ENGINEERING CHANGE NOTICE

Page 1 of 2 KN

1. ECN 655423

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental ○ Direct Revision ● Change ECN ○ Temporary ○ Standby ○ Supersedure ○ Cancel/Void ○	David Tedeschi E6-15, 372-1485	○ Yes ● No	May 16, 2000
	6. Project Title/No./Work Order No.: Fuel Retieval System /SNF	7. Bldg./Sys./Fac. No.: 105 KE/105 KW/70.1	8. Approval Designator: N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.): HNF-3526 rev 2	10. Related ECN No(s).: N/A	11. Related PO No.: N/A

12a. Modification Work	12b. Work Package No.	12c. Modification Work Completed	12d. Restored to Original Condition (Temp. or Standby ECNs only)
○ Yes (fill out Blk. 12b) ● No (NA Blks. 12b, 12c, 12d)	N/A	N/A Design Authority/Cog. Engineer Signature & Date	N/A Design Authority/Cog. Engineer Signature & Date

13a. Description of Change 13b. Design Baseline Document? ● Yes ○ No

This ECN revises "Design Package for Fuel Retrieval System Fuel Handling Tool Modification" HNF-3526 from rev 2 to rev 3:

The following changes were made:

1) Discussed evaluations of prototypes.
2) Added in pictures
3) Added in ATP for final designs

14a. Justification (mark one)	14b. Justification Details
Criteria Change ○ Design Improvement ● Environmental ○ Facility Deactivation ○ As-Found ○ Facilitate Const. ○ Const. Error/Omission ○ Design Error/Omission ○	These additions will keep all the design life information assembled into one package. This package has been assigned an approval designator of N/A per HNF-PRO-233. USQ Categorical Exclusion, AP-NS-001-14 Appendix C Item K.

15. Distribution (include name, MSIN, and no. of copies)

DJ Tedeschi E6-15 1 Advanced
PA Young X3-88 1
GE Stegen X3-76 1
TA Delucchi L6-38 1
DR Jackson K5-22 1
Central Files B1-07 1
RL Reading Rm. H2-53 1
FRS Working Files X3-88 1
KBasin Project Files X3-85 1
JM Henderson G6-87 1
JA Dent X3-65 1
JC Tucker K5-22 1
SD Godfrey X3-88 1

RELEASE STAMP

JUN 13 2000
DATE: HANFORD RELEASE
STA: 15
ID: 21

A-7900-013-2 (10/97)

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): 655423

16. Design Verification Required
- ○ Yes
- ◉ No

17. Cost Impact

	ENGINEERING	CONSTRUCTION
Additional	$ N/A	$ N/A
Savings	$ N/A	$ N/A

18. Schedule Impact (days)
- Improvement ○ N/A
- Delay ○ N/A

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	☐	Seismic/Stress Analysis	☐	Tank Calibration Manual	☐
Functional Design Criteria	☐	Stress/Design Report	☐	Health Physics Procedure	☐
Operating Specification	☐	Interface Control Drawing	☐	Spares Multiple Unit Listing	☐
Criticality Specification	☐	Calibration Procedure	☐	Test Procedures/Specification	☐
Conceptual Design Report	☐	Installation Procedure	☐	Component Index	☐
Equipment Spec.	☐	Maintenance Procedure	☐	ASME Coded Item	☐
Const. Spec.	☐	Engineering Procedure	☐	Human Factor Consideration	☐
Procurement Spec.	☐	Operating Instruction	☐	Computer Software	☐
Vendor Information	☐	Operating Procedure	☐	Electric Circuit Schedule	☐
OM Manual	☐	Operational Safety Requirement	☐	ICRS Procedure	☐
FSAR/SAR	☐	IEFD Drawing	☐	Process Control Manual/Plan	☐
Safety Equipment List	☐	Cell Arrangement Drawing	☐	Process Flow Chart	☐
Radiation Work Permit	☐	Essential Material Specification	☐	Purchase Requisition	☐
Environmental Impact Statement	☐	Fac. Proc. Samp. Schedule	☐	Tickler File	☐
Environmental Report	☐	Inspection Plan	☐	None	☒
Environmental Permit	☐	Inventory Adjustment Request	☐		☐

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number/Revision
None		

21. Approvals

	Signature	Date		Signature	Date
Design Authority	GE Stegen [signature]	6/5/00	Design Agent	DJ Tedeschi [signature]	5/31/00
Cog. Eng.			PE		
Cog. Mgr.	W.A. Evans [signature]	6/5/00	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other			Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

ሆ

HNF-3526
Revision 3

Design Package for Fuel Retrieval System Fuel Handling Tool Modification

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200
Fluor Hanford
P.O. Box 1000
Richland, Washington

HNF-3526
Revision 3
ECN 655423

Design Package for Fuel Retrieval System Fuel Handling Tool Modification

Document Type: TR   Division: SNF

D. J. Tedeschi
Fluor Federal Services

Date Published
June 2000

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200
Fluor Hanford
P.O. Box 1000
Richland, Washington

JUN 13 2000
DATE:
STA: 15
HANFORD RELEASE
ID: 21

Karen Noland   6/13/2000
Release Approval   Date   Release Stamp

Total Pages: 31 KN

RECORD OF REVISION	(1) Document Number HNF-3526	Page 1

(2) Title

Design Package For Fuel Retrieval System Fuel Handling Tool Modification

Change Control Record

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	(5) Cog. Engr.	(6) Cog. Mgr.	Date
0	(7) EDT-607377 11/11/98 KN			
1	Added in testing documentation [illegible] 3/5/99	Bruce Gunn	[illegible]	
2	Remove items dealing with elastomer [illegible]. Added new items pertaining to new stinger design. See ECN 627[illegible] for more details	Gary Strom	[illegible] 3/27/00	
3 RS	Added pictures of prototypes and information on which one was chosen. Added ATP for final tools	[illegible]	[illegible] 6/5/00	

A-7320-005 (10/97)

Design Package for

Fuel Retrieval System Fuel Handling Tool Modification

HNF-3526 Rev 3

May 16, 2000

By *David Tedeschi*
of

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Richland, WA 99352

For Spent Nuclear Fuel Project, Fuel Retrieval System Sub-Project
in
Fluor Hanford Inc.
P.O. Box 1000
Richland, WA 99352

1.0 Introduction

The Fuel Retrieval System (FRS) Subproject at Hanford's 100 K basins Spent Nuclear Fuel Project has employed robotic arms (named Konan) to load fuel elements into long term storage baskets.

One Konan uses a fuel handling tool ("stinger tool") to load outer fuel elements into the fuel baskets. The stinger is inserted inside an outer fuel element after the element is placed vertically in a go-no-go gage, used to determine if the fuel can be loaded into an MCO basket socket. The Schilling supplied stinger operates by expanding an elastomer spring inside the outer fuel element. The spring is actuated in its expanded mode when the Konan jaws are opened. The spring's expansion exerts enough force against the inner diameter of the element's wall that it can be lifted.

Use of the Schilling stinger tool in FRS testing and training proved to be inadequate for the expected throughput requirements. This design package provides a new stinger design that will meet requirements listed in this document. The new design will incorporate Schilling's design for attaching the stinger to the Konan.

2.0 Scope

2.1 Objectives

This design package documents design, fabrication, and testing of new stinger tool design. Future revisions will document further development of the stinger tool and incorporate various developmental stages, and final test results.

2.2 Products Delivered

Results from this package will deliver the following:

<u>Documents</u>

a) Functions and requirements, analysis, graphical depictions, test specifications, test procedures, and final test reports

b) Hanford formatted drawings and ECN/modifications to vendor information files

c) Acceptance test requirements for production units

d) Vendor information

Hardware
a) Prototype stinger tool
b) Final stinger tool

3.0 Brief Description of Problem

The actuation mechanism of the stinger provided by Schilling, is prematurely failing due to loads it endures under normal basket loading conditions. High concentrated stresses exceed the yield strength of the actuation mechanism, which causes deformation and eventual failure. The actuation mechanism is a push-pull cable type device. It consists of a wire rope sliding through a wire-braided sleeve. When the Konan jaws are opened, a lever arm attached to the sleeve pushes the sleeve over the wire rope. The sleeve applies a compressive force to the urethane spring that causes the spring to expand. The elastomer spring expansion applies a force against the inner wall of the fuel element, which enables the fuel element to be lifted. A fuel element will be lifted, as long as the frictional forces between the wall of the element and the elastomer spring are not overcome by the weight of the fuel element. See vendor information file CVI 50062, drawing number 101-3737, by GEC Alsthrom, for graphical depiction of the Schilling stinger.

4.0 Products Requirements and Constraints

General design requirements/criteria for the Spent Nuclear Fuel Project Fuel Retrieval subproject are in HNF-S-0461, *Specification For Design Of The SNF Project Fuel Retrieval Subproject*. The following additional requirements apply specifically to the stinger tool.

4.1 Dimensional/Physical Constraints

a) Stinger will pick up an outer fuel element that is placed in the vertical position but not be required to pick up an inner fuel element.

b) Length of the actuator mechanism is approximately 18 + 2, -0. inches but will be determined by testing through successful loading of an dummy outer fuel element into an MCO basket.

c) Stinger end-effector must be able to accommodate the following dimensions:

Fuel Elements
- Outer fuel element maximum inside diameter: 1.779 inches.

- Outer fuel element minimum inside diameter: 1.691 inches.

(Dimensions taken from drawing number H-1-39775)

- Assume outer fuel element weighs approximately 35 lbs. in air. Reference HNF-SD-SNF-TI-009, rev. 2, *105-K Basin Material Design Basis Feed Description for Spent Nuclear Fuel Project Facilities*.

Based on the above information, the design parameters are the following:

a) Stinger can pick up fuel elements weighing 35 lbs. (dry weight) with inside diameters ranging from 1.64 to 1.9 inches.

b) Stinger can pick up a fuel elements weighing 35 lbs. (dry weight) when its end-effector is inserted in the element a minimum of .25 inches.

4.2 Environmental Constraints

a) Stinger material must be able to withstand the effects of a high radiation field of 40 rem/hr for 90 days. This value is a conservative interpretation of BNFL Inc. Report L/B-SD-SNF-RPT-04, *Radiological Shielding Design Plan for the SNF Fuel Retrieval Project*.

b) Stinger shall be submersible in deionized water at a temperature of 50 °F for its design life.

4.3 Operational Requirements

a) Stinger should operate for a minimum period of 3 months assuming 3 shifts per day, 7 days a week, and process about 140 fuel assemblies per day. The stinger life expectancy should be 90 days, based on these assumptions.

b) Stinger shall be able to operate under 7-20 feet of water.

c) Stinger actuation design shall take into account the following possible forces induced on it in the various directions:

- A tensile force due to lifting the fuel element (approximately) 35 lbf dry weight.
- A compressive force due to placement of element. Actual amount of force is unknown and may vary with the stinger design. However, an estimated maximum force is about 400 lbf.

- A lateral force due to inserting the stinger in the element, rotating the fuel basket, and placing an element inside the basket. Actual amount of force is unknown.

d) Stinger shall be able to be inserted in a fuel element and used to rotate the fuel basket.

e) Stinger tool shall be flexible enough to hang plumb when being inserted into an element and when trying to insert an element into a fuel basket. The design needs to accommodate a free motion of the block ± 6 inches in a hemispherical direction.

f) Stinger shall not cause damage to the camera or hinder wrist movement when wrist rotates. Upon wrist rotation, it is desired that the stinger hangs with a tip to toe distance of 1 foot.

g) Stinger will not be used to pull fuel from a canister.

h) Stinger should account for potential snags that could produce a load of 350 lbf in tension. (This reemphasizes requirement 4.3 C).

4.4 Maintenance Requirements

a) Stingers will be thrown away unless there is an inexpensive method for replacing failed parts.

b) The Schilling supplied stinger block that attaches the stinger to the Konan arm shall be used as a part of any new design. The block has been designed for easy attachment and removal from the Konan and it has been accepted by Operations.

c) Stinger shall be fully retrievable if it fails when inside a fuel element. *Note: This requirement was not incorporated in the value analysis evaluation of the design but was accounted for in the designs.*

4.5 Applicable Laws, Regulations, and Standards

Applicable Fluor Daniel Hanford Engineering and SNF Project procedures shall be used for documenting development stages of design, reviews, and approvals of engineering documents.

4.6 Additional Objectives

These objectives are to be considered when evaluating prototypes that meet all the requirements but need additional reasons for determining the best design.

- Fabrication cost
- Higher life expectancy
- Takes abuse well
- Handles better/ minimal aligning required for deployment
- Minimal training required
- Operator preference

5.0 Development of Product

5.1 Management of Task

5.1.1 Engineering

Engineering will be done using a team made up of staff from Fluor Federal Services, Cogema, and Pacific Northwest National Laboratories. Documents will be approved by Fluor Hanford Inc. Fuel Retrieval System Design Authority(s).

5.1.2 Procurement

Developmental materials will be procured using credit cards from Numatec, Cogema, or Pacific Northwest Laboratories. Final parts will be ordered using appropriate Quality levels as directed by the Design Authority(s).

5.1.3 Initial Project Fabrication and Construction

Fluor Federal Services will be responsible for managing final fabrication and DynCorp or HAMTC personnel will be responsible for final construction. The FRS Project Manager will determine use of another contractor for managing the fabrication as required.

5.1.4 Prototype

Prototypes will be assembled using Fluor Federal Services, Cogema, and Pacific Northwest Laboratories. The Engineer in charge will maintain redline control of prototype fabrication drawings/sketches. Prototype testing and test results will be documented by the FRS test engineer.

5.2 Discussion of Development

Operational testing of the Schilling stinger tool revealed that the tool had to be modified significantly for long-term use. See previous revisions of this document for a history on what was done to reach this determination.

The first modification made was a replacement of the large elastomer spring. Operational testing showed that the stinger tool needed to lift an outer element only and that the inner elements would be loaded with the jaws. This led to modifications accommodating outer elements exclusively. Based on engineering experiences with similar devices, it was decided to use an expanding collet rather than the elastomer spring. After prototype testing several collets with various materials, Inconel 718 gave the best results. It has a yield strength of 170 ksi if heat treated, which proved to provide the collet with necessary spring properties.

The collet is a split tube with concentric internal angles on either side. The collet expands when two stainless steel conical end pieces, cut to the same angle as the collet, are forced into the collet. The dual pieces cause the collet to uniformly expand which helps prevent it from deforming if it is inserted only partialy into an element.

Operational testing also demonstrated us of the Schilling mounting block that connects the stinger to the Konan and its ease of removal. A separate tool was developed to remove the block and can be found on drawing H-1-83905, "K-Basin FRS Konan Manipulator Fuel Tool Extractor Device".

Observation of the failed Schilling tool and other prototypes showed that failure occurred primarily in the actuation mechanism that expands the collet. A team consisting of Operations, Engineering and Technicians were assembled to evaluate the problem. The team refined the stinger requirements (refinements have been incorporated in section 4.0) and brainstormed 7 solutions. Solutions can be found in Appendix F. The team decided that the final design should use the collet design with the Schilling mounting block and concentrate efforts on modifying the actuation method. Several solutions were brainstormed and then evaluated using a value analysis process.

A value analysis process ranks the criteria/requirements of the tool and evaluates them against each potential design (with what knowledge is known about the design). The designs are then ranked based on the highest score it receives. Analysis documentation including the Criteria Matrix, Evaluation Matrix, and the Criteria can be found in Appendix F.

The value analysis showed the design most able to meet the requirements was the reverse acting design that has the collet normally expanded. The actuation mechanism is used to relieve the expansion when the jaws are opened. The second ranked design uses self-contained hydraulics as a means for actuation the collet. This design uses water as its hydraulic fluid. The third ranked design is a modification of the existing style with a cable inside a sheath for its actuation.

Fluor Federal Services(FFS), Cogema (COE), and Pacific Northwest National Labs (PNNL)each took one of the three designs and built a prototype for testing. PNNL's design modified the Schilling stinger, FFS design implemented a stinger using hydraulic actuation, and COE's design used a reverse actuation style. The PNNL tool was finished first and was tested on the Konan for the longest time. It was chosen by Operations to be used in the basin. See Section 5.3 for a discussion on how the tools were evaluated. See Appendix A for pictures of the designs.

Final designs were documented on drawings. The Hanford retrieval numbers for them are:

PNNL design	H-1-84841
COE design	H-1-84843
FFS design	H-1-84839

5.2.1 Sketches/Drawings

All graphical depictions will be found in Appendix A. This Appendix contains the following:

- Sketch of test setup
- Pictures of designs and test setup

5.3 Verification of Product Design

Verification of the stinger modifications were done through prototype testing. The testing verified features/requirements listed in section 4 of this document. Upon satisfaction of a prototype, the design(s) will be documented using an H-1- series drawing and a final tool will be fabricated from a released drawing. Final design verification tests will be performed per the attached verification test specification and attached in Appendix D. Acceptance testing of fabricated stingers to be used in the basin will be done to confirm that the tool was fabricated correctly and that it still operates like the prototype stinger. This testing will be done before being used in the field.

5.3.1 Analysis

5.3.1.1 Calculations

There were no calculations done.

5.3.1.2 Testing

Each design underwent testing as apart of its verification. This testing was to include a consistent evaluation, (as discussed in the previous revision). Due to lack of funding and time constraints, the evaluations consisted of minimal operation time on the Konan and placing the tools on cyclic machine. Consequently, the evaluation sheets were never filled out.

All three designs were placed on a cyclic machine that continually actuates the collet. Each design successfully underwent 50,000 plus cycles and still operated after testing was complete. During the test, the collet's diameter was measured in the fully actuated and nonactuated position. Minimal degrading was observed in any of the designs. The reverse actuation (COE's design,) did encounter significant wear issues but were overcome by a better choice of materials. The other two designs worked near almost flawlessly. Significant changes noted were documented in a logbook. Copies of the log are in Appendix C. See Appendix A for a sketch and pictures of the test setup.

Final fabrication of the stinger will be subjected to an Acceptance test. The test is attached in Appendix D. This test will verify that the tools were a fabricated correctly and will ensure any minor adjustments are made before releasing them into service.

6.0 Turn Over of Product

6.1 Final Design Description

The final design(s) were documented on separate drawings. See discussion for a list of the drawing numbers.

7.0 References

Radiological Shielding Design Plan for the SNF Fuel Retrieval Project.
BNFL Inc. Report L/B-SD-SNF-RPT-04

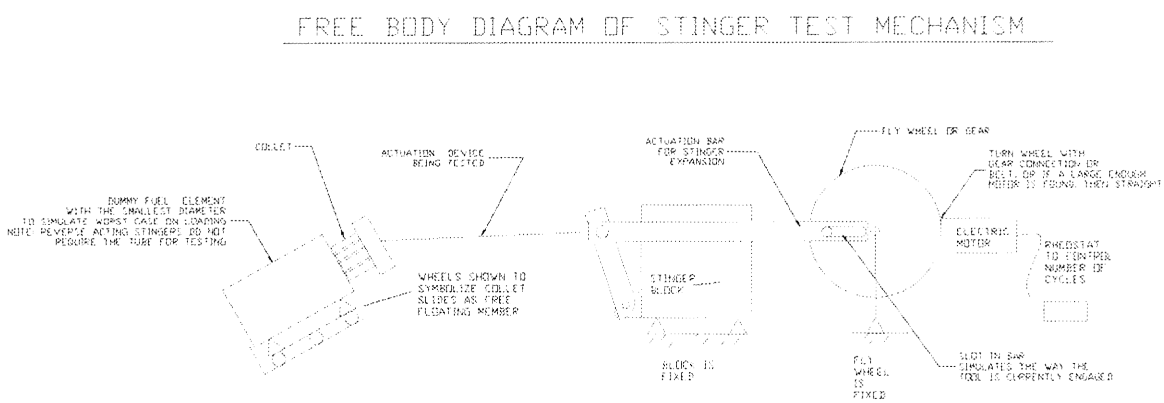
105-K Basin Material Design Basis Feed Description for Spent Nuclear Fuel Project Facilities. HNF-SD-SNF-TI-009, rev. 2

Specification For Design Of The SNF Project Fuel Retrieval Subproject,. HNF-S-0461

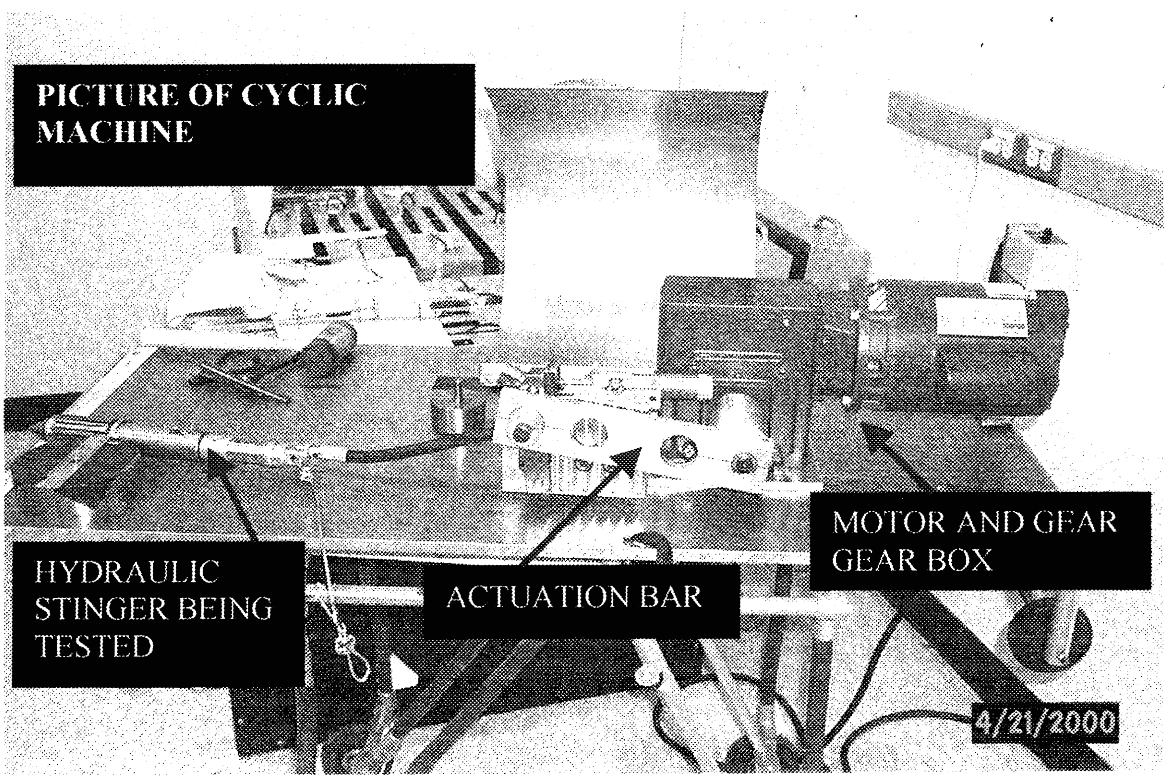
Final Report –Spent Nuclear Fuel Retrieval System Manipulator System Cold Validation Testing, PNNL - 12135

Appendix A

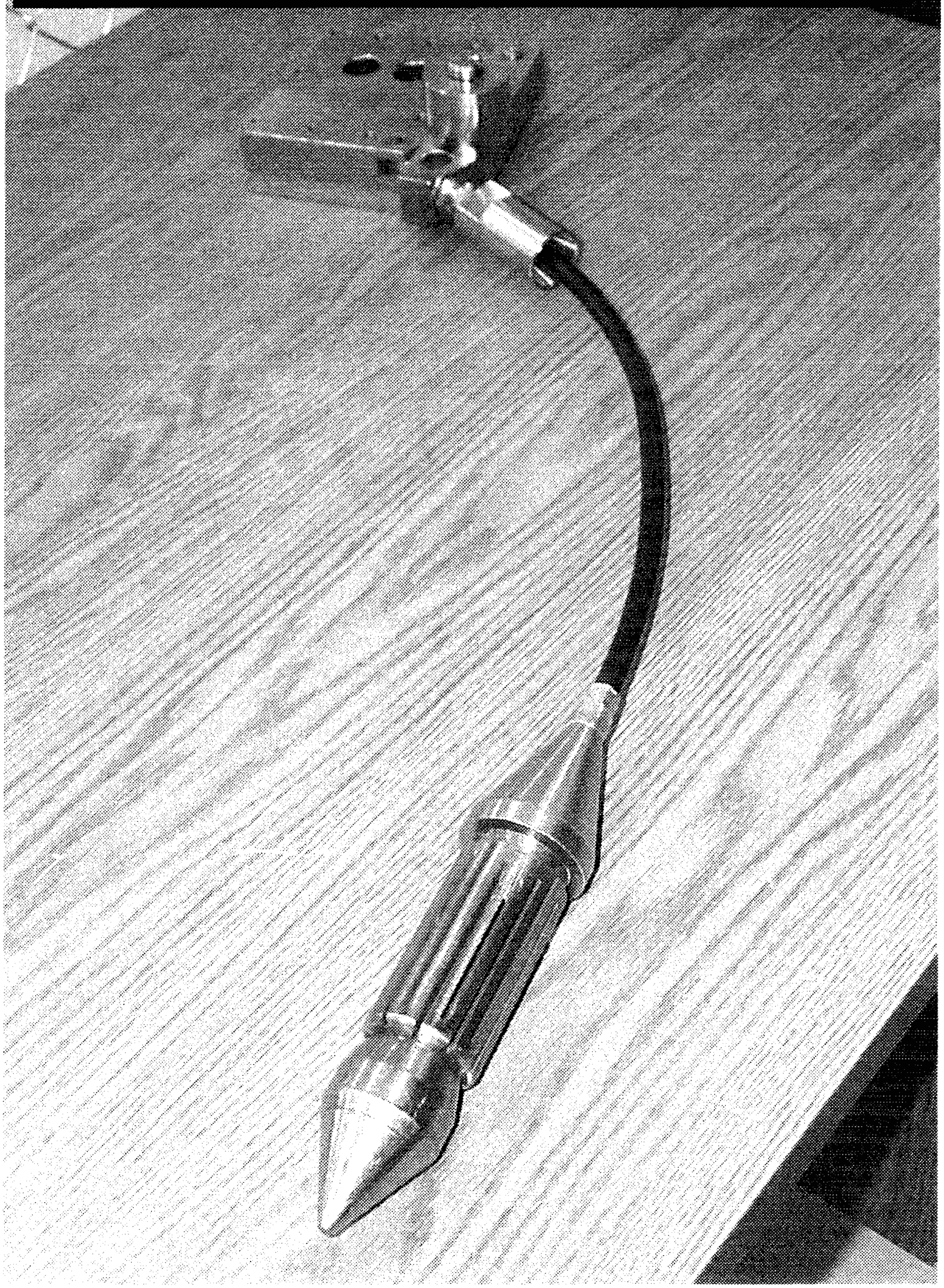
Graphical Depictions of Product

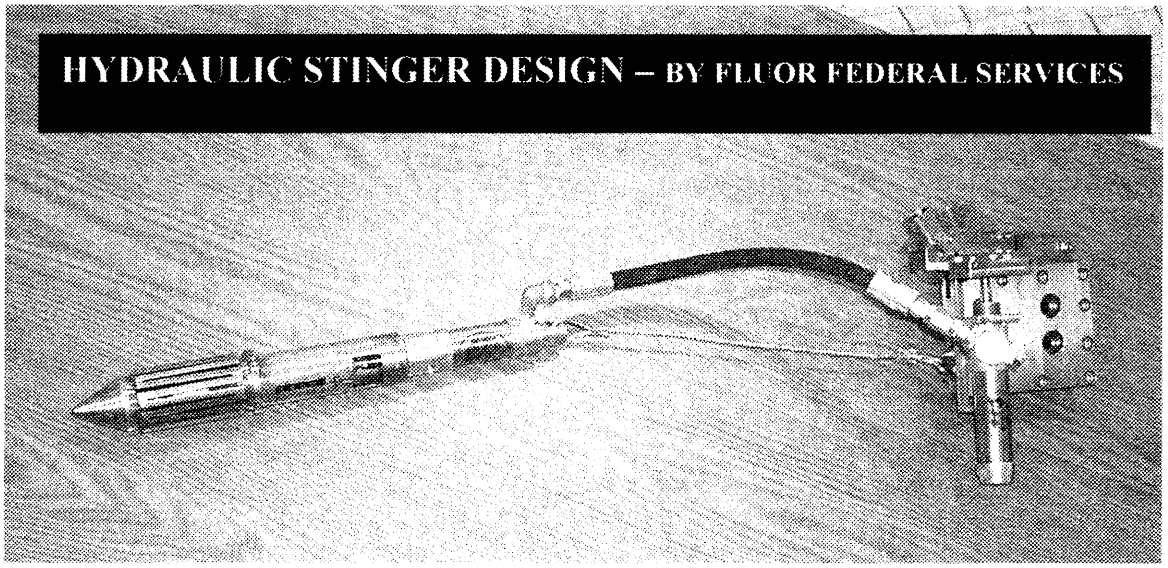


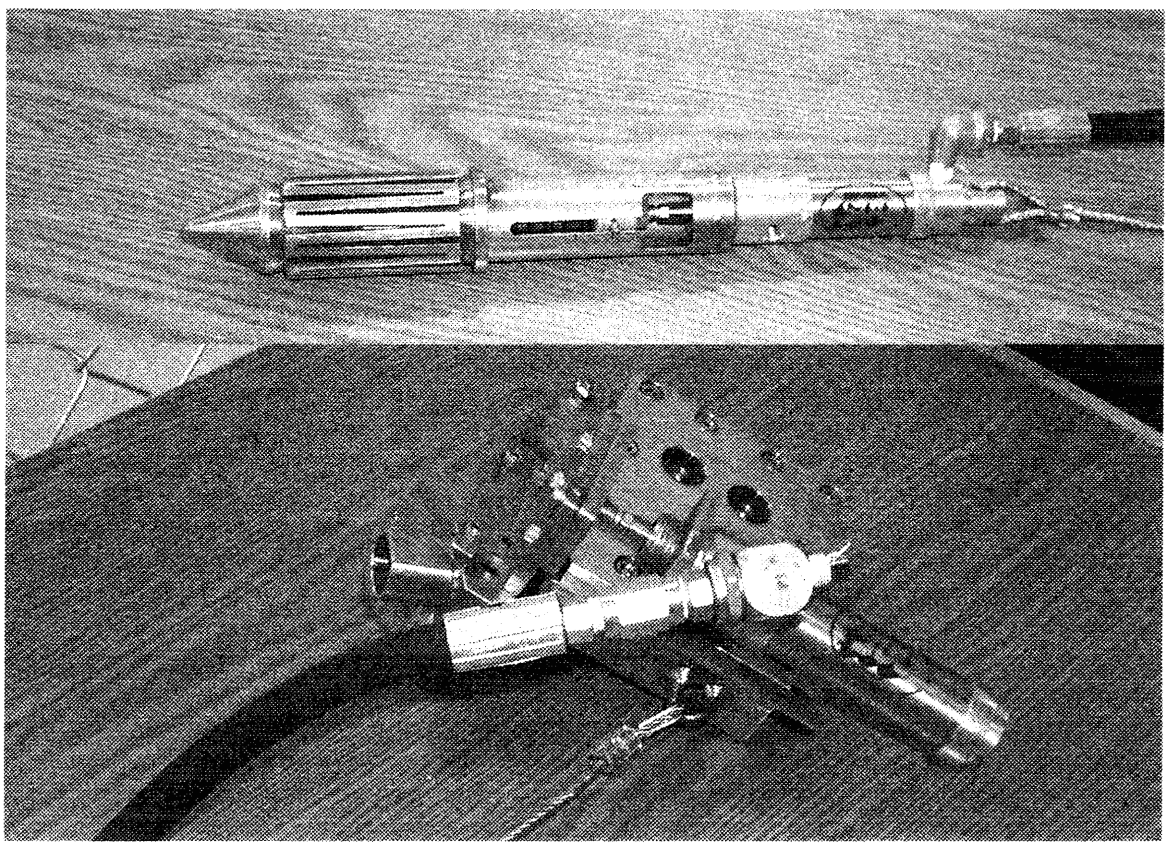
Sketch of Cyclic Machine used to test stinger collet actuation.

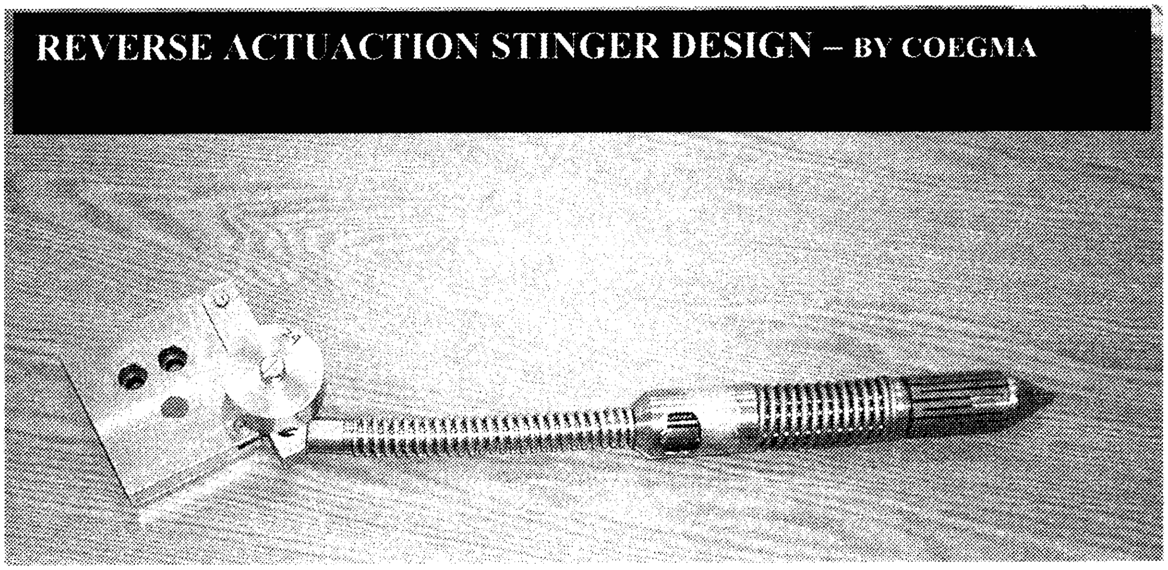


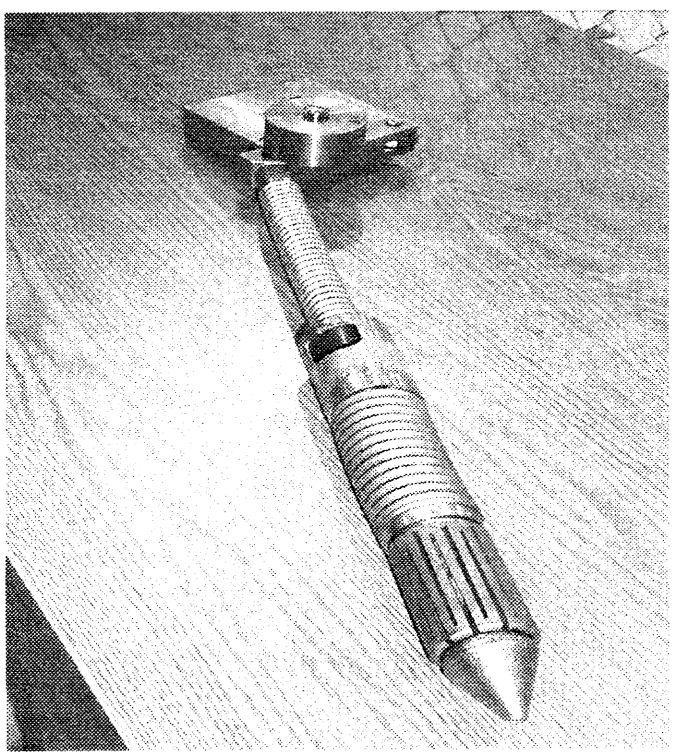
DIRECT ACTING STINGER DESIGN - BY PACIFIC NORTHWEST NATIONAL LABORATORY




HYDRAULIC STINGER DESIGN – BY FLUOR FEDERAL SERVICES




REVERSE ACTUACTION STINGER DESIGN – BY COEGMA



Appendix B

Calculations
(See revision 1 for calculations)

Appendix C

Test Specifications:

Prototype Test Matrix

Prototype Test Procedure

Prototype Test Evaluation Sheet

Testing Log Sheets

SEE PREVIOUS REVISIONS FOR :
Prototype Test Matrix, Prototype Test Procedure, Prototype Test Evaluation Sheet

COGEMA DESIGN

DATE	TIME	INITIALS	condition	tot. hours	tot. cycles	observations
4-5-00	1300	CSM	(start)			
	1400	CSM	OK	1	2700	34°C some gear noise
						straightened pull by elevating
						tool [illegible] inches from table
	1500	CSM	OK	2	5400	35°C
	1600	CSM	OK	3	8100	36°C
	1700	CSM	OK	4	10,800	36° (Shut Down)
4-6	0800	CSM	OK	restart		26°C (noticeably quieter)
			OK			37°C ("growl" is back)
	0900	CSM	OK	5	13,500	(noted expanding collet
						separated)
	1000	CSM	OK	6	16,200	34° collet still working
						(most of expansion at
						one area)
	1100	CSM	OK	7	18,900	35°
	1102	CSM	X	7		cable broke, spring action
						terminated
						new cable cut to 12" and
						crimped to leave ½" threads on
						end "1" and 1" thds. on end "2"
						(TL = 14⅜) trimmed to 14⅛
						(Spring 8") 13⅞
4-6	1530	CSM	OK	(restart)		
	1630	CSM	OK		2700	33° [illegible] Noise reduced ?? (Shut Down)
4-7	7:00	JD	OK	(restart)		
	0800	CSM	OK	2	5400	
	0900	CSM	OK	3	8100	34°
	1000	CSM	OK	4	10,800	35°
	1100	CSM	OK	5	13,500	36
	1200	JD	OK	6		
	1340	CSM	noise developing	7.6		36°
						temp shutdown; Motor noise
	1408	CSM	restart			diminished
	1420		shutdown	8.0	21,700	noise returns, (bearing ??)
4-10	8:45	JD	OK			(added Fan for motor cooling)
	9:45	CSM	OK	9.0	24,400	27°C
	10:45	CSM	OK	10.0	27,000	28°C
	11:45	CSM	OK	11.0	29,700	28°C
	1245	CSM	OK	12.0	32,400	29°C
	1345	CSM	OK	13.0	35,100	30°C
	1445	CSM	OK	14.0	37,800	31°C
	1545	CSM	OK	15.0	40,500	Shut down for PM
	0700	JD	OK			
	0800	JD	OK	17.00	44,500	
	0900	JD	OK	1800	46200	
	1100	JD	OK	2000	51600	Test Complete JD 4/11/00

~45 rpm for 10 min 4-4-00 CSM

FFS DESIGN

DATE	TIME	INITIALS	condition	tot. hours	tot. cycles	observations
4-12	1315	csm	(Start)	0	0	30°C, opens to 1.83
	1415	csm	loosebolt	1	2700	35°C, tightened angle plate
	1515	csm	OK	2	5400	34°
	1615	csm	OK	3		33° shut down for PM
4-13	1030	csm	Start	—	—	repaired ball/socket - had come apart
						28° 1.825/1.000
	1130	csm	OK	4	10,800	30°
	1200	JSP	OK			
	1230	JSP	OK	5		
	1300	JSP	OK			
	1430	csm	OK	7		39°
	1530	csm	OK	8	21,600	
	1630	csm	OK	9	24,300	31°C (Shut down for weekend)
4-17	7:00	[illegible]	OK			(restart)
	0812	csm	OK	10	27,000	1.82/~~[illegible]~~ 1.62
	0900	csm	(broken fixture bolt) down for repair [illegible]			
	1300	csm	replaced 5/8 x 1/2-13 shoulder bolt (shop made)			
			(restarted)	10	27000	1.82/1.61
	1500	csm		12	32,400	
	1600	csm	OK	13	35,100	(down for the night)
4-18	0900	csm	restart	↓	↓	
	1000	csm	OK	14	37,800	
	1100	csm	OK	15	40,500	25°C
	1200	csm	OK	16	43,200	27°C
	1300	csm	OK	17	45,900	28°C
	1400	csm	OK	18	48,600	25°C
	1500	csm	OK	19	51,300	1.820/1.620
						Terminate Test
						[signature]

Test #3 (PNNL Tool)

DATE	TIME	INITIALS	condition	tot. hours	tot. cycles	observations
						(1) shortened stroke to .500 due to excessive expansion
						(2) fitted setup w/ "dummy fuel" to restrict expansion to 1.68 (1.65 x 1.85 range)
5-17	1315	CSm	start	0	0	slides in and out of "fuel" rod, releases each time and regrips
	1330	CSm	OK	0.25	700	
	1345		OK	0.5	1400	34°C – (added fan)
	1445	CSm	OK	1.5	4100	26°
	1515	CSm	OK	2.0	5400	27°
	1615	CSm	OK	3.0	8100	25° (shut down for night)
5-18	0700	TD	OK	3.0		
	0800	CSm	OK	4.0	10,800	25 – (Fan on low)
	0900	CSm	OK	5.0	13,500	26°
	1000	CSm	OK	6.0	16,200	27°
	1100	CSm	OK	7.0	18,900	28° squeeking inside probe (lubricated) w/ NNS, noise abated
	1200	CSm	OK	8.0	21,600	
	1300	CSm	OK	9.0	24,300	
	1400	CSm	OK	10.0	27,000	
	1500	CSm	OK	11.0	29,700	29°
	1600	CSm	OK	12.0	32,400	
	1630	CSm	(shutdown for the night)			
5-19						
	0700	TD	OK	12.5	33,700	
	1200	CSm	OK	17.5	46,200	
	1300	CSm	OK	18.5	48,900	
	1400	CSm	OK	19.5	51,600	conclusion of Test (1.64 x 1.84)

Appendix D

Design Verification Test Specification and Acceptance Test Specification

SEE PREVIOUS REVISIONS FOR :
Design Verification Test Specification

FRS Manipulator Fuel Stinger
Adjustment and Acceptance Test Procedure

Objective:
This procedure is to be used to verify that each production stinger tool (each unit) is properly adjusted and fully functional prior to deployment. This procedure will be performed only after shop fabrication and quality inspection has been completed. This procedure is not intended to document fabrication quality or inspection results.

Adjustment Procedure:
Activate the stinger tool several times prior to recording collet OD. The tool adjustment will be rechecked after completion of the ATP to verify that adjustment is still set correctly. If readjustment is required, repeat ATP portion of this procedure.

1. Adjust or activate stinger tool so that the expanding collet collapses to its natural position (minimum outside diameter).
2. Measure collet outside diameter using dial caliper.
3. Record measurement: ________________ Measurement should be less than 1.64"
4. Place the 30 lbs test element with an ID of 1.9" on the table.
5. Place the test element with an I.D. of 1.64" into the go/no-go gage.

NOTE: For operator safety, exit the fenced area any time the manipulator system is active. The manipulator will be controlled remotely from the EOC. Test personnel will activate the local E-Stop before entering the fenced area and keep it depressed the entire time they are inside the fenced area. This effectively prevents the HPU from starting. Reset the E-Stop when exiting the fenced area.

6. Place stinger tool on the manipulator and activate stinger tool to full collet expansion.
7. Measure collet outside diameter using dial caliper.
8. Record measurement: ________________ Measurement should be equal to or greater than 1.9"

Acceptance Test Procedure:
1. Use the manipulator to lift the 30 lbs test element with an ID of 1.9".
2. Set the 30 lbs test element with an ID of 1.9" back onto the table and release it.
3. Repeat steps 1 and 2 twelve times. Readjust tool as required and repeat series of twelve lifts.
4. Use the manipulator to pick up (clear of go/no-go gage) and reset the test element with an I.D. of 1.64" twelve times.
5. Place the 30 lbs test element with an ID of 1.9" into a bucket of water on the mockup table.
6. Use the manipulator to lift the submerged 30 lbs test element with an ID of 1.9" clear of bucket twelve times.
7. Use the manipulator to load the go/no-go gage with dummy outer fuel elements.
8. Load the dummy outer fuel elements into the mockup MCO fuel basket.
9. Repeat steps 7 and 8 until all the MCO basket slots have been filled.
10. Load 20 of the dummy inner elements into the mockup MCO fuel basket.

Recheck Tool Adjustment
1. Fully expand the collet and re-measure the outside diameter.
2. Record measurement: ________________ Measurement should be ~~equal to~~ or greater than 1.9"
3. Fully collapse the collet and re-measure the outside diameter
4. Record measurement: ________________ Measurement should be less than 1.64".

FRS Manipulator Fuel Stinger
Adjustment and Acceptance Test Procedure

Acceptance Criteria and Data Sheet:

Date: ____________________

Tool Description (dwg#, S/N, etc.): ____________________

Test Operator(s) (Name): ____________________

Test Director Acceptance: ____________________

1. **Did** the tool pick up the test element with an I.D. of 1.64" twelve consecutive times?
   Yes / No **Comments:**

2. **Did** the tool pick up the 30 lb test element with an ID of 1.9" twelve times?
   Yes / No **Comments:**

3. **Did** the tool pick up the submerged 30 lb test element with an ID of 1.9" twelve times?
   Yes / No **Comments:**

4. **Was** a basket fully loaded with no adjustments made to stinger?
   Yes / No **Comments:**

5. Do all fasteners, adjustments, etc. appear to still be tight and the tool functioning normally?
   Yes / No **Comments:**

6. **Were any operational or functional abnormalities identified during the test?**

7. **Does a post test inspection reveal any evidence of wear, damage or other abnormalities?**

If the answers to all of the above questions 1 – 5 are yes and 6 & 7 are no, then the tool is acceptable. The test director will sign above only if the tool was acceptable.

Appendix E

Design Verification Test Report
(This section will be filled in at a later date.)

Appendix F

Value Analysis
(See previous revision for attachments)