Week 8

APPLICATION EXERCISE

Solar Farm Construction

Answers

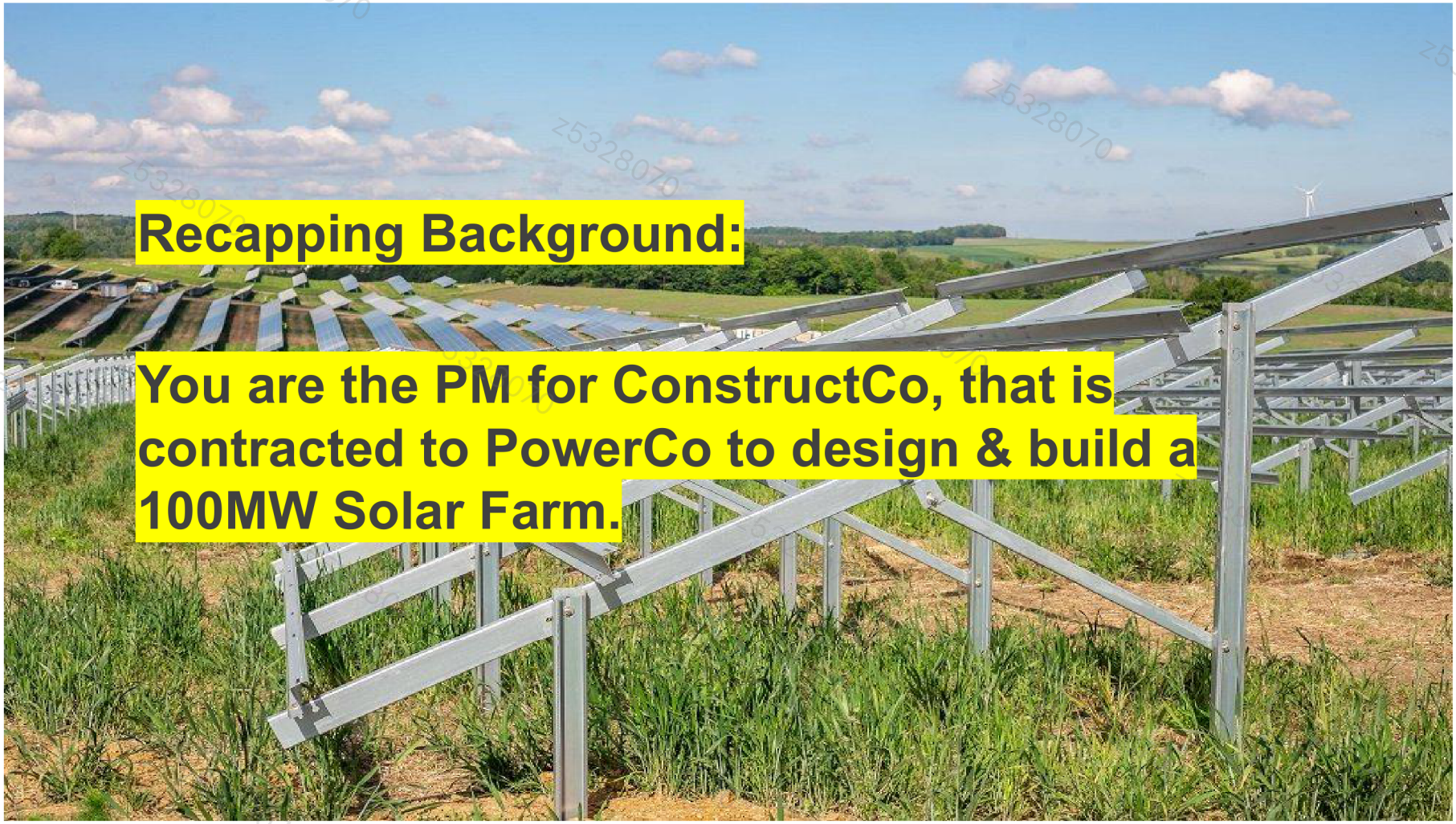
GSOE9820 Engineering Project Management

Term 1 2022

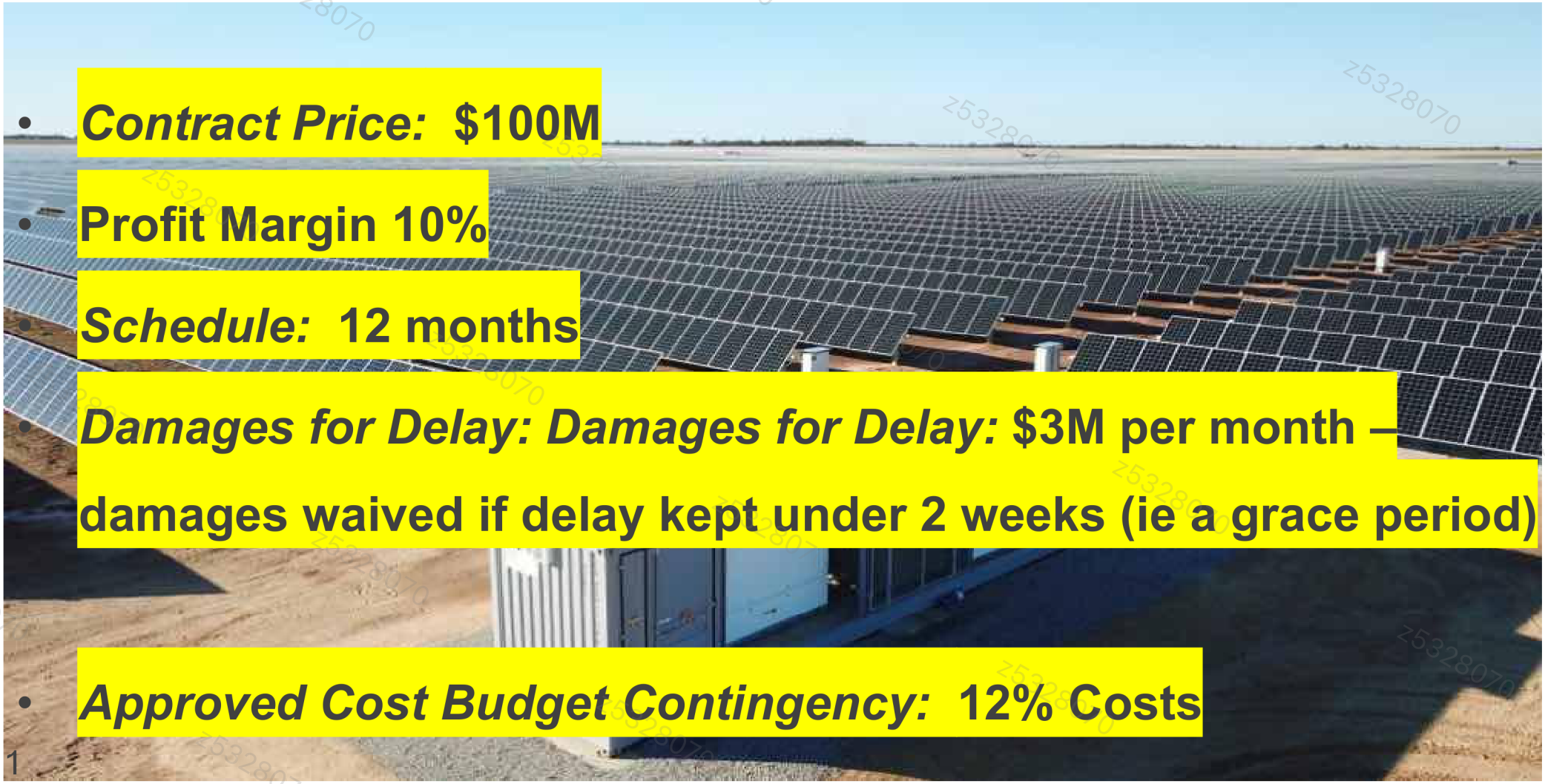
Bernard Hayes

UNSW SYDNEY

APPLICATION EXERCISE: Solar Farm Construction



APPLICATION EXERCISE: Solar Farm Construction



- *Contract Price:* $100M
- Profit Margin 10%
- *Schedule:* 12 months
- *Damages for Delay: Damages for Delay:* $3M per month – damages waived if delay kept under 2 weeks (ie a grace period)
- *Approved Cost Budget Contingency:* 12% Costs

First Step – Calculate Overall Cost Budget:

Step 1: Calculate Overall Cost Budget (BAC)

Given:

- Contract Price: $100M
- Profit Margin 10%

calculate

- **Overall Cost Budget (BAC): $100M - $10M (10% profit) = $90M**

Approved Contingency = 12% x $90M = **$10.8M**

APPLICATION EXERCISE: Solar Farm Construction

Current Status: The project is currently at the last day of Month 9.

As per the Attached Earned Value Analysis to end of Month 8, the Project has run smoothly, always ahead of schedule, under budget and forecast to remain so.

EV Analysis data from Accts for Month 9:

EV = $ 10M

AC = $ 11M

PV = $ 11M

EV Report to End of Month 8 – On Time / Under Budget

Aurhorised current budget (BAC)	Earned Value (EV) for Month	EV Cumumative	Actual Cost (AC) for month	Cummulative AC	Planned Value (PV) (assessed) for month	PV (assessed) Cumulative	SV	CV	CPI at end of month	SPI at end of Month	Estimated Cost to Complete (ETC)	Forecast costs at Completion (EAC)	Forecast Cost Variance at Complrtion
$90,000,000	$7,000,000	$7,100,000	$7,000,000	$7,000,000	$7,000,000	$7,000,000	$100,000	$100,000	1.01	1.01	$81,732,394	$88,732,394	$1,267,606
$90,000,000	$7,500,000	$14,600,000	$7,400,000	$14,400,000	$7,300,000	$14,300,000	$300,000	$200,000	1.01	1.02	$74,367,123	$88,767,123	$1,232,877
$90,000,000	$6,900,000	$21,500,000	$7,000,000	$21,400,000	$7,000,000	$21,300,000	$200,000	$100,000	1.00	1.01	$68,181,395	$89,581,395	$418,605
$90,000,000	$7,000,000	$28,500,000	$7,100,000	$28,500,000	$7,100,000	$28,400,000	$100,000	$0	1.00	1.00	$61,500,000	$90,000,000	$0
$90,000,000	$9,200,000	$37,700,000	$8,900,000	$37,400,000	$9,100,000	$37,500,000	$200,000	$300,000	1.01	1.01	$51,883,820	$89,283,820	$716,180
$90,000,000	$10,800,000	$48,500,000	$10,600,000	$48,000,000	$10,900,000	$48,400,000	$100,000	$500,000	1.01	1.00	$41,072,165	$89,072,165	$927,835
$90,000,000	$11,900,000	$60,400,000	$12,000,000	$60,000,000	$11,800,000	$60,200,000	$200,000	$400,000	1.01	1.00	$29,403,974	$89,403,974	$596,026
$90,000,000	$12,200,000	$72,600,000	$12,100,000	$72,100,000	$12,000,000	$72,200,000	$400,000	$500,000	1.01	1.01	$17,280,165	$89,380,165	$619,835

Week 8

APPLICATION EXERCISE

Solar Farm Construction

Answers

GSOE9820 Engineering Project Management

Term 1 2022

Bernard Hayes

UNSW SYDNEY

Question 1: ANSWER

End of Month 9: Inverter is on Critical Path & damaged during installation. Four Options considered:

Option 1): Ship the Inverter back to original Supplier for repair – Cost $2M; Schedule Delay: 6 Months

(Incurs Delay Penalty 6 x $3M = $18M)

Option 2): Order In-stock new Inverter from Alternative Overseas Supplier and transport via Antonov Heavy Lift Air Transport: Cost $12M; Schedule Delay: 1 week (0.25 Months).

No Delay Penalty (< 2 weeks delay – damages waived)

End of Month 9:

Option 3): Repair Inverter at Local Workshop: Cost $5M;

Schedule Delay: 1 Month

Incurs Delay Penalty 1 x $3M = $3M)

Option 4): Order replacement Inverter from Original Supplier –

Cost $4M: Schedule Delay: 4 Months

(Incurs Delay Penalty 4 x $3M = $12M)

Recall Formulae:

CV = EV – AC

SV = EV – PV

CPI = EV / AC

SPI = EV / PV

ETC = Estimated Cost to Complete

= (BAC – EV) / CPI

EAC = Estimated Cost at Completion

= AC + ETC

Use these formulae to complete project monthly report for Month 9 for each option

Option 1) Ship Inverter back to Supplier for Repair

MONTH 9														
MONTH	Aurhorised current budget (BAC)	Earned Value (EV) for Month	EV Cumumative	Actual Cost (AC) for month	Cummulative AC	Planned Value (PV) (assessed) for month	PV (assessed) Cumulative	SV	CV	CPI at end of month	SPI at end of Month	Estimated Cost to Complete (ETC)	Forecast costs at Completion (EAC)	Forecast Cost Variance at Complrtion
1	$90,000,000	$7,000,000	$7,100,000	$7,000,000	$7,000,000	$7,000,000	$7,000,000	$100,000	$100,000	1.01	1.01	$81,732,394	$88,732,394	$1,267,606
2	$90,000,000	$7,500,000	$14,600,000	$7,400,000	$14,400,000	$7,300,000	$14,300,000	$300,000	$200,000	1.01	1.02	$74,367,123	$88,767,123	$1,232,877
3	$90,000,000	$6,900,000	$21,500,000	$7,000,000	$21,400,000	$7,000,000	$21,300,000	$200,000	$100,000	1.00	1.01	$68,181,395	$89,581,395	$418,605
4	$90,000,000	$7,000,000	$28,500,000	$7,100,000	$28,500,000	$7,100,000	$28,400,000	$100,000	$0	1.00	1.00	$61,500,000	$90,000,000	$0
5	$90,000,000	$9,200,000	$37,700,000	$8,900,000	$37,400,000	$9,100,000	$37,500,000	$200,000	$300,000	1.01	1.01	$51,883,820	$89,283,820	$716,180
6	$90,000,000	$10,800,000	$48,500,000	$10,600,000	$48,000,000	$10,900,000	$48,400,000	$100,000	$500,000	1.01	1.00	$41,072,165	$89,072,165	$927,835
7	$90,000,000	$11,900,000	$60,400,000	$12,000,000	$60,000,000	$11,800,000	$60,200,000	$200,000	$400,000	1.01	1.00	$29,403,974	$89,403,974	$596,026
8	$90,000,000	$12,200,000	$72,600,000	$12,100,000	$72,100,000	$12,000,000	$72,200,000	$400,000	$500,000	1.01	1.01	$17,280,165	$89,380,165	$619,835
9	$90,000,000	$10,000,000	$82,600,000	$31,000,000	$103,100,000	$11,000,000	$83,200,000	-$600,000	-$20,500,000	0.80	0.99	$9,236,562	$112,336,562	-$22,336,562
10														
11														
12														

AC= $11M + $2M + $18M = $31M

CPI < 1.0

FCVAC > Conting. $10.8M

UNSW SYDNEY

Option 2) – Airlift in Alternative Supplier Inverter

MONTH 9														
MONTH	Aurhorised current budget (BAC)	Earned Value (EV) for Month	EV Cumumative	Actual Cost (AC) for month	Cummulative AC	Planned Value (PV) (assessed) for month	PV (assessed) Cumulative	SV	CV	CPI at end of month	SPI at end of Month	Estimated Cost to Complete (ETC)	Forecast costs at Completion (EAC)	Forecast Cost Variance at Complrtion
1	$90,000,000	$7,000,000	$7,100,000	$7,000,000	$7,000,000	$7,000,000	$7,000,000	$100,000	$100,000	1.01	1.01	$81,732,394	$88,732,394	$1,267,606
2	$90,000,000	$7,500,000	$14,600,000	$7,400,000	$14,400,000	$7,300,000	$14,300,000	$300,000	$200,000	1.01	1.02	$74,367,123	$88,767,123	$1,232,877
3	$90,000,000	$6,900,000	$21,500,000	$7,000,000	$21,400,000	$7,000,000	$21,300,000	$200,000	$100,000	1.00	1.01	$68,181,395	$89,581,395	$418,605
4	$90,000,000	$7,000,000	$28,500,000	$7,100,000	$28,500,000	$7,100,000	$28,400,000	$100,000	$0	1.00	1.00	$61,500,000	$90,000,000	$0
5	$90,000,000	$9,200,000	$37,700,000	$8,900,000	$37,400,000	$9,100,000	$37,500,000	$200,000	$300,000	1.01	1.01	$51,883,820	$89,283,820	$716,180
6	$90,000,000	$10,800,000	$48,500,000	$10,600,000	$48,000,000	$10,900,000	$48,400,000	$100,000	$500,000	1.01	1.00	$41,072,165	$89,072,165	$927,835
7	$90,000,000	$11,900,000	$60,400,000	$12,000,000	$60,000,000	$11,800,000	$60,200,000	$200,000	$400,000	1.01	1.00	$29,403,974	$89,403,974	$596,026
8	$90,000,000	$12,200,000	$72,600,000	$12,100,000	$72,100,000	$12,000,000	$72,200,000	$400,000	$500,000	1.01	1.01	$17,280,165	$89,380,165	$619,835
9	$90,000,000	$10,000,000	$82,600,000	$23,000,000	$95,100,000	$11,000,000	$83,200,000	-$600,000	-$12,500,000	0.87	0.99	$8,519,855	$103,619,855	-$13,619,855
10														
11														
12														

AC= $11M + $0M + $12M = $23M

CPI < 1.0

FCVAC > Conting. $10.8M

Option 3) Repair Inverter at Local Workshop

MONTH 9														
MONTH	Aurhorised current budget (BAC)	Earned Value (EV) for Month	EV Cumumative	Actual Cost (AC) for month	Cummulative AC	Planned Value (PV) (assessed) for month	PV (assessed) Cumulative	SV	CV	CPI at end of month	SPI at end of Month	Estimated Cost to Complete (ETC)	Forecast costs at Completion (EAC)	Forecast Cost Variance at Complrtion
1	$90,000,000	$7,000,000	$7,100,000	$7,000,000	$7,000,000	$7,000,000	$7,000,000	$100,000	$100,000	1.01	1.01	$81,732,394	$88,732,394	$1,267,606
2	$90,000,000	$7,500,000	$14,600,000	$7,400,000	$14,400,000	$7,300,000	$14,300,000	$300,000	$200,000	1.01	1.02	$74,367,123	$88,767,123	$1,232,877
3	$90,000,000	$6,900,000	$21,500,000	$7,000,000	$21,400,000	$7,000,000	$21,300,000	$200,000	$100,000	1.00	1.01	$68,181,395	$89,581,395	$418,605
4	$90,000,000	$7,000,000	$28,500,000	$7,100,000	$28,500,000	$7,100,000	$28,400,000	$100,000	$0	1.00	1.00	$61,500,000	$90,000,000	$0
5	$90,000,000	$9,200,000	$37,700,000	$8,900,000	$37,400,000	$9,100,000	$37,500,000	$200,000	$300,000	1.01	1.01	$51,883,820	$89,283,820	$716,180
6	$90,000,000	$10,800,000	$48,500,000	$10,600,000	$48,000,000	$10,900,000	$48,400,000	$100,000	$500,000	1.01	1.00	$41,072,165	$89,072,165	$927,835
7	$90,000,000	$11,900,000	$60,400,000	$12,000,000	$60,000,000	$11,800,000	$60,200,000	$200,000	$400,000	1.01	1.00	$29,403,974	$89,403,974	$596,026
8	$90,000,000	$12,200,000	$72,600,000	$12,100,000	$72,100,000	$12,000,000	$72,200,000	$400,000	$500,000	1.01	1.01	$17,280,165	$89,380,165	$619,835
9	$90,000,000	$10,000,000	$82,600,000	$19,000,000	$91,100,000	$11,000,000	$83,200,000	-$600,000	-$8,500,000	0.91	0.99	$8,161,501	$99,261,501	-$9,261,501
10														
11														
12														

AC= $11M + $5M + $3M
1 **= $19M**

CPI < 1.0

FCVAC < Conting. $10.8M

UNSW SYDNEY

Option 4) Replacement Inverter from OEM

MONTH 9														
MONTH	Aurhorised current budget (BAC)	Earned Value (EV) for Month	EV Cumumative	Actual Cost (AC) for month	Cummulative AC	Planned Value (PV) (assessed) for month	PV (assessed) Cumulative	SV	CV	CPI at end of month	SPI at end of Month	Estimated Cost to Complete (ETC)	Forecast costs at Completion (EAC)	Forecast Cost Variance at Complrtion
1	$90,000,000	$7,000,000	$7,100,000	$7,000,000	$7,000,000	$7,000,000	$7,000,000	$100,000	$100,000	1.01	1.01	$81,732,394	$88,732,394	$1,267,606
2	$90,000,000	$7,500,000	$14,600,000	$7,400,000	$14,400,000	$7,300,000	$14,300,000	$300,000	$200,000	1.01	1.02	$74,367,123	$88,767,123	$1,232,877
3	$90,000,000	$6,900,000	$21,500,000	$7,000,000	$21,400,000	$7,000,000	$21,300,000	$200,000	$100,000	1.00	1.01	$68,181,395	$89,581,395	$418,605
4	$90,000,000	$7,000,000	$28,500,000	$7,100,000	$28,500,000	$7,100,000	$28,400,000	$100,000	$0	1.00	1.00	$61,500,000	$90,000,000	$0
5	$90,000,000	$9,200,000	$37,700,000	$8,900,000	$37,400,000	$9,100,000	$37,500,000	$200,000	$300,000	1.01	1.01	$51,883,820	$89,283,820	$716,180
6	$90,000,000	$10,800,000	$48,500,000	$10,600,000	$48,000,000	$10,900,000	$48,400,000	$100,000	$500,000	1.01	1.00	$41,072,165	$89,072,165	$927,835
7	$90,000,000	$11,900,000	$60,400,000	$12,000,000	$60,000,000	$11,800,000	$60,200,000	$200,000	$400,000	1.01	1.00	$29,403,974	$89,403,974	$596,026
8	$90,000,000	$12,200,000	$72,600,000	$12,100,000	$72,100,000	$12,000,000	$72,200,000	$400,000	$500,000	1.01	1.01	$17,280,165	$89,380,165	$619,835
9	$90,000,000	$10,000,000	$82,600,000	$27,000,000	$99,100,000	$11,000,000	$83,200,000	-$600,000	-$16,500,000	0.83	0.99	$8,878,208	$107,978,208	-$17,978,208
10														
11														
12														

AC= $11M + 4M + $12M= $27M

CPI < 1.0

FCVAC > Conting. $10.8M

Answer Q1 - ANSWER

	Cost Variance	CPI	Forecast Variance at Completion	Less than Contingency (-$10M)
Option 1)	-$20.500M	0.80	-$22.336M	NO
Option 2)	-$12.500M	0.87	-$13.619M	NO
Option 3)	-$8.500M	0.91	-$9.261M	YES
Option 4)	-$16.500M	0.83	-$17.978M	NO

APPLICATION EXERCISE: Chemical Plant Expansion- ANSWER Q1

Lowest Forecast Variance at Completion

So, (c) Option (3) – Repair Inverter at Local Workshop - is the only option with a Forecast Variance at Completion less that the -$10.8M allowable contingency.

Answer Q2: CPI for Option (2) - Airlift in Replacement

	Cost Variance	CPI
Option 1)	-$20.500M	0.80
Option 2)	-$12.500M	0.87
Option 3)	-$8.500M	0.91
Option 4)	-$16.500M	0.83

ANSWER: (c) - CPI shows Option (2) would put project Over Budget because CPI < 1.0

CPI is NOT related to schedule

CPI is part of equation for calculating forecast variance at completion but does not directly indicate it

Answer Q3: SPI for Option (3) – Air Lift Replacement

	SPI
Option 1)	0.99
Option 2)	0.99
Option 3)	0.99
Option 4)	0.99

ANSWER: (b) SPI does not indicate future effects of Option (3) on schedule.

Only assessing a Tracking Gantt Chart can be used to do this.

Question 4 - ANSWER

Best way to assess Optimum Course of Action:

a) The Option with the highest combined CPI + SPI

Per above:

- CPI cannot indicate forecast costs at completion
- SPI cannot forecast future schedule effects or associated costs

Therefore, a combination of the two makes little sense and cannot be used to compare options.

Question 4 - ANSWER

Best way to assess Optimum Course of Action:

b) The Option with the highest CV

CV is an:

- Accurate estimate of current state of budget

However, it does NOT:

- Accurately estimate of efficiency of spending to date (that is CPI)
- Accurately forecast variance at completion; nor even enter into equation for variance at completion

So, (b) is not a basis for comparing optimum Course of Action

Question 4 - ANSWER

Best way to assess Optimum Course of Action:

c) The Option with the least negative Forecast Variance at Completion

Analysis:

Incorporating delay penalties into costs makes a straight cost comparison possible as it 'monetises' the downside of delay for ConstructCo.

Then using Forecast Variance at Completion allows you to see how project costs are estimated to finish for each option relative to budget (BAC) , with the least negative Forecast Cost at Completion being the optimum result for ConstructCo, on the project.

Question 4 - ANSWER

Best way to assess Optimum Course of Action:

d) The Option with the highest SPI.

SPI cannot:

- Accurately forecast schedule delay at completion, so cannot quantify delay forecast
- Cannot forecast costs at completion

Answer Q4 – ANSWER SUMMARY

	Highest CPI + SPI?	Highest CV?	Least neg. Forecast Variance at Completion?	Highest SPI?
Option 1)	1.79	-$20.500M	-$22.336M	0.99
Option 2)	1.86	-$12.500M	-$13.619M	0.99
Option 3)	1.90	-$8.500M	-$9.261M	0.99
Option 4)	1.82	-$16.500M	-$17.978M	0.99

1

Answer Q5 – ANSWER SUMMARY

	Delay (months)	Least neg. Forecast Variance at Completion?
Option 1)	6	-$22.336M
Option 2)	0.25	-$13.619M
Option 3)	1	-$9.261M
Option 4)	4	-$17.978M

Question 5 - ANSWER

Best way to assess Optimum Course of Action:

From Q4, the option with the least negative forecast variance at completion is Option 3 which has forecast variance at completion of -$9.261M, within the allowed contingency.

The option with the least disruption on schedule is Option 2 – the Airlifting of a new rotor. It has a forecast cost at completion of -$13.619M

Question 5 - ANSWER

Best way to assess Optimum Course of Action:

So, the additional cost would be -$13.619M – (-$9.261M)

= **-$4.358M**

Therefore (b) is correct answer


Reminder – you can make an appeal if you believe you have a more optimum answer to any of those we have calculated !!