SAE International™

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1900

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Seals—Bond Test Fixture and Procedure

Foreword—If the actual environment of a bonded radial lip seal is examined, the following facts become clear:

With few exceptions, the greatest stress that most radial lip seals experience is the physical installation into the application.

Once the seal is installed, other minor stresses to the bond are elastomer oil swell, differential thermal expansion between elastomer and metal, torque imparted by shaft rotation, shaft dynamics, and system pressures less than 275 kPa.

Certain applications such as medium to high pressure (690 to 12 400 kPa) power steering seals as well as bonded clutch and servo pistons do require an extremely high quality bond.

1. Scope—Bond, as it relates to elastomeric seals, is defined as "The adhesion, established by vulcanization, between two cured elastomeric surfaces, or between one cured elastomeric surface and one nonelastomeric surface."[1] Vulcanization refers in this case to chemical bonding. Good bond is essential to the function of elastomeric radial lip seals and other precision bonded parts.

This SAE Recommended Practice describes a universal bond test fixture developed by the RMA that can be mounted to a conventional tensile test machine. This will allow a quantitative evaluation of bond rather than a merely qualitative one.

2. References

2.1 Applicable Publication—The following publication forms a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J111—Terminology of Radial Lip Seals

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1. SAE J111 Terminology of Radial Lip Seals

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3. Bond Test Fixture Design

3.1 Objective—The primary objective was to develop a test fixture and procedure with the following qualities:

3.1.1 UNIVERSAL—Develop a fixture for bond evaluation that does not require special tooling for each part size to be evaluated.

3.1.2 QUANTITATIVE EVALUATION—The past method was qualitative. The equipment and procedure must provide numbers to eliminate operator judgment.

3.1.3 REPEATABLE—The fixture and procedure must be capable of producing repeatable results. This is essential to the long-term tracking of bond quality.

3.2 Description—Figures 1 through 5 are illustrations of the fixture developed based upon the objectives in 3.1. Drawings of the fixtures and components are included in the Appendix of this document. The fixture is designed to be used with standard tensile test equipment.

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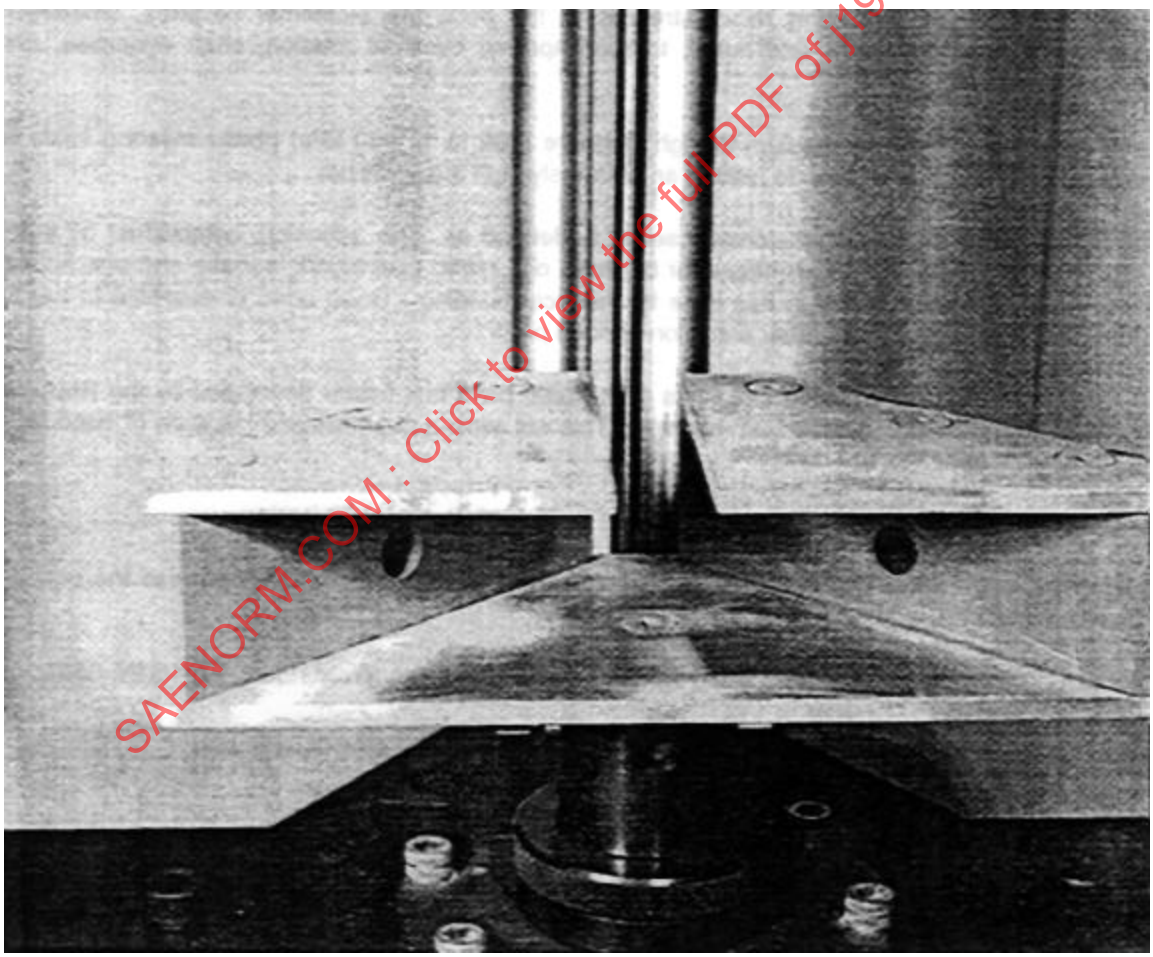

FIGURE 1—UNIVERSAL LOWER FIXTURE

FIGURE 2—JAWS FOR AIR CHUCK CLAMP—PARTIALLY INSTALLED (UPPER FIXTURE)

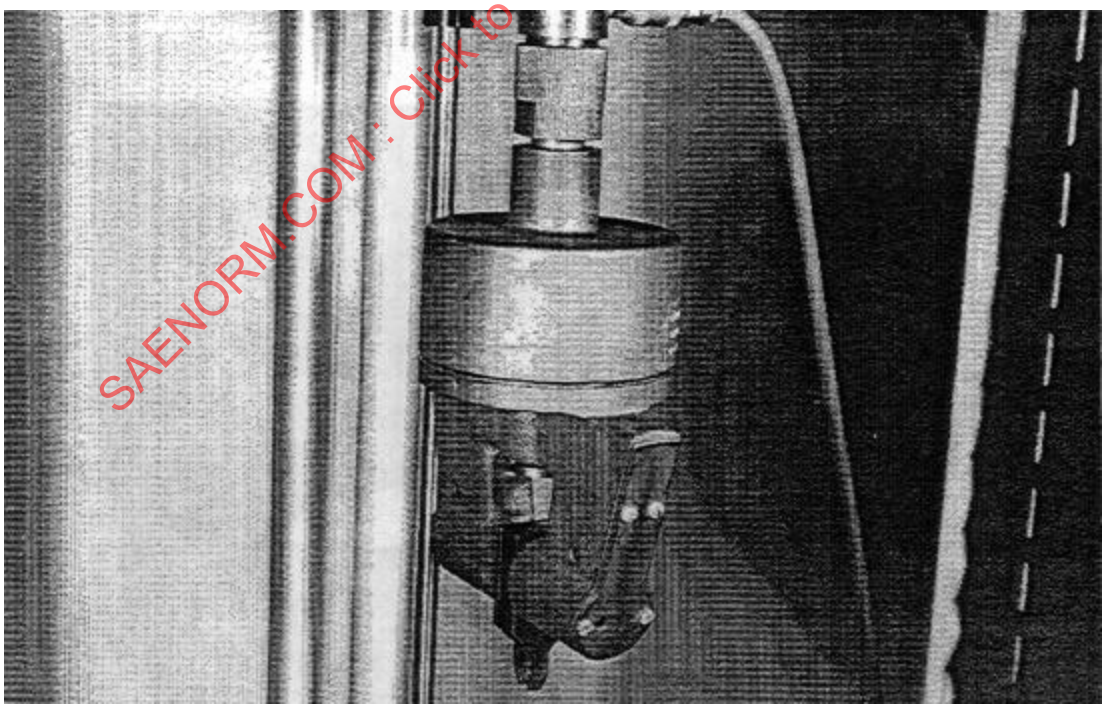

FIGURE 3—AIR CHUCK CLAMP (UPPER FIXTURE)

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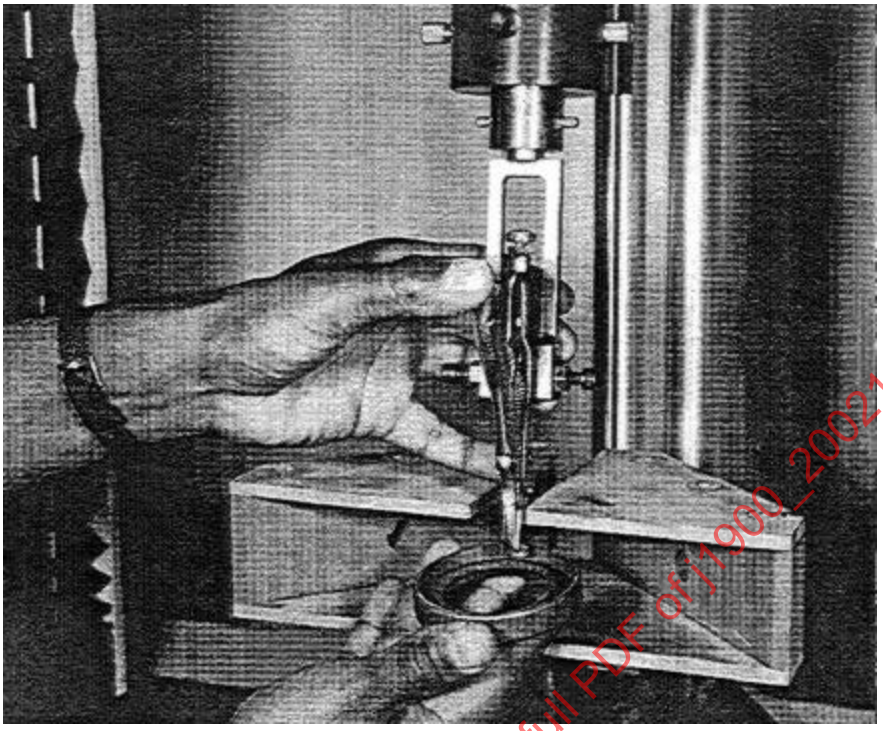

FIGURE 4—MECHANICAL CLAMP ALTERNATIVE (UPPER FIXTURE)

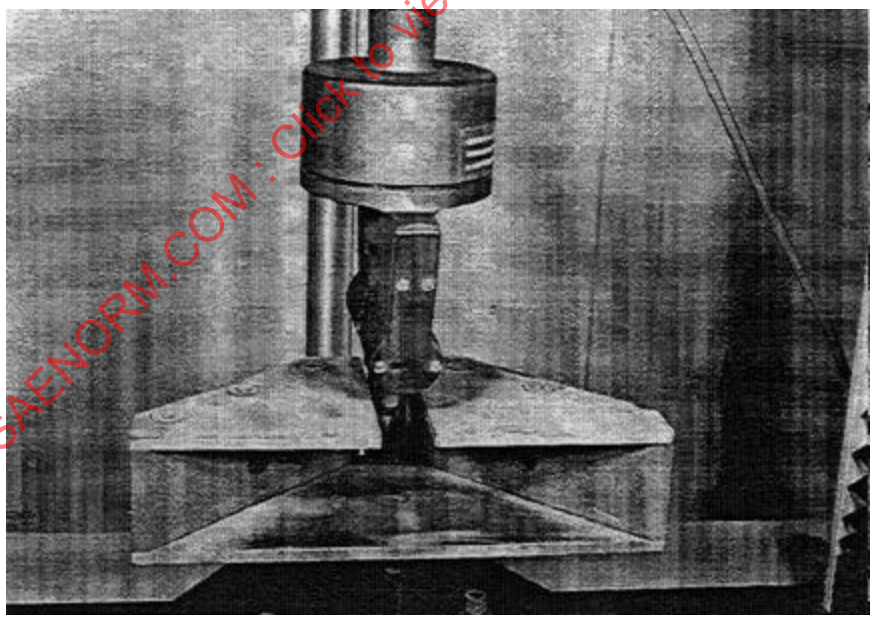

FIGURE 5—UPPER FIXTURE JAWS—EXTENDED WELL INTO LOWER FIXTURE

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3.2.1 LOWER FIXTURE—The lower fixture retains the seal or other bonded rubber product. It is designed to accept round parts with a diameter range of 40 to 250 mm without making any adjustments. It is designed to fit into the female receptable of most tensile test units with no modification.

3.2.2 UPPER FIXTURE OR CLAMP—There are two options for clamping the elastomeric element:

3.2.2.1 Air Chuck—If the tensile test unit to be used has an air chuck attachment, special jaws can be fabricated for the chuck. (See Appendix A.) This will allow the clamping force to be regulated with air pressure. This is the preferred method of elastomer retention.

NOTE—The pneumatic jaws detailed in the appendix were designed to fit an Instron 890 N pneumatic grip, catalog #2712-003.

3.2.2.2 Mechanical Clamp—If the device chosen for bond testing does not have air chuck capability, a mechanical clamp can be used satisfactorily. (See Appendix A.)

4. Bond Test Procedure—The fixture and test procedure can be used for evaluation of compounds, cements, and designs. It can also be used as a measure of production quality. The variations will be discussed in this section.

4.1 Installation and Adjustment—The following steps are required to install and adjust the equipment in a standard tensile tester. The procedure is identical for all uses.

4.1.1 The lower fixture is installed in the receptable of the tensile tester and secured with a pin. (See Figure 1).

4.1.2 The special jaws are installed in the air chuck and secured with pins. (See Figures 2 and 3). The air supply regulator is adjusted to apply an adequate clamping force (i.e., no slippage during test) based upon the particular jaw configuration and the type of parts being tested. Once this has been determined it should be kept constant.

4.1.3 MECHANICAL CLAMP OPTION—The upper fixture containing the mechanical clamp is installed and pinned in place. (See Figure 4.) The jaws of the mechanical clamp should be adjusted to apply an adequate clamping force (i.e., no slippage during test) based upon the type of parts being tested. The locknut should then be tightened to secure the adjustment.

4.1.4 The lower limit of the upper fixture travel is adjusted so that the end of the jaws of the upper fixture project well into the lower fixture to allow the seal to be clamped easily. (See Figure 5.)

4.1.5 The cross head speed of the instrument should be adjusted to 50 mm per minute. This completes the installation and adjustment of the bond test fixture.

4.2 Operation—The following is a description of the bond test procedure for any bonded rubber part.

4.2.1 Select a sample lot of parts to be tested (usually 5). The seals should be visually inspected for obvious nonbond or nonfill conditions prior to test. Remove springs if applicable.

4.2.2 Grip a seal in the upper clamp as illustrated in Figure 6.

NOTE—Consistent proper positioning of the upper clamp is most important for repeatable readings. The upper fixture is free to move for easy clamping.

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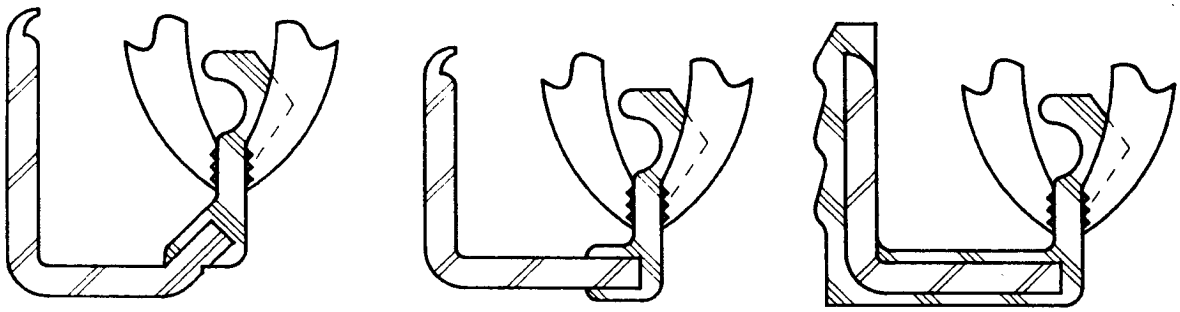

FIGURE 6—PROPER POSITION OF UPPER FIXTURE JAWS

4.2.3 Position the clamped part in the lower fixture as shown in Figure 7.

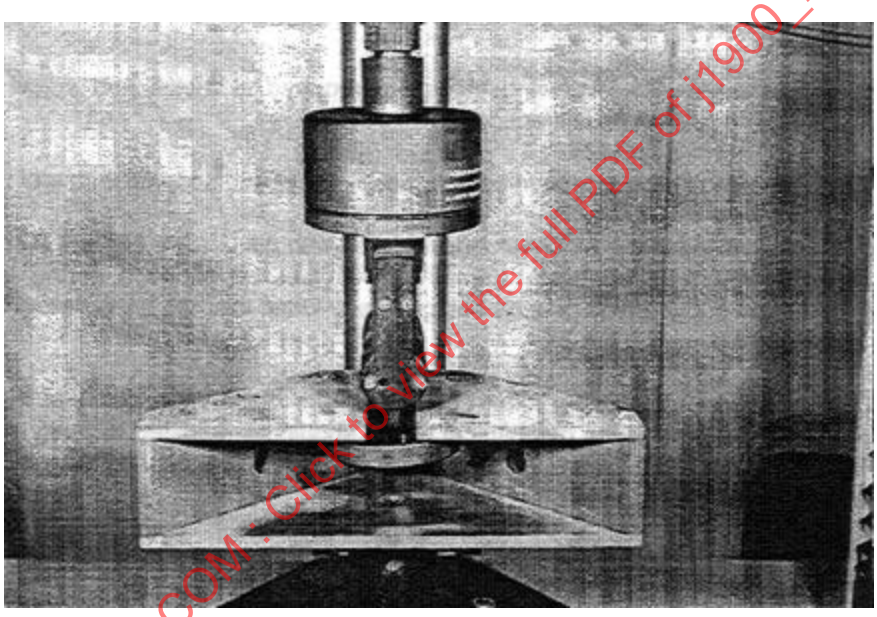

FIGURE 7—TEST SEAL POSITIONED IN LOWER FIXTURE

4.2.4 Raise the cross head at a rate of 50 mm per minute until a separation occurs. The separation can be classified as follows:

4.2.4.1 *Type A*—A break has occurred in the rubber at some point between the jaws and the metal.

4.2.4.2 *Type B*—A separation has occurred between the rubber and the metal.

4.2.4.3 *Type C*—A break has occurred at the interface between the rubber and the jaws.

4.2.5 Read the peak load from the strip chart. (See Figure 8). Record this value.

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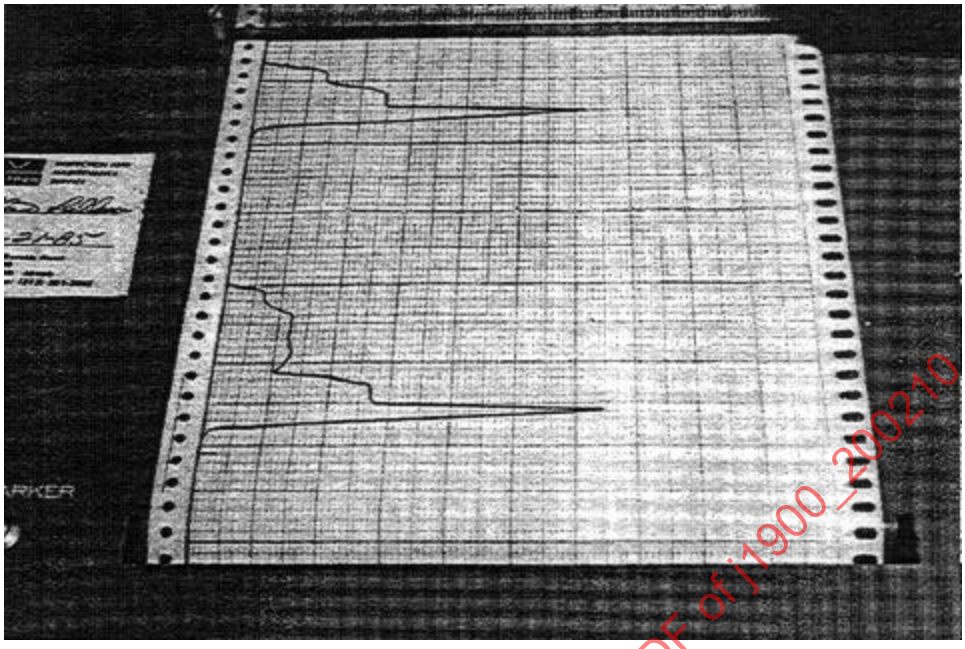

FIGURE 8—STRIP CHART

4.2.6 Repeat steps 4.2.2 through 4.2.5 for the balance of the seals in the sample lot.

4.2.7 The three types of separation should be evaluated as follows:

4.2.7.1 *Type A*—The bond strength exceeds the tensile strength of the rubber. Bond is acceptable.

4.2.7.2 *Type B*—The tensile strength of the rubber exceeds the bond strength. A minimum acceptable value should be empirically determined for each seal section and compound to be evaluated based upon application factors. A separation below the minimum level indicates that the bond is not acceptable.

4.2.7.3 *Type C*—If the break occurs at the jaws below the minimum acceptable value, that test should be discarded due to possible jaw damage of the rubber. If the value exceeds the minimum acceptable level, the bond is acceptable.

4.3 Production Bond Testing—The following is a description of a recommended procedure for evaluating the bond quality of a specified production part.

4.3.1 Pull a five piece sample of parts at an interval to be determined by the particular circumstances.

4.3.2 Pull bond tests per the procedure in 4.2. Construct a median chart from the data. Once a minimum acceptable value is established, this line should be shown on the chart. A value below the minimum acceptable line is cause for review of the process. See Figure 9 for an example.

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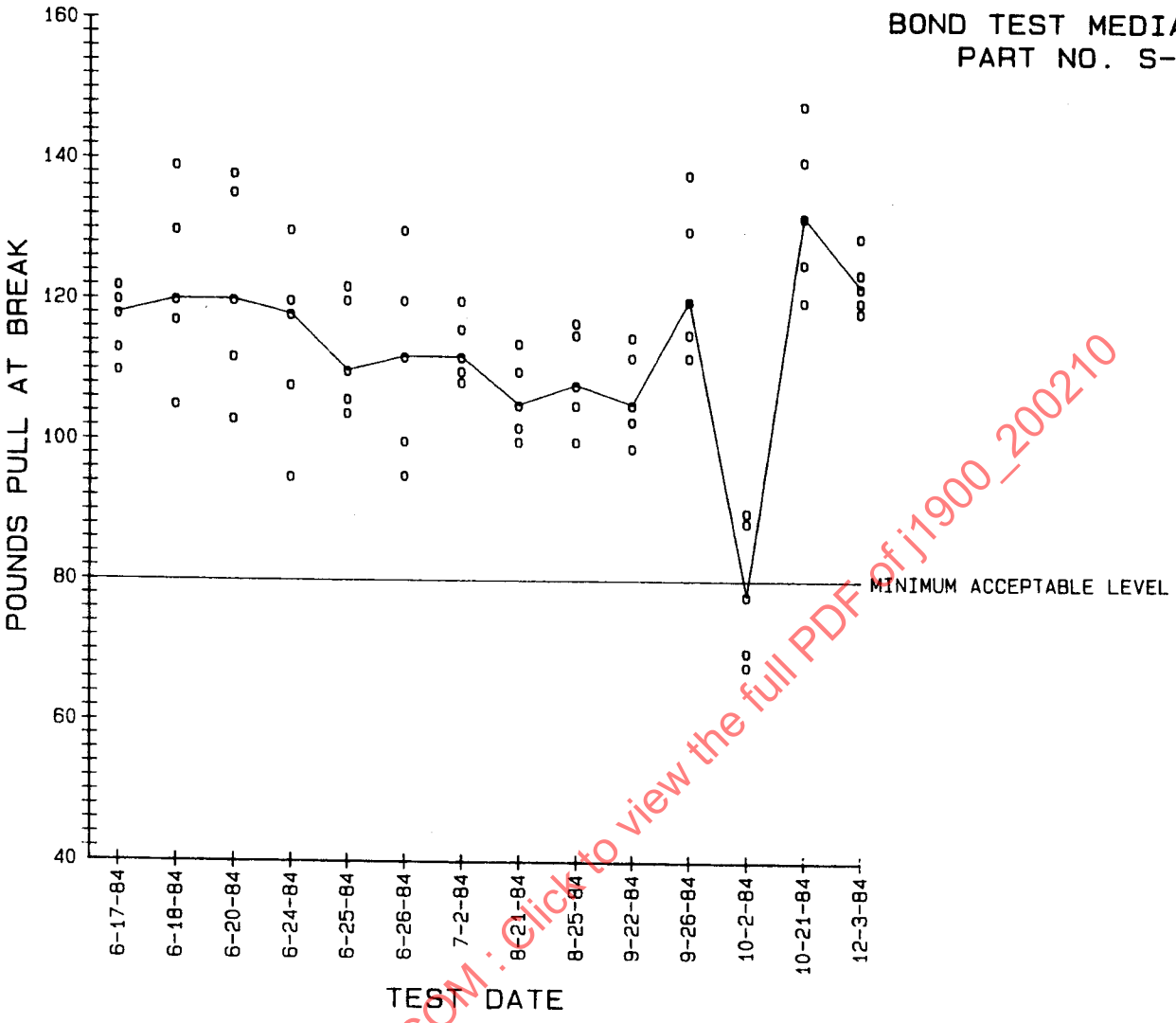

FIGURE 9—EXAMPLE MEDIAN CHART

5. ***Significance of Bond Test Measurement—***Bond test values are an indication of the consistency of manufacture of a specific seal design/compound combination. It has not been possible to determine generalized limits for polymer classes or applications.

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PREPARED BY THE SAE MOTOR VEHICLE COUNCIL

APPENDIX A

A.1 Drawings of the universal lower fixture and mechanical clamp (see Figure A1).

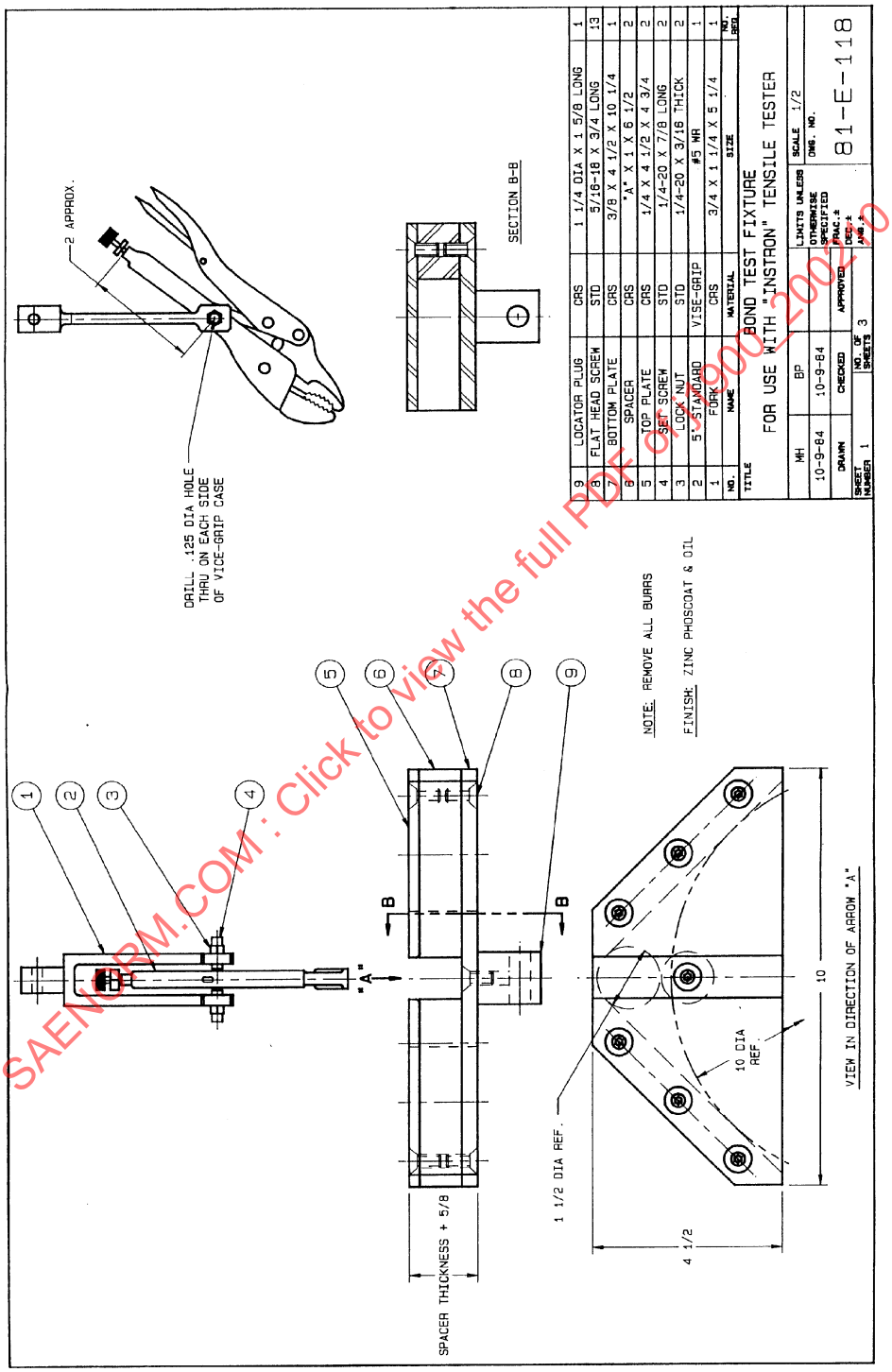

FIGURE A1—UNIVERSAL LOWER FIXTURE AND MECHANICAL UPPER FIXTURE DRAWINGS

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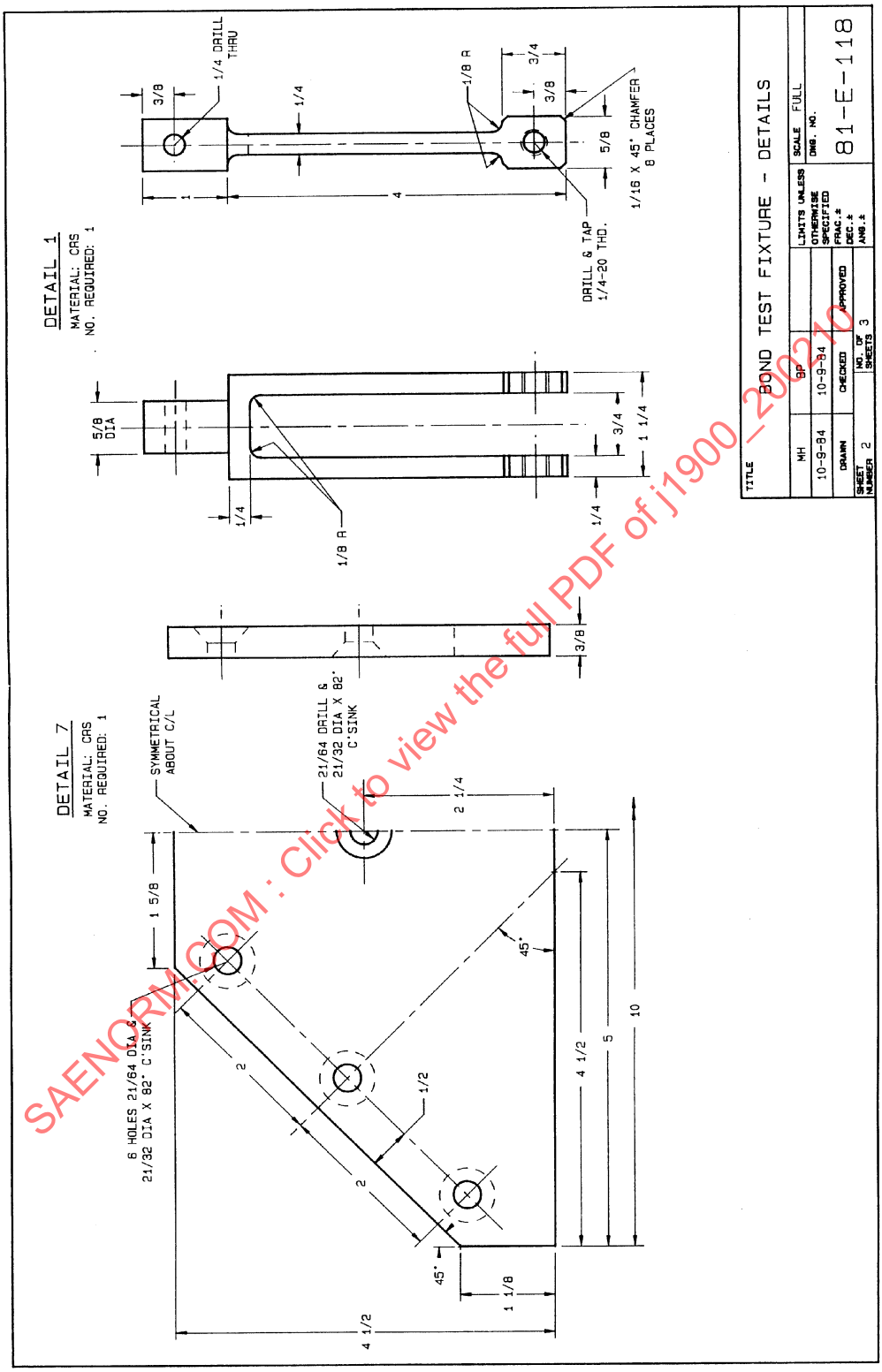

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FIGURE A1—UNIVERSAL LOWER FIXTURE AND
MECHANICAL UPPER FIXTURE DRAWINGS (CONTINUED)