

PRODUCT SPECIFICATION

TITLE	DATE	REV
Product Requirements	3 August 2018	3

Project: Autoclave Upgrade for Corrosion Fatigue Testing

Product Requirements

Autoclave Experts

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Document History

Rev Number	Date	Modified By	Reason
0	25May2018	M. Swenson	Initial Release
1	21June2018	J. Tyler	First Revision
2	27June2018	Team	Revision with input from lead instructor
3	3August2018	J. Tyler	Revision at end of Summer semester

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1 Objective

The objective of this document is to document the requirements for the *Autoclave Upgrade for Corrosion Fatigue Testing* project. The objective of this project is to expand the U of I's current fatigue testing capabilities to include an autoclave load frame for use in fatigue testing of materials with a focus in metals to be used in nuclear power plants.

2 Scope

The scope of this document is to define the requirements outlined by the customer and refined by the engineering project team for the *Autoclave Upgrade for Corrosion Fatigue Testing* project. Currently, no system is on hand to accomplish the fatigue testing desired by Dr. Stephens. The scope of this project includes designing/purchasing all of the components for the fatigue testing apparatus, assembling it, and testing it for proper usability as defined in this document.

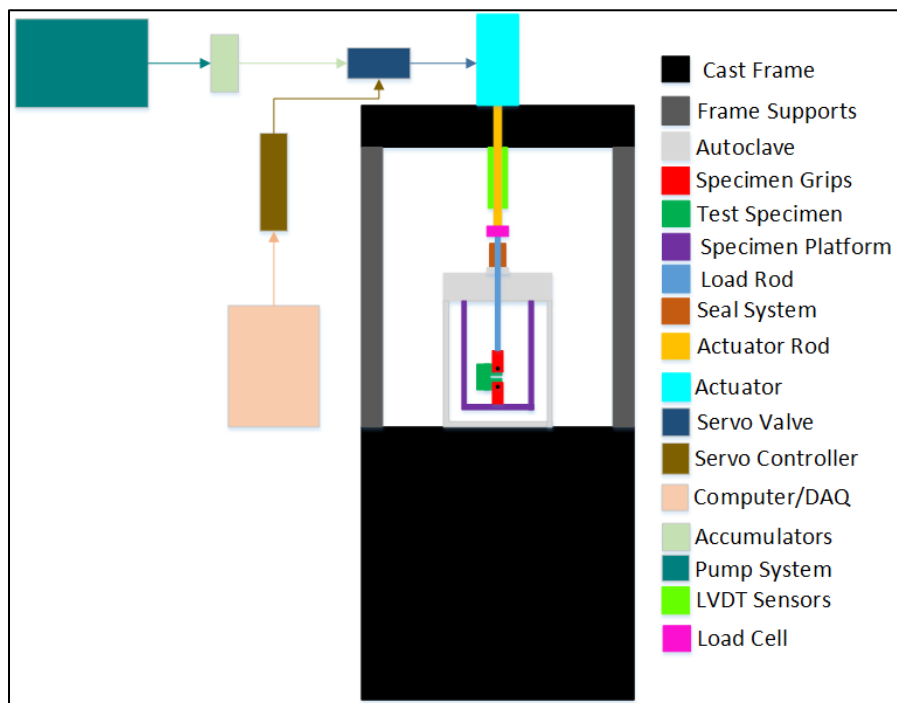


Figure 1 - Early schematic of experimental setup

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3 References

3.1 Cited Documents

This is the place to cite any relevant standards, regulations, etc. relevant to the requirements... **Go ahead and inventory various manuals/product catalogs you've assembled this far here**

3.2 Acronyms

UI	User Interface
LVDT	Linear Variable Differential Transformer
DCPD	Direct Current Potential Drop
EPO	Engineering Purchase Order
ER	Engineering Release
POC	Proof of Concept

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4 Functional Requirements

4.1 User Interface Requirements

- Emulate UI of other load frames currently in use by U of I.



Figure 2 - Example of Cortest autoclave setup for fatigue testing

4.2 What it should do

- Emergency stop function digitally via LabView UI and mechanically via physical “button”.
- Extension rates up to 0.05mm/s during testing.

5 Mechanical Requirements

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5.1 Strength Requirements

- The loading system (motor/drive/gearbox) design shall be able to deliver a maximum load of at least 10,000 pounds.

5.2 Spatial Requirements

- The Enclosure shall fit within the existing autoclave without modification. **Include picture of autoclave**

5.3 Mounting / Interface Requirements

- Design shall be able to accommodate standard sized test specimens. **=> Can you better quantify specimen sizes/geometry, perhaps through pictures of previous specimens?**
- Load cell shall be calibrated in line with seal.
- A lid lifting/holding device shall be integrated into design.

5.4 Durability Requirements

- A DFMEA will be constructed that will cite all conceivable failure modes, estimating their severity and frequency. Where possible, each part will be built for infinite life, validated with industry standard stress life equations.

5.5 Reliability Requirements

- All components shall have 99% reliability. The aforementioned DFMEA will take this into account.

6 Electrical Requirements

6.1 Operational Voltage

- Design shall utilize available on-campus power (120v or 240v).
- **You also might say something about length of cable runs and their location wrt device orientation. A picture of the anticipated location that illustrates electrical fixtures would be a nice addition.**

7 Software Requirements

7.1 Functionality

- Emulate user interface of other load frames currently in use by U of I. **=> Try to inventory these (equipment type and location)**

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- Programmable loading waveforms including: => Try to visualize each with a sketch
 - Variable strain rate
 - Fatigue (cyclic loading, variable frequencies)
 - Creep fatigue (variable hold time and set loading)
 - Constant load
- Crack measurement/monitoring via DCPD

7.2 User Interface => Perhaps envision layout of the LabView screen

- Manual linear frame control for setup via LabView UI.
- Control via load feedback and displacement feedback.
- Emergency stop function digitally via LabView UI
- Over/under warnings for temperature, pressure and load.

8 Environmental Requirements

8.1 Temperature

- All internal autoclave components shall be designed to withstand temperatures of at least 300° C.

8.2 Environmental Sealing

- All internal autoclave components and seals shall be designed to withstand pressures of at least 28Mpa (≈4000 psi)
- Is there an anticipated frequency of Autoclave use at different pressure levels (i.e. what fraction of time will tests be done <500 psi, <1000psi, <2000psi, <3000psi)

8.3 Corrosion Resistance

- All internal autoclave components and seals shall be designed to withstand the same corrosives as the 316H stainless steel that the autoclave is made of.

9 Regulatory Requirements

9.1 ASTM Requirements

- Grip design shall conform to ASTM E 647, specimen and grip geometry requirements.

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Figure 3 - Grip currently in use in the Fatigue & Fracture lab

10 Cost Requirements

10.1 Project Cost

- Cost to build system shall not exceed \$40,000.

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Component	Estimated Cost
Actuator & Ball Screw	\$300-14,000
Motor	\$300-\$4000
INCONEL 718 Rod (For gripper arms)	\$200
318H Steel	\$200
LVDT Sensor	\$600
Load Sensor	\$?
DAQ	\$4000
Computer & Peripherals	\$500
Hardware	\$500
Seal	\$300
Total	\$6900-\$24,300

Table 1 - Initial cost analysis of project

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Purchase Rundown			
Products	Prices	Purchased	Received
Electronics			
Computer	\$699.00	✓	✓
Screen	\$100.00	✓	✓
HDMI cable	\$5.00	✓	✓
input card	\$224.99	✓	
DAQ	\$5,415.88	✓	
DCPD	\$0.00	✓	✓
Load cell	\$829.37	✓	✓
LVDT	\$1,243.00	✓	
Total	\$8,517.24		
Hardware			
All metal stock	\$750.00	✓	
Spring seal			
Stuffing seal	\$48.14		
Hydraulic lines			
Water line hook up	\$130	✓	✓
Bolts	\$5.99	✓	✓
Total	\$934.13		
Hydraulic system			
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	✓	
Relief valve	\$145.00	✓	
Johnson control	\$181.47	✓	✓
Pint accumulator	\$250.00	✓	✓
Quart accumulator	\$296.67	✓	✓
Temperature/level gauge			
Pressure valve			
Servo valve	\$1,349.25	✓	
Total	\$5,921.33		
Sum Total	\$15,372.70		

Table 2 – Actual current running budget

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11 Schedule Requirements

The following are the major Project Milestones:

- Approval of Requirements June. 25, 2018
- Concept Design Review Aug. 2, 2018
- EPO of long lead parts Aug. 2, 2018
- **Client requested system test date** Sept. 17, 2018
- **Detailed Design Review** Sept. 22, 2018
- Complete Prototype build Sept. 30, 2018
(Customer requirement)
- UI Design EXPO Nov. 30, 2018
- **Final Report / Drawings** Dec. 8, 2018