



University  
of Idaho

# **AUTOCLAVE UPGRADE FOR CORROSION FATIGUE TESTING**

**A PROJECT BY THE AUTOCLAVE  
EXPERTS**

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# SCOPE OF PROJECT



- Design and build load frame system that conforms to the product requirements of Dr. Stephens and fits budget of \$40,000
- Design and build specimen platform gripper arms and dynamic seal.
- Design and code LabView user interface (UI)
- Validate system in time for use after Fall Senior Design class ends



# VALUE PROPOSITION



## EXPANDING THE UNIVERSITY OF IDAHO'S TESTING CAPABILITIES



- Load Frame/Autoclave combo will be a unique addition to U of I's research equipment
- Project will expand Dr. Stephen's ability to test fatigue of experimental materials
- Similar product previously quoted by Cortest at \$100,000+

Similar Cortest System

# INITIAL EQUIPMENT



## THE CORTEST AUTOCLAVE



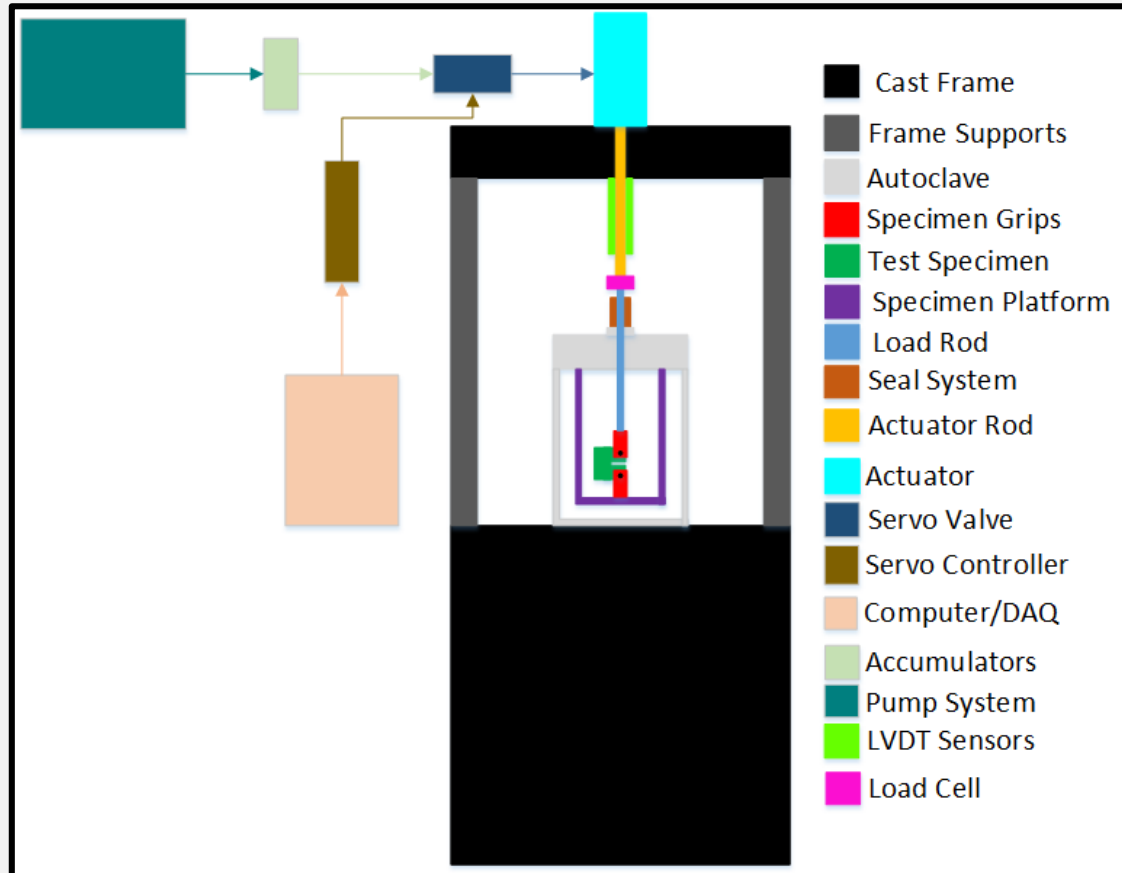
- This autoclave is not currently in use by the college.
- Autoclaves like this are used to create a high temperature/pressure environment. This model can also accommodate corrosive conditions.
- Capable of reaching 300 °C and 4000 psi (setting our design goal).
- Designed to accommodate a load frame system with its heavy structure.

# DESIGN CONCEPT



Our design work includes:

- Computer & data acquisition equipment
- Hydraulic pump equipment and actuation system
- Sensors for monitoring and data output
- High temperature/pressure dynamic seal
- Specimen retainment system
- Wire and set up microcontroller



# HARDWARE REQUIREMENTS



## THE CORE REQUIREMENTS DRIVING OUR DESIGN

### Actuation System

- Extension rate of at least 0.05mm/s during testing
- Capable of delivering a load of 10,000 lbf

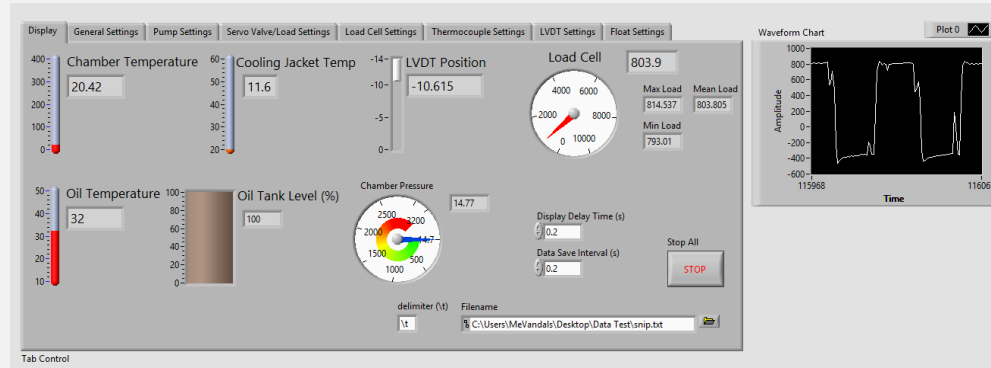
### Specimen Testing

- Specimen platform will fit in autoclave without modification
- Design shall accommodate standard test specimens
- Grip design will conform to ASTM E647 requirements

### Internal Components

- Need to survive 300 °C & 4000 psi environment
- Must withstand same corrosives as 316H stainless

# SOFTWARE REQUIREMENTS



- Emulate LabVIEW user interface of other University of Idaho load frames in use.
- Monitor system sensors to provide control feedback & emergency stop functionality.
- Programmable loading waveforms.
- Fatigue sample crack measurement.
- Manual linear load frame control.
- Integrate microcontroller to LabVIEW to run system

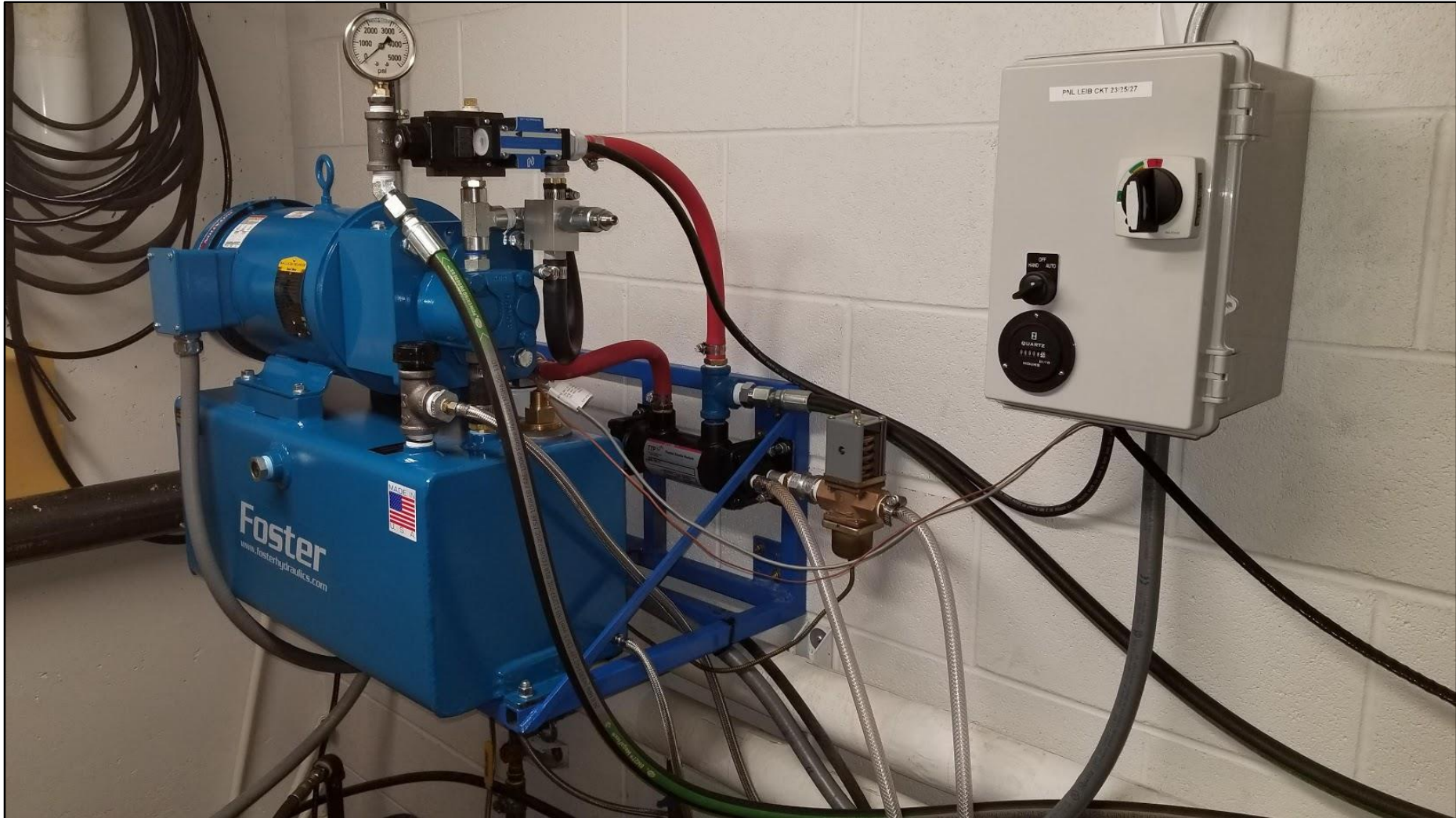
# MICROCONTROLLER



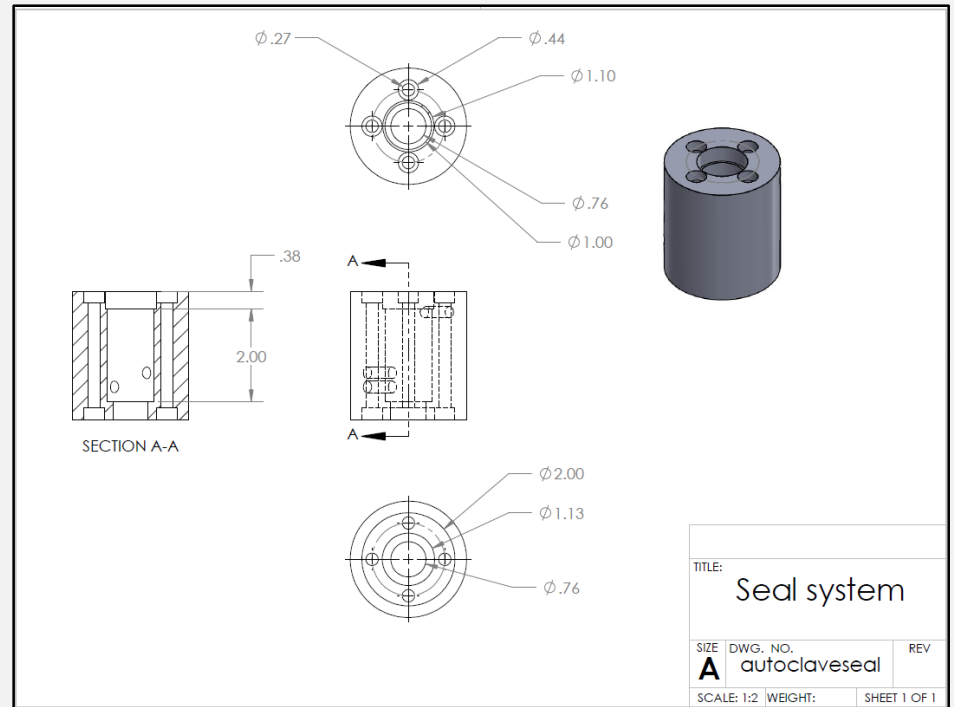
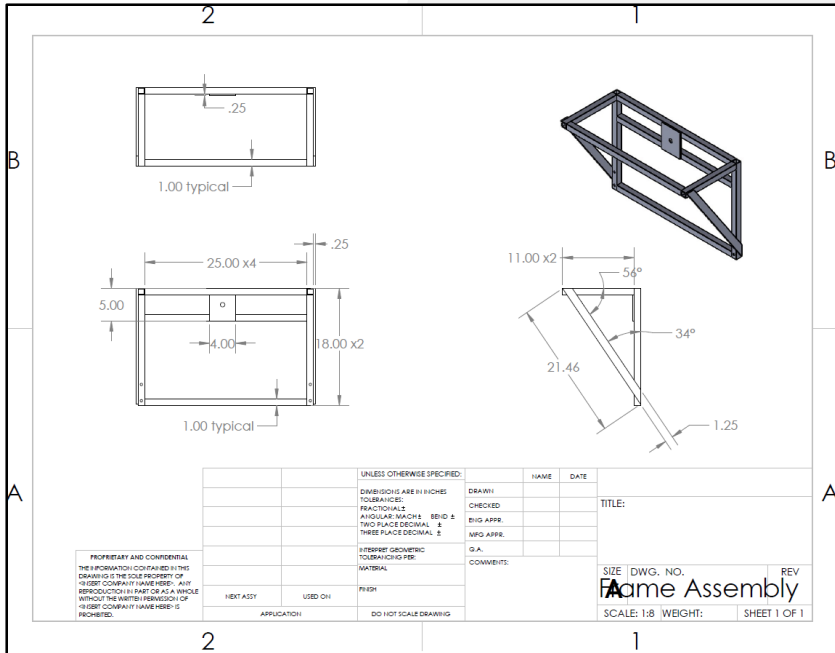
- Manufactured by MTS in 1972
- Utilized for control system simplicity
- Same model used elsewhere in lab



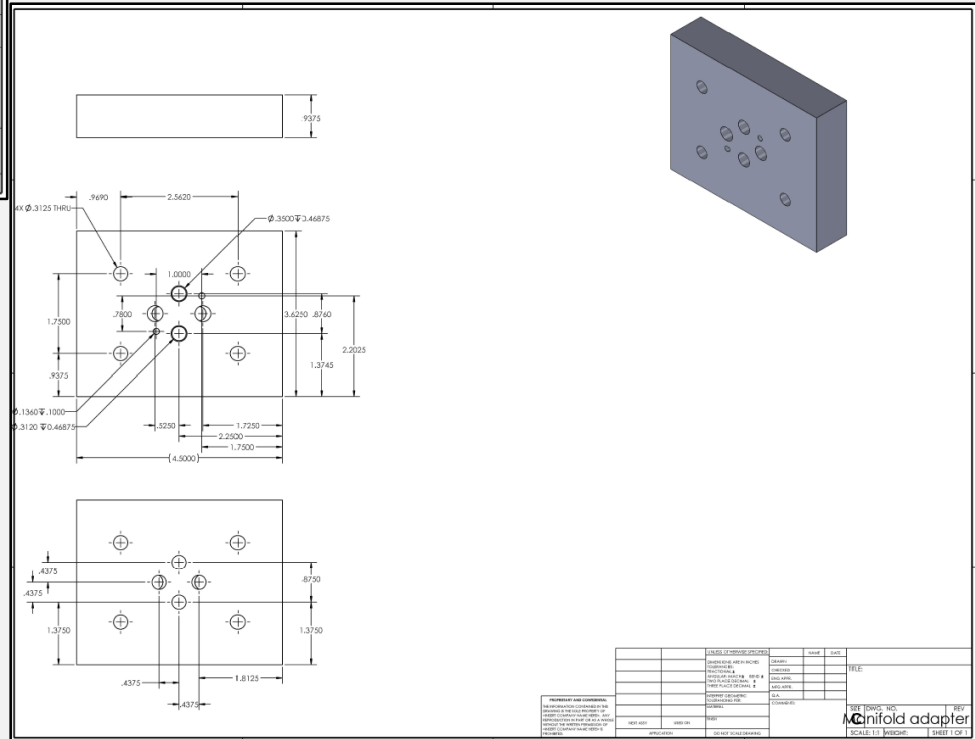
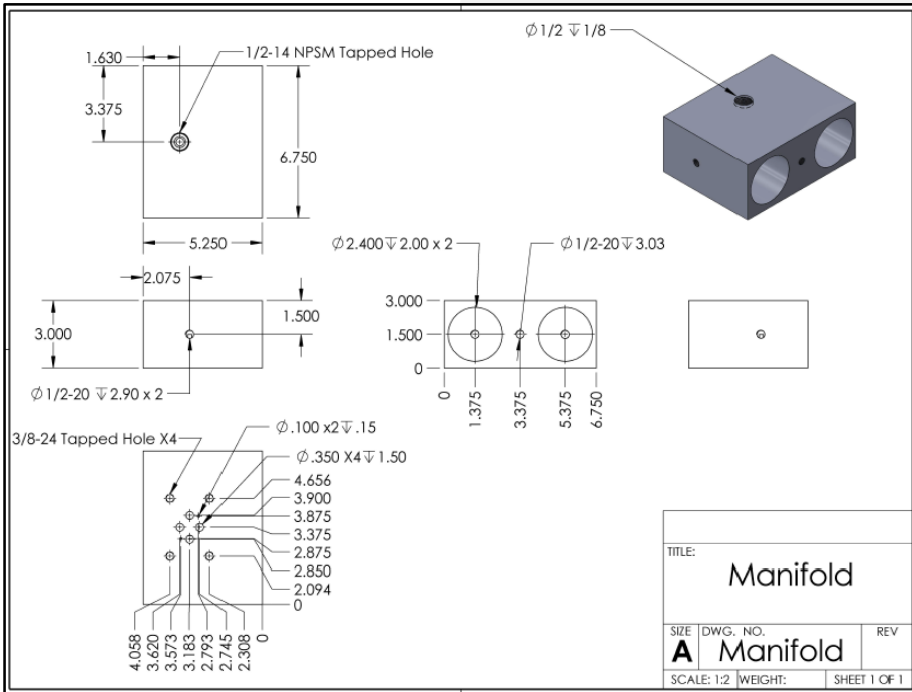
# PUMP SYSTEM



# PUMP FRAME AND DYNAMIC SEAL



# MANIFOLD AND ADDAPTOR





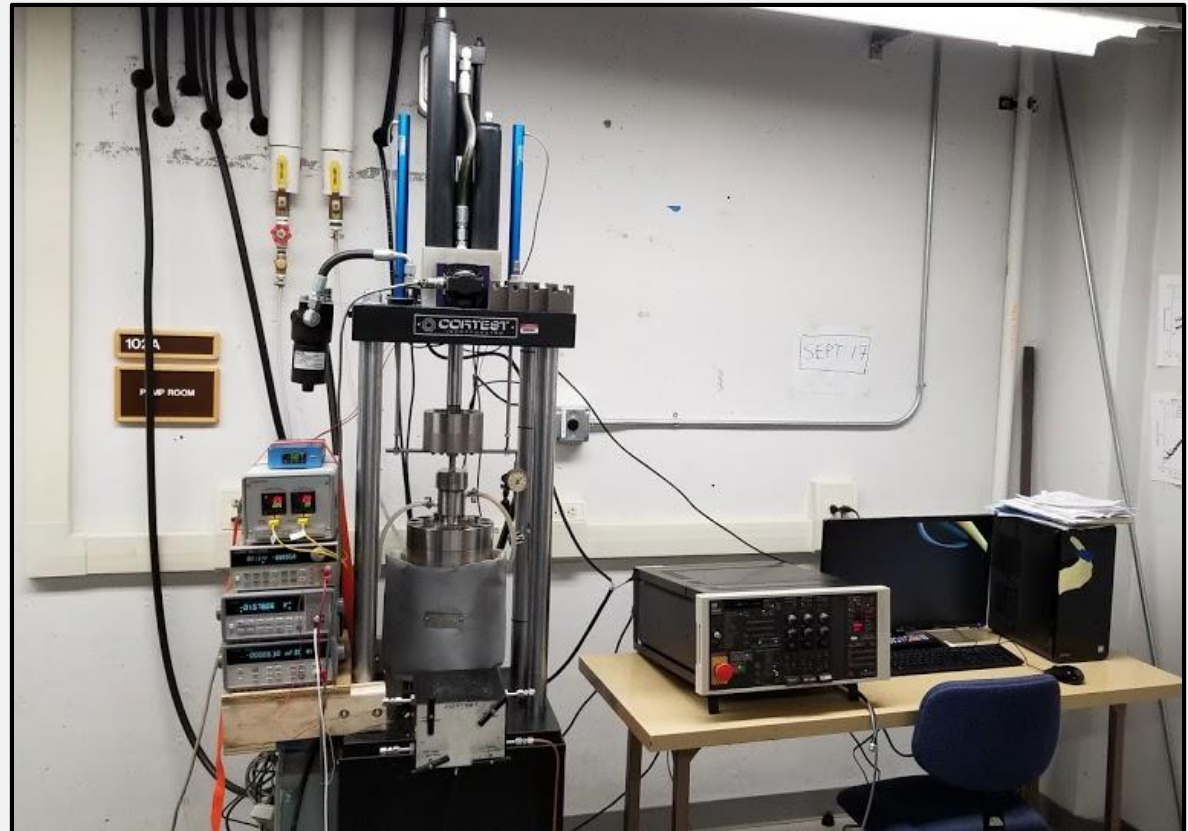
# SYSTEM BUILT



BEFORE:



AFTER:





# BILL OF MATERIALS



## Purchase Rundown

Products	Prices	Purchased	Received
<b>Electronics</b>			
Computer	\$699.00	✓	✓
Screen	\$100.00	✓	✓
HDMI cable	\$5.00	✓	✓
input card	\$224.99	✓	✓
DAQ	\$5,415.88	✓	✓
DCPD	\$0.00	✓	✓
Load cell	\$1,658.74	✓	✓
LVDT	\$1,243.00	✓	✓
<b>Total</b>	<b>\$9,346.61</b>		
<b>Hardware</b>			
All metal stock	\$750.00	✓	✓
Spring seal	\$11.28	✓	✓
Stuffing seal	\$48.14	✓	✓
Hydraulic lines	\$485.00	✓	✓
Water line hook up	\$130	✓	✓
McMaster Carr Orders	\$166	✓	✓
Bolts	\$5.99	✓	✓
<b>Total</b>	<b>\$1,596.36</b>		

<b>Hydraulic system</b>			
hydraulic filter case	\$294.17	✓	✓
Actuator	\$1,753.43	✓	✓
Hydraulic filter	\$78.00	✓	✓
Pressure gauge	\$13.99	✓	✓
Heat exchanger	\$217.03	✓	✓
Motor starter	\$349.00	✓	✓
Trumeter (hour)	\$18.32	✓	✓
Pump	\$905.00	✓	✓
Return line filter	\$70.00	✓	✓
Hydraulic pump	\$79.00	✓	✓
Relief valve	\$145.00	✓	✓
Johnson control	\$181.47	✓	✓
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Pint accumulator	\$250.00	✓	✓
Quart accumulator	\$296.67	✓	✓
control valve	\$164.97	✓	✓
Temperature/level gauge	\$291.74	✓	✓
Thermocouple	\$54.50	✓	✓
Switches and buttons	\$131.00	✓	✓
Relay	\$41.00	✓	✓
Metal	\$108.62	✓	✓
Servo valve	\$1,349.25	✓	✓
<b>Total</b>	<b>\$6,973.63</b>		
<b>Sum Total</b>	<b>22,005.07</b>		

# DESIGN VALIDATION



## Completed testing:

- Comparison between 0.5" & 0.75" seal packing with pressurized tank.  
**0.5" Results:** Lost 5 MPa overnight (acceptable) but lost all pressure when test was restarted. Not enough packing used.  
**0.75" Results:** Lost 1.2 MPa over 9 days. Restarted test with no pressure loss
- Test of Labview data acquisition, seal friction force, & cooling jacket integrity.  
**Results:** Labview acquired data from all sources and saved to file. Seal friction force over time saved and ready for analysis. Cooling jacket integrity verified.

## Future testing:

- Verify integrity of entire system under maximum temperature and pressure.
- Integrate DCPD system for measuring crack length.
- Run full fatigue test on dummy specimen.

# FUTURE WORK AND CHALLENGES



- Complete work on LabView UI
- Continue testing design integration
- Complete validation of completed system
- Run a full test to completion with dummy specimen



# LABVIEW CLOSEUP



Case Structure.vi

File Edit View Project Operate Tools Window Help

▶ ◀ ⏸

Display | General Settings | Pump Settings | Servo Valve/Load Settings | Load Cell Settings | Thermocouple Settings | LVDT Settings | Float Settings

Chamber Temperature: 20.42

Cooling Jacket Temp: 11.6

LVDT Position: -10.615

Load Cell: 803.9

Max Load: 814.537

Mean Load: 803.805

Min Load: 793.01

Oil Temperature: 32

Oil Tank Level (%): 100

Chamber Pressure: 14.77

Display Delay Time (s): 0.2

Data Save Interval (s): 0.2

Stop All

STOP

delimiter (\t) | Filename: C:\Users\MeVandals\Desktop\Data Test\snip.txt

Waveform Chart | Plot 0

Amplitude

Time

Tab Control