National Aeronautics and Space Administration

Independent Cost Estimate Evolution

An Improvement to Goddard Independent Estimate at Completion (IEAC) Calculation and Reporting

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BLUF: Goddard Flight Projects IEAC Change

- In the Fall of 2023, Goddard projects were directed by the Flight Projects Directorate to report new calculations for Independent Estimates at Complete (IEAC) at Monthly Status Reviews (MSR).

- IEAC reporting was previously based upon standard EVM formulas and carried all non-EVM elements as fixed passthrough items. The change focused on capturing elements that were not captured by EVM and which could drive programmatic performance.

- Adjustments took into account project risks, through incorporating risk based projected budget margin consumption, and fixed price elements by factoring fixed price scope based on schedule performance.

Background and Challenge

- **Background:**
  - The IEAC is an Earned Value Management (EVM) based forecast of total project costs utilizing historical project performance.
  - IEACs test the reasonableness of current Estimates at Completion (EAC).
  - Projects, programs, and independent assessors typically generate several IEACs to establish a reasonable cost range for comparison to a project's lifecycle cost (LCC) estimate or estimate at complete (EAC).

- **Challenge:**
  - Flight Projects were observing gaps without Fixed Price elements in programmatic reporting. Teams were providing EVM data monthly – and the exclusion of fixed price data resulted in a lack of performance insights.
    - Firm Fixed Price element were experiencing growth, but were "passed through" without detailed analysis.
    - Some projects had large portions of the LCC that were not assessed.
  - Executives were unable to quickly compare data to the Management Agreement (MA) and Agency Baseline Commitment (ABC) to understand commitment breach risk.
  - Inconsistency in project reporting.

Solution: Standardizing IEAC Forecasting

- The Flight Projects Directorate (FPD) standardized IEAC calculations to aid management in understanding and comparing project IEACs consistently.

- Navigating the Need:
  - Still provide a range in IEACs to measure uncertainty.
  - A common discussion starting point (standardized).
  - Incorporate all project aspects to reach and measure against a MA/ABC.
    - Needed to account for fixed price hardware contracts and not just pass them through.
    - Needed to estimate programmatic impact in cases of limited insights.
  - When to measure performance on the lifecycle (portfolio includes concepts through operations).
  - How to apply to projects without EV requirements.

- Key Philosophy:
  - IEACs are programmatic forecasting.
  - IEACs are not EVM. EVM is part of some IEAC calculations/formulas.
  - IEACs are a mixture of forecasting tools used together (cost, schedule, EV, risks/threats, reserves) – a wholistic approach.

Approach: Projects Conducting EVM

- Required projects performing EVM to report the following three formulas:

Reflects "best case" – allows for projects that have on track FFPs

IEAC-A: ACWP + BCWR + Non-EVM Elements + Liens + Weighted Threats

Reflects "most likely" – begins to weight fixed price elements for schedule performance (BEI)

IEAC-B: ACWP + (BCWR/(.5*CPI + .5* SPI)) + Non-EVM Elements, excluding fixed price hardware contracts + Liens + Weighted Threats + (FPCAC + (FPCWR/Cum BEI)) for each fixed price hardware contract

Reflects "worst case"

IEAC-C: ACWP + (BCWR/(CPI*SPI) + Non-EVM Elements, excluding fixed price hardware contracts + Liens + Weighted Threats + (FPCAC + (FPCWR/Cum BEI)) for each fixed price hardware contract

Notes:

1. ACWP = Actual Cost of Work Performed; BCWR = Budgeted Cost of Work Remaining.
2. FPCAC = Fixed Price contract Cumulative Actual Cost. FPCWR = Fixed Price Contract Work Remaining, calculated as Contract Value less FPCAC.
3. Projects should utilize the Cumulative CPI and Cumulative SPI since the most recent project rebaseline.
4. Non-EVM Elements include items that are not subject to EVM and may vary by project (e.g., launch vehicle, Phase E, fixed price contracts etc.). For some projects, Level of Effort (LOE) elements such as Science may also be treated as a Non-EVM Elements for IEAC purposes.
5. Cumulative BEI (Cum BEI) is specific to each fixed price contract, i.e. it is not a project level BEI.

Approach: Projects Not Conducting EVM

- One IEAC formula required for projects without an EVM requirement and those with an EVM requirement but not yet conducting EVM, starting at KDP-B:

IEAC: Cumulative Total Project Actual Costs + (Budget Estimate to Complete/Cum Project Level BEI) + Launch Vehicle + Phase E + Liens + Weighted Threats

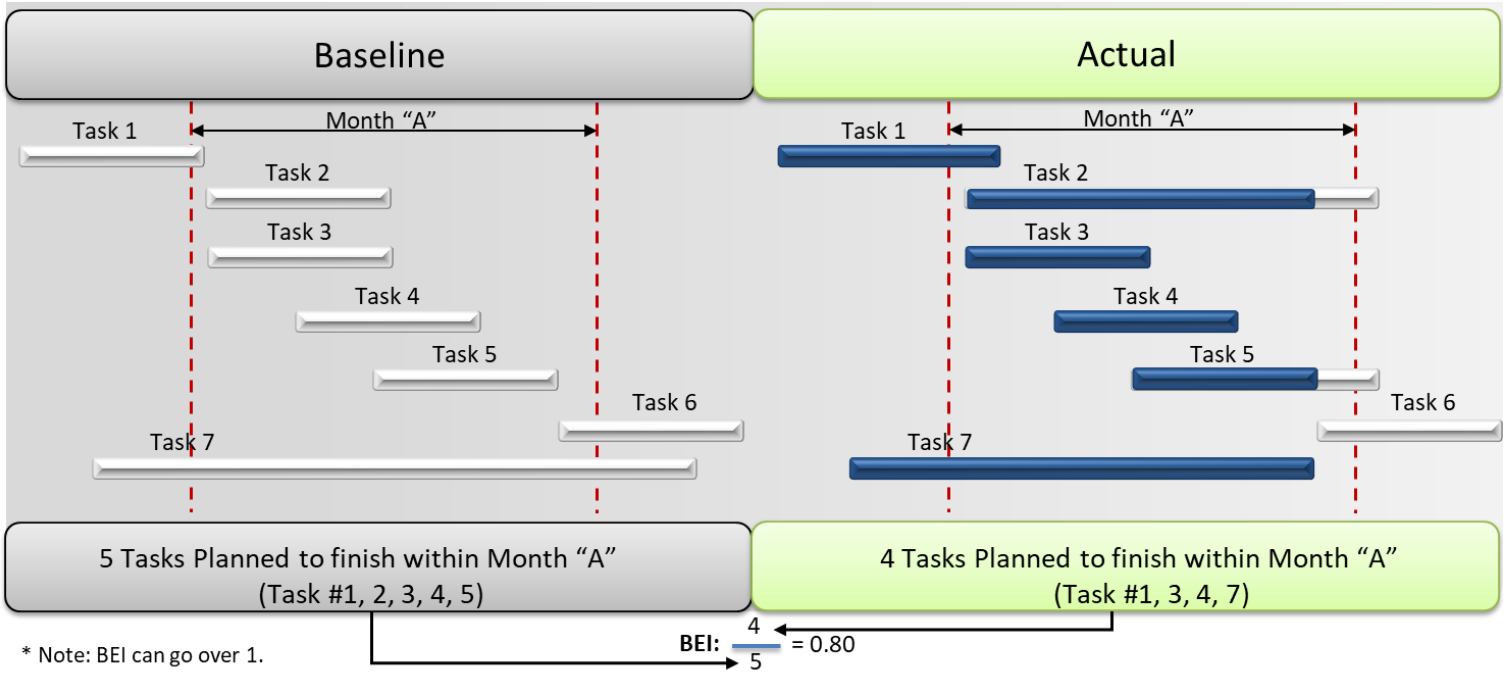
Notes:

1. Cumulative Total Project Actual Costs excludes items that may not be included in the MA for some projects, e.g. pre-Phase A budget.
2. Cumulative Total Project Actual Costs includes fixed price contracts and excludes passthrough elements, e.g. Launch Vehicle.
3. Budget Estimate to Complete (BEC) includes fixed price contracts and excludes project UFE and passthrough elements such as Launch Vehicle and Phase E.

What Is BEI?

Baseline Execution Index (BEI) measures the number of tasks completed as a ratio to those tasks that should have completed for the month according to the original (baseline) plan. It reveals the "execution pace" to the baseline plan and gives credit for completing activities ahead of baseline plan. BEI is calculated monthly and cumulatively.

$$BEI = \frac{\sum \text{\# Task Actually completed}}{\sum \text{\# Baseline Tasks Planned to be completed}}$$



Changes in Project Reporting (1 of 2)

From:

Life Cycle Cost			
Estimate at Completion	Change from last month	MA LCC	Agcy Agmt LCC
$3,411.3M	$1.0M	$3,578.2M	$3,883.0M

Project UFE			
	Mar	Apr	May
$ Reserve Guideline	25.0%	25.0%	25.0%
$ Reserve thru Liens & Encumb.	20.5%	14.1%	14.6%
$ Reserve thru Threats	17.5%	15.4%	16.0%

FY23 Summary		
FY NOA	Obligations [1]	Cost [2]
$404.8M	$240.9M	$284.5M

Schedule			
Estimated LRD	FSM change from last month	MA LRD	Agcy Agmt LRD
Oct-26	no change	Oct-26	May-27

To:

Life Cycle Cost MA - $3578.2M; Agency Total - $3883.0M			
	Apr	May	Jun
EAC	3410.3	3411.3	3423.0
IEAC-A	3647.0	3616.0	3626.0
IEAC-B	3690.0	3658.0	3666.0
IEAC-C	3733.0	3703.0	3707.0

(EAC is MSR reporting month; IEACs are calculated with prior month EVM data)

Project UFE	Apr	May	Jun
$ UFE Guideline	25.0%	25.0%	25.0%
$ UFE thru Liens & Encumb.	14.1%	14.6%	13.5%
$ UFE thru Threats	15.4%	16.0%	15.2%

Schedule			
Estimated LRD	MA LRD	Agcy Agmt LRD	FSM change from last month
Oct-26	Oct-26	May-27	no change

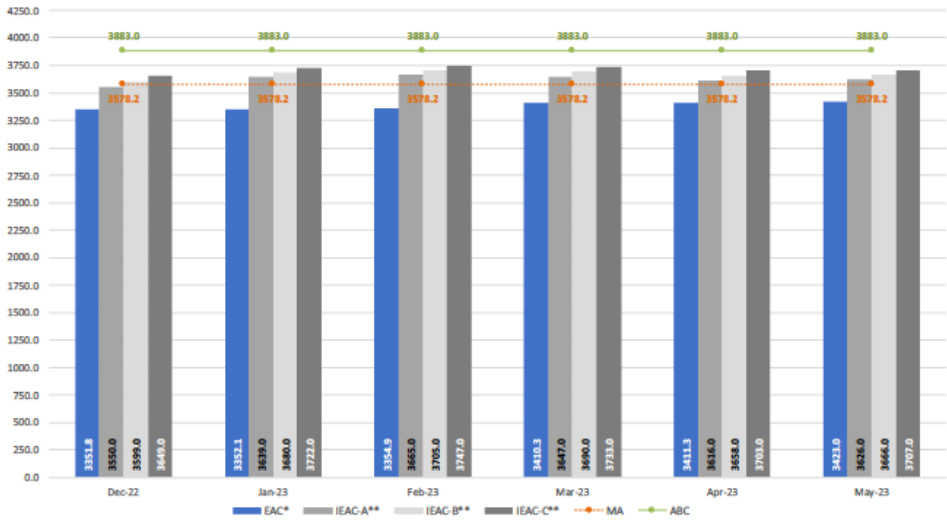
Funded Schedule Margin	Apr	May	Jun
FSM Days Required	117	114.5	111.5
FSM Days	133	133	112
Delta (Days)	16	18.5	0.5

- Improvements:
  - IEACs (objective, formula driven) now compared to project EAC (subjective).
  - Established a three-month trend for both EAC and IEACs.

Changes in Project Reporting (2 of 2)

From:

To:



- Improvements:
  - Easy, ”apples to apples”, comparison of project EAC to IEAC range, the MA and the ABC
    - EAC and IEACs include all, EVM and non-EVM, project elements (consistent with the MA and ABC).
    - This example clearly reflects an optimistic EAC.
  - Six-month trend versus one month snapshot.

Common Questions/Debates

- My fixed price contract is being over estimated?
  - Based on past experience, firm fixed price cost growth is a real possibility (from scope changes and/or poor performance).
  - Some argument that IEAC-B and IEAC-C approach of using schedule performance on a firm fixed price may or may not be realized in a contractual modification.
  - IEAC-A provides the view of a firm fixed price contract being firm.

- Adding in liens and threats double books against my EVM performance
  - Acknowledged as partially true. However, this will correct itself over time as any EVM PMBs are updated once MR is released.
  - UFE encumbrances sometimes improve EVM performance. In other cases, scope is added and performance continues at the same level.
  - IEAC-A does not factor BCWR, so no double booking on one of three IEACs.

- Getting schedule data from fixed price contracts is difficult…
  - Have a philosophy that regardless of financial reporting on a firm fixed price contract, some schedule insights should be provided to support an integrated master schedule.
  - If all data collection efforts fail, the overall project BEI is used to factor fixed price elements.
  - Future fixed price contracts should include actual cost and schedule data deliverables to enable accurate BEI calculations.

- Why use BEI?
  - BEI is relatively simple to calculate and measure.
  - Measures completion relative to the baseline plan similar to EVM

Lessons Learned Thus Far

- Projects EACs have become less optimistic in some cases with the benefit of the additional IEAC data for comparison purposes.
  - The IEAC data has provoked thought and analysis at the project level resulting in better EACs in some cases.
- EAC/IEAC comparisons and trend information has resulted in additional scrutinization and questioning of MSR data.
  - This has led to more productive MSR discussions surrounding project programmatic data.
  - Also believe that this leads better CMC, DPMC, APMC replan and KDP meeting preparedness at all levels (project/program/directorate/center).
- Difficulty in obtaining the necessary data to calculate BEI highlights the need for deliverable information that is currently lacking on many fixed price contracts.
  - Fixed price contract scope often impacts the project critical path and accounts for a large portion of the total project budget in some cases.
  - Some basic cost and schedule data is required to monitor progress and evaluate and mitigate impacts on the overall project.
- The additional scrutiny on MSR packages in order to ensure compliance uncovered a few instances of missing/inconsistent programmatic data, resulting in better MSR packages overall.

Programmatic Forecasting: Holistic and Ever Evolving

Back-up: MSR UFE Chart

PACE UFE Status

PACE UFE Status (Pandemic Replan DPMC)

Status as of June 30, 2022

$K	FY22	FY23	FY24	FY25	FY26	FY27	TOTAL
TOTAL PACE Mission UFE - (Not including HQ UFE)	27,459	13,878	1,777	1,275	838	458	45,685
TOTAL PACE Mission NOA REQUIREMENT	**81,943**	**94,763**	**55,510**	**20,947**	**22,287**	**7,477**	**282,927**
% Total PACE Mission UFE (FY NOA Based) Excl. HQ Sci., SDS, & LV	***74%***	***26%***	***9%***	***17%***	***11%***	***15%***	***36%***
ENCUMBRANCES & OTHER CHANGES	(21,233)	11,950	4,118	(783)	(564)	(245)	(6,757)
OCI optical system delays, SPCA addition, FPA rework, Discharge System and Mechanical Structure delays, workforce changes and yearly funding rephasing (details in project files) (ENC-055)	(6,098)	1,507	119				(4,472)
Rephasing to year of need and other baseline changes for workforce, ODCs and actuals to date (details in project files) (ENC-055)*	(3,462)	6,418	1,593	(783)	(564)	(245)	2,958
Incorrect assumption due to last second directed budget change before DPMC (ENC-055)*	(1,800)						(1,800)
Code 500 IT and Lab Assessments (ENC-055)	(1,461)	(1,000)	(300)				(2,761)
HARP2 detector delamination 2 month delivery delay to May 2022 (ENC-054)	(190)	0	(21)				(211)
Reserve Rephasing (ENC-056)	(7,752)	5,025	2,727				0
GN&C RWA Support and Spares (ENC-057)	(350)						(350)
OCI Discharge System parts fab and radiation lab testing (OCI-CCR-1205)	(120)						(120)
* Starting reserve of $45,685 was placeholder at time of DPMC due to directed budget reduction less than 24 hours before chart submission. These two items account for changes after having time to develop a detailed rebaseline plan to the new budget allocation.							
TOTAL PACE MISSION-HELD UFE THROUGH ENCUMBRANCES	**6,226**	**25,828**	**5,895**	**493**	**275**	**213**	**38,928**
% Total PACE UFE thru Encumb. (NOA Based) Excl. HQ Sci., SDS, LV	***11%***	***63%***	***37%***	***6%***	***3%***	***6%***	***29%***
LIENS	(3,749)	(344)	0	0	0	0	(4,093)
HARP2 Prism Failure (LIEN-042)	(553)	(262)					(815)
PACE/OCI Engineering & Technical Support (LIEN-043)	(664)						(664)
RF Comm Transmitter, ECA, LGA PFRs (LIEN-044)	(257)						(257)
Thermal TVAC software engineer (LIEN-045)	(94)	(82)					(176)
Mechanisms Tilt System analyst support of LTU & Flt builds and retest of LTU due to slippage PFR (LIEN-046)	(111)						(111)
OCI Workforce Ramp-down delays (actuals through June)	(1,955)						(1,955)
SCA FLT/FLT Spare Cost Overrun/Flt Spare Bakeout (OCI-CCR-1251)	(115)						(115)
TOTAL PACE MISSION UFE THROUGH LIENS	**2,477**	**25,484**	**5,895**	**493**	**275**	**213**	**34,836**
% Total PACE UFE thru Liens (NOA Based) Excl. HQ Sci., SDS, LV	***4%***	***62%***	***37%***	***6%***	***3%***	***6%***	***25%***
THREATS (Probabilistic Estimate Of Cost Risks)	(1,668)	(2,128)	(1,647)	(1,320)	(1,200)	0	(7,963)
Red Threats	0	0	0	0	0	0	0
Yellow Threats	(855)	(1,166)	(1,600)	(1,320)	(1,200)	0	(6,141)
Green Threats	(813)	(962)	(47)	0	0	0	(1,822)
TOTAL PACE MISSION UFE THROUGH THREATS	**809**	**23,356**	**4,248**	**(828)**	**(926)**	**213**	**26,872**
% Total PACE UFE thru Threats (NOA Based) Excl. HQ Sci., SDS, LV	***1%***	***54%***	***24%***	***-8%***	***-10%***	***6%***	***18%***

Yellow highlighted data is changed from prior month

PACE MISSION UFE THRU LIENS ON DEVELOPMENT COST-TO-GO:	
NOA REQUIRED FY22 Thru Completion	282,927
LESS LV NOA FY22 Thru Phase D	35,177
LESS HQ PACE SCIENCE NOA FY22 Thru Phase D	24,669
LESS POST LAUNCH OPERATIONS NOA FY22 Thru Completion	79,148
DEVELOPMENT NOA FY22 Thru Phase D	143,933
LESS Project-Held UFE THRU LIENS FY22 Thru Completion	34,836
LESS Project-Held UFE Phases E-F	3,159
Project-Held UFE thru Phase D	31,677
PLUS PRIOR YEAR UNCOSTED (exclude LV & EPO)	60,436
PLUS PY21 FUNDS RECEIVED IN FY22	-
LESS FY22 ACTUAL COSTS Thru June 2022 (excluding LV & HQ PS)	69,876
REMAINING COST-TO-GO Thru Development	102,817
PERCENT PACE MISSION UNLIENED UFE ON DEVELOPMENT COST-TO-GO	30.8%

PACE MISSION UFE THRU THREATS ON DEVELOPMENT COST-TO-GO:	
NOA REQUIRED FY22 Thru Completion	282,927
LESS LV NOA FY22 Thru Phase D	35,177
LESS HQ PACE SCIENCE NOA FY22 Thru Phase D	24,669
LESS POST LAUNCH OPERATIONS NOA FY22 Thru Completion	79,148
DEVELOPMENT NOA FY22 Thru Phase D	143,933
LESS Project-Held UFE THRU THREATS FY22 Thru Completion	26,872
LESS Project-Held UFE Phases E-F	3,159
Project-Held UFE thru Phase D	23,713
PLUS PRIOR YEAR UNCOSTED (exclude LV & EPO)	60,436
PLUS PY21 FUNDS RECEIVED IN FY22	-
LESS FY22 ACTUAL COSTS Thru June 2022 (excluding LV & HQ PS)	69,876
REMAINING COST-TO-GO Thru Development	110,780
PERCENT PACE MISSION UNTHREATENED UFE ON DEVELOP COST-TO-GO	21.4%

PACE Level Threats

Project Level Threats With Likelihood > 1 - $K

June 30, 2022

Risk ID	Risk Title	Threat Likeli-hood	Threat Conse-quence	Full Value (FV) Cost Impacts FY22	FY23	FY24	FY25	FY26	FY27	Total	Full Value Schedule Impact (days)	Proba-bility	Probabalistic Cost Impacts FY22	FY23	FY24	FY25	FY26	FY27	Total	Expected Schedule Impact (days)	Critical Path Impact (days)	Total Change Since Last Month
				$ -						$ -	0	0.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	0		$ -
Total Project Level Red Threat Impact				$ -	$ -	$ -	$ -	$ -	$ -	$ -	0		$ -	$ -	$ -	$ -	$ -	$ -	$ -	0	0	$ -
PACE-00240	Launch Date Move From January 30, 2024 to January 9, 2024	2	3		$ 3,500	$ 2,000				$ 5,500	17	0.20	$ -	$ 700	$ 400	$ -	$ -	$ -	$ 1,100	3		$ -
GS-00243	Missing Real data from the S/C for Gnd testing (Ground)	4	3	$ 425	$ 351					$ 776	1	0.60	$ 255	$ 211	$ -	$ -	$ -	$ -	$ 466	1		$ -
GS-00248	PACE Post-Launch Mission Budget (Mission Ops)	4	3			$ 2,000	$ 2,200	$ 2,000		$ 6,200	0	0.60	$ -	$ -	$ 1,200	$ 1,320	$ 1,200	$ -	$ 3,720	0		$ -
PACE-00255	FY22 Funding Reduction (All Elements)	2	3	$ 3,000	$ (3,000)					$ -	10	0.20	$ 600	$ (600)	$ -	$ -	$ -	$ -	$ -	2		$ -
Total Project Level Yellow Threat Impact				$ 3,425	$ 851	$ 4,000	$ 2,200	$ 2,000	$ -	$ 12,476	28		$ 855	$ 311	$ 1,600	$ 1,320	$ 1,200	$ -	$ 5,286	6	0	$ -
PACE-00195	Support Service Contracts Recompete (All Elements)	4	1	$ 228						$ 228	3	0.60	$ 137	$ -	$ -	$ -	$ -	$ -	$ 137	2		$ -
PACE-00112	Stray Light (glint) (Systems Eng)	2	2	$ 100						$ 100	20	0.20	$ 20	$ -	$ -	$ -	$ -	$ -	$ 20	4		$ -
PACE-00210	Center Operating Costs Passed To Project (Spacecraft)	3	2	$ 63	$ 188					$ 250	0	0.40	$ 25	$ 75	$ -	$ -	$ -	$ -	$ 100	0		$ -
GS-00220	Key Fill Tool laptop (Ground)	2	2	$ 82						$ 82	0	0.20	$ 16	$ -	$ -	$ -	$ -	$ -	$ 16	0		$ -
PACE-00182	Annual Leave Use or Lose Build up Due to COVID-19 (All Elements)	2	2	$ 2,250						$ 2,250	10	0.20	$ 450	$ -	$ -	$ -	$ -	$ -	$ 450	2		$ -
GS-00225	PACE Cloud DMZ Operational Availability	2	1	$ 10						$ 10	0	0.20	$ 2	$ -	$ -	$ -	$ -	$ -	$ 2	0		$ -
GS-00236	NSN's PACE FY22 Cost Risk (Ground)	3	2	$ -	$ 520	$ 117				$ 637	0	0.40	$ -	$ 208	$ 47	$ -	$ -	$ -	$ 255	0		$ -
PACE-00247	Ka-band subsystem not meeting spectrum unwanted emission mask	3	2	$ 140						$ 140	1	0.40	$ 56	$ -	$ -	$ -	$ -	$ -	$ 56	0		$ -
Total Project Level Green Threat Impact				$ 2,873	$ 708	$ 117	$ -	$ -	$ -	$ 3,697	34		$ 706	$ 283	$ 47	$ -	$ -	$ -	$ 1,036	8	0	$ -
Total Project Level Threat Impact				$ 6,298	$ 1,559	$ 4,117	$ 2,200	$ 2,000	$ -	$ 16,173	62		$ 1,561	$ 594	$ 1,647	$ 1,320	$ 1,200	$ -	$ 6,322	14	0	0

OCI Level Threats

OCI Level Threats With Likelihood > 1 - $K

June 30, 2022

Risk ID	Risk Title	Threat Likeli-hood	Threat Conse-quence	Full Value (FV) Cost Impacts FY22	FY23	FY24	FY25	FY26	FY27	Total	Full Value Schedule Impact (days)	Proba-bility	Probabalistic Cost Impacts FY22	FY23	FY24	FY25	FY26	FY27	Total	Expected Schedule Impact (days)	Critical Path Impact (days)	Total Change Since Last Month
				$ -						$ -	0	0.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	0		$ -
Total OCI Red Threat Impact				$ -	$ -	$ -	$ -	$ -	$ -	$ -	0		$ -	$ -	$ -	$ -	$ -	$ -	$ -	0	0	$ -
PACE-00244	OCI Post Delivery Support	4	2		$ 1,426					$ 1,426	0	0.60	$ -	$ 856	$ -	$ -	$ -	$ -	$ 856	0		$ -
Total OCI Yellow Threat Impact				$ -	$ 1,426	$ -	$ -	$ -	$ -	$ 1,426	0		$ -	$ 856	$ -	$ -	$ -	$ -	$ 856	0	0	$ -
OCI-00254	OCI Workforce Ramp-down	3	2	$ 255	$ 1,698					$ 1,952	0	0.40	$ 102	$ 679	$ -	$ -	$ -	$ -	$ 781	0		$ (144)
Mech	Complete Flight Spare SCA	2	2	$ 25	$ -					$ 25	0	0.20	$ 5	$ -	$ -	$ -	$ -	$ -	$ 5	0		$ -
Total OCI Green Threat Impact				$ 280	$ 1,698	$ -	$ -	$ -	$ -	$ 1,977	0		$ 107	$ 679	$ -	$ -	$ -	$ -	$ 786	0	0	$ (144)
Total OCI Threat Impact				$ 280	$ 3,124	$ -	$ -	$ -	$ -	$ 3,403	0		$ 107	$ 1,535	$ -	$ -	$ -	$ -	$ 1,642	0	0	$ (144)