Development of a Project Cost Estimating Capability

NASA Cost Symposium

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Outline

- **A New Universe**

- **Overview of the Requirements and Architecture**

- **Overview of v1**

- **The Challenges**

- **Way Forward**

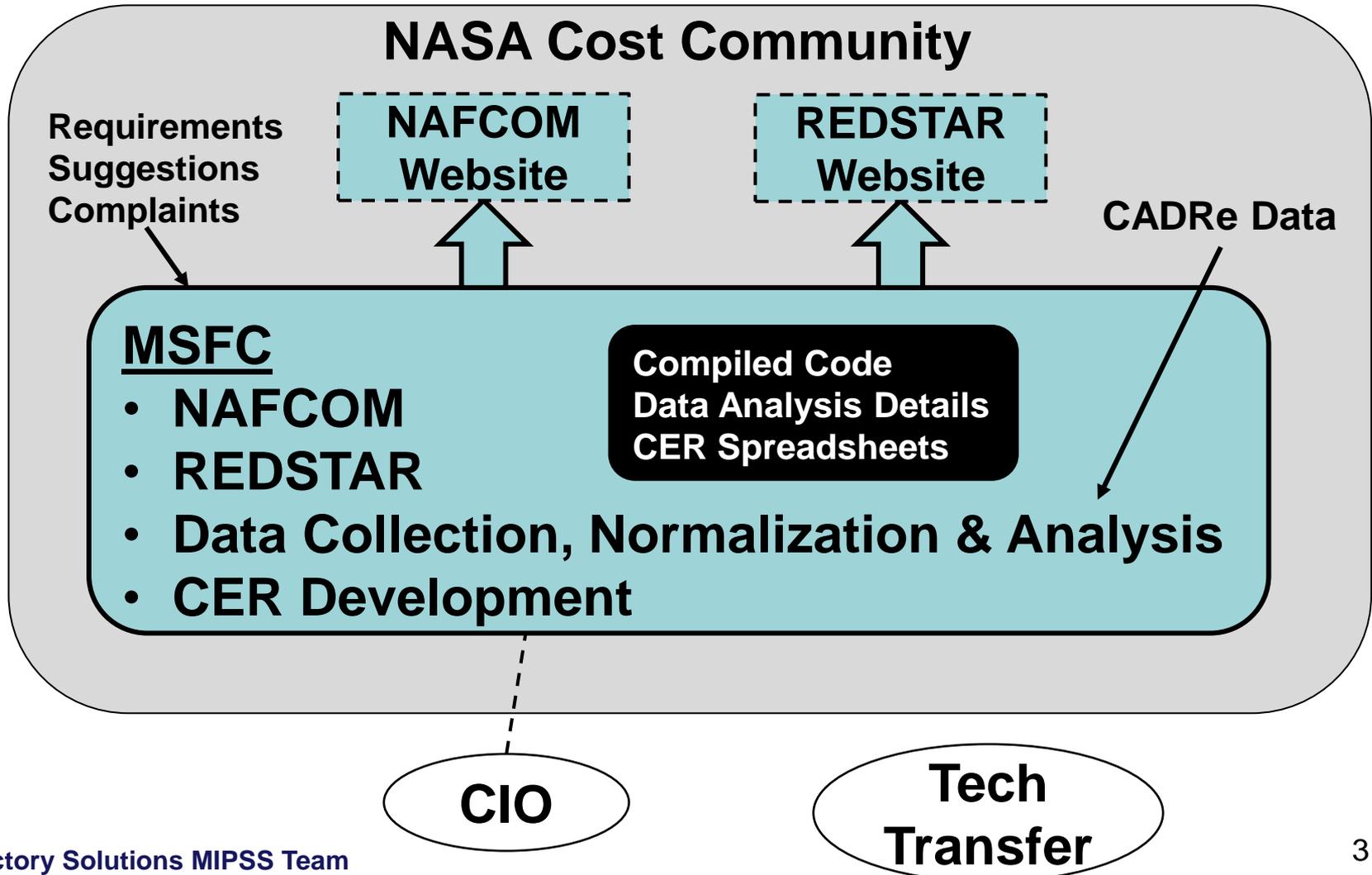**Victory Solutions MIPSS Team**

The NAFCOM Universe

Closed System

NASA Cost Community

Requirements
Suggestions
Complaints

NAFCOM Website

REDSTAR Website

CADRe Data

MSFC
- **NAFCOM**
- **REDSTAR**
- **Data Collection, Normalization & Analysis**
- **CER Development**

Compiled Code
Data Analysis Details
CER Spreadsheets

CIO

Tech Transfer

The PCEC Universe

Open and Transparent System

NASA Cost Community

Knowledge
Expertise
Tools
Capabilities
Etc.

Software Release Authority

REDSTAR & ONCE
Data Analysis & CER Details

CADRe Data

MSFC
- PCEC
- REDSTAR
- Data Collection, Normalization & Analysis
- CER Development

Excel Add-In
CER Libraries
VBA Code

CIO

Tech Transfer
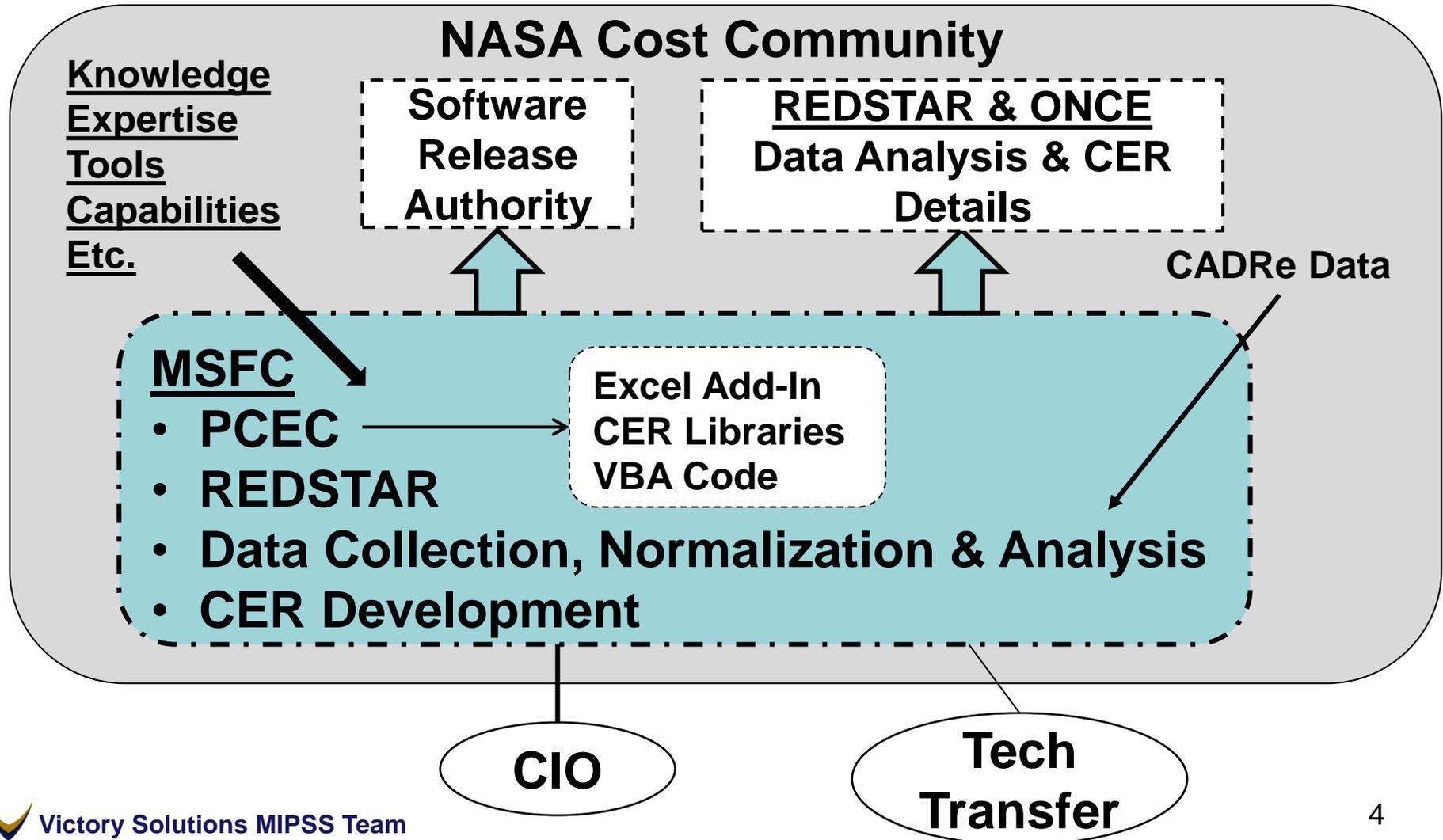
PCEC Requirements

- **The PCEC team formed a PCEC Steering Committee to guide, define, and develop core requirements**
  - Total of 25 Requirements Spread over 3 Levels

- **Key Attributes:**
  - Transparent and Customizable
  - Meet all NASA IT Security Requirements
  - Include Documentation and Statistics for all CERs
  - Traceable to the NASA Standard WBS
  - Separate CER Libraries and Software
  - Contain No Data or Links to Databases
  - *Implement an Agreed-Upon List of NAFCOM Capabilities to Carry Forward*

The PCEC Architecture

Key Elements of Project Cost Estimating Capability (PCEC) – Overview

- **REDSTAR Library**
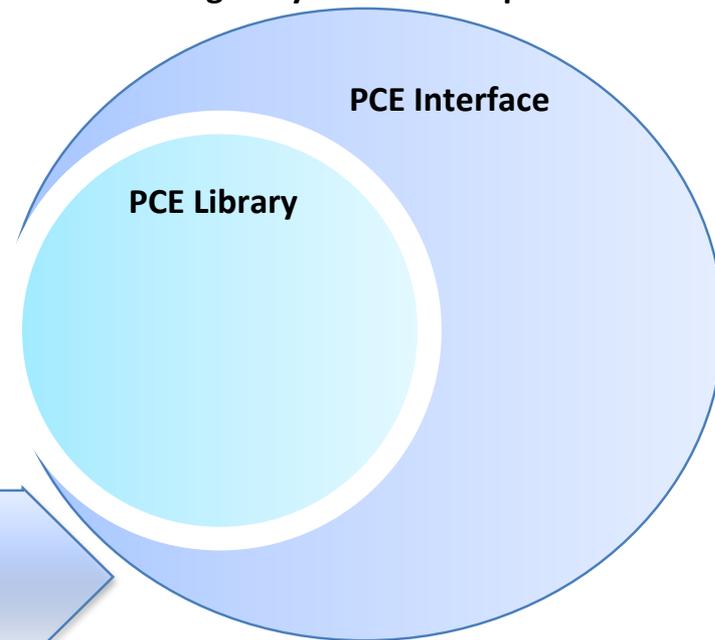- **One NASA Cost Engineering (ONCE) Database**

Data Source

CER Development & Source Documentat ion

Accessible with NASA User ID and Account Approval

PCEC: Managed by PCEC Development team

PCE Interface

PCE Library

Publically Releasable via NASA Software Release Authority Process

NASA IT Security Interface

PCEC Elements

PCEC Library

- Store core cost estimating artifacts (CERs, WBS, Inflation, basic historical mission data)
- Contains NAFCOM12 CERs with associated statistics, as well as NAFCOM WBS templates and other information
- Excel Workbook

PCEC Interface

- Facilitate the use of the PCEC Library information (e.g., inserting CERs, building WBSs) for creating estimates
- Automate redundant estimating processes
- Excel Add-In

CER Library Organization

- **Introduction**
- **General Information**
  - Variable List
  - Variable Influence Tables
  - Mission Information
  - WBS Dictionary
  - Inflation Table
  - CER Documentation Help

- **WBS Templates**
  - NASA NPR 7120.5E
  - NASA CADRe
  - NC12 Earth Orbiting Spacecraft
  - NC12 Planetary Spacecraft
  - NC12 Uncrewed Spacecraft
  - NC12 Crewed Spacecraft
  - NC12 Launch Vehicle Stage

- **Recommended CERs**
  - System Level
  - Group Level
  - Subsystem Level
  - Component Level

Contents of Each CER Tab
- **CER Documentation**
- **Cost Calculation**
- **Risk Calculations**

- **Legacy CERs**
  - Group Level
  - Subsystem Level
  - Component Level

Victory Solutions MIPSS Team

CER Interface Organization

- **Microsoft Excel Add-in Workbook (XLAM)**

- **Provide features to facilitate the integration of project estimating artifacts contained in the *PCEC Library* into Excel-based cost models**
  - Automate Some of the Redundant Processes in Developing a Cost Estimate
  - Custom Tab on Excel's Ribbon
  - VBA based Methods for Formatting and Manipulating Worksheets

The ribbon contains the following button groups:

Models/Estimate
- Load and save model templates
- Launch an Estimate to get stared quickly with a custom model
- Insert individual CERs as a few lines or entire preformatted worksheets

Inform/Document
- Learn more about CERs and variables
- Document and validate CERs used in your workbook

Tools/Help
- Insert WBS templates, Library worksheets and Inflation information into your workbook
- Use the in-tool Help file to learn more about what the PCEC can do for you

Engineering Cost Office
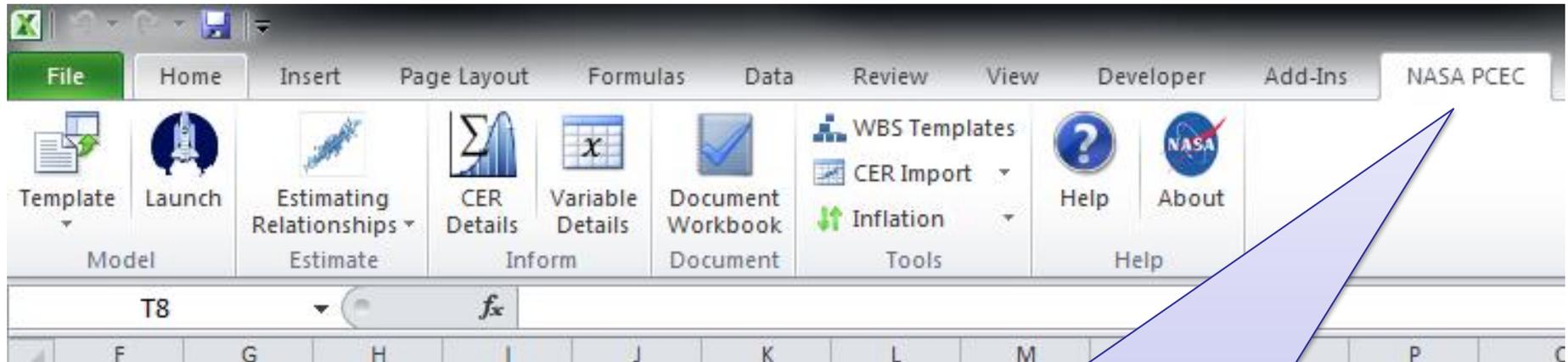
The PCEC Ribbon Tab provides ease of access to all PCEC features, including:
- Cost Estimating Relationships   - Work Breakdown Structures
- Templates and Model Generation   - Inflation tool
- Documentation and Information   - Help

- **Following an Incremental Development Approach to Incorporate Updates over the Next Several Releases (v1.x)**
  - Implementation of Uncertainty for First-Pound and System Integration
  - Integration of Outputs from other Excel-based Models: NICM, SOCM, etc.
  - Phasing
  - User-requested Improvements/Updates
  - Under the Hood Enhancements

- **Establishment of the PCEC Review & Release Process**

- **Upload v1 Data and CER Spreadsheets to REDSTAR**

- **Development of Training Materials and Example Models with Uncertainty/Risk**

- **Get State Department Approval for General Release!!**

PCEC v2 Challenges

- **Integrated Model Construct**
  - Integration of Parallel Model Development Efforts
  - Incorporation of Legacy Tools (i.e. NICM)
  - CERs vs. Models

- **CADRe vs. Pre-CADRe Data**

- **Limited Data Sets for Crewed System, Launch Vehicles, and Space Transportation Systems**
  - Modeling Development and Production Environments

- **Approach to Data Analysis**
  - Full Cost Accounting
  - WBS and FBS
  - Cost Allocation by Phase

- **Objective vs. Subjective Variables**

- **Modeling System Level Costs**

Future PCEC Development

- **PCEC Library and Interface v2**
  - Changes in the Estimating Framework but…
  - Same Look, Feel, and Operation as the Existing Interface

- **Key Changes for v2**
  - NASA Standard WBS: Migration away from NAFCOM WBS
  - Space Flight hardware CER updates: New normalizations, new missions added, Tailored CERs/Models by Mission Type (robotic, crewed, launch vehicles)
  - New CERs for "wraps": Results of Ongoing PM/SE/MA/I&T Research
  - Inclusion of more Models/Capabilities that Enable Total Life-Cycle Cost Estimating

- **New Data Normalization/Analysis and CER Workbooks Uploaded to REDSTAR (and ONCE?)**

- **PCEC v2 is Planned for Release 1Q FY15**

PCEC v2 & NASA Std WBS

Legend:
- NAFCOM & PCEC v1
- PCEC v2

Flight Development And Operations Project

| Project Management 01 | Systems Engineering 02 | Safety & Mission Assurance 03 | Science / Technology 04 | Payload(s) 05 | Aircraft / Spacecraft 06 | Mission Operations 07 |

- **Project Management 01**
  - Wrap Research CERs/Model

- **Systems Engineering 02**
  - Wrap Research CERs/Model

- **Safety & Mission Assurance 03**
  - Wrap Research CERs/Model

- **Payload(s) 05**
  - NICM
  - Wrap Research CERs/Model

- **Aircraft / Spacecraft 06**
  - Robotic S/C CER Updates
  - Crewed & LV CER Updates
  - First Pound
  - Wrap Research CERs/Model

- **Mission Operations 07**
  - SOCM
  - OCM

| Launch Vehicle / Services 08 | Ground System(s) 09 | Systems Integration & Testing 10 | Education and Public Outreach 11 |

- **Launch Vehicle / Services 08**
  - Crewed & LV CER Updates
  - First Pound
  - LRECM
  - Historical LV Price List

- **Systems Integration & Testing 10**
  - Wrap Research CERs/Model

Questions?

PCEC Library

Overall PCEC Antenna description:

Estimating Level: Component
The antenna is the part of the uplink/downlink that enables a signal to be transmitted and/or received. There are many different types of antennas, but using one method of

CER Name and description of what is being estimated

Design and Development CER

CER Information

CER:

$$[Deployable]^{1.708}$$

Pre-calculations:

Text versions of the CER and any precalculations

Methodology:
Log-linear regression

UID:
016-01-01-01

Variables

Name	Constant	WeightPerU	CommSC	ReconSC	TMI	Crewed	DDMR	NewDesign	Deployable
Coefficien	3.877	0.490	-0.395	-1.032	-1.586	1.279	0.098	1.651	1.
SE	0.922	0.066	0.23336954	0.36861582	0.34973144	0.48633191	0.30590261	0.24181503	0.48992586
P-value	0.000	0.000	9.64E-02	7.10E-03	3.24E-05	1.11E-02	0.74977497	7.85E-09	9.79E-04

> **Coefficients and associated regression information**

Regression Statistics

Logspace					Logspace	Unit space
R^2	0.868	Regression DF	8	SSR	179.037	5964.2
Adj R^2	0.849	Residual DF	54	SSE	27.185	5888.8
F-Stat	44.455	Total DF	62	SST	206.222	15426.5
F-Stat P-V	0.000			SEE	0.710	10.443
PING Facto	1.241			Y_Bar	0.129	6.190
SPE	1.06227925			CV	5.495	1.687
				Pearson's Co	0.932	0.81476191

> **Regression analysis information and statistics**

Descriptive Statistics

Name	DDFY12	WeightPerU	CommSC	ReconSC	TMI	Crewed	DDMR	NewDesign	Deployable	P
Min	0.017	0.300	1.000	1.000	4.000	1.000	0.245	0.250		
Max	91.068	155.900	2.718	2.718	12.000	2.718	0.797	1.000	2.718	4
Mean	6.190	19.741	1.682	1.136	10.381	1.136	0.507	0.634	1.070	
Median	0.999	5.600	1.000	1.000	12.000	1.000	0.482	0.640	1.000	0
SD	15.774	32.004	0.847	0.468	2.732	0.468	0.160	0.249	0.326	9.727

> **Data descriptive statistics**

Correlation Matrix

	DDFY12	WeightPerU	CommSC	ReconSC	TMI	Crewed	DDMR	NewDesign	Deployable
DDFY12	1.0000	0.5415	0.1109	-0.3090	-0.6315	0.5275	0.2716	0.6093	0.3118
WeightPerU	0.5415	1.0000	0.3682	-0.2874	-0.2452	-0.0376	-0.0633	0.0339	0.1533
CommSC	0.1109	0.3682	1.0000	-0.2381	-0.2488	-0.2381	0.1652	-0.0243	-0.0115
ReconSC	-0.3090	-0.2874	-0.2381	1.0000	0.1614	-0.0862	-0.2393	0.0652	-0.0648
TMI	-0.6315	-0.2452	-0.2488	0.1614	1.0000	-0.5564	-0.2324	-0.2947	0.0657
Crewed	0.5275	-0.0376	-0.2381	-0.0862	-0.5564	1.0000	0.3118	0.3682	-0.0648
DDMR	0.2716	-0.0633	0.1652	-0.2393	-0.2324	0.3118	1.0000	0.3056	0.0423
NewDesign	0.6093	0.0339	-0.0243	0.0652	-0.2947	0.3682	0.3056	1.0000	0.2141
Deployable	0.3118	0.1533	-0.0115	-0.0648	0.0657	-0.0648	0.0423	0.2141	1.0000

> **Data correlation matrix**

Red Flag if Abs >=	0.7
Yellow Flag if Abs >=	0.6

Missions Used

AE-3	DMSP-5D	GPSMYP	NATO III	TDRSS
AMPTE-CCE	DMSP-5D3	HEAO-1	OMV	TOPEX
Apollo LM	DSCS-II	INTELSAT-IV	OSO-8	UFO
ATS-6	DSCS-IIIA	LRO	P78	
Chandra	DSP	MARISAT	SMS-1	
CRRES	GPS-IIR	Mars Pathfinder	TACSAT	

Missions whose data was used for regression

Variable Descriptions

INPUTS:

Name	Brief Desciption	Possible Values
WeightPerUnit	Weight Per Unit: Weight of each unit (pounds)	pounds, 0+
CommSC	Communication Spacecraft: Denotes whether the spacecraft class is Communication	1 if No, =EXP(1) if Yes.
ReconSC	Recon Spacecraft: Denotes whether the spacecraft class is Reconnaissance	
TMI	TMI: Technology Maturity Index of the element	
Crewed	Crewed: Denotes whether system is Crewed	
NewDesign	New Design: Rating based on the amount of new design expected for a subsystem	
Deployable	Deployable: Denotes whether the antenna is deployable	
MfgMethods	Manufacturing Methods: Rating that denotes the degree of use of advance manufacturing techniques	0-100% (Decimal in [0-1])
EngMngt	Engineering Management: Rating based on the level of engineering management for the system.	0-100% (Decimal in [0-1])
FndAvail	Funding Availability: Rating that reflects the anticipated funding availability for the system	0-100% (Decimal in [0-1])
TestApp	Test Approach: Rating based on the level of testing be conducted on the system	0-100% (Decimal in [0-1])
IntegComplexity	Integration Complexity: Rating based on the expected number of interfaces involving multiple contractors and/or centers	0-100% (Decimal in [0-1])
PreDevStudy	Pre-Development Study: Rating based on the amount of the study efforts that were/are being conducted prior to the start of	0-100% (Decimal in [0-1])

Variable descriptions

CALCULATED:

Name	Brief Desciption	Possible Values
DDFY12	DD FY12: Design & Development (D&D) Cost in fiscal year 2012 millions of dollars (FY12 $M)	FY12 $M, 0+
DDMR	DD Management Rating: Design and Development Management Rating	0-100% (Decimal in [0-1])

Model Uncertainty Analysis Information

Prediction Interval Distribution

 Distribution: T-Distribution

 Degrees of Freedom: 54

Squared Design Matrix

Constant	63	117.48375	24.9999832	4.99999664	144.158187	4.99999664	-46.202783		
WeightPerU	117.48375	375.449975	64.4989148	1.6140661	260.121996	8.31594564	-88.307181		
CommSC	24.9999832	64.4989148	24.9999664	0	54.4618716	0	-16.594409		
ReconSC	4.99999664	1.6140661	0	4.99999327	12.4245249	0	-5.0598765		
TMI	144.158187	260.121996	54.4618716	12.4245249	337.932302	8.05069797	-107.51333		
Crewed	4.99999664	8.31594564	0	0	8.05069797	4.99999327	-1.8516953		
DDMR	-46.202783	-88.307181	-16.594409	-5.0598765	-107.51333	-1.8516953	41.2446466	27.8983275	-1.7987906
NewDesign	-34.16088	-62.248428	-13.879504	-2.231434	-81.040663	0	27.8983275	30.3028771	-0.3302715
Deployable	2.69314584	7.97083671	0.99999865	0	6.44958287	0	-1.7987906	-0.3302715	2.48045032

Uncertainty information

20

PCEC Antenna Cost Calculation

Value Name	Input/ Calculation			
	Major Inputs			
	Weight			
Total Weight				
	Thruputs			
Design & Development				
System Test Hardware				
Flight Unit				
	Common Multivariable Inputs	DD	FU	
Manufacturing Methods	(3) Mod. Mfg Techniques	5%	65%	0.5
Engineering Management	(3) Mod Design Changes	60%	5%	0.5
New Design	(8) New design. Components validated in lab environ or relevant environment (100%)			1
Funding Availability	(2) Some Infrequent Delays Possible	5%	5%	0.5
Test Approach	(2) Moderate Testing, Qualification at Prototype/Protoflight Level	6%	15%	0.5
Integration Complexity	(1) Minimal Major Interfaces Involving Multiple Contractors/Centers	12%	5%	0.25
Pre-Development Study	(3) Less Than 9 Months of Pre-Phase C/D Study	12%	5%	0.75
	PCEC Antenna Component Specific Inputs			
Deploy	Yes			2.718281828
Spacecraft Class	(1) Communication			1
TMI	(12) Technology is mature (> 10 yrs) of flight experience encompassing at least 5 missions and			12

A calculating version of the CER set up similar to NAFCOM12 with dropdown lists for certain inputs

Other Inputs		
Quantity Next Higher Level	1	1

CER Methodology	
Multivariable Type	(6) Shuttle Calibrated

Additional CER inputs

Globals		
Flight Year	2015	2015
Units	Thousands	1000

System Test Hardware (STH)		
STH Quantity	1	1
FU Percent	130	130

DD Point Estimate $FY12	$	
STH Point Estimate $FY12	$	
FU Point Estimate $FY12	$	12,915.03
Total $FY12	$	141,335.85

CER outputs

Uncertainty Adjusted Cost Estimate

...timate from the Cost Calculation section and a probability distribution function... ...ce a range of cost values. This can be used directly in a Monte Carlo simulation...

Placeholder for inserting a probability distribution from a Monte Carlo Excel Add ins

A calculating version of modeling uncertainty.

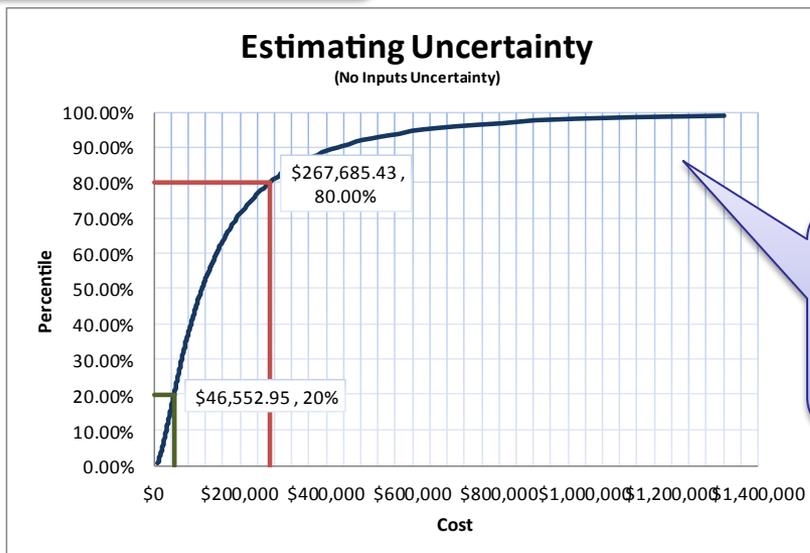|	
Distribution type:	T-Distribution
...f Freedom:	54
...ty Distribution here:	
...Standard Error Factor:	1.031
Log space Point Estimate:	4.715
Uncertainty Adjusted Log Space Estimate:	4.715
Uncertainty Adjusted Unit Space Estimate: $	111.63
Uncertainty Adjusted Cost Value $FY12: $	**111,631.29**

Takes point estimate from previously discussed Cost Calculation section

Outputs can be used in directly in a Monte Carlo model

...ession Error Cumulative Distribution Function

...error surrounding the current point estimate from the Cost Calculation section.

Estimating Uncertainty
(No Inputs Uncertainty)

$267,685.43 , 80.00%

$46,552.95 , 20%

Percentile (y-axis): 0.00% – 100.00%
Cost (x-axis): $0 – $1,400,000

S-Curve Percentiles

20%	$ 46,552.9
80%	$ 267,685.4

Percentile	Cost $FY12
80%	$ 267,685.4
90%	$ 425,312.7

This section shows uncertainty around the current point estimate as a CDF and at certain percentiles

NASA

Engineering Cost Office

First-Pound Cost CER Documentation

Overall CER description:

This CER provides a relationship that can used to estimate the cost of a group/subsystem/component using only the weight of the element being est...

A-value: Calibrated value of the coefficient for the individual mission calculated by inputting the mission's actual Cost, Weight... log space.

b-value: Exponent for the equation Cost = A * Weight ^ b for the element being modeled. It is computed based on regression of historical costs by group/subsystem/component. It represents the slope of regression line in log space.

Design and Development & Fligh...

CER Information

CER:

DD FY12 = A * Weight^b

FU FY12 = A * Weight^b

Variable Definitions:

A = The geometric mean of the A-values of the selected table entries.

b = The average of the b-values of the selected table entries

Instructions for Use:

1. Input element weight (and uncertainty, if desired) and complexity factors in "CER Calcul... at right
2. Select analogous element(s) from historical missions in the table
3. Complete quantity information in "Learning, LRIP, and Production Rate Calculator" section at right
4. Link cost results at right to your WBS summary worksheet

	D&D		Flt Unit	
	D&D A-Value	D&D b-value	Flt Unit A-value	Flt Unit b-value
Average Values Based on Selection	N/A	N/A	N/A	N/A

Note: If "N/A" appears in a cell above, please select at least one element with a non-zero value

Select one or more entries in the table by entering an "X" in the "Selected Element" column to include that element in the A- and b-value calculations for the CER equations

Elements Selected 0

Selected Element	Mission	Subsystem Element	WBS Item	Estimating Level	Hardware		Unit value	Hardware ID
	ACTS	Antenna	Antenna	Component	Uncrewed		0	462
	ACTS	Antenna	Antenna	Component			0	471
	ACTS	Antenna	Antenna, Multibeam	Component			0	465
	ACTS	Antenna	Structure, Multibeam Antenna	Component	Uncrewed		0	458
	ACTS	Communication	Amplifier, Traveling Wave Tube	Component	Uncrewed		0.80	464

Description of the First Pound Cost estimating methodology

Calculations for equation parameters (A and b-values)

Instructions for using this worksheet

Table of hardware from which to select one or more analogous data points

First-Pound Cost CER Calculation (Analogy)

Subsystem Name

	DDT&E	D&D	STH	Flight Unit	Production	Total
	$ -	$ -	$ -	$ -	$ -	$ -

Cost outputs from CER

CER Calculations

For Weight Uncertainty

DD Point ~~Estimate~~

$

Placeholder for input uncertainty information

Distribution Formula	Distribution Type	Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5

Flt Unit Point Estimate	**Weight Per Unit**	**Flt Unit A-value**	**Flt Unit b-value**	**Complexity Factor**
$ -	0	N/A	N/A	1

Distribution Formula	Distribution Type	Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5

Cost Calculations

Flight Unit Cost	**FY12 $M**
LRIP Items	$ -
Post-LRIP Items	$ -
Total	$ -

STH Cost	**FY12 $M**
Total	$ -

Production Cost	**FY12 $M**
LRIP Items	$ -
Post-LRIP Items	$ -

Inputs and calculations for Learning Curve

Learning, LRIP, and Production Rate Calculator

Inputs	Q_NHA	Q_Prod	Production Start Unit	Learning Curve Slope	Theory Type	Q_LRIP	LRIP Stepdown %	Q_STH	Flight Unit % (for STH)	Production Rate (per year)	Production Rate %
	1	1	1	100%	Unit	0	0%	1	130%	1	100%

Calculations	Learning Multiplier		Start	Quantity	Lot Avg Unit Cost Multiplier (Unit Theory)	Lot Avg Unit Cost Multiplier (Cum Avg Theory)
Flight Unit	LRIP Qty (up to Q_NHA)		1	0	0.000	1.000
	Post-LRIP Qty		1	1	1.000	1.000
Production	LRIP (up to Q_NHA)		1	0	0.000	1.000
	Post-LRIP Qty		1	1	1.000	1.000

Quanity:	1	2	3	4	5	6
Learning %: 100%	1	1	1	1	1	1

Production Rate Multiplier	1

System Integration Cost CER Documentation (Analogy)

Overall CER description:

This CER provides a relationship that can used to estimate the cost of a System Integration cost element using spacecraft hardware

A-value *: Calibrated value of the coefficient for the mission calculated by inputting the mission's actual SI Cost, Weight, and b-value the y-intercept of the regression line in log space.*

b-value *: Exponent for the equation SI Cost = A * HardwareCost ^ b for the element being modeled. Computed based on regression*

> **Description of System Integration estimating methodology**

Design and Development & Flig

CER Information

CER:
*DD FY12 = A * Cost^b*
*FU FY12 = A * Cost^b*

> **Instructions for using this worksheet**

1. *Input total spacecraft costs (D&D, STH, Flt Unit, Prod.) in the "CER Calculations" section to the right (or link to WBS)*
2. *Select analogous mission(s) in the table below*
3. *Input any additional factors you wish to apply to the costs in the section to the right*
4. *Link cost results in "System Integration Costs" section at right to your WBS summary worksheet*

Variable Definitions:

A = The geometric m
b = The average of t
Cost = Spacecraft Ha

> **Calculations for equation parameters (A and b-values)**

Average Values Based on Selection

	DDT&E A-value	DDT&E b-Value	Flt Unit A-value	Flt Unit b-Value
IACO	N/A	N/A	N/A	N/A
STO	N/A	N/A		
GSE	N/A	N/A		
SE&I	N/A	N/A	N/A	N/A
PM	N/A	N/A	N/A	N/A
LOOS	N/A	N/A		

Note: If "N/A" appears in a cell above, please select at least one element with a non-zero value

Spacecraft Cost to Use

	DDT&E	Flt Unit
IACO	STH	Flt Unit
STO	D&D + STH	
GSE	D&D + STH	
SE&I	D&D + STH	Flt Unit
PM	D&D + STH	Flt Unit
LOOS	D&D + STH	

Select one or more entries in the table by entering an "X" in the "Selected Mission" column to include that mission in the A- and b-value calculations for the CER equations.

Elements Selected   0

Selected Mission	Mission	Hardware Class	Orbit	Spacecraft Class	Estimating Level		Flt Unit A-value - STO	Flt Unit B-Value - STO
	ACTS	Uncrewed	Earth Orbiting	Communication	System			
	AE-3	Uncrewed	Earth Orbiting	Scientific	System			
	AEM-HCMM	Uncrewed	Earth Orbiting	Scientific	System			
	ALEXIS	Uncrewed	Earth Orbiting	Scientific	System			

> **Table of hardware from which to select one or more analogous data points**

System Integration Costs

	DDT&E	D&D	STH	Flight Unit	Production	Total
IACO	$ -			$ -	$ -	$ -
STO	$ -					$ -
GSE	$ -					$ -
SE&I	$ -			$ -	$ -	$ -
PM	$ -			$ -	$ -	$ -
LOOS	$ -					$ -

> **Cost outputs from CER**

CER Calculations

Spacecraft Cost Inputs   *Link to WBS*

> **CER Calculations**

IACO	$ -	$ -	N/A	N/A	1.00		$ -	$ -	N/A	N/A	1.00	$ -
STO	$ -	$ -	N/A	N/A	1.00							
GSE	$ -	$ -	N/A	N/A	1.00							
SE&I	$ -	$ -	N/A	N/A	1.00		$ -	$ -	N/A	N/A	1.00	$ -
PM	$ -	$ -	N/A	N/A	1.00		$ -	$ -	N/A	N/A	1.00	$ -
LOOS	$ -	$ -	N/A	N/A	1.00							

PCEC Interface

PCEC Interface
Templates

Structured for CER Inputs
CER Output Summary for DDT&E, D&D, STH, Flight Unit, Production and Total Cost

PCEC Power Distribution

	DDT&E	D&D	STH	Flight Unit	Production	Total
$	11.021	$ 11.021	$ -	$ -	$ -	$ 11.021

Structured for CER Inputs
Multivariable CER FU and DD sections with variable input information and CER formula references in place

CER Calculation

PCEC Power Distribution DD	Weight Per Unit	Launch Vehicle	Crewed	New Design	DD Management Rating	Manufacturing Methods	Engineering Management
$ 11.021	1000	1	1	0.75	0.534	0.8	0.56
	9.8593E-06	1.00602E-05	0.018137938	0.000862701	0.050984275	---	---
	pounds, 0+	1 if No, =EXP(1) if Yes.	1 if No, =EXP(1) if Yes.	0-100% (Decimal in [0-1])	0-100% (Decimal in [0-1])	0-100% (Decimal in [0-1])	0-100% (Decimal in [0-1])

Uncertainty Adj. Prediction	SSE Adjusted	Adjustment Factor	SEE	T-Distribution	Degrees of Freedom
11.02053177	0.690063994	1.071588041	0.643963881		31

Notes:

PCEC Power Distribution FU	Weight Per Unit	Launch Vehicle	Crewed	New Design	Planetary Rating	FU Management Rating	Manufacturing Methods
$ -	1000	1	1	0.75	1	0.738	0.8
	4.66569E-05	0.03926264	0.005373827	0.026690061	0.091531793	0.924792728	---
	pounds, 0+	1 if No, =EXP(1) if Yes.	1 if No, =EXP(1) if Yes.	0-100% (Decimal in [0-1])	1 if No, =EXP(1) if Yes.	0-100% (Decimal in [0-1])	0-100% (Decimal in [0-1])

Uncertainty Adj.	SSE Adjusted	Adjustment Factor	SEE	T-Distribution	Degrees of
#NUM!	#NUM!	#NUM!	0.621478963		30

Notes:

Additional Calculation Sections
Sections for calculating Learning, LRIP, and Production Rate based on CER inputs

Modify WBS Elements
Add and remove CERs from WBS Hardware sections

Tailor WBS Hierarchy
Create summary elements and sub-elements to tailor WBS

CER Search
Search PCEC CERs by keyword or category for inclusion in WBS

Launch an Estimate
Create estimate that includes the created WBS with links to the selected CERs

Engineering Cost Office

CER Search
Search PCEC CERs by keyword or categories such as: Level, WBS, or Methodology

NASA PCEC: Insert CER

Search for a CER:

Type a brief description of what you want to estimate and then click Go   Go

Or select a category: Multivariable

Select a CER:

*Insert a Multivariable Regression equation into the selected cell

PCEC Amplifier DD
PCEC Amplifier FU
PCEC Antenna DD
PCEC Antenna FU
PCEC Attitude Control DD
PCEC Attitude Control FU
PCEC Battery DD
PCEC Battery FU
PCEC Cable DD
PCEC Cable FU
PCEC CCDH DD
PCEC CCDH FU
PCEC CDH DD

PCEC Amplifier DD   ...

Estimating Level: Component

Help on this Form   OK   Cancel

CER Description
See detailed information about the selected CER

Multivariable CER Info
View detailed info about CER including statistics and documentation

CER Description
Proceed to the next step in entering a CER into your model

Multivariable CER Inputs
Input values into CERs as values or references to cells

Input Descriptions
View context sensitive information about the selected input variable

NASA PCEC: Multivariable Regression based CER Function Arguments

PCEC Amplifier DD

WeightPerUnit		=	number
TMI		=	number
Crewed		=	number
Solid_State		=	number
TWT		=	number
DDMR		=	reference

=

PCEC Amplifier DD: Level - Component; Method - Log-linear regression

WeightPerUnit

Weight Per Unit: Weight of each unit (pounds)
Input Range: pounds, 0+

CER Result =

Help on this Form   lbl   x   Xp   Xr   OK   Cancel

Output Options
Specify what information to output with the CER as well as format choices and uncertainty calculations

CER Search
Search PCEC CERs by keyword or category

CER Information
View detailed information for Multivariable CERs including: Equation Text, Variable Info, Regression Statistics, Included Missions, Variable Correlation, and Uncertainty Info

NASA PCEC: Multivariable CER Information

CER Selection

Search for a CER:

Type a brief description of what you want to estimate and then click Go   [Go]

Or select a category: All

Select a CER:

PCEC Amplifier DD
PCEC Amplifier FU
PCEC Antenna DD
PCEC Antenna FU
PCEC Attitude Control DD
PCEC Attitude Control FU
PCEC Battery DD
PCEC Battery FU
PCEC Cable DD
PCEC Cable FU

CER Description
PCEC Amplifier DD
Estimating Level: Component

CER Information

CER Text | Variables | Regression | Missions | Correlation | SDM

CER Text:

[DDFY12] = 0.115 * [WeightPerUnit]^1.156 * [TMI]^-0.383 * [Crewed]^1.917 * [Solid_State]^2.823 * [TWT]^0.548 * [DDMR]^0.1

Precalculations:

[DDMR]= [MfgMethods]*0.05 +[EngMngt]*0.6 +[FndAvail]*0.05 +[TestApp]*0.06 +[IntegComplexity]*0.12 +[PreDevStudy]*0.12

Help on this Form

OK   Cancel

Variable Information
View critical information about CER variables such as Name, Friendly Name, and range of possible input values

Variable Description
View variable definition and a detailed description of how input Values impact a CER output

NASA PCEC: Variable Information

Variable Name	Friendly Name	Possible Values
[DDMR]	DD Management Rating	0-100% (Decimal in [0-1])
[DDSpecialMat]	DD Special Material Factor	0 if No, 94 if Yes.
[DDTech]	DD Tech	0+
[DDTEFY12]	DDTE FY12	FY12 $M, 0+
[Deployable]	Deployable	1 if No, =EXP(1) if Yes.
[DesignLife]	Design Life	months, 1+
[DL120ND79]	DL >= 120 & ND >= 79%	1 if No, =EXP(1) if Yes.
[DLGT72]	Design Life >= 72	1 if No, =EXP(1) if Yes.
[DRGT1]	Date Rate > 1K	1 if No, =EXP(1) if Yes.
[EngMngt]	Engineering Management	0-100% (Decimal in [0-1])
[FndAvail]	Funding Availability	0-100% (Decimal in [0-1])
[FUFY12]	FU FY12	FY12 $M, 0+
[FULouvers_Heaters]	FU Louvers/Heaters	0 for "No Louvers / No Heaters" , 3 f
[FUMR]	FU Management Rating	0-100% (Decimal in [0-1])

DD Special Material Factor

Rating based on whether any material out of the ordinary used in the thermal control subsystem (D&D)

This is a dimensionless variable used in the Thermal Control Tech Rating calculation. Special materials or configuration denotes anything out of the ordinary used in the thermal control/protection system, such as the gold plating used on NEAR or the carbon phenolics used on the Galileo Probe. Choices for Special Materials / Special Configurations are the following:

(1) Yes = Input of 94

Help on this Form   OK   Cancel

PCEC Interface Document Workbook

Estimating Relationship Documentation Report created at: 5/12/2014 3:55:15 PM

Estimating Relationship Name	Worksheet	Address	Valid
PCEC Amplifier DD	Sheet1	B2	TRUE
PCEC Structures DD	PCEC Structures CER	C13	TRUE
PCEC Structures FU	PCEC Structures CER	C35	TRUE
PCEC Thermal Control DD	PCEC Thermal Control CER	C13	TRUE
PCEC Thermal Control FU	PCEC Thermal Control CER	C35	TRUE
PCEC Reaction Control DD	PCEC Reaction Control CER	C13	TRUE
PCEC Reaction Control FU	PCEC Reaction Control CER	C35	TRUE
PCEC Electrical Power DD	PCEC Electrical Power CER	C13	TRUE
PCEC Electrical Power FU	PCEC Electrical Power CER	C35	TRUE
PCEC CCDH DD	PCEC CCDH CER	C13	TRUE
PCEC CCDH FU	PCEC CCDH CER	C35	TRUE
PCEC Attitude Control DD	PCEC Attitude Control CER	C13	TRUE
PCEC Attitude Control FU	PCEC Attitude Control CER	C35	TRUE
PCEC Solid Rocket Motor DD	PCEC Solid Rocket Motor CER	C13	TRUE
PCEC Solid Rocket Motor FU	PCEC Solid Rocket Motor CER	C35	TRUE
PCEC Power Distribution DD	PCEC Power Distribution CER	C13	TRUE
PCEC Power Distribution FU	PCEC Power Distribution CER	C35	TRUE

CER Document Table
View a table of all CERs included in the workbook. The table contains links to CER Documentation and the CER's cell location in the workbook

CER Documentation
CER documentation contains the following information about Multivariable CERs: CER Description, Equation Text, Variable Information, Regression Statistics, and Descriptive Statistics,

Victory Solutions MIPSS Team

Engineering Cost Office

Select WBS
Select WBS from all WBS available in the PCEC library

WBS View
View the elements of the selected WBS

Element Description
View the elements of the selected WBS

NASA PCEC: Insert Work Breakdown Structure

Select Work Breakdown Structure:

NASA NPR 7120.5E

WBS #/Level	WBS Element
1	Space Flight Project
1.1	PM
1.2	SE
1.3	Safety & Mission Assurance
1.4	Science & Technology
1.5	Payload(s)
1.6	Spacecraft
1.7	Mission operations
1.8	Launch Vehicle/Services
1.9	Ground System(s)
1.10	Systems Integration & Testing
1.11	Education and Public Outreach

NASA NPR 7120.5E

Space Flight Project

Help on this Form   OK   Cancel

Insert WBS
Insert WBS as a new worksheet or as a list of values in a specified location

NASA NEW START INFLATION INDEX--(ACTUALS THRU September 2013)																			
YEAR	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	TQ	1977
INFL.RATE	4.0%	4.3%	3.2%	4.0%	3.5%	4.5%	3.4%	6.0%	4.9%	5.4%	5.7%	6.9%	6.3%	5.7%	5.7%	7.2%	10.8%	9.0%	2.1%	8.5%
FACTORS	1.040	1.043	1.032	1.040	1.035	1.045	1.034	1.060	1.049	1.054	1.057	1.069	1.063	1.057	1.057	1.072	1.108	1.090	1.021	1.085

Inflation Table
Insert the NASA NEW START INFLATION INDEX table as a new worksheet in the workbook

NASA PCEC: Insert Inflation Factors for Specific Years

Destination Cell

M6

Choose Years

Base Year	Start Year	Final Year
2012	2014	2019

Help on this Form   OK   Cancel

Inflation Factors
Specify a range of years to return a subset of the inflation table

PCEC Interface
Insert Library Worksheets

Library Worksheets
Generate PCEC Library worksheets as new worksheets in the workbook or as worksheets in a new workbook

NASA PCEC: Generate Library Worksheets

Select Library Worksheeets to generate:

Available Library Worksheets

- ☑ Variable List
- ☑ Inflation Table
- ☐ First Pound Cost (Analogy)
- ☐ First Pound Cost (Database Average)
- ☑ System Integration (Analogy)
- ☑ System Integration (Database Average)
- ☑ PCEC Amplifier
- ☐ PCEC Antenna
- ☐ PCEC Attitude Control
- ☐ PCEC Battery
- ☐ PCEC Cable
- ☐ PCEC CCDH
- ☐ PCEC CDH
- ☐ PCEC Communications

Help on this Form

OK   Cancel

PCEC Interface In-Tool Help File

In-Tool Help File
Access context sensitive and searchable Help material for all PCEC features