

## **APPENDIX B**

### **TESTING PROTOCOLS**

**Method A: Straight Test**

**Method B: Angular Deflection Test**

**Method C: Shear Load Test**

## METHOD A. STRAIGHT PIPE JOINT TEST

In order to simulate the straight pipe-joint condition this model test (Fig. B1) is proposed using 30 in. diameter pipe. A composite watertight bladder was designed and used at the joint to apply the necessary water pressure for testing (Fig. B2). This bladder configuration was selected because of its flexibility. The neoprene was 3/16 in. thick with a durometer hardness of 60. The valves to bring the water and bleed the air are placed directly on the pipe (Fig. B1). Any preconditioning for the joint as recommend by the manufacturer will be done before the test. Water pressure to be applied to the joint will be applied up to 7 psi. The 7 psi pressure will simulate approximately 16-feet of water head on the pipe joint to be tested. Infiltration leakage is to be collected from the pipe interior and measured. Procedure for preparing the pipe joint is as follows:

1. The pipe manufacturer or a selected representative will assemble the jointed pipe on the test frame. The two pieces of pipe (3 ft. each) will have ¾ NPT pipe nipple male (approximately 6 in. from the centerline of pipe joint) attached for easy connection to water supply.
2. The watertight bladder will be assembled at the test site. Expected time to assemble the bladder is 48 hours, partly because the glue has to harden.
3. The bladder will be filled with water and then pressurized in stages. The pressure will be applied in steps of 1 psi. Pressures of 3, 4, 5 and 6 psi will be held for 5 minutes each and pressure of 7 psi will be held for 10 minutes.
4. Any leak at the joint will be measured accurate to 1 mL. A water absorbing sponge will be used to collect small quantities of water at the joint.

The pipe will be placed on a leveled platform for the test. Angularity between the two pipes will be recorded using a digital protractor.

### (a) Measurements

**(i) Testing Parameters:** Pressure and time used for pressure test will be noted. All pressures to be reported as gauge pressures.

**(ii) Leak Rate:** Joint will be subjected to hydrostatic pressure up to 7 psi. The leak rates will be determined at pressures 3, 4, 5 and 6 as mentioned above. Each pressure will be held for 5 minutes. 7 psi test will be for 10 minutes.

**(iii) Visual Inspection:** After the test the pipe joint will be carefully inspected and any special features will be noted. If no failure is observed, the assembly may be used for the angular test at the option of the pipe manufacturer.

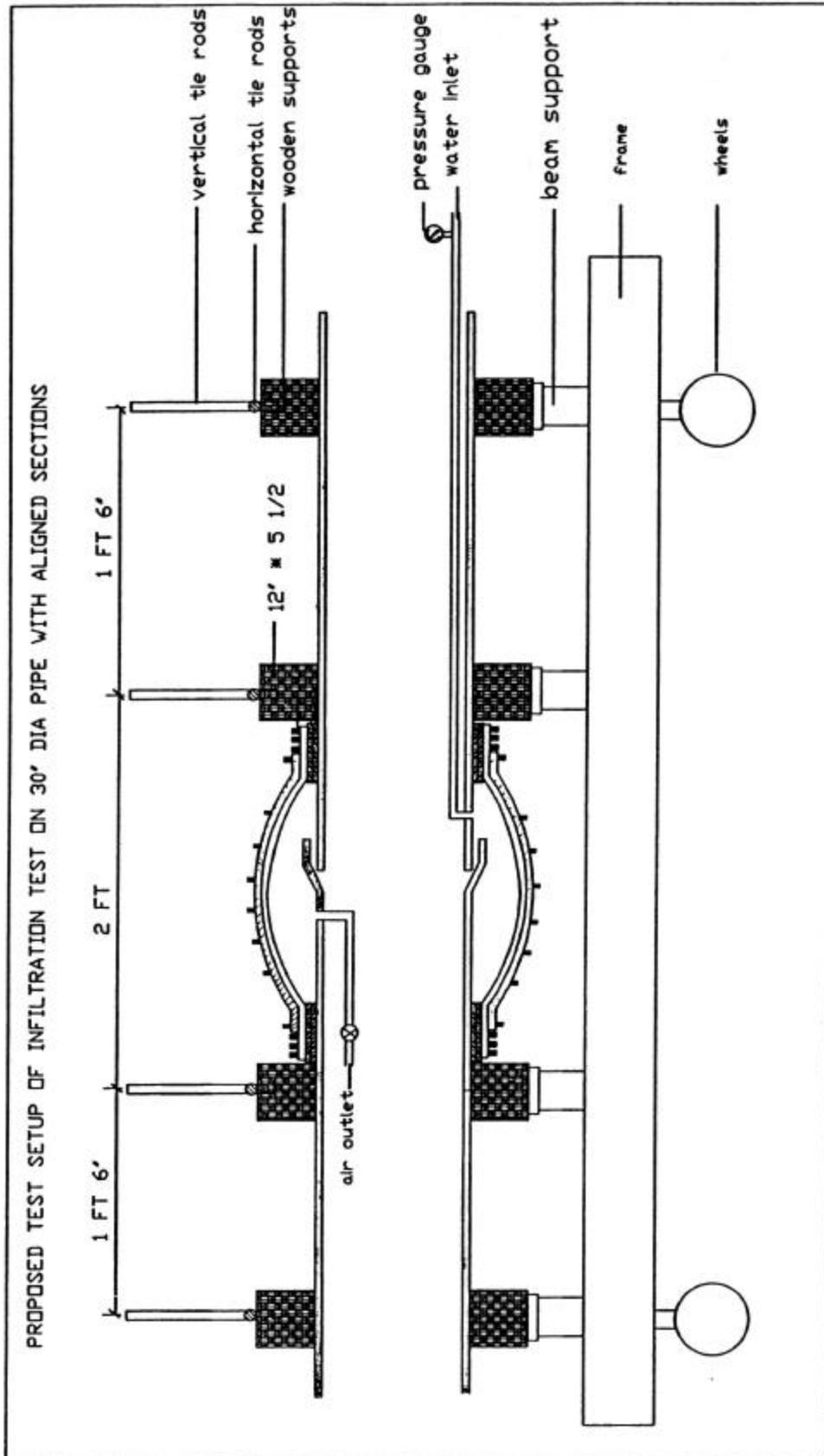


Figure B1. Configuration for Straight Pipe Joint Test (Method A)

PROPOSED SETUP DIMENSIONS FOR STUDIES OF INFILTRATION TEST ON 30" DIA. PIPE

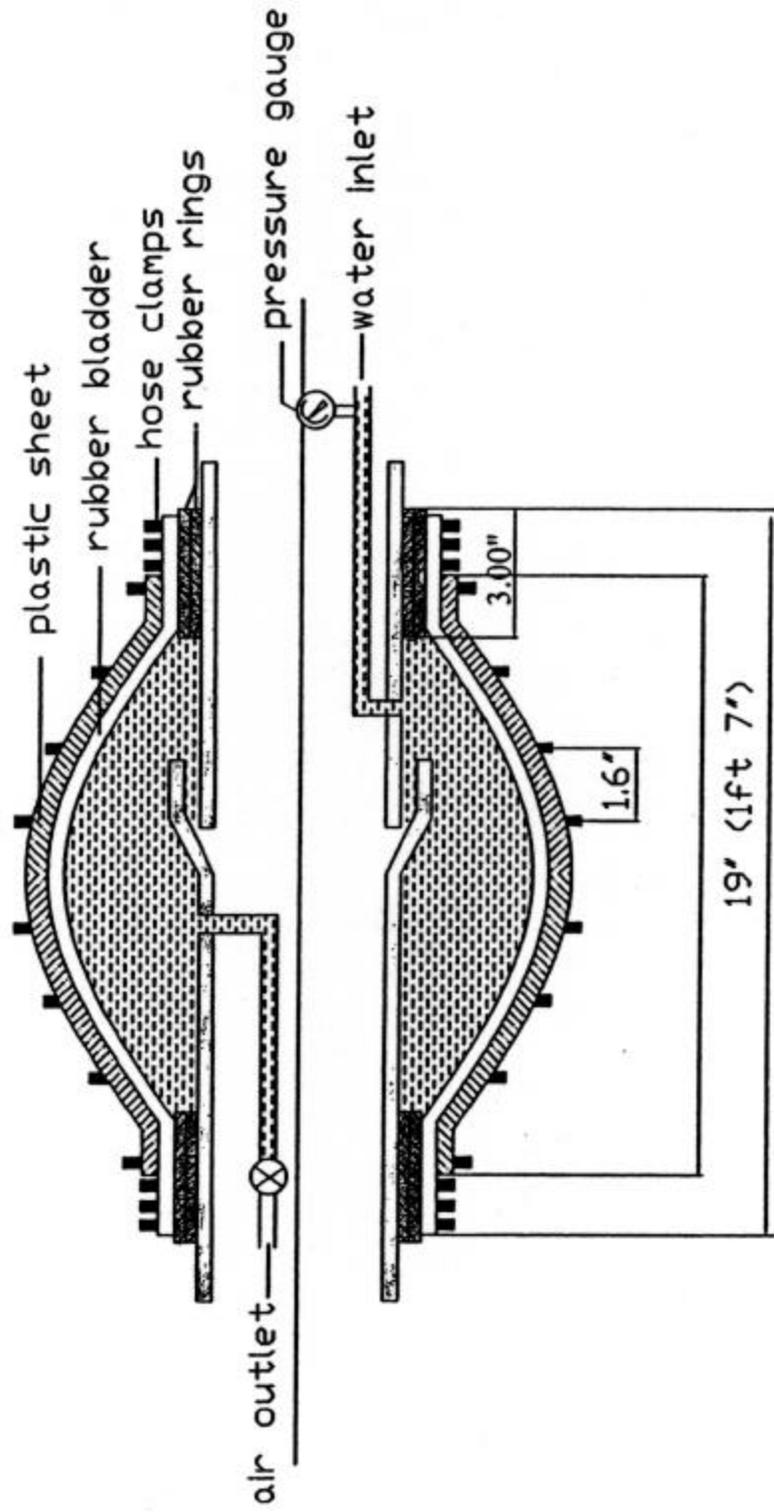


Figure B2. Details of the Pressure Bladder for the Hydrostatic Test

## METHOD B. ANGULAR DEFLECTION TEST

In order to simulate the angularity at the pipe-joint condition this model test (Fig. B3) is proposed using 30 in. diameter pipe. A composite water tight bladder will be used at the joint to apply the necessary water pressure during the rotation of the joint. This bladder configuration was selected because of its flexibility. The neoprene was 3/16 in. thick with a durometer hardness of 60. The valves to bring the water and bleed the air are placed directly on the pipe (Fig. B3). Any preconditioning for the joint as recommended by the manufacturer will be done before the test. The procedure for preparing the pipe joint is as follows:

1. The pipe manufacturer or a selected representative will assemble the jointed pipe on the test frame. The two pieces of pipe (3 ft. each) will have 3/4 NPT pipe nipple male (approximately 6 in. from the centerline of pipe joint) attached for easy connection to the water supply. (Note for some pipes, the nipple can be on the same pipe. Example PVC)
2. The watertight bladder will be assembled at the test site. Expected time to assemble the bladder is 48 hours, partly because the glue has to harden.
3. Pieces of pipes will be moved up carefully as shown in Fig.B3 and the angle of deflection will be measured at the joint. The joint will be tested at every 0.5-degree rotation. The rotation of the pipe will be measured using a digital protractor accurate to 0.1 degree. Maximum rotation for the test is 2 degrees or as specified by the pipe manufacturer.
4. The bladder will be filled with water and then pressurized in stages. The pressure will be applied in steps of 1 psi. Pressures of 3, 4, 5 and 6 psi will be held for 5 minutes each and pressure of 7 psi will be held for 10 minutes.
5. Any leak at the joint will be measured accurate to 1 mL. A water absorbing sponge will be used to collect small quantities of water at the joint.

The pipe will be placed on a leveled platform for the test. Angularity between the two pipes will be recorded using a digital protractor.

### (b) Measurements

**(i) Testing Parameters:** Pressure and time used for pressure test will be noted. All pressures to be reported as gauge pressures.

**(ii) Leak Rate:** Joint will be subjected to hydrostatic pressure of 3, 4, 5, 6 and 7 psi and the leak rate will be determined. Each pressure will be held as stated above.

**(iii) Visual Inspection:** After the test the joint will be carefully inspected for any defects. If no failure is observed, the assembly may be used for the shear test at the option of the pipe manufacturer.

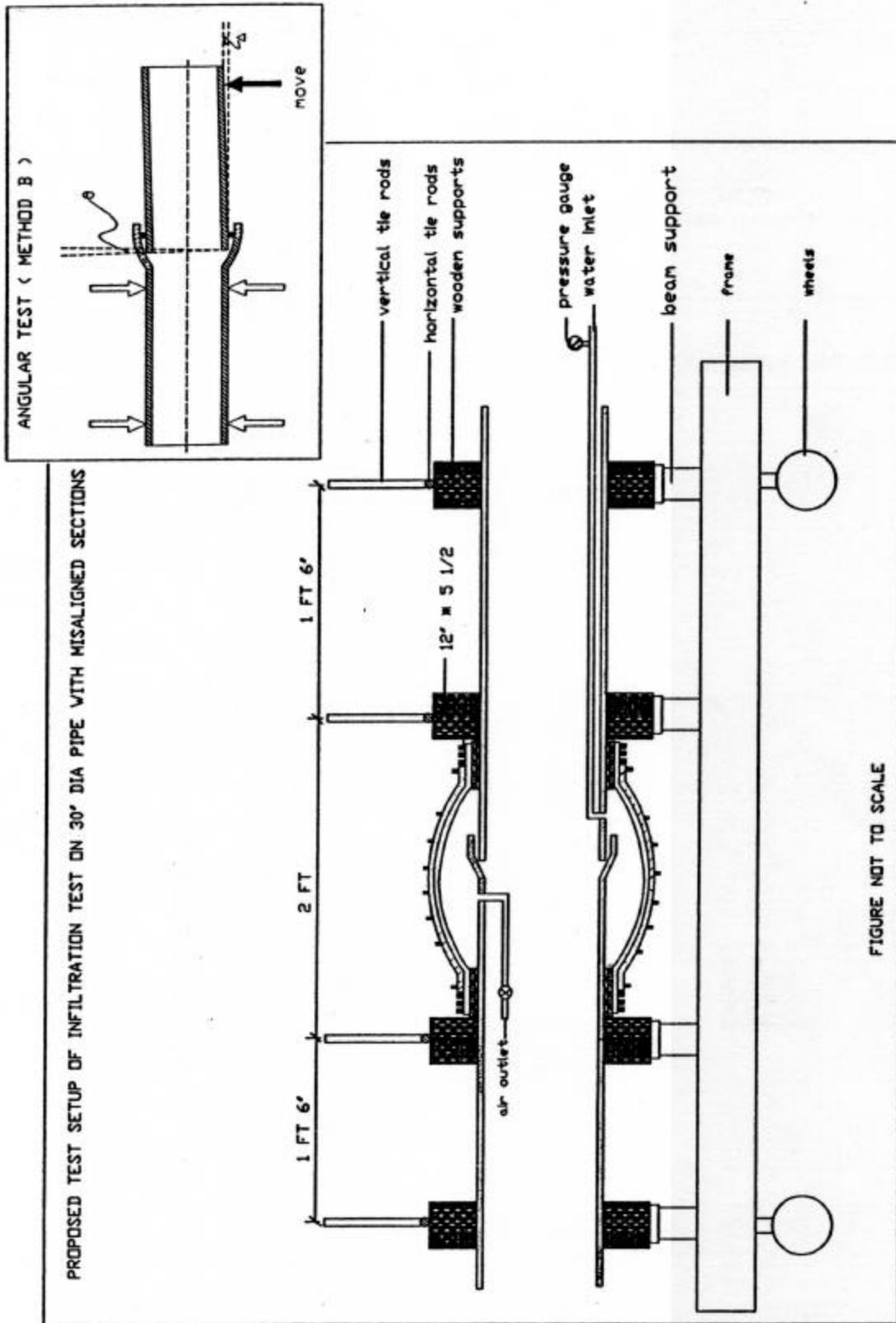


Figure B3. Configuration for Angular Deflection Pipe Joint Test (Method B)

## METHOD C. SHEAR LOAD TEST

In order to simulate the shear loading at the pipe-joint condition this model test (Fig. B4) is proposed using 30 in. diameter pipe. A composite watertight bladder will be used at the joint to apply the necessary water pressure during the shearing of the joint. This bladder configuration was selected because of its flexibility. The neoprene was 3/16 in. thick with a durometer hardness of 60. The valves to bring the water and bleed the air are placed directly on the pipe (Fig. B4). Any preconditioning for the joint as recommend by the manufacture will be done before the test. The procedure for preparing the pipe joint is as follows:

1. The pipe manufacturer or a selected representative will assemble the jointed pipe on the test frame. The two pieces of pipe (3 ft. each) will have 3/4 NPT pipe nipple male (approximately 6 in. from the centerline of pipe joint) attached for easy connection to the water supply.
2. The watertight bladder will be assembled at the test site. Expected time to assemble the bladder is 48 hours, partly because the glue has to harden.
3. Shear load/deflection will be carefully applied as shown in Fig. B4 and the pipes will be supported as shown. The joint will be tested at every 500-lb. shear load. In flexible pipe the vertical and horizontal deflection will be measured with extensometer under the point of loading. Maximum load of 4500 lb will be applied or as specified by the pipe manufacturer. The shear loads applied will be measured using miniature load cells.
4. The bladder will be filled with water and then pressurized in stages. The pressure will be applied in steps of 1 psi. Pressures of 3, 4, 5 and 6 psi will be held for 5 minutes each and pressure of 7 psi will be held for 10 minutes.
5. Any leak at the joint will be measured accurate to 1 mL. Water absorbing sponge will be used to collect small quantities of water at the joint.

The pipe will be placed on a leveled platform for the test. Initial angularity between the two pipes will be recorded using a digital protractor.

### (c) Measurements

**(i) Testing Parameters:** Pressure and time used for the hydrostatic test will be noted. All pressures to be reported as gauge pressures. Applied shear load/deflection will be recorded in pound force. Deflection is to be reported as percentage of the outside diameter for flexible pipe.

**(ii) Leak Rate:** Joint will be subjected to hydrostatic pressure up to 7 psi and the leak rate will be determined. Pressures 3, 4, 5, 6 and 7 psi will be held as stated above.

**(iii) Visual Inspection:** After the test the joint will be carefully inspected for any defects.

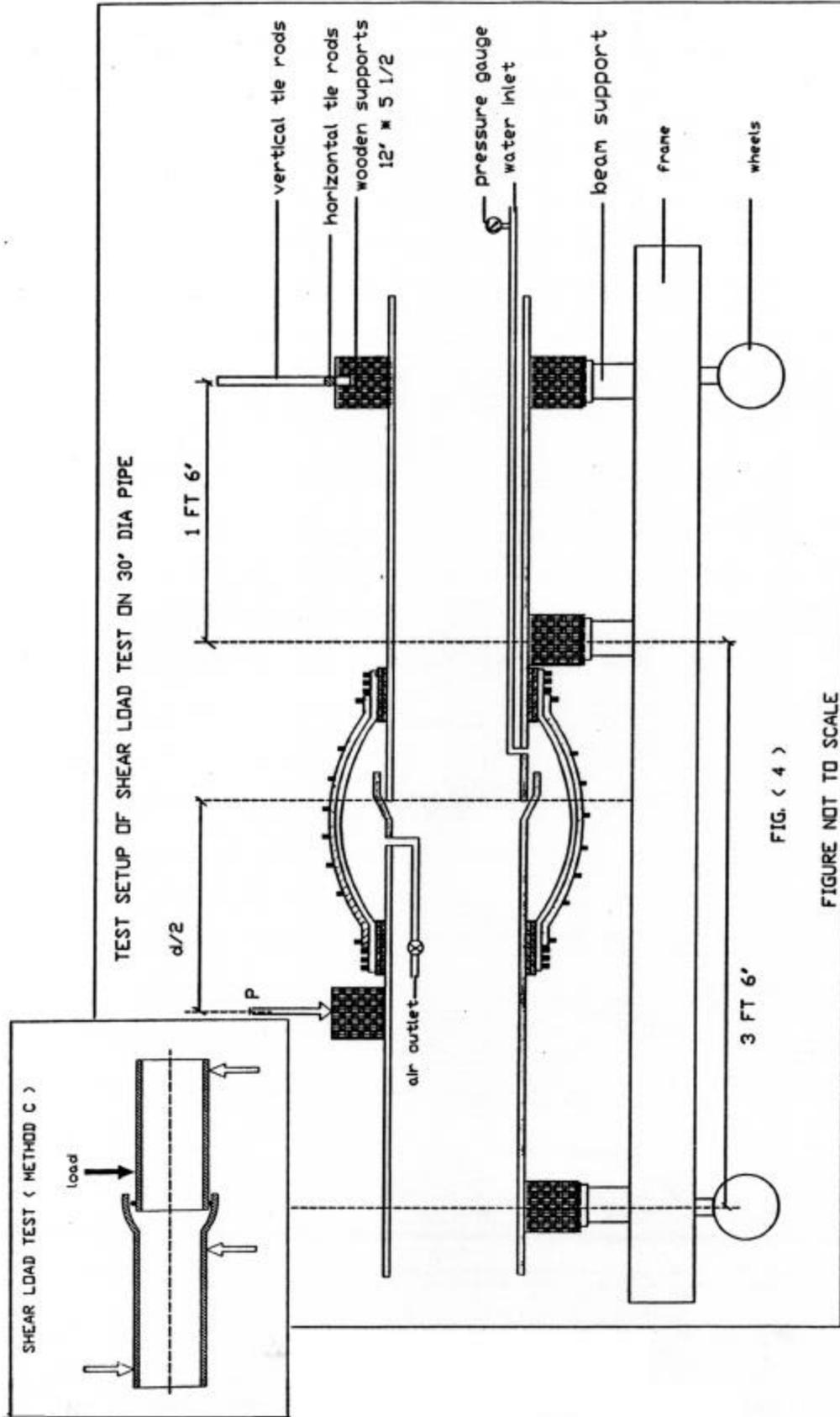


Figure B4. Configuration for Shear Load/Deflection Pipe Joint Test (Method C)