Expansion Joint Test Stand

Garlock SEALING TECHNOLOGIES©

P13671 THE DREAM TEAM

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What is an Expansion Joint?

An ***Expansion Joint*** (*EJ)* is used to connect two rigid sections of pipe and is designed to compensate for misalignment or relative motion between the pipes due to vibration, thermal expansion or contraction, settlement, etc. These joints are a composite product typically composed of layers of rubber and fabric and can range in size from two inches to over 10 feet in diameter!

Garlock Sealing Technologies is acknowledged as the global leader in high-performance fluid sealing products, and pipe expansion joints are one of their key products. Each EJ is customized for the buyer and made by hand at their facility in Palmyra, NY.

Our project group with Wayne Evans (Garlock) and Jason Kolodziej (Sponsor).

Why Are EJs Important?

Expansion joints are used extensively in a wide range of industries including power generation, chemical processing, and mining. An unexpected shut down of a critical system due to a failed expansion joint is costly and has the potential to be a safety hazard. A test stand that simulates the conditions an EJ may see in the field will help Garlock to better understand how their products hold up under rigorous use and provide means of more accurately determining the predicted life of any given unit. This information will add value to their product and distinguish them in the market.

P13671's goal is to develop a test stand that is able to axially actuate the EJ ± 1", provide a uniform temperature distribution throughout the EJ up to 400˚ F and accommodate multiple diameter EJs (anywhere from 2" to 12").

The Design Process

The primary functionality of the test stand can be broken down into two categories consisting of the actuation system and the heat transfer system. The rest of the structure was designed to allow these core systems to operate efficiently; for example, the amount of piping was minimized to reduce the heat loss between the heater and EJ.

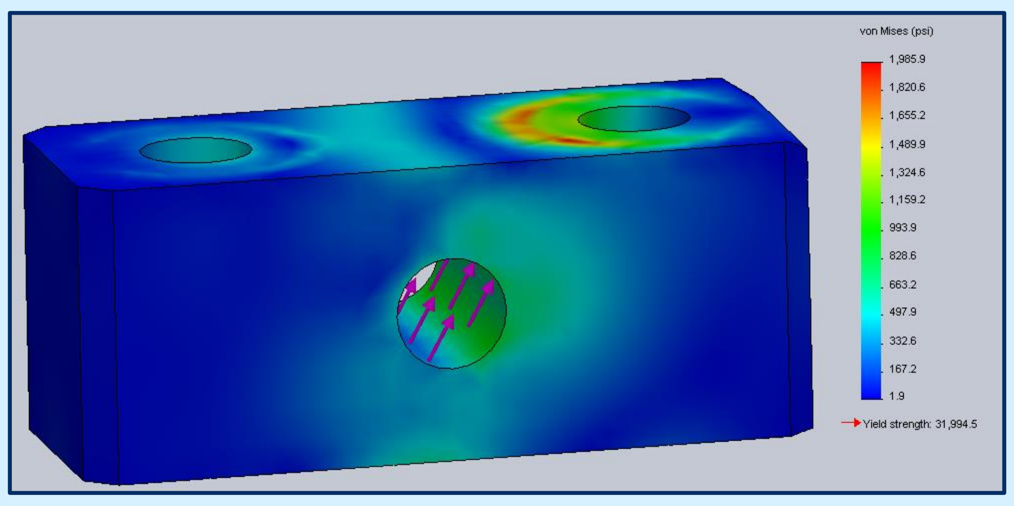
The actuator is mounted directly over the top of the joint to minimize complexity, eliminating the need for a strong outer skeleton and allowing for fine tuning of alignment via the adjustable turnbuckles. Safety and accessibility were also primary considerations; the acrylic panels allow high visibility of the system components, channel any fluid spills to the drip tray, and are removable in critical locations to allow access to the heater and EJ.

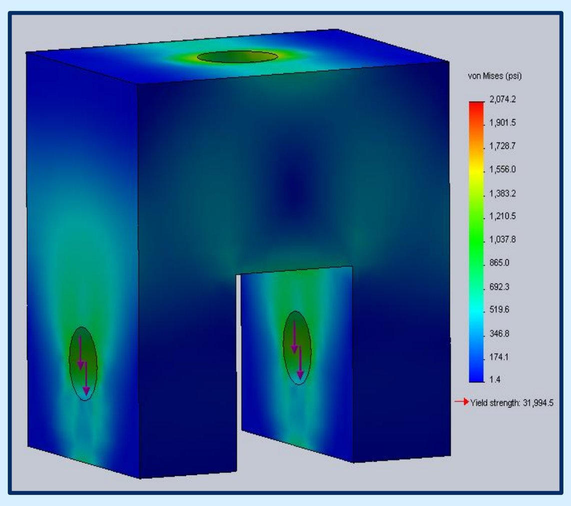
Actuation & Structural Design

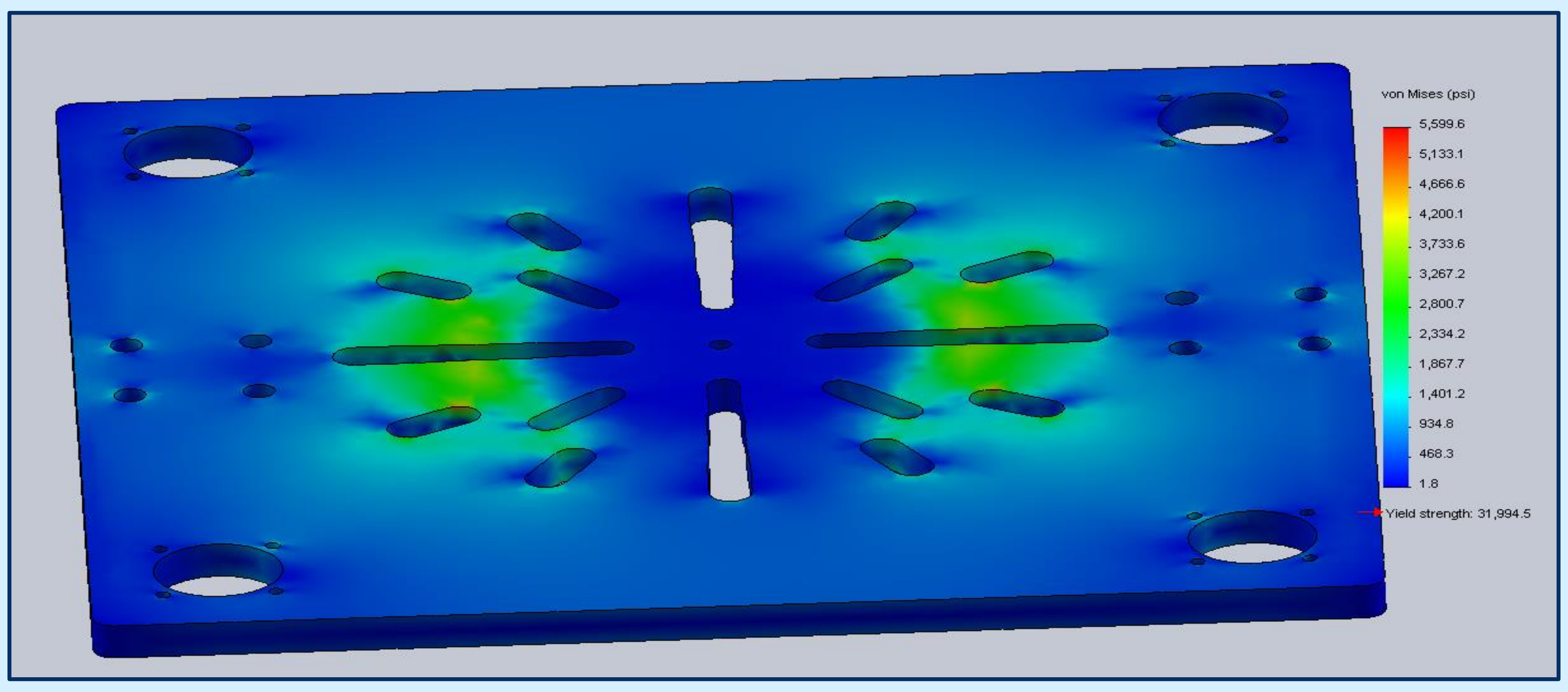
After brief testing, we found that we'd need an actuator that could produce a load of over 1600 lbs. in order to compress a 6" diameter EJ one inch. We over-designed the system by purchasing the pneumatic actuator and components through ***Empire Automation*** that:

- Produces up to a 3,000 lbs. load (compression or tension)
- Includes it's own custom-programmed controller

Below, are a few components that we designed. Top left is a bracket where the top diagram is the bracket in tension under a 3,000lb load with a 6" EJ. Similarly in tension, to the top right is our actuation clevis and on the bottom you will find the mounting plate that moves and displaces the EJ.

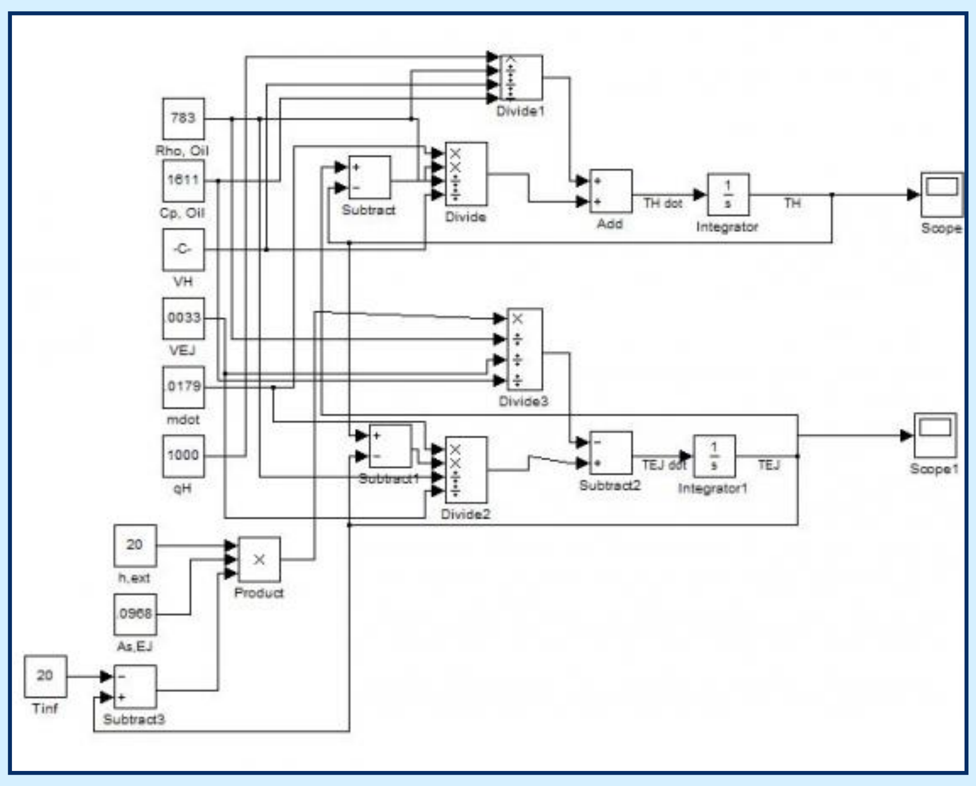


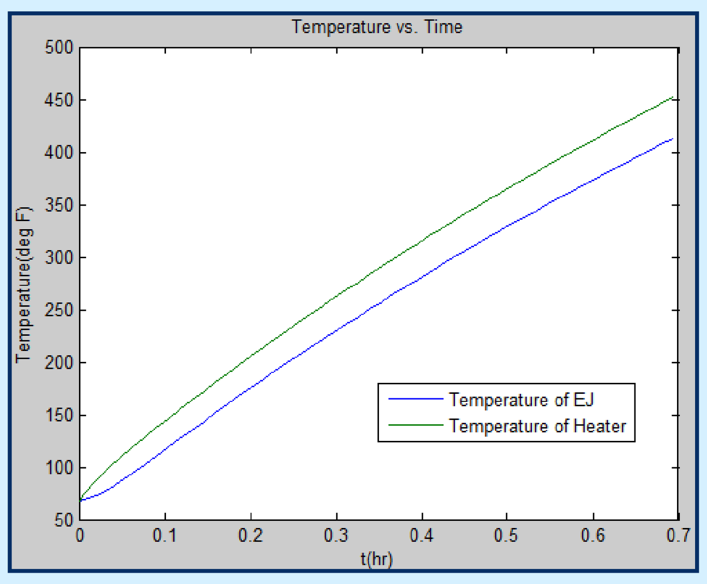




Fluid Choice & Thermal Design

Knowing that our system needs to be able to heat up to 400˚ F, we had to choose a fluid that could handle this maximum temperature while also having a high thermal conductivity. We initially chose a commercial thermal fluid, however when we looked at the properties of some common oils we found that ***soybean oil*** would be cheaper and be extremely similar to the original one we chose. After determining the fluid we would be using, we chose a heater using the fluid properties and our required temperature of 400˚ F. We worked with a local company, ***ANTECH Diagnostics***, to design our heating system.





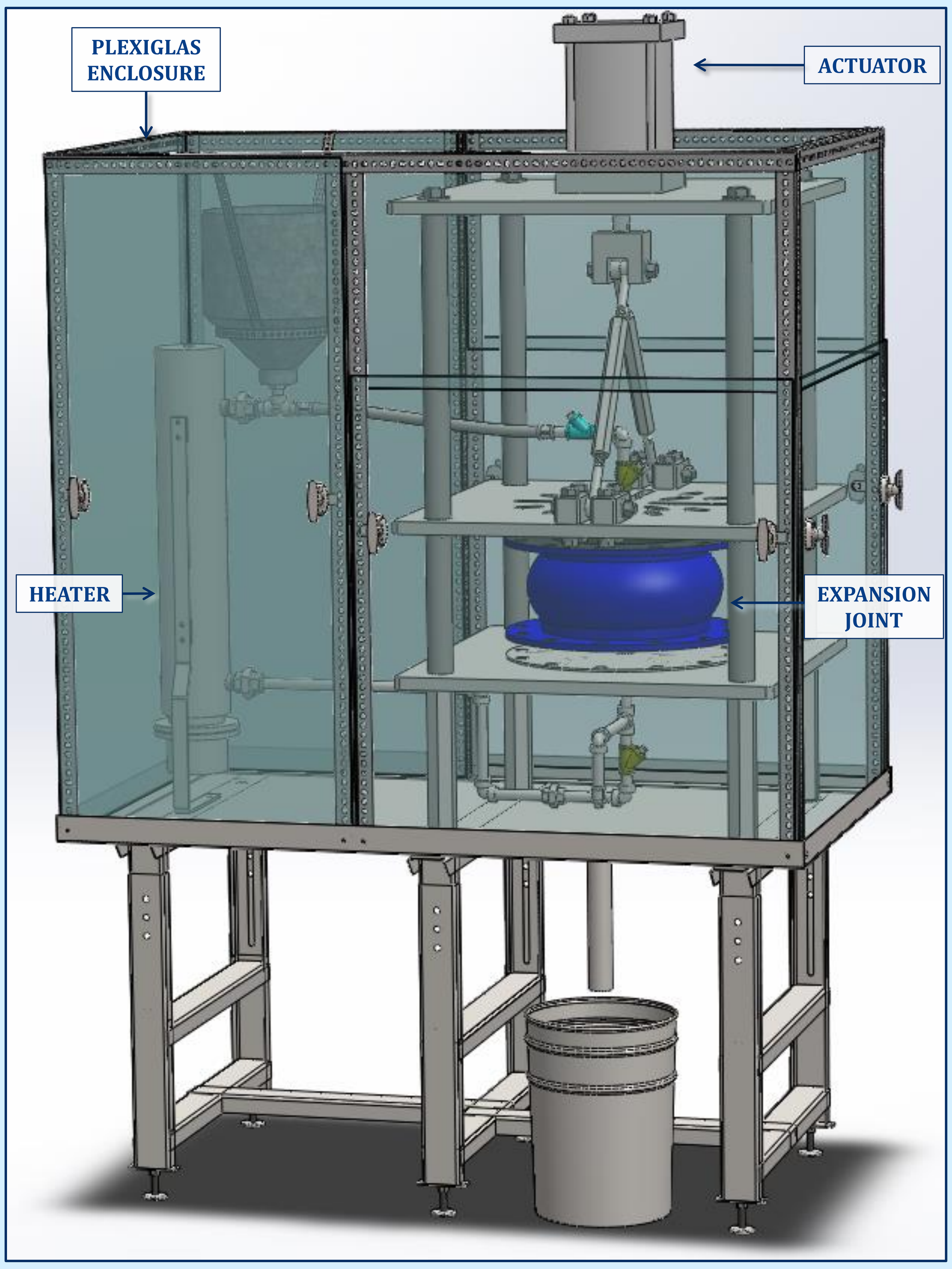
To the left is our Simulink diagram of the thermal simulation on our system. Above, the results can be seen for the temperature of the fluid versus time.

System Specifications

Spec. Number	Customer Need	Metric Description	Importance to Customer	Target Units	Target Value	Preferred Direction
ES1, ES13	1.1, 2.1	Accommodate various EJ diameters	9	in	2-12	range
ES2, ES3	1.3	Axially displace EJ	9	in	± 1	up
ES6	1.1, 1.2	Maximum Temperature (*demonstrated*)	9	ºF	400	up
ES7	1.2, 1.4	Uniform system temperature tolerance (including within EJ)	9	ºF	± 5	down
ES4, ES5, ES10	3.1	Accommodate various *pressure* (do not need to demonstrate)	1	Y/N	Y	N/A
ES9, ES11	3.2	Accommodate various media (*do not need to demonstrate*)	1	Y/N	Y	N/A
ES14, ES15	2.1, 2.2	Able to Change working fluid	3	Y/N	Y	N/A
ES12	4.1	Must be safe to operate and maintain	9	Y/N	Y	N/A
C1	3.3	Accommodate health monitoring (*do not need to demonstrate*)	1	Y/N	Y	N/A
C2	4.1, 4.2	Provide list of improvements needed for future use/design	9	Y/N	Y	N/A
C3	5.1	Fit through standard double door, Movable to Garlock	9	Y/N	Y	N/A
C3	5.1	Footprint of System	9	ft^2	4x6	down
C4		Cost to customer	9	$	10,000	down

System Assembly

Below is an overview of our system's final design. The actuator, placed top-right, is held by the top steel plate. The actuator is connected by two control rods to the middle steel plate. The middle steel plate and the bottom steel plate are where the EJ is mounted between. The fluid system is integrated by connecting pipes to the middle and bottom steel plates which then connects to the heater and accumulator. The overall system is enclosed by Plexiglas doors and walls.



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ANTECH Diagnostics
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