and the drop orientations and testing sequences for future prototype testing. PacTec indicated they would consider issues raised by the staff during further development and testing of the package design.

PacTec then discussed the planned schedule for testing and licensing of the package design. PacTec indicated that they plan to begin full-scale prototype testing in September 2001 and invited NRC staff to observe the testing. PacTec also indicated that they plan to submit an application by approximately March 2002 and request NRC approval by June 2003. The staff and PacTec agreed that additional public meetings prior to prototype testing and the application would be beneficial.

Docket No.: 71-9295

Attachments: 1. Attendance List
2. Packaging Technology Meeting Notes

Distribution: (TAC No. L23014) *w/Att. 1 only

NRC File Center	PUBLIC	*NMSS R/F	*SFPO R/F	*NRC Attendees
EWBrach	WHodges	EEaston	MTokar	SGagner, OPA
APersinko, FCSS		WGleaves, FCSS		

G:\PacTec\meet-sum02.wpd

OFC	SFPO	E	SFPO	E	SFPO	C		
NAME	MWaters:mw MOW		EZiegler EZ		SBaggett SB			
DATE	11 / 14 /2000		11/ 14 /2000		11/ 15 /2000			

OFFICIAL RECORD COPY

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 15, 2000

MEMORANDUM TO: Susan F. Shankman, Deputy Director
Licensing and Inspection Directorate
Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards

FROM: Michael D. Waters, Project Engineer MDW
Licensing Section
Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards

SUBJECT: SUMMARY OF SECOND MEETING WITH PACKAGING TECHNOLOGY, INC., REGARDING THE MIXED OXIDE (MOX) FRESH FUEL PACKAGE (TAC NO. L23014)

On October 4, 2000, the Nuclear Regulatory Commission (NRC) staff met with representatives of Packaging Technology, Inc., (PacTec), at NRC Headquarters in Rockville, Maryland. The purpose of the meeting was to discuss package design and technical issues of the MOX fresh fuel package. This meeting was noticed on September 14, 2000, and open to members of the public. The staff made no regulatory decisions during the meeting. Persons that attended the meeting are listed in Attachment 1 and the presentation notes provided by PacTec are included as Attachment 2.

PacTec briefly discussed the intended use of the package by the Department of Energy (DOE). DOE plans to use the MOX fresh fuel package to transport fresh MOX fuel within Safe Secure Transport Vehicles from a fabrication facility to "mission" commercial nuclear power plants. DOE awarded a contract to a consortium of Duke, Cogema, and Stone and Webster (DCS) to design, license, and build a MOX fuel fabrication facility, MOX PWR fuel assemblies, and MOX fresh fuel transportation packages. PacTec has been subcontracted by DCS to design the MOX fresh fuel package.

PacTec presented the design overview of the package. The design consists of a cylindrical, stainless-steel containment shell that can transport three MOX fresh fuel assemblies. The MOX fuel will be similar to the Westinghouse 17x17 PWR fuel design and will have a maximum plutonium enrichment of 6.0 weight percent. The fuel is positioned in a triangular pitch and supported by a strongback (with attached neutron poisons) and support discs within the package. The package is leaktight and is sealed with a bolted closure lid. Impact limiters will also be installed on the ends of the package.

PacTec discussed their preliminary criticality, thermal, and structural results for the package design. PacTec had performed drop tests with a half-scale model of the package body and impact limiters to obtain preliminary structural results. The staff asked several questions regarding technical aspects of the package, including criticality modeling, impact limiter design, and the drop orientations and testing sequences for future prototype testing. PacTec indicated they would consider issues raised by the staff during further development and testing of the package design.

PacTec then discussed the planned schedule for testing and licensing of the package design. PacTec indicated that they plan to begin full-scale prototype testing in September 2001 and invited NRC staff to observe the testing. PacTec also indicated that they plan to submit an application by approximately March 2002 and request NRC approval by June 2003. The staff and PacTec agreed that additional public meetings prior to prototype testing and the application would be beneficial.

Docket No.: 71-9295

Attachments: 1. Attendance List
2. Packaging Technology Meeting Notes

ATTENDANCE LIST

Second Meeting with Packaging Technology regarding the MOX fresh fuel package

- October 4, 2000 -

Name	Organization
Randy Hall	NRC/NMSS/SFPO
Jack Guttman	NRC/NMSS/SFPO
Steven Baggett	NRC/NMSS/SFPO
Nancy Osgood	NRC/NMSS/SFPO
David Tiktinsky	NRC/NMSS/SFPO
Bernie White	NRC/NMSS/SFPO
Andrew Barto	NRC/NMSS/SFPO
Ken Erwin	NRC/NMSS/SFPO
Daniel Huang	NRC/NMSS/SFPO
Michael Waters	NRC/NMSS/SFPO
Andrew Persinko	NRC/NMSS/FCSS
Gary Clark	Packaging Technology
Phil Nos	Packaging Technology
Joe Nichols	Packaging Technology
Toney Mathews	Duke, Cogema, Stone & Webster
Scott Ludwig	ORNL
Mike Klimes	DOE
Leslie Collins	Westinghouse
Tara Neider	Transnuclear
Sidney Crawford	Public

Attachment 1

MOX Fresh Fuel Package
2nd NRC Meeting

NRC Docket No. 71-9295

October 4, 2000

PacTec

Agenda

- Introduction
- Design Overview
- Preliminary Criticality Analysis Results
- Preliminary Thermal Analysis Results
- Preliminary Structural Analysis Results
- Planned Schedule

Introduction

- Purpose
  - Update NRC SFPO
  - Present status of the MOX fresh fuel package (MFFP) design
  - Obtain NRC views of:
    - Design approach
    - Preliminary analysis results
    - Certification test plan

Introduction

- Background
  - Excess plutonium (PU) from various DOE defense programs
  - Consortium of Duke, COGEMA, & Stone & Webster (DCS) awarded contract by DOE-MD (Materials Disposition) to design, license and build:
    - MOX fuel fabrication facility (MFFF)
    - MOX PWR fuel assemblies
    - Transportation packages (MFFP)
  - Fuel fabrication facility & transportation package to be NRC-licensed
  - Fuel to be transported between MFFF and mission reactors by DOE using Safeguards Transport (SGT) Vehicles

Design Overview

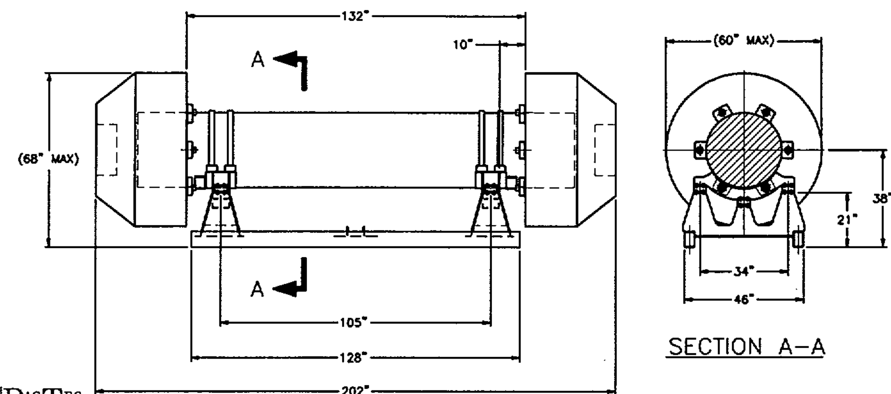
- Design Overview
  - System Overview
  - Containment Boundary
  - Impact Limiters
  - Payload (Strongback and MOX Fuel Assemblies)

Design Overview

- General Configuration:
  - Overall Envelope Parameters (Approx.)
    - Length: **174.5 inches** (w/o impact limiters)
    - Containment Shell Outer Diameter: **29⅝ inches**
    - Impact Limiter Outer Diameter: **60 inches**
    - Package Gross Weight: **14,500 pounds (15,000 Maximum)**
    - Weight of Internals (strongback, support discs, fuel assemblies): **7,100 pounds**

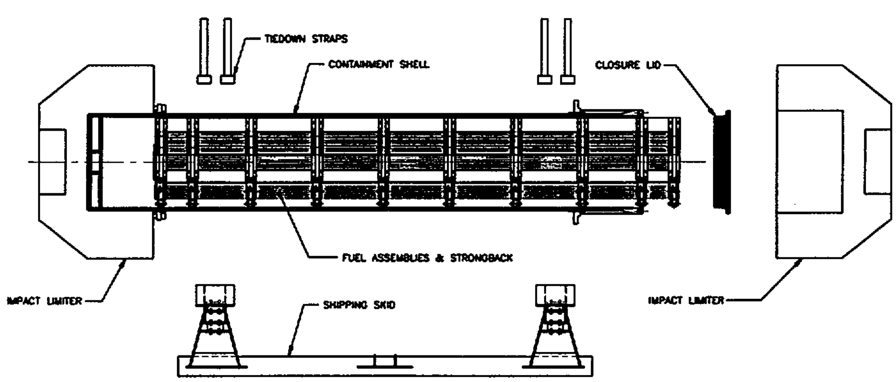
Design Overview

- General Configuration:
  - Type B(U)F-85 packaging
  - Single containment boundary per 10 CFR §71.63(b)(1)



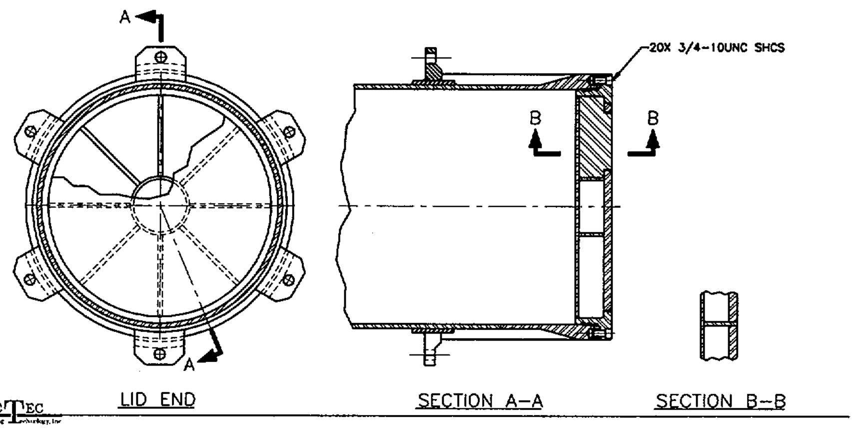
Design Overview

- General Configuration:
  - Cylindrical containment shell with conventional, polyurethane foam filled impact limiters at each end



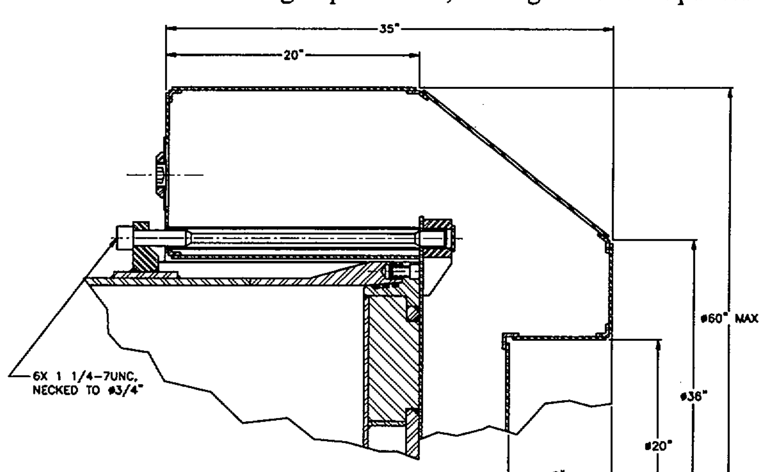
Design Overview

- Containment Boundary:
  - Cylindrical, high strength stainless steel shell, reinforced flat ends, and a bolted closure lid at one end
  - Leaktight containment boundary (shell, inner bottom plate, closure lid, and seals)



Design Overview

- Impact Limiters - Top Impact Limiter
  - In addition to limiting impact forces, is designed to resist puncture

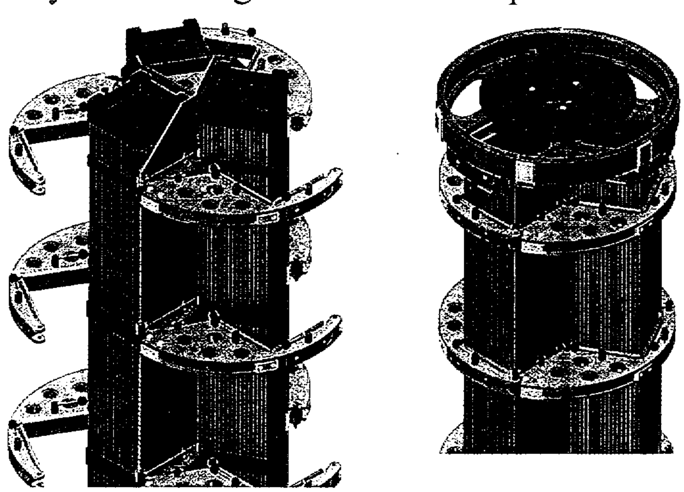


Design Overview

- Payload
  - MOX Fresh Fuel Assemblies
    - MOX 17 × 17 PWR Fuel Assemblies
    - Physical configuration and cladding similar to commercial Mark-BW fuel design
    - Maximum total Pu enrichment: 6.0 weight percent (w/o)
    - Maximum assembly weight: 1,550 pounds (approximate)
    - MOX Fuel Material does not require specific radiation shielding

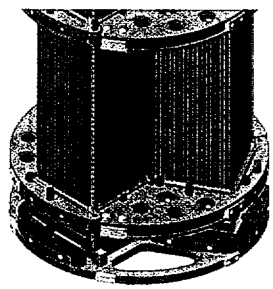
Design Overview

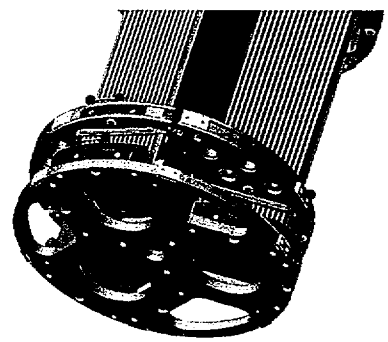
- Payload: Strongback & Fuel - Top View



Design Overview

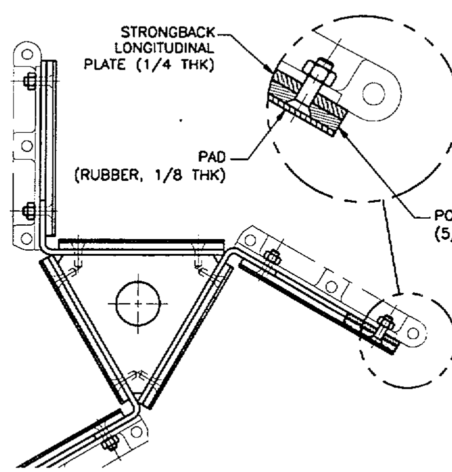
- Payload: Strongback & Fuel - Bottom View





Design Overview

- Detailed View (without clamp arms)



Preliminary Criticality Results

- Design Criteria
  - The package must remain subcritical per 10 CFR 71
    - Subcriticality defined as $K_{eff} < 0.95$
      - Code bias added to calculated
      - 2σ added to calculated values
    - Single Undamaged Package Case (NCT)
      - Full water reflection
      - No Internal Flooding
      - No Damage
    - Single Damaged Package Case (HAC)
      - Optimum Internal Flooding
      - Full Water Reflection
      - HAC Damage

Preliminary Criticality Results

- Criticality Source Term
  - Criticality source term is based on:
    - A blend of depleted uranium and WG plutonium
    - Plutonium "enrichment" up to 6.0 w/o of heavy metal
    - Depleted uranium assumed to contain 0.3% ^{235}U
    - Mark-BW 17x17 PWR fuel assembly design

Isotope	Range of Concentration (w/o)	Criticality Basis Concentration (w/o)
Pu-239	90-95	95
Pu-240	5-9	5
Pu-241	<1	0
Pu-242	<0.1	0

Preliminary Criticality Results

- MOX Fuel Plutonium Enrichments

MFFP Design Basis		
Enrichment Zone	**Number of Fuel Rods**	**w/o Pu***
Low (corners)	12	2.279
Medium (edges)	68	3.525
High (interior)	184	4.717
Total or Average	264	4.300

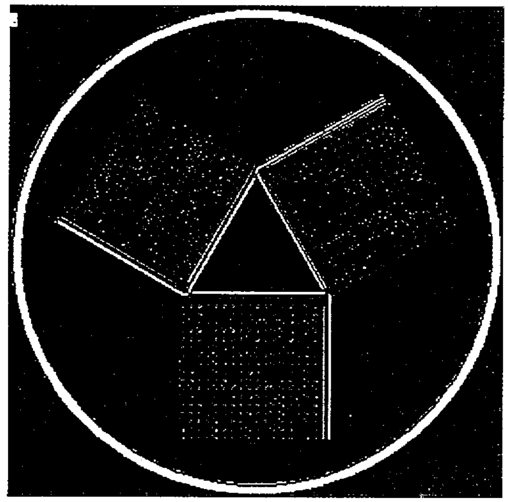
*The criticality analyses use an uniform enrichment of 6.0 w/o Pu

Preliminary Criticality Results

- Criticality Models
  - Numerous MCNP calculations, including
    - Various poison configurations
    - Variations in internal water density
    - Variations in fuel assembly configuration
  - Benchmarking
    - MCNP calculations based on available benchmark data
    - MCNP code bias determined
  - Poison Design
    - Majority of analyses based on borated aluminum poison plates
    - Analyses show that borated stainless or gadolinium also provide sufficient poisoning

Preliminary Criticality Results

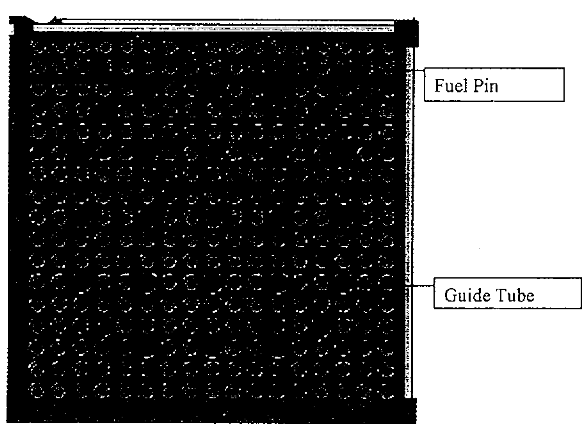
- Base Model



October 4, 2000 MOX Fresh Fuel Package Page 18

Preliminary Criticality Results

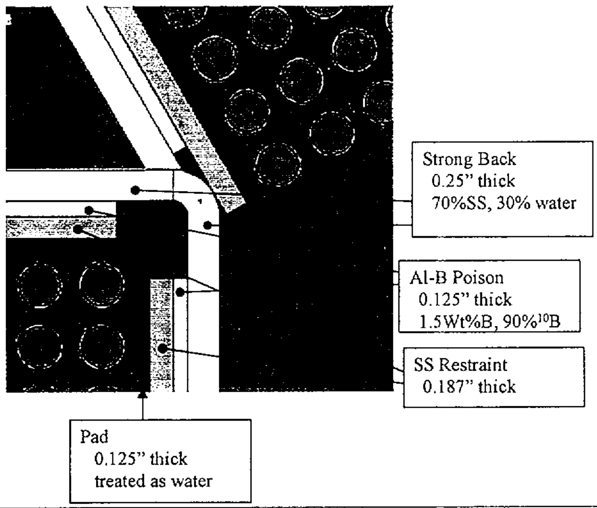
- Base Model - Details



October 4, 2000 MOX Fresh Fuel Package Page 19

Preliminary Criticality Results

- Base Model - Details



Preliminary Criticality Results

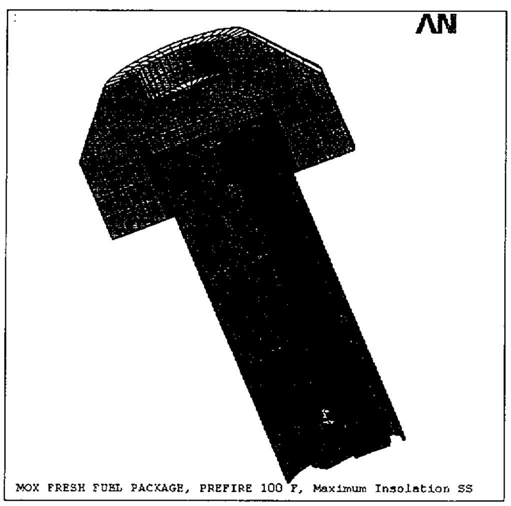
- MFFP Preliminary Criticality Results

Case	Keff + 2σ	Keff + 2σ + bias
Base NCT: No damage, nominal positioning, no moderation	0.2680+0.0011	0.2838
Base HAC: No damage, nominal positioning, full moderation	0.9187+0.0009	0.9344
HAC-1: Worst case damage caused by horizontal accelerations	0.9130+0.0009	0.9287
HAC-2: Worst case damage caused by vertical accelerations	0.9326+0.0010	0.9483

Preliminary Thermal Analysis

- Thermal Model
  - FEA model developed with ANSYS 5.3
  - 80 Watts/assy (240 Watt/MFFP) conservatively assumed
  - 180° section, upper half modeled
  - Fuel assumed to have properties of unirradiated WE 17x17 standard fuel assemblies
  - Heat dissipation methods
    - Conduction/Radiation from fuel assemblies to inner surface of package (No convection in package cavity).
    - Convection and radiation from package surface
    - Axial conductivity within package occurs primarily through strongback and fuel

Preliminary Thermal Analysis



FEA Thermal Model of MFFP
(Air Elements Removed for Clarity)

Preliminary Thermal Analysis

Thermal Acceptance Criteria

	NCT	HAC
Seals	311 °F	400 °F for 8 hours
Limiter Foam	150 °F*	N/A
Fuel Cladding	392 °F	1,337 °F
Neutron Poison (Steel Based)	800 °F	2,250 °F
Structural Members (304SS, XM-19)	800 °F	2,250 °F

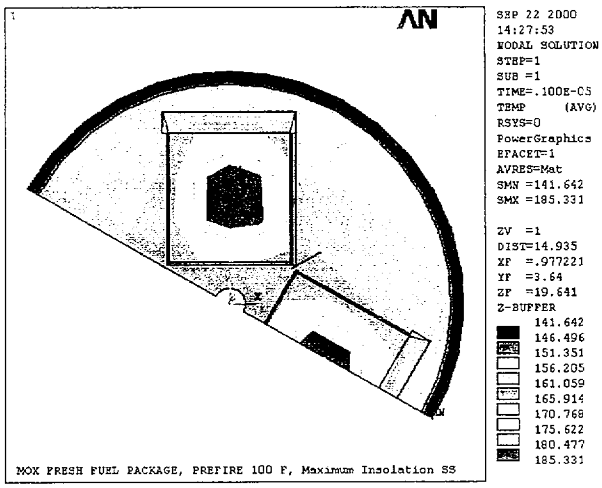
*Used to evaluate structural properties of foam but not an intrinsic foam limit.

Preliminary Thermal Analysis

Preliminary NCT Results

- Normal Conditions of Transport
  - Low Heat Load to Surface Area Ratio Limits Normal Condition Temperatures (i.e. decay heat load is small)
  - Peak Component Temperatures NCT (100 °F ambient, full solar)
    - Fuel Cladding: 188 °F (392 °F Limit)
    - Seals: 145 °F (311 °F Limit)
    - Bulk Foam: 132 °F (150 °F Limit)
    - Neutron Poison: 168 °F (800 °F Limit)

Preliminary Thermal Analysis

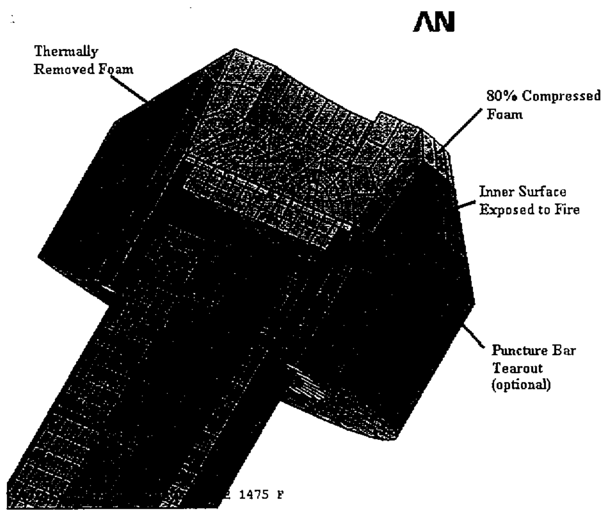


Cross Sectional Temperature Distribution for NCT Maximum

Preliminary Thermal Analysis

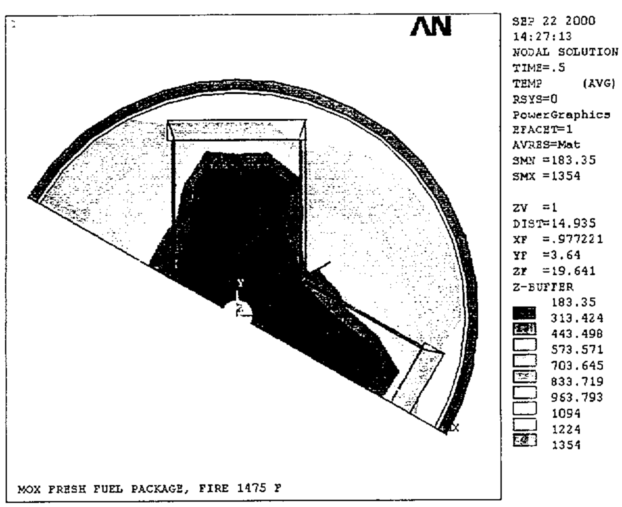
- HAC Damage Assumptions
  - Impact limiter radially crushed 80% over 360°
  - No puncture perforation of limiter skin based on engineering model tests
  - Additional case evaluated with perforation through to inner surface of impact limiter adjacent to seal.
- Package HAC Thermal Performance
  - Heat paths to seal
    - Primary path via conduction through package walls and 1/4" impact limiter skin
    - Secondary path via conduction through fuel and strongback radiated to seal area.
  - Heat Path to Fuel/Strongback
    - Primarily radiation from approx. 1,350 °F Package Wall

Preliminary Thermal Analysis



Thermal Modeling of HAC Damage

Preliminary Thermal Analysis



Cross-Sectional Temperature Distribution at End of Fire

Preliminary Thermal Analysis

- HAC Peak Component Temperatures
  - Fuel Cladding: 1,060 °F (1,337 °F Limit)
  - Seals: 248 °F (400 °F Limit)
  - Neutron Poison: 1,025 °F (2,550 °F Limit)
  - Seals *with perforation of impact limiter skin:* 335 °F
- Conclusions
  - Conservative model yields temperatures well below limits
  - Current design provides adequate thermal protection for the containment seals

Preliminary Structural Results

- Critical Areas
- Engineering Test Unit Results
- Certification Tests
  - Test unit configuration
  - Drop & puncture test orientations
  - Thermal test

Preliminary Structural Results

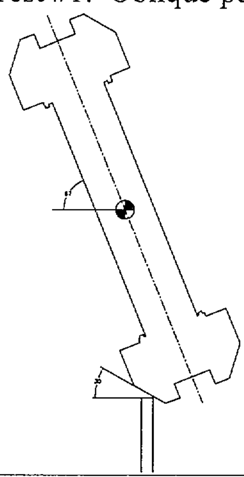
- Critical Areas
  - Primary areas of focus are containment and criticality control
  - Containment
    - Puncture resistant impact limiter protects the seal region from direct attack from the puncture bar and from significant thermal load during the HAC fire
  - Criticality Control
    - Non-linear FEA analyses & engineering test results show stability of the shell
    - Non-linear FEA analyses show stability of the strongback during drop events

Preliminary Structural Results

- Engineering Test Unit Results
  - Half-Scale Test of the MFFP Cask and Limiters
    - Check the minimum thickness required for an impact limiter skin to resist perforation during a puncture test
    - Evaluate the performance of the seal for puncture impacts near the seal region
    - Check the stability of the cask shell for the 30 foot side drop
    - Evaluate the amount of deformation of the cask shell for the centrally located impact of the puncture bar

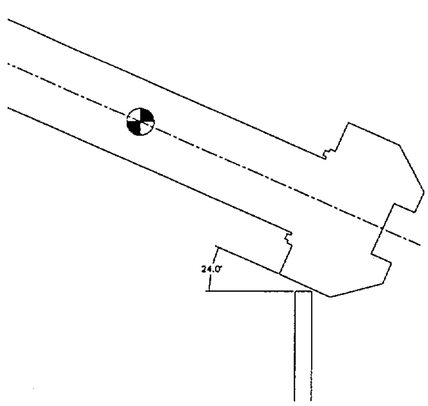
Preliminary Structural Results

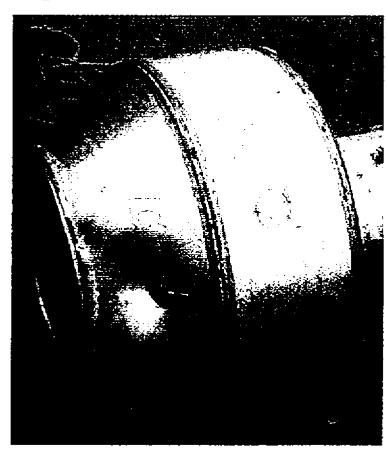
- Engineering Test Unit Results
  - Test #1: Oblique puncture drop onto 'thick' limiter



Preliminary Structural Results

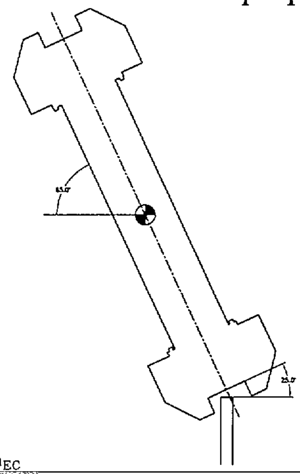
- Engineering Test Unit Results
  - Test #2: Oblique puncture drop onto 'thick' limiter

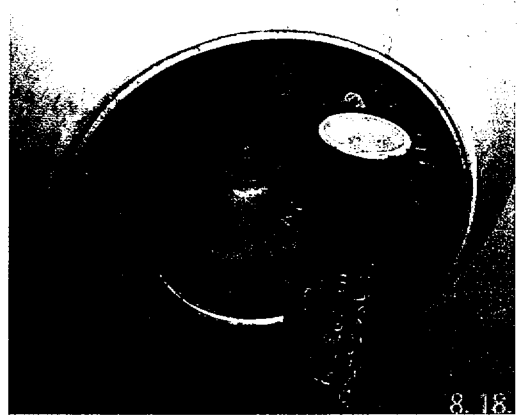




Preliminary Structural Results

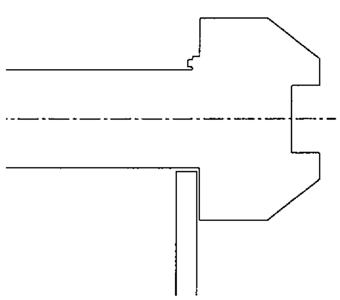
- Engineering Test Unit Results
  - Test #3: Oblique puncture drop onto 'thick' limiter





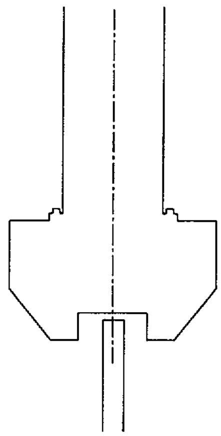
Preliminary Structural Results

- Engineering Test Unit Results
  - Test #4: Horizontal puncture drop near seal region



Preliminary Structural Results

- Engineering Test Unit Results
  - Test #5: Vertical puncture drop onto 'thin' limiter

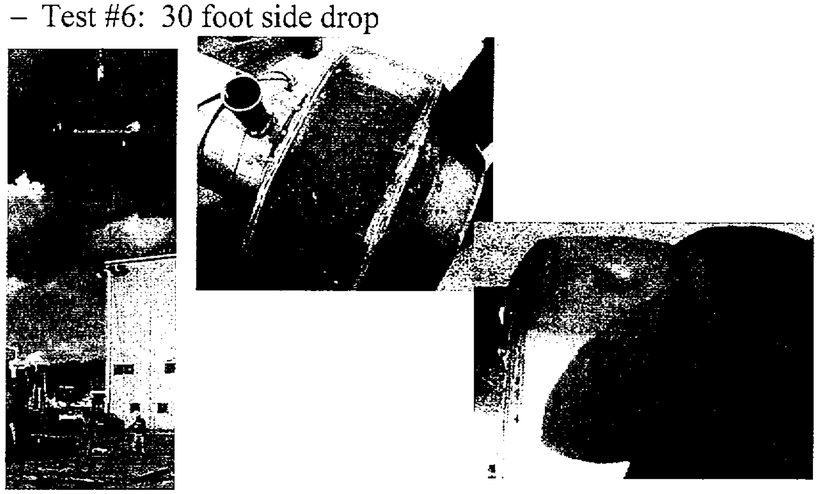


PACTEC

October 4, 2000 MOX Fresh Fuel Package Page 38

Preliminary Structural Results

- Engineering Test Unit Results
  - Test #6: 30 foot side drop

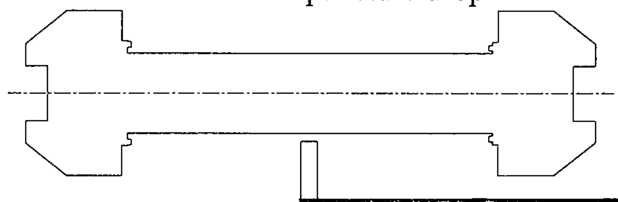


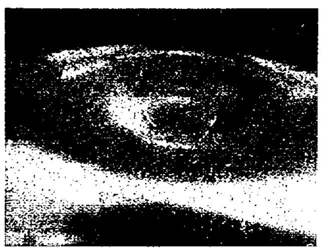
PACTEC

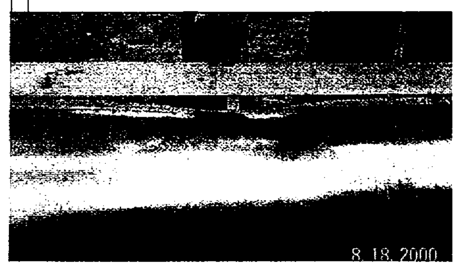
October 4, 2000 MOX Fresh Fuel Package Page 39

Preliminary Structural Results

- Engineering Test Unit Results
  - Test #7: Horizontal CG puncture drop

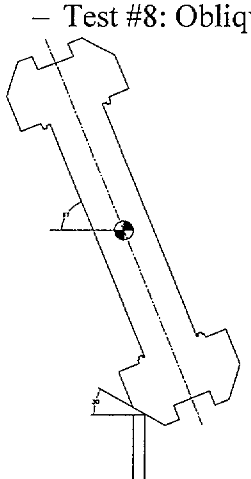






Preliminary Structural Results

- Engineering Test Unit Results
  - Test #8: Oblique puncture drop onto 'thick' limiter



Certification Test Plan

- Certification by Test, With Supporting Analysis
  - Test approach chosen since strongback and fuel are not amenable to detailed analysis
- Full-Scale Prototypic Test Article
- Test to Include Free Drop and Puncture
  - Tests include worst case orientations for containment shell, impact limiters, strongback, and fuel assembly
  - Each test focuses on specific aspect of package design
- HAC Thermal event, immersion event, and all NCT conditions by analysis

Certification Test Plan

- HAC Thermal Event Approach
  - Only the elastomer containment seals are sensitive to fire event temperatures
  - Detailed, conservative thermal model shows large temperature margins:
    - Peak fire seal temperature = 248 °F
    - Limit based on test = 400 °F for 8 hours (TRUPACT-II)
  - Large design margin afforded by:
    - Relatively thick polyurethane foam impact limiters (t≅ 13")
    - Limiter skin thickness which resists puncture perforation
    - Even including severe puncture damage, maximum seal temperature (335 °F) is still well below the limit
  - Large design margins support analysis approach vs. test

Certification Test Plan

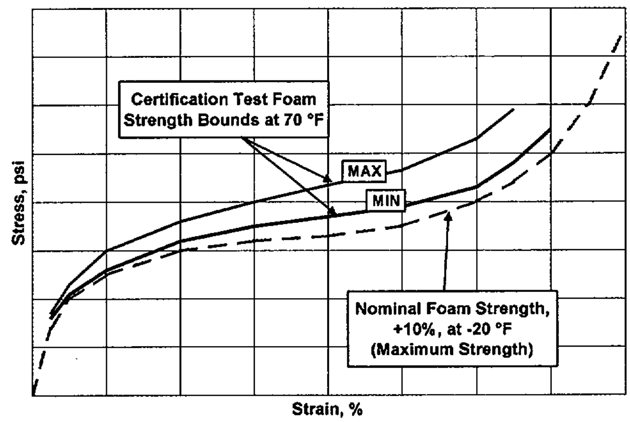
- Certification Test Article Configuration
  - Full-Scale
  - Completely prototypic in material, design, and fabrication
  - Weight and center of gravity prototypic
  - Will use mock fuel assemblies in most cases for weight
    - Mock assemblies are designed to apply loads to the strongback in a way similar to prototypic fuel
  - Will use prototypic fuel when necessary to demonstrate actual fuel behavior
    - Prototypic fuel made using tungsten carbide or similar "fuel" pellets

Certification Test Plan

- Certification Test Article Configuration, *cont.*
  - Use of prototypic vs. mock fuel assemblies:
    - In side drop, fuel rods may compress together (pitch decrease); criticality analyses show k_{eff} decreases with decreasing rod pitch
    - In vertical drop, lateral compressing forces are absent, so fuel behavior is less deterministic
    - Fuel behavior is only of interest in vertical end drop

Certification Test Plan

- Certification Test Article Configuration, *cont.*
  - Strength properties of polyurethane foam at -20 °F will be simulated using ambient temperature foam:



Certification Test Plan

- Certification Test Article Configuration, *cont.*
  - Since testing will be conducted at ambient temperatures, maximum impact will be obtained by using a polyurethane foam density which exhibits the stress-strain properties of cold, plus-tolerance prototypic foam
  - The response of maximum temperature impact limiters
    - Evaluated by analysis using in-house impact limiter computer codes
    - Extrapolated from certification test results
    - Demonstrate no bottom-out

Certification Test Plan

- Certification Test Article Configuration, *cont.*
  - Shell stress due to internal pressure is negligible, therefore no internal pressure will be used during testing
    - MNOP < 10 psig
- Instrumentation
  - High speed films will be used to record events
  - As necessary, maximum deformation and acceleration can be calculated from films
  - Supplemental techniques may be used, such as crush gages

Certification Test Plan

- Determination of Tests Performed
  - Containment Components:
    - evaluate **shell** for buckling under maximum moment **[Side Drop]**
    - evaluate **shell** for perforation under puncture **[Side Puncture]**
    - evaluate **closure** under maximum lateral loads **[Slapdown]**
    - evaluate **closure** under maximum axial loads **[End Drop]**
  - Strongback & Fuel Components:
    - evaluate **strongback** under maximum lateral loads in all potentially vulnerable orientations **[Slapdown]**
    - evaluate **fuel** response in drop **[End Drop]**
  - Impact Limiter Components:
    - evaluate **impact limiter** resistance to perforation **[Oblique Punctures]**
    - evaluate **impact limiter** retention **[Slapdown]**

Summary of Certification Tests

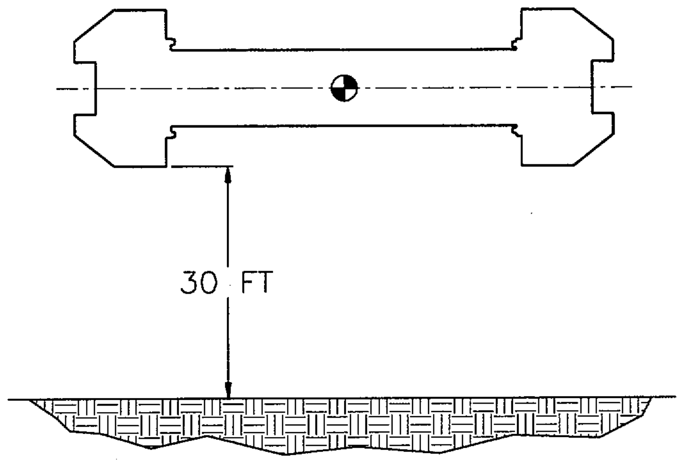
Test	Purpose	Acceptance
Horizontal Free Drop	Apply Max. Bending Moment to Shell	Shell Remains Structurally Stable
Vertical Free Drop	Apply Max. Loads to Closure Lid; Supply Worst Case Fuel Reconfig. To Criticality Analysis	Fuel Deformations Within Criticality Assumptions; Package Leaktight
Slapdown Free Drop, Azimuth #1	Apply Max. Loads to Strongback in Weakest Orientation	Strongback Deformations Within Criticality Assumptions; Leaktight
Slapdown Free Drop, Azimuth #2	Apply Max. Loads to Strongback in Weakest Orientation & Closure	Strongback Deformations Within Criticality Assumptions; Leaktight
Series of Punctures on Upper Limiter	Demonstrate No Perforation of Skin	No Perforation
Side Puncture on Shell	Demonstrate No	Leaktight

Certification Test Sequence

- Test 1: 30 Ft. Free Drop, Horizontal
  - Payload: Bundle of steel rods (prototypic weight, very low stiffness)
  - Purpose: Apply governing bending moment to containment shell
  - Acceptance Criteria: Containment shell does not buckle
  - Post Test Activity:
    - Measure shell deformation (if any)
    - Measure impact limiter deformations

Certification Test Sequence

- Figure of Test 1



October 4, 2000 MOX Fresh Fuel Package Page 52

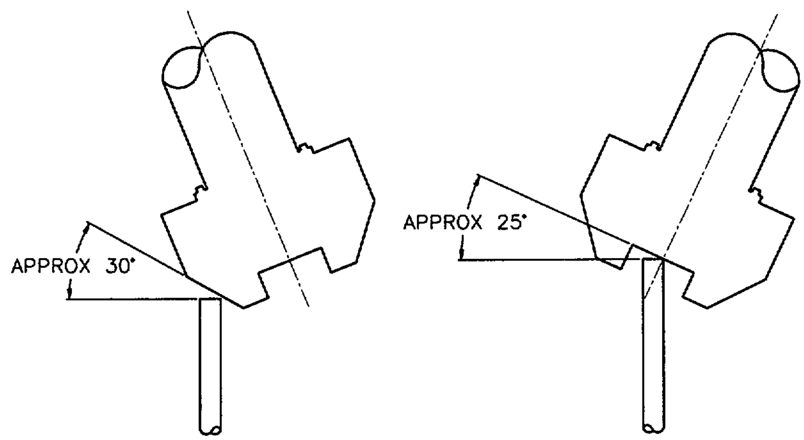
Certification Test Sequence

- Test 2: Series of 2 or 3, Worst-case Oblique Punctures on the Closure Lid End Impact Limiter
  - Payload: Bundle of steel rods
  - Purpose: Demonstrate that the puncture event cannot penetrate impact limiter shell
  - Acceptance Criteria: No complete penetration (partial tears acceptable)
  - Post Test Activity:
    - Record impact limiter puncture deformations
    - Change payload
    - Install a pair of new impact limiters

October 4, 2000 MOX Fresh Fuel Package Page 53

Certification Test Sequence

- Figure of Test 2

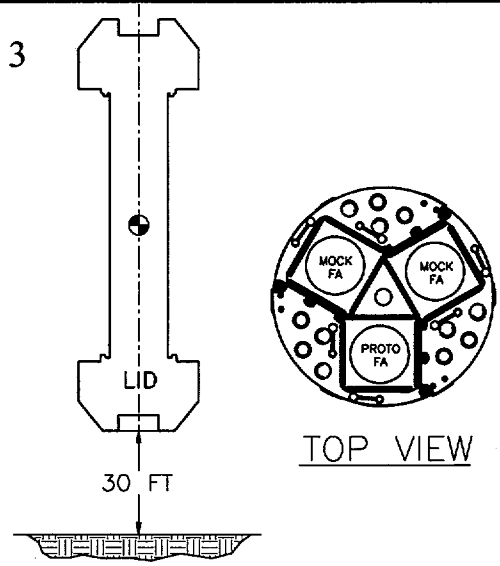


Certification Test Sequence

- Test 3: 30 Ft Free Drop, Vertical, Lid Down
  - Payload: Strongback, 1 prototypic fuel assembly, and 2 mock fuel assemblies
  - Purpose: Apply governing loads to closure lid and demonstrate that prototypic fuel deformations are within criticality assumptions
  - Acceptance Criteria: Closure lid remains leaktight and fuel deformations bounded by assumptions
  - Post Test Activity:
    - Measure impact limiter deformation
    - Helium leak test containment seals
    - Examine prototype fuel assembly, change payload
    - Replace limiter

Certification Test Sequence

- Figure of Test 3

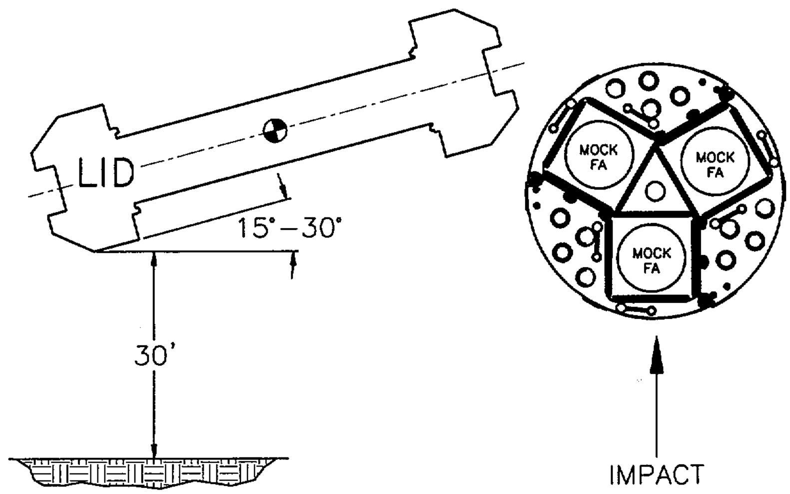


Certification Test Sequence

- Test 4: 30 Ft Free Drop, 15° - 30° Slapdown, Lid Primary
  - Payload: Strongback and 3 mock fuel assemblies
  - Purpose: Demonstrate that strongback can support fuel under the maximum lateral load (azimuth #1)
  - Acceptance Criteria: Strongback deformations bounded by criticality analysis assumptions
  - Post Test Activity:
    - Measure impact limiter deformations (strongback deformations evaluated after Test 6)

Certification Test Sequence

- Figure of Test 4

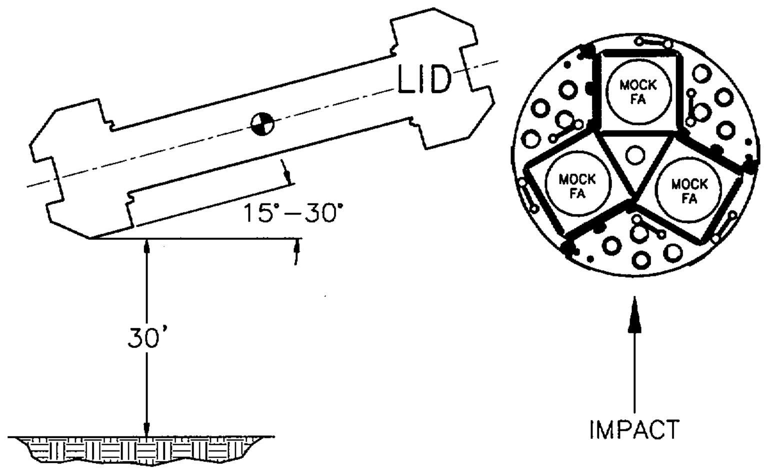


Certification Test Sequence

- Test 5: 30 Ft Free Drop, 15° - 30° Slapdown, Lid Secondary
  - Payload: Strongback and 3 mock fuel assemblies
  - Purpose: Demonstrate that strongback can support fuel under the maximum lateral load (azimuth #2); apply maximum lateral load to closure
  - Acceptance Criteria: Closure lid remains leaktight and strongback deformations bounded by criticality analysis assumptions
  - Post Test Activity:
    - Measure impact limiter deformations (strongback deformations evaluated after Test 6)

Certification Test Sequence

- Figure of Test 5

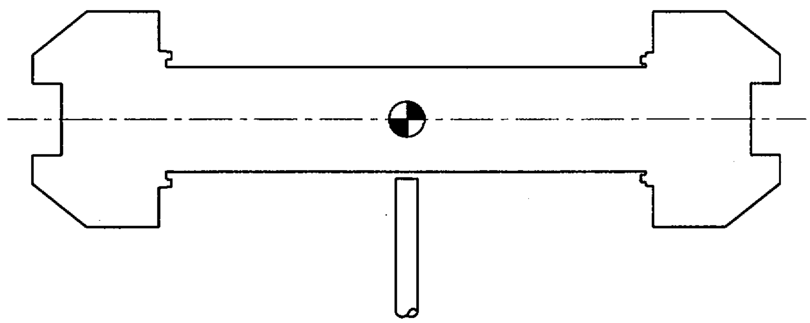


Certification Test Sequence

- Test 6: Puncture on Package C.G., Perp. to Shell
  - Payload: Strongback and 3 mock fuel assemblies
  - Purpose: Demonstrate that containment shell can resist perforation and remain leaktight under worst case puncture
  - Acceptance Criteria: Containment shell remains leaktight
  - Post Test Activity:
    - Measure containment shell deformation
    - Perform helium leak test of containment seals and containment boundary
    - Remove payload and evaluate strongback deformations

Certification Test Sequence

- Figure of Test 6



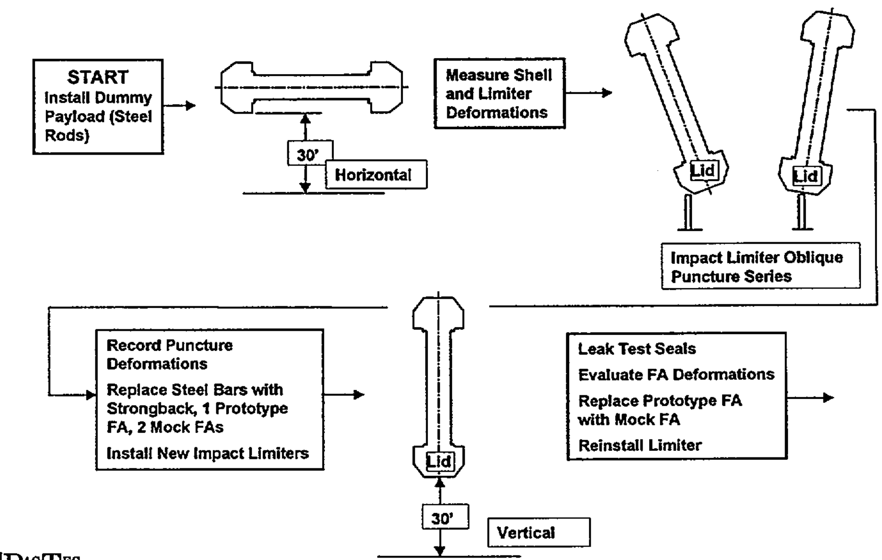
Certification Test Plan

- Oblique Puncture on the Containment Shell Not Planned
  - Other fresh fuel packages subject to perforation are:
    - Approx. 1/4 inches thick and made of carbon steel
  - MOX fresh fuel package is:
    - More than twice as thick and made of XM-19 stainless steel
    - More resistant to perforation
  - Engineering test oblique puncture on 1/4-inch thick impact limiter skins demonstrates no perforation
  - Puncture bar would need to be approx. 7 ft. long; would begin yield at approx. 2g impact load, which is much less than the normal puncture impact of > 20g
  - Oblique puncture test is not necessary

Planned Schedule

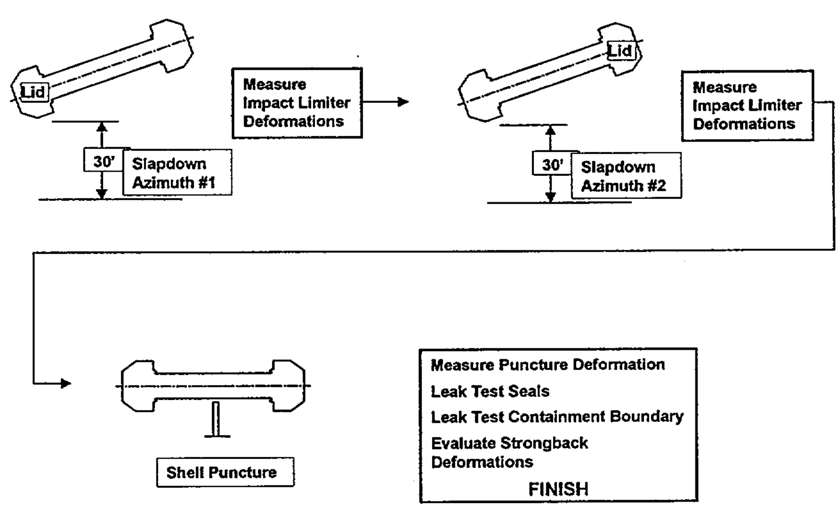
- Certification Tests
  - September 2001
- Application Submittal
  - March 2002
- Certificate of Compliance
  - June 2003 [Estimate]

Certification Test Summary



October 4, 2000 MOX Fresh Fuel Package Page 76

Certification Test Summary



October 4, 2000 MOX Fresh Fuel Package Page 77