Summary of ARIES Power Core Unit Costs

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ARIES Meeting at UCSD

Background

- At the September 2004 meeting, I presented the costs for a set of materials for one of the candidate blanket/ maintenance schemes.
- Since then, I have expanded the cost basis to include the other configurations
- The cost basis is a combination of data from prior studies as well as new material quotes
- Also, I have prepared a trade study assessment tool for the proposed blanket concepts to help document the rationale for the selection into the next study phase

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Candidate Power Core Concepts

Designation	A	B	C	D1	D2A	D2B	E
Description	Self Cooled Molten Salt	Self Cooled LiPb	Li Dual Coolant	LiPb Dual Coolant	LiPb Dual Coolant	LiPb Dual Coolant	Ceramic Breeder
VV location	Internal to Coils	Internal to Coils	External to Coils	Internal to Coils	External to Coils	External to Coils	Internal to Coils
First Wall, Blanket	ODS FS Be Pebbles Flibe (30% Li6)	SiC/SiC $Li_{17}Pb_{83}$ (90%Li6)	ODS/RA FS Li (natural) He	ODS/RA FS Li17Pb83(90%Li6) He	ODS/RA FS Li17Pb83(90%Li6) He	ODS/RA FS Li17Pb83(90%Li6) He	ODS/RA FS Li4SiO4 20-90Erchd Be Pebbles He
Local Shield	RAFS WC plates Flibe (30% Li6)	SiC/SiC WC Plates Li17Pb83 (90%Li6)	RAFS WC plates He	RAFS WC plates He	RAFS WC plates He	RAFS WC plates He Borated H_2O (LT Shld)	RAFS WC plates He
Shield	RAFS Borated FS Plates Flibe (30% Li6)	SiC/SiC Borated FS Plates Li17Pb83 (90%Li6)	RAFS Borated FS plates He	RAFS Borated FS Plates He	RAFS Borated FS Plates He	RAFS Borated FS Plates He H_2O(LT Shld)	RAFS Borated FS plates He
Vac Vessel	RAFS Borated Water	RAFS Borated FS Plates H_2O	RAFS He	RAFS Borated FS Plates H_2O	RAFS He	RAFS He	RAFS Borated FS Plates H_2O

Cost data presented 9/2004

This is the complete list of concepts the team has defined and analyzed for Phase I.

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Unit Costs Data for Systems Code

- First Three Candidate Systems -

Designation	A			B			C		
Description	Self Cooled Molten Salt			Self Cooled LiPb			Li Dual Coolant		
VV location	Internal to Coils	$/kg	kg/m3	Internal to Coils	$/kg	kg/m3	External to Coils	$/kg	kg/m3
First Wall, Blanket	ODS FS Be Pebbles Flibe (30% Li6)	$103.00 $250.00 $40.88	7800 1848 1987	SiC/SiC $Li_{17}Pb_{83}$ (90%Li6)	$510.00 $20.00	3200 8897	ODS/RA FS Li (natural) He	$103.00 $55.00	7800 473
Local Shield	RAFS WC plates Flibe (30% Li6)	$103.00 $30.00 $40.88	7800 15500 1987	SiC/SiC WC Plates Li17Pb83 (90%Li6)	$510.00 $30.00 $20.00	3200 15500 8897	RAFS WC plates He	$103.00 $30.00	7800 15500
Shield	RAFS Borated FS Plates Flibe (30% Li6)	$78 $31.00 $40.88	7800 7800 1987	SiC/SiC Borated FS Plates Li17Pb83 (90%Li6)	$510.00 $31.00 $820.00	3200 7800 8897	RAFS Borated FS plates He	$78.00 $31.00	7800 7800
Vac Vessel	RAFS Borated Water	$56.00 ~ $0	7800 1000	RAFS Borated FS Plates H_2O	$56.00 $31.00 ~ $0	7800 7800	RAFS He	$56.00 $31.00	7800 7800

More

- **New ROM quote for Beryllium from Brush Wellman was provided, $220-$275/kg**
- **Refinement of natural Lithium cost is in work**
- **My prior estimate for Li17Pb83 90% enriched was in error, should be atom%. Revised number would be much lower**
- **Historical enriched lithium and LiPb estimates from MARS, UWTOR-M, and BCSS (circa 1980-1983) suggest $16-20/kg for 90% enriched Li17Pb83**

Unit Costs Data for Systems Code

- Final Four Candidate Systems -

Designation	D1			D2A			D2B			E		
Description	LiPb Dual Coolant			LiPb Dual Coolant			LiPb Dual Coolant			Ceramic Breeder		
VV location	Internal to Coils	$/kg	kg/m3	External to Coils	$/kg	kg/m3	External to Coils	$/kg	kg/m3	Internal to Coils	$/kg	kg/m3
First Wall, Blanket	ODS/RA FS Li17Pb83(90%Li6) He	$103.00 $20.00	7800 8897	ODS/RA FS Li17Pb83(90%Li6) He	$103.00 $20.00	7800 8897	ODS/RA FS Li17Pb83(90%Li6) He	$103.20 $20.00	7800 8897	ODS/RA FS Li4SiO4 20-90Erchd Be Pebbles He	$103.00 $ TBD $250.00	7800 8897 1848
Local Shield	RAFS WC plates He	$103.00 $30.00	7800 15500	RAFS WC plates He	$103.00 $30.00	7800 15500	RAFS WC plates He Borated H_2O (LT Shld)	$103.00 $30.00 ~ $0	7800 15500 1000	RAFS WC plates He	$103.00 $30.00	7800 15500
Shield	RAFS Borated FS Plates He	$78.00 $31.00	7800 7800	RAFS Borated FS Plates He	$78.00 $31.00	7800 7800	RAFS Borated FS Plates He H_2O(LT Shld)	$78.00 $31.00 ~ $0	7800 7800 1000	RAFS Borated FS plates He	$78.00 $31.00	7800 7800
Vac Vessel	RAFS Borated FS Plates H_2O	$56.00 $31.00	7800 7800	RAFS He	$56.00 $0	7800 0	RAFS He	$5600 $0	7800 0	RAFS Borated FS plates He	$56.00 $31 ~ $0	7800 0 1000

I have a new quote for natural Lithium Orthosilicate ($44/kg) and need to convert it to 90% enriched Lithium Orthosilicate.

Unit Costs Data for Systems Code

Link to Cost Database

Blanket Evaluation and Selection Process

We Should Reach Consensus On Key Blanket Attributes For Selection and Their Importance

Key Factors in Blanket Concept Selection

Factor	Discussion	Value 0-5
Tritium Breeding Ratio	All designed to satisfy 1.1 criteria; may need enriched lithium or beryllium	2
Operating Temperature	Determines thermal efficiency and overall plant performance	4
Complexity, Technical Maturity	Influences development risk and cost	3
Inherent Safety	All designs to be safe, but some are more inherently safe, e.g. dual coolant designs	2
Pumping Power	Higher pumping power reduces net power	1
Thickness of Breeding Zone	Influences cost of power core components	2
Radioactive Waste Products	Influences public acceptance and waste disposal costs	2
Service Lifetime	All blankets are designed for 40 FPY	0
Inherent Reliability	Too early to define data	0

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This Trade Study Spreadsheet Illustrates the Evaluation Process

- Data is for illustration only -

						Option A		Option B		Option C		Option D1		Option D2A		Option D2B		Option E	
		Poor	Adequate	Good	Excellent	Self Cld, Flibe, FS, Be, Intnl VV		Self Cld, LiPb, SiC, Intl VV		Dual Cooled, He, Li, FS, Ext VV		Dual Cooled, He, LiPb, FS, Intl VV		Dual Cooled, He, LiPb, FS, Ext VV, He-Cld Shld		Dual Cooled, He, LiPb, FS, Ext VV, He/H2O Shld		He, FS, Be, Cerm Brdr Ext VV	
Evaluation Parameter	**Wt**	**1**	**2**	**3**	**4**	**UnWtd**	**Wtd**	**UnWtd**	**Wtd**	**UnWtd**	**Wtd**	**UnWtd**	**Wtd**	**UnWtd**	**Wtd**	**UnWtd**	**Wtd**	**UnWtd**	**Wtd**
Tritium Breeding Ratio	2	Needs Be Multiplier	90% Enrch Lithium	30% Enrch Lithium	Natural Lithium	1	2	2	4	4	8	2	4	2	4	2	4	1	2
Operating Temperature, °C	4	>600	600-750	750-900	1000-1200	1	4	4	16	2	8	2	8	2	8	2	8	2	8
Complexity, Technical Maturity	3	Very Cmpx, Immature	Cmpx, Low Mat	Cmpx, Mod Mat	Low Cmpx, Good Mat	3	9	3	9	2	6	2	6	2	6	2	6	1	3
Inherent Safety	2	Poor	Adequate	Good	Excellent	2	4	2	4	4	8	4	8	4	8	4	8	4	8
Pumping Power	1	High	Moderate	Mod. Low	Low	1	1	3	3	3	3	3	3	3	3	3	3	4	4
Thickness of Breeding Zone, m	2	>1.3	1.2 - 1.3	1.1 - 1.2	< 1.1	2	4	3	6	3	6	3	6	3	6	3	6	4	8
Radioactive Waste Products	2	Poor	Adequate	Good	Excellent	2	4	2	4	3	6	2	4	2	4	2	4	4	8
Sum	*16*	*16*	*32*	*48*	*64*		**28**		**46**		**45**		**39**		**39**		**39**		**41**

The closeness of the scores suggest either a) the blankets are similar in performance b) the evaluation parameters/weightings are not indicative of the true discriminators, or c) the evaluation scores are wrong