

# EBAA IRON Connections™

TECHNICAL DATA FOR THE WATER & WASTEWATER PROFESSIONAL

PV - 1

## THE 2000PV, A BACKGROUND & SUMMARY OF TESTS

The 2000PV is a restraint for PVC pipe and the standardized mechanical joint. This product is the result of years of testing and evaluation and its performance has been proven by thousands of hours of proof tests as well as third-party evaluations. This report describes the 2000PV through the twelve-inch size.

### BACKGROUND

EBAA Iron started making joint restraint products for PVC pipe in the early '80s. The first restraint products that we provided to the market worked well during testing but the installation procedure involved requirements that were not easily followed in the field. As a result, the installation of the restraint was not straightforward and proper procedures were not followed in several cases. There was also an absence of testing procedures to prove the performance of any product on PVC pipe to answer the questions of people concerned about any attachment on PVC pipe.

The testing of early prototypes of various configurations of restraint on large diameter PVC pipe also indicated that a restraint device must be capable of consistency and reliably gripping the pipe, otherwise, the restraint can slip under pressure, resulting in sudden impact, and cause the pipe to burst. This situation can be aggravated by improper installation of the restraint product.

Armed with this background knowledge and an appreciation for the capabilities of PVC pipe, EBAA purposefully deviated from what many in the industry considered to be the "correct" way to grip PVC pipe. The result of this testing and research is the Series 2000PV restraint device.

### INSTALLATION

The design of the 2000PV incorporates the gripping mechanism into the design of the mechanical joint gland and utilizes a simple two-part assembly process. First, the procedure for assembling the joint is the same as any standard mechanical joint. The assembly procedure we recommend is that established in AWWA C600. The second is the actuation of the restraint. This conventional, two-step procedure makes the installation simple and straightforward. While the performance of a product is of major import, if the product is difficult to assemble correctly, the chances are great that it will not be assembled properly or function properly.

### PIPE PERFORMANCE

With any piping material, the performance of a joint restraint product should be compatible with the performance of the pipe. That is why we have subjected the 2000PV to a battery of tests that demonstrate the capability of the PVC pipe with the 2000 series to perform as well as or better than the pipe alone.

Two pressure tests are required by AWWA C900 and ASTM D-2241. They are a burst pressure test and a sustained pressure test. The hoop stress for the minimum burst pressure requirement is 6400 psi. The equivalent internal pressures for different thicknesses of pipe are shown below.

ANSI/ AWWA C-900		ASTM D2241	
CI OD		IPS OD	
DR14	650psi	SDR17	530psi
DR18	500psi	SDR21	420psi
DR25	350psi	SDR26	340psi

Sustained Pressure Requirements for PVC Pipe.

TABLE 2

These are the internal pressures that the pipe must be capable of attaining without failure within sixty to seventy seconds.

The hoop stress for the sustained pressure test is 4200 psi. The equivalent internal pressures for different thickness of pipe are shown below.

ANSI/ AWWA C-900		ASTM D2241	
CI OD		IPS OD	
DR14	650psi	SDR17	530psi
DR18	500psi	SDR21	420psi
DR25	350psi	SDR26	340psi

Sustained Pressure Requirements for PVC Pipe.

TABLE 2

These are the pressures that the pipe must be capable of maintaining without failure for a period of not less than 1000 hours.

A third quality of PVC pipe is its performance in cyclic pressure applications. In the design of systems that will be subjected to cyclic stresses the Uni-Bell Handbook for PVC pipe recommends that the Vinson equation be used as a conservative tool to determine the cyclic capability of a system. This equation is based on cyclic tests performed by Herbert Vinson and reported in his paper "Response of PVC Pipe to Large, Repetitive Pressure Surges" published by ASCE in the International Conference on Underground Plastic Pipe, 1981, edited by B. Jay Schrock.

### SERIES 2000PV TESTING

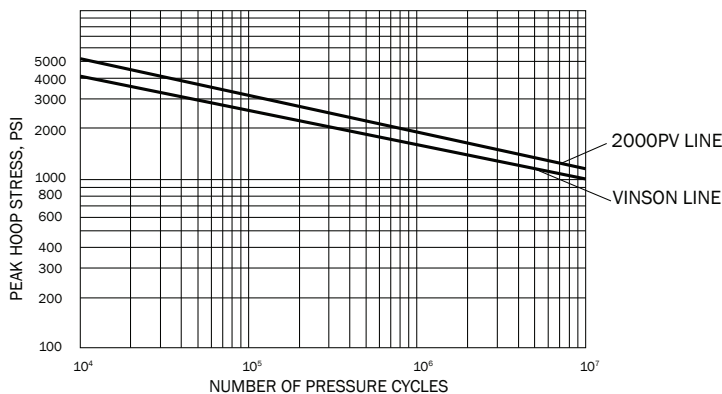
It is the design philosophy of the 2000 Series that the PVC pipe with the restraint should have the same pressure rating and safety factor as the pipe alone. Therefore, the pipe and restraint should be capable of the same testing and performance criteria established for the pipe alone. The 2000 Series does this and more.

We have successfully tested the 2000 Series to the same burst pressure tests, sustained pressure tests, and cyclic tests as the pipe alone.

PVC pipe is made of resin that has been qualified by a 10,000-hour test at the minimum sustained pressure. Once in production, the pipe is required to be capable of maintaining this pressure for 1000 hours without failure. Every size of 2000PV has been tested to over 1000 hours at 500 psi (minimum sustained pressure for D18 PVC pipe). The 1000 hour limit was exceeded by many test specimens as detailed in Connections Bulletin PV-2. In his article "Changes in Strength of Pressurized PVC Pipe with Time" published in the July 1981 issue of Journal AWWA, Robert T. Hucks, Jr. presented a PVC pipe stress regression line. The equation for this line indicated that for PVC pipe with a hoop stress of 5228 psi (615 psi pressure for D18 pipe) the projected life of the pipe was 1000 hours. On July 29, 1993, a test was completed that subjected four through twelve-inch specimens to a 615 psi pressure test for over 1000 hours without failure.

The 2000PV has been tested to pressures higher than the minimum burst pressure of the pipe in each size and on most DRs and SDRs.

At a peak pressure of 187 psi, DR18 PVC pipe is capable of withstanding 1,000,000 pressure cycles without failure according to the Vinson equation. The four through twelve inch 2000PV have been tested to an excess of 1,000,000 cycles. When the pipe selections did fail, the failure mode was a longitudinal break in the mid-span of the pipe away from the restraint device. These failures are typical of those in pipe tests with no restraint attachment and are a result of hoop stress in the pipe. This test will accelerate any affects that an attachment to the pipe might induce. Figure 1 shows the cyclic stress regression curve for pipe tested with the 2000PV compared to the curve generated by the Vinson equation.

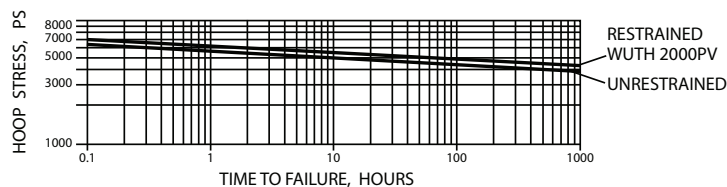


COMPARISON OF CYCLIC STRESS REGRESSION CURVES  
2000PV AND VINSON EQUATION

FIGURE 1

An alternative to the pressure tests is provided in ASTM 2241. That is an accelerated stress regression test. This testing has been performed on 2000PV test specimens in accordance with that standard and showed that the attachment of the 2000PV to the pipe does not affect the long-term performance of the pipe.

Figure 2 shows a stress regression curve for pipe tested with the 2000PV series and one without restraint products.



STRESS REGRESSION LINE COMPARISON  
UNRESTRAINED PIPE AND PIPE RESTRAINED WITH 2000PV'S

FIGURE 2

## SPECIFICATIONS, APPROVALS, AND LISTINGS

Uni-Bell is a PVC pipe manufacturer's organization that published a test method for PVC joint restraint products and is endorsed by its pipe producing members. That standard is UNI-B-13-92. The 2000PV has been tested according to this specification and meets or exceeds all requirements.

The 2000PV is approved by Factory Mutual, Inc. This involved high-pressure tests that were witnessed by FM personnel and annual quality control audits.

The 2000PV is listed by Underwriters Laboratories. This involved short-term burst tests, long-term burst tests, and cyclic pressure tests plus quarterly quality control audits. All of the testing was done at the UL facility. The UL performance requirements are more stringent than those established by the UNI-Bell.

## SUMMARY

All of these tests prove that the 2000PV design works and the product does not damage the pipe in any way. Pipe that has been tested with the 2000PV can actually perform better than pipe without joint restraint. The long-term tests at elevated pressures prove there is no immediate or long-term damage to the pipe. Cyclic testing provides an accelerated method of determining whether or not an attachment will cause premature failure of the pipe. The cyclic testing done on the 2000PV proves that there is no damage done to the pipe by utilizing the 2000PV as a joint

restraint system.

## REFERENCES

Uni-Bell Handbook of PVC Pipe-Design and Construction, Third Edition, September 1991.  
"Recommended Performance Specification for Joint Restraint Devices for Use with Polyvinyl Chloride (PVC) Pipe", Uni-B-13-92, Uni-Bell PVC Pipe Association, Dallas, Tx.