# RESTRAINT OF PRESSURIZED WATER/WASTEWATER SYSTEMS

## REVISION RECORD

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**This document has been revised in its entirety.**

## 1.0 INTRODUCTION

### 1.1. PURPOSE:

This procedure establishes a guideline to assure that pressurized water and/or wastewater piping systems are modified and/or installed with adequate provisions to prevent pipe separation at the push-on or mechanical joints.

### 1.2. SCOPE AND APPLICABILITY:

This procedure is applicable to all BOSS Operations and Maintenance personnel that review, install, maintain or modify pressurized water and wastewater systems that utilize, or will utilize, Ductile-Iron or Polyvinyl Chloride (PVC) pipe with rubber-gasket joints (push-on or mechanical), on the Kennedy Space Center (KSC).

### 1.3. ROLES AND RESPONSIBILITIES

**Water/Wastewater Supervisor:** Responsible for assigning personnel and support services as needed to assure compliance with all applicable State mandated maintenance/operation of water treatment and distribution systems.

**Water Operators:** Responsible for the day to day operation and maintenance of the potable water treatment and distribution system.

**System Maintenance Engineer (SME):** The SME will provide support to the Operators and Supervisor as needed to assure operations comply with all regulatory requirements. SME is also responsible for notification of regulators and customers in the event of an anomaly/malfunction.

**BOSS Environmental Assurance Office:** Ensures operations meet regulatory and permitted requirements and provides notification of changes to these requirements.

### 1.4. REFERENCES

**Contract/Authority Documents:**

| | |
|---|---|
| NNK08OC01C | Institutional Services Contract, PWS 2.4.1 Potable Water |
| ANSI/AWWA C600 | AWWA Standard for the Installation of Ductile-Iron Water Mains and their Appurtenances |
| ANSI/AWWA C900 | AWWA Standard for the Installation of Polyvinyl Chloride (PVC) Pressure Pipe, 4” through 12” for Water Distribution |
| ANSI/AWWA C111/A21.11 | American National Standard for Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings |
| ASTM A716 | Standard Specification for Ductile Iron Pipe |

**BOSS Level 1:**

| | |
|---|---|
| QMS-QP | BOSS Quality Plan |
| QMS-P-0003 | Control of Records |
| PMO-P-0014 | BOSS Records Management |

**BOSS Level 2:**
None

**BOSS Level 3:**
None

**BOSS Level 4:**
None

**BOSS Level 5:**
None

## 1.5. DEFINITIONS

**Joints and accessories**: For the purpose of this procedure, the term joint includes accessories.

**Mechanical joint**: A bolted joint of the stuffing-box type. Each joint shall consist of (1) a bell that is cast integrally with the pipe or fitting and provided with an exterior flange having bolt holes or slots, and a socket with annular recesses for the sealing gasket and the plain end of the pipe or fitting; (2) a pipe or fitting plain end; (3) a sealing gasket; (4) a follower gland with bolt holes; and (5) tee-headed bolts and hexagonal nuts.

**Push-on joint**: A single rubber-gasket joint that is assembled by positioning a continuous, molded, rubber-ring gasket in an annular recess in the pipe or fitting socket and forcing the plain end of the entering pipe or fitting into the socket. The gasket and the annular recess are designed and shaped so that the gasket is locked in place against displacement.

# 2.0 PROCESS

## 2.1. GENERAL INFORMATION

This document provides basic information required to evaluate and select the proper method best suited to secure unrestrained joints in pressurized water distribution and wastewater force main systems. Refer to manufacturer's recommendations, published standards and Best Available Technology (BAT) prior to installing or modifying a water/wastewater system.

Ductile Iron pipe (C600) and Polyvinyl Chloride (PVC) pipe (C900) and fittings are joined with push-on (Figure 1) or mechanical joint assembly (Figure 2). Neither of these joints provides significant restraint against longitudinal separation other than the friction between the gasket and the plain end of the pipe or fitting. These joints should be considered as offering no longitudinal restraint for design purposes.

At many locations in an underground or aboveground pipeline, the configuration of the pipeline results in unbalanced forces of hydrostatic or hydrodynamic origin that, unless restrained, can result in joint separation. Generically, these unbalanced hydrostatic and hydrodynamic forces are called THRUST FORCES.

Thrust forces occur at any point in the piping system where the direction or cross-sectional area of the waterway changes. There will be thrust forces at bends, reducers, offsets, tees, wyes, dead ends, and valves. Balancing thrust forces in underground pipelines is usually accomplished with bearing or gravity thrust blocks, restrained joint systems, or combinations of these methods.

Therefore, when a determination has been made to the design or modification of water or wastewater pressurized systems and the use of push-on or mechanical joint piping is anticipated, one of the following approved restraint methods should be selected.

## 2.2. **ACCEPTABLE RESTRAINED JOINT SYSTEMS**

### 2.2.1. THRUST BLOCKS

The most common method of providing resistance to thrust forces is the use of thrust blocks. Resistance is provided by transferring the thrust force to the soil through the
larger bearing area of the block such that the resultant pressure against the soil does not exceed the horizontal bearing strength of the soil.

Design of thrust blocks consists of determining the appropriate bearing area of the block for a particular set of conditions. The parameters involved in the design include pipe size, design pressure, angle of the bend (or configuration of the fitting involved), and the horizontal bearing strength of the soil.

Vertical and horizontal thrust blocks are made of concrete and placed between solid ground and the fitting(s) to be anchored. The blocking must be located so as to contain the resilient thrust force in such a way that the pipe and fitting joints will be accessible for repair.

### 2.2.2. THRUST BLOCK NOTES

Wrap all fittings with polyethylene film before pouring thrust block. Make certain to keep concrete away from all bolts, glands and flanges. Thrust blocks are to be poured against undisturbed soil. Required volume and various details are shown in Appendix A of this procedure.

### 2.2.3. RESTRAINED JOINTS

An alternative method of providing thrust restraint is the use of restrained joints. A restrained joint is a special type of push-on or mechanical joint that is designed to provide longitudinal restraint. Restrained joint systems function in a manner similar to thrust blocks, insofar as the reaction of the entire restrained unit of piping with the soil balances the thrust forces. Tie rods, clamps, or other components should be made of corrosion resistant material or suitably protected against corrosion.

### 2.2.4. METAL TIE RODS

Mechanical joints can be restrained using metal rods installed between the pipe, fitting or valve and the mechanical joint to be restrained. The threaded metal rod should be the same diameter as the bolts supplied with the joint accessories. Generally two (2) threaded rods are used, placed opposite each other, equal distance around the joint to be restrained. However additional rods can be employed when restraining valves at the end of a pipe or where hydrostatic pressures may vary, i.e. water hammer. The restraining rod is anchored in place by hex nuts tightened securely to the mechanical joint or flange at both ends.

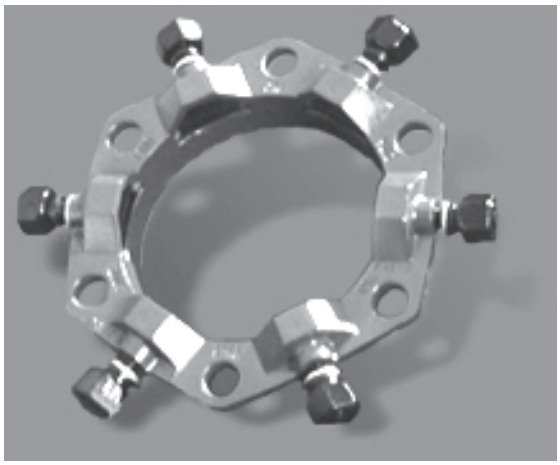


### 2.2.5. MEGALUG MECHANICAL JOINT RESTRAINTS

MEGALUG Mechanical Joint Restraints replace external restraints such as cumbersome concrete thrust blocks and corrodible metal tie rods creating a quicker, safer and more economical installation.



MEGALUG for Ductile Iron Pipe



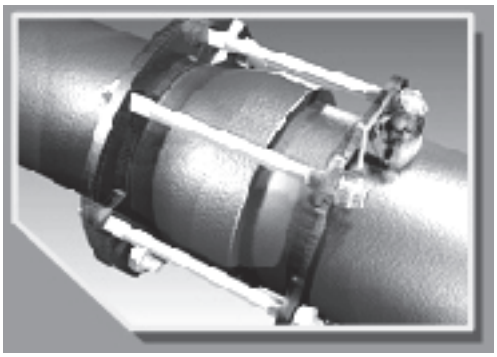
MEGALUG for C-900 (PVC) Pipe

### 2.2.6. PUSH-ON PIPE RESTRAINT

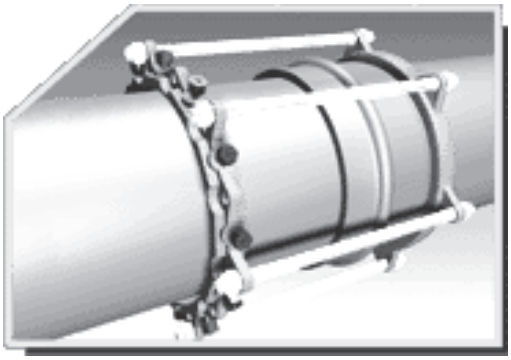
To restrain Push-on Pipe joints, either C-900 PVC or Ductile Iron, special restraining devices, combing both the MEGALUG and Metal Tie Rod principle, can be used in lieu of or in combination with thrust blocks.

Note: Where mechanical joint restraints devices are used to control thrust movements of fabricated fittings, consult with the fittings manufacturer to determine the tensile thrust limitations for the specific sizes, configurations and pressure classes specified.

Push-On Pipe Restraint for Ductile Iron Pipe



Push-On Pipe Restraint for PVC Pipe



An installation guide for typical push-on joint piping is shown in Appendix B.

## 3.0 RECORDS

The following records are retained by the organizations listed below.

| Record | Responsible Organization | Retention Period |
|---|---|---|
| None | | |

The following revisions have been applied to this document:

| Revision Number | Change Description | Date |
|---|---|---|
| 5 | Complete revision to incorporate BOSS Document Control Requirements | |
| 6 | Administrative change only. Document updated to remove branding of previous contract. | 04/01/19 |

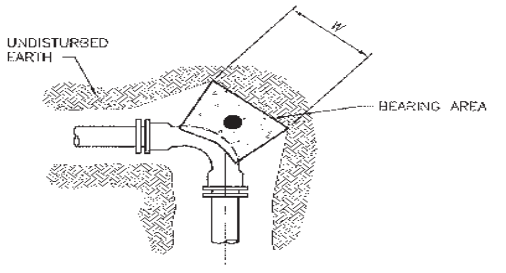
**DOCUMENT APPROVALS**

Signature on file

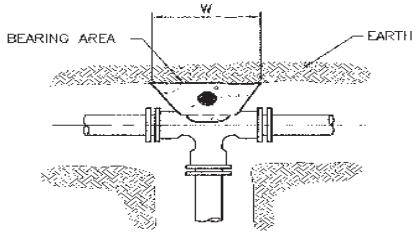
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Manager, FSEU OM&E

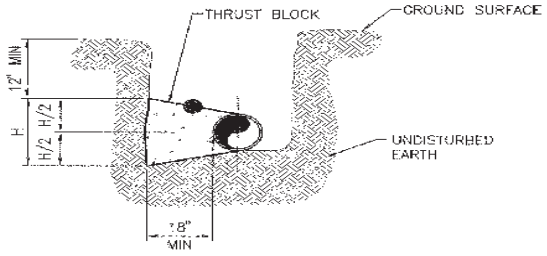
## APPENDIX A: thrust block DETAILS



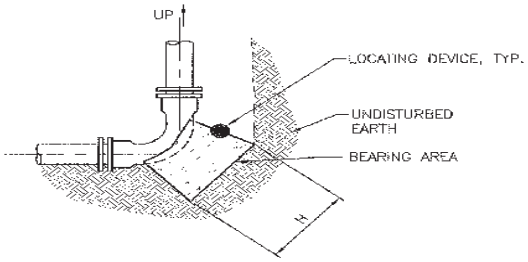

BENDS PLAN



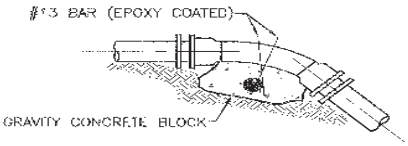

TEE PLAN



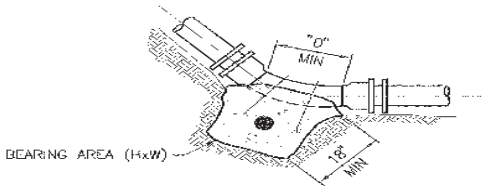

ILLUSTRATIVE SECTION




BENDS IN SECTION




VERTICAL DOWN




VERTICAL UP

| VERTICAL DOWN BENDS REACTION BLOCK VOLUMES | | | | |
|---|---|---|---|---|
| FITTING SIZE (in) | 11 1/4° BEND (CY) | 22 1/2° BEND (CY) | 45° BEND (CY) | 90° BEND (CY) |
| 2–4 | 0.25 | 0.25 | 0.50 | 1.00 |
| 6 | 0.25 | 0.50 | 1.00 | 1.75 |

IN CONC W/ DIRECTION SE

| REACTION BLOCK BEARING AREA DIMENSIONS | | | | | |
|---|---|---|---|---|---|
| FITTING | 11 1/4° BEND | 22 1/2° BEND | 45° BEND | 90° BEND | TEE * |
| SIZE (in) | H x W (in) | H x W (in) | H x W (in) | H x W (in) | H x W (in) |
| 2–4 | 12x12 | 12x12 | 12x12 | 15x15 | 12x12 |
| 6 | 11x11 | 15x15 | 22x22 | 30x30 | 25x25 |

5 C13

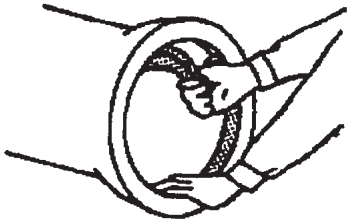
### REACTION BLOCK NOTES

1. BASED ON 150 PSI PRESSURE & 2000 PSF SOIL BEARING VALUE, AND 1.5 SAFETY FACTOR.
2. BEARING AREAS FOR PLUGS SHALL BE THE SAME AS FOR TEES.
3. FORM REACTION BLOCKS TO KEEP CONCRETE CLEAR OF JOINTS AND BOLTS.
4. REACTION BLOCKS SHALL BE PLACED AGAINST UNDISTURBED MATERIAL. WHERE TRENCH WALL HAS BEEN DISTURBED, EXCAVATE ALL LOOSE MATERIAL AND EXTEND REACTION BLOCK TO UNDISTURBED MATERIAL.
5. PLACE PRESSURE TREATED WOOD BOARDS IN FRONT OF PLUG, AT TEE, CROSS OR END OF PIPE BEFORE POURING CONCRETE REACTION BLOCK.
6. BACKFILL SHALL CONSIST ENTIRELY OF CLEAN SAND AND ROCK FRAGMENTS. ANY MUCK ENCOUNTERED SHALL BE REPLACED WITH BACKFILL COMPACTED TO 95% MODIFIED PROCTOR MAXIMUM DRY DENSITY, ASTM D1557.
7. CONTRACTOR TO OBTAIN LOCATING DEVICES (GTE) AND TO EMBED THE DEVICE INTO THE TOP SURFACE ON THE THRUST BLOCK SUCH THAT HALF THE DEVICE IS EXPOSED AND THE LOCATION IS AT THE CENTROID OF THE THRUST BLOCK TOP SURFACE AREA. THE LOCATING DEVICES SHALL BE OMNI MARKER MODEL 161 WATER MARKER OR APPROVED EQUAL.

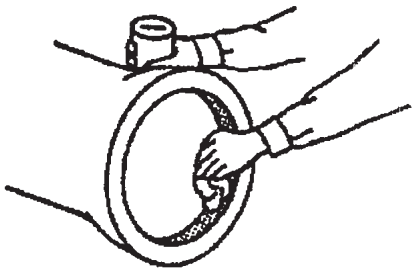
**TYPICAL REACTION BLOCK (THRUST BLOCK) DETAILS** 3 C7

NTS

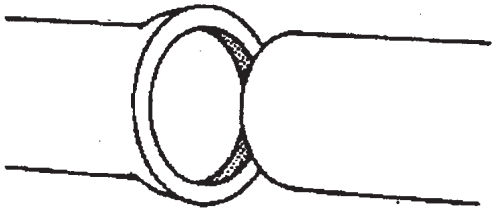
## APPENDIX B: PUSH-ON JOINT INSTALLATION GUIDE



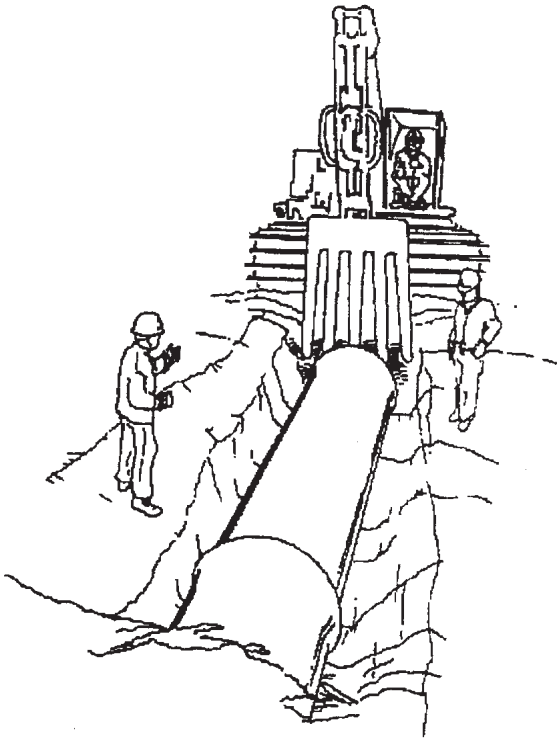
1. Thoroughly clean the groove and the bell socket of the pipe or fitting; also clean the plain end of the mating pipe. Using a gasket of the proper design for the joint to be assembled, make a small loop in the gasket and insert it in the socket, making sure the gasket faces the correct direction and that it is properly seated. NOTE: In cold weather, it is necessary to warm the gasket to facilitate insertion.



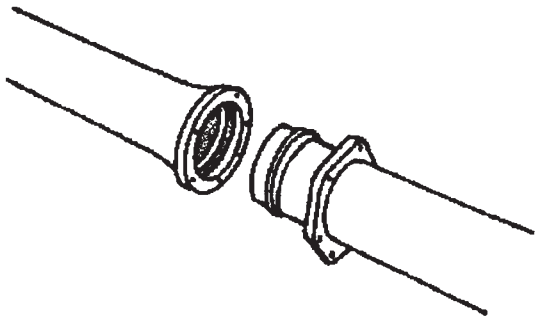
2. Apply lubricant to the gasket and plain end of the pipe in accordance with the pipe manufacturer's recommendations. Lubricant is furnished in sterile containers, and every effort should be made to protect against contamination of the container's contents.



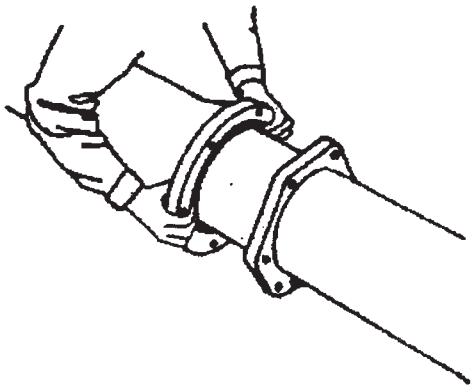
3. Be sure that the plain end is beveled; square or sharp edges may damage or dislodge the gasket and cause a leak. When pipe is cut in the field, bevel the plain end with a heavy file or grinder to remove all sharp edges. Push the plain end into the bell of the pipe. Keep the joint straight while pushing. Make deflection after the joint is assembled.



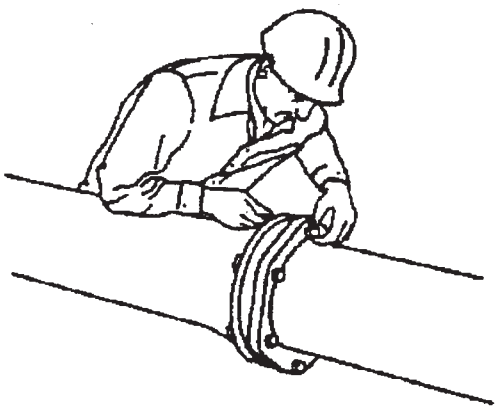
4. Small pipe can be pushed into the bell socket with a long bar. Large pipe requires additional power, such as a jack, lever puller, or backhoe. The supplier may provide a jack or lever puller on a rental basis. A timber header should be used between the pipe and jack or backhoe bucket to avoid damage to the pipe.



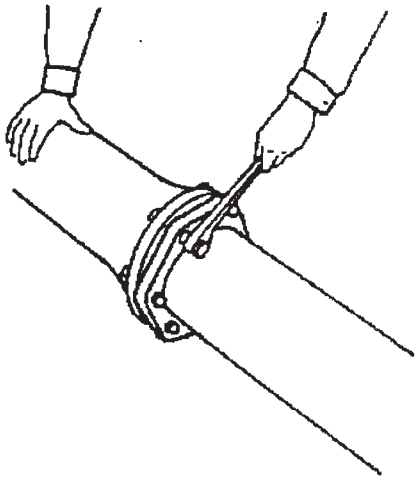
1. Clean the socket and the plain end. Lubrication and additional cleaning should be provided by brushing both the gasket and plain end with soapy water or an approved pipe lubricant meeting the requirements of ANSI/AWWA C111/A21.11, just prior to slipping the gasket onto the plain end for joint assembly. Place the gland on the plain end with the lip extension toward the plain end, followed by the gasket with the narrow edge of the gasket toward the plain end.



2. Insert the pipe into the socket and press the gasket firmly and evenly into the gasket recess. Keep the joint straight during assembly.



3. Push the gland toward the socket and center it around the pipe with the gland lip against the gasket. Insert bolts and hand-tighten nuts. Make deflection after joint assembly but before tightening bolts.



4. Tighten the bolts to the normal range of bolt torque as indicated in Table 3 while at all times maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. This can be accomplished by partially tightening the bottom bolt first, then the top bolt, next the bolts at either side, finally the remaining bolts. Repeat the process until all bolts are within the appropriate range of torque. In large sizes (30–48 in. [762–1219 mm]), five or more repetitions may be required. The use of a torque-indicating wrench will facilitate this procedure.