
**Pacific Northwest
National Laboratory**

Operated by Battelle for the
U.S. Department of Energy

**Summary Report for
Contract 330088-A-T9**

**Procurement of Zircaloy-4 Products
from Superior Tube Company**

R. E. Graves

June 2007



Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

This report documents the initial procurement activities from the Superior Tube Company (STC) associated with production quantities of Zircaloy-4 components (Contract 330088-A-T9) and the demonstration of their capability to produce full-length getter (FLG) components (Contract 406957-A-T5). Advanced planning for this contract began in spring 1999. STC was awarded a firm, fixed-price contract with the potential for added incentive payments based on their ability to control their manufacturing processes. Incentives were included in this contract based on the potential benefit to reduce Pacific Northwest National Laboratory's (PNNL's) quality costs and schedule risk. The contract was negotiated to a firm fixed price plus incentives with a not-to-exceed price.

The manufacturing activities for the contract included two phases. The first phase consisted of demonstrating production capability for the production of getter-tube stock and inner-liner tubes. The second phase originally consisted of procuring Zr-4 feedstock and producing Zr-4 components, but 13 modifications were made to the contract. There were delays, but STC was able to produce the required amount of components as specified by their contract.

There were concerns regarding product quality, including the inside diameter, the outside diameter, and straightness characteristics. Non-contact methods of inspection were implemented to minimize flexing of the tubes during inspection, and the design specification was revised to allow averaging of measurements. Along with the inspection and specification changes, STC continued to pursue process improvements that would yield a better product. Even though the product quality improved significantly, some lots still failed the initial inspection, resulting in a 100% inspection for those lots.

To accommodate the long lengths of FLG tube stock, alternative inspection equipment was needed for measuring the inside diameter. The Single Tube Air Gage Scanner, originally developed to inspect cladding tubes, was identified to meet this need. This equipment was supplied to STC as government-furnished equipment. With the inspection hardware, PNNL supplied shipping, re-assembly, training, and all necessary software for operating the equipment. Currently, ownership of this equipment remains with PNNL.

Lessons learned and improvements realized include the following key items.

Cpk Incentives: This contract included financial incentives that were based on quality performance as measured by the Cpk. This aspect of the contract proved to be a strong motivator for STC to pursue continuous improvement of the PNNL products.

Long Lead Item Planning: The manufacture of the components for this contract required purchasing TREX tubing as feedstock. The lead time for this material was 8 to 12 months.

Lot Size: The initial contract included specific quantities for each shipment. Producing manufacturing lots to meet those specific quantities was difficult, if not impossible. More thought needs to go into identifying natural lot sizes based on TPBAR assembly campaigns and plating campaigns to make the overall process as efficient as possible.

Inspection Methods: After the manufacture of the Lead Test Assembly (LTA) components, it was determined that inspection methods used by STC were not consistent with the flexible nature of the product. After the LTA effort, a study was done at PNNL to evaluate inspection methods. It was determined that non-contact measurement techniques, such as laser gage and air gage, were best suited for the components of this contract.

Flexible Component Measurement Averaging: The design documents for the STC components were modified to allow averaging of the diameter (inside and outside) measurements. This change was based on the flexible nature of the tubing. The use of averaging reduced the likelihood of rejecting components as a result of small levels of ovality.

Acronyms

ABIS-AG	Advanced Bench-scale Inspection System – Air Gage
Cpk	process capability index
DOE	U.S. Department of Energy
FLG	full-length getter
GFE	government-furnished equipment
ID	inside diameter
LTA	lead test assembly
MAQP	Manufacturing and Quality Control Plan
OD	outside diameter
PNNL	Pacific Northwest National Laboratory
QA	quality assurance
RFP	request for proposal
SOW	statement of work
STAGS	Single Tube Air Gage Scanner
STC	Superior Tube Company
TPBAR	Tritium Producing Burnable Absorber Rod
TTP	Tritium Technology Program
TTQP	Tritium Target Qualification Project

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1.0 Introduction

Superior Tube Company (STC) successfully completed a four-phase vendor qualification as defined by the guidance provided in *Tritium Target Qualification Project: Component Vendor Qualification Strategy* D. Senor, December 1995. The strategy is referenced in a memo dated December 22, 1995, from R. J. Guenther to J. L. Etheridge. The final phase of this strategy, Phase IV, is documented in the memo report dated June 9, 1998, from C. R. Eiholzer to C. L. Painter.

This report documents the initial procurement activities associated with production quantities of Zircaloy-4 (Zr-4) components (Contract 330088-A-T9) and the demonstration of the capability to produce full-length getter (FLG) components (Contract 406957-A-T5). Contract 330088-A-T9 was originally awarded for the manufacture of production-design (short getter) components. Upon completion of successful demonstration activities associated with the manufacture of FLG tube stock and plating of FLG tubes, a decision was made to transition to the FLG design. Contract 330088-A-T9 was modified to discontinue the manufacture of production-design getter and spacer stock and divert the remaining contract funding to the manufacture of FLG getter and spacer stock.

2.0 Contract Activities

Advanced planning for this contract began in spring 1999. A request for expressions of interest and capabilities statements was published in the *Commerce Business Daily* on May 27, 1999. Based on advertising and previously known sources of this material, a solicitation list of eight potential offerors was developed. The Request for Proposal (RFP) No. 33088 was transmitted to the eight firms on November 29, 1999. One proposal was received in response to the RFP, resulting in a “single source” evaluation process. Ultimately, STC, the single respondent, was awarded a firm, fixed-price contract with the potential for added incentive payments based on their ability to control their manufacturing processes. Incentives were included in this contract based on the potential benefit to reduce Pacific Northwest National Laboratory’s (PNNL’s) quality costs and schedule risk. The contract was negotiated to a firm fixed price plus incentives with a not-to-exceed price. Additional details for the contracting process are available in a *Memorandum of Procurement* to the 330088 contract file from K. Whelan dated July 13, 2000.

The manufacturing activities for the contract included two phases. The first phase consisted of demonstrating production capability for the production of getter-tube stock and inner-liner tubes. Under the demonstration phase, STC completed the following deliverables:

- Manufacturing and Quality Control Plan (MAQP) that encompassed each type of tube
- Final Certification and Data Package for each type of tube with
 - Information required by specification
 - Gage repeatability and reliability results
 - The process capability index (Cpk) as defined in the statement of work (SOW)
 - All inspection data for tubes inspected
- 500 bottom spacer tube stock units
- 500 production getter-tube stock units
- 524 production standard inner-liner tubes.

The second phase originally consisted of procuring Zr-4 feedstock and producing the following quantities of Zr-4 components:

- 4,000 bottom-spacer stock units
- 95,200 production getter stock units
- 12,600 variable-length inner-liner tubes
- 56,700 standard-length inner-liner tubes.

A total of 13 modifications were made to the contract. These changes can be categorized as follows:

- Specification: modifications resulting from specifications revisions
- Schedule: modifications driven by schedule changes
- Quantity: modifications affecting quantity of delivered components
- Cost: modification affecting contract cost
- Scope: modifications driven by a change in scope

- Quality Assurance (QA): modifications including changes in QA requirements, such as QA clauses.

Table 2.1 summarizes the changes by category. More detailed information pertaining to the contract modifications is included in Appendix A. The “Process Change” column of Table 2.1 indicates modifications that had an impact on the manufacturing process itself.

Table 2.1. Contract-Modification Summary

Quantity of Mods Affected	Specification	Schedule	Quantity	Cost	Scope	QA	Process Change
	9	7	3	2	3	2	1
Mod 1	X	X					
Mod 2				X	X		
Mod 3	X						
Mod 4		X					
Mod 5		X	X				
Mod 6	X	X				X	
Mod 7	X	X					
Mod 8	X						
Mod 9	X						
Mod 10					X	X	
Mod 11	X	X	X	X	X		X
Mod 12	X						
Mod 13	X	X	X				

The changes in Modification 5 were significant because of the impact on the plating vendor. The initial contract included specific quantities for each shipment. Producing manufacturing lots to meet those specific quantities was difficult, if not impossible. As a result, STC was splitting lots to make up the quantities required by the contract. Often, the split lots resulted in small quantities that were not practical for use by the plating vendor. To remedy this situation, STC was allowed to deviate from the individual shipment quantities as long as the total shipped-to-date quantities were within 10% of the contract quantities. Additionally, the contract allowed a 5% overage at contract completion. Modification 13 reduced the overage allowance to 2% on most components and clarified that any charges for additional components and any applicable incentives could not exceed the ceiling amount specified in the contract.

Modification 11 represented a change in direction by the U.S. Department of Energy (DOE). In September 2002, a decision was made to incorporate the FLG design as a replacement for the production (short) getter design. The manufacture of production getter stock was discontinued, and the contract was re-negotiated based on the remaining value of the components. Additional details pertaining to this contract modification are available in *Memorandum of Procurement – Mod #11* to the 330088 contract file from Kerry Cullerton dated July 14, 2003. The resulting component quantities for Modification 11 were as follows:

- 2,000 production bottom spacer tube stock units (completed)
- 48,600 production getter-tube stock units (completed)
- 12,600 production variable-length inner-liner tubes
- 56,700 production standard inner-liner tubes
- 3900 FLG spacer stock units (14-inch length)
- 4100 FLG tube stock units.

During the contract modification process, STC was allowed to continue manufacturing production getter stock material to a point in the process that was compatible with the FLG stock specification. This allowed STC to minimize the impact both to their production projections and to the Tritium Target Qualification Project (TTQP) (former name of the Tritium Technology Program [TTP]) schedule. This material was specified as “interim getter” material and is included as such in Appendix B, “Summary of Milestone Deliverables.”

3.0 Summary of Components Delivered

3.1 Production Rate

Within the overall confines of the period of performance, a shipping schedule was provided for Phase II. The purpose of the shipping schedule was to provide components to the plating vendor in a manner commensurate with the plating schedule. The schedule was designed to provide ample product for plating without surpassing the storage capacity of the plating vendor. This schedule was documented in the contract as the Milestone Payment Schedule. Throughout the life of the contract, this schedule was modified on several occasions because of the needs of the TTQP, STC, and the plating vendor. Appendix B summarizes the components provided for each milestone.

Initially, a throughput capability of 4000 TPBARs/year worth of components was a requirement for the Zr-4 component manufacturer. Over the life of the contract, this requirement was significantly reduced as the result of changing requirements from DOE. The contract milestone schedule was designed to produce getter-tube stock at a rate of 38,000 tubes/year (3200 TPBAR equivalents) and inner liners at a rate of 30,000 liners/year (2500 TPBAR equivalents).

Early in the production phase of the contract, STC production was delayed by an internal union strike. Following the strike, STC scaled up the getter-tube stock production to recover the lost schedule. The production rate during this recovery was sustained at approximately 6000 tubes/month for 5 months. This constitutes an equivalent annual rate of 72,000 tubes/year (6000 TPBAR equivalents). The cumulative getter-tube stock production is shown in Figure 3.1.

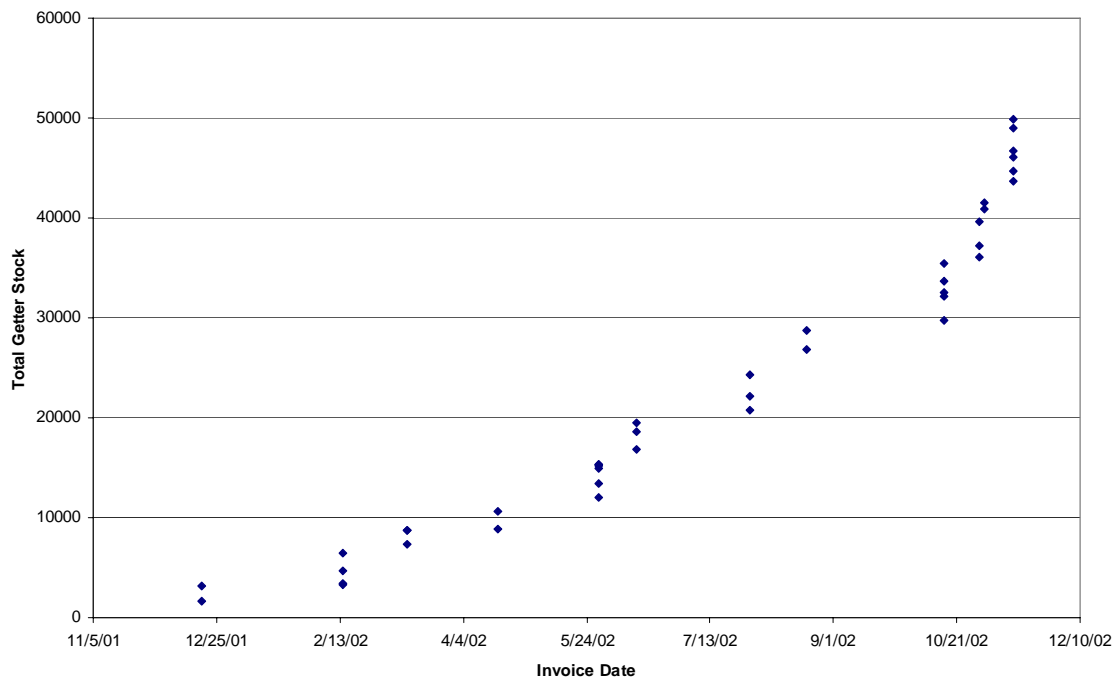


Figure 3.1. Cumulative Getter-Tube Stock Production

The production for liners during this same timeframe was maintained at the contracted rate of approximately 2500 liners/month. The cumulative standard inner liner and variable inner-liner tube production are shown in Figure 3.2 and Figure 3.3.

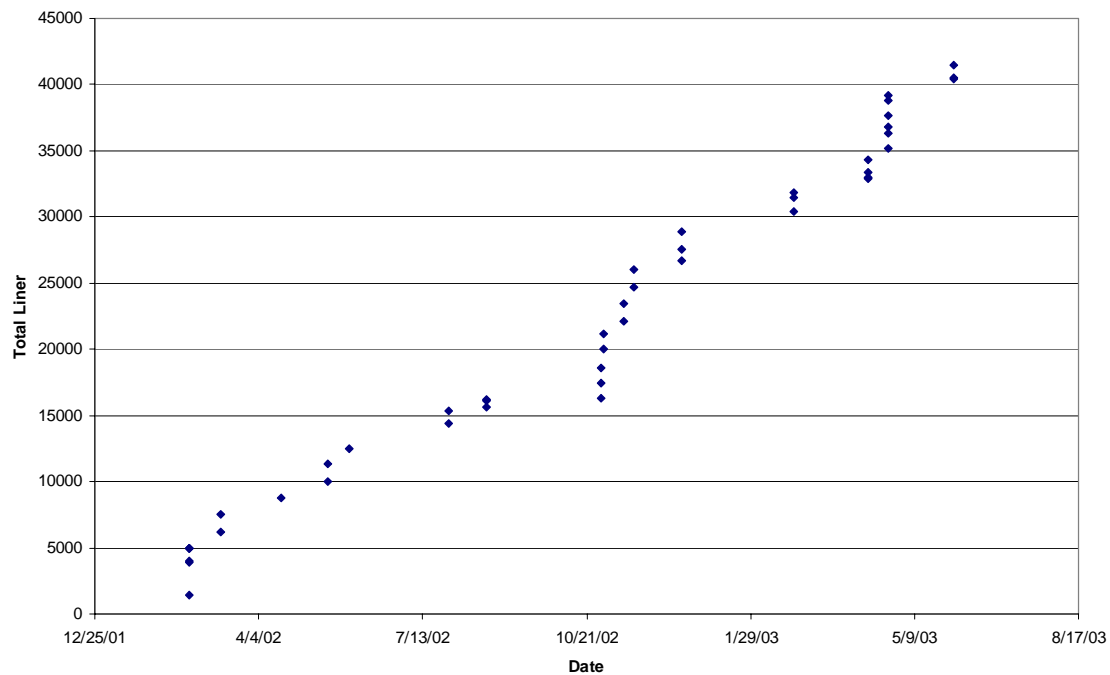


Figure 3.2. Cumulative Standard Inner-Liner Production

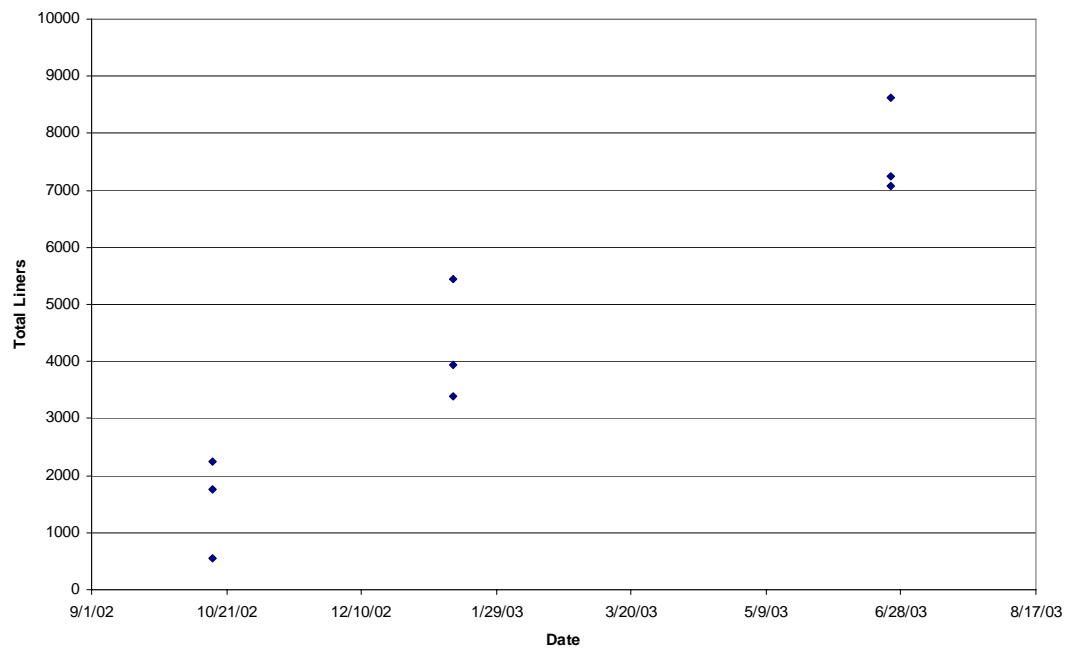


Figure 3.3. Cumulative Variable-Length Inner-Liner Production

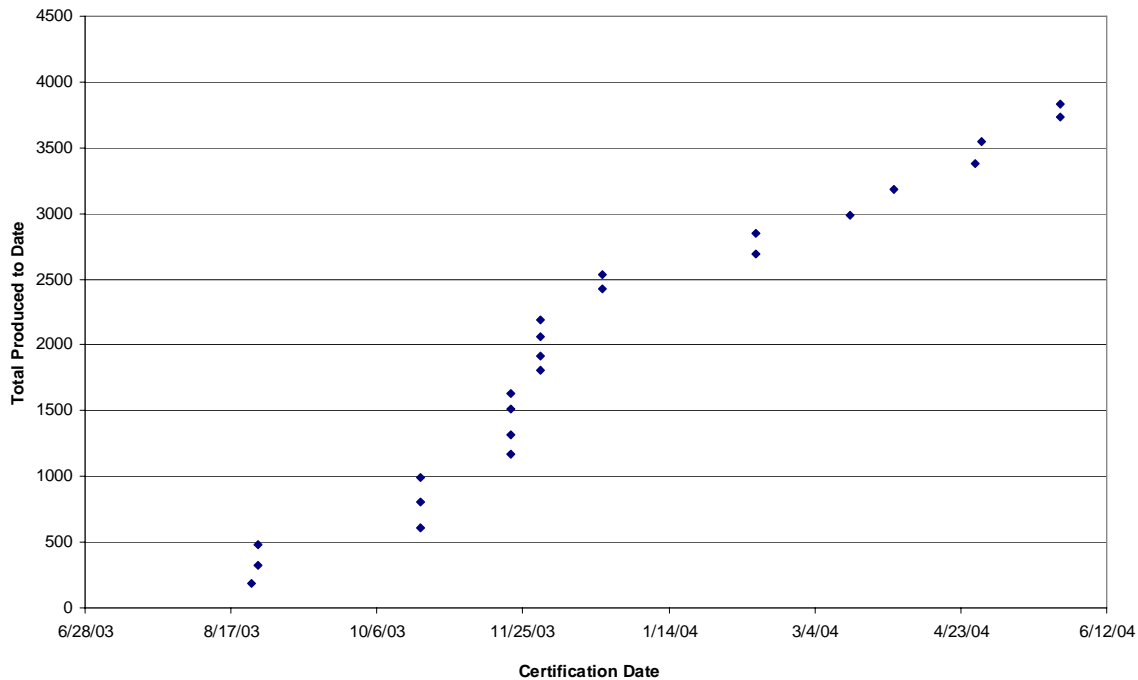


Figure 3.4. Cumulative Full-Length Getter-Tube Stock Production

The cumulative FLG tube stock production is shown in Figure 3.4. The average production rate for the FLG tubes was approximately 4600 tubes/year. This production rate was determined by the contract and did not necessarily represent the maximum capability of the STC process. Since the FLG tubes are simply production stock getter tubes that were not cut, it is reasonable to expect that the production capability is commensurate with the 6000 tubes/year (TPBAR equivalent) indicated above.

3.2 Product Quality

The *Phase IV Qualification Report – Getter Tube Vendor* memo from C. Eiholzer to C. Painter dated June 9, 1998, indicated areas of concern relative to component quality. The primary areas of concern were inside diameter (ID), outside diameter (OD), and straightness characteristics. In that report, inspection technique and allowances for “non-rigid” components were identified as key contributors to apparent QA issues present during the production of getter tubes for the TTQP lead test assembly (LTA).

In a follow-on study by PNNL, a “Gage Repeatability & Reproducibility” (Gage R&R) study was done indicating that “non-contact” inspection methods were best suited for these components. The non-contact methods of inspection minimize the occurrence of tube flexing during inspection. The methods recommended for getter tubes were laser gage for the OD and air gage for the ID. STC accepted this recommendation and purchased a digital Moore Data Gage (for use with air gage) and a laser gage. A summary of the Gage R&R study is shown in Table 3.1.

Table 3.1. Gage Repeatability and Reproducibility

Equipment	Dimension	R & R Value	Tolerance	% of Tolerance
Laser Gage	OD	0.000059	0.001	6
Inside Micrometer	ID	0.000826	0.001	83
Magna-Mike	Wall Thickness	0.000496	0.001	50
Balance/Digital Caliper	Weight/Length	0.000202	0.09	0.2
Air Gage	ID	0.00005	0.001	5

In addition to the new inspection methods, the design specification was revised to allow averaging of measurements for inspection of non-rigid components. To verify that the averaging did not allow extreme ovality, STC implemented a self-imposed restriction on the maximum deviation from the nominal dimensions. The design specification was also revised to increase the tolerances on both the ID and OD of the getters.

Along with the inspection and specification changes, STC continued to pursue process improvements that would yield a better product. The Cpk incentives of the contract served as a motivator towards this objective. As a result, STC adjusted their manufacturing approach to strive for nominal dimensions. The progress was tracked based on the reported Cpk values. Overall, the Cpk values during production were significantly better than those of the LTA, particularly for the FLG Tubes. However, some lots were below the 1.1 minimum Cpk incentive level.

The Cpk was calculated as follows:

$$Cpk = \text{The smaller of } Cpu \text{ and } Cpl \quad (3.1)$$

where $Cpu = (USL - \bar{X})/3\sigma$
 $Cpl = (\bar{X} - LSL)/3\sigma$

where Cpu = Capability ratio based on the upper specification limit
 Cpl = Capability ratio based on the lower specification limit
 \bar{X} = Mean tube OD or ID
USL = Upper specification limit
LSL = Lower specification limit
 σ = Standard deviation of the OD or ID.

The Cpk trends for each of the components are shown in Figure 3.5 through Figure 3.8.

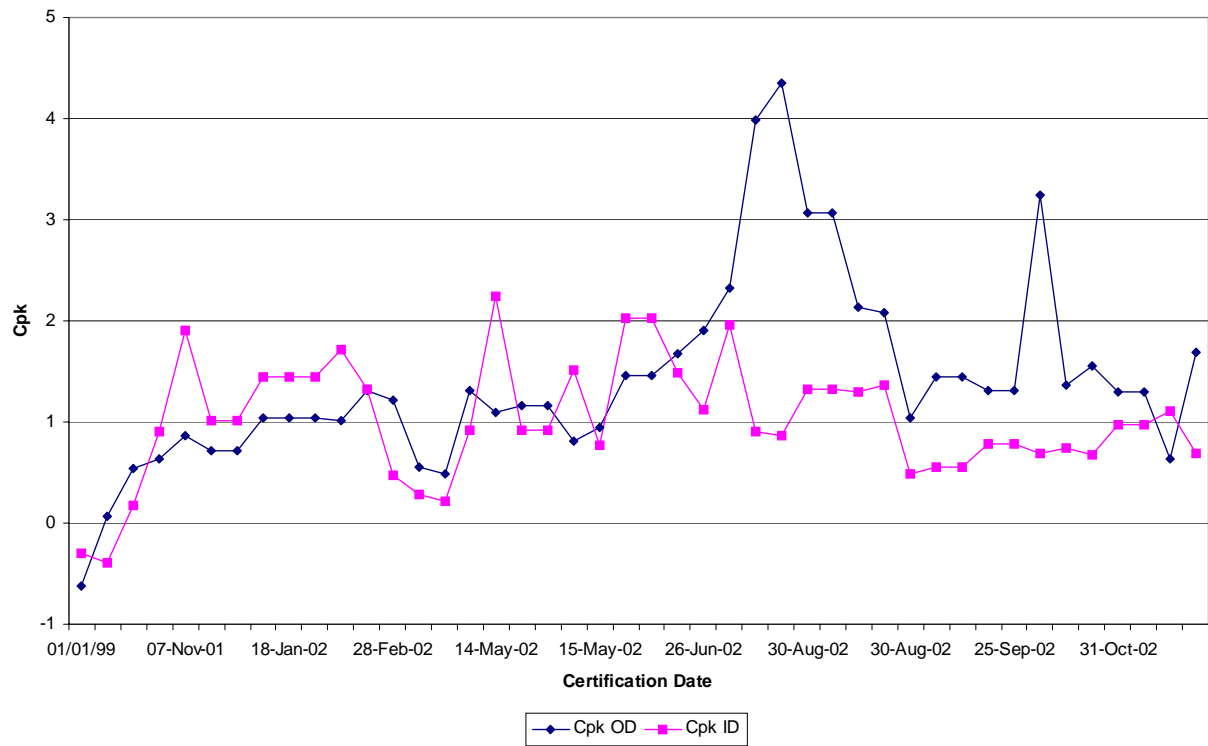


Figure 3.5. Getter Stock Cpk Trends

Note: First three data points on each curve are from LTA getter-tube stock.

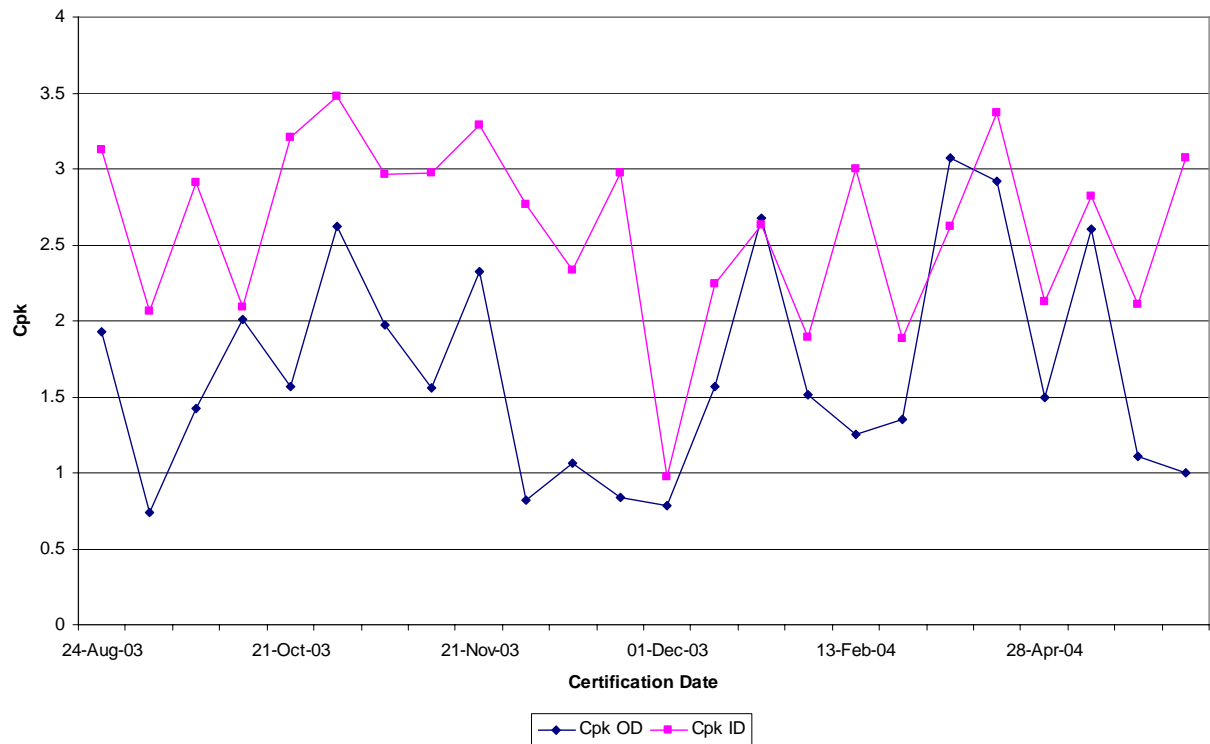


Figure 3.6. FLG Tube Stock Cpk Trends

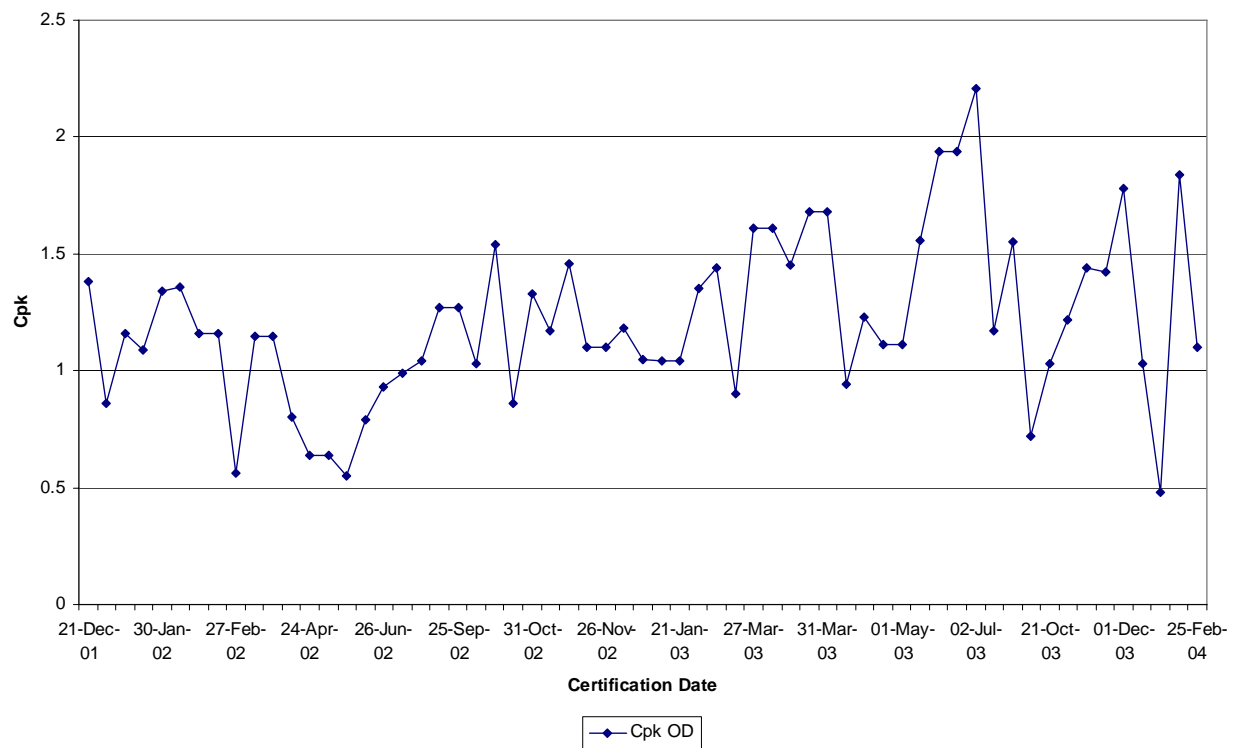


Figure 3.7. Standard Inner-Liner Cpk Trends

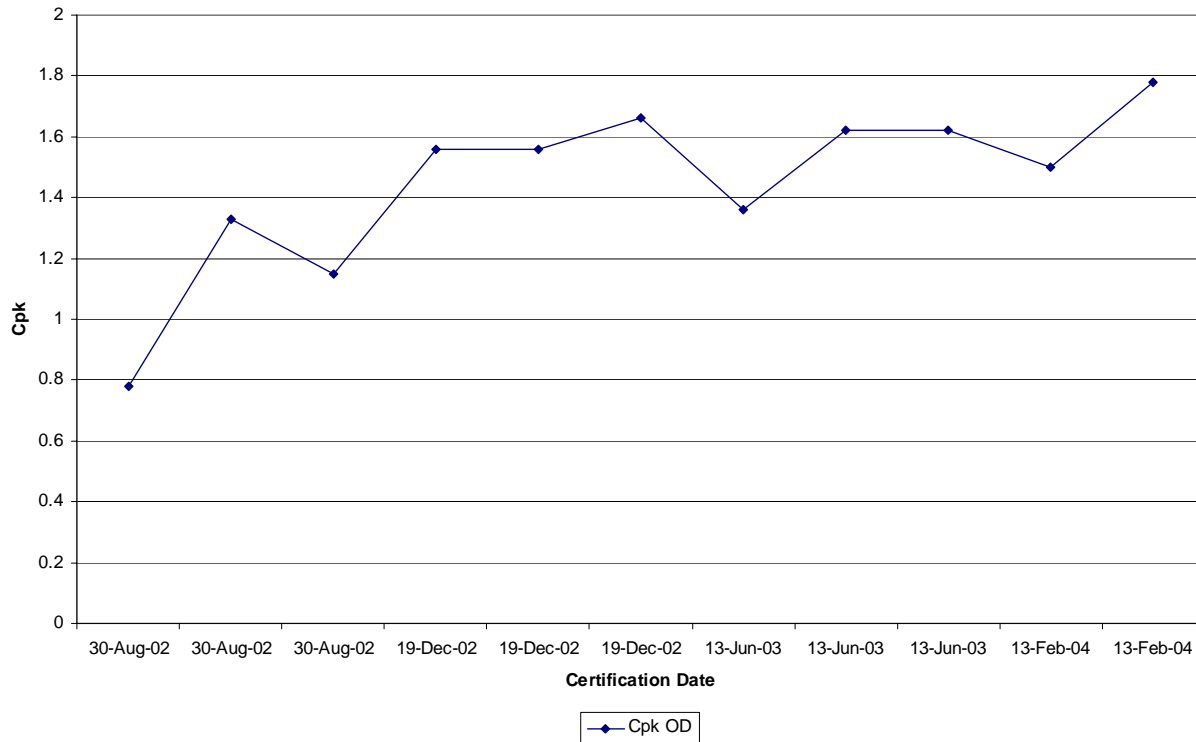


Figure 3.8. Variable-Length Inner-Liner Trends

Although the product quality improved significantly as compared to the LTA material, some STC lots still failed the initial sampling-based inspection, resulting in a 100% inspection for those lots. However, the losses due to sorting were 5% to 15%, rather than as high as 40% seen during the LTA inspections. Table 3.2 summarizes the lot inspection results. The quantities for the various attributes (straightness, ID, OD, etc.) indicate the number of lots that required 100% inspection.

Table 3.2. Lot Inspection Summary

Description	Total Lots	Straightness	ID	OD	Visual	Flange Size	Weight	Total Quantity	% Through Inspection
Getter Tubes	33	14	12	10	13			49832	90.7
FLG Tubes	24			10	13			3836	96.8
Standard Liners	40	4		12	16	10		44016	90.9
Variable Liners	7			1	3	1	1	8629	85.2

Some of the sampling-based lot failures came during source verification. This was more likely the result of stringent sampling criteria (accept 0/reject 1) than the result of poor inspection quality by STC. Although many of the lots met the 95/95 criteria, they were not “well beyond” this limit. With this scenario, the probability of a false-lot failure during sampling was increased. If the number of sampling-based inspections was also increased, as with source verification, the number of lots requiring 100% inspection would be further increased. Appendix C summarizes the source verification activities.

3.3 Government-Furnished Equipment

To accommodate the long lengths of FLG tube stock, alternative inspection equipment was needed for measuring the inside diameter. The Single Tube Air Gage Scanner (STAGS), originally developed to inspect cladding tubes, was identified to meet this need. This equipment was supplied to STC as government-furnished equipment (GFE). With the inspection hardware, PNNL supplied shipping, re-assembly, training, and all necessary software for operating the equipment. Currently, ownership of this equipment remains with PNNL. Responsibility for maintaining software also resides with PNNL. PNNL developed the software for operating the STAGS system. The current version of the software is AGDataTaker 2.3.2 (STAGS, ABIS-AG) dated October 13, 2003. The hardware and software documentation (including software verification) is located in the TTP records as shown in Table 3.3.

Table 3.3. STAGS Hardware and Software Documentation

STAGS Documentation		
Software Documentation		
SOFTWARE TESTING PLAN FOR TTQP.AGDATATAKER VERSION 1	TTP.7386	5/6/1997
SOFTWARE DEVELOPMENT PLAN TTQP.AGDATATAKER.SRS.1	TTP.7389	2/11/1997
SOFTWARE REQUIREMENTS SPECIFICATION TTQP.AGDATATAKER.SRS.1	TTP.7390	2/10/1997
SOFTWARE DESIGN DESCRIPTION TTQP.AGDATATAKER.SDD.1	TTP.7393	4/28/1997
SOFTWARE VERIFICATION AND VALIDATION PLAN AGDATATAKER	TTP.7395	5/5/1997
SOFTWARE VERIFICATION AND VALIDATION TESTS AGDATATAKER	TTP.7396	5/22/1997
SOFTWARE REQUIREMENTS FORM TTQP AGDATATAKER (ALL VERSIONS)	TTP.7398	4/1/1997
SOFTWARE VALIDATION FOR AGDATATAKER, VERSION 2.3 AS USED ON STAGS (SINGLE-TUBE AIR GAGE SCANNER)	TTP.33208	12/5/2002
SOFTWARE USER DOCUMENTATION (AG-ABIS & STAGS) - AGDATA TAKER, VERSION 2.3.1	TTP.33747	4/1/2003
SPECIAL MEDIA: CD-ROM FOR AGDATA TAKER 2.3.2 STAGS SOFTWARE (2 CD'S PROVIDED; 1 RECORD COPY & 1 COPY FOR DUAL STORAGE, DATED OCTOBER 13, 2003; LABELED UNCLASSIFIED)	TTP.35409	10/13/2003
NEW VERSION REPORT - AGDATATAKER 2.3.2 (STAGS, ABIS-AG)	TTP.35676	10/13/2003
Hardware Documentation		
AIR GAGE SCANNER, SCANNER NUMBER 1 (WD24951)	TTP.27452	5/1/1997

4.0 Lessons Learned

The length of this contract afforded the opportunity to incorporate improvements throughout the life of the contract. The key items are listed below.

Cpk Incentives: This contract included financial incentives that were based on quality performance as measured by the Cpk. This aspect of the contract proved to be a strong motivator for STC to pursue continuous improvement of the PNNL products. From discussions with STC personnel, it was clear that STC management was dedicated to providing resources necessary to meet the incentive requirements as measured by Cpk. Studies conducted by STC revealed how handling of the product between process steps could adversely affect product quality because of the thin-walled nature of this product. As a result, STC invested many resources to set up a dedicated product line such that handling of the finished product was minimized. The incentive appeared to work well as a motivator and contributed to a significant improvement in product quality.

Long Lead Item Planning: The manufacture of the components for this contract required purchasing TREX tubing as feedstock. The lead time for this material was 8 to 12 months.

Lot Size: The initial contract included specific quantities for each shipment. Producing manufacturing lots to meet those specific quantities was difficult, if not impossible. As a result, STC was splitting lots to make up the quantities required by the contract. Often, the split lots resulted in small quantities that were not practical for use by the plating vendor. The resulting modifications to the contract are described above in the contract activities section. With respect to the getter tubes, more thought needs to go into identifying natural lot sizes based on TPBAR assembly campaigns and plating campaigns to make the overall process as efficient as possible.

Inspection Methods: After the manufacture of the LTA components, it was determined that inspection methods used by STC were not consistent with the flexible nature of the product. After the LTA effort, a study was done at PNNL to evaluate inspection methods. It was determined that non-contact measurement techniques, such as laser gage and air gage, were best suited for the components of this contract. Requirements for these measurement techniques were added to the contract.

Flexible Component Measurement Averaging: The design documents for the STC components were modified to allow averaging of the diameter (inside and outside) measurements. This change was based on the flexible nature of the tubing. The use of averaging reduced the likelihood of rejecting components as a result of small levels of ovality.

Appendix A

Contract Modification Summary

Appendix A: Contract Modification Summary

Supp/Mod	Summary of Changes
1 9/15/2000	Document Revisions: H-3-307855, Rev. 4 H-3-307857, Rev. 4 H-3-307858, Rev. 4 H-3-307859, Rev. 5 SOW Rev. 2 Section 2.3.1.2 of SOW modified to allow approval of MAQP in sections.
2 9/27/2000	Ceiling amount increased Authorized milestones 1.1 through 1.4 and 2.1 through 2.21
3 10/5/2000	Document Revision: H-3-307857, Rev. 5 SOW Rev. 3 Editorial change to SOW
4 12/11/2000	SOW Rev. 4 Extended completion date of Phase I to December 28, 2000 Modified due dates for deliverables 1.3, 1.4, and 1.5 Milestone Payment Schedule, Rev. 1 Modified due dates for Milestones 1.1, 1.2, and 1.3
5 2/7/01	SOW Rev. 5 Editorial clarifications Extended completion of Phase I to March 30, 2001 Lots sizes changed to <u>approximate</u> quantities Split shipment of bottom spacers to include a shipment of 120 tubes to the plating vendor Milestone Payment Schedule, Rev. 2 Modified due dates for Milestones 1.1, 1.2, and 1.3
6 5/17/01	Document Revisions: TTQP-1-073, Rev. 3 TTQP-1-077, Rev. 2 TTQP-1-081, Rev. 5 SOW Rev. 6 Extended completion of Phase I to June 15, 2001 Extended completion of Phase II to March 2004 Modified shipping schedules to coincide with extended completion dates Changes to QA provisions 162, 170 and 190
7 10/31/01	Document Revisions: TTQP-1-073, Rev. 4 TTQP-1-077, Rev. 3 TTQP-1-095, Rev. 3 TTQP-1-096, Rev. 5 TTQP-1-081, Rev. 6

Supp/Mod	Summary of Changes
	H-3-307857, Rev. 6 H-3-307858, Rev. 5 SOW Rev. 9 Extended completion of Phase II to September 30, 2001 Modified due date for Milestone 1.5
8 11/29/01	Document Revisions: TTQP-1-081, Rev. 7 TTQP-1-096, Rev. 6 H-3-307855, Rev. 5 H-3-307859, Rev. 6 SOW, Rev. 10—Document revisions only
9 12/21/01	Document Revisions: H-3-307857, Rev. 7 H-3-307858, Rev. 6 SOW, Rev. 11—Document revisions only
10 4/8/02	Document Revisions: none SOW, Rev. 12 The statement of work was modified to allow deviations from the exact quantities specified in the shipping schedule. The following deviations were allowed: <ul style="list-style-type: none"> • A (-0%, +5%) allowable deviation was added to total quantity for each component • A running total deviation of 10% was added to the individual shipments Section 2.3.1.2—A statement was added indicating the need to hold shipments of inner liners until after the receipt of a Certificate of Conformance from PNNL.
11 4/8/03	Major contract modification to transition from the Production Getter design to the FLG design. Document Revisions: TTQP-1-132, Rev. 0 PNNL-TTQP-1-920 Addendum 1, Rev. 0 H-3-307314, Rev. 0 H-3-307322, Rev. 1 Completed Production Getter Stock and Bottom Spacer Stock at current quantities <ul style="list-style-type: none"> • Getter stock, 48,600 • Bottom Spacer Stock, 2000 Added FLG Tube Stock and FLG Spacer Stock <ul style="list-style-type: none"> • FLG Tube Stock, 4100 • FLG Spacer Stock, 3900 Milestone Payment Schedule, Rev. 4 <ul style="list-style-type: none"> • Eliminated future shipments of Production Getter Stock and Bottom Spacer Stock • Added shipments for FLG Tube Stock and FLG Spacer Stock
12 5/19/03	Document Revision: TTQP-1-081, Rev. 8 SOW, Rev. 14—Document revision only

Supp/Mod	Summary of Changes
13	Document Revision: TTQP-1-095, Rev. 4 SOW, Rev. 15 Document Revisions Quantity clarification Editorial

Appendix B

Summary of Milestone Deliverables

Appendix B: Summary of Milestone Deliverables

Milestone	1.1	Total	500
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>	
33000-00	Bottom Spacer Demo		500
Milestone	1.2	Total	500
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>	
33001-00	Getter Tubes Demo		500
Milestone	1.3	Total	524
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>	
33002-0	Demo Liners		406
33002-4	Demo Liners		118
Milestone	1.4	Total	0
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>	
32999-00	Feed Stock		0
Milestone	2.01	Total	2000
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>	
33006-00	Bottom Spacers		2000
Milestone	2.02	Total	3241
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>	
33009-0	Getter Tubes		1542
33009-1	Getter Tubes		1592
33009-2	Getter Tubes		107
Milestone	2.03	Total	2497
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>	
33028-0	Standard Liners		581
33028-1	Standard Liners		937
33028-2	Standard Liners		70
33028-3	Standard Liners		807
33028-4	Standard Liners		102
Milestone	2.04	Total	3240
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>	
33011-0	Getter Tubes		1216
33011-1	Getter Tubes		1843
33011-2	Getter Tubes		181
Milestone	2.05	Total	2497
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>	
33029-0	Standard Liners		637
33029-1	Standard Liners		1860
Milestone	2.06	Total	3240
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>	

33010-1	Getter Tubes	1300
33010-3	Getter Tubes	48
33010-4	Getter Tubes	125
33010-5	Getter Tubes	900
33016-1	Getter Tubes	867
Milestone 2.07	Total	2497
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
33031-0	Standard Liners	1227
33031-1	Standard Liners	1270
Milestone 2.08	Total	3240
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
33012-0	Getter Tubes	1399
33012-1	Getter Tubes	1841
Milestone 2.09	Total	2497
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
33030-0	Standard Liners	1269
33030-1	Standard Liners	1228
Milestone 2.10	Total	3240
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
33009-2S	Getter Tubes	131
33011-0	Getter Tubes	2
33012-0S	Getter Tubes	249
33013-0	Getter Tubes	1282
33013-1	Getter Tubes	1576
Milestone 2.11	Total	2497
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
33035-0	Standard Liners	1362
33035-1	Standard Liners	1135
Milestone 2.12	Total	3240
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
33016-0	Getter Tubes	1686
33016-1	Getter Tubes	1554
Milestone 2.13	Total	2255
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
33030-1S	Standard Liners	122
33031-1S	Standard Liners	317
33036-0	Standard Liners	981
33043-0	Standard Liners	835
Milestone 2.14	Total	4843
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
33015-0	Getter Tubes	1353
33015-1	Getter Tubes	2099
33015-2	Getter Tubes	1391

Milestone	2.15	Total	2777
Lot Number	Description	Quantity	
33037-0	Variable Liners	480	
33037-1	Variable Liners	1199	
33037-3	Variable Liners	558	
33044-0	Variable Liners	540	
Milestone	2.16	Total	1960
Lot Number	Description	Quantity	
33017-1	Getter Tubes	1960	
Milestone	2.17	Total	2335
Lot Number	Description	Quantity	
33029-0S	Standard Liners	458	
33038-0	Standard Liners	1877	
Milestone	2.18	Total	3564
Lot Number	Description	Quantity	
33014-0	Getter Tubes	1033	
33017-0	Getter Tubes	2531	
Milestone	2.19	Total	2342
Lot Number	Description	Quantity	
33039-0	Standard Liners	1163	
33039-1	Standard Liners	1153	
33039-4	Standard Liners	26	
Milestone	2.20	Total	3276
Lot Number	Description	Quantity	
33014-0	Getter Tubes	344	
33014-1	Getter Tubes	1685	
33014-3	Getter Tubes	1247	
Milestone	2.21	Total	2550
Lot Number	Description	Quantity	
33040-0	Standard Liners	1151	
33040-1	Standard Liners	1399	
Milestone	2.22	Total	3564
Lot Number	Description	Quantity	
33018-1	Getter Tubes	2323	
33018-2	Getter Tubes	1241	
Milestone	2.23	Total	2564
Lot Number	Description	Quantity	
33042-0	Standard Liners	1233	
33042-1	Standard Liners	1331	
Milestone	2.24	Total	3564
Lot Number	Description	Quantity	
33019-0	Getter Tubes	1154	
33019-1	Getter Tubes	2410	

Milestone	2.25	Total	2335
Lot Number	Description	Quantity	
33041-0	Standard Liners		939
33041-1	Standard Liners		1396
Milestone	2.26	Total	3689
Lot Number	Description	Quantity	
33018-2	Getter Tubes		625
33019-0	Getter Tubes		679
33020-0	Getter Tubes		2385
Milestone	2.27	Total	2058
Lot Number	Description	Quantity	
33043-0	Standard Liners		640
33043-1	Standard Liners		1418
Milestone	2.28	Total	2967
Lot Number	Description	Quantity	
33020-1	Getter Tubes		2167
33021-0	Getter Tubes		800
Milestone	2.29	Total	2851
Lot Number	Description	Quantity	
33044-0	Variable Liners		1157
33044-1	Variable Liners		1514
34957-1	Variable Liners		180
Milestone	2.30	Total	2963
Lot Number	Description	Quantity	
33021-0	Getter Tubes		557
33021-1	Getter Tubes		1057
33021-2	Getter Tubes		1349
Milestone	2.31	Total	
Lot Number	Description	Quantity	
33022-0	Int Getter		
33022-1	Int Getter		
Milestone	2.32	Total	2497
Lot Number	Description	Quantity	
33045-0	Standard Liners		1455
33045-1	Standard Liners		1042
Milestone	2.33	Total	2467
Lot Number	Description	Quantity	
33045-1	Standard Liners		407
33046-0	Standard Liners		1031
33046-1	Standard Liners		1029
Milestone	2.34	Total	
Lot Number	Description	Quantity	
33023-0	Int Getter		

33023-1	Int Getter		
33024-0	Int Getter		
33024-1	Int Getter		
Milestone 2.35		Total	2492
Lot Number	Description	Quantity	
33046-2	Standard Liners		371
33046-3	Standard Liners		102
33047-0	Standard Liners		1208
33047-1	Standard Liners		811
Milestone 2.37		Total	2459
Lot Number	Description	Quantity	
33047-1	Standard Liners		478
33048-0	Standard Liners		1147
33048-1	Standard Liners		834
Milestone 2.38		Total	
Lot Number	Description	Quantity	
33025-0	Int Getter		
33025-1	Int Getter		
Milestone 2.39		Total	2490
Lot Number	Description	Quantity	
33048-1	Standard Liners		345
33049-0	Standard Liners		1209
33049-1	Standard Liners		936
Milestone 2.4		Total	187
Lot Number	Description	Quantity	
33023-0	FLG Tube		187
Milestone 2.40		Total	
Lot Number	Description	Quantity	
34940-0	Int Getter		
34940-1	Int Getter		
Milestone 2.41		Total	3001
Lot Number	Description	Quantity	
34957-0	Variable Liners		1621
34957-1	Variable Liners		1380
Milestone 2.42		Total	297
Lot Number	Description	Quantity	
33024-0	FLG Tube		141
33024-1	FLG Tube		156
34941-0	Int Getter		
34941-1	Int Getter		
Milestone 2.43		Total	0
Lot Number	Description	Quantity	

34942-0	Int Getter	0
34942-1	Int Getter	0
Milestone 2.44	Total	2494
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
33049-1	Standard Liners	139
34958-0	Standard Liners	1247
34958-1	Standard Liners	1108
Milestone 2.45	Total	388
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
33025-0	FLG Tube	193
33025-1	FLG Tube	195
Milestone 2.46	Total	2472
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
34958-1	Standard Liners	193
34959-0	Standard Liners	1139
34959-1	Standard Liners	1140
Milestone 2.47	Total	124
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
33023-1	FLG Tube	124
Milestone 2.48	Total	2337
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
34960-0	Standard Liners	1200
34960-1	Standard Liners	1137
Milestone 2.49	Total	321
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
34940-0	FLG Tube	170
34940-1	FLG Tube	151
Milestone 2.50	Total	2532
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
34961-0	Standard Liners	1531
34961-1	Standard Liners	1001
Milestone 2.51	Total	312
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
34941-0	FLG Tube	195
34941-1	FLG Tube	117
Milestone 2.52	Total	2532
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
34962-0	Standard Liners	1383
34962-1	Standard Liners	1149
Milestone 2.53	Total	284
<i>Lot Number</i>	<i>Description</i>	<i>Quantity</i>
34942-0	FLG Tube	179
34942-1	FLG Tube	105

Milestone	2.54		Total	3234
Lot Number		Description	Quantity	
		34963-0	Standard Liners	1562
		34963-1	Standard Liners	1672
Milestone	2.55		Total	279
Lot Number		Description	Quantity	
		34943-0	FLG Tube	147
		34943-1	FLG Tube	132
Milestone	2.57		Total	345
Lot Number		Description	Quantity	
		34944-0	FLG Tube	236
		34944-1	FLG Tube	109
Milestone	2.58		Total	1931
Lot Number		Description	Quantity	
		34195-1	Variable Liners	968
		34965-0	Variable Liners	963
Milestone	2.59		Total	311
Lot Number		Description	Quantity	
		34945-0	FLG Tube	160
		34945-1	FLG Tube	151
Milestone	2.60		Total	2292
Lot Number		Description	Quantity	
		34966-0	Variable Liners	1178
		34966-1	Variable Liners	-93
		34966-1	Variable Liners	1207
Milestone	2.61		Total	3986
Lot Number		Description	Quantity	
		34985-1	FLG Spacers	1450
		34985-2	FLG Spacers	1502
		38165-1	FLG Spacers	138
		38165-2	FLG Spacers	896
Milestone	2.63		Total	337
Lot Number		Description	Quantity	
		34947-0	FLG Tube	138
		34947-1	FLG Tube	199
Milestone	2.64		Total	358
Lot Number		Description	Quantity	
		34948-0	FLG Tube	191
		34948-1	FLG Tube	167
Milestone	2.65		Total	293
Lot Number		Description	Quantity	
		34949-0	FLG Tube	190
		34949-1	FLG Tube	103

Appendix C

Source Verification Activities

Appendix C: Source Verification Activities

LOT #	STC LOT TRACE INFO /	APP. CONT SUPMT	# SHIP FROM STC	SOURCE INFO -DATE -REPORT / RELEASE (x)	GE T *LG	LIN	SP	C of C (Liner)	RE-INSPECT STATUS ** 100% STC Inspect * 100% due to Source
33006-0		6	2000	<u>9/27/01</u> -(x)			X	-	*Straightness
33006-0S		6	-	" (x)			X		[76 to Stock]
33002-4		5	117	" (x)		X		-	(Ship to PNNL)
33002-0		5	406	" (x)		X		-	(Ship to PNNL)
33009-0	33009-3	6	1542	<u>11/7/01</u> (x)	X			-	**OD, Straightness, Burrs
33009-1	33009-2	6	1592	" (x)	X			-	**ID
34936-0			452	<u>12/19/01</u> (x)	X			-	
34933-0			61	" (x)	X*			-	**Straightness, OD, Splits
34933-1	34933-0		10	" (x)	X*			-	**Straightness, OD, Splits
34934-0			109	" (x)	X*			-	**Burrs, OD, Visual, Straightness
33028-0	33028-3	9	581	" (x)		X		2/15/0 2	
34935-0		9	109	<u>1/15/02</u> (x)	X*			-	*OD **ID, (Ship to PNNL)
33009-2	33009-1	9	107	" (x)	X			-	
33009-2S	33013-2 (131)	9	131	" (x)	X			-	[To Stock 131]
33009-3		-	-	-	X			-	LOT SCRAP BY STC
33011-0		9	1216	" (x)	X			-	**ID
33011-0S	33010-5 (900) 33013-3 (2)	9	982	" (x)	X			-	[To Stock 982]
33011-1		9	1843	" (x)	X			-	
33011-2		9	181	" (x)	X			-	
33028-1		-	-	"		X		-	*OD - NOT RELEASED See 1/28/02 Source
33028-2		9	70	" (x)		X		2/7/02	
33029-1		9	1860	<u>1/28/02</u> (x)		X		2/7/02	
33028-1		9	937	" (x)		X		2/7/02	*Flange, **OD, Flange, Straightness
33028-4	33029- 0S 33029-0	9	102	" (x)		X		2/7/02	
33029-0	33028-4 33028-0s	9	637	" (x)		X		2/7/02	
33029-0S	33028-4	9	560	" (x)		X		-	[To Stock 560] Reference:

LOT #	STC LOT TRACE INFO /	APP. CONT SUPMT	# SHIP FROM STC	SOURCE INFO -DATE -REPORT / RELEASE (x)	GE T *LG	LIN	SP	C of C (Liner)	RE-INSPECT STATUS ** 100% STC Inspect * 100% due to Source
	(102)								7/29/02 Source.
33028-3		9	807	" (x)		X		2/7/02	**Visual
33031-0		9	1227	<u>2/25/02</u> (x)		X		3/6/02	**OD
33031-1		9	1270	" (x)		X		3/6/02	
<i>33031-IS</i>		9	317	" (x)		X		-	[To Stock]Reference 7/29/02 Source
33010-1		9	1300	" (x)	X			-	**Visual, ID, Straightness
33010-3		9	48	"(x)	X			-	*ID/Str,
33010-5	33011-0s	9	900	"(x)	X			-	**Vis, OD, Flange
33010-0		-	-	-	X			-	*ID/OD -Not Released See 3/18/02
33012-1		9	1841	<u>3/18/02</u> (x)	X			-	**Straightness, Visual
33010-0		-	-	-	X			-	*ID, **OD/ID Lot Scrap by STC
LOT #	STC LOT TRACE INFO /	APP. CONT SUPMT	# SHIP FROM STC	SOURCE INFO -DATE -REPORT / RELEASE (x)	GE T *LG	LIN	SP	C of C (Liner)	RE-INSPECT STATUS ** 100% STC Inspect * 100% due to Source
33030-0		9	1269	<u>3/26/02</u> (x)		X		4/6/02	**Surface, OD, Flange
33012-0	See 5/13/02 Source	-	-	<u>4/24/02</u>	X			-	*ID **Straightness, Visual
<i>33012-0S</i>	"	-	-	-	X			-	*ID
33013-1	"	-	-	-	X			-	*ID **OD/ID, Visual, Straightness
33013-0	"	-	-	-	X			-	*ID **OD, Visual,
<i>33013-IS</i>	"	-	-	-	X			-	*ID **Visual, OD
33030-1		9	1228	" (x)		X		5/31/02	**Visual, OD
<i>33030-IS</i>		9	122	" (x)		X		-	[To Stock 122]Reference 7/29/02 Source
33035-0		9	812	" (x)		X		5/31/02	(550 Ship to PNNL) **Surface
33012-0		9	1399	<u>5/13/02</u> (x)	X			-	
<i>33012-0s</i>		9	249	" (x)	X			-	[To Stock 249] (Ship to PNNL)
33013-0		9	1282	" (x)	X			-	
33013-1		9	1576	" (x)	X			-	
33035-1		9	1135	" (x)		X		6/14/0	*Flange, **Visual

LOT #	STC LOT TRACE INFO /	APP. CONT SUPMT	# SHIP FROM STC	SOURCE INFO -DATE -REPORT / RELEASE (x)	GE T *LG	LIN	SP	C of C (Liner)	RE-INSPECT STATUS ** 100% STC Inspect * 100% due to Source
								2	
33035-1s		9	15			X			[To Stock 15]
33013-2	33009-2S	9	131	See 1/15/02	X			-	(Ship to PNNL)
33013-3	33011-0S	9	2	See 1/15/02	X			-	(Ship to PNNL)
33016-0		9	1686	<u>5/27/02(x)</u>	X			-	**OD/ID, Visual
33016-1	33016-1S	9	2421	(x)	X			-	**ID
33016-1S		9	364	(x)	X			-	[To Stock 364] **ID
33015-0		10	1354	<u>6/26/02 (x)</u>	X				*ID **OD/ID, Straight
33015-1		10	2099	"(x)	X				
33036-0		10	981	"(x)	X	X		8/01/02	**OD, Flange
33038-0		10	1877	"(x)		X		8/01/02	*OD**Flange
33015-2		10	1391	"(x)	X				
33036-1	-	-	-	-		X			Lot Scrap by STC
33017-0		10	2531	<u>7/29/02 (x)</u>	X				**Straightness
33017-1		10	1960	"(x)	X				**Straightness
33029-0s	Stock	9	458	"(x)		X		8/26/02	
33030-1s	Stock	9	122	"(x)		X		8/26/02	
33031-1s	Stock	9	317	"(x)		X		8/26/02	
33037-0		10	480	<u>8/26/02</u>		X/V		9/19/02	
33037-1		10	1199	"(x)		X/V		9/19/02	**Weight
33037-3		10	558	"(x)		X/V		9/19/02	**Visual, Flange Size
33014-0		10	1377	"(x)	X				
33014-1		10	1685	"(x)	X				**Visual
33014-3		10	1247	"(x)	X				
33018-1		10	2332	"(x)	X				**Straightness
33039-0		10	1163	<u>9/23/02</u>		X		12/16/02	**Visual
33039-1		10	1153	"(x)		X		12/16/02	
33039-4		10	26	"(x)		X		12/16/02	*Visual **Visual, Straight, OD
33040-0		10	1151	"(x)		X		12/16/02	*OD **Visual, OD, Flange

LOT #	STC LOT TRACE INFO /	APP. CONT SUPMT	# SHIP FROM STC	<u>SOURCE INFO</u> -DATE -REPORT / RELEASE (x)	GE T *LG	LIN	SP	C of C (Liner)	RE-INSPECT STATUS ** 100% STC Inspect * 100% due to Source
									Size
33040-1		10	1399	“(x)		X		12/16/02	**Visual, Flange Size
33018-2		10	1866	“(x)	X				**Straightness, OD, ID
33019-0		10	1833	“(x)	X				
LOT #	STC LOT TRACE INFO /	APP. CONT SUPMT	# SHIP FROM STC	<u>SOURCE INFO</u> -DATE -REPORT / RELEASE (x)	GE T *LG	LIN	SP	C of C (Liner)	RE-INSPECT STATUS ** 100% STC Inspect * 100% due to Source
33019-1		10	2410	“(x)	X				**Visual
33020-0		10	2385	Source Waive 10/02	X				**Visual
33020-1		10	2167	“	X				**ID
33021-0		10	1357	“	X				**ID, Straightness
33021-1		10	1057	“	X				**OD, ID, Straightness
33021-2		10	1349	“	X				**Visual, Straightness
33041-0		10	939	“		X		12/16/02	CNCR 330088-004
33041-1		10	1396	“		X		12/16/02	CNCR 330088-004
33042-0		10	1233	“		X		12/16/02	**OD
33042-1		10	1331	“		X		12/16/02	**Flange Size
33043-0		10	1475	Source Waiver 11/02		X		1/7/03	**Visual, OD
33043-1		10	1418	“		X		1/7/03	**Visual
33022-0		10	-	“	X				Transition Lots to LG
33022-1		10	-	“	X				Transition Lots to LG
33023-0		10	-	“	X				Transition Lots to LG
33023-1		10	-	“	X				Transition Lots to LG
33044-0		10	1697	Source Waiver 12/02		X/V		1/7/03	**Visual
33044-1		10	1514	“		X/V		1/7/03	**Visual
33024-0		10	-	“	X				Transition Lots to LG
33024-1		10	-	“	X				Transition Lots to LG
33045-0		10	1445	Waiver		X		3/6/03	**Visual, OD
33045-1		10	1449	Waiver		X		3/6/03	**OD
33046-0		10	1031	Waiver		X		3/27/03	**OD, Flange Size
33046-1		10	1029	Waiver		X		3/27/03	**Visual
33046-2	33044-1	10	371	Waiver		X		3/27/03	**OD flange,
33046-3		10	102	Waiver		X		3/27/03	

LOT #	STC LOT TRACE INFO /	APP. CONT SUPMT	# SHIP FROM STC	<u>SOURCE</u> <u>INFO</u> -DATE -REPORT / RELEASE (x)	GE T *LG	LIN	SP	C of C (Liner)	RE-INSPECT STATUS ** 100% STC Inspect * 100% due to Source
								3	
33047-0		10	1208	Waiver		X		4/22/03	**Visual, Straightness
33047-1		10	1289	Waiver		X		4/22/03	
33048-0		10	1147	Waiver		X		4/22/03	**Visual
33048-1		10	1179	Waiver		X		4/22/03	**Visual
33049-0		11	1209	Waiver		X		5/29/03	**OD, Visual
33049-1		11	1075	Waiver		X		5/29/03	**Visual
34957-0		12	1621	Source 5/03		X-V		6/10/03	
34957-1		12	1560	Source 5/03		X-V		6/10/03	**OD
34938-0		40695 7Mod 6	150	Source 5/03			X- FL	-	?
38165-1		12	13	Waiver			X- FL	-	?
34958-0		12	1247	Waiver		X		7/18/03	
34958-1		12	1301	Waiver		X		7/18/03	