ROCKWELL VISCOUS DAMPER SPECIFICATIONS

Specifications for Rockwell Building

As Supplied To:

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SPECIFICATION - ROCKWELL VISCOUS DAMPERS

1. General

1.1 Description

This specification covers the set of 10 linear fluid viscous dampers along with their mounting brackets and pins to be used on the Rockwell Building located at Jamboree Road and Birch in Newport Beach, California. These dampers provide an output force in either tension of compression that is directly proportional to the relative velocity between the two ends of the dampers. The damper output force varies only with velocity, and does not change with damper stroke position or orientation angle. The function of the dampers is to absorb earthquake energy, thereby reducing the amount the building moves when an earthquake occurs.

The 10 dampers are located in the diagonal elements that run from the top of floor one to the top of floor two. There are four 330 Kip dampers in one direction ("A" dampers) and six 250 Kip dampers in the other ("B" dampers).

1.2 References

The following specifications and standards are referred to in this specification. The latest revision of these documents forms a part of this specification, unless called out otherwise. Substitution of alternative specifications is not acceptable.

ASTM E4 - Load Verification of Testing Machines

ASTM A36 - Specification for Structural Steel

ASTM A325 - Specification for High Strength Steel Bolts

AWS D1.1 - Structural Welding Code of the American Welding Society

MIL-STD-120 - Gage Inspection

MIL-STD-889 - Dissimilar Metals

MIL-STD-970 - Standards and Specifications, Order of Preference for the Selection of

MIL-Q-9858A - Quality Program Requirements

MIL-I-45208A - Inspection System Requirements

MIL-STD-45662A - Calibration System Requirements

ISO 9001 - Model for Quality Assurance

AISC "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings", by the American Institute of Steel Construction

AISC "Code of Standard Practice for Steel Buildings and Bridges"

SSPC "Steel Structures Painting Council"

MIL-HDBK-5 "Specifications for Metallic Materials"

1.3 Warranties and Guaranties

The vendor shall guarantee that the viscous dampers supplied shall conform to all portions of this specification for a period of at least 10 years following installation of the dampers. All repairs or replacements of any defective or malfunctioning parts shall be at vendor's expense including shipping costs. As part of this guarantee vendor shall supply failure reports and attendance by his engineering staff as required in any failure investigation.

2. Products

2.1 Materials and Parts

2.1.1 Order of Preference of Specifications and Standards

Except as specified herein, the materials, parts and processes used in the design and manufacture of the dampers shall conform to specifications and standards selected in the order of precedence established by MIL-STD-970. All materials and processes used shall be identified in vendor drawings by specifications or standards.

2.1.2 Materials

2.1.2.1 General

Materials shall have allowable stress values taken from MIL-HDBK- 5. Unless suitably protected against electrolytic corrosion, dissimilar materials as defined in MIL-STD-889 shall not be used in contact with each other. Dissimilar metal joints shall not be permitted without a non-metallic separator or gasket at least .06 inches thick. The use of aluminum, aluminum alloys, magnesium, magnesium alloys, beryllium and beryllium alloys is prohibited. The use of non-stainless steel internally exposed to internal pockets of air or gas (as could occur in an internal reservoir) is prohibited.

2.1.2.2 Fungus Resistant Materials

Only materials that are non-nutrient to fungus shall be used in the dampers.

2.1.2.3 Castings

Cast parts shall not be used in the construction of the dampers.

2.1.2.4 Weldments

The use of weldments or welded parts for any part of the dampers is prohibited. Building connection brackets may be welded, with welding conforming to the specifications listed in section 1.2.

2.1.3 Parts

2.1.3.1 Age Sensitive Parts

All non-metallic packings, seals, wipers or gaskets shall be of non-age control materials.

2.1.3.2 Plating

No plating of any type will be permitted on piston rods or any other metal parts that slide relative to a seal.

2.1.3.3 Working Fluid

The dampers shall use inert silicone fluid as the operating fluid medium which shall comply with and be certified to U.S. Federal Standard VVD-D-1078. This fluid is both non-toxic and non-flammable under current OSHA standards. Substitution of another working fluid is not acceptable.

3. Quality Assurance

3.1 Quality Control

3.1.1 Product Quality Control

To insure effective control over product quality, the vendor shall establish and maintain a manufacturing/processing control system including written process specifications and procedures to insure that manufacturing, processing inspection and testing are accomplished in accordance with at least one of the following:

Control of Quality MIL-Q-9858A

The vendor shall provide and maintain a system that complies with U.S. Specification MIL-Q-9858A, "Quality Program Requirements".

Control of Quality MIL-I-45208A

The vendor shall provide and maintain a system that complies with U.S. Specification MIL-I-45208A, "Inspection System Requirements".

Control of Quality ISO 9001

The vendor shall provide and maintain a system that complies with U.S. requirements of the International Standard Organization (ISO) 9001 model for quality assurance in design, development, production, installation and servicing of the dampers. Certification to ISO 9001 by an individual or firm located outside of the United States of America is prohibited.

3.1.2 Manufacturing Process Control

In addition to compliance with one of the three quality assurance systems listed above, the vendor must also maintain a system for manufacturing process control of this project which includes as a minimum the following:

A. Specific Raw material Traceability

B. Special Process Certification Traceability

C. Detailed manufacturing instructions that identify by operation and machine the work performed.

D. Inspection instruction.

E. In-process and final detail component inspection instruction with actual dimensions.

3.1.3 Part Information

Specific instruction for detail part marking providing for one way backward traceability to the information listed in paragraph 3.1.2 (above) shall be provided by the vendor. This information shall be readily retrievable and shall be combined into one inclusive document that is controlled and approved by quality assurance personnel at the vendor's facility.

3.1.4 Calibration System Requirements

All devices used to measure, gage, test, inspect or otherwise examine items to determine compliance with specification and/or contractual requirements shall be calibrated in compliance with MIL-STD-120 and MIL-STD-45662A, to a calibrated measurement standard which has known valid relationship traceable to the National Institute of Standards and Technology (NIST).

4. Fabrication

4.1 Protective Treatment

Materials subject to deterioration when exposed to environmental conditions likely to occur during service shall be protected against such deterioration in a manner that will in no way prevent compliance with the requirements of this specification.

4.2 Maintainability/Serviceability

The dampers shall be maintenance and service free over a period of at least 20 years and preferably over the 75 year expected life of the building. This means that no refilling or replacement of fluid or any other parts shall be needed. The dampers shall be designed and constructed so that installation, removal, or replacement, if necessary, shall be a simple process not requiring any special tools or methods.

4.3 Change Control

After initial design completion and approval or initial hardware delivery, whichever occurs first, any change or substitution of material, dimensions, processes of other characteristics must be approved by Rockwell International prior to incorporation. The vendor shall exercise the same configuration control over his suppliers.

5. Technical Requirements

5.1 Function

5.1.1 Fluid Expansion Compensation

The dampers shall contain provisions to allow for thermal expansion and contraction of the fluid medium to prevent excessive buildup of internal pressure and to also prevent formation of a vacuum over the temperature range of +32^{O}F to +120^{O}F.

5.1.2 Dimensions

The overall dimensions of the dampers and mounting brackets shall be held to a minimum consistent with the requirements of this specification, and in no case shall they exceed the dimensions specified in Figures 1A and 1B.

5.2 Construction

5.2.1 General

The dampers shall be of corrosion protected construction with a solid stainless steel piston rod that is internally mounted.

5.2.2 Design Loads

5.2.2.1 Axial Design Loads

The maximum axial design loads shall be 330 kips tension or compression for the A dampers and 250 kips tension or compression for the B dampers with the rod fully extended, retracted or at any intermediate position.

5.2.2.2 Fluid Pressure

The dampers shall be designed to withstand the following internal pressure:

Proof: 125 percent of the maximum operating pressure.

Burst: 250 percent of the maximum operating pressure.

5.2.2.5 Factors of Safety

Minimum factors of safety for the dampers shall be 2.0 limit and 2.5 ultimate. The dampers shall not yield when subjected to limit loads and there shall be no failure of any kind when subjected to ultimate loads. Limit and ultimate loads shall include the effects of the load factors specified herein.

5.3 Performance

5.3.1 Damping Law (Force as a Function of Velocity)

The dampers shall provide a force that varies with velocity per the equation F=CV, where C is 200 kips per ft/sec for the A dampers and is 120 kips per ft/sec for the B dampers at any stroke position and angular orientation. In this equation F is the nominal force, with a tolerance band as shown in Figure 2. Note that the tolerance band applies across the entire range of operating temperatures.

5.3.2 Duty Cycles

The dampers shall be designed to withstand the following duty cycles:

A. Wind Loading - .2 inch single amplitude at 1 Hz for 300,000 cycles per year.

B. Seismic Loading - 1.5 inch single amplitude at .75 Hz for five cycles per year.

5.3.3 Leakage

The dampers shall be designed to allow a dynamic leakage level that will have no effect on performance over the life of the building (75 years) This leakage shall be quantified in a way that is easily measurable. Under non-operating conditions, static seals shall not leak externally. When subject to proof pressure for five (5) minutes the dampers shall show no visible evidence of external leakage.

5.3.4 Stroke

The dampers shall be capable of meeting all performance requirements of this specification at any point in their 5.0 inch working stroke from fully retracted to fully extended.

6. Testing

6.1 Qualification Testing

Prior to contract award, the vendor shall submit to Rockwell a damper qualification test report in compliance with the specifications listed in section 1.2 of this document. If the tests described in this report were performed on a scaled damper, the minimum allowable force scale factor is 1/8 (or a maximum force of 41.25 kips for the A dampers). The maximum permissible damping exponent is 1.2, where this exponent is "n" in the equation $F=CV^n$ in which F is the damper force in kips, V is the velocity in ips and C is a constant. As a minimum, qualification tests shall include the following:

6.1.1 Sine wave cycling at a minimum of four different peak stroking velocities in the .5 ips to 20 ips range, using at least +/- 1.0 inch of damper stroke. At least one test shall be run at a damper force level above 35 kips.

6.1.2 Temperature testing consisting of repeating the tests of 6.1.1 at $+32^{O}F$ and $+120^{O}F$ damper temperatures, after stabilizing the damper at the required temperature for at least one hour prior to the test.

6.1.3 Correlation testing of the sine wave test results of 6.1.1 with results from heavy weight drop testing of the subscale dampers in the same test lab that will be used to test the full scale dampers.

6.1.4 Test Reports and Acceptance Criteria

The vendor shall submit a test report for the tests of 6.1 inclusive that shall include all raw data in addition to force- velocity relationships including temperature dependent variations and comparisons from both types of tests. All test reports shall be submitted to Rockwell for review.

The test results shall be used to provide a preliminary indication of the properties of the full scale dampers, their variation with temperature and number of strokes, and to provide a basis for correlating dynamic cyclic testing with drop testing. A variation of 10% between the measured results of the cyclic testing and the drop testing shall be deemed acceptable.

6.2 Full Scale Damper Tests

The first production full scale damper of each type (A and B) shall be performance tested for conformance to the requirements of this specification. All tests in this section shall be performed at room temperature.

The purpose of this testing is to provide confirmation of the force-velocity characteristics of each of the two types of dampers and to verify the soundness and leak proof nature of the construction under proof loading and cyclic testing.

6.2.1 Acceptance Criteria

No visible leakage or signs of physical deterioration or degradation in performance shall be observed during or after the series of tests. There shall be no signs of yielding or permanent deformation.

The force-velocity results form the drop tests, adjusted for expected variations due to temperature and number of strokes, shall fall entirely within the upper and lower bound curves in Figure 2.

6.2.2 Test Series

6.2.2.1 Proof Tests

An internal pressure of 125% of the maximum operating pressure shall be applied to each test unit and maintained for a minimum of 120 seconds.

6.2.2.2 Life Cycle Test

One test unit, either type A or type B, shall be cycled through its full end-to-end displacement for a minimum of 120 cycles. The cyclic velocity is expected to be much slower than the design maximum velocity and shall depend on the capacity of the testing apparatus.

6.2.2.3 Drop Tests

Each test unit shall be drop tested using a heavy weight drop tower at velocities from 5 inch per second to the maximum expected velocity of 20 inches per second for the A damper and 24 inches per second for the B damper in 5 inch per second increments. The force, displacement and time measurements shall be accurately obtained and recorded and force-velocity plots constructed. There shall be two hammer drops at each velocity increment, each at a different piston stroke position.

6.3 Production Unit Testing

Production unit testing shall be conducted in order to verify the quality and manufacturing consistency of each production unit.

6.3.1 Test Series

Each production unit shall be drop tested at 20 inches per second velocity for the A dampers and 24 inches per second velocity for the B dampers.. These tests shall take place at room temperature and with the piston rod at the nominal (centered) position. The output force must fall within the performance bands of Figure 2.