

CAD Funded Cost Research

Estimating Facilities is Easy....

Isn't It?

Glenn Butts

Office of the CFO

KSC/GG-G

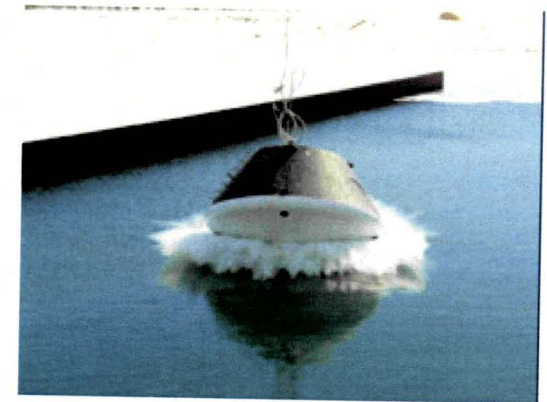
February 2012

Houston - We Have a Problem!



- ◆ ***A-3 Test Stand SSC - Ares 1***
 - ◆ \$157 M initial estimate
 - ◆ \$320 M latest available project estimate
 - ◆ *2 times original estimate*
 - ◆ Latest available duration 7 years
 - ◆ *1.75 times longer than original estimate*
- ◆ ***SET GRC - Orion***
 - ◆ \$ 63 M original estimate
 - ◆ \$152 M latest available estimate
 - ◆ *2.4 times original estimate*
 - ◆ Latest available duration 7 years
 - ◆ *1.75 times longer than original estimate*
- ◆ ***O&C IOZ KSC - Orion***
 - ◆ \$18 M original estimate
 - ◆ \$55.2 M latest available estimate
 - ◆ *Construction Duration 18 months original - actual 27.3 months*
- ◆ ***LaRC – Hydro Impact Basin - Orion***
 - ◆ **Bid Busted**
 - ◆ Conceptual design construction cost estimate: \$1.89M
 - ◆ Final design construction cost estimate: \$2.60M
 - ◆ Construction duration - 90 days estimate, 210 days reality
- ◆ ***White Sands – LAS Orion***
 - ◆ Initial estimate: \$2M
 - ◆ Final cost: \$5.7M

Some of the CxP Program Facility Cost and Schedule Growth Issues

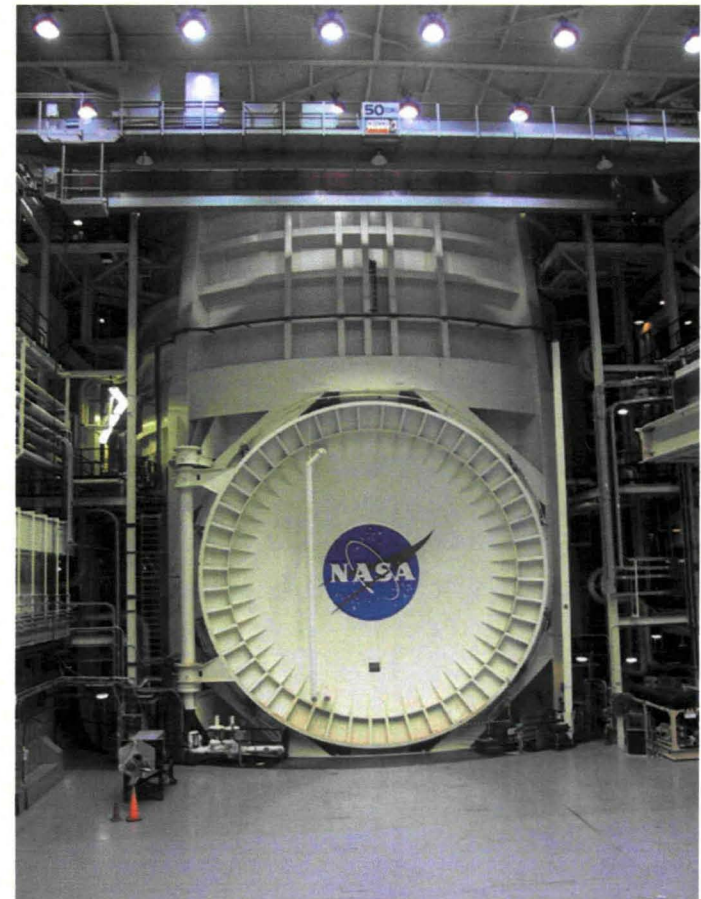
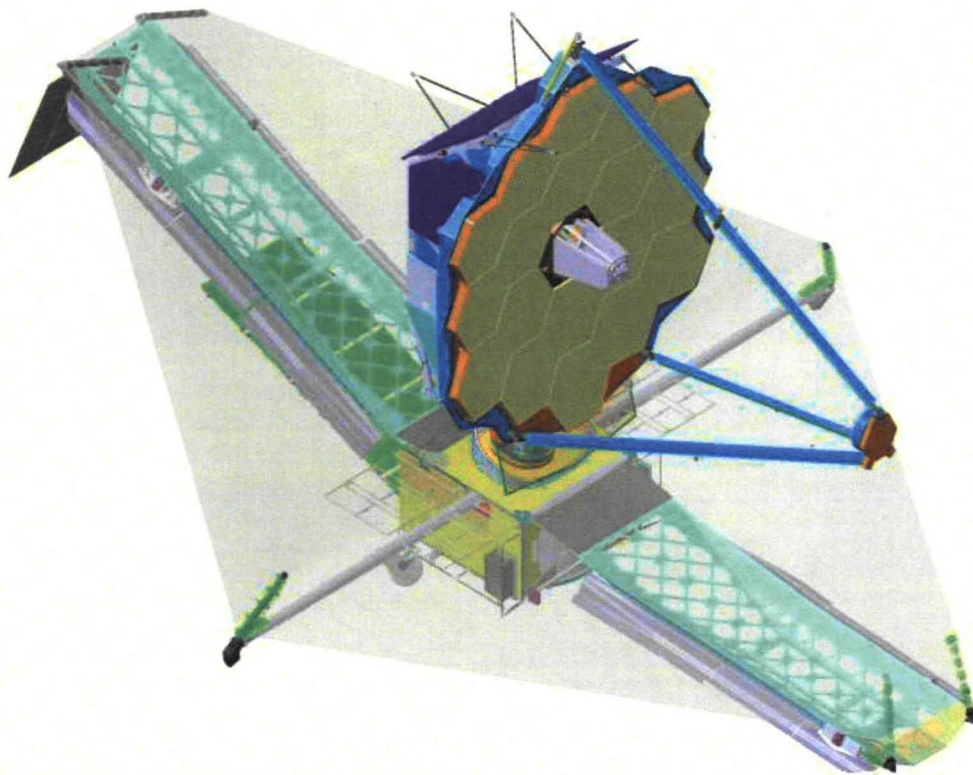


Some program requirements did change from initial requests
However, program requirements can often be interpolated – *but no one likes that answer*

We build satellites, *we don't need facilities!*



- ◆ JWST had to spend ~\$100 million on JSC Chamber A
 - ◆ Additional funds spent on GSE/STE



Every NASA project is built and tested in one or more facilities
Most facilities require repairs, modifications or upgrades

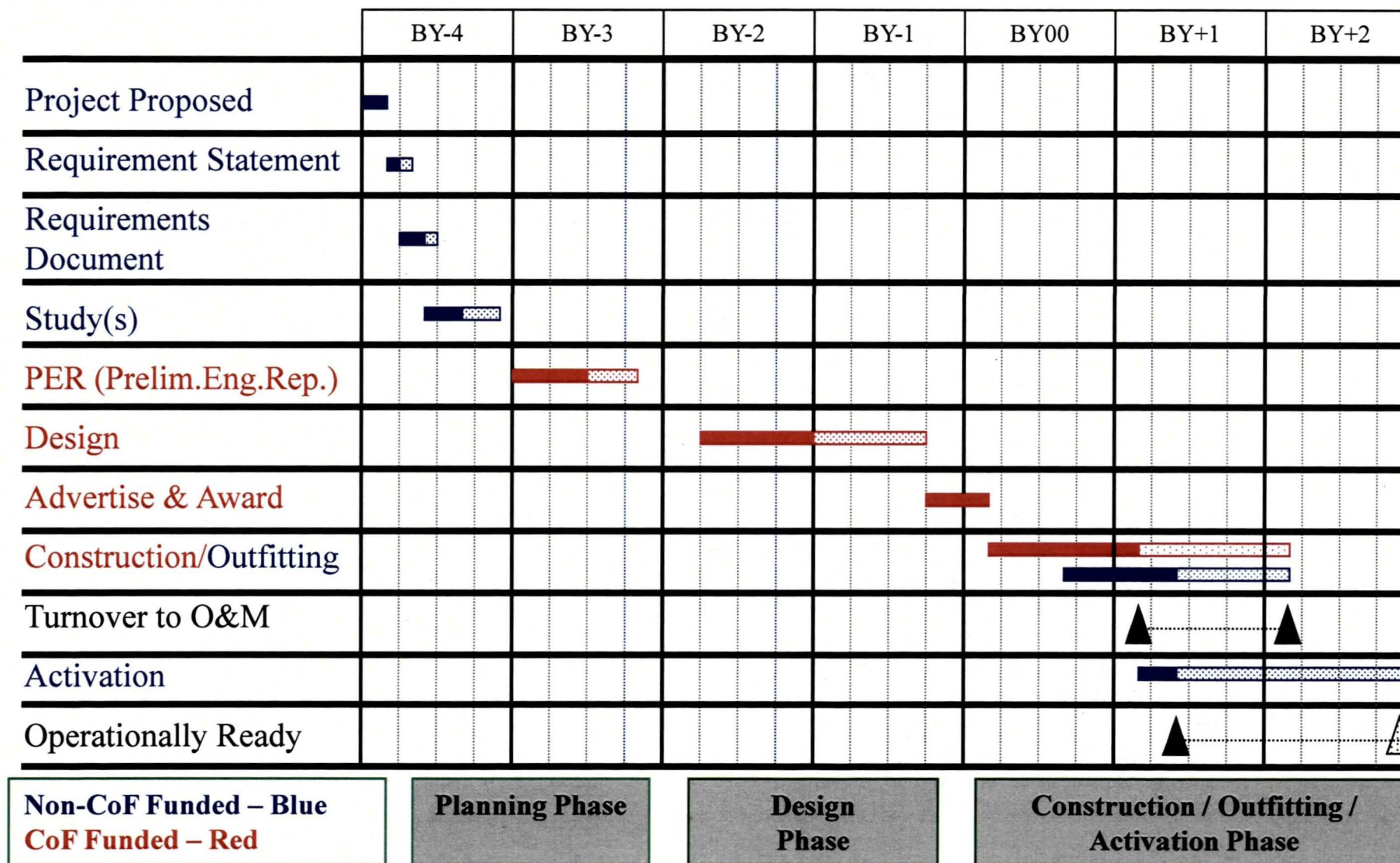
Background



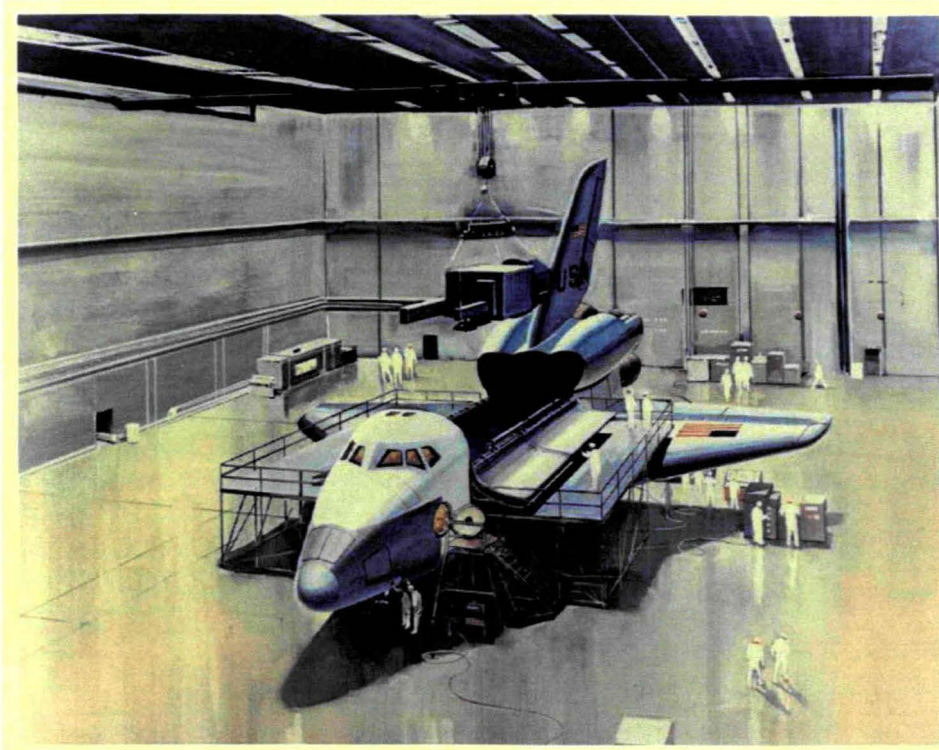
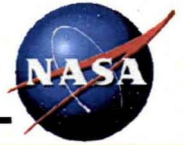
- ◆ **Myth – estimating facilities is easy**
- ◆ **Reality – estimating facility costs is difficult**
 - ◆ Early estimates developed with nebulous requirements
 - ◆ But costs are expected to be accurate
 - ◆ Facilities have unique set of rules
 - ◆ Funding
 - ◆ Approval Requires – Center, HQ & Congressional line item approval
 - ◆ Phasing – Cost vs. Obligations
 - ◆ *Generally all funding must be available before project can be awarded*
 - ◆ Different colors of money FP&D, CoF, & non CoF
 - ◆ Schedule - long timelines – **Typically 5-7 year process**

CoF Typical Timeline

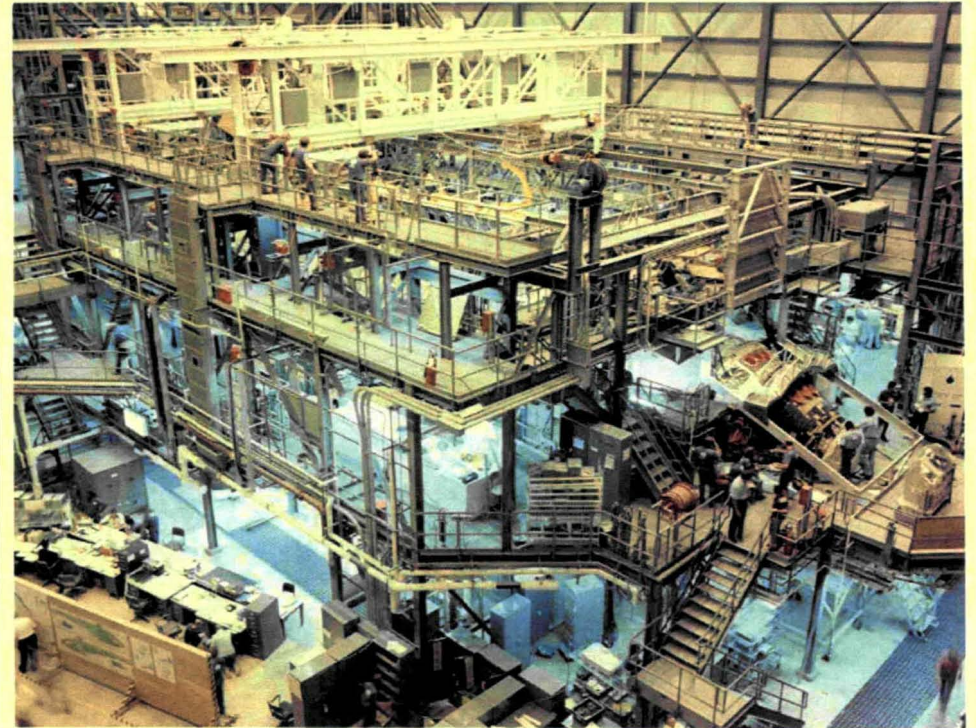
5-7 Years



Assumptions



Shuttle Operations Concept 1974
What was estimated



Shuttle Operations Reality Today
What was built

Bad Assumptions = Bad Estimates
But we are Smarter Now!
& Better Looking!

Historical Data



- Single most useful way to quickly estimate new projects
- Must be used with caution to ensure entire scope is represented
 - NASA method of funding projects makes it very difficult to ascertain total project costs.
 - Result of different funding streams
 - CoF, R&D, FP&D, GSE, Support Contractors, Etc
- New requirements are excluded from historical data
 - Code changes
 - Human rated systems, taller rockets, larger cryogenic systems
- Project final costs should be
 - Adjusted for scope
 - Escalated to midpoint of construction



Real Life Example

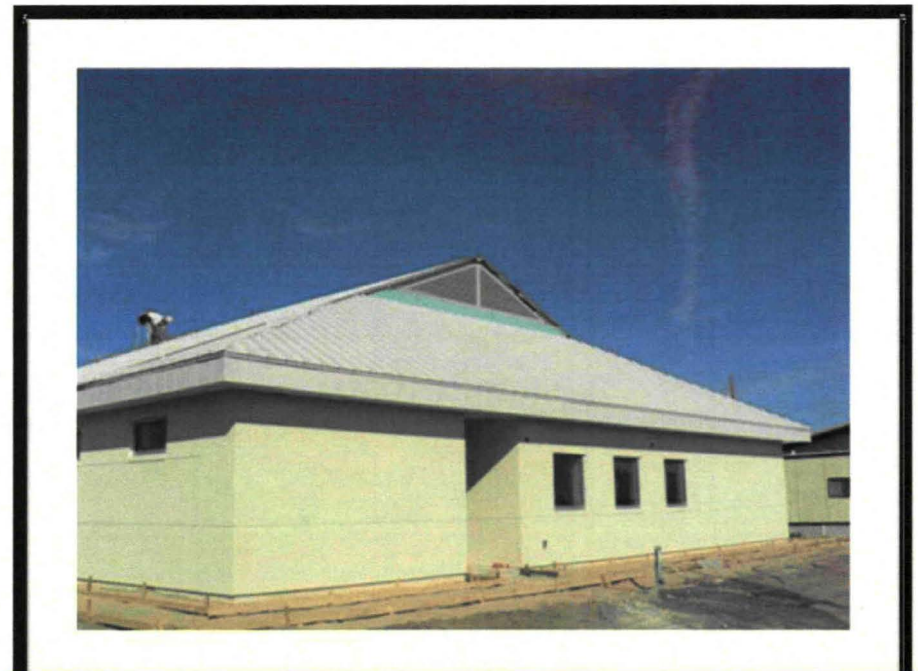


- ◆ KSC hired engineering firm to design 4,200 sf facility
 - ◆ Engineering firms initial estimate for this project was \$2.4M
 - ◆ PM concerned facility had to be downsized or additional funding found
 - ◆ Instead an independent assessment of the project was done, estimate was \$1.3M
 - ◆ Assessment performed using available historical data
- ◆ Awarded value \$1.2M (within 3% of independent assessment)
 - ◆ ½ of initial engineering firms estimate

**This is how it
How it “should work”**

One of the best ways to define early estimates is to compare to historical projects

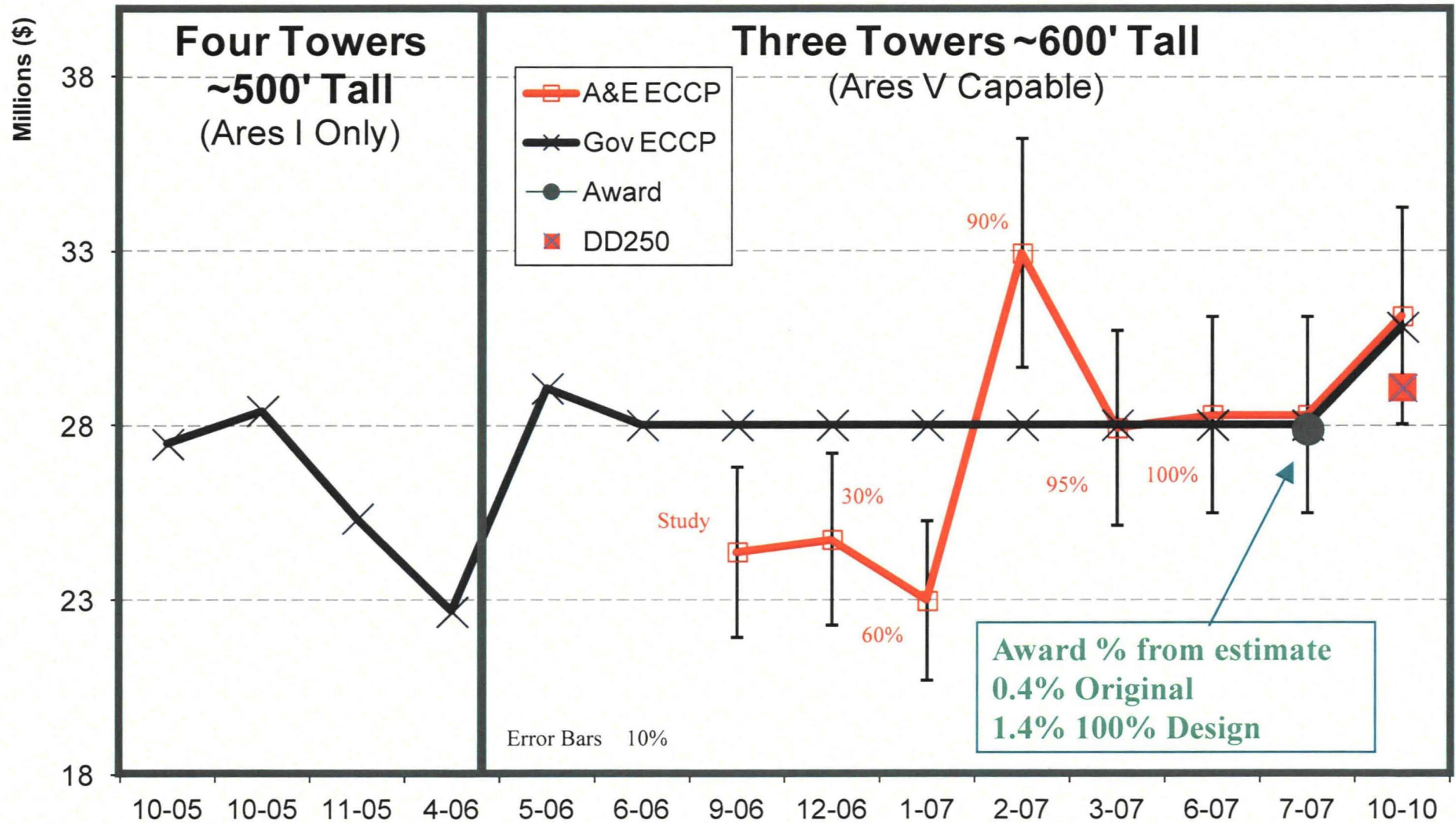
However, limited data available for these type of assessments



**Replacement Operations Building,
Fuel Storage Area No. 1**

Real Life Example #2

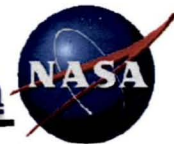
LC39B Lightning Protection Towers Estimate History



Had quote for \$8M, but historical data suggested this was low

Subset of NASA Current KSC Data

http://www.ksc.nasa.gov/nasa-only/finance/COST_EST/Index_files/Page617.htm




Introduction - Windows Internet Explorer

http://www.ksc.nasa.gov/nasa-only/finance/COST_EST/Index_files/Page617.htm

File Edit View Favorites Tools Help

Introduction

NASA - KENNEDY SPACE CENTER FL



Estimating & Cost Engineering

Introduction

This website contains the best available copies of available aerospace cost information for CoF, R&D & GSE projects. If you are aware of information that is not included or a have a better copy please contact [Glenn Butts](#).

There is a great deal of useful information buried in the archives that can be helpful for preparing estimates.

Unfortunately unless you are aware that the information exists, and are willing to spend the requisite time to locate it, the information is useless. Therefore the information has been compiled, and cataloged here in an attempt to make this valuable resource available to others.

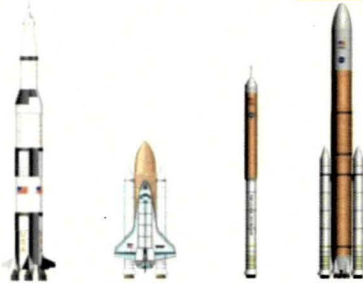
The documents presented here are the cumulative works of many people, and have been compiled with the help of many more.

Cost Estimating Workshop Materials

Warnings

This information has not been evaluated for SBU, or ITAR Restrictions—So its release is limited to NASA, and NASA Contractors ONLY. Review the restrictions [HERE](#).

This information does not work well with FIREFOX Browsers




Space Vehicles—past present & future
(Click to Enlarge)

Information List

Cost Engineering Reference Materials

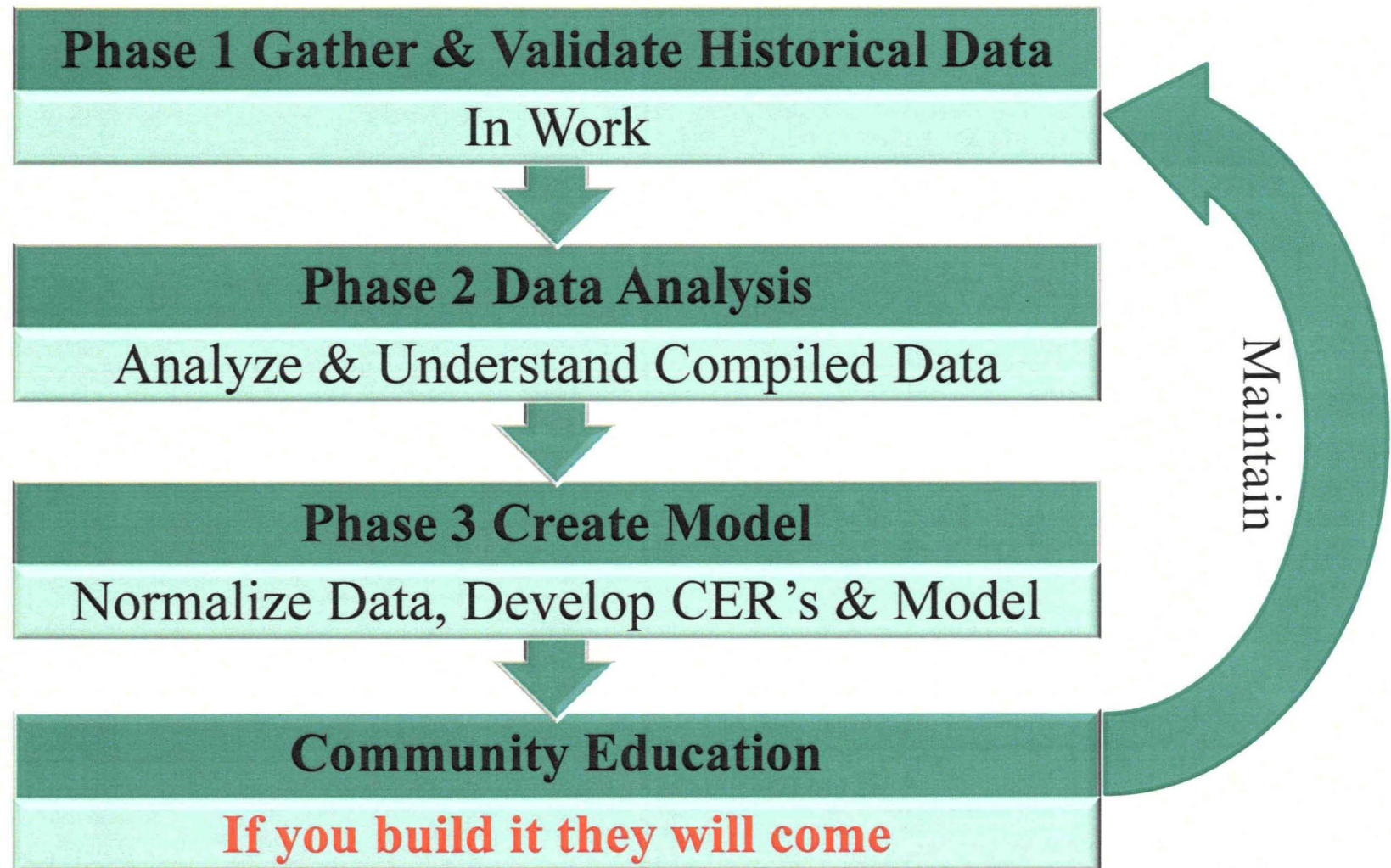
Useful estimating information, Specifications, rules of thumb, and lessons learned.



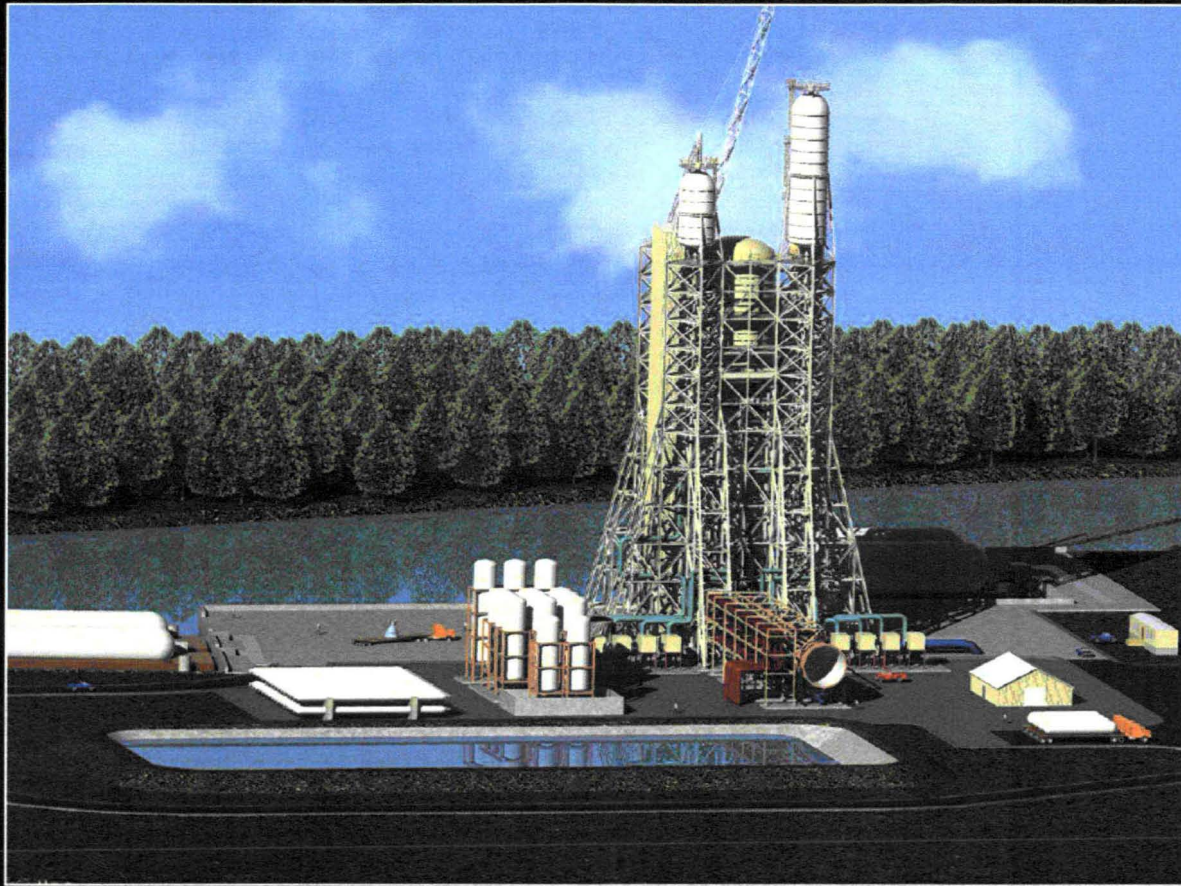
- [More details...](#)

**Over 3 Gigabytes
NASA Specific Data
Must be behind NDC
Firewall to access**

Facility Database Project Vision



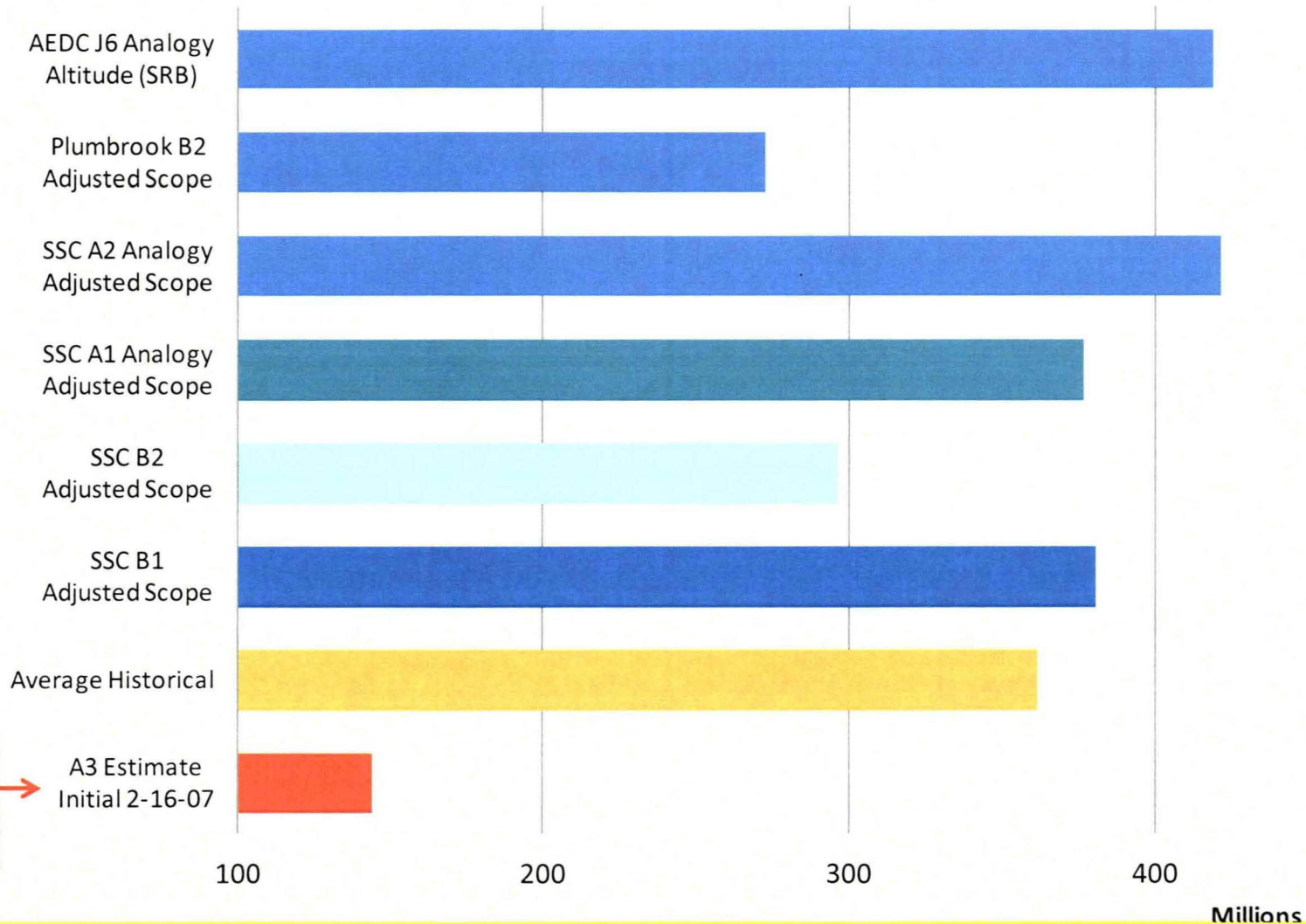
A-3 Test Stand



- 300 feet tall
- Open steel frame structure
- Up to 1 million pounds of thrust
- Simulates altitudes up to 100,000 feet by generating steam to create a vacuum

The new A-3 Test Stand will allow engineers to test operating parameters of the J-2X engine for the Ares launch vehicles by simulating conditions at different altitudes.

A3 Initial Estimate Sanity Check



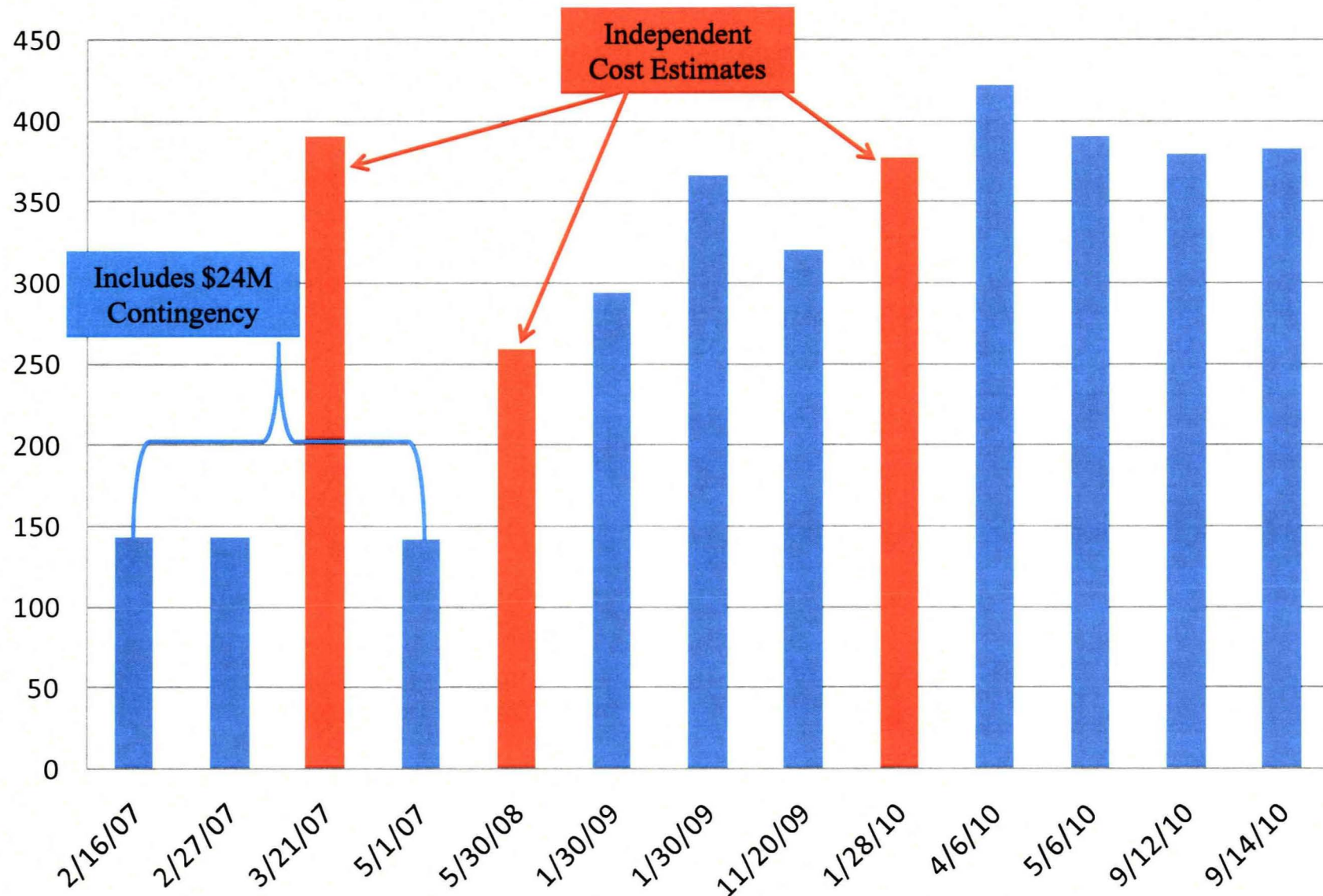
Includes \$24M Contingency (20%)



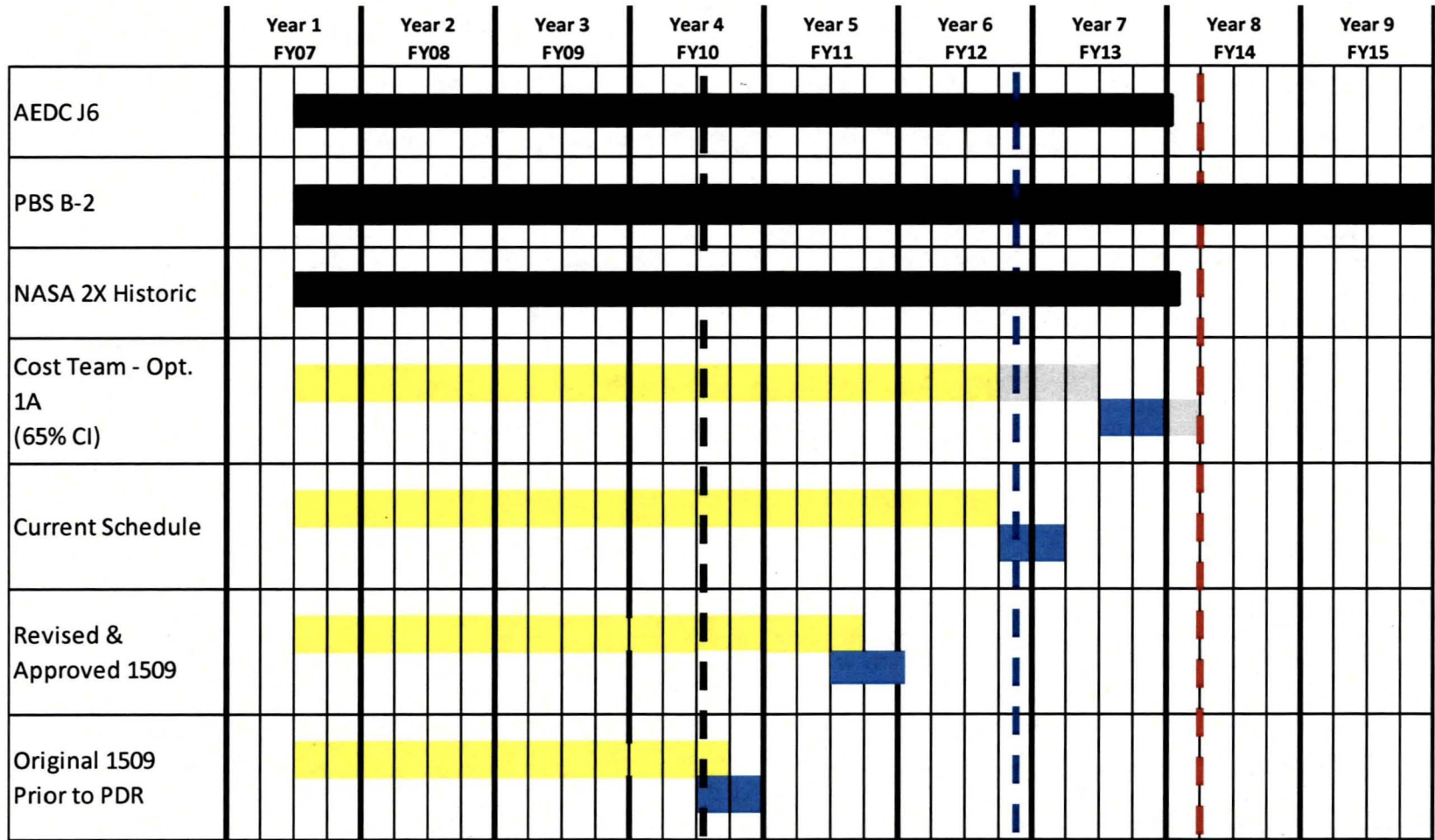
A3 Estimate Initial 2-16-07

**Compared projects are not for the same scope
But give an indication that initial estimate was optimistic**

A3 Cost History



A3 Schedule



Independent Assessment

Assessment Date

Test Need Date*

Construction
Activation
Contingency

**Remember
Typical Project Takes 5-7 Years**

Facilities Database

Phase 1 Status



- Integrating available Facility and GSE databases
 - Data for 1,345 projects has been entered in database
 - Some data is conflicting, validation is slow process
- **Actively seeking cost and schedule data from other centers**
- **Looking for facility GSE, & STE data**
 - Data = estimates, summary schedules, bid abstracts, DD250's, activation costs, design costs, pictures

– Can you help?



Additional Help

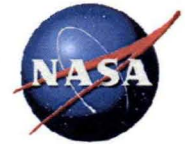


- The new NASA Cost Estimating Handbook
 - Located here
http://www.nasa.gov/offices/pae/organization/cost_analysis_division.html
 - Has an Appendix that provides overview of CoF Process, and a discussion on how to adjust historical facility data
 - Appendix P - Construction of Facilities and Ground Support Equipment Cost Assessment



BACKUP

NASA New Start Escalation Index Should NOT be Used For Facilities



□ NASA New Start Composition

Total Weighted Index (weighting values)	100%	
Labor total without total weighting applied	81%	
Wages and Salary, Private, Professional, Scientific, Technical		50%
AHE Aerospace Product and Parts Manufacturing		10%
Avg. Hourly Earnings, Computer System Design & Related Svc		10%
Employment Cost Index, Benefits, Private, All Workers		30%
Material total without weighting applied	12%	
Nonferrous Metals		3%
Semiconductor & Other Electronic Components		4%
Search, Detection, Navigation & Guidance Systems		5%
General total without weighting applied	7%	
CPI (all items less food & energy)		5%
CPI Fuels & Utilities		2%

Index designed for spacecraft, the only thing it should be used on!

Phase 1 Status



- Data for 1,345 projects has been entered in database
 - Some data is conflicting, validation is slow process
- Project is integrating available KSC Facility and GSE databases

Facility Projects			
Project Title Long: Replace Electrical Maintenance Facility (EMF)			
Project Title: Repl. Electrical Maintenance Facility			
Project Prefix:	NNK	DRAW #:	79K38333
No:	09CA41D	Spec #:	79K38334
PCN:	97995	Contractor:	H.W. Davis Const
FY Funded:	2009	Design Actual Start Date:	
Project Manager:	Rivieccio	Design Actual Finish Date:	
Lead Design Engineer:	Ramos	Design Completion Cost:	
Construction Manager:	MCBRIDE	Budget (\$):	5,900,000
Inspector:	MILLER	AFPC (\$):	
Program:	Institutional	Funds Released (\$):	
PROJ Class:	Building	Constr Compl Est (CCE):	4,000,000
Facility #:	K6-1446K	ECCP:	3,849,096
A/E:	JEA	C-100:	
Spec Conditions:	2/9/2009	Procure Method:	Gen. IDIQ
Procurement Method:	Gen. IDIQ	Location:	KSC
Dept funded:	189,204	Construction Type:	Regular
NTP:	9/15/2009	No Bidders(includes gov Est):	8
\$ Gov Est:	3,426,471	Bid Date:	6/10/2009
Construction Award Date:	6/29/2009	Construction NTP End Date:	3/9/2011
\$ Award Amount:	3,572,316	Construction Actual Completion:	
DD250:		Draw#2:	
Final \$ Amount:		Draw#3:	
PCN3:		Comments:	Validation Comments:
PCN2:		Period of performance is extended to July 7, 2011.	Data reviewed 4-8-2011 sbz
DateEntered:			
Scope:	Construct 18,200 square foot Electrical Maintenance Facility office building, modifying an existing 7,500 square foot warehouse building, and demolishing two structures on the site of the existing Electrical Maint Fac. Task 1 (Base Bid) awarded \$3,181,222. Option 1 Construct Asphalt Parking, awarded \$22,264. Option 2 Construct Existing Warehouse Modifications awarded \$228,933. Option 3 Construct Existing Administration Building Demolitions awarded \$92,295. Option 4 Construct Existing Fire Alarm Shop building Demolition awarded \$47,602.		

Project Summary



- **Project:**
 - Facility and Ground Support Equipment (GSE) Project Cost & Schedule Database

- **Description:**
 - KSC has completed 1,500+ facility and GSE projects which are scattered across multiple databases. This project requests funding to integrate the multiple databases into one database, validate the data and provide a search engine so that parametric and detailed project estimates can be prepared from actual historical data.
 - Integrate database into the Marshall Space Flight Center Engineering Cost Office Resource Data Storage and Retrieval (REDSTAR) system, or a REDSTAR type system

- **Beneficiaries:**
 - Agency wide Facility and GSE Offices.

National Aeronautics & Space Administration

NASA's Constellation program – based largely on existing technologies – was based on a vision of returning astronauts back to the Moon by 2020.

However, *the program was over budget, behind schedule*, & lacking in innovation due to a failure to invest in critical new technologies.

The President's Budget *Cancels Constellation* & replaces it with a bold new approach that invests in the building blocks of a more capable approach to space.

In the last 20 years NASA has spent at least \$21B on canceled
Space Transportation Programs

~7% of its Budget

Overruns can have real consequences

Database Screen Shots



Adobe Acrobat
Document



CoF Definition

- ◆ CoF: Facilities, Facility Systems and Collateral Equipment
 - Site work, buildings and building systems normally acquired and installed as a part of a facility project
 - Collateral Equipment
 - General building systems and subsystems such as electrical, plumbing, pneumatic, fire protection, and control and monitoring systems.
 - Building-type equipment normally required to make a facility useful and operable. Built-in or affixed to the facility in such a manner that removal would impair the usefulness, safety, or environment of the facility. Includes such items as elevators; heating, ventilating, and air-conditioning systems; transformers; and compressors and other like items generally accepted as being an inherent part of a building or structure and essential to its utility.
 - Built-in or large substantially affixed equipment/property of any type other than building type equipment which is built in, affixed to, or installed in real property in such a manner that the installation cost including special foundations or unique utility services, or facility restoration work required after its removal, exceeds \$100,000.



Non-CoF (R&D) Definition

◆ Non-CoF: Outfitting, Activation and Non-Collateral Equipment

➤ Non-collateral Equipment

- Equipment other than collateral equipment which, when acquired and used in a facility or a test apparatus, can be severed and removed after erection or installation without substantial loss of value or damage to the premises where installed.
- A unit of equipment may be considered non-collateral if it has such a close relationship to a Program project hardware item (i.e., prototype or test article, launch vehicle, spacecraft) that it is essentially an extension of the Program hardware item in that its configuration and/or operating characteristics must constantly reflect unpredictable changes in the Program item.
- The relationship between the equipment item under consideration and the Program item must be clear and significant; and, it must be evident that sufficiently frequent changes in the equipment item are definitely to be expected due to the nature or complexity of the Program item although it may not be possible to predict the extent or actual frequency of such changes.



CoF vs. Non-CoF Examples

Examples of CoF Items	Example of Non-CoF Items
<p>Building Structure (foundation, walls, windows, doors, roof, access floor/platforms etc.) Site work, parking, roads, landscaping HVAC systems AC Power Electrical conduit Potable water Fire suppression system Fire detection system hardware Wastewater system Facility grounding & lightning protection Cranes (including control systems and software programs) Elevators (including control systems and software programs) Exhaust systems Cabling duct banks (power & communications) Emergency power generation Original finished flooring and ceiling Facility Propellants Drain Systems Fluids/Gases (Piping, pedestals)</p> <p>Current Non-CoF items to become CoF items in FY13: Premise wiring</p>	<p>Furniture and window treatment Electronic equipment racks Removable raised flooring Under floor HVAC for raised flooring systems (cooling for equipment racks, computers, data equipment) Fire detection system software Communication cables (including data circuits) and "end item" equipment Telephones Computers Application software Laboratory equipment and systems including work benches, sinks, cabinets, exhaust hoods Uninterruptible Power System (UPS) DC Power Paging & Area Warning System (PAWS) Fluids/Gases (regulator panels & controls) Operational Intercom systems (OIS-D) Cafeteria and kitchen equipment/furniture Activation, relocation/move-in expense Calibration & operator certification/training Groundbreaking & dedication Kennedy Space Center Complex Control System (KCCS)</p>

April 21, 2011