

Senior Capstone Design

Project: Autoclave Upgrade for Corrosion Fatigue Testing

Primary Author: Tyler Jones

Team: Autoclave Experts

Date: 12/7/2018

Design Validation Plan & Results (DVP&R)

	Requirement	Test	Test Subject	Target Date	Result	Recommendation
Actuation System	Extension rate up to 0.05mm/s	Measure extension rate of ram/screw with final system.	Ram (hydraulic) Screw (electric)	Upon completion of sub-system (may not need to be mounted) Approx. 9/15/18	Requirement met upon system testing. Validated: 11/9/18	None, meets requirements.
	Loading system shall be able to deliver a max load of at least 10,000 pounds.	Lock gripper arms together and apply 10,000 pounds + SF for one million cycles at max frequency (approx one day).	Ram (hydraulic) Screw (electric) Inconel rod and specimen platform.	10/1/18	Test not completed as described. Continuous loads of approx. 3000+ lbf have been validated. Tested: 11/26/18	Complete described test after more pertinent testing has been finished.
	Lid lifting/holding device shall be integrated into design.	Lift lid with actuator and swap specimen/grips/other parts to verify safety and room to work.	Autoclave lid, Actuator, Lifting/holding device (currently undetermined)	10/1/18	Lid raised using friction of packing seal, which requires approx. 800 lbf to overcome. Lid assembly only weighs 50 pounds, so this was deemed an acceptable result. Validated: 10/3/18	None, meets requirements.
Internal /Seal	All internal autoclave components and seals shall be designed to withstand 3000 psi.	Raise pressure of autoclave to 3000 psi + SF and hold for 3 days. Check for deformation of parts and leaks. If 3000 psi is impossible with current equipment, test at max pressure.	Autoclave chamber & lid, Specimen platform & gripper arms, Lid seal	8/25/18	Components tested under similar pressure for approx. 3 hours. Tested: 9/13/18	Further testing not needed as all internal components are built of stainless steel or inconel, which are rated far above the pressure needed.
	All internal autoclave components and seals shall be designed to withstand 300°C. (Down from previous requirement of 400°C)	Raise temperature of autoclave to 300°C (Max temp rating of chamber) and hold for 3 days. Check all parts for deformation/damage.	Autoclave chamber & lid, Specimen platform & gripper arms, Lid seal	8/25/18	Unable to test at full temperature due to pressure limitations.	While testing may be prudent, all internal components are built of stainless steel or inconel, which are rated above the temperature needed.
	Design shall be able to accommodate standard sized test specimens.	Standard sized specimens will be mounted to specimen platform and validated for fit.	Specimen platform, Gripper arms	8/1/18	Specimen mounted to platform successfully. Validated: 12/7/18	None, meets requirements.
	Specimen platform shall fit within the existing autoclave without modification	Specimen platform will be attached to autoclave lid and unobstructed fit validated.	Specimen platform, Autoclave chamber & lid	8/1/18	Platform fits without modification. Validated: 9/26/18	None, meets requirements.
	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.	All components will be checked for corrosion resistance based on their material.	Specimen platform & gripper arms, Lid Seal, Rod	7/10/18	All components made from same material as autoclave body (316SS) or Inconel 718 which has a higher resistance to corrosion Validated: 7/10/18	Requirement is met

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Grip design shall conform to ASTM E 647, specimen and grip geometry requirements.	Grip design will be checked for conformance to ASTM E 647 standards	Gripper arms	7/16/18	Design conforms to ASTM standard Validated: 7/16/18	Requirement is met
Emulate UI of other load frames currently in use by U of I.	Similarity to current UI will be validated by Nick Schaber.	Labview UI code	9/1/18	Nick, primary programmer and operator, has been satisfied with the design of our Labview UI. Validated: 12/7/18	None, meets requirements, but future modifications for greater functionality expected.
Emergency stop function digitally via LabView UI and mechanically via physical "button".	Emergency stop will be validated while actuator is running, using both the digital and physical stops.	Labview UI code, Physical stop button	9/1/18	Physical button located on MTS controller functions as desired. Interlock safety stops for overload and position limits are automatically run via the same controller. Tested: 11/16/18	Labview UI currently has no emergency stop capability, and there is no system in place to stop a temperature or low hydraulic fluid emergency. This can be added in the future via a pin on the MTS controller.
Programmable loading waveforms including: o Variable strain rate o Fatigue (cyclic loading, variable frequencies) o Creep fatigue (variable hold time and set loading) o Constant load	Output of Labview UI code will be checked for waveforms considered. Actuator will be run with considered waveforms and validated using LVDT output.	Labview UI code, Actuator	9/1/18	All desired waveforms are programmable with the MTS controller. Validated: 11/16/18	None, meets requirements.
Over/under warnings for temperature, pressure and load.	Over pressure, temperature, and load warnings will be validated using simulated input in Labview.	Labview UI code	9/1/18	Warning sound and light integrated into Labview UI. Validated: 12/5/18	None, meets requirements.
Crack measurement/monitoring via DCPD	Validity of measuring/monitoring system will be checked against physical measurements of cracks.	DCPD, Labview UI code, DAQ	10/7/18		
Manual linear frame control in Labview UI	Manual control will be validated using output from LVDT.	Actuator, Labview UI code	9/1/18	Manual control achieved with the MTS controller as desired. Validated: 11/9/18	None, meets requirements.
Control via load feedback and displacement feedback	Test will be conducted with loads and displacements applied to actuator.	Actuator, Labview UI code	10/1/18	MTS controller handles both load feedback and displacement feedback control as expected. Validated: 11/26/18	None, meets requirements.

Software & Control