Repository Disposition Evaluation for INEL SNF and High-Level Waste

"Meeting Waste Acceptance Criteria"

Presentation to the

U.S. Nuclear Waste Technical Review Board
Panel on the Engineered Barrier System

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Hierarchal Systems Engineering Design

- System Design
- Segment Design
- Subsystem Design
- Component Design

- System Integration
- Segment Integration
- Subsystem Integration
- Component Integration

- Construction at the Component Level

Hierarchal Systems Engineering Design (cont'd)

- **System Design**
  - regulatory requirements
  - repository geology
- **Segment Design**
  - DOE fuels characterization
  - Performance Assessment
- **Subsystem Design**
  - MPCs
  - overpacks
  - Waste Acceptance Criteria
- **Component Design**
  - individual fuel types
  - chemistries
  - 'neutronics'
- **Construction at the Component Level**
  - material selection
  - MPC construction QA
- **Component Integration**
  - 'treatment'
  - drying operations
  - accountability
- **Subsystem Integration**
  - loading/packaging
  - thermal affects
- **Segment Integration**
  - storage
  - transportation
- **System Integration**
  - final disposal
  - backfill?
  - repository closure

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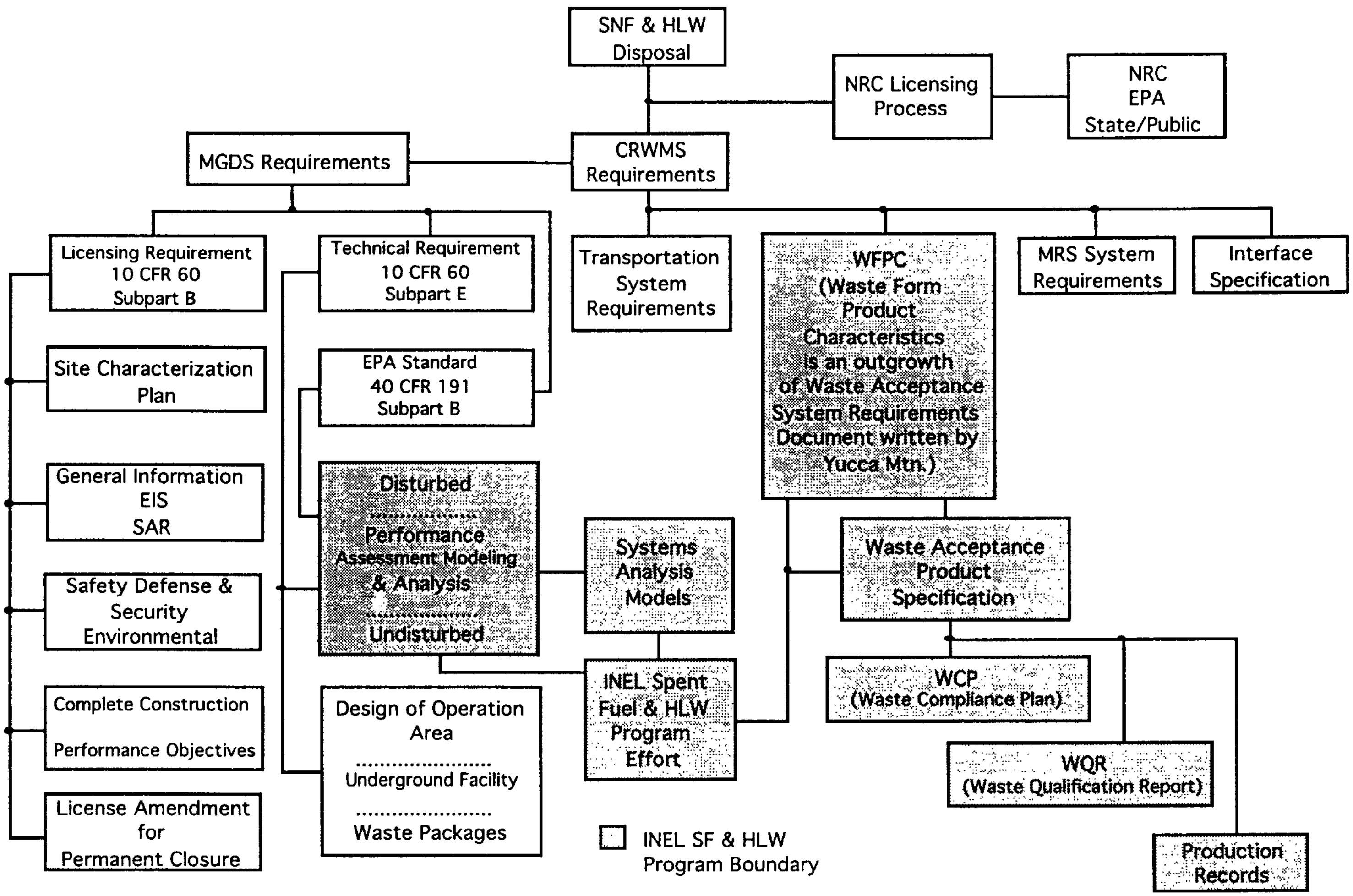
DOCUMENTATION CHRONOLOGY

	Date Issued
YMP Waste Acceptance - Systems Requirements Document (Rev. 0)	Jan 93
EM-WAPS (Savannah River HLW Product)	Feb 93
INEL Performance Assessment ('93)	Jan 94
INEL Preliminary Waste Acceptance Criteria	Jan 94
YMP Waste Acceptance - Systems Requirements Document (Rev. 1)	Mar 94
INEL Performance Assessment ('94)	Apr 95
INEL Waste Form Product Characteristics	Jan 95
YMP MGDS License Application Annotated Outline	Mar 95
INEL Performance Assessment ('95)	expected early 96
INEL Draft Waste Compliance Plan (for HLW)	being drafted

PICTORIAL SUMMARY OF INEL SPENT FUEL AND HIGH-LEVEL WASTE PROGRAM



MGDS Annotated Outline, Chap 5 (EBS Degradation Mechanisms)		Waste Form Product Characteristics	
[YMP/94-05 Draft A 01/25/95]		[INEL-95/0063 Jan 1995]	
5.2.1.1.2.1	Solubility	4.3.8	Solubilities
5.2.1.1.2.2	Oxidation/Reduction Reactions		
5.2.1.1.2.3	Corrosion	4.3.10	Corrosion
5.2.1.1.2.4	Hydriding	4.3.4	Chemically Reactive Species
5.2.1.1.2.5	Gas Generation	4.3.11	Gas Generation
5.2.1.1.2.6	Thermal Effects	4.2.5	Temperature Limits on Waste Forms
5.2.1.1.2.7	Mechanical Strength	4.3.12	Mechanical Properties
5.2.1.1.2.8	Mechanical Stress		

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MGDS Annotated Outline, Chap 5 (EBS Degradation Mechanisms)		Waste Form Product Characteristics	
[YMP/94-05 Draft A 01/25/95]		[INEL-95/0063 Jan 1995]	
5.2.1.1.2.9	Radiolysis	4.3.13	Radiolysis
5.2.1.1.2.10	Radiation Damage	4.3.14	Surface Dose Limits
5.2.1.1.2.11	Radionuclide Retardation		
5.2.1.1.2.12	Leaching	4.3.9	Leach Rates
5.2.1.1.2.13	Fire and Explosion Hazards	4.3.3	Explosiveness, Pyrophoricity, Explosiveness
5.2.1.1.2.14	Thermal Loads	4.2.4	Heat Generation
5.2.1.1.2.15	Synergistic Interactions		

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Quantity of Waste [inventory] - (FSV [(Th/U)C2 particles in carbonaceous matrix (54% enriched)])

INN	YMP Requirements	DOE-SNF Requirements	Qualifying Assumptions	DOE SNF Information Need	Information Source	QA Level	Type Data Qualification	Est. Cost
							(R/T/E/M/P)*	($k)
5.1.2.2-2	Table showing anticipated burnup distribution/age of SNF received at the repository as a function of time and cumulative total from 2010 to 2032.	Inventory values will account for isotope distribution of all actinide species, both for inventory (transport calculations) and accountability (new INN specific to DOE SNF)	• ORIGEN calculations based on estimated or generic burnup values and time-out-of-reactor(TOOR) data may be the only radionuclide inventory information available	1. Develop table of the FSV fuels showing the burnup, age, and the information could be included as part of the Priority List INN 5.1.2.2-1	FSV currently stored dry; provide storage history data in. May not be QA'd to level needed.		Available ORIGEN code data needs to be validated in comparison to equivalent data provided for CNF	
			• Range of reactor operating conditions (burnup, time-out-of-reactor, power levels, fuel position) will be used to predict 'worst case' inventories	1. Identify typical and extreme power levels in the reactor that could have been experienced by a typical fuel element	Burnup, time-out-of-reactor, power level, fuel position available on individual ORIGEN data sheets		Available ORIGEN code data needs to be validated in comparison to equivalent data provided for CNF	
			• Data should reflect both U-235 and U-233 masses in fuel elements (based on ORIGEN code calculations) for both inventory and transport/release rates	1. Individual actinide concentrations, with special emphasis on fissile species, needs to be tabulated by fuel element	Yes/No, see above		Extract actinide inventories of interest from individual ORIGEN data sheets (once approved)	
			• Reactor-specific operating data for individual fuels is available relative to dates, duration, and location each element was in the reactor, and at what power levels	1. Given the need to report radionuclide inventories, develop an 'age distribution' for cumulative fuels in storage to account for decay/buildup of radionuclides between reactor discharge and disposal in the repository	Data from ORIGEN code calculations needs to be decayed to values used in PA work associated with YMP disposal dates based on assigned shipment priorities		Available ORIGEN code data needs to be validated in comparison to equivalent data provided for CNF	

R = Records; T = Testing; E = Equivalency; M = Modeling; P = Peer Review

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Additional Waste Form Product Characteristics Requirements

4.3.1	Solids	10 CFR 60.135(C)(1)
4.3.2	Liquids	10 CFR 60.135(b)(2)
4.3.5	Neutron Absorbers	DOE-ID 5480.5A
4.3.6	Criticality	10 CFR 60.131(b)(7)
4.3.7	Safeguards and Material Accountability	10 CFR 71.55
4.3.15	Radionuclide Inventory	40 CFR 191 10 CFR 60.113
4.3.16	Organics	10 CFR 60.135(a)(2)
4.3.17	Inert Gases	10 CFR 60.135(b)(1)
4.2.1	Materials Consideration	10 CFR 60.135(a)(1)
4.2.2	Waste Package Weight	WASRD-3.7.1.2.1.2.1
4.2.3	Waste Package Configurations	WASRD-3.7.1.2.1.1.2.1
4.2.6	Allowable Void Space	WASRD-3.7.1.2.1.2.1
4.2.7	Package Labeling	10 CFR 60.135(b)(4)
4.2.8	Waste Package Handling Features	WASRD-3.7.1.2.1.2.16

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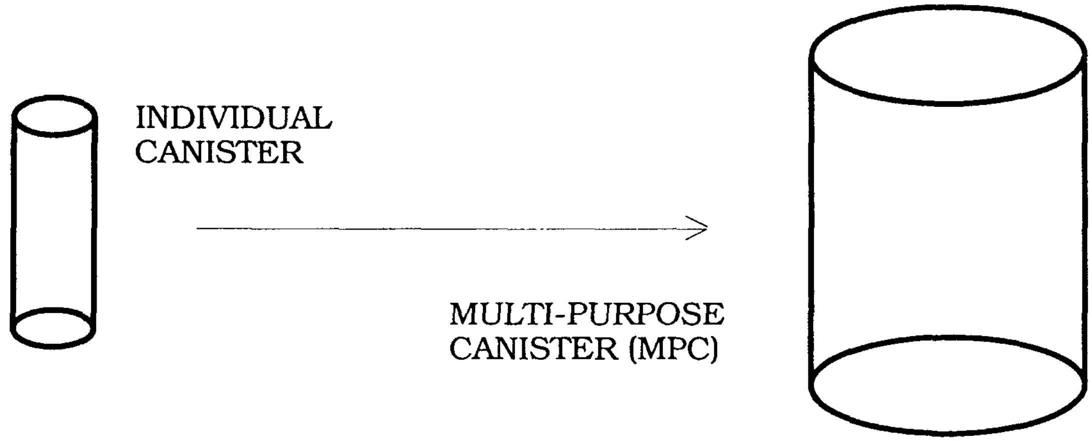
DOE - SNF PA MODEL EVOLUTION for U-235 PACKAGING



<u>ASSUMPTIONS: for '93 PA</u>

- dealing with HEU (up to~90%)
- fully moderated (except for salt)
- fuel matrix reconfiguration possible
- no credit for internal neutron absorbers
- low fissile loadings
  - 0.700 gm/can (granite)
  - 10.0 kg/can (salt)
- double contingency requirements expected through life of repository

<u>ASSUMPTIONS: for '94 PA</u>

- dealing with ~3.5 - 90% enrichment
- no initial moderation anticipated
- fuel integrity maintained
- fixed neutron absorbers acceptable
- high fissile loadings
  - to 235 kg per package (in tuff)
- double contingency requirements assured through operational phase of repository

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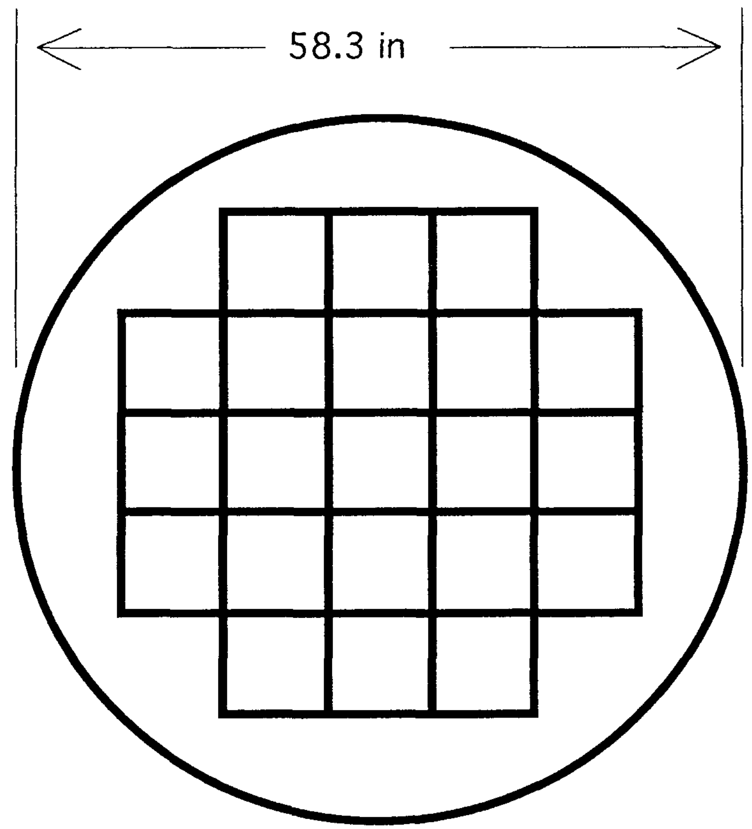
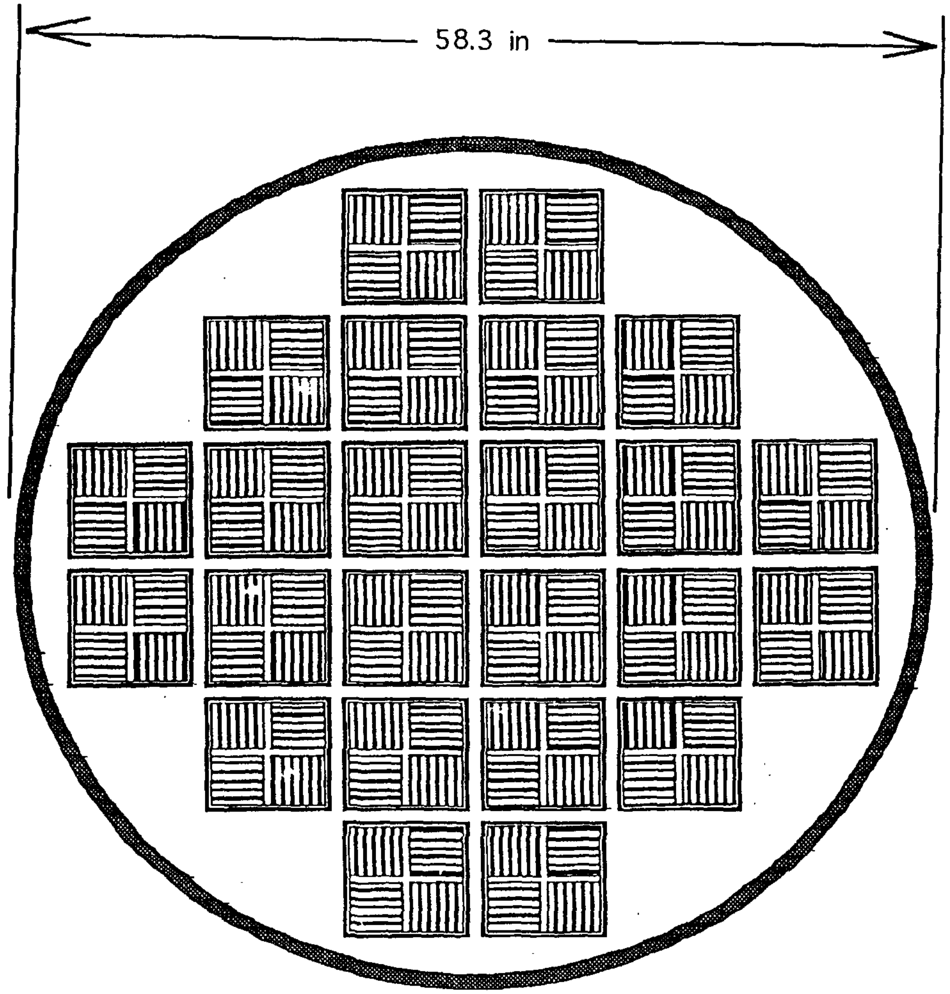
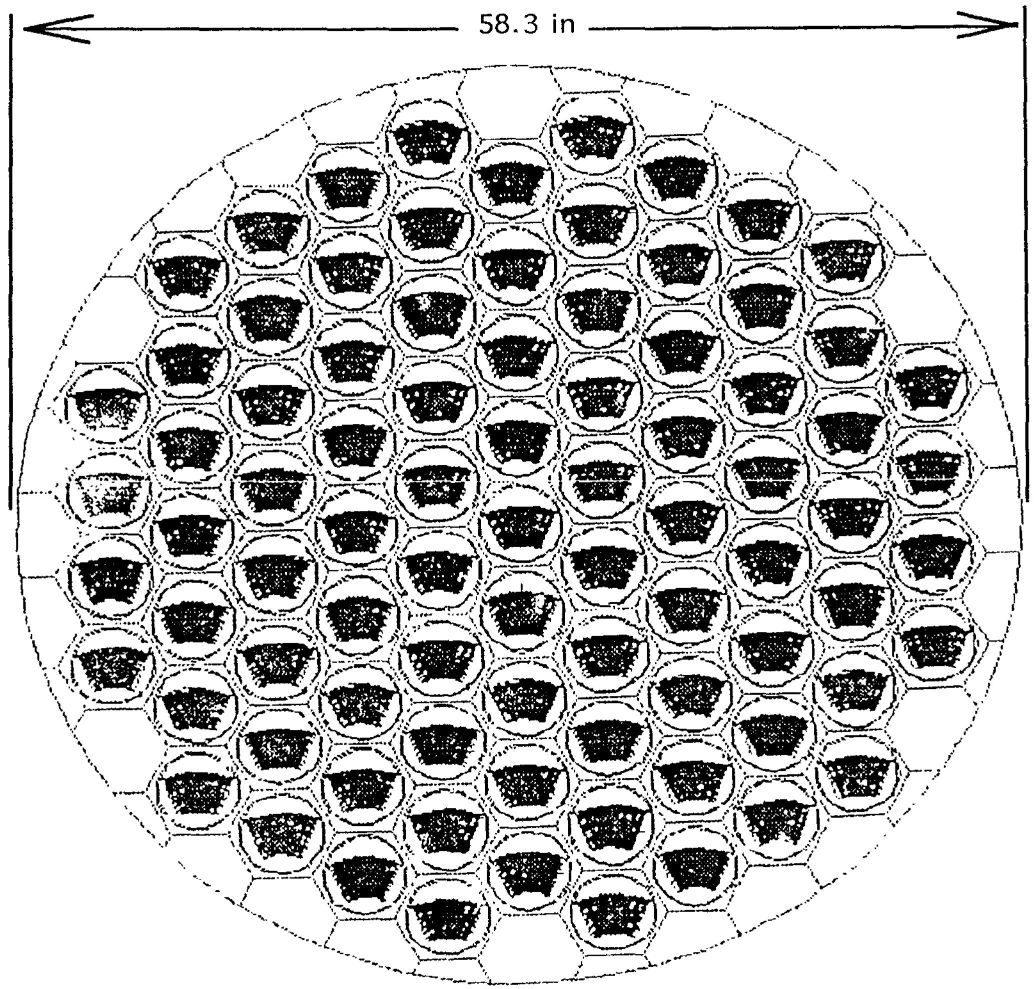


Proposed Configuration of the
PWR Subassemblies in the MPC



Proposed Shippingport-PWR Assemblies in MPC
(22.86 cm pitch)



X-Y Plot View of MPC Containing 85 ATR Fuel Elements per Layer (3 layers/MPC)

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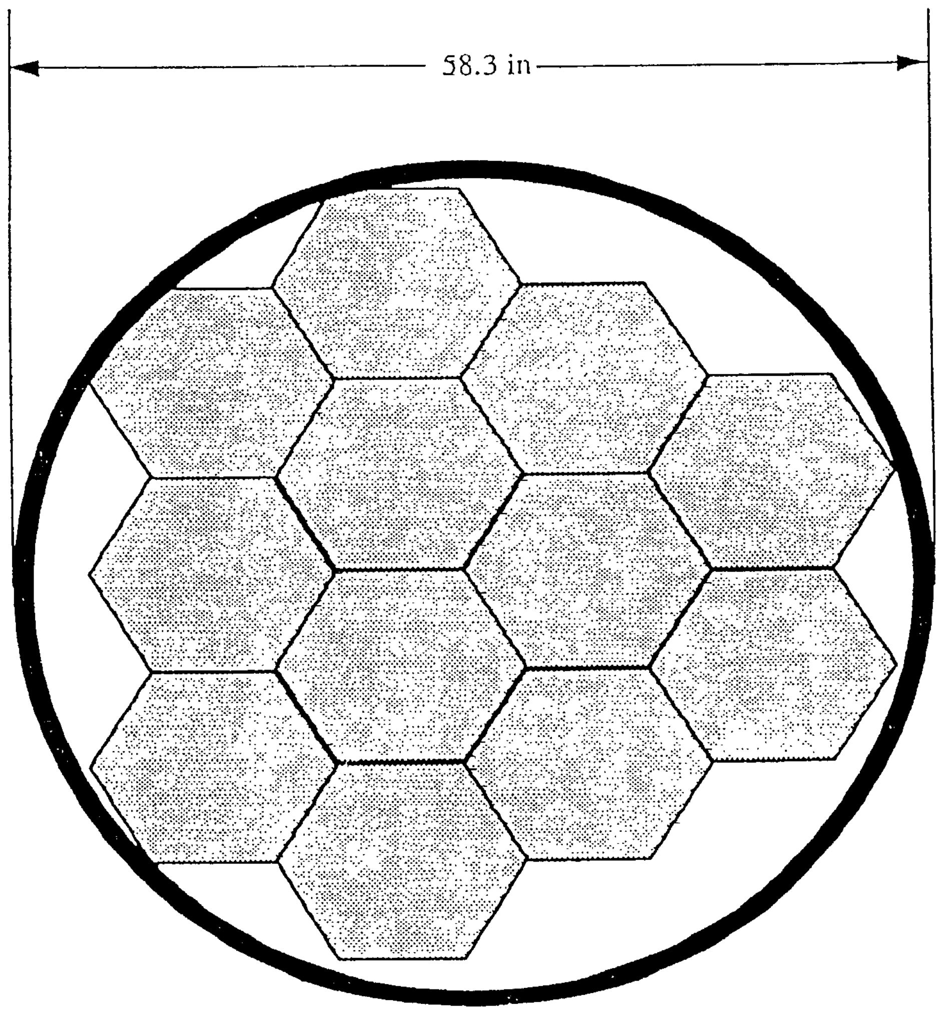

Proposed Configuration of Ft. St. Vrain Elements in the MPC