LAWRENCE
LIVERMORE
NATIONAL
LABORATORY

LLNL-TR-578073

NASA COR

P. Sandoval

August 30, 2012

Disclaimer

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

Preface

This report fulfills the NASA statement of work, (request number NNL10AA061) as amended by Lorie R. Grimes-Ledesma via a post-visit e-mail dated July 13, 2012. The statement of work and subsequent e-mail are included in this report, which includes:

- Parts list spreadsheet for load frames by account code.
- Available information regarding procurement of elevated temperature ovens.
- Grip and strand information.
- Copy of the presentation made at Cobham, (December 2010).
- Review comments to strand and grip installation procedure as provided by NASA.

The shipping plan and shipment determinations were developed and shared with Lorie R. Grimes-Ledesma shortly after receiving her e-mail, July 13, 2012.

National Aeronautics and Space Administration

NASA-Interagency Purchase Request

1. DATE	2. REQUEST NUMBER	3. AMENDMENT NUMBER
05/16/2012	NNL10AA06I	000003

NOTE. – See attached pages for delivery schedules, preservation and packing, shipping, disposition of property, and special instructions.

4. TO:	5. FROM *(Agency, name, telephone number of originator)*
LAWRENCE LIVERMORE NATIONAL LAB 7000 EAST AVENUE LIVERMORE CA 94550-9698	Langley Research Center NASA/Langley Research Center Hampton VA 23681-2199

6 ITEM DESCRIPTION

ITEM NUM a.	DESCRIPTION OF SUPPLIES OR SERVICES (Federal Stock Number, Nomenclature, Specification and/or Drawing No., etc.) b.	QUANTITY c.	UNIT d.	ESTIMATED UNIT PRICE e.	ESTIMATED TOTAL PRICE f.
	In accordance with the National Aeronautics and Space Act (51 USC 20113(e)) and NASA FAR Supplement 1817.7001 the purpose of this modification between the Department of Energy/Lawrence Livermore National Laboratory (LLNL) and the National Aeronautics Space Administration to add Modification Number 3 for funding in the amount of $30,016.00 to accommodate the shipping charges associated with the attached statement of work from LLNL to NASA Johnson Space Center (JSC) White Sands Test Facility (WSTF). The new total dollar amount is hereby increased by from $1,165,000 by $30,016.00 for a new total order value of $1,195,016.00. The period of performance for the shipment of the items is hereby changed to June 30, 2012. Appropriation Data: Agency Locator Code: 80000501 DUNS: 027613459 CAGE Code: 3K1D2 Appropriation Code: 8012/130126 Continued ...				

7 GRAND TOTAL ▶ $1,195,016.00

8 THIS REQUEST ☒ IS SUBJECT TO SECTION 305 OF THE NATIONAL AERONAUTICS AND SPACE ACT OF 1958, OR ☐ IS SUBJECT TO THE INSPECTOR GENERAL ACT OF 1978 (5 U.S.C. APPENDIX SECTION 6(a)(9)). *(Authorizing Officer, see special instructions on reverse side.)*

9. MAIL BILLINGS TO:
NASA/Shared Services Center
Financial Management Division (FMD)
Accounts Payable
Bldg 1111, C Road
NSSC-AccountsPayable@nasa.gov
Stennis Space Center MS 39529-6000

10. NASA APPROPRIATION SYMBOL
see block 6b

11. AUTHORIZING OFFICER *(Typed name and title)*	12. SIGNATURE
Teresa M Hass	

NASA FORM 523 NOV 05 PREVIOUS EDITIONS ARE OBSOLETE

CONTINUATION SHEET	REFERENCE NO. OF DOCUMENT BEING CONTINUED	PAGE	OF
	NNL10AA06I/000003	2	2

NAME OF OFFEROR OR CONTRACTOR
LAWRENCE LIVERMORE NATIONAL LAB

ITEM NO. (A)	SUPPLIES/SERVICES (B)	QUANTITY (C)	UNIT (D)	UNIT PRICE (E)	AMOUNT (F)
	PR 4200430224; G/L 6100.2530; 969021.03.07.02.01.02; I/O FC000000; Cost Center 23C101; Fund CASX12012D; $30,016.00; In accordance with NASA FAR Supplement 1817.7005-2(c), the servicing agency shall forward written acceptance of this interagency agreement to the requesting agency within 30 days after receipt thereof. INCO TERMS 1: FOB INCO TERMS 2: Destination				
003	Modification for Packaging and Shipping, NNL10AA06I FOB: Destination Ship to: NASA-JSC White Sands Test Facility ATTN: Darren Cone Building 120 12600 NASA Road Las Cruces, NM 88012 Send IPAC Invoices to: NASA/Shared Services Center Financial Management Division Accounts Payable Bldg. 1111; C Road Stennis Space Center, MS 39529-6000 NSSC-AccountsPayable@nasa.gov Phone: 877-677-2123 FAX: 866-209-5415 Technical POC: Linda Anderson 757-864-3745 Linda.W.Anderson@nasa.gov Procurement POC: Marie Hamann 757-864-2258 Marie.W.Hamann@nasa.gov				30,016.00

Statement of Work
LLNL Transfer of Prior Work (MIPR NNL10AA06I) and Shipment to WSTF

Background

NASA LaRC, NASA Engineering and Safety Center (NESC), and the Lawrence Livermore National Laboratory (LLNL) established a MIPR agreement (NNL10AA06I) in December 2009 to develop a fiber static load test apparatus for the generation of load versus time test data to support the determination of Stress Rupture Life Prediction Model(s) for Composite-Overwrap Pressure Vessels (COPVs) for an NESC Assessment. This work was initially to take place in 3 phases.

Two phases of work took place from December 2009-March 2011. During Phase I, LLNL provided test specimen fabrication protocol and initial design for the test apparatus. During Phase II, LLNL (1) provided fiber static load test apparatus design (drawings, engineering, structural analyses, bill of materials) capable of meeting requirements as specified in the original statement of work, (2) provided two functional prototypes of NASA approved static load test apparatus design, and (3) provided test specimen and grip design verification test data.

As specified in the original MIPR agreement, NASA would decide whether or not to award the remaining Phase 3 work based on funds availability. Funds were not available to continue work with LLNL. Due to the budgetary constraints, NASA NESC decided not to proceed with an award of the Phase III work with LLNL. Among other changes to the test program, it was decided that this work should be performed at the White Sands Technical Facility (WSTF) and Marshall Space Flight Center (MSFC) to save cost. The WSTF work will build to print designs from LLNL, conduct strand tests and perform the remainder of this work within NASA. WSTF will need to reassemble the test stands upon shipment arrival. The work at MSFC involves strand and grip fabrication based on the LLNL design.

LLNL Responsibilities

The NESC needs to transfer work performed by LLNL under Phases I and II to NASA WSTF to build the design, conduct strand tests, and perform the work remaining. Drawings, design details, and any remaining hardware related to strand manufacture and test is needed. To conduct the transfer, LLNL needs to complete the following:

1. Document the Load Test Stands (2) assembly, photograph, and label parts so that the test stands may be reassembled at WSTF.
2. Write a Packaging/Shipping Plan to include (a) any required special shipping materials or shipment container, (b) shipping methods and packaging, (c) insurance requirements, (d) liability considerations, (e) how the stands will be disassembled, (f) instructions to WSTF for reassembling the stands, (g) how the

stands will be mounted in the shipping container, and (h) other pertinent information. This Plan will be written to ensure that the shipment arrives safely to NASA. Review this plan with NASA Technical Leads in a Pre-shipment review and obtain NASA approval for this plan. The review and approval will occur by Jun 1, 2012 and shall be via a one hour phone conference.

3. Provide Phase II deliverables (Phase II: 1.2 Provide fiber static load test apparatus design (drawings, engineering structural analyses, bill of materials)) and other information generated and presented to NASA between the Phase I design review and the suspension of the project in March 2011. Transfer the CAD models to PDF drawings on CD.
4. Check authorizations for LLNL lab space (Integrated Work Sheet (IWS) for B132/R1880) and update as necessary for preparation for shipment (additional personnel, operations, etc.)
5. Disassemble the 2 Test Load Frames, substructure, and place in shipping containers in accordance with the Packaging/Shipment Plan. Provide any remaining strands, grips, alignment fixtures, or other hardware that may be remaining at LLNL that was used during phases I or II. LLNL shall also ship these items according to Packaging/Shipping Plan in paragraph (2) above.
6. Transport container to shipping and receiving. Shipping container should be designed and built or modified if required.
7. Replace 4 secure floor panels in order to restore the LLNL lab space to original condition. The LLNL test rigs were mounted below the false floor; therefore, the floor at LLNL will need to be repaired.
8. Remove hand tools and associated benches from LLNL lab space facility to restore the LLNL lab space to original condition. Tools and benches will need to be restored to original locations.
9. Prepare shipping documents (a) from the lab to LLNL shipping facility and (b) for final shipment from LLNL shipping facility to WSTF and process shipping charges for payment. This will involve discussions between shipping and Lab personnel, and will involve use of equipment to transfer items to shipping.
10. LLNL will manage the above work tasks, refine cost estimate as needed for shipping the two test rigs, test rig structure and other applicable hardware associated with the rigs from LLNL to NASA – Johnson Space Center (JSC) White Sands Test Facility (WSTF). Address of shipment at WSTF is:

NASA-JSC White Sands Test Facility
ATTN: Darren Cone
Building 120
12600 NASA Road
Las Cruces, NM 88012

Point of contact information at WSTF is:

Darren Cone
Metallurgy and Materials Engineering
Propellants and Hazardous Aerospace Fluids Nondestructive Examination (NDE)
NASA White Sands Test Facility Materials & Components Laboratories Office RF PO Box 20 Las Cruces. NM 88004-0020
(575) 524-5493 office
(575) 524-5260 fax
(915) 276-2779 cell

The period of performance is from date of award through June 30, 2012.

Subject: Actions from Thursday's meeting
Date: Friday, July 13, 2012 6:03:07 AM PT
From: Grimes-Ledesma, Lorie R (353D)
To: Sandoval, Paul, Gallegos, Gil
CC: Reeder, James R. (LARC-D309), Anderson, Linda W. (LARC-C101)

Paul, Gil,
Thanks a lot for hosting yesterday's meeting at LLNL. It was very productive- we were able to gain a lot of information about the load frames and strand/grip manufacture. Below are the actions I had in my notes at the end of the meeting (please let me know if I missed any).

LLNL:
-Cross check parts list spreadsheet for load frames by account code to ensure that drawing revisions are up to date
-Provide shipping plan in word via email for review
-Include residual hardware (in the cabinet) in the shipment to WSTF
-Provide any available information regarding procurement of elevated temperature ovens
-Determine if all residual strand and grip hardware can be shipped to another NASA center (MSFC) directly
-Determine if residual grip epoxy can be shipped to MSFC
-Provide grip and strand information/hardware per James' list (James will email separately)
-Provide a copy of the presentation made at Cobham (Dec. 2010)
-Review and provide comments to strand and grip installation procedure as provided by NASA

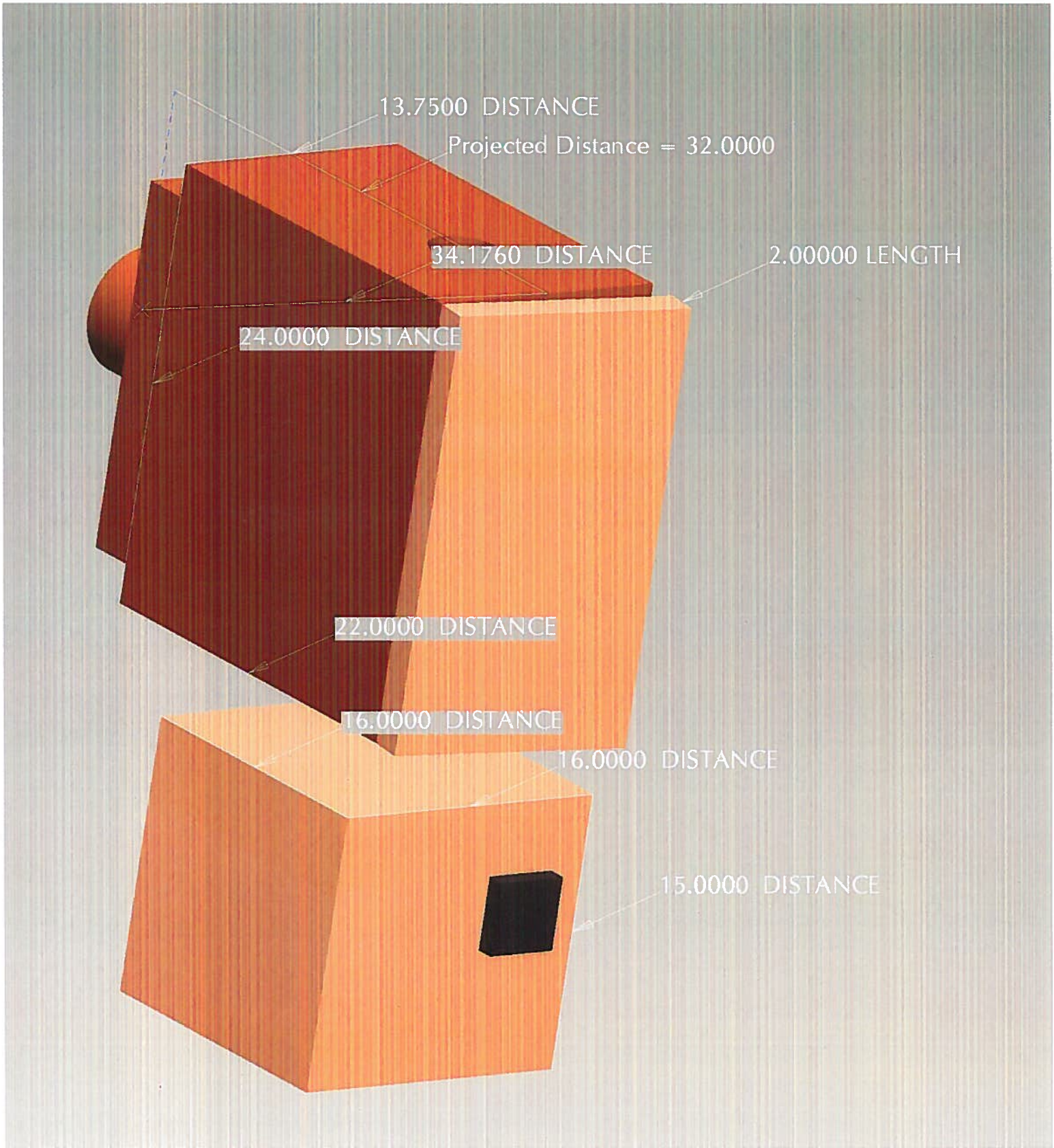
NASA:
-Provide writeup of strand manufacture and grip installation procedure
-Extend the contract from June 30 to Aug. 30
-Consider providing travel for LLNL personnel to WSTF to support assembly of test rigs after shipment

Thanks,
Lorie

Project/Task	Card ID	TRR	Order#	Type	Supplier	Requester	GL Date	JE Amt
34088/810122	6260	BURKE, STEPHEN	U1506292	DA	Motion Industries, Inc.	FINLEY, JAMES D	11/12/10	47.2
34088/810122	6260	BURKE, STEPHEN	U1501855	DA	Lukas Machine, Inc.	FINLEY, JAMES D	11/24/10	1931.14
34088/810122	6260	BURKE, STEPHEN	U1500632	DA	Carpenter Rigging and Supply dba Carpenter Crane Hoist	FINLEY, JAMES D	11/12/10	526.65
34088/810122	6260	BURKE, STEPHEN	U1500541	DA	Small Parts, Inc.	FINLEY, JAMES D	10/22/10	26.39
34088/810122	6260	BURKE, STEPHEN	U1500370	DA	Perine Danforth Company LLC	FINLEY, JAMES D	10/22/10	161.5
34088/810122	6260	BURKE, STEPHEN	U1500370	DA	Perine Danforth Company LLC	FINLEY, JAMES D	11/5/10	101
34088/810122	6260	BURKE, STEPHEN	U1500257	DA	Lista International Corp.	FINLEY, JAMES D	12/3/10	6600.33
34088/810122	6260	BURKE, STEPHEN	U1496463	DA	Lukas Machine, Inc.	FINLEY, JAMES D	11/24/10	6895.93
34088/810122	6260	BURKE, STEPHEN	U1506597	DA	Interface, Inc.	FINLEY, JAMES D	11/24/10	860
34088/810122	6260	BURKE, STEPHEN	U1504110	DA	Mccombs-Wall Inc. Engineering	FINLEY, JAMES D	12/22/10	1209.68
34088/810122	6260	BURKE, STEPHEN	U1493580	DA	Western Tool & Supply Co.	FINLEY, JAMES D	9/10/10	2686.45
34088/810122	6260	BURKE, STEPHEN	U1493580	DA	Western Tool & Supply Co.	FINLEY, JAMES D	9/17/10	533.65
34088/810122	6260	BURKE, STEPHEN	U1506793	DA	Eraser Company	GARCIA, RICHARD N	11/24/10	1764
34088/810122	6260	BURKE, STEPHEN	U1502005	DA	Perine Danforth Company LLC	FINLEY, JAMES D	11/5/10	81.96
34088/810122	6260	BURKE, STEPHEN	U1502005	DA	Perine Danforth Company LLC	FINLEY, JAMES D	11/12/10	119.6
34088/810122	6260	BURKE, STEPHEN	U1509634	DA	McMaster Carr Supply Company	BERNAL, GUSTAVO	11/24/10	46.33
34088/810122	6260	BURKE, STEPHEN	U1509756	DA	G.A. Wirth Company, Inc.	BERNAL, GUSTAVO	12/10/10	24
34088/810122	6260	BURKE, STEPHEN	U1491855	DA	McMaster Carr Supply Company	FINLEY, JAMES D	8/27/10	204.6
34088/810122	6260	BURKE, STEPHEN	U1491837	DA	Small Parts, Inc.	FINLEY, JAMES D	8/27/10	97.7
34088/810122	6260	BURKE, STEPHEN	U1498100	DA	Lukas Machine, Inc.	FINLEY, JAMES D	11/24/10	10589.7
34088/810122	6260	BURKE, STEPHEN	U1512316	DA	McMaster Carr Supply Company	FINLEY, JAMES D	12/10/10	151.76
34088/810122	6260	BURKE, STEPHEN	U1511945	DA	G.A. Wirth Company, Inc.	FINLEY, JAMES D	12/22/10	146.7
34088/810122	6260	BURKE, STEPHEN	U1511936	DA	Interface, Inc.	FINLEY, JAMES D	12/22/10	410
34088/810122	6260	BURKE, STEPHEN	U1511919	DA	McMaster Carr Supply Company	FINLEY, JAMES D	12/10/10	28.68
34088/810122	6260	BURKE, STEPHEN	U1510833	DA	Hilti, Inc.	FINLEY, JAMES D	12/17/10	100.12
34088/810122	6260	BURKE, STEPHEN	U1508723	DA	McMaster Carr Supply Company	GARCIA, RICHARD N	11/24/10	7.13
34088/810122	6260	BURKE, STEPHEN	U1508649	DA	Lukas Machine, Inc.	FINLEY, JAMES D	1/7/11	2503.75
34088/810122	6260	BURKE, STEPHEN	U1509990	DA	Interface, Inc.	FINLEY, JAMES D	1/7/11	2630
34088/810122	6260	BURKE, STEPHEN	U1501083	DA	Lukas Machine, Inc.	FINLEY, JAMES D	12/10/10	4905.3
34088/810122	6260	BURKE, STEPHEN	U1499362	DA	G.A. Wirth Company, Inc.	FINLEY, JAMES D	10/22/10	652.8
34088/810122	6260	BURKE, STEPHEN	U1499118	DA	McMaster Carr Supply Company	FINLEY, JAMES D	10/22/10	217.47
34088/810122	6260	BURKE, STEPHEN	U1496409	DA	Dynamic Enterprises, Inc.	FINLEY, JAMES D	10/22/10	4005
34088/810122	6260	BURKE, STEPHEN	U1514929	DA	Century Spring Corp.	GRUNDLER, WALTER	1/7/11	166.35
34088/810122	6260	BURKE, STEPHEN	U1505871	DA	McMaster Carr Supply Company	FINLEY, JAMES D	11/5/10	104.21

CF_LLNL_MANAGER_NAME

Lawrence Livermore National Security, LLC


13.7500 DISTANCE
Projected Distance = 32.0000
34.1760 DISTANCE
2.00000 LENGTH
24.0000 DISTANCE
22.0000 DISTANCE
16.0000 DISTANCE
16.0000 DISTANCE
15.0000 DISTANCE

Paul,

I also included what I had for the oven. It isn't much. I had also contacted some Instron folks but must have deleted the emails but here is the contact:

Stephanie Mattson Senior Account Representative Covering Northern California, Northern Nevada & Utah Instron Direct: 781-575-5629 Fax: 781-575-5725 Email: stephanie_mattson@instron.com Web: http://www.instron.com

-Steve

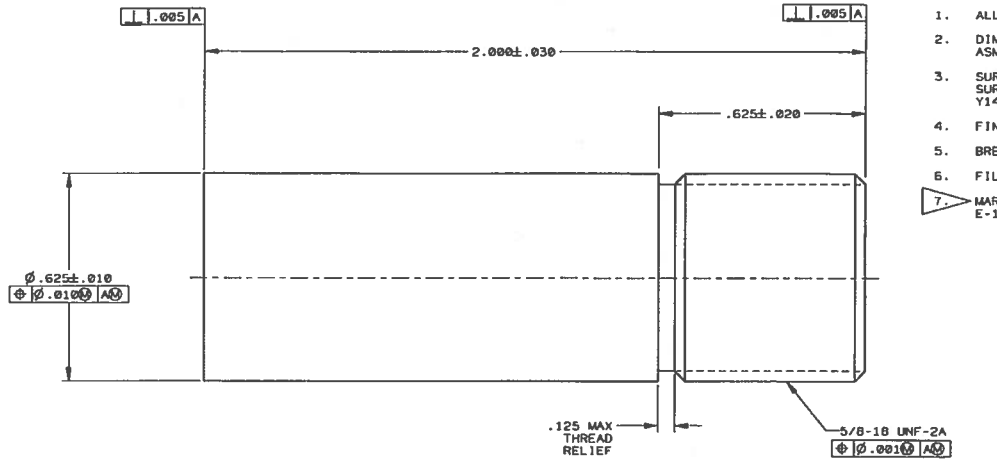
UNCLASSIFIED

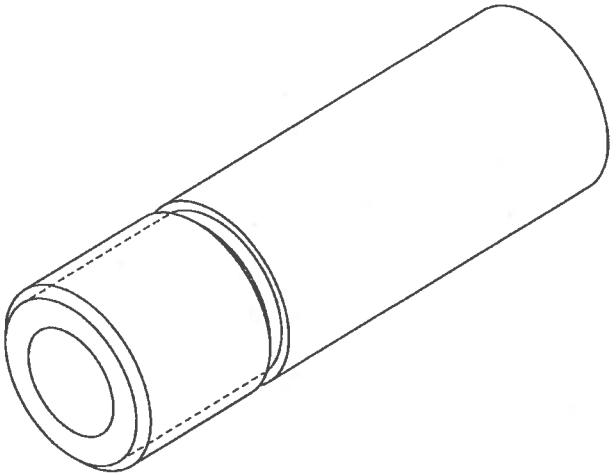
PART NUMBER	REVISIONS			
	ISS	SHEET ZONE	DESCRIPTION	DATE
-	AA		ORIGINAL ISSUE	05-Nov-10

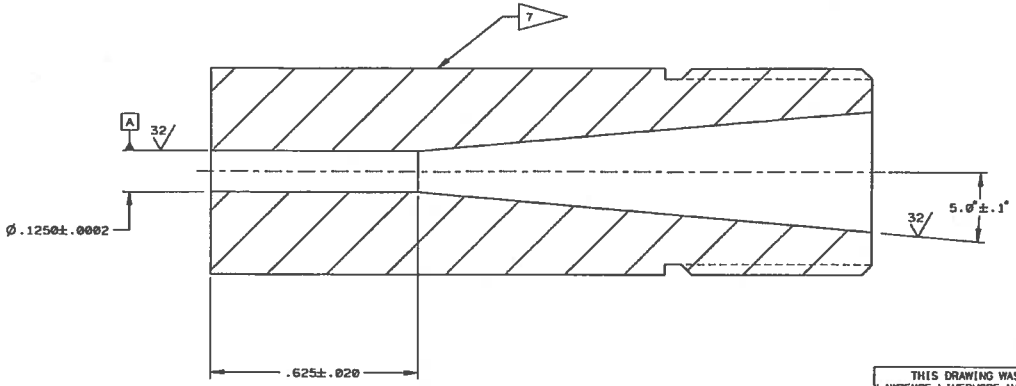
NOTES

UNLESS OTHERWISE SPECIFIED:

1. ALL DIMENSIONS ARE IN INCHES.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.
3. SURFACE TEXTURE PER ASME B46.1-2002. SURFACE TEXTURE SYMBOLS PER ASME Y14.36-1996.
4. FINISH: 125 MICROINCHES ALL OVER.
5. BREAK EDGES .030 MAX RADIUS OR CHAMFER.
6. FILLET R.020 MAX.
7. MARK PART NUMBER PER 9919100, CLASS E-1-B IN APPROXIMATE LOCATION SHOWN.







AR	-	-	AL 6061-T6	0.098	0.05	
NA	9919100	MARKING, GENERAL METHODS				
NA	9900000	GENERAL REQUIREMENTS				
NO REDD	PART/CONTROL NO	DESCRIPTION/MATERIAL		DENSITY (LB/IN³)	WEIGHT (LBS)	ITEM

QUANTITY ABBREVIATIONS: NA = NO QUANTITY FOR DOCUMENTS; ALT = ALTERNATE; PM = PROCESS MATERIAL; EM = EXPENSE MATERIAL; AR = AS REQUIRED; ARS = AS REQUIRED FOR ASSEMBLY

DRAWING: 10-501987-UNC
MODEL: 10-501987-UNC
TYPE: PART

LAWRENCE LIVERMORE NATIONAL LABORATORY
P.O. Box 808 Livermore, CA 94551

THIRD ANGLE PROJECTION

TITLE: NASA LOAD FRAME TEST GRIP (U)

PART CLASSIFICATION: UNCLASSIFIED

DRAWING CLASSIFICATION: UNCLASSIFIED

ENGLISH

SIZE	DRAWING NUMBER	ISSUE
D	AAA10-501987	AA

CAGEC 14067 | SCALE 6/1 | SHEET 1 OF 1

ORIGIN: LL-PRO/E-WF4 | STATUS: LL-REL-05-Nov-10

THIS DRAWING WAS CREATED BY THE LAWRENCE LIVERMORE NATIONAL SECURITY, LLC (LLNS) WHICH OPERATES LAWRENCE LIVERMORE NATIONAL LABORATORY (LLNL) FOR THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT NO. DE-AC52-07NA27344. ANY REPRODUCTION, DISSEMINATION AND/OR FABRICATION IS PROHIBITED WITHOUT THE PERMISSION OF COGNIZANT LLNS PERSONNEL.

CURRENT ISSUE APPROVALS

DRAWN:	KROHN1
CHECKED:	KROHN1
DESIGNED:	LeBLANC2
APPROVED:	FINLEY2

TEMPLATE	VERSION	RELEASE
MODEL:	AA.1	REL
DRAWING:	AA.2	REL

ERC:1050:1987AAS:1 2010:071305

UNCLASSIFIED

Hey Paul,
Attached is the test matrix I started. Below you will find a list of the info / hardware I've provided. We are going to work on the release of the presentation and grip drawing. Let me know if there is anything else you need or if you have any questions.
Please let me know if you can use some help with any of the other NASA wrap up work. Thanks, Vic

Specs / Info:

- Oven Cure Cycle [Strand] - 250˚F, 3 Hours
- Oven Cure Cycle [Grip Epoxy] - 250˚F, 1 Hour, let cure overnight
- Steel Wool spec – Sample along with vendor info in the box
- Epoxy [for grips] – Loctite 9462 Hysol
- Mold Release [for grips] – Miller-Stephenson Chem Co., MS-143H PTFE Release Agent Dry Lubricant

Testing Hardware provided:

- Silicon Pieces for grips
- End Caps for grips
- All remaining grips
- Tube stripping tool w/blades
- 2 grip holder racks
- Sample of steel wool
- Binder with Strand measurements, Cross section images, temperature plots

NASA Strand Test Matrix

	Sample		Measurements (in)					Grip #		Gauge	Test Results	
Date Pulled	Batch	Strand	Left/Bottom	Center	Right/Top	Quality/Condition	Date Tested	Top	Bottom	Length (in)	lbf	Xhead (mil)
12/13/10	28	1	0.0346	0.0342	0.0341	Good	1/7/11	015	012	6.2	342	260
12/13/10	28	2	0.0337	0.0332	0.0338	Questionable						
12/13/10	28	3	0.0350	0.0340	0.0335	OK						
12/13/10	28	4	0.0348	0.0343	0.0334	Good	1/7/11	007	007	6.4	351	241
12/13/10	28	5	0.0335	0.0337	0.0343	OK						
12/13/10	28	6	0.0335	0.0289	0.0337	Questionable						
12/13/10	28	7	0.0369	0.0373	0.0338	Questionable						
12/13/10	28	8	0.0332	0.0339	0.0342	OK						
12/13/10	28	9	0.0349	0.0341	0.0342	Good	1/7/11	016	020	6.2	407	270
12/13/10	28	10	0.0388	0.0384	0.0376	OK						
12/13/10	29	1	0.0388	0.0383	0.0367	Good	1/7/11	011	010	6.2	353	278
12/13/10	29	2	0.0358	0.0371	0.0364	Good	1/7/11	014	013	6.4	254	264
12/13/10	29	3	0.0363	0.0356	0.0354	Good	1/7/11	003	006	6.3	381	252
12/13/10	29	4	0.0335	0.0332	0.0332	Good	1/7/11	002	018	6.1	389	293
12/13/10	29	5	0.0344	0.0343	0.0339	Good	1/7/11	001	008	6.4	280	260
12/13/10	29	6	0.0344	0.0339	0.0337	OK						
12/13/10	29	7	0.0347	0.0335	0.0340	OK						
12/13/10	29	8	0.0349	0.0342	0.0341	OK						
12/13/10	29	9	0.0339	0.0332	0.0336	Good	1/7/11	019	004	6.5	268	212
12/13/10	29	10	0.0345	0.0344	0.0338	Good	1/7/11	017	009	6.1	410	273
12/14/10	30	1	0.0424	0.0425	0.0427	OK						
12/14/10	30	2	0.0354	0.0355	0.0354	Good	1/12/11	001	018	5.9	393	262
12/14/10	30	3	0.3685	0.0372	0.0362	Good	1/12/11	033	020	5.8	369	242
12/14/10	30	4	0.0368	0.0359	0.0353	Good	1/12/11	037	021	6.1	404	278
12/14/10	30	5	0.0338	0.0352	0.0338	Good	1/12/11	008	016	5.6	412	259
12/14/10	30	6	0.0389	0.0381	0.0361	Good	1/12/11	017	010	5.9	293	212
12/14/10	30	7	0.0360	0.0364	0.0335	OK						
12/14/10	30	8	0.0383	0.0375	0.0365	Good	1/12/11	035	004	5.9	386	250
12/14/10	30	9	0.0349	0.0341	0.0344	Good	1/12/11	023	036	5.7	414	267
12/14/10	30	10	0.0347	0.0345	0.0347	Good	1/12/11	038	040	5.9	412	268

12/14/10	30	11	0.0332	0.0338	0.0326	Questionable						
12/14/10	30	12	0.0336	0.0356	0.0351	Questionable						
12/14/10	30	13	0.0365	0.0336	0.0332	Questionable						
12/14/10	30	14	0.0361	0.0364	0.0350	Questionable						
12/14/10	30	15	0.0345	0.0348	0.0340	OK						
12/14/10	30	16	0.0342	0.0343	0.0337	Questionable						
12/14/10	30	17	0.0333	0.0349	0.0339	OK						
12/14/10	30	18	0.0333	0.0349	0.0339	Good	1/12/11	039	009	5.6	393	246
12/14/10	30	19	0.0366	0.0359	0.0343	Good	1/12/11	011	024	5.8	397	257
12/14/10	30	20	0.0337	0.0340	0.0354	Questionable						
1/3/11	31	1	0.0340	0.0346	0.0339	Good	1/13/11	045L	042L	5.7	421	324
1/3/11	31	2	0.0359	0.0352	0.0350	Good						
1/3/11	31	3	0.0349	0.0352	0.0341	Good						
1/3/11	31	4	0.0370	0.0367	0.0362	Good						
1/3/11	31	5	0.0331	0.0334	0.0328	OK						
1/3/11	31	6	0.0370	0.0365	0.0355	Good	1/13/11	041L	046L	5.9	400	301
1/3/11	31	7	0.0350	0.0347	0.0337	Good						
1/3/11	31	8	0.0349	0.0341	0.0342	Good						
1/3/11	31	9	0.0363	0.0359	0.0361	Good	1/13/11	042L	044L	5.8	387	295
1/3/11	31	10	0.0366	0.0364	0.0358	Good	1/13/11	043L	045L	5.9	395	304
1/3/11	31	11	0.0353	0.0354	0.0345	Good						
1/3/11	31	12	0.0386	0.0383	0.0384	OK						
1/3/11	31	13	0.0364	0.0363	0.0359	Questionable						
1/3/11	31	14	0.0374	0.0365	0.0357	Good	1/13/11	044L	043L	5.8	401	332
1/3/11	31	15	0.0395	0.0391	0.0376	OK						
1/3/11	31	16	0.0386	0.0381	0.0381	Questionable						
1/3/11	31	17	0.0397	0.0394	0.0367	Questionable						
1/3/11	31	18	0.0346	0.0348	0.0346	Good						
1/3/11	31	19	0.0381	0.0381	0.0374	OK						
1/3/11	31	20	0.0405	0.0407	0.0367	Questionable						
1/10/11	32	1	0.0361	0.0356	0.0353	Good						
1/10/11	32	2	0.0348	0.0343	0.0344	Good						
1/10/11	32	3	0.0355	0.0352	0.0345	Good						
1/10/11	32	4	0.0360	0.0354	0.0346	Questionable						
1/10/11	32	5	0.0369	0.0367	0.0348	Good						
1/10/11	32	6	0.0360	0.0353	0.0330	Good						

1/10/11	32	7	0.0376	0.0369	0.0335	Questionable						
1/10/11	32	8	0.0379	0.0361	0.0346	Good						
1/10/11	32	9	0.0375	0.0370	0.0343	OK						
1/10/11	32	10	0.0361	0.0355	0.0358	Good						
1/10/11	32	11	0.0347	0.0335	0.0340	OK						
1/10/11	32	12	0.0402	0.0394	0.0336	Questionable						
1/10/11	32	13	0.0374	0.0342	0.0338	Good						
1/10/11	32	14	0.0342	0.0329	0.0328	Good						
1/10/11	32	15	0.0353	0.0347	0.0340	Good						
1/10/11	32	16	0.0374	0.0358	0.0343	Questionable						
1/10/11	32	17	0.0397	0.0350	0.0346	Good						
1/10/11	32	18	0.0362	0.0358	0.0345	Good						
1/10/11	32	19	0.0340	0.0354	0.0337	Good						
1/10/11	32	20	0.0381	0.0371	0.0365	Good						

NASA Strand Fabrication Procedure

12/14/2010

Mary LeBlanc / Rick Garcia

S&T Directorate—Engineering

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

Lawrence Livermore National Laboratory

LLNL Winder Settings

ENGINEERING

- T1000 fiber
- 862W resin
- 5lb tension
- Depth of epoxy on the roll is 0.009" (doctor blade setting)
- Bath temperature 130 °F (to achieve resin temperature of 115°F)

Preparation

ENGINEERING

- To keep the materials free of skin oils and to protect your skin from the epoxy, wear gloves for the whole operation.

- Collect the necessary hardware:

  Tyco medical grade heat shrink tubing (special) DEVT-LWA-NO.63-X-SP, 20-inch lengths

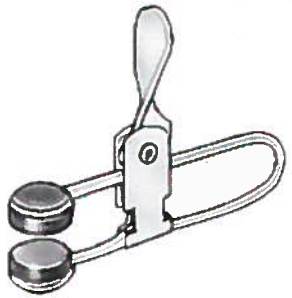
  Piano wire hook (0.015" diameter)

  Manual take-up roll (4" dia. PVC plastic pipe coupling)

Preparations

ENGINEERING

Cam-action clamps (McMaster-Carr) with (LLNL-made) silicone pads



Tubing clamps (LLNL) and hose clamps (McMaster-Carr)

Heat shrink gun

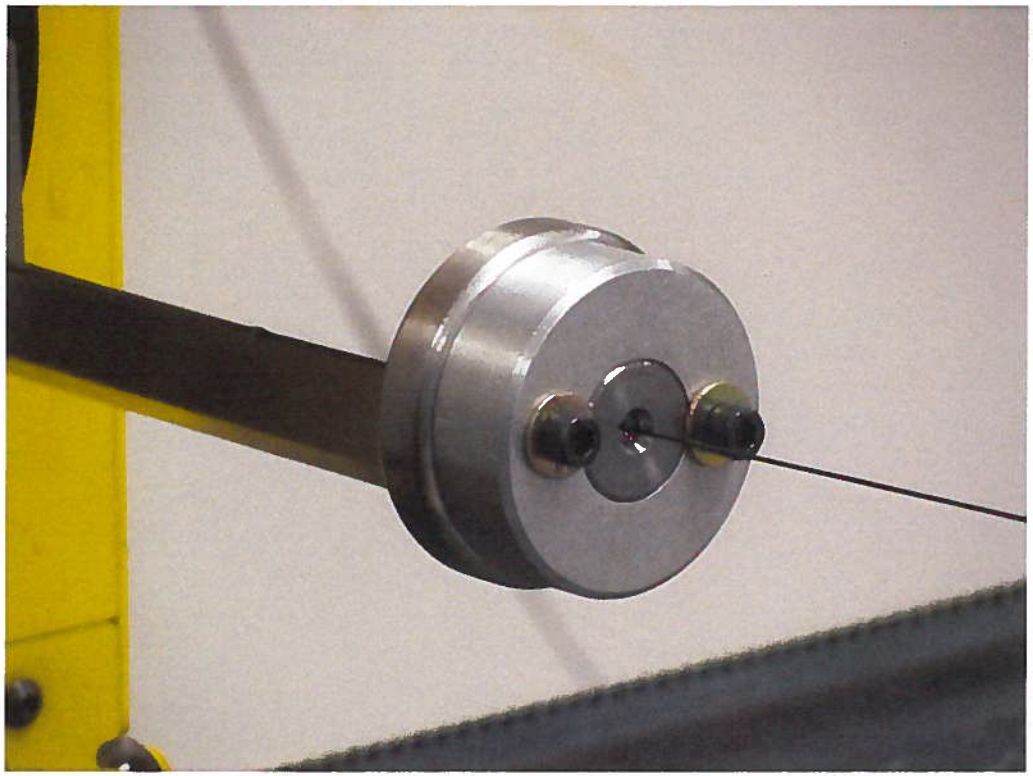
Hanging hardware and weights (0.5lb)

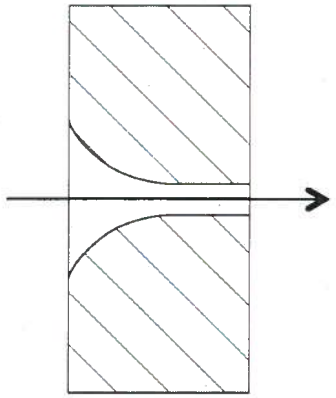
Automatic heat shrink device

Winder setup

ENGINEERING

- Mount a round die (0.029" – 0.030" in diameter) on the front of the winder. Feed the tow through the die.

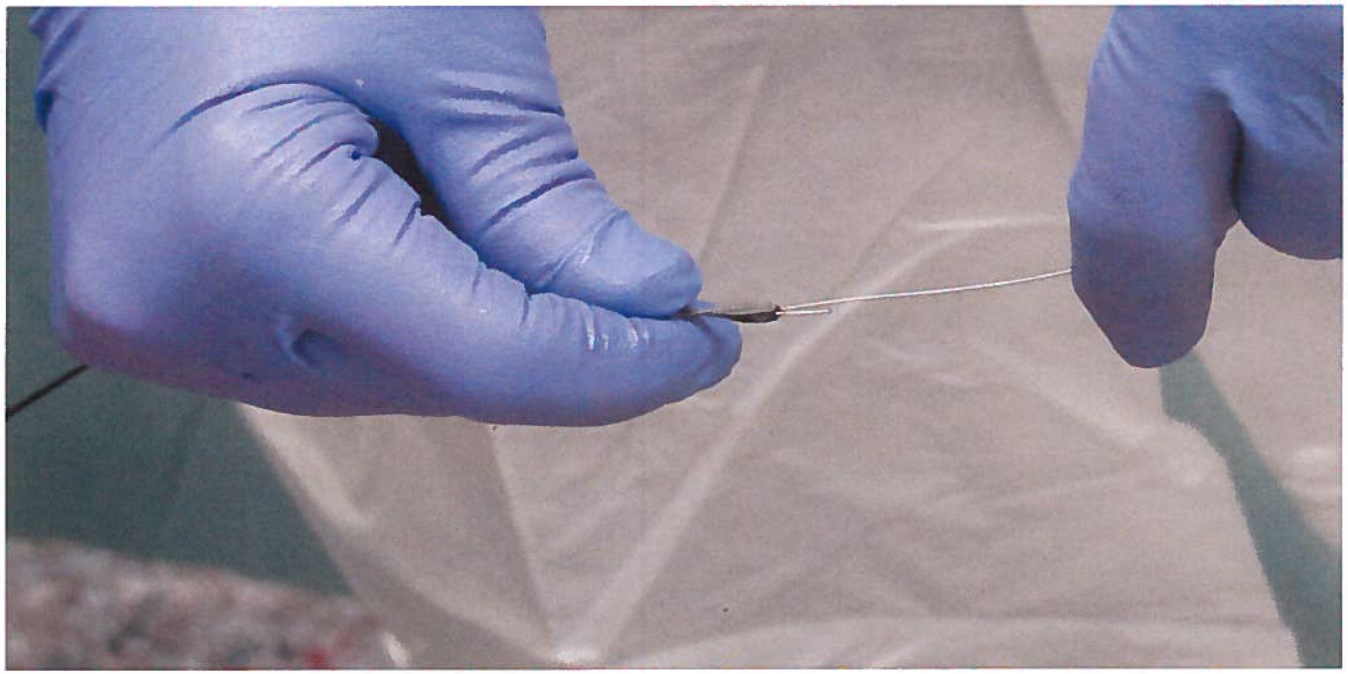




Thread the tow into the shrink tubing

ENGINEERING

- Thread a piano wire hook through a 20" length of shrink tubing, then loop the tow around the hook.



Attach the tow to the take-up spool

ENGINEERING

- Use the wire to pull the tow through the shrink tube. Then begin winding it on to the plastic tube.

Tension the tow

ENGINEERING

- Apply 5lb tension to the tow and continue pulling it slowly and evenly through the tube until the whole length was pulled across the epoxy roller under tension.

Replace the resin stripped off by the die

ENGINEERING

- Then pull an additional length while adding warm epoxy after the tow leaves the die.

Seal the heat shrink tube at the bottom

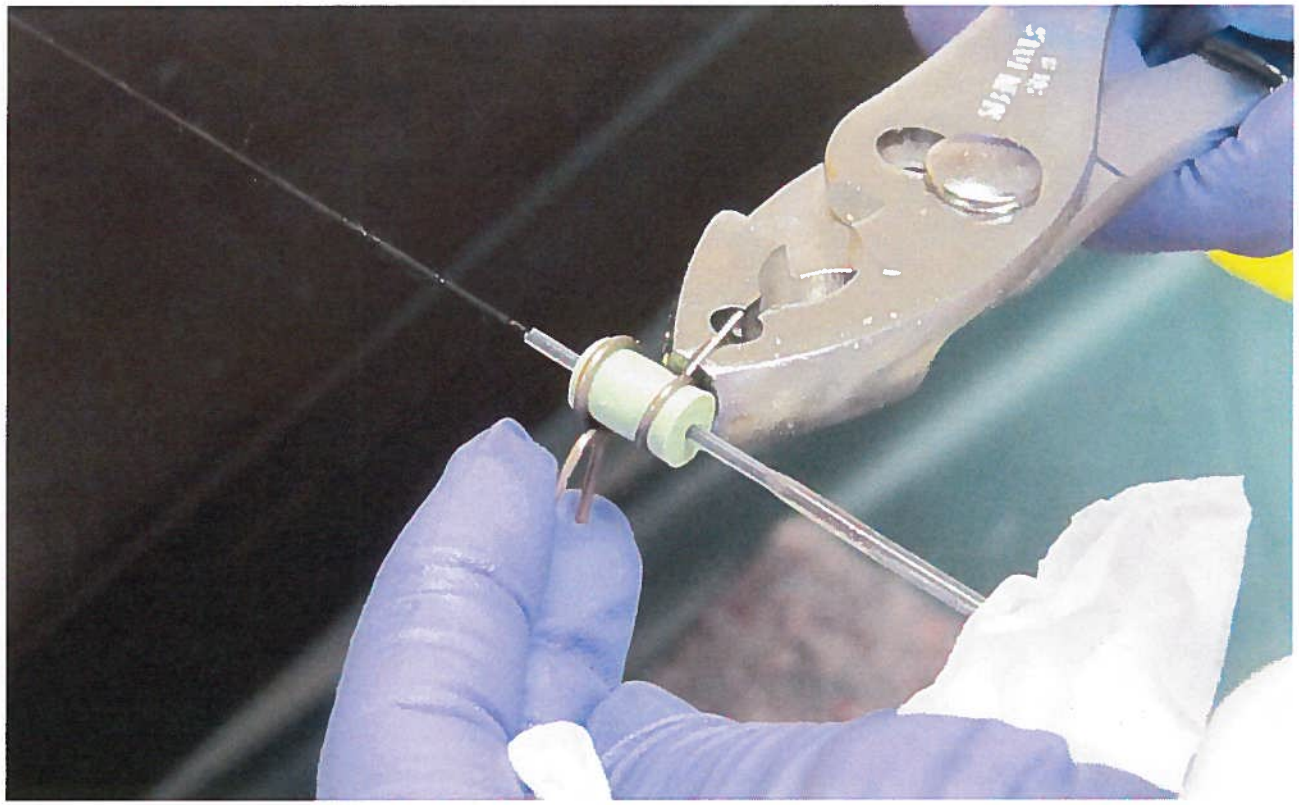
ENGINEERING

- Use a heat gun to shrink the tube around the tow at one end (will be the bottom as the epoxy cures). Shrink about 1" of the tube.

Apply a physical clamp

ENGINEERING

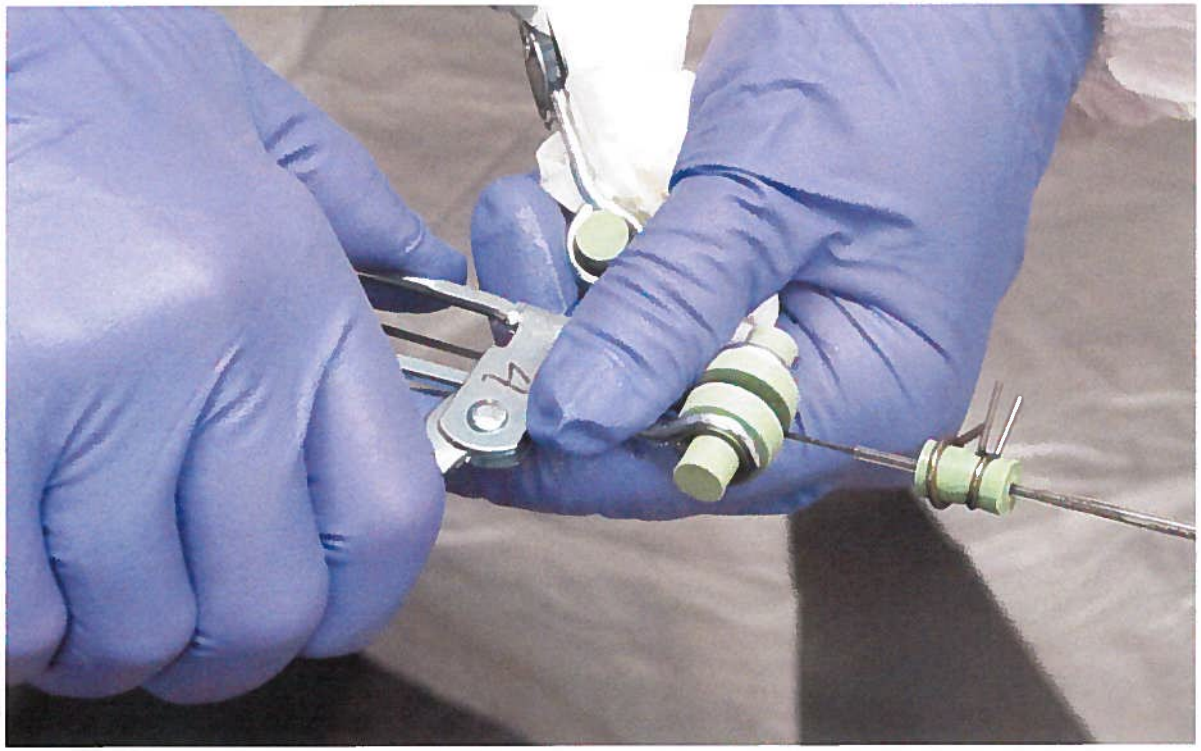
- Attach a clamp around the shrunk end of the tube. A split, silicone cylinder is shown below. Small, silicone O-rings work too (001S70).



Attach gripping clamps to the tow

ENGINEERING

- Attach cam clamps to both ends of the tow beyond the heat shrink tube. Attach the clamps while the tow is still under tension, keeping them as in-line with the tow as possible.



Hang the strands from the clamps

ENGINEERING

- Release tension, cut the tow beyond the clamps, and attach a 0.5 lb weight to the bottom (the end with the shrunk tubing).
- Hang the tow and weight with the pre-shrunk end at the bottom.
- Keep the epoxy warm (store them in an 150°F oven until ready to shrink the tubing).

Shrink the tubing

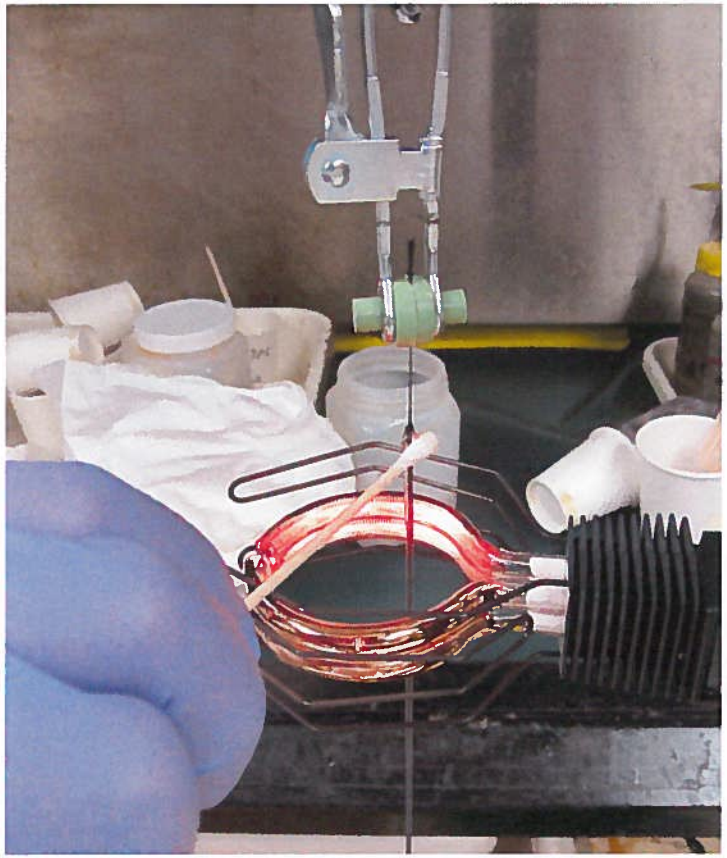
ENGINEERING

- Shrink the tubing, working from the bottom to the top.
- We have constructed an automatic device with a moving glow ring to shrink the tubing.

Shrinking details

ENGINEERING

- Wipe off the excess epoxy as it reaches the top of the tube.
- If the epoxy is not warm enough it will not flow up the tube properly.
- When the amount and temperature of the epoxy are correct, you will be able to watch the level rise above the shrinking region. You also may see small bubbles rising through the liquid.
- If the temperature is low or there is too much epoxy the shrink tube will not shrink uniformly.



Cure the strands

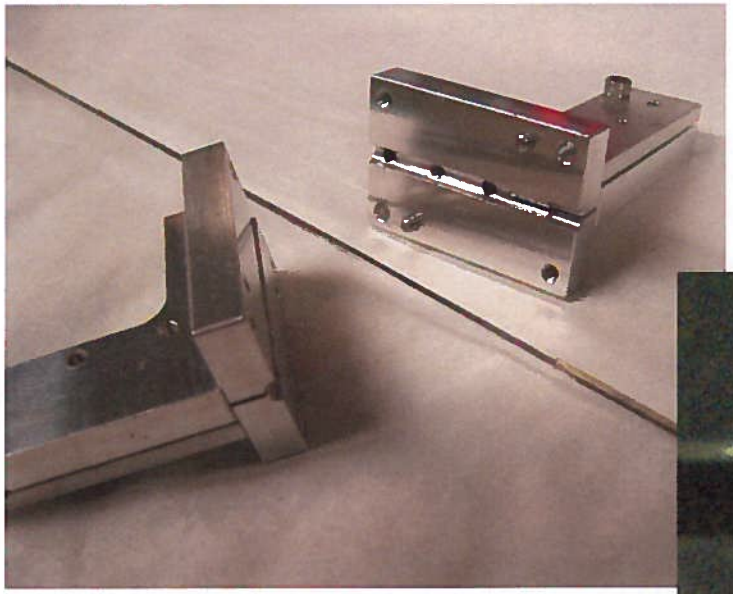
ENGINEERING

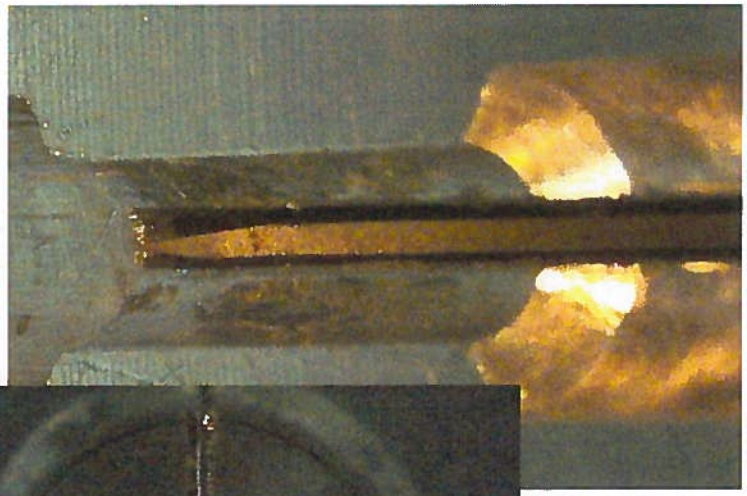
- Hang the strand in an oven (with the weight still attached).
- Cure the strands at 250°F for 3 hrs. Cool.
- Remove the weights and cam clamps.
- Leave the strands in the shrink tube. Label each strand and store the strands in rigid containers.

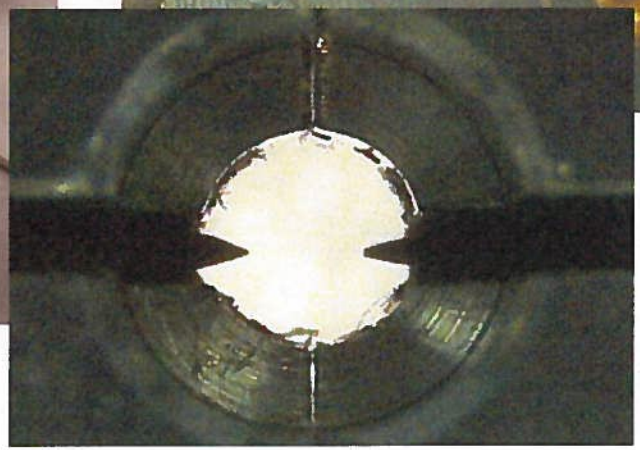
Removing the tubing

ENGINEERING

- At LLNL we remove the shrink tube with a custom, dual-knife-edge stripping device. Once the process has been successfully transferred, we will want the strands un-stripped.







A good strand has a uniform gel coat

ENGINEERING

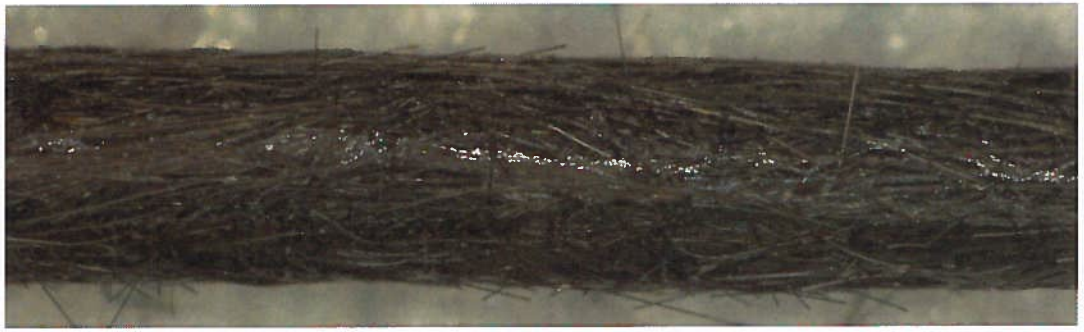
- Good strands will have a uniform gel coat. Our fibers are 0.033" to 0.034" in diameter.

- If the shrink tube is not sealed or there is insufficient resin the strand will be resin-starved.

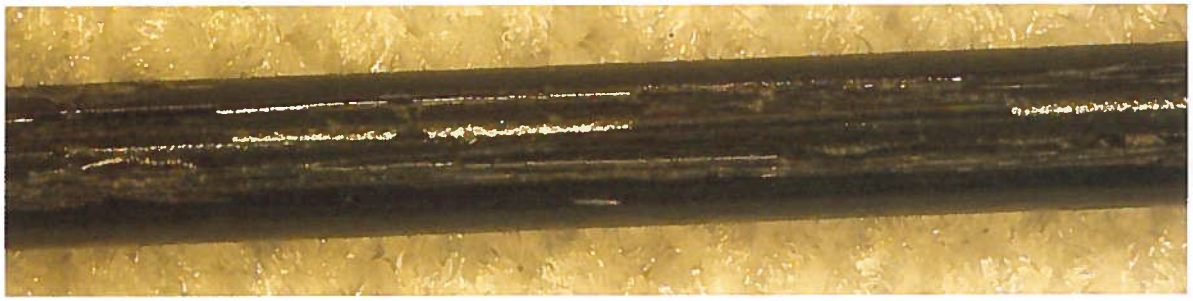
Other strand proplems

ENGINEERING

- Without a die there may be "rat' s nests". The die tends to remove most of the loose fiber. The rear of the die will need periodic cleaning.



- Insufficient resin or an improper shrink tube can leave voids.



Strand and Grip Procedure

Strand

-Pull strand through the resin bath (heated bath – temperature 130°F)

-Feed the strand through the die

-Feed the wire through the shrink tube prior to attaching it to the strand

-Catch the end of the strand with the hook (The length of the strand that doubles over at the hook should be long enough that it does not pull free)

-Pull strand through a 20 inch section of the tubing gently rotating the tubing to help it feed through. Pull should be at a slow consistent pace. No jerking motion.

-apply 5 lb tension and pull an additional strand length of 2-3x the length of the tubing through, while gently rotating the tubing. if not getting enough wetting on the outside of the strand after going through the die (if the die is pulling off too much resin), use syringe to add resin to the outer surface of the strand before it goes into the tubing (make sure that all fiber within the tubing has both sufficient resin and also 5 lb tension). The key is to produce a fiber with a nice even gel coat. If too much resin is added and the shrink tube is not shrunk immediately after the pull it will become difficult to force the resin upward thus causing the strand to "cork screw".

-While holding tension, apply local heat to shrink down the first inch of the tubing on the side closest to the die. (bottom of the strand)

-Apply the silicone bushing to the shrunken area and apply 2 spring hose clamps.

-While holding tension, apply "weight clamp" to strand on the bottom side (not to the tubing) an ½" or so beyond the end of the tubing

-Apply a similar clamp on top side above the tube

-Release the tension

-Cut the strand

-Rotate the strand vertically and immediately apply ½ lb weight to the bottom side, hang in the oven.

-keep strand warm through the rest of this process 150°F until the cure step has been completed

-Move strand to the curing oven set to 150°F

-shrink the tubing in the curing oven using a heat gun with circular radiator starting from the bottom and working up at a slow pace. You will begin to see the resin migrating upward (resin should come out of the top of the tubing and be sure that the tubing shrinks uniformly on the way up to get a smooth surface). Shrink the strand tubing immediately after they are pulled.

-collect the resin that comes out the top to keep it from dripping down the sides

-After shrinking, gently wipe down the outside of the tubing to ensure any epoxy drips have been removed from the outside of the tubing. There will be some epoxy drips during the cure cycle which you cannot help. This is a manageable amount, excess amounts though will create problems during the stripping process. Minimizing the drips is the key here.

-

-Cure at 250°F for 3 hours and let strands sit overnight.

hepa1 7/23/12 8:40 AM
Deleted: Pull

hepa1 7/18/12 1:54 PM
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hepa1 7/18/12 1:52 PM
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hepa1 7/18/12 2:00 PM
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hepa1 7/18/12 11:05 AM
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-Use tool to score tubing. Ensure the blades are adjusted to the appropriate diameter to avoid damaging the strand. Excess cured epoxy drops on the outside of the shrink tube will hinder the tools ability to cut smoothly and may damage the blades. If necessary, prior to using the tool, use a micro cutting tool/knife to chip off any large drippings of epoxy.
-Peel off the shrink tubing.
-Visually inspect the strand for any flaws that may cause a premature failure during test: Areas starved of epoxy, Bulges or rats nests of fibers that may contain an internal void, Nicks or cuts through the gel coat that may have severed fibers.
-cut to 11"-12", length using diamond wheel cutter (cut dry)
-abrade outside of strand at the grip installation locations (about 2" on each side) using mild steel wool

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Grip
-Pre-treat grip with Teflon release and bake (1st time only) on successive uses, reapply release without baking
-To avoid bubbles in the grip, first partly fill the grip from the small hole end
-Turn the grip over so that the small hole is on the bench (on a silicone pad) and fill the large cavity with epoxy (submerge the syringe tip into the previously injected epoxy to avoid voids or bubbles)
-Turn the grip over once again so that the larger bore end in now down on the bench forcing epoxy upward out of the smaller bore end.
-Install the Teflon plug onto the end of the strand (about 1 inch longer than grip-length from end of strand)
-Slowly insert the end of the strand into the filled grip (slight rotation helps uniform wetting of strand exterior)
-Rotate the grip horizontally and continue to push strand through grip until Teflon plug seats into small end of grip. Ensure that there is approximately 1/2" protruding out of the end of the grip.
-Thread end of strand into the grip cap hole and tighten grip cap
-Holding the strand at the small bore end Install the Teflon plug into the end of the grip cap side and slide into the grip cap
-Clean any excess grip epoxy off of the grip to avoid adhering to the curing stand.
-Hang the specimen from the grip-curing fixture
-Cure (250 F cure), 1 Hour
-Repeat process on the other side, measuring to ensure gage length of approximately 6".
-Cure (250 F cure), 1 Hour
-Let the specimens sit at least overnight before testing to be sure there is good adhesion between the grip epoxy and the strand.

Additional Notes:
-We pre-heated the resin before it was poured into the already at temperature bath.
-Do not allow the strand to be pulled back in the reverse direction into the tubing and die. Strand can bunch up in the die or in the tubing.
-Periodically (3-4 strands) the die may need to have some bunched up fiber removed from where the strand enters the die. This prevents breaking the stand.
-While pulling strands in large batches (more than 10) the resin in the bath needed to be replaced or added to. The viscosity went up enough that it became very difficult to pull strands through the tubing.
-If the strand begins to cork screw during shrinking, you may have an opportunity to recover from this by re-shrinking the area ~1"-2" below the cork screw section and continuing up the strand.