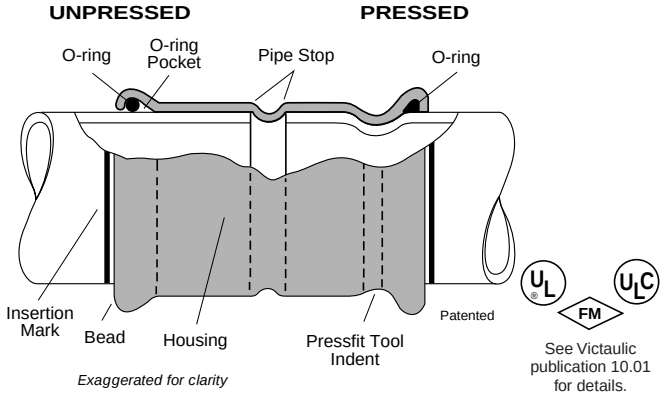
# Design Data
# Pressfit® Qualification Tests

The Victaulic Pressfit System for both carbon steel and stainless steel pipe is designed specifically to join plain end steel pipe; refer to the Pressfit System Product Assembly Manual I-500 for additional details.

The system incorporates Schedule 5 carbon steel pipe and approved stainless steel from 3/4 through 2" with a system of Pressfit couplings, elbows, tees, reducers, and adapters. A portable, hand-held electric or hydraulic tool assembles the fitting on the pipe with a permanent mechanical attachment.

## 1. PRESSFIT COMPONENTS




**O-ring:** The precisely molded synthetic rubber o-ring compresses against the pipe O.D. and inner housing for a lifelong, leak-tight seal. Grade "E" is rated for –30°F to +230°F (–34°C to +110°C) for water, compressed air and mild chemical services; UL classified in accordance with ANSI/NSF 61 for potable water service. Grade "T" (nitrile) is recommended for petroleum products from –20°F to +150°F (–29°C to +66°C). Grade "O" (fluoroelastomer) is recommended for many oxidizing acids, petroleum oils, halogenated hydrocarbons, lubricants, hydraulic fluids, organic liquids and air with hydrocarbons to +300°F (+149°C).

**⚠ CAUTION**

**Pressfit products must be used only on services compatible with o-ring and fitting materials. Incompatible services may result in leakage. For services not listed or special services, contact Victaulic for recommendations.**

**Housing:** Precision formed of carbon steel or Type 316/316L stainless steel, the housing incorporates the gasket and a pipe stop. The unique design assures permanent engagement into the pipe when pressed with the Victaulic Pressfit Tool. Using available adapters, the Pressfit System allows easy field make-up of fitting combinations for reductions and adaption to threaded components.

**Pipe Stop:** To assure a uniform takeout from overall center-to-end or end-to-end dimensions, an integral, internal pipe stop locates pipe position (except for the special Slip Coupling).

**⚠ WARNING**

- **Always mark pipe using a Pressfit Pipe Marking Gauge or per Pressfit Insertion Mark Depth table.**
- **Always fully insert pipe into fitting.**
- **Always properly position fitting in press jaw before pressing.**

**Failure to do so could result in serious injury, improper assembly, joint leakage or joint failure, and property damage.**

**O-ring Pocket:** Sized to contain the o-ring before assembly, the pocket is formed around the o-ring during the pressing operation to fully surround and compress it for a complete leak-free seal.

**Press Tool Indent:** The Victaulic Pressfit Tool jaws engage the entire circumference of the bead on the fitting housing and uniformly compresses it to the pipe to provide a secure attachment of pipe and fitting.

**Pressfit Insertion Mark Depth – Inches/millimeters**

| Size | 3/4<br>20 | 1<br>25 | 1¼<br>32 | 1½<br>40 | 2<br>50 |
|---|---|---|---|---|---|
| Depth | 1<br>25,4 | 1<br>25,4 | 1¼<br>31,8 | 1½<br>38,1 | 2<br>47,8 |

Pressfit carbon steel products are UL/ULC Listed and FM Approved at 175 psi (1200 kPa) on Schedule 5 carbon steel pipe* fire protection systems and are in accordance with NFPA-13 (National Fire Protection Association, Standard for the installation of Sprinkler Systems). In order to qualify for UL/ULC Listing and FM Approval, the Pressfit products were evaluated and tested in accordance with UL and FM requirements.

**TESTS:**

These tests were performed on carbon steel pipe. Pressfit Stainless 316/316L and Vic-Press 304™ products when used on approved stainless steel pipe will meet these requirements.

### A. Pressure Test:

*Description:*

Pressfit products were assembled and tested on carbon steel Schedule 5 pipe. Each test consisted of a fitting assembled on two short sections of pipe with the outer ends capped. The assembly was filled with water and connected to a pressure pump. Pressure was raised to twice the working pressure and a check was made for leakage or any sign of failure. The pressure was then raised until failure occurred.

*Results:*

All pressure tests for the Pressfit products were above the minimum requirements specified by Factory Mutual and Underwriters Laboratories. Typical results are given below:

| SIZE Nominal In. mm | Minimum Req'd PSI/kPa | SIZE Nominal In. mm | Minimum Req'd PSI/kPa |
|---|---|---|---|
| 1<br>25 | 875<br>6000 | 1 1/2<br>40 | 875<br>6000 |
| 1 1/4<br>32 | 875<br>6000 | 2<br>50 | 875<br>6000 |

### B. Flexure Test

*Description:*

Pressfit products were assembled in the same manner as in the Pressure Tests and connected to the pressure pump. The complete assembly was mounted in a frame and was internally pressurized to 175 psi (1200 kPa) and a load was placed on the fitting with the ram. The load from the ram was then increased to requirements as specified by Factory Mutual and Underwriters Laboratories. Typical results are listed below:

| SIZE Nominal In. mm | Minimum Req'd Ft. Lb./N • m | SIZE Nominal In. mm | Minimum Req'd Ft. Lb./N • m |
|---|---|---|---|
| 1<br>25 | 195<br>265 | 1 1/2<br>40 | 375<br>510 |
| 1 1/4<br>32 | 315<br>425 | 2<br>50 | 515<br>700 |

*Results:*

These flexure (bending moment) tests show the Victaulic Pressfit to have superior bending moment resistance as compared to the minimum requirements.





Victaulic Company of America • Phone: 1-800-PICK-VIC (1-800-742-5842) • Fax: 610-250-8817 • e-mail:pickvic@victaulic.com
Victaulic Company of Canada • Phone: 905-884-7444 • Fax: 905-884-9774 • e-mail: viccanada@victaulic.com
Victaulic Europe • Phone:32-9-381-1500 • Fax: 32-9-380-4438 • e-mail: viceuro@victaulic.be
Victaulic America Latina • Phone: 610-559-3300 • Fax: 610-559-3608 • e-mail: vical@victaulic.com
Victaulic Asia Pacific • Phone: 65-6235-3035 • Fax: 65-6235-0535 • e-mail: vicap@victaulic.com

**C. Pressure Cycling Test**

*Description:*
Representative Pressfit products were assembled on Schedule 5 carbon steel pipe with the ends capped. The system was filled with water and the assembly subjected to 20,000 cycles from zero to 175 psi (1200 kPa).

*Results:*
After the cycle test, the Pressfit products were hydrostatically tested to 700 psi (4800 kPa) without any signs of leakage or failure.

**D. Vibration Test**

*Description:*
Representative products were subjected to tests to determine the effects of vibration on their performance. The products were bolted to a vibration machine and vibrated as follows:

| Amplitude (Inches) | .04 | .02 | .04 | .15 | .04 | .07 |
|---|---|---|---|---|---|---|
| Frequency (cycles per sec.) | 35 | 28 | 28 | 28 | 18 - 37 | 18 - 37 |
| Duration (Hours) | 120 | 5 | 5 | 5 | 5 | 5 |

*Results:*
The products withstood the effects of vibration without deterioration of their performance characteristics. Hydrostatic testing resulted in no leakages.

**E. Low Temperature Exposure**

*Description:*
Pressfit assemblies were exposed to –40°F (–40°C) temperatures for 40 days and then submerged in antifreeze and pneumatically pressurized to 50 psi (345 kPa).

*Results:*
The assemblies were pneumatically pressurized to 50 psi (345 kPa) and found to be leak-tight.

**F. High Temperature Exposure**

*Description:*
Pressfit assemblies were exposed to recirculating hot water at +275°F (+135°C) and 300 psi (2065 kPa) for 60 days.

*Results:*
Pressfit assemblies exhibited unparalleled performance compared with threaded connections.

**G. Fire Tests**

*Description:*
Representative assemblies were subjected to a series of fire test exposures to determine product integrity. The source of the fire tests included 350 lb. sprinkler fire test cribs as described in Standard UL 199, and a 25 gallon source of n-heptane.

*Results:*
The grid of assemblies were hydrostatically tested to 120 psi (825 kPa) after the fire tests, maintained integrity and showed no signs of leakage.

**H. Seismic Evaluation**

Tests were performed to compare representative threaded products and Victaulic Pressfit products with respect to the effects of induced piping oscillations and structural integrity of joining methods. The oscillations were intended to provide a relative baseline for a serviceability assessment of joints used in regions prone to seismic disturbances.

*Description:*
Representative samples of threaded tees and Victaulic Pressfit Style 520 Reducing Outlet Tees were assembled on 1½" nominal IPS pipe using Schedule 40 for threaded and Schedule 5 for Pressfit. As the purpose of the test was to evaluate the Victaulic Pressfit method against the traditional method, pipe wall thicknesses corresponding to those commonly used were selected. Four fittings were spaced at 10' - 0" intervals with one end of the pipe run rigidly fixed and the other end connected to the motion generator. The assembly was left unsupported between ends so that severe motions and accelerations could be achieved. Both ends of the pipeline were capped, filled and pressurized with water.

Each test assembly was pressurized to an internal working pressure of 175 psi (1200 kPa) and the motion generator started. The motion generator produced a total vertical movement of 2 ¼" at the free end with frequencies in the range of 1.3 to 1.5 cycles per second. Each test assembly ran for a minimum of 5 minutes, and acceptance criteria based upon the duration of typical disturbances.

*Results:*
The Pressfit products were subjected to peak accelerations without leakage or failure. The stress concentration inherent in a pipe thread was evident during the preliminary oscillation test of the threaded tees, as a fracture occurred within 1 minute 24 seconds, culminating in a joint separation at 2 minutes 2 seconds. All test frequencies and amplitudes used in this investigation were approximations intended solely for the development of a relative database. They were not intended to address specific conditions at any particular location.

**I. Factory Mutual Research Corporation Tests**

*Description:*
Piping and fittings, both carbon steel and stainless steel, were assembled into a combined configuration for the testing at the direction of Factory Mutual Research Corporation.

**Additional Testing**

**1. Air Test**

The test assembly was pressurized with air to 60 psi (413 kPa). While still pressurized, after one hour, no leakage was detected based on visual examination of the joints and the pressure reading. With the assembly still pressurized, a minimum load of 770 ft. lb. (3388 N•m) was applied to the locations on the assembly shown in the drawing and held for 10 minutes. The load was applied by a hydraulic ram with a bearing surface of 2.76 In.$^2$ (1780 mm$^2$). After 10 minutes, no leakage was observed. The loads were removed with no loss of pressure indicated.

The test assembly was evacuated to a vacuum of 25.2 in. Hg (640 mm Hg). With the pump isolated from the assembly, the vacuum was maintained for one hour. At the conclusion of one hour, no change in the vacuum was noted on the gauge. While still maintaining the vacuum, a minimum load of 770 ft. lb. (3388 N•m) was applied to the locations on the assembly shown and held for 10 minutes; no leakage was observed. The load was removed and no leakage was detected.

**2. Water Test**

The test assembly was pressurized with water to 450 psi (3100 kPa) and maintained at that pressure for 16 hours. At the conclusion of this time period, no leaks were observed. A minimum load of 770 ft. lb. (3388 N•m) was applied to the locations on the assembly shown and held for 10 minutes. No leakage was observed. With the loads removed, it was determined through visual examination that no leakage had occurred.

With the test assembly filled with water and a minimum load of 770 ft. lb. (3388 N•m) applied to those locations shown, cycle tests were conducted. The assembly was cycled from 0 to 300 psi (2068 kPa) for 1000 cycles. The assembly was observed during the cycling with no detectable leaks. At the conclusion of the 1000 cycles, the applied loads were removed. No leakage was observed.

**3. Helium Test**

The test assembly was pressurized with Helium to 12 psi (83 kPa). After one hour, the gauge reading remained unchanged. A minimum load of 770 ft. lb. (3388 N•m) was applied to the locations on the assembly shown and held for 10 minutes. No leakage was observed based on the gauge reading. With the loads removed, the pressure reading remained unchanged.

The test was pressurized with Helium to 12 psi (83 kPa). After one hour, the gauge reading remained unchanged. A minimum load of 770 ft. lb. (3388 N•m) was applied to the locations on the assembly shown and held for 10 minutes. No leakage was observed based on the gauge reading. With the loads removed, no pressure loss was indicated.

**CONCLUSIONS**

The array of tests conducted on the Victaulic Pressfit System demonstrates its capability to meet qualification criteria provided by nationally recognized standards, laboratories, and approval

agencies which govern the use of such products. The tests conducted substantiate this product's excellent performance and reliability when evaluated against prominent national standards.

The data provided us intended for use as an aid to qualified designers when products are installed in accordance with the latest available Victaulic product assembly instructions.

**ACCELERATED AGE TESTING**

Request Report No. 0414 for complete Southwest Research Co. Pressfit System (carbon and stainless steel) accelerated age testing.

**Accelerated Aging and Performance Test of Victaulic Pressfit® System Components**

Performed by:

Mechanical and Fluids Engineering Division
Southwest Research Institute
San Antonio, Texas

**Introduction**

Southwest Research Institute (SwRI) was contracted by the Victaulic Company of America to perform an accelerated aging and thermal cycling performance test of Victaulic Pressfit® system components in order to satisfy the requirements of state and local agencies with regulatory authority over building codes and component specifications. The tests were conducted by the Mechanical and Fluids Engineering Division of SwRI between the dates of January 20, 1994 and April 18, 1994.

**Test Articles**

The Victaulic Company supplied SwRI with the components to be tested. Pressfit components are rated for 300 psig at 230°F (110°C) in continuous service in closed loop systems. The Pressfit fittings consist of a metal sleeve which slides over the plain ends of two pieces of pipe to be joined, as illustrated in Figure 1 taken from the product brochure. The sleeve contains internal indentations on each end into which an o-ring is fitted. The ends of the pipe are marked to ensure proper insertion depth. After inserting the ends of the pipes to be joined into the sleeve, a pressing tool is used to crimp the sleeve onto the ends of the pipe. In the crimping process, the o-ring is also compressed against the outside diameter of the pipe. Each end of the fitting is pressed to make the complete pipe joint. Sealing is achieved by a combination of the mechanical interference between the sleeve and pipe and the compression of the o-ring seal. The mechanical strength of the joint is achieved from the crimping process.

Victaulic supplied two assemblies of fittings for the test. The first consisted of a series of carbon steel fittings and short pipe nipples ranging from 2" pipe size at the large end down to a $^3/_4$" pipe size at the small end. The overall length of the first test article was $38^3/_{16}$".

The second test assembly consisted of 316/316L stainless steel fittings and short stainless steel pipe nipples of similar sizes as the carbon steel assembly. The overall length of the stainless steel assembly was $46^1/_2$". Each test article was assembled from stock production parts by Victaulic. The details of each test article assembly are shown in the Victaulic drawing B-U-006-396-001, a copy of which is available upon request.

**Test Apparatus**

The test apparatus consisted of a hot water recirculating flow loop which circulated hot, high pressure water through the test articles. The test apparatus is shown schematically in Figure 1. The primary flow loop components were a high pressure pump, an electric immersion heater, a turbine flowmeter, and an accumulator. The total flow loop volume was approximately 3.5 gallons.

Water temperatures were measured using K-type thermocouples, and loop pressure was measured using an Omega PX94 0 - 300 psi amplified electronic pressure transducer. A Fluke *Hydra* data logger was used to convert thermocouple signals into degrees Fahrenheit, flowmeter pulses into gallons per minute, and pressure transducer signals into pounds per square inch (gauge) for display. The data logger was interfaced to a data acquisition computer which polled the data logger at preset intervals and recorded loop temperatue, pressure, and flow rate over the duration of each test run.

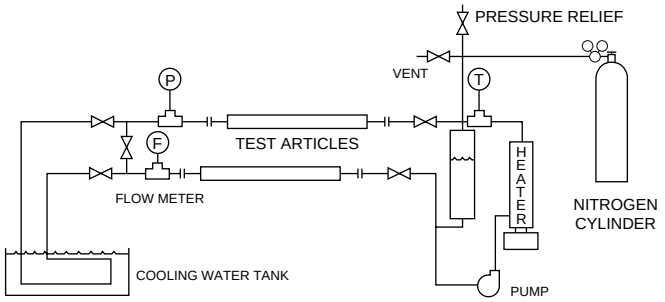



**Figure 1**
**Test Apparatus Schematic**

The water flow rate through the loop was measured using a Halliburton $1^1/_2$" diameter turbine flowmeter with special high temperature magnetic pick-up. Nominal flow rate through the loop during testing was approximately 26.5 gpm, resulting in flow velocities of 2.7 ft/sec to 19.3 ft/sec in the 2" and $^3/_4$" fittings, respectively.

The loop temperature was controlled by a temperature controller system using thermocouples in the main flow loop and attached to the heating element. The controller system employed a PID controller to maintain loop temperature at the test set point. A pressure switch on the flow loop was set to interrupt power to the heater whenever loop pressure fell below a set point of about 140 psi.

Loop pressure was controlled independently of temperature using a high pressure nitrogen bottle and pressure regulator to admit nitrogen to the accumulator. the accumulator was fitted with a manual vent valve and a safety pressure relief valve set at 330 psig.

All thermocouples were calibrated before the testing was begun in a hot oil bath against a temperature reference traceable to NIST standards. The pressure transducer was likewise calibrated using a dead weight tester before the testing started.

**Test Procedure**

The test loop was filled with deionized water and sealed. The pump was started, and the nitrogen system used to pressurize the system to about 150 psig to permit the heater unit to operate. The heater unit was then energized, and the loop permitted to heat to the testing temperature of 275°F (135°C). During the heat-up phase, the pressure was vented manually to prevent over-pressure of the loop, especially as the loop temperature rose above 212°F (100°C). When the loop temperaure stabilized at the test temperature, a process requiring about two hours, the pressure on the system was slowly increased with the pressure regulator to the 300 psig test point.

The data acquisition system was initialized and programmed to log loop temperature, pressure, and flow rate every 10 minutes for the duration of the test run.

The loop was run at 275°F (135°C) and 300 psig for seven days, at which time the heater was de-energized and the bypass lines were opened to cool the system to ambient temperature. Cooling typically required about $1^1/_2$ hours. The pump was then stopped, and the system pressurized to 300 psig for 10 minutes. During this hydrostatic test, the test articles were examined for leaks or other signs of deterioration. Upon completion of the hydrostatic test, the next test run was started using the procedure just described.

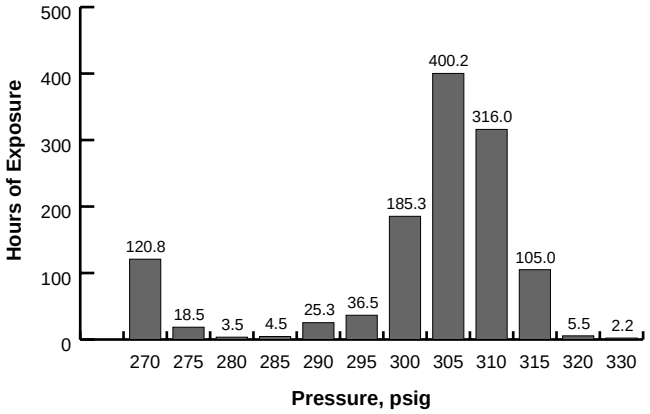



**Figure 2**
**Test Pressure History**

The original plan called for a total of seven weeks of testing, with each seven day period punctuated with a cool down and hydrostatic test of the fittings. Thus, the test profile was to consist of 1176 hours of exposure at 275°F (135°C) and 300 psig and seven cooling/ hydrostatic test cycles.

**Test Results**
The test exposure profiles are summarized in Figures 2, 3, and 4. Figures 2 and 3 are pressure and temperature exposure histograms, respectively, during the testing period January 20, 1994 through April 18, 1994.

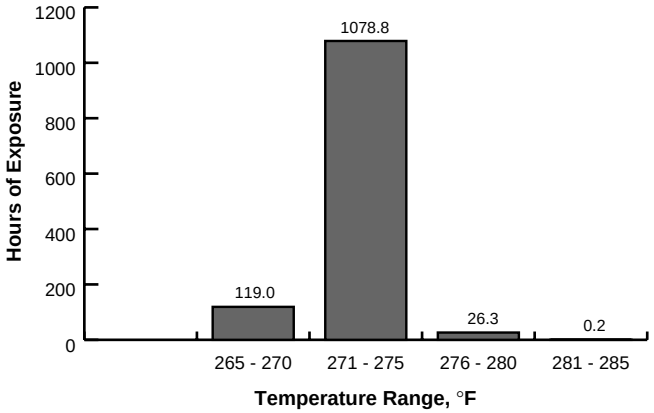



**Figure 3**
**Test Temperature History**

Equipment problems with flow loop components necessitated diviations from the original test plan. Frequent leaks from non-Pressfit threaded joints in the flow loop and numerous pump seal failures resulted in several additonal cooling/hydrostatic cycles in order to fix the leaks or replace the pump seals. The test loop was constructed from Schedule 40 and Schedule 80 pipe and threaded fittings. Over the duration of the test, virtually every threaded pipe joint developed severe leaks at one time or another, necessitating test interruption to fix the leaks. Three different pipe thread compounds were used until satisfactory results were obtained with a special high temperature compound with a heavy fiber content. As a rule, the larger the pipe diameter, the more difficult was the task of obtaining a satisfactory seal. Ultimately, leaks in the 3" pipe immersion heater housing became such a nuisance that the heater housing was rebuilt with 2" pipe. As a result of the numerous test interruptions, the initially planned test profile for thermal cycling was greatly exceeded. While seven cycles were planned, a total of 18 cycles between test conditions and ambient were recorded during the tests.

During the final hydrostatic test, a minor weep was detected on the carbon steel assembly at the straight $1^1/_4$" Pressfit coupling on the end towards the small diameter end of the test article. The leak was measured at approximately four drops per minute at a pressure of 305 psig. The leak was directly underneath one of the crimp scars, indicating that the o-ring in this location may have been slightly pinched in the crimping process. This was the first and only leak detected during the entire exposure test, and occurred after 59.5 days of elevated pressure and temperature exposure. The test loop pressure remained constant at 305 psi for 15 minutes during the final hydrostatic test, indicative of the minor nature of the leak.

**Conclusions**
Both test articles survived the accelerated testing at high temperatue and pressure without mechanical failure and with only a very small leak in one of the 32 Pressfit couplings in the two test articles. The test articles were exposed for a total fo 59.5 days to 300 psig, 275°F (135°C), flowing water and 18 pressure and temperature cycles between maximum test conditions and ambient. During the course of the testing, both test articles became slightly bowed. This deflection from the original straight configuration is attributed to thermal distortions of the test articles and is an artifact of the close joining of the fittings in the test articles. The Pressfit couplings performance was clearly superior to the threaded pipe joints in the test loop, which leaked excessively and repeatedly during the test.

**Test Engineer's Comments**
The performance of the tests was delayed considerably by the failure of flow loop components not associated with the Pressfit products. The pump seals supplied with the circulating pump were unable to withstand the test conditions, and considerable time and effort was expended in resolving the frequent pump seal failures. The pump seal material was changed from stainless steel on carbon to ceramic on carbon after two seal failures. The ceramic pump seals subsequently failed seven more times, and never performed according to the pump manufacturer's specifications. The pump seals were able to endure the test conditions only after the pump was modified by SwRI to add a special cooling water jacket to the seal housing. A separate cooling water pump was used to circulate cooling water from a reservoir through the seal housing.

The continued problems with threaded pipe joints was unanticipated. The repair and rework of joint leaks extended the test program considerably. It is the test engineer's opinion that the Pressfit couplings offered distinct advantages over conventional threaded pipe components.

NOTE:
The Pressfit system is SBCCI PST and ESI Listed, evaluation report No. 9535 (carbon steel); BOCA Evaluation Services, Inc. Listed, Research Report No. 93-3 – HVAC systems (Cat. 22) and Fire Protection (Cat. 15) (carbon steel); ICBO Evaluation Services, Inc., Listed for mechanical services in accordance with the Uniform Mechanical Code UMC, ICBO-ES Report No. 5079.