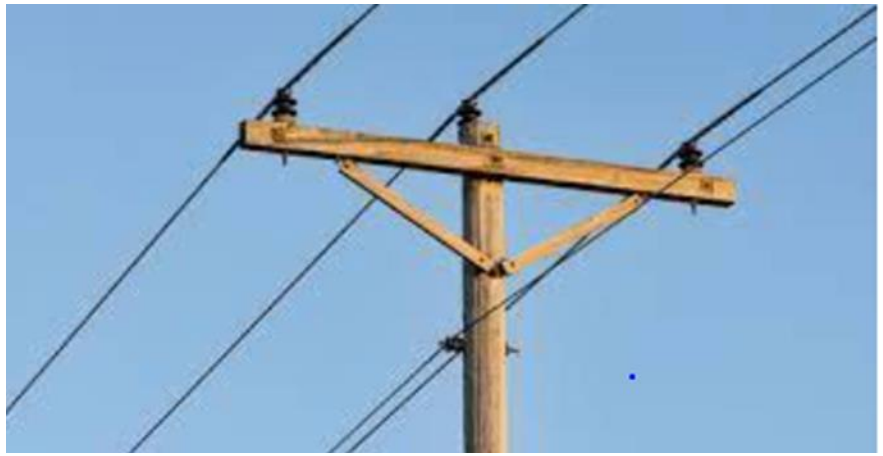


Group 1 Exercise (Feb 17)

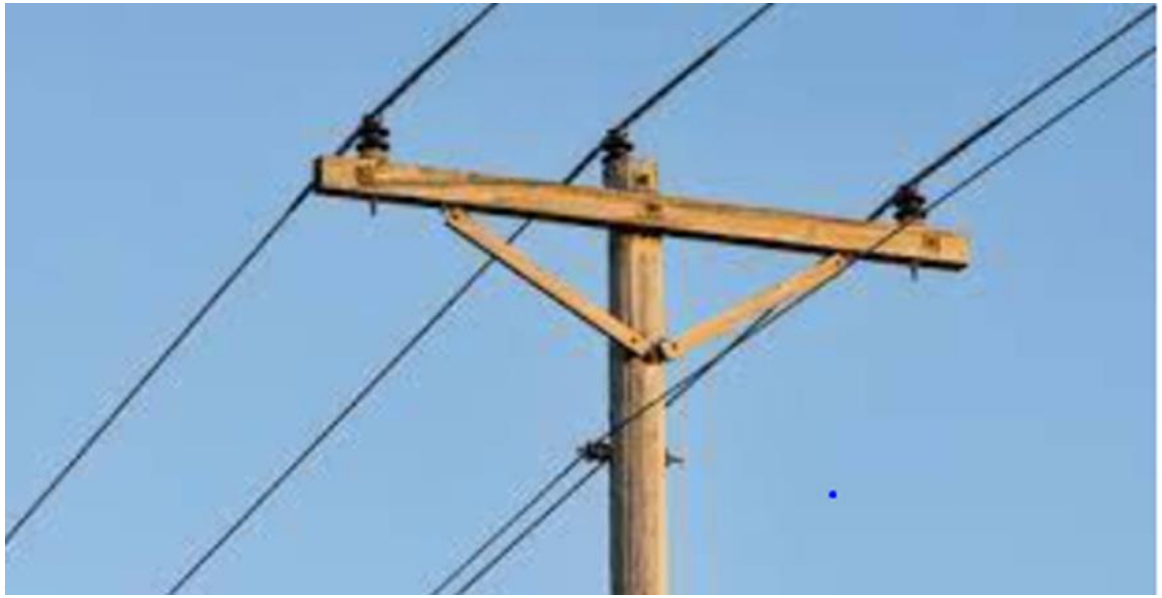
Electricity Utilities

Pacific Region Infrastructure Facility

SPC Secretariat of the Pacific Community

Asset Condition Assessment For Power Lines

- Condition Assessment of a 10 km long, 3-ph, 11 kV, single circuit distribution line with 120 sq. mm AAC conductor, in Palau revealed the entire line section looks as shown in the photograph below. The wood poles and cross-arms are badly decayed but the conductors and insulators are in fair condition.
- The line experiences frequent breakdowns and reliability has been dropping over past 5 years.
- Calculate the asset condition index and formulate investment plan.



Asset Condition Assessment of Power line

Since we have information available on both physical condition and functional performance of the power line, to calculate condition assessment index and develop investment plan for this line, we will use the second approach which consists of the following steps, Figure 2-2 (Section 2):

STEP 1	Perform condition assessment to determine PCR of asset components (use Table 2-1 for ratings)
STEP 2 A	Establish FPR of asset by assessing recent asset performance (use Table 2-5 for ratings)
STEP 2 B	Calculate asset condition index (use appropriate table for the asset ACI algorithm from section 3)
STEP 3	Assess the risk of failure and estimate the remaining useful life of asset (use Table 2-3)
STEP 4	Select the optimal investment option (use Table 2-4)

Step 1

- Perform condition assessment to determine PCR of asset components (use Table 2-1 for ratings)

To assess the condition of the line section, we will assign the physical condition ratings to each of the line's main components (described in Section 3.8), using Table 2-1 from Section 2.

Table 2-1

Asset Component Condition	Physical Condition Rating	Interpretation
Asset Component in brand new condition, with no wear, no damage, no deformation, no defects, no deterioration, no impairment	5	Excellent
Asset Component in "like new" condition, with minor wear and no damage, no defects, no deformation, no deterioration and no impairment	4	Good
Asset Component shows minor wear, minor deformation, minor damage, minor defects, minor deterioration, minor impairment, asset condition can be maintained through normal preventative maintenance	3	Fair
Asset Component with major deformation, degradation, deterioration, damage or defects and serious impairment in condition; however component condition can be restored through economically efficient rehabilitation/refurbishment of degraded/faulty components.	2	Poor
Asset Component with major degradation, deterioration, damage or defects and serious impairment in condition, and it is not possible to restore the component condition through economically efficient rehabilitation/refurbishment	1	Very Poor

Step 1

- Perform condition assessment to determine PCR of asset components (use Table 2-1 for ratings)

Section 3.8 describes the following components for overhead lines which needs to be assessed and assigned a physical condition rating:

- Poles and cross arms
- Conductors and insulators

Step 1

- Perform condition assessment to determine PCR of asset components (use Table 2-1 for ratings)

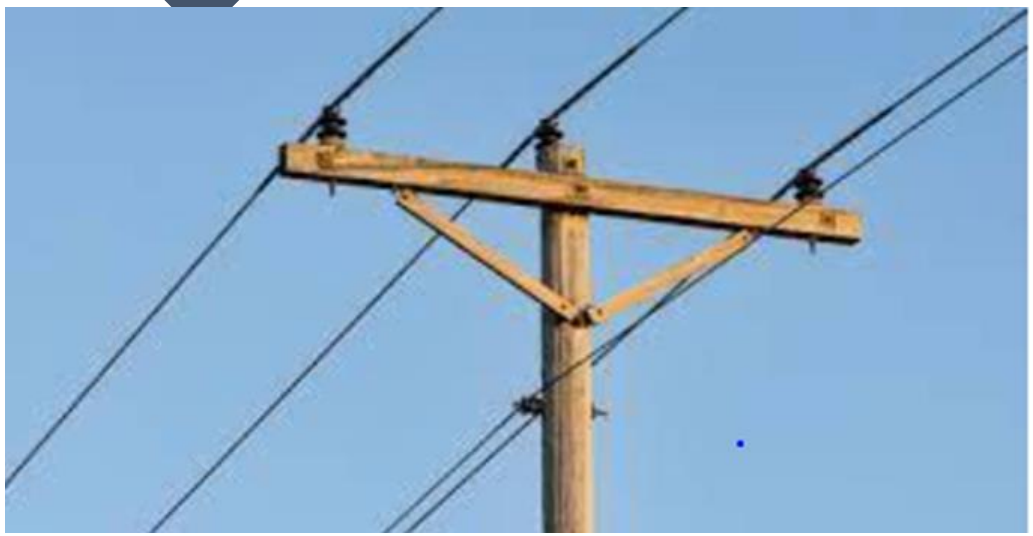
Asset Component Condition	Physical Condition Rating	Interpretation
Asset Component in brand new condition, with no wear, no damage, no deformation, no defects, no deterioration, no impairment	5	Excellent
Asset Component in "like new" condition, with minor wear and no damage, no defects, no deformation, no deterioration and no impairment	4	Good
Asset Component shows minor wear, minor deformation, minor damage, minor defects, minor deterioration, minor impairment, asset condition can be maintained through normal preventative maintenance	3	Fair
Asset Component with major deformation, degradation, deterioration, damage or defects and serious impairment in condition; however component condition can be restored through economically efficient rehabilitation/refurbishment of degraded/faulty components.	2	Poor
Asset Component with major degradation, deterioration, damage or defects and serious impairment in condition, and it is not possible to restore the component condition through economically efficient rehabilitation/refurbishment	1	Very Poor

Based on the given information in second slide,

- Which rating would you give to the poles and crossarms?
- Please discuss within your group and assign a rating.

Step 1

- Perform condition assessment to determine PCR of asset components (use Table 2-1 for ratings)



Physical Condition Rating	Interpretation
5	Excellent
4	Good
3	Fair
2	Poor
1	Very poor

Based on the given information in the second slide,

- Which rating would you give to the insulators and conductors? Please read the given information about insulators and conductors
- Please discuss within your group and assign a rating.

Step 2A

- Establish FPR of asset by assessing recent asset performance (use Table 2-5 for ratings)

To establish the Functional Performance Rating, we need recent performance assessment. Based on the initial description, we know this line section has been experiencing frequent outages and reliability has bee dropping. Use Table 2-5 to assign a functional performance rating to this section of the line.

Table 2-5: Asset Functional Performance Ratings

Asset Functional Performance Rating	Condition Score	Interpretation
Asset's functional performance exceeds the upper limit of the desired service levels.	5	Excellent
Asset's functional performance meets the upper limit of the desired service levels.	4	Good
Asset's functional performance meets the lower limit of the service level requirements.	3	Fair
Asset's functional performance does not meet the lower limit of the service level requirements, however through refurbishment/renewal it is possible to restore the performance to acceptable level.	2	Poor
Asset's functional performance does not meet the lower limit of the service level requirements, and it is not possible to restore the performance to acceptable levels through renewal/refurbishment.	1	Very poor

Step 2B

• Calculate the Asset Condition Index

Now that we have assessed the physical condition and the performance of the line section and we have assigned them a rating, we will input them into Table 3-30 to calculate the Asset Condition Index.

Table 3-30 (Section 3)

Condition Criteria	Components	Weight	Condition Ratings	Maximum Score	Actual Score
Component Physical Condition	Poles & Crossarms	6	2	30	12
	Conductors & Insulators	4	3	20	12
Asset Functional Performance		4	2	20	8
Total Score				70	32
Asset Condition Assessment Index (ACI) = (Actual Score / Maximum Score) x 100					46

Risk of Failure and Remaining Useful Life

Step 3

- Assess the risk of asset failure and remaining useful life Use Table 2-3 (Section 2) shown below

Based on the Asset Condition Index value calculated in the previous slide, find the correct row in the first column of the table and then move to column 3 in the same row to find the remaining useful and move to column 4 in the same row to find the risk of asset failure.

Table 2:3 (Section 2)

Asset Condition Index	Interpretation	Remaining Useful Life	Risk of Failure in Service
0 to 20	Very Poor	< 5% of TUL	Very High
21 to 40	Poor	<20% and ≥5% of TUL	High
41 to 60	Fair	<50% and ≥20% of TUL	Moderate
61 to 80	Good	<85% and ≥50% of TUL	Low
81 to 100	Excellent	≥85% of TUL	Very Low

Investment plan

Step 4

- Select the optimal investment plan Use Table 2-4 (Section 2) shown below

- Based on the Asset Condition Index value calculated in the previous slide, what is the recommended action?

Table 2-4 (Section 2)

Asset or Component Condition	Recommended Action for Investment Planning
ACI = 0 to 20	Plan Asset Replacement - with High Priority
ACI = 21 to 40	Plan Asset Replacement
ACI>40, but one or more component's Rating 2 or Less	Plan Renewal of Components with Condition Rating of 2 or Less
ACI >50 and all components with rating of 3 or higher	Only Scheduled Maintenance and inspectuibs are Required

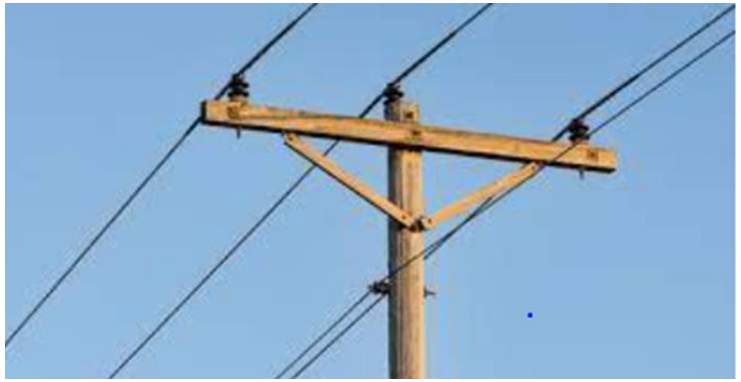
Electricity Distribution Line – Cost Estimate

Table 4-14: Unit Costs for Electricity Infrastructure

Infrastructure Asset	Unit	Cost
11kV, 3ph, 1 circuit overhead line (120 mm² AAC)	$/km	$60,000
11kV, 3ph, 1 circuit overhead line (120 mm² AAC with ABC LV underbuilt)	$/km	$85,000
11kV, XLPE, 3ph, (120 mm² Copper) direct buried	$/km	$150,000
100 kVA pole mounted transformer (3 phase)	$/each	$2,000
300 kVA pad mounted transformer (3 phase)	$/each	$4,000
5 MW medium speed diesel generator	$/each	$5,550,000
1 MW high speed diesel generator	$/each	$160,000
100 kW PV solar power	$/each	$200,000

Overhead Line Specifications			Units
Length	L	10	km
Voltage : 11kV			
Phasing : 3 ph, single circuit			
Support type: Wood poles			
Conductor size: 120 mm^2 AAC			
Unit Costs for Line Construction(From Section 4)			
Unit cost for overhead line (Table 4-14)	C_{mv}	$60,000.00	USD/km
Price Adjustment Factor for Palau (Table 4-2)	P_{af}	1.3	
Cost Estimate			
Estimated Cost of Distribution Line	$L \times C_{mv} \times P_{af}$	$ 780,000	USD

Group 1 Exercise Results



Condition Assessment of Distribution Line

- Condition Assessment of a 10 km long, 3-ph, 11 kV, single circuit distribution line with 120 sq. mm AAC conductor, in Palau revealed the entire line section looks as shown in the photograph below. The wood poles and cross-arms are badly decayed, but the conductors and insulators are in fair condition.
- The line experiences frequent breakdowns and reliability has been dropping over past 5 years.

Physical Condition Ratings	
Poles and cross arms	2
Conductors and Insulators	3
Functional Performance Rating	2
Asset Condition Index	46
Remaining Useful Life	20% to 50%
Risk of Failure	moderate
Estimated Investment	780K