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ENGINEERED SOLUTIONS FOR
NUCLEAR EXPANSION JOINTS,
BRAIDED METAL HOSE,
AND SPENT FUEL
CONTAINMENT SYSTEMS





QUALITY ASSURANCE/ QUALITY CONTROL

Senior Flexonics Pathway operates under a quality assurance program for all nuclear items under ASME's N and NPT Certificates of Authorization. Through these stringent certifications we design and manufacture NPT stamped bellows-type expansion joints, braided metal hoses, welded pipe, piping sub-assemblies, and spent nuclear fuel containment systems.

- ▶ Braided Metal Hose
- ▶ Expansion Joints
- ▶ Welded Pipe and Fabrications
- ▶ Spent Nuclear Fuel Containment Systems
- ▶ Bellows-type Containment Penetration Seals

NUCLEAR AUDITS

Our Nuclear Quality Assurance Program is surveyed and audited by various state, national and international organizations on a regular basis. Our Quality Assurance Program complies with the following:

- ▶ ASME Section III, Divisions 1 & 3
- ▶ ASME NQA-1
- ▶ 10 CFR 50 Appendix B
- ▶ ANSI N45.2





— [EXAMINATION & TESTING] —

The examination and testing of bellows and other equipment is performed at various stages of the manufacturing process. The nondestructive examinations and tests include:

- ▶ Material Overchecks
- ▶ Dimensional Checks
- ▶ Visual Inspection
- ▶ Hydrostatic Test
- ▶ Helium Leak Tests
- ▶ Dye-Penetrant Examination
- ▶ X-Ray Examinations



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— [BRAIDED METAL HOSE] —

Senior Flexonics Pathway provides braided metal hose and expansion joints as replacements for those installed during construction (originally manufactured by Metal Bellows Corporation) and for new service applications. These items provide thermal and seismic stress relief to instrumentation connections and piping connections. Typical applications include instrumentation connections in main steam piping and reactor coolant piping, and vibration, thermal, and seismic movement isolation for piping.

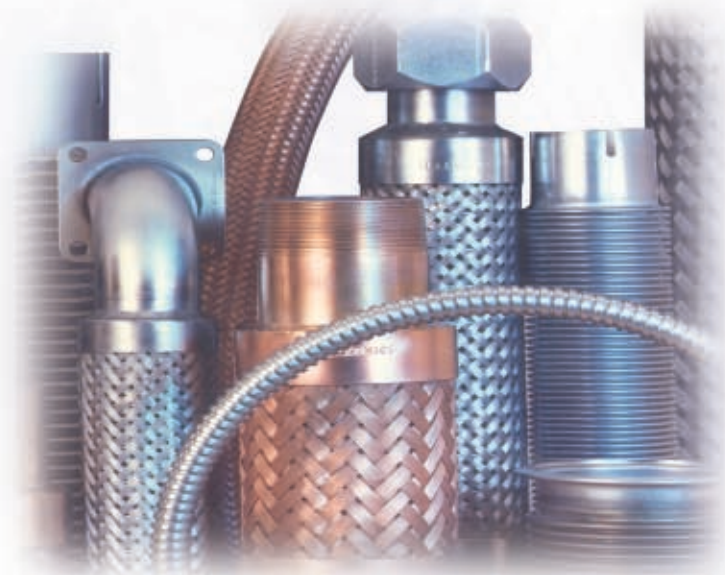
- ▲ Piping Connections
- ▲ Lubrication Piping Connections
- ▲ Instrumentation Lines
- ▲ Equipment Vibration Isolation
- ▲ Cooling Water Connections

MANUFACTURING CAPABILITIES

Hoses are manufactured from 1/2" to 10" in diameter, allowing movement from 0.03" to 10". The primary difference between a hose and a metal bellows is the use of the hoses' external braided cover to resist the forces of pressure thrust. The only established definition that separates expansion joints from metal hoses is in ASME Code Case N-192-2, which states that the rule for designing a hose is invoked after a length-to-diameter ratio of 3 is exceeded. Hoses are designed to handle system design conditions of up to 3000 psi and 800°F. Expansion joints and penetration seals are manufactured from 2" NPS up to 35 feet diameter.

APPLICATIONS:

- ▲ Cooling water seals
- ▲ Thermal barrier water lines
- ▲ Upper oil cooler lines
- ▲ Condensation lines
- ▲ Instrumentation lines
- ▲ Fuel pool sweep
- ▲ Personnel door lock
- ▲ Diesel generators
- ▲ Pressure monitoring/measurement
- ▲ Pressure riser valve
- ▲ Cooling water piping





— [W E L D E D P I P E & W E L D E D F A B R I C A T I O N S] —

Senior Flexonics Pathway's fabricating ability is utilized to supply various sizes and grades of pipe spools for nuclear specification requirements. We have the capacity to cut, roll and weld carbon steel plate up to 5" thick and stainless steel plate up to 3" thick. Piping assemblies can incorporate fittings such as elbows, tees, flanges, and can be installed by our field service personnel.



— [M E T A L L U R G I C A L A N D R E S E A R C H F A C I L I T Y] —

Senior Flexonics Pathway's research and development center in Bartlett, Illinois is dedicated to state of the art development of flexible elements. Results of tests and evaluations are the cornerstone of the advancements made with metal bellows and braided hoses. Technicians are available to our clients for material suggestions, failure analysis and prototype testing. We have the largest and most comprehensive testing capability with over 40,000 dedicated square feet. We routinely perform the following tests:

- ▶ Vibration
- ▶ Seismic Shake
- ▶ Elevated Temperature
- ▶ Cyclic Fatigue
- ▶ Cryogenic
- ▶ Destructive testing

Test results empirically validate EJMA (The Expansion Joint Manufacturers Association) calculations and refine pressure thrust, pipe load and spring rate values. Extensive research and development has provided valuable information about the properties of the ClamShell solution.



CLAM-SHELL BELLOWS PENETRATION SEALS

Reactor coolant water piping and main steam piping pass through the reactor containment wall. Bellows-type containment penetration seals are used to allow flexibility of the piping penetration while maintaining the integrity of the containment boundary. During plant construction, the piping was inserted through the bellows seal. However, the piping can not practically be removed in order to install a new bellows that may be needed to replace an original bellows that may have degraded over the years. The practical solution is to remove the existing bellows and install a Clam-Shell™ Bellows, that is, a bellows that has been split in half for installation around existing piping, as pictured below.

PRODUCT APPLICATIONS

- ▶ Containment Piping Penetrations
- ▶ Expansion Joints Steam extraction piping
- ▶ Coolant piping
- ▶ Steam lines
- ▶ Turbine crossover
- ▶ Condenser seals
- ▶ Ductwork
- ▶ Drywell containment seal
- ▶ Refueling seal
- ▶ Suppression chamber
- ▶ Fuel transfer bellows
- ▶ Feedwater turbine exhaust



THE MANUFACTURING PROCESS

ClamShells are formed either hydraulically or mechanically. Hydraulic forming is a single step process. The mechanical process may require an initial punch-form followed by a re-roll to gather and refine the profile of the convolutions. The forming process may also be followed by an anneal to eliminate all residual stresses. The bellows is then cut in two and shipped to the field for final assembly.



CLAM-SHELL BELLOWS INSTALLATION SPECIALISTS

Senior Flexonics Pathway has specialized in the design and installation of Clam-Shell Bellows in nuclear power plant containment penetrations. The ASME Section III, Class MC design and Quality Assurance processes are controlled by Senior Flexonics' Nuclear Quality Assurance Program; the installation process has been developed and refined over years of practical experience by Senior Flexonics skilled installation crews.

