ENGINEERS
AUSTRALIA
Newcastle Division

ASSET MANAGEMENT COUNCIL
Newcastle Chapter

FMECA in Action

Gary Winsor
Manager – Asset Modelling & Transmission Mains
Energy Australia
gwinsor@energy.com.au

Sydney Chapter Chair
Asset Management Council
gary.winsor@amcouncil.com.au

EnergyAustralia™
We're on it

Today

1. Background on Energy Australia
2. What is FMECA?
3. FMECA and OPEX
4. FMECA and Capex

EnergyAustralia
We're on it

Overview - About us...

- State Owned Corporation
- The largest single electricity network in Australia
- Distributing electricity to the Sydney, Central Coast and Hunter regions
- Services more than 1.6 million customers across a 22,275 square kilometre area
- Distributes more than 28,700 GWh of electricity annually
- Peak demand 5,868MW

Overview - Asset base

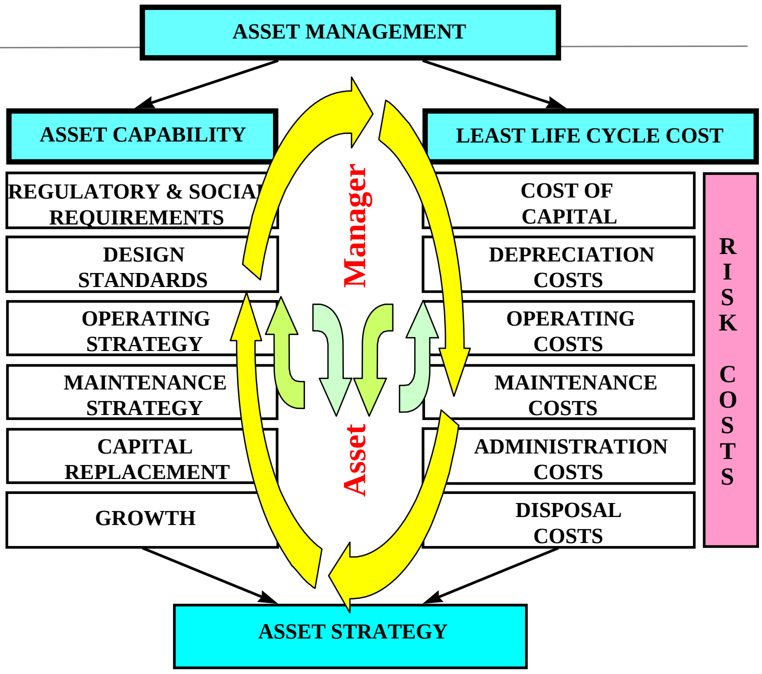
- $36 billion Network assets
- Consisting of
  - 4,700 km of sub-transmission voltage conductors
  - 17,000 km of high voltage conductors
  - 28,000 km of low voltage conductors.
  - More than 230 Zone and transmission Substations
  - More than 29,000 distribution substations.
  - More than 550,000 poles
  - Approximately 250,000 street lights

EnergyAustralia We're on it

How did Energy Australia's Asset Management framework mature?

- "Our maintenance is broken, I want you to fix it"
- FMECA / RCM methodology adopted
- FMECA / RCM and Regulatory framework drove the need for information
- Maintenance needs evolved into asset management
  - Defect reporting linked to analysis
  - Maintenance cannot fix it if it's the wrong asset for the business
  - Development of asset tools and economic models requiring both technical and financial information
  - iAMS

EnergyAustralia We're on it



Why Do FMECA?

- The basic approach of regulation is:

Where the network operator can show that in it's circumstances the work is justified, it must be allowed to recover the efficient cost of performing the work.

- So how does FMECA help?

What is FMECA?

- **F**ailure **M**ode, **E**ffect and **C**riticality **A**nalysis – a Structured analysis process for:
  - Identification of equipment/system functions
  - Identification of functional failures
  - Identification of Failure Modes
  - Identification of the effects of the failure
  - Assessing criticality of the failure
- Uses
  - Elimination of undesirable failure modes during design
  - Input to RCM Analysis
  - Input to asset condition risk assessment
  - Input into asset safety assessment

EnergyAustralia We're on it

What is RCM?

Reliability Centred Maintenance

- An analysis process centred on achieving inherent levels of equipment safety and reliability at minimum cost.
- History:
  - Original reliability work conducted (1945)
  - Logic process first defined by United Airlines (1965)
  - Expanded to support the Boeing 747 program (1972)
  - Adapted by Royal Australian Air Force (1975)
  - Seminal RCM document by Nowlan and Heap for DoD (1978)
  - Adapted from RAAF to the Victorian rail industry (1986)
  - Now accepted practice across all commercial industry
  - Latest success with Energy Australia (2000-2008)

EnergyAustralia We're on it

RCM analysis

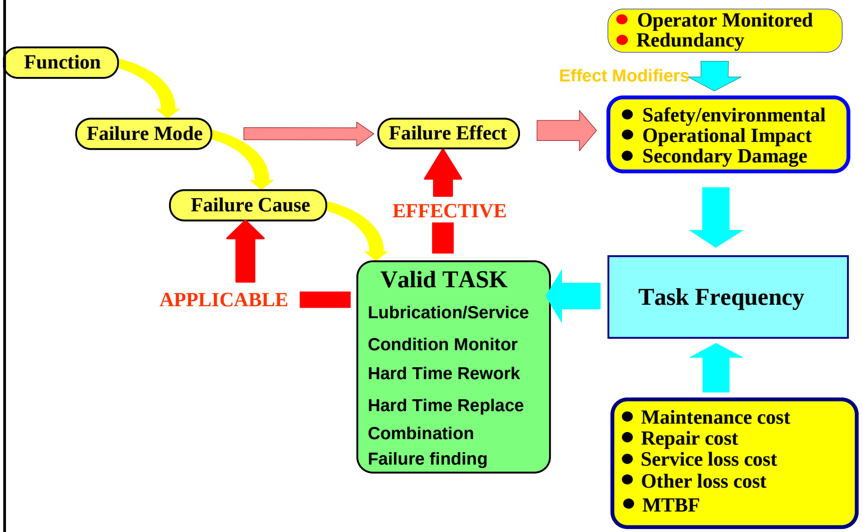
- Asks seven questions
  - What assets are important to the business?
  - What is the asset's function(s)?
  - How does it fail to perform that function?
  - Why causes it to fail?
  - What happens when it fails?
  - How can that failure be managed?
  - What can be done if the failure cannot be managed?

FMECA

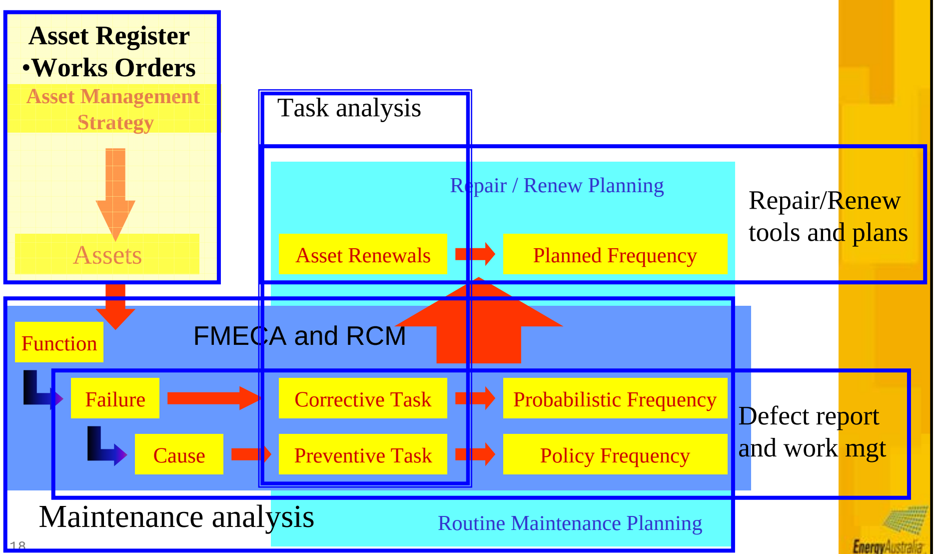
RCM analysis

- Selects maintenance tasks from five possible options
  - examines items to detect potential failures
  - restores items before a maximum age
  - discards items before a maximum age
  - checks items to find failures that are not evident
  - applies default tasks of "run to failure" or "redesign"
- The TMP is the sum of the above tasks for each asset that are applicable and effective in managing the effects of failures.

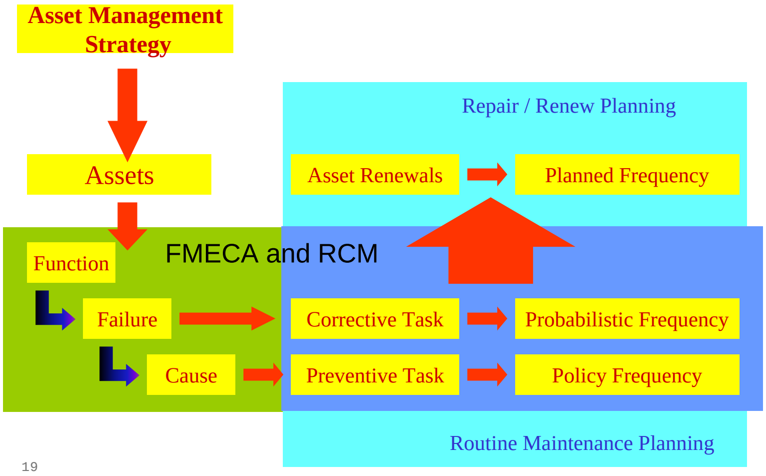
FMECA/RCM model (maintenance)



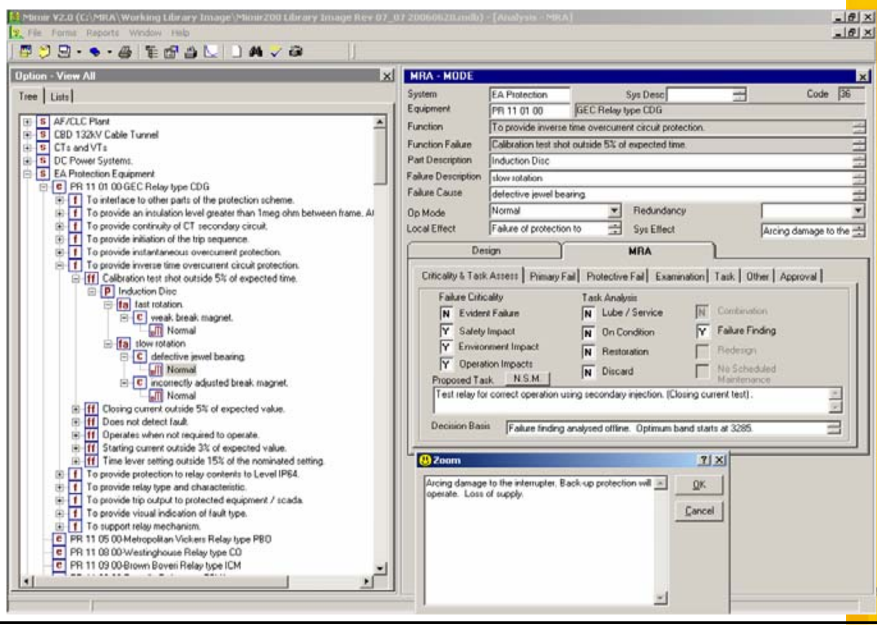
FMECA/RCM



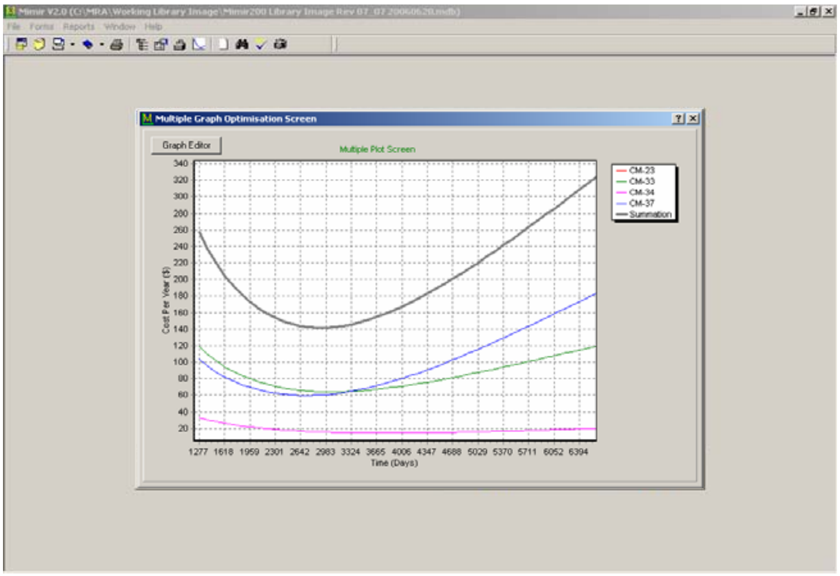
FMECA/RCM



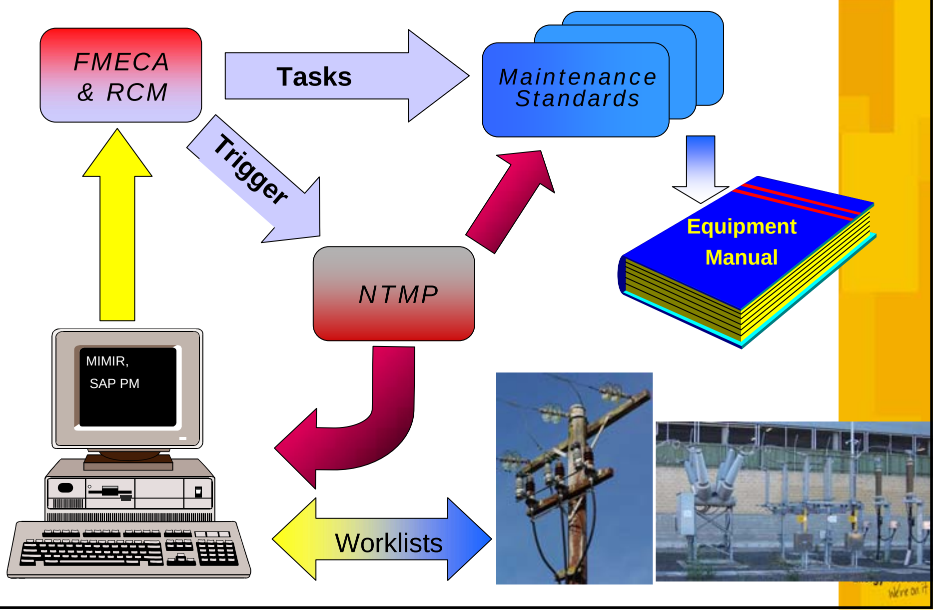
FMECA/RCM



FMECA/RCM



How does this all fit?



What has been the result?

- 380 New maintenance standards were produced for 99% of the electrical network assets in 4 years.
- Some maintenance periods have been increased and some decreased.
- Reduced rates of ‘in service’ failures
- Inspection task backlogs reduced by 98.4 % over 3 years
- Mature Opex / Capex tradeoff approach
- Solid framework for maintenance requirements reviews

FMECA in OPEX

Regulatory Outcomes

- 1999-2009
  – Increased funding for System OPEX as the need for the work was clearly and objectively articulated
- 2009-14
  – System OPEX funding sustained
- Why?

Robust methodology which provides greater transparency to the Australian Energy Regulator

FMECA in CAPEX

- Energy Australia's capital programme of the 2009-14 period is $8bn of which approx 50% is replacement
- Capital Programme doubles again from 2004-9 including:
  - 50 new Zone/STS substations
  - Retire 40 Zone/STS substations
  - Replacement of 132kV oil cables – 141km
  - Replacement of 33kV cables – 155km
  - Significant replacement of aged 11kV switchgear
    - 1263 panels
- So where does FMECA Fit?

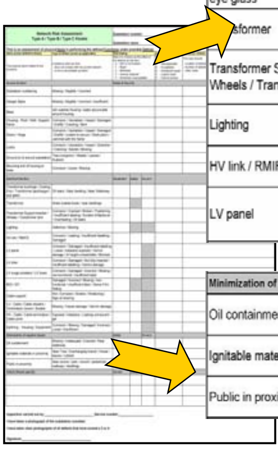
Replacement Strategy

- **Our Operations Investment Managers monitor the failure rates and modes on our assets and identify assets which have emerging issues.**
- **We also monitor the asset performance via specialist committees which draw subject matter experts from the business to review incidents and raise issues**
- **An investigation is initiated via the replacement manager**
- **Improved data enables us to move from an age surrogate to an actual condition and risk based combined approach.**

Replacement Subprograms

- Risk Assessment Report
  - The assets are identified
  - Risks associated with the asset and its environment are reviewed
  - A sample of assets and sites are visited and a risk assessment worksheet developed
  - The risk assessment worksheet is reviewed by the Operations Investment Team
  - All assets are visited and risk assessed by the one person. (Photos are taken where possible)
  - A risk rating is assigned to each asset

FMECA derived Risk Check List



Electrical function		Equipment	Safety	Enviro't
Transformer bushings / Cooling Fins / Transformer tapchanger / eye glass	Oil leaks / Near dwelling / Near Waterway			
sformer	Noise outside kiosk / near dwellings			
Transformer Support bracket / Wheels / Transformer tank	Corrosion / Cracked / Broken / Positioning / Insufficient labeling / Evident of flashover / Overheating / Oil leaks			
Lighting	Defective / Missing			
HV link / RMIFS	Corrosion / Leaking / Insufficient labelling / Damaged			
LV panel	Corrosion / Damaged / Insufficient labelling / Loose / Asbestos exposed / Vermin damage / At height unreachable / Blocked			

Minimization of negative impact		Safety	Enviro't
Oil containment	Missing / Inadequate / Cracked / Near waterway	1	0
Ignitable materials in proximity	Near Tree / Overhanging branch / house / leaves / rubbish	3	2
Public in proximity	Near school / park / church / pedestrian walkway / dwellings	4	

FMECA & Risk Assessment

Risk Score calculation & priority

- Total score = weighted sum of the risk rating

  (weightings determined by the consequence of failure of each failure mode)

- Final priority reflects the urgency of replacement

  in some locations the safety & environmental risks are the over-ridding risk of the whole kiosk.

Final adjusted score	Note	Total weighted score		Access								Tx Oil Leak			Tx Noise		Tx structure			lig	HV Links/ RMI			LV Panel		LV Link		Surg	M	Cabl		LV Ca		HV Ca		Earthing		Oil contain		Ignitable		Pu
			Weights	1	4	2	10	10	10	5	2	3	5	5	2	5	2	5	5	1	3	5	5	2	5	2	5	1	5	1	1	3	1	10	3	10	1	10	5	5	10	5	10
740	Security - Serious Car Accident, par	740		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
400	Safety - combination of leaking gel,	118		1	3	0	2	3	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	3	2	1	0	0	0	0	0	1
400	Safety - externally exposed earthing	113		1	0	0	1	2	0	1	1	1	0	0	0	0	0	0	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	3	0	0
400	Security - poor corrosion on housing	96		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Replacement Subprograms

- Risk Rated List of Assets
  - The assets are listed with their associated risk ratings or scores
  - These scores are sorted from highest to lowest
  - The order and scores are reviewed by a group of OIM team members as a sanity check
  - Priorities are allocated to the final list, with the highest priority for replacement being assigned to the number 1
- Replacement Plan 2009-14
  - $1.49bn + Area Plan projects

FMECA and Asset acquisition

- Design FMECA is just the first step
- Eliminates failure modes in appropriate point in asset lifecycle
- Provides a view of the residual risk to be managed by operations / maintenance
- Provides a framework to capture asset performance.
  - maintenance reviews over lifecycle
  - feedback to designers

FMECA and Asset acquisition

If FMECA tells us how the asset fails….

And RCM tells us how to manage the failure mode

Then……

O&M manuals can be created to describe all tasks

- Training requirements can be determined

For a quantified analysis

- Task periods can be objectively determined
- Spare parts needs can be objectively determined

FMECA in Action

Discussion

EnergyAustralia™
We're on it