Progress On Cost Modeling- Cost Accounts 22

L. Waganer

6-7 September 2007
ARIES Project Meeting at GA

General Costing Approach

- There is a need to convey a level of costing detail that is consistent with the engineering and physics assessment
  - Better understand and convey the underlying technical basis
  - Allows future in-depth assessments and benchmarking

Revision of ARIES Systems Code Cost Modeling Is Under Way

- **Costing model is being documented to a greater extent than in the past**
- **Additional cost data will be reported, e.g. 22.03 through 22.08 (old #s)**
  - 22.03 Cryogenic Cooling
  - 22.04 Radioactive Waste Treatment and Disposal
  - 22.05 Fuel Handling and Storage
  - 22.06 Reactor Plant Maintenance Equipment
  - 22.07 Reactor Plant Instrumentation and Control
  - 22.08 Other Reactor Plant Equipment
- **All subsystem costs will be benchmarked and updated on a semi-regular basis**

Zoran Dragojlovic has modeled the FWBS and is working on the coil systems.
Les Waganer has documented the land and facilities (Acct 20, 21) and is commencing on Acct 22.

Land and Land Rights, 20

- **The reference plant site was chosen to be 1000 acres in a Midwestern location. The land requirements are less severe than for an LWR in regard to exclusion boundaries, therefore 1000 acres are deemed adequate. In the case of constructing multiple plants at the common site, sufficient space is provided.**
- **The cost associated with the land and privilege acquisition is estimated at 1000 acres times the cost per acre. Most of the prior fusion studies estimated the cost of land escalating with general land values for a Mid Western site, per PNL-2648**

Land Costs	PNL-2648	Starfire	Genrmk	Promths	A-SPPS	A-AT
Cost Estimate Year	1978	1980	1986	1991	1992	1992
Acres	1000	1000	1000	1000	1000	1000
$/Acre, Then $	$2	$2	$3,000	$5,000	$10,000	$10,000
Escalation Factor	2	2.212	1.678	1.415	1.384	1.384
$/Acre, 2007 $	$6,030	$6,636	$8,390	$7,075	$13,840	$13,840
2007 Estimate, M$	$6.03	$6.64	$8.39	$14.15	$13.84	$13.84

Review of June Presentation

- **This data shows a steady progression of escalating land values, which is historically correct. An examination of 2006 good cropland values along the Missouri or Mississippi rivers is currently in the range of $2500/A to $3000/A. Assuming there would be a sizable premium to obtain a contiguous site of 1000 A, it is not unreasonable to assume that the current land price would be $10,000/A. Thus the cost of Land and Privilege Acquisition, $C_{20.01}$ is $10.00 M.**
- **The Relocation of Buildings, Utilities, Highways, and Other Services is typically 10% of the land costs, or $C_{20.02}$ is $1.00 M**

Structures and Site Facilities, 21

This account covers all direct costs associated with the physical plant buildings such as reactor, turbine, electrical equipment, cooling system structures, site improvements and facilities, miscellaneous structures and building work, and ventilation stack. All provisions for cooling, site access and security will be provided.

The facility is located in a secured area within the site. The site is adjacent to the "North River" which supplies adequate water for cooling purposes. The river is assumed to be navigable by barge traffic throughout the year to provide a means to ship in the large modules and equipment. Highway access is also provided by eight kilometers of secondary road leading to a state high[illegible] secondary road requires no improvement to permit [illegible] access will be provided by constructing a five mile ra[illegible] the main line to the plant site. Other site-related assumptions have been established as follows:

Review of June Presentation

- **Incoming power will be provided by two independent EHV power sources, probably 345-kV or high voltage lines.**
- **Power and water for construction are available at the site boundary.**
- **Communication lines will be provided at the site boundary.**
- **Sanitary sewage system will be available for tie-in at the site boundary.**
- **An auxiliary boiler furnishing plant auxiliary steam is included in the facility design.**
- **Plant utility systems including compressed air, inert gas storage and distribution, and portable and de-mineralized water are included in the facility design.**
- **Personnel parking will be located outside the facility perimeter close to the guard station that will control incoming and outgoing personnel, vehicles and rail cars.**
- **The facility will be located on level ground at an elevation unaffected by potential flooding.**
- **Seismic criteria UBC Zone 2 will be assumed for all structures.**

Structures and Site Facilities, 21(Cont'd)

- **The direct cost for the Structures and Site Facilities, Acct 21, represents a very significant portion of the total facility cost and maybe higher than that for a comparable PWR. However the cost increases can be identified and are reasonable.**
- **The Reactor Building much larger than a PWR containment building but contains more equipment. The remote handling features in the Reactor and Hot Cell Building contributes to increased size and cost. Tritium containment and detritiation contributes to the cost.**
- **The Fuel Handling and Storage (Tritium Reprocessing) Building is additional as is the h[illegible] of tritium. The premi[illegible] have very low release rates of [illegible] material activation, and a very high factor of safety, which greatly impacts the overall facility cost.**
- **The Hot Cell is another facility which is additive to a PWR system. Because of the large sizes of the components and large number of components handled within the Hot Cell, a large building is required designed with remote handling and hazardous waste handling considered.**
- **Several prior studies enlisted A&E firms for the buildings and facilities, e.g., Starfire (RM Parsons Company), Ebasco (Prometheus), and Bechtel (Osiris/Sombrero)**

Review of June Presentation

21	**Structures and Site Facilities**
21.01	Site Improvements and Facilities
21.02	Reactor Building
21.03	Turbine Building
21.04	Heat Rejection Structures and Facilities
21.05	Electrical Equipment and Power Supply Building
21.06	Plant Auxiliary Systems Building (including Switchgear)
21.07	Hot Cell Building (including Maintenance and Radioactive Waste/Recycle)
21.08	Reactor Service Building (Non-Radioactive Service?)
21.09	Service Water Building
21.10	Fuel Handling and Storage Building
21.11	Control Room Building
21.12	On-Site AC Power Supply Building
21.13	Administration Building
21.14	Site Service Building
21.15	Cryogenics and Inert Gas Storage Building
21.16	Security Building
21.17	Ventilation Stack
21.98	Spare Parts Allowance (Include in indiv costs)
21.99	Contingency (include as Acct

Example of Level of Detail in Acct 22

Example is ARIES-AT, but is typical for all ARIES designs

20	Land and Land Rights	10.589		
21	Structures & Site Facilities	253.537		
22	Reactor Plant Equipment	761.016		
22.1	Reactor Equipment		481.956	
22.1.1	FW/blanket/reflector			64.28
22.1.2	Shield			69.409
22.1.3	Magnets			126.686
22.1.4	Supplemental Heating/CD Systems			37.06
22.1.5	Primary Structure and Support			26.933
22.1.6	Reactor Vacuum Systems (unless integral)			98.772
22.1.7	Power Supply, Switching & Energy Storage			50.746
22.1.8	Impurity Control			4.094
22.1.9	Direct Energy Conversion			0
22.1.10	ECRH Plasma Breakdown System			3.975
22.2	Main Heat Transfer and Transport Systems		125.968	
22.X	Other Reactor Plant Equipment		153.092	
23	Turbine Plant Equipment	243.034		
24	Electric Plant Equipment	98.505		
25	Miscellaneous Plant Equipment	47.353		
26	Heat Rejection System	23.317		
27	Special Materials	83.766		
90	**Total Direct Cost**	**1521.117**		

Some additional detail can be found in the Systems Code printouts, but it is difficult to obtain full system cost definition.

Account 22.x represent several sub-accounts not reported, but included in total direct cost

Consistency and clarity lacking

Recommended Level of Detail In All Accounts

Show **Excel spreadsheet** of new cost account definition

- Discuss the new accounts added
  Explore the options on how accounts are defined
  Show detail under each sub-account

New Subject:
Keeping Track of Changing Cost Basis

- **Inflation creates a moving baseline for our costing assessments**

One of the best inflation indices is the Gross Domestic Product (GDP) index published by the US Commerce Department, Bureau of Economic Analysis, www.bea.gov

The GDP index is published quarterly and contains GDP values for the current quarter and inflation adjusted values to a basis year, currently 2000. The GDP index has been published since 1929.

We can use this to adjust for commodity priced items and general labor rates

There are some other more specific cost indices, but this is the best general index

Link to GPD Excel spreadsheet

Link to inflation-adjusted fusion material database

Next Actions

- **Work with Subsystem experts to create and verify costing algorithms for each subsystem and major component**

Determine number of identical subsystems and major components necessary for the selected design (including EPR, subsystem demonstrations, DEMO, initial prototypes, and initial power reactors leading to the 10th of a kind power plant, including spares

Assess the learning curve associated with the subsystem and major components