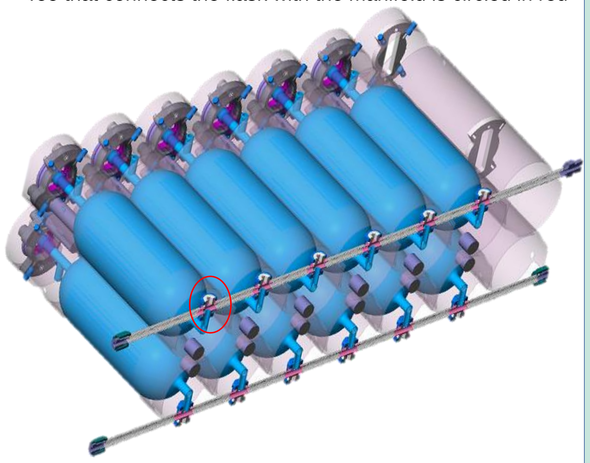
Modification of NOAA Programmable Flask Package manifold to support atmospheric O_2 measurements

Emily Johnson, Britton Stephens, Todd Bernatsky

Background (Legacy Design)

The NOAA Programmable Flask Package (PFP)

- Automated air sampling system with 12 glass flasks
- Used to monitor gas concentrations
- A flexible stainless-steel manifold connects the flasks
- Before filling the flasks, the manifold is first flushed with air to remove any old air that would affect the sample
- Tee that connects the flask with the manifold is circled in red



Airborne O_2 Measurement Challenges

- Airborne O_2 has a high background concentration and therefore requires a fine precision of measurement
- The current PFP manifold tubing has a large surface area due to the convoluted structure
- The flask valves have large dead volumes
- Surface interactions between the PFP's metal and glass components and the air sample
- Test results are influenced by changes in pressure, temperature, and water vapor

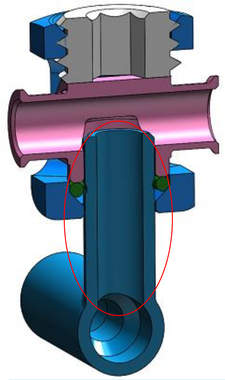
Tee Redesign

Design Goal: Add "dip tube" to flush out old air

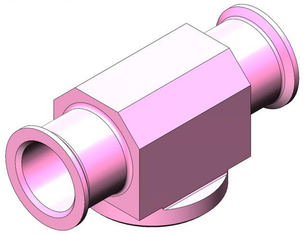
Design Considerations:

- Maintain consistent air flow path cross-sectional area
- Retain the current clamp and seal methods to glass flask
- New tee should have mass of current Tee and a low profile

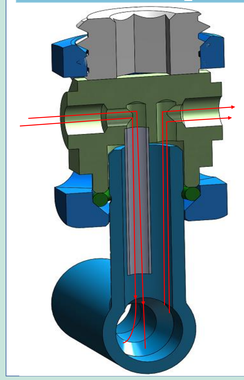
Tee/Valve Legacy Design



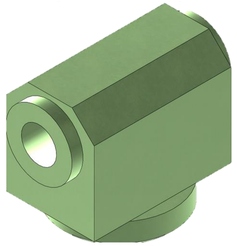
- Air does not fully flush out the glass valve (circled in red)
- White nut compresses the green O-ring into the groove to seal manifold to glass vessel



O_2 Design Modifications



- Dip tube directs the air flow
- Forces air in and out of the valve
- Flushes out remaining air left from previous sample



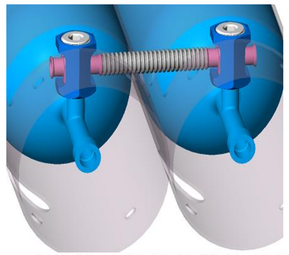
Manifold Tubing Redesign

Design Goal: Replace convoluted tubing with constant ID tubing to further reduce surface area

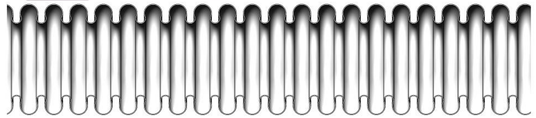
Design Considerations:

- Electropolish surface finish to maximize smoothness
- Minimize pressure drop
- Retain some flexibility of tubing

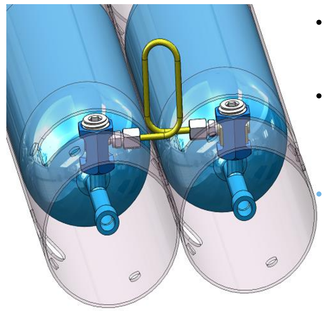
Manifold Tubing Legacy Design



- Convoluted tubing is flexible which allows for irregularities in the glass dimensions and movement
- O_2 adsorption / desorption increases with greater surface area of convoluted tubing



O_2 Design Modifications

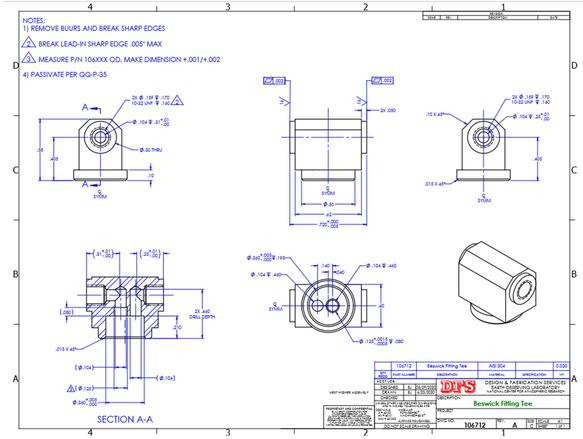


- Smooth wall tubing means less surface area for O_2 interactions
- Custom tube profile allows for some flexibility for irregularities or misalignments
- Finite Element Analysis provided comparative flexibility analysis of tubing geometries

Deliverables

Deliverables

- Tee Part Drawing
- Manifold Tube Part Drawing
- Tee and Tube Assembly Drawing
- Assembly Model of Entire Prototype Version



Next Steps

- Fabrication of tee, dip tube, and manifold tube (Aug 2020)
- Assembly of parts
- Testing of manifold assembly
- Finish developing a welded version of manifold
- Fabricate 6 copies of the welded version

Acknowledgments

- Britton Stephens
- Todd Bernatsky
- Sean Zeeck
- Karl Schwenz
- SUPER Internship Program

Contact Info

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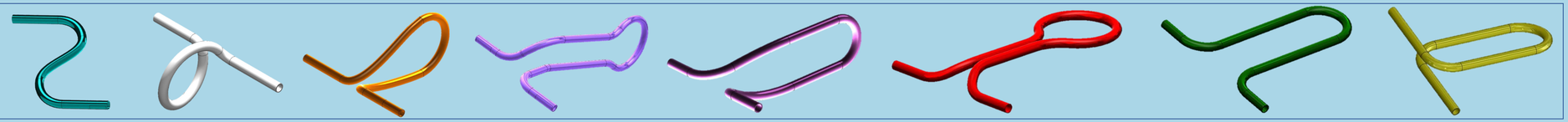
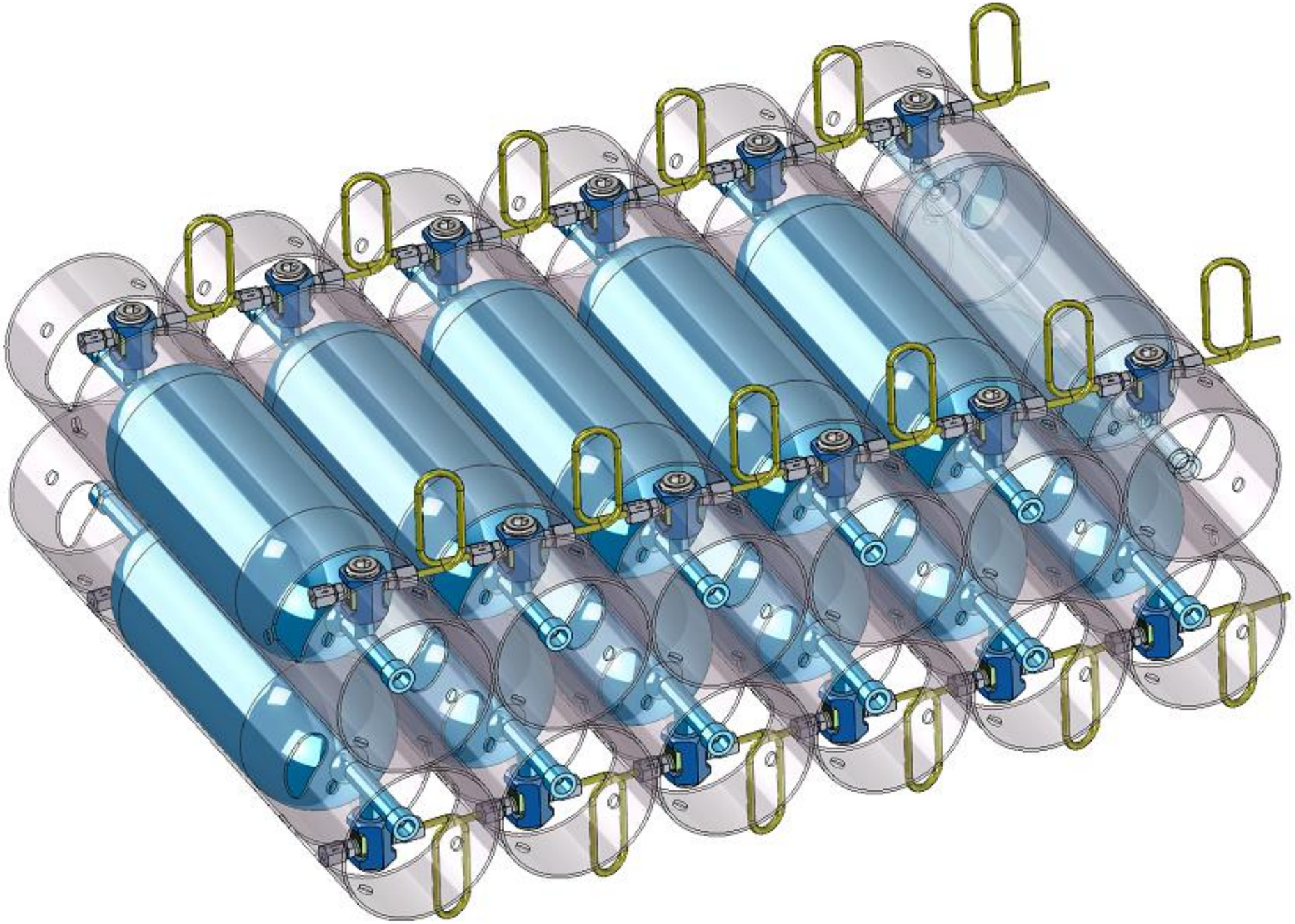
Design iterations of custom tube profiles:

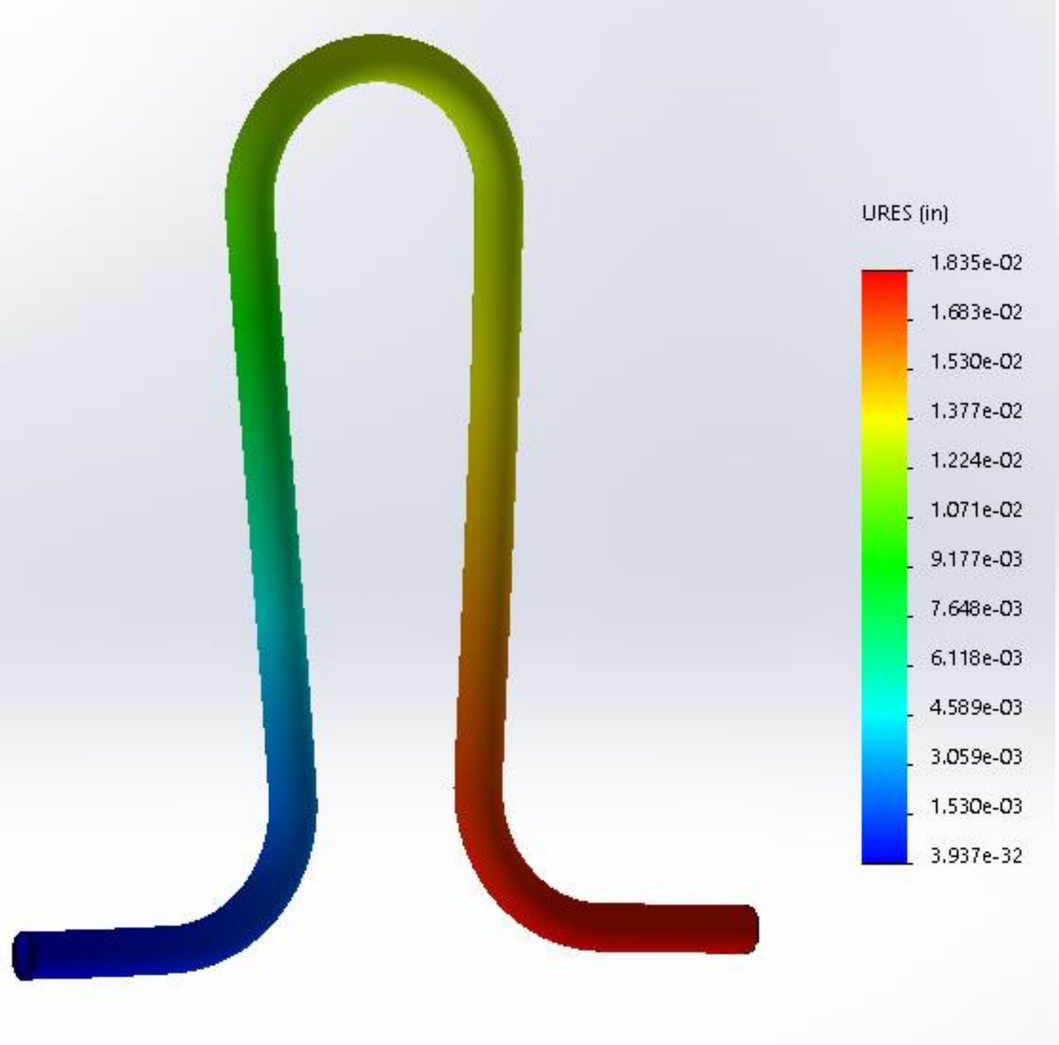


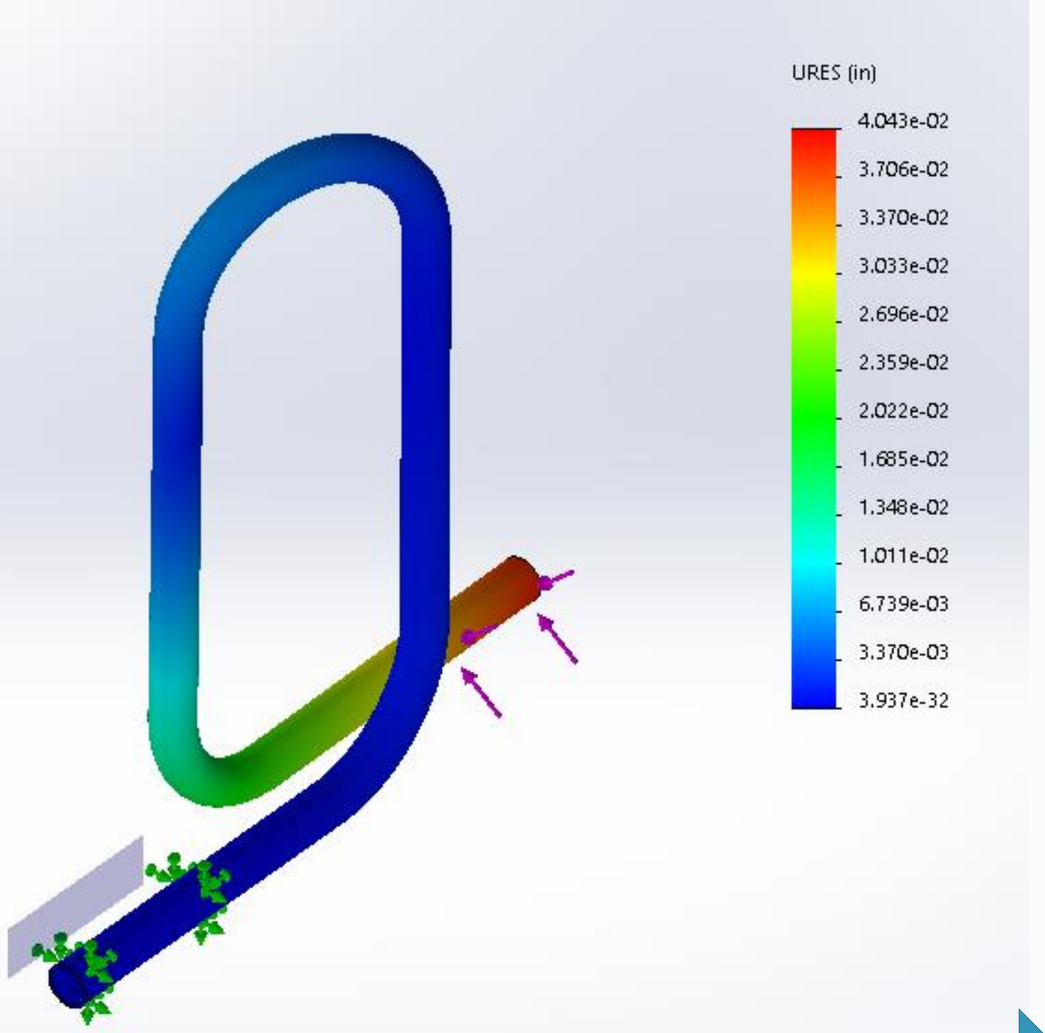


BACK

BACK

Finite Element Analysis to improve intuition about flexibility





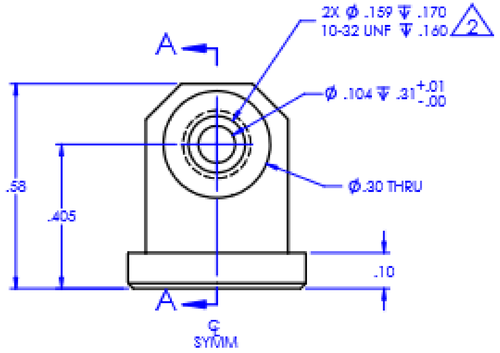
BACK

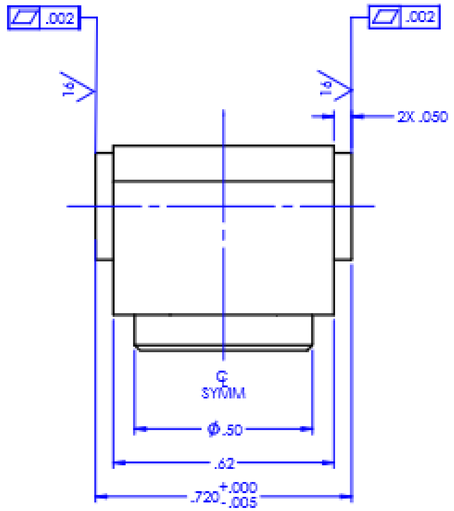
NOTES;
1) REMOVE BUURS AND BREAK SHARP EDGES

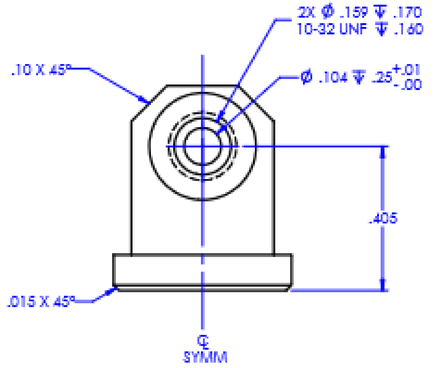
2 BREAK LEAD-IN SHARP EDGE .005" MAX

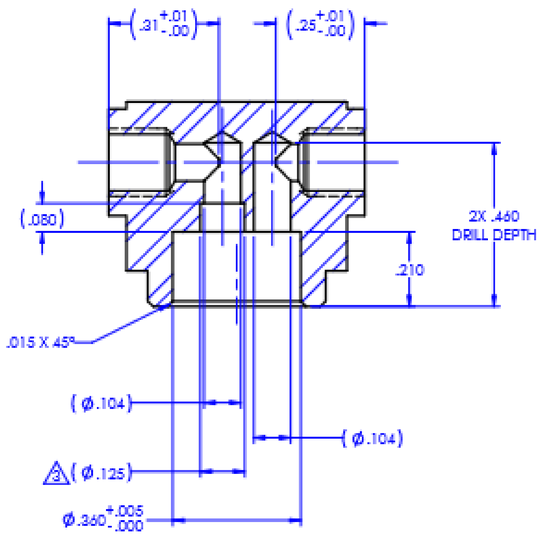
3 MEASURE P/N 106XXX OD, MAKE DIMENSION +.001/+.002

4) PASSIVATE PER QQ-P-35

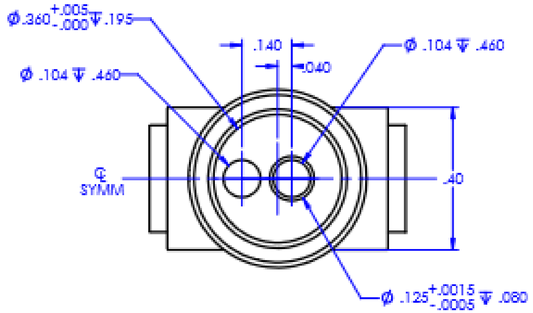


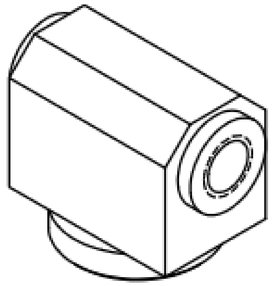






SECTION A-A





QTY REQD	PART NUMBER	DESCRIPTION	MATERIAL	SPECIFICATION	WT
	106712	Beswick Fitting Tee	AISI 304		0.030

ACCT/JOB:

DESIGNED	EJ	05/29/2020
DRAWN	EJ	6/23/2020
CHECKED		

NEXT HIGHER ASSEMBLY

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
DECIMALS: X = ±0.03, .XX = ±0.01, .XXX = ±0.005
ANGULAR: FORMED = ±5°, MACHINED = ±0.5°
SURFACE ROUGHNESS:
DO NOT SCALE DRAWING

DFS
DESIGN & FABRICATION SERVICES
EARTH OBSERVING LABORATORY
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

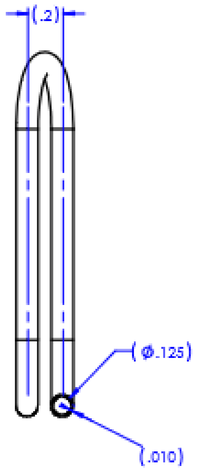
DESCRIPTION: Beswick Fitting Tee

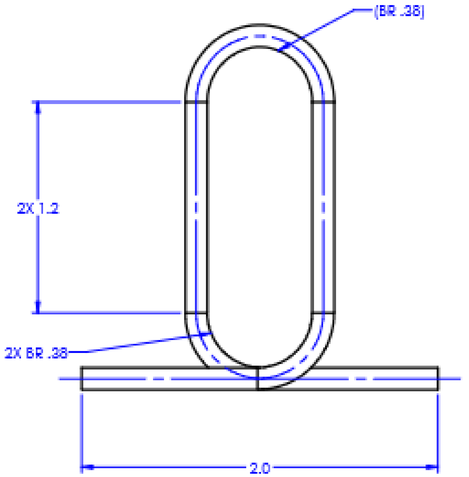
PROJECT

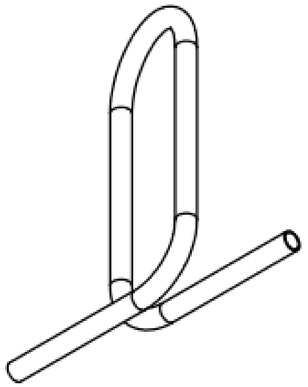
DWG NO.	REV.	SIZE	SCALE	SHEET
106712	A	C	4:1	1 of 1

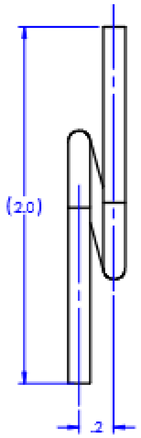
BACK

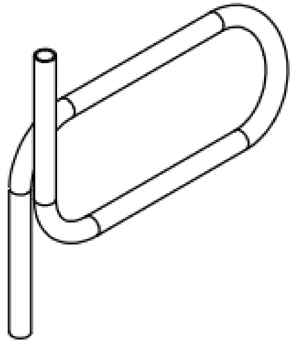
NOTES:
1) MAKE FROM XXXX .125" OD AND .105" ELECTROPOLISHED ID
2) REMOVE BURRS AND BREAK SHARP EDGES











QTY REQD	PART NUMBER	DESCRIPTION	MATERIAL	SPECIFICATION
		Manifold Tube Version 1 Beswick Fitting	AISI 304	

NEXT HIGHER ASSEMBLY

ACCT/JOB:

DESIGNED	EJ	06/09/2020
DRAWN	EJ	7/14/2020
CHECKED		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
DECIMALS: X = ±0.05, XX = ±0.01, XXX = ±0.005
ANGULAR: FORMED=±2°, MACHINED=±0.5°
SURFACE ROUGHNESS √

DO NOT SCALE DRAWING

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NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

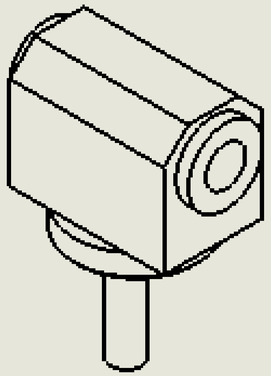
DESCRIPTION: Manifold Tube Version 1 Beswick Fitting

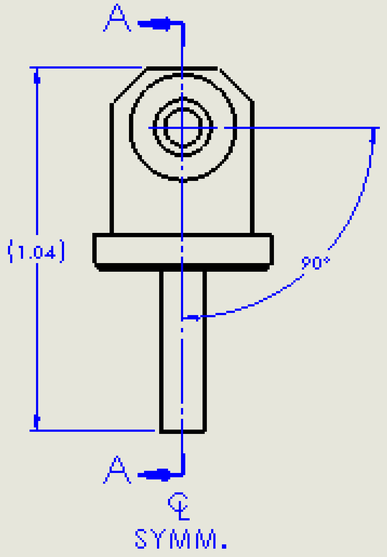
PROJECT

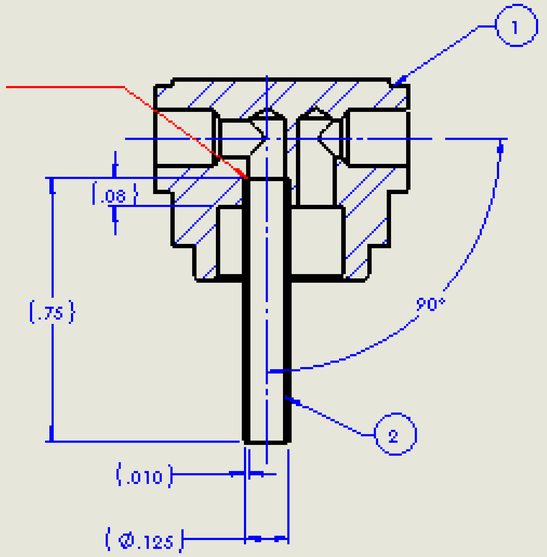
DWG NO.	REV.	SIZE	SCALE	SHEET
106715	A	C	2:1	1 of 1

BACK

NOTES:
1) SEAT MATING SURFACES OF TEE AND TUBE BEFORE WELDING
2) MAINTAIN ALIGNMENT OF TUBE IN TEE







SECTION A-A

	2	106710	Dip Tube	AISI304	
	1	106712	Beswick Fitting Tee	AISI304	
QTY PER	ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	SPECIFICATION

ACCT/JOB:		
DESIGNED	EJ	07/16/2020
DRAWN	EJ	7/16/2020
CHECKED		

DESIGN & FABRICATION SERVICES
EARTH OBSERVING LABORATORY
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

DESCRIPTION: **Tee with dip tube assembly**

PROJECT

DWG NO. **106759** | REV. **A** | SIZE B | SCALE 3:1 | SHEET 1 OF 1

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
DECIMALS: .X ± 0.05, .XX ± 0.01, .XXX ± 0.005
ANGULAR: MACH BEND ± 2°, MACH BEND ± 0.5°
SURFACE ROUGHNESS: √

DO NOT SCALE DRAWING

BACK