Inquiry:
Under What Rules Can Viscoelastic Dampers Be Qualified as Dynamic Restraints?

Reply:
It is the opinion of the Committee that Viscoelastic Dampers can be qualified in accordance with the following rules which apply in addition to the existing rules of Section QDR of the ASME QME-1 Standard.

1. Scope
These rules apply to the qualification of viscoelastic dampers identified as dynamic restraints.

2. Boundaries of Jurisdiction
The Boundaries of Jurisdiction are defined as being from the connection of the viscoelastic damper and the piping/component attachment to the connection of the viscoelastic damper to the supporting structure; or from the connection of the attachment of the viscoelastic damper to one piping/component/structure to the connection of the attachment to another piping/component/structure.

3. Definitions

Activation: the change of condition from passive to active in which a viscoelastic damper resists rapid displacement of the attached pipe or component.

Cavitation: the opening of a gap between the piston and the viscoelastic liquid as a result of a force and velocity applied to the piston.

Cavitation Load: that force and velocity applied to the piston that causes cavitation.

Damping Resistance: a linear approximation of the relationship of the load velocity characteristics of the viscoelastic damper piston.

Extreme Position: that limit on the piston position relative to the barrel of the damper where the specified damping or stiffness characteristics are no longer applicable.

4. Qualification Principals and Philosophy
Viscoelastic restraints are used to control dynamic system responses. Under steady state or static forces the system or component supported by viscoelastic dampers at operating temperatures will move within the travel limits of the damper. The movement results in a resisting drag force on the system or component equal to a small percentage of the rated load capacity of the viscoelastic damper. The stiffness and damping characteristics of a viscoelastic damper are functions of the viscosity of the viscoelastic liquid, which is dependent on the temperature of the liquid, the rate of applied loading, and the load frequency. When a force is applied suddenly, viscoelastic dampers
control dynamic response so that the stresses in the supported piping system or component will not exceed Code limits.

The basic characteristic of a viscoelastic damper is its ability to develop a force displacement/velocity relationship that will restrain, with no dead band, movement from seismic and operational vibration frequencies and amplitudes as well as from impact or impulse loads.

The qualification program for viscoelastic dampers will adequately define this force-displacement/velocity relationship at specified frequencies, rates of loading, and temperatures for each type of damper.

Each type of viscoelastic damper shall have functional parameters (rated load, drag, spring rate stiffness, allowable displacement, damping resistance) specified and confirmed by test and analysis qualification.

The force-displacement and force-velocity relationships of viscoelastic dampers are used by piping system designers for the modeling of restraints in the analysis of the supported piping system or component. The spring rate stiffness and damping resistance are simplified expressions of the force-displacement and the force-velocity relationship of the viscoelastic damper under action of a dynamically (cyclic, impact or impulse) applied load, up to the magnitude of the rated load capacity of the viscoelastic damper. The spring rate stiffness and damping resistance vary as a function of the frequency, rate of loading, magnitude of the applied load, and temperature and viscosity of the viscoelastic liquid.

5. Functional Parameters for Initial Qualification of a Viscoelastic Damper by Type and Size at Operating Temperature

The functional parameters of viscoelastic dampers are essential inputs for the design of the piping systems or components that are supported or restrained. These parameters are drag, rated load, allowable displacement, spring rate stiffness and damping resistance, as applicable to the individual size and type of viscoelastic damper at specified operating temperatures.

Initial Qualification of a Damper by Type or Size

a. Drag is determined by measuring the force required to move the damper piston at a specific velocity. Qualification testing shall be performed measuring horizontal (transverse and longitudinal), and vertical drag force.

b. Rated load shall be determined by test and analysis in accordance with ASME B&PVC Section III, Subsection NF Code requirements and cavitation load when subjected to cyclic loading as identified in a Functional Qualification Report for each type and size of damper.

c. Spring rate stiffness shall be determined dynamically as a function of frequency or velocity of the applied load. The applied loads divided by the recorded displacements describe the spring rate stiffness. Methods of spring rate stiffness determination shall be identified in a Functional Qualification Report for each type and size of damper.
d. Damping resistance characteristics shall be determined dynamically as a function of frequency or velocity of applied load. Method of damping resistance determination shall be identified in a Functional Qualification Report for each type and size of damper.

e. The allowable displacement range of the damper is a parameter established for each size and type of damper.

6. Functional Parameter Testing and Analysis of Viscoelastic Damper by Type and Size at Other Than Operating Temperatures

All parameters described in paragraph 5 shall be defined for the range of temperatures wherein each type and size of viscoelastic damper is qualified to function as an active damper. Temperature shall be recorded at the beginning and end of each of the required tests. The viscosity of the viscoelastic liquid will be measured and recorded. Method of determination of viscosity or related quantity shall be identified in the Functional Qualification Report.

Viscoelastic dampers at higher temperatures no longer function as a damper due to viscosity changes and function instead as gap restraints. The temperature at which this change in function occurs shall be identified for each type and size of damper. A separate qualification of the device as a gap restraint shall be performed to satisfy QME1-QDR requirements and documented in the Functional Qualification Report.
Attachment 1 contains Non-Mandatory examples that could be included in a Functional Qualification Report to validate the functional parameters contained in the Design Specification.

Attachment 1
1. Functional Qualification Report Requirements for Viscoelastic Dampers Initial Qualification Testing by Size and Type
   a. Limits for the drag force associated with moving the piston with rated load applied under a range of specific applied velocities at various temperatures. At a determined temperature the viscoelastic damper will act as a gap restraint and shall be qualified according to existing QME-QDR requirements.
   b. Rated loads for applicable ASME Code Service Levels A, B C and D for active damper’s axis shall be defined.

If damper is intended to resist cyclic loads:
   a. The spring rate stiffness of the damper for active degrees of freedom at a different velocity of the piston applied as a cyclic load at 0.1 Hz (effectively static load) and at 3 Hz incremental rates of loading in the 3 to 33 Hz range for test duration of at least 10 seconds at each frequency or using multi-frequency white noise procedure enveloping all of the above frequency ranges
   b. Spring rate stiffness at various temperatures.
   c. Restraint spring rate stiffness curves for different levels of rated load with a cyclic rate of loading equal to 1.0 Hz, 4.0 Hz, 10 Hz, 20 Hz, and 35 Hz for the load applied as a sine beat wave.
   d. From the damper spring rate stiffness curves a representative stiffness shall be developed to define damper elastic stiffness
   e. Determine damping resistance characteristics for cyclic load, size and temperature as required for stiffness evaluation

If the damper is intended as a restraint for an impactive or impulsive load:
   a. The spring rate stiffness of the damper for rated load application at representative impact or impulse loading rates
   b. Resultant damper spring rate stiffness and damping at various temperatures.
   c. Damper functional characteristics above a maximum defined temperature shall be in accordance with gap restraint qualification procedures.

2. Functional Requirements for Viscoelastic Dampers Initial Qualifications of Production Dampers
   a. Test viscosity or related quantity will be recorded during type and size qualification testing for comparison to the viscosity of damper viscoelastic fluid used in initial qualification of production dampers
   b. Visual checks to determine geometry and material certification in the production damper is the same as the initial qualification size and type testing