $540,000 |
| Minus investment | | (300,000) |
| Subtotal | | 240,000 |
| Minus operator expense + interest | | (120,000) |
| Net Margin | | $120,000 |

To date, one company obtained their investment back in 3months, and no one has gone longer than 6 months. Once they have a machine, the work comes to them instead of them hunting the work.

We have in development three other patents.

- Full Flow Facer Blade – This innovation removes the ID and OD bead during the welding process so that debris or interference with flow rate without having to downgrade the pressure capacity of the pipe itself
- Simultaneous Welding of Plural Pipes – this innovation allows for the welding of more than one pipe at the same time. Typically two pipes but could be any combination there of.
- Pipe Cleaner – this innovation will clean the pipe OD for any application.

Additional incremental revenue per year from these will be an estimated $1.5M

**Background of the Innovation**

The technology has been applied in the following applications:

- Natural Gas
- Clean Water & Waste Water projects
- Brine Water
- Oil
- Drilling Operations
- Chemical
- Dredging
- Mining
- Geothermal
- Telecommunications
- Industrial
- Municipal
- Irrigation
- Landfill
- Manufacturing applications.

The benefit has been the improvement of the quality of the welding of plastic pipe with a significant increase of daily production that reduced the cost of the welding of the pipe and created a cost saving to the overall project as it was completed and in service in a shorter timeline than estimated.

**Daily Production per 8 Hour Day (for SDR 7 pipe)**

| OD | Fast Fusion | Conventional |
|---|---|---|
| 4" | 6,200 ft (minimum) | 2,750 ft. (maximum) |
| 6" | 4,660 ft (minimum) | 2,000 ft. (maximum) |
| 8" | 3,700 ft (minimum) | 1,800 ft. (maximum) |
| 10" | 3,100 ft (minimum) | 1,500 ft. (maximum) |
| 12" | 2,300 ft. (minimum) | 1,100 ft. (maximum) |
| 18" | 1,900 ft. (minimum) | 950 ft. (maximum) |
| 20" | 1,600 ft. (minimum) | 800 ft. (maximum) |

**Cost Comparison of Fusion Methods for 40 ft Joints ($/ft)**

| OD | Conventional | Fast Fusion | $ Saved | % Savings |
|---|---|---|---|---|
| 2" | $0.27 | $0.22 | $0.04 | 16% |
| 4” | $0.40 | $0.26 | $0.07 | 36% |
| 6" | $0.50 | $0.30 | $0.20 | 41% |
| 8" | $0.58 | $0.35 | $0.23 | 39% |
| 10" | $0.75 | $0.41 | $0.34 | 45% |
| 12" | $0.82 | $0.50 | $0.32 | 39% |
| 14" | $1.06 | $0.51 | $0.54 | 51% |
| 16" | $1.19 | $0.58 | $0.61 | 51% |
| 18" | $1.19 | $0.69 | $0.50 | 42% |
| 20" | $2.57 | $1.12 | $1.44 | 56% |
| Average Savings 6" - 20" = 47% | | | | |
| 24" | $3.12 | $1.44 | $1.68 | 54% |
| 24" | $3.12 | $1.44 | $1.68 | 54% |
| 28" | $3.92 | $1.68 | $2.24 | 57% |
| 30" | $4.20 | $1.80 | $2.40 | 57% |
| 34" | $4.76 | $2.04 | $2.72 | 57% |
| 36" | $5.40 | $2.16 | $3.24 | 60% |
| 40" | $6.00 | $2.40 | $3.60 | 60% |
| 46" | $7.36 | $2.76 | $4.60 | 63% |
| 48" | $8.64 | $2.88 | $5.76 | 67% |
| Average Savings 24" - 48" = 59% | | | | |
| Average Savings Using Fast Fusion, All Sizes = 51% | | | | |

We have in development three other patents.

- Full Flow Facer Blade – This innovation removes the ID and OD bead during the welding process so that debris or interference with flow rate without having to downgrade the pressure capacity of the pipe itself

- Simultaneous Welding of Plural Pipes – this innovation allows for the welding of more than one pipe at the same time. Typically two pipes but could be any combination there of.
- Pipe Cleaner – this innovation will clean the pipe OD for any application.

Additional incremental revenue per year from these will be an estimated $1.5M

**Responsibility for the Innovation** (remarks by Dick McKinley)

The Inventor – Mr. George Rakes[3]

Ricky Heflin, Senior Engineer
Davis Precision Design
Route 1 Box 245, Woodward, OK 73801
(580) 334-3413 Heflin@pldi.net

Ricky took what was basically a rough idea I purchased and notes that I gave to him on the back of napkins, note pads, and emails and developed the technical engineering of the innovation to a product for manufacturing that worked.

Pat Weiler, President
Five Star Industries
PO 2819, Knoxville, IA 50138
(641) 828-6622 weilerpj@fivestarind.com

Pat's company Five Star Industries manufactures the Fast Fusion, LLC equipment and his insight [and] knowledge of equipment manufacturing was a complement to the engineering developed by Fast Fusion.

Carolyn McKinley
PO Box 158, Palisade CO 81526
(970) 216-1543
cmckinley@fast-fusion.com

[My wife] Carolyn contributed to the variables of operation of the material handling, the mediums to be used for the weld cooling and the over seeing of product development for the idea to the application working. She was integral in the fit, form and function of the operator control of the simplicity of the function in the field. I would also add that for any innovation there has to be one person that inspires all of us and she is it for her patience, fortitude of knowing to never give up and her every lasting questioning do I really have any idea of what we are doing!

Dick McKinley, President & CEO
Fast Fusion, LLC
PO 158, Palisade, CO 81526

[3] See Patent in Exhibits

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I am responsible for taking an idea that was not developed [previously by anyone else] and developing it to the innovation that it is today and discovering why and how it would work.

The mobile work platform with an all weather cab – this was the inventor idea but it never was identified for how to should be built to what the innovation could achieve but the use of it. Climate controlled for the pipe being welded and having it equipped with the fit, form and function to increase the quality of the weld process.[4]

I personally developed the material handling to be hydraulic and electronic controlled and to increase the speed the pipe is loaded, welded and unloaded in the machine that would increase productivity per shift at least double of conventional fusion but would also decrease the factor's that could damage the pipe or the weld over conventional fusion. This resulted in a better quality, increased production and a cost savings to the industry.

I was the sole person responsible for the development of the weld cooling technology to success. The inventor created the idea but could not prove it scientifically / technically. I discovered that you had to have specific's such as the air psi, volume and pattern but most importantly was the temp of the air compared to the ambient temperature the technology is operating in worldwide. Under my direction the technology was developed to meet and be accepted under the most stringent standards of the pipe manufacturers themselves. We are the only company to test our technology to that standard. This created more productivity per day and also decreased the cost per weld.

I also am responsible for making it simple so that the innovation could be marketed to success in an industry that was desperate for innovation that would increase efficiencies, productivity and profitability for the use of polyethylene pipe for the good of the industry as a whole.

**Opinions of Persons Contacted**

All people contacted agree that Fast Fusion is a paradigm shifting improvement to high-density polyethylene pipe construction that has completely changed the business through dramatic improvement in cost, quality, time, dependability, and safety. It delivers substantial benefits to all involved: land owners, pipeline owners, contractors, and workers. HDPE is used in wide variety of sizes for a wide variety of purposes including delivering natural gases, petroleum products, water, and other fluids. I literally never heard or saw a negative word or opinion about it.

[4] Carr interpretation: "The mobile work platform with an all weather cab was the inventor's idea, but he never described how it should be built to achieve the benefits that would make it innovative, which were controlling the climate in which the pipe was welded and providing the fit, form, and function that would increase quality of the welding process."

**Investigator's Comments**

I was positively impressed by Fast Fusion at ConExpo 2005, and I suggested to Dick McKinley that it be nominated for the Nova Award. He does not recall that conversation, but he does recognize himself in a photograph of his machine that is on my construction photo web site.[5] I nominated it myself in 2006. From the press, reports, and interviews I have reviewed in this investigation, it is apparent to me that FF is probably the strongest improvement in HDPE construction since development of the process itself.

[5] http://myconstructionphotos.smugmug.com/gallery/437952/1/18281106/Large

## SELECTED INTERVIEW SUMMARIES

Dick McKinley, President and CEO
Fast Fusion, LLC
PO 158, Palisade, CO 81526
(970) 216-1543
dmckinley@fast-fusion.com
Telephone conversations by Bob Carr

I had one long conversation with McKinley at start of investigation, followed by several emails and a couple of shorter conversations. He has been my contact with Fast Fusion, and he has supplied me with a lot of written information via email/internet to answer my many specific requests. He has been quite responsive, most of the information in this report came from him, and most of the text in this report is in his words. Therefore, reporting his remarks by phone is superfluous, because his written remarks in supplied for this report provide better information.

Len Torgerson, President and CEO
Big Country Energy Services (BC)
Suite 1320, 530 8th Avenue SW, Watermark Tower
Calgary, Alberta, T2P 3S8
Ph: (403) 225-8867 Cell: 403-501-4500
Telephone conversations by Bob Carr, October 6, 2006

BC is getting its third Fast Fusion (FF) machine. A FF machine produces 70-80 joints/day for 6" O.D. pipe and up, in all kinds of weather/field conditions. Conventional fusion achieves 15-20 fused joints/day under good field conditions. BC has developed a skid-steer machine with robot arm to assist FF. Therefore, FF has crew of two, each working in a controlled, safe environment producing 75-80 joints/day vs conventional fusion crew of six working down in the dirt manually with pipe, assisted by tractor with side mounted pipe layer boom producing 15-20 joints/day. FF is much safer. FF enhances quality control because fusion is in controlled environment regardless of wind, snow, rain.

There was one past competitor of FF, called Fusion Car, that was used on one sizeable job and the joints it produced failed horribly, giving cooled fusion joints a bad name. FF uses air that is almost clinically clean and dry through filtration, with patented technique that produces turbulence to uniformly cool the fusion joint. Fusion Car pulled its air off a standard air conditioner and directed the air at fused joint through three air jets, which produced very poor quality. Therefore, some engineers in Calgary are wary of any air-cooled fusion joints. However, about 80% of clients are happy with FF.

Ted Amaya, Director International Sales
ISCO Industries
460 Fife Rd

Mulberry FL 33860
(813) 494-4497
teda@isco-pipe.com
Telephone conversations by Bob Carr, October 3, 2006

ISCO is distributor of FF, started in 1962 to supply/perform golf course irrigation using polyethylene (PE) pipe. PE is all ISCO does. They have always distributed McElroy fusion machines, which represent 97% of HDPE market.

FF came out of nowhere. The basic fusion process has gone on for 35 years with same technology. Contractor puts pipe in one place and drags it through the fusion machine, waiting for fused to cool in ambient air. McKinley was not in fusion business, but he saw the original invention in which inventor put fusion in a cab and blew cold air on freshly fused joint. McKinley saw the potential for improvement to entirely change the industry. The result is FF, which is a complete paradigm change of stringing the pipe out, cooling fused joints quickly, and moving fusion along pipe. It reduces cost and time by 50%, and it improves quality, because it doesn't put stress on freshly fused joints by pulling pipe through machine.

Pipeline owners like it, because it reduces their cost and construction time and improves their quality, so they are now requiring FF on their projects. Quality is much more important in gas piping than in water and sewer piping, because leaks in gas cannot be tolerated. It has taken over the Calgary oil-patch, where agricultural and construction season is short. It leaves smaller footprint on farm land, and it gets construction off farm land in much less time, which pleases farmers. Contractors like it, once they are convinced of its efficacy, which is where ISCO comes in as distributor/marketer. It lowers contractors' construction cost and time, and it improves their competitiveness, safety, and quality. Fusion operators like it, because it improves their working conditions and safety.

Les Klaudt, President
Fusion Technologies, Inc
5585 Bison Lane
Lolo, Montana 5947
406-273-7273 or 406-273-3837
Telephone conversation by Bob Carr, October 3, 2006

Klaudt was referred to me by Bryan Obland of High Country Fusion as the person he knew was most familiar with FF. Klaudt is in process of acquiring FF and putting FF-based operation together. Klaudt has been in fusion business 13+ years, installing HDPE pipe from 1" OD to 63" OD, and his company has worked in Alaska, Oregon, Washington, Idaho, Arizona, California, as well as Montana. He is very direct and articulate.

He has studied FF well for some time and he knows it well. FF is highly concise, efficient method of handling HDPE with strong quality control. It has greater safety, no weather or seasonal influence, and requires fewer men and equipment. Transportation of equipment is a non-issue, because it is small and light, compared to other construction equipment. FF is a

completely unique approach to something that has been around for decades without significant change. It has completely changed the HDPE laying business.

He carefully tracks his jobs' efficiency, and he has compared standard fusion techniques against FF on other contractors' projects. FF achieves 60% more productivity at 40% less cost. He has bid against FF and lost, including one job only 200 miles from home. He has followed that job, and that contractor achieved the productivity the contractor had estimated and bid. That really got Klaudt's attention, convincing him that he must acquire FF, as he is doing.

Bryan Obland, Equipment Sales
High Country Fusion
Fairfield, Idaho
800-780-6330
Telephone conversation by Bob Carr, October 3, 2006

Obland has not seen FF work. HCF is helping Les Klaudt put a set of FF equipment together. HCF and Klaudt have done a lot of work together in past: HCF supplies pipe and fittings (to be installed) and Klaudt handles the equipment and installs the pipe. ISCO portrays itself as sole distributor of FF, but other firms can sell it, and HCF is preparing to distribute/sell FF equipment soon, because FF is taking over the HDPE business.

# SUPPORTING EXHIBITS

1. **Self Propelled Pipe Fusion Machine**
   Patent 4,990,209, Feb. 5, 1991, pg 1.

2. **Fast Fusion Product Sheet**

3. **ISCO Product Release**

4. **Patent Explanation of Weld Cooling**

5. **Analytical Testing of Advanced Butt Fusion Technology for HDPE Pipe**

6. **Hauser Laboratory Report**

7. **Additional Photographs**

# United States Patent [19]

**Rakes**

[11] **Patent Number: 4,990,209**

[45] **Date of Patent: Feb. 5, 1991**


## [54] SELF PROPELLED PIPE FUSION MACHINE


[76] Inventor: **George C. Rakes,** 2120 Fairway Dr., Bozeman, Mont. 59715



[21] Appl. No.: **451,315**

[22] Filed: **Dec. 15, 1989**

**Related U.S. Application Data**

[63] Continuation of Ser. No. 879,589, Jun. 27, 1986, abandoned.

[51] **Int. Cl.**[5] ..... **B32B 31/00**

[52] **U.S. Cl.** ..... **156/351;** 156/359; 156/362; 156/366; 156/498; 156/499; 156/503; 156/574

[58] **Field of Search** ..... 156/158, 304.2, 304.6, 156/498, 502, 351, 359, 503, 362, 366, 574, 499



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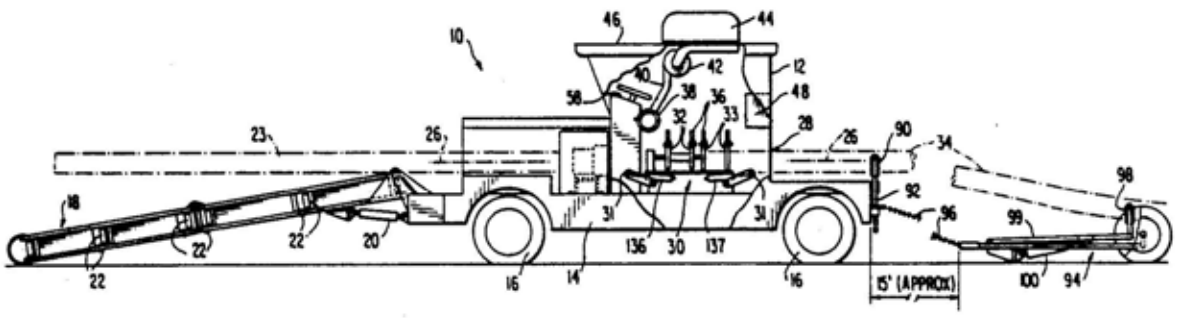
*Primary Examiner*—William J. Van Balen
*Assistant Examiner*—J. Davis
*Attorney, Agent, or Firm*—Reed Smith Shaw & McClay



[57] **ABSTRACT**

A self propelled enclosed apparatus for coupling sections of plastic pipe by fusion together to form a pipe line. The apparatus comprises a housing having a forwardly extending boom or trough for receiving pipe sections. Pipe sections are loaded onto the boom and fed to a fusion machine in the housing. The fusion machine is provided with hydraulically operated clamps and rollers to align and hold a section of pipe in mating relationship with a pipeline and a heating plate for forming a fused joint between the pipe section and the pipeline. Cooling apparatus is provided at the joint to reduce its temperature following fusion. Kick out rollers are provided, and the fused togehter pipeline exits the apparauts to a trialer towed thereby to be laid on the earth's surface or in trench. The trailer, self propelled apparatus, and boom are equipped with pipe support members to provide strain relief on the joint during fusion. The apparauts is self contained and all functions other than loading the pipe sections onto the forwardly extending boom are carried out within the machine by a driver-operator.


**13 Claims, 4 Drawing Sheets**





# Now fuse HDPE up to 50% faster–anytime, anywhere.

Imagine what it would mean to your productivity – and profitability – to be able to fuse HDPE up to 50% faster?

The Fast Fusion™ MobileFusion Trac 20 is the revolutionary machine incorporating mobility, efficient pipe handling, and a patented enhanced cooling system – to dramatically increase the production capacity and number of fusion welds per hour.

The 18,750 lb. self-propelled machine features a specially designed climate-controlled cab mounted on an interchangeable rubber or steel tracked undercarriage. It's powered by a fuel-efficient CAT® diesel engine. The MobileFusion Trac 20 has 'quick change' technology that allows it to accept any one of four popular McElroy Manufacturing, Inc. upper works that is mounted inside the unit. Depending on the upper works equipment that is installed, the unit can butt fuse 2" up to 20" OD / HDPE. Rather than pulling pipe through a stationary fusion

*Continued on back side*




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MOBILEFUSION TRAC20
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unit, the tracked machine itself moves along the pipe, weld after weld. The process is unaffected by time of day and inclement weather – and the in-cab cooling system delivers easier, quicker completed fusion welds.

The machine also features easy-to-operate joystick controls, 6,000-watt generator, large working platform, and programmable Logic Controller for production settings and data storage and more. The MobileFusion Trac 20 is supported by a three-year warranty.

Step up to more productivity – **and profitability.** Call Tom O'Neill today at **800-345-4726 (ext. 6713)** or email at **tomo@ISCO-pipe.com**; for specs, pricing and additional information.

**Projected productivity: 50-foot straight lengths of HDPE over 8 hours:**

| Fast Fusion | | | Traditional Butt Fusion | | |
|---|---|---|---|---|---|
| Pipe Size IPS Inches | Joints Per Day | Feet Per Day | Pipe Size IPS Inches | Joints Per Day | Feet Per Day |
| 6" | 122 | 6,100 | 6" | 28 | 1,400 |
| 8" | 102 | 5,100 | 8" | 24 | 1,200 |
| 10" | 88 | 4,400 | 10" | 22 | 1,100 |
| 12" | 72 | 3,600 | 12" | 20 | 1,000 |
| 14" | 70 | 3,500 | 14" | 18 | 900 |
| 16" | 62 | 3,100 | 16" | 16 | 800 |
| 18" | 52 | 2,600 | 18" | 16 | 800 |
| 20" | 32 | 1,600 | 20" | 12 | 800 |

ISCO INDUSTRIES

ISCO Industries is the exclusive distributor for Fast Fusion™ equipment in North and South America.

## CASE STUDY:

### Fast Fusion machine makes quick work of Montana sewer expansion project

Faced with a challenging, fast-track sewer expansion project in Bozeman, Montana during an equally challenging time of the year for that part of the county, Williams Plumbing, Heating & Utilities and Utility Solutions, LLC made a January call to ISCO Industries.

With only 85 days to complete the entire project -- including pipe installation – the Fast Fusion machine offered many advantages. The heated, enclosed cab would allow work to continue through anticipated harsh winter weather. Faster fusion rates would assure meeting the project's deadline, even if problems arose. Simplicity and ease of pipe handling meant lower labor costs, and an ISCO-provided qualified operator meant no time lost in training a separate crew.



The project called for installation of 17,100 feet of 16" HDPE used as a sanitary force main running from an area being developed to an existing wastewater treatment plant purchased by Utility Solutions, LLC three years ago. 8,300 feet of 10" HDPE pipe was also installed as a force main for treated water that would be injected into the ground. Typically a sanitation collection system uses gravity to flow to the treatment plant, but this plant was uphill from the development, requiring a force main system.

After considering the options, Morrison-Maierle Engineering of Bozeman spec'd HDPE for its advantages in such a system. Although the anticipated bad weather didn't materialize, unseasonable temperatures in the 40's and low 50's melted much of the 10" snow base, making the worksite muddy and sloppy. Thanks to the design of the track system, the Fast Fusion unit moved easily along the pipeline quickly fusing long lengths of pipe run.

Bottom line, a similar project using a standard fusion project would have taken nearly a month to complete, fusing 8 hours a day without stopping. The Fast Fusion machine was able to fuse all the pipe required for the Bozeman project in only 8 days, working 8 hours a day.

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Product Release

**For Immediate Release**

***ISCO Industries***

**Product:** Fast Fusion MobileFusion Trac 20

**LOUISVILLE** – (September 2004) -- ISCO Industries has become the exclusive distributor for the Fast Fusion™ MobileFusion Trac 20 machine. The new machine incorporates mobility, efficient pipe handling, and a patented enhanced cooling system to increase the production capacity and number of fusion welds per hour – by up to 50% over conventional fusion methods.

The 18,500 lb. self-propelled machine features a specially designed climate-controlled cab mounted on an interchangeable rubber or steel tracked undercarriage. It's powered by a fuel-efficient CAT® diesel engine. The MobileFusion Trac 20 has 'quick change' technology that allows it to accept any manufacturer's fusion equipment that is mounted inside the unit. Depending on the fusion equipment installed, the unit can butt fuse 2" up to 20" OD / HDPE.

The machine moves along the pipe, weld after weld. The process is unaffected by time of day and inclement weather – and the in-cab cooling system delivers easier, quicker completed fusion welds.

The machine also features easy-to-operate joystick controls, 6,000-watt generator, large working platform, and programmable Logic Controller for production settings and data storage and more. The MobileFusion Trac 20 is supported by a three-year warranty. It will be on display and demonstrated during 2005 ISCO Fusion Academy sessions nationwide.

Additional information and specs are available on-line at www.isco-pipe.com, or by calling ISCO at 800-345-4726.

For additional release information:

Ryan Harrington
ISCO Industries
(502) 318-6616

ISCO INDUSTRIES

Coming through.

Fast Fusion, LLC

**"Proprietary & Confidential Information"[6]**

## Patent Explanation of Weld Cooling

The innovation of the weld cooling is that it is a technology that had not been discovered [by anyone before us[7]]. George Rakes was the original inventor and had come up with the idea that if he took a fan and blew air upon a weld surface that he could actually cool the weld similar to blowing on hot soup to a temperature that he could put it in his mouth type thought. This idea did not work very well because of high failure rates under weld test conditions and field application.

This weld cooling occurs after the two pieces of pipe have been joined under pressure and thermal fusion completed.

Once I had purchased the patents we then took the idea into a lab environment and began to break down the idea for what it was and discovered how it should work and would meet industry standards each and every time.

The failures [Rakes] were caused by not controlling the pipe material molecules of the polyethylene resin as the weld temperature decreased.

On the machine itself one of the working mechanical components driven by the engine is the operation of the technology itself. We have a whole system and process dedicated to it. We designed the requirements of the equipment needed and went to Ingersoll-Rand to provide it and we mount it on the machine itself. It looks like a portable air compressor inside a box with two fan coolers above it.

We take outside air at ambient temperature and then by moving it through a compressor inlet / filtration system we pull it into a hydraulic driven screw compressor. As it comes into the screw compressor we mix very light viscosity oil into the air stream as it is compressed and the compression heats the air to 180 degree's F to 220 degree's F. By mixing the oil and air we then can process the air to make it less than 4% in relative humidity making it relatively dry air whether we are operating in a high humidity region of the world or a dry climate region. Having the oil air mix is easier to remove impurities through filtration also.

Once the oil and air have mixed and have been compressed then the blended mix moves through high pressure piping to a separator tank. At the separator tank the bulk of the oil drops out by density weight separation and the remaining air/and remaining oil in the mix

[6] This was furnished by Dick McKinley specifically for review by Nova Award Investigators and Jury with the proviso that those individuals would respect its proprietary nature and treat it as confidential, to be used only to evaluate for the Nova Award. Bob Carr

[7] Comments are by Bob Carr.

stream goes through a heat exchanger that has a temp sensor on it that then removes the remaining oil from the air by flash cooling it.

At this point we have separated the air completely away from the oil but both are still between 180 degree's and 220 degree's. The oil then re-circulates through a series of filters, separators and another radiator type cooler and then returns to the tank awaiting the next fusion cycle.

The air stream now has been somewhat cleaned and the relative moisture removed from the flow. It currently is now at 120 PSI and remaining at 180 degree's to 220 degree's. The reason there is some variance in temperature at this point is the ambient temperature itself the machine is operating. If it is -45 degree's ambient then it is 180 degree's if it is 117 degree's ambient then it is operating at 220 degree's.

Through high pressure piping the air stream is now sent through a radiator type heat exchanger that is operated by a fan that has a temp sensor on it. There is also a sensor that is monitoring the inlet air temperature as the air is pulled into the inlet of the compressor. Depending on the outside ambient temperature this air cooler will either cool it a lot or little to none.

The air goes through one more water separator just too again be sure the air stream is relatively dry. If any moisture remained in the stream then that moisture is piped through a check valve orifice to the outlet of the turbo of the engine to be evaporated away as not to have anything leaving drip anywhere or have to be collected and dumped.

From that separator the air is piped from the engine area into the cab to the actual fusion equipment itself.

Directly below the fusion equipment are two vortex tubes. The air is being split into two piping systems through a tee at 120 psi. One vortex tube feeds ½ of the halo system we use for the ½ of the circumference of the pipe and the other vortex tube is for the other ½ of the circumference of the pipe.

Each fusion machine has a specific halo system that is added to it which is designed with a specific number of orifices which controls the outlet air stream and direction of the flow around the circumference of the pipe based upon multiple groupings of the OD of the pipe.

As the air comes into the vortex tubes the temperature of the air based upon ambient will have a 15 degree to 70 degree difference than ambient temperature the machine is operating.

If it is 55 degree's ambient the air temperature delivered to the weld zone would be 40 degrees.

If it is 72 degree's ambient the air temperature delivered to the weld zone would be 50 degree's.

If it is 110 degree's ambient it would be 85 degree's ambient.

If we go the other way,

From freezing, 32 degree's the machine will sense that it is much colder outside and instead of cooling the air now the air cooler with the ambient air temp sensor monitoring the air will make an adjustment and will start warming the air from ambient instead of cooling it.

At 30 degrees the air temp delivered to the weld zone is appx 35 degree's

At 0 degree's the air delivered to the weld zone will be 45 degrees

At -45 degree's the air delivered to the weld zone would be 55 degrees

Once we knew the parameters of how it would work each and every time we the created a time chart tied to the OD and the SDR of the pipe. The Fast Fusion – Fusion Calculator. This simplified the implementation of the technology into the industry.

Mounted in the cab of the machine in the ceiling so it is always very visible to the operator we mounted a programmable computer that has a digital screen in the front of it.

The operator knowing the OD and the SDR of the pipe they are welding will look up the calculations needed on the chart of the Fast Fusion – Fusion Calculator and through three data input screens enter a specific heat time, fusion time and cooling time for that OD and SDR of pipe.

Once the operator has entered the information for all three cycles and is ready to fuse the pipe the heating iron has been placed between both sides of the pipe and a melt bead begins the operator pushes the start button on the PLC.

There was a specific time period entered for that OD and SDSR of the pipe and a digital clock is shown on a screen that the operator can easily see. It begins counting down from the whole number entered.

Three seconds prior to the heat cycle ending an audible sound and a bright light tell the operator they need to be prepared to fuse the pipe. The PLC then automatically switches from the heating cycle to the fusion cycle.

The fusion cycle is a time period that it takes him to remove the heating iron and fuse the pipe under pressure which is normally less than 12 seconds. We call this the fusing time screen. Again it was already entered into PLC.

At the end of that cycle the pipe has been fused together and would now be in what is considered the cool down period. If this is conventional fusion then the operator would just

stand there as do all others involved in loading the pipe and unloading the pipe for at least 18 to 60 minutes until the weld is cool to the touch which is 140 degree's.

This is where the innovation of Fast Fusion takes over.

Fast Fusion can accelerate the heat removed from the weld zone and heat effected zone by applying the air at a specific psi, volume, pattern and temperature with a rate from 50% to 80% faster than conventional fusion.

Once the PLC completes the fusion cycle it again automatically switches to the cooling cycle. As it begins it cycle it sends an electronic signal to a valve that opens and starts the hydraulic driven air compressor.

The compressor is the delivering the processed air around the entire circumference of the weld through the designed halo system.

A fusion weld begins at 425 degree's and before the two pieces of pipe can be removed and another two pieces joined to make a contiguous pipeline it must have a weld temperature of less than 140 degree's.

By applying our innovation the weld will begin at 425 degree's but within half the time period under the cooling cycle the weld material molecules are less than 240 degree's which is the fixation point of the parent material. The remaining half of the cooling cycle is to continue to lower the weld zone and heat effected zone temperature to less than 140 degree's before the cooling cycle time has been completed. Under the use of Fast Fusion at the end of the cooling cycle the weld temperature will be 129 degree's and will be in a time frame that takes 50% to 80% less time to be achieved than what is the industry conventional standard which is to let the outside air cool the weld to cool to 140 degree's and accomplish with a cost reduction per weld from 47% to 67% than conventional fusion.

The inventor had missed several things that interfered with the integrity of the pipe weld with the fan application of the air such as in how the air is applied, what range of psi required, the pattern the air is applied, a halo system so that the air applied covers the entire circumference of the weld and the key that in warm weather the air has to be cooler than ambient and in colder air working conditions the air needs to be warmer than ambient. In cold weather and warm weather they tried to apply the same temperature air to the weld and it would fail for it was either to hot or to cold and caused the weld to crack or cold fuse.

Again this innovation was never discovered [by anyone before us] and its application helps an entire industry not just an individual or individual company.

HAUSER
LABORATORIES

August 23, 2005
Test Report No: 63753-02


**CLIENT:** Fast Fusion, LLC
P.O. Box 55264
Grand Junction, CO 81505

Attention: Dick McKinley

**BACKGROUND:**

Specifications for polyethylene (PE) pipe are promulgated by many organizations, including ASTM International, the American Water Works Association (AWWA), CSA International, the American Petroleum Institute (API), and others. These specifications typically include requirements for elevated-temperature sustained-pressure testing, which is performed to assure the long-term performance of the extruded pipe. The most stringent (most demanding) requirements for elevated-temperature sustained-pressure testing of PE pipes appear in ASTM D2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.* Test specimens with butt-fused joints made using the proprietary Fast Fusion process were tested under the conditions specified by D2513-04a, in order to verify that the fusion joints meet the same performance requirement as the pipe itself.

The pipes tested included pipes made with a conventional HDPE (PE3408), a conventional medium-density PE (PE2406), and a PE100 / PE3408 material.

**SAMPLES:** Nine test specimens were received from the Client, representing three types and sizes of polyethylene (PE) pipe. Each specimen consisted of two lengths of the sample pipe, butt-fused using the Client's proprietary process. PE end-caps were butt fused at each end of the test pipe, using the same process and settings. One end-cap in each specimen also had a PE stub and steel flange adapter fused to the end to create a fill and drain port. The samples and specimens were identified as follows:

Test I PE3408 18-in IPS DR7 with 18 IPS DR7 end cap. The fusion settings as reported by the Client for this sample were: 200 seconds heat, 16 seconds fusion, 360 seconds cooling. The pipe sections were approximately 15 in. long, with the overall specimen length of approximately 42 inches, excluding the flange adapter. The minimum wall thickness for each sample was determined by the Client prior to fusing. These were:

Specimen 1/2: 2.648 in.
Specimen 3/4: 2.664 in.
Specimen 5/6: 2.668 in.

Test II PE2406 12-in IPS SDR 11 with standard butt-fused end-cap. The fusion settings as reported by the Client for this sample were: 100 seconds heat, 16 seconds fusion, 210 seconds cooling. The pipe sections were approximately 10 in. long, with an overall specimen length of approximately 42 inches, excluding the flange adapter.

This report applies only to the sample(s) tested or analyzed. This report may be copied only in its entirety, unless prior written consent has been granted by an authorized agent of the Hauser Laboratories Division of Microbac Laboratories, Inc.

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The minimum wall thickness for each sample was determined by the Client prior to fusing. These were:

Specimen 1/2: 1.187 in.
Specimen 3/4: 1.182 in.
Specimen 5/6: 1.173 in.

Test III PE3408 12-in IPS SDR 11 with standard butt-fused end-cap. This pipe material was also reported to be PE100 per ISO nomenclature. The fusion settings as reported by the Client for this sample were: 100 seconds heat, 16 seconds fusion, 210 second cooling. The pipe sections were approximately 10 in. long, with an overall specimen length of approximately 42 inches, excluding the flange adapter. The minimum wall thickness for each sample was determined by the Client prior to fusing. These were:

Specimen 1/2: 1.175 in.
Specimen 3/4: 1.197 in.
Specimen 5/6: 1.184 in.

**TESTS:** Sustained pressure testing was performed in accordance with ASTM D1598-02 as specified in ASTM D2513-04a. Table A3.1 was followed for the Test I and Test II samples, while Table X3.3 was followed for Test III samples. Therefore, the test temperature was 80°C, and the test stress, test pressure, and minimum test time for each specimen were in accordance with the following Table 1. Outside Diameter (OD) was measured with a pi-tape in accordance with ASTM D2122-98(2004).

**Table 1: ASTM D1598-02 at 80°C**

| Specimen | OD – inches | Stress – psi | Pressure – psi | Time - hours |
|---|---|---|---|---|
| I – 1/2 | 18.250 | 670 | 227 | 170 |
| I – 3/4 | 18.250 | 670 | 229 | 170 |
| I – 5/6 | 18.250 | 670 | 229 | 170 |
| II – 1/2 | 12.733 | 670 | 138 | 170 |
| II – 3/4 | 12.733 | 670 | 137 | 170 |
| II – 5/6 | 12.733 | 670 | 136 | 170 |
| III – 1/2 | 12.750 | 798 | 162 | 165 |
| III – 3/4 | 12.750 | 798 | 166 | 165 |
| III – 5/6 | 12.750 | 798 | 163 | 165 |

**RESULTS:** All specimens completed the tabulated test times without failure. Specimen Test I – 5/6 has been left on-test at 229 psi and has accumulated 361+ hours test time through the date of this report. A photograph of a representative specimen from each test group is shown as Photo 1.

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**Photo 1:** Representative Specimens After Testing



Photo 1 shows, left to right, one tested specimen from Test III (PE100), Test I (PE3408), and Test II (PE2406) samples.

**REPORT WRITTEN BY:**

D. W. Woods
Senior Scientist

**REPORT REVIEWED BY:**

Steve Ferry
Director – Hauser Laboratories

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