

## **Ability of Mechanical Bolted Pipe Couplings to Withstand High Impact Shock Loads in Naval Combat Applications**

Representative samples of Victaulic Style 07 Zero-Flex rigid pipe couplings and Style 77 Flexible pipe couplings were subjected to high impact loading conditions per MIL-S-901D (NAVY), Shock Tests, H.I. (High Impact); Shipboard Machinery, Equipment and Systems, Requirements For (17, March 1989)

Supporting standards as well as both Federal and Military Specifications as referenced by the US Department of Defense Index of Specifications and Standards (DoDISS) are incorporated per paragraph 2.1.1 of MIL-S-901D.

### **Relevant Data:**

#### **Applicable Shock Grade: Grade A**

Grade A components are defined as those items that are essential to the safety and continued combat capability of the ship. Systems in this category may include (but are not limited to) fuel supply, propulsion, navigation / steering and other critical hydraulic systems, weaponry, power generation, ventilation / AC, fire safety and related electronics and communication. (Source: MIL-S-901D, pp 1.2.2)

#### **Equipment Class: Class I**

Class I is defined as that which is required to meet the shock requirement of this standard without the use of resilient mountings installed between the equipment and the ship structure or foundation. (Source: MIL-S-901D, pp 1.2.3)

#### **Shock Test Type: Type A, Medium Weight**

A Type "A" test is a test of a principal unit. Principal units are items which are directly supported by the ship structure or by a foundation which is directly attached to the ship structure, and items mounted in piping systems, ducting systems and similar systems which are supported by the ship structure. The shock response of a principal unit is primarily a function of the rigidity and mass of the item and the shipboard mounting structure, the shipboard mounting location and the configuration of the item. (Source: MIL-S-901D, pp 1.2.4)

## Equipment Mounting Location Aboard Ship: Hull Mounted

Hull mounted items are those mounted on:

**For surface ships** – The main structural members of the ship including structural bulkheads and structural bulkhead stiffeners below the main deck, and shell plating above the water line.

**For submarines** – The main structural members of the ship including hull frames, structural bulkheads and structural bulkhead stiffeners. (Source: MIL-S-901D, pp 1.2.5)

## Equipment Mounting Plane Aboard Ship: Other (Pipe Mounted)

## Equipment Mounting Orientation Aboard Ship: Unrestricted

### Test Set-Up:

Each test coupling was fully assembled onto roll grooved Schedule 40 pipe spools with the outer-most ends welded closed. The assembly was clamped to the fixture and tack-welded in place to prevent rotation within the clamps. Since a real-world installation of these products could include assembly to an adjacent pipe, fitting, valve or other mechanical components, the test assembly is dummy loaded on each side of the coupling to examine any potential influences on shock damage from the inertial effects of these components. In the case of the 6" Style 07 coupling, a dummy load of 157 pounds was applied to each side of the coupling, which includes the section of pipe used for fixturing of the coupling (based on 5 feet of 6" Schedule 40 carbon steel pipe filled with water). The dummy loads are evenly spaced one pipe diameter outboard of each clamp and provide a convenient method to simulate these inertial forces. The entire assembly is then mounted to a 34"x 34" x 1" thick steel base plate. The base plate is then mounted to the shock test machine's standard mounting surface.

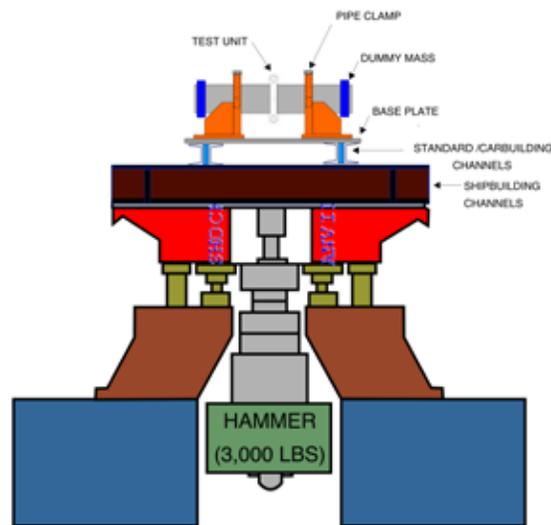
### Test Procedure:

Testing is conducted in three (3) orientations;

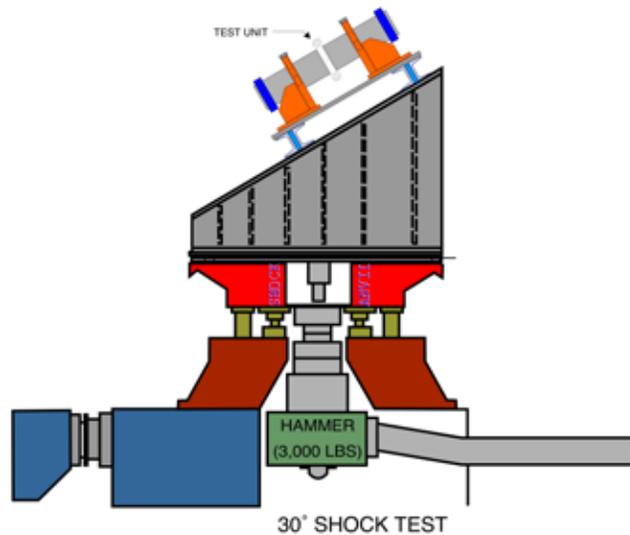
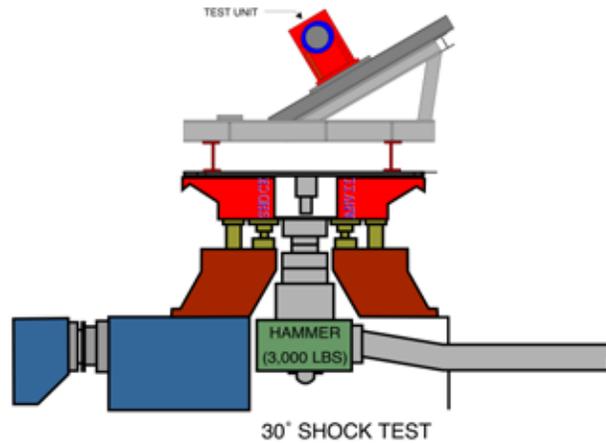
30° position (pressure ports up and down the incline)

30° position (pressure ports across the incline)

Vertical position (pressure ports perpendicular to the applied impact)



VERTICAL SHOCK TEST



Prior to application of the shock load conditions, the test assembly is subjected to a hydrostatic leak test at 348 psi (1.5 times the working pressure rating of 232 psi). The test assembly is then subjected to 3 shock impacts in each of the three orientations (total of 9 shock impacts per test sample) while exposed to the internal hydrostatic pressure of 348 psi. The forces generated by the shock impact at three separate height settings of the 3000 pound hammer result in loading conditions in the range of 120 to 200 g's. After each hammer impact, the assembly is visually inspected for any signs of leakage, deformation or any other abnormality. The internal hydrostatic pressure is also verified to have been maintained throughout the test.

## Results:

Throughout the course of these high impact loading conditions, the Victaulic Style 07 and Style 77 couplings maintained both their joint restraining and pressure-holding performance. In fact, both rigid and flexible couplings demonstrated identical performance consistently over the range of impact and shock load conditions. Following these tests, the coupling housings were visually and dimensionally examined for any signs of deformation, and were found to be in excellent condition. Additionally, these parts were examined by X-ray and confirmed to have no damage, cracks or other abnormalities. Based on these results, the test samples were considered suitable for re-use.

## Conclusions:

The successful completion of the MIL-S-901D (Navy) shock load evaluations provides another series of performance data points that further demonstrate the durability and reliability of Victaulic mechanical pipe joining products under extreme service conditions. The ductile iron housings inherently absorb high pressure and external loading conditions by way of their tensile strength, yield strength and material elongation properties. These properties are maintained consistently through state-of-the-art casting process technology employed at all Victaulic foundry locations globally. For shipboard piping applications, Victaulic products have also maintained Type Approval status for many years with such renowned Classification Society members as American Bureau of Shipping (ABS), Det Norske Veritas / Germanischer Lloyd (DNV-GL), Lloyds Register (LR), Bureau Veritas (BV) and many others. The piping system component qualification testing conducted by these organizations is considered by many as some of the most stringent across a wide range of heavy industries.

Lloyds Register Marine recently included new references to the shock load testing conducted on Style 07 and Style 77 couplings in accordance with MIL-S-901D within Victaulic's Type Approval Certificate 99/60180(E4). This is another point of recognition for the quality and technical credibility that Victaulic drives forward in its efforts to design and manufacture the most durable mechanical pipe joining products available today in the maritime industry. We see a great opportunity and many benefits for such products in both combat and non-combat naval systems applications.

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