Gerrit Teunissen,
General Manager
City Power,
Johannesburg,
South Africa

"How to justify and prioritise maintenance requirements throughout an organisation"

Presentation outline

- *Background: What is MAINTENANCE?*
- *Maintenance Costs*
- *Financial Perspective*
- *Maintenance Methodologies*
- *Maintenance mix*
- *Condition Monitoring Techniques*
- *Determination of Risk Value*
- *Failures averted due to Condition Monitoring*
- *Requirements for maintenance execution*
- *Closure*

What is MAINTENANCE?

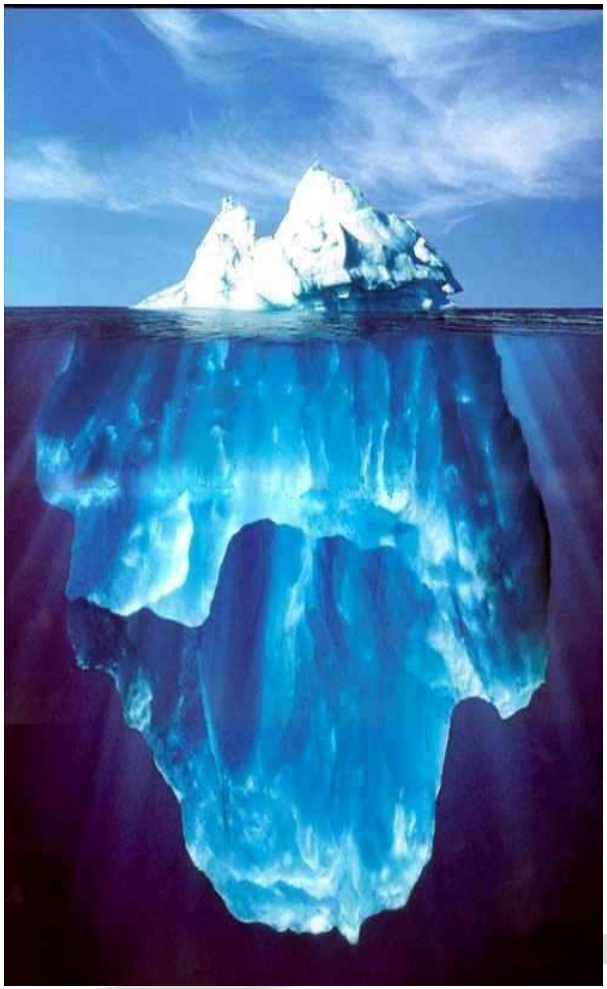
1. ***General: Activities required to conserve as nearly, and as long, as possible the original condition of an asset or resource while compensating for normal wear and tear.***
2. ***Accounting: Periodic cost incurred in activities that preserve an asset's operational status without extending its life. Maintenance is an expense that, unlike capital improvement (which extends an asset's life), is not capitalized.***

What is MAINTENANCE?

3. ***Engineering***: ***Actions*** ***necessary for retaining or restoring an equipment, machine, or system to the specified operable condition to achieve its maximum useful life. It includes corrective maintenance and preventive maintenance.***

Maintenance Costs

Maintenance costs = Direct costs + Indirect costs



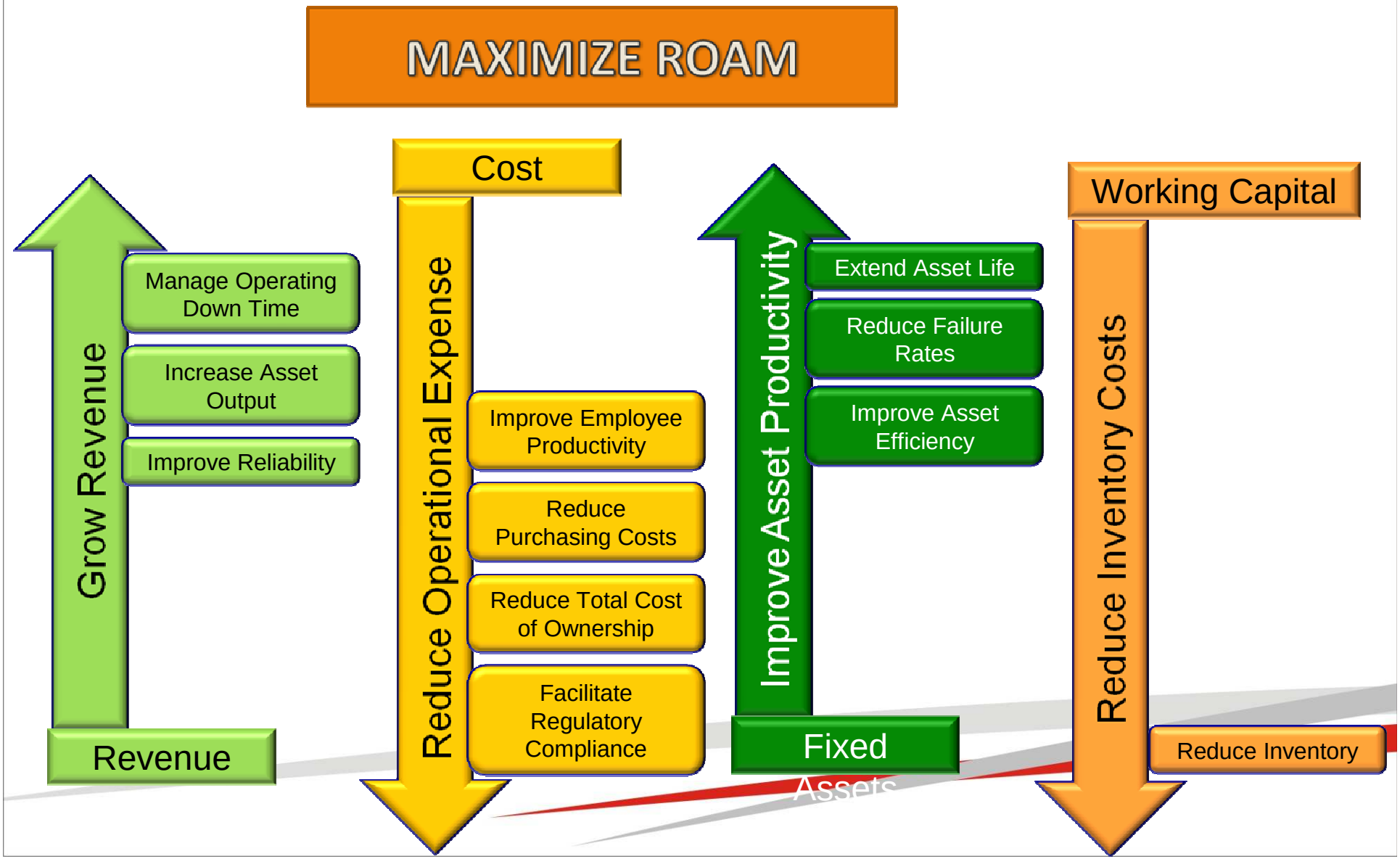
DIRECT

- Maintenance labour
- Spare parts
- Sub-contractor
- Transport

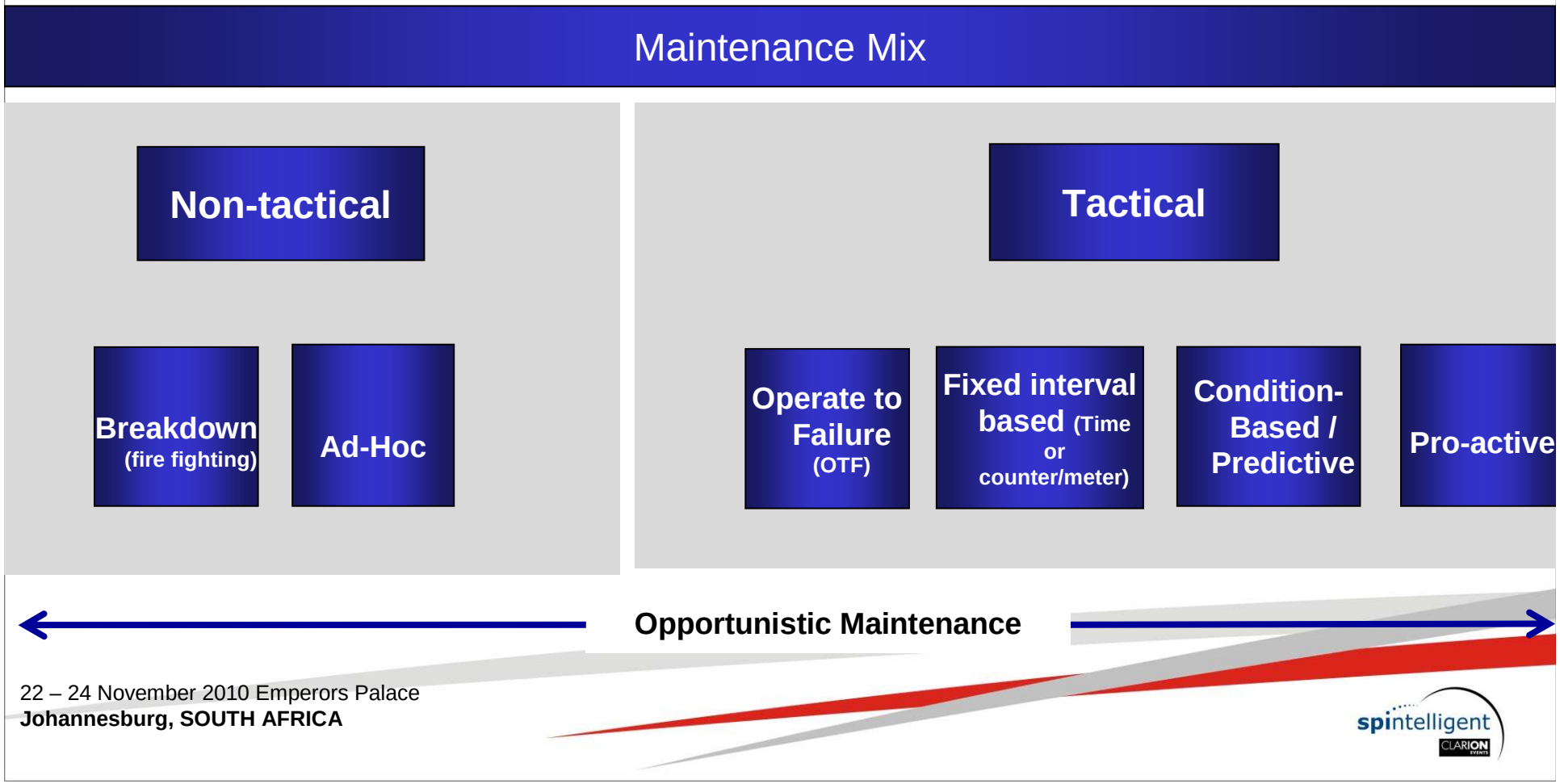
INDIRECT

- Loss of revenue (lost sales)
- Increased spares holding (higher inventory carry costs)
- Re-work
- Unnecessary work (Secondary damage, etc)
- Increased scrap
- Extra capacity (network, personal and material)
- Increased overtime
- Increased customer dissatisfaction
- NRS 048 & 047 non-compliance
- Disposal costs
- Safety (accidents, liabilities, etc)
- Increased insurance premiums

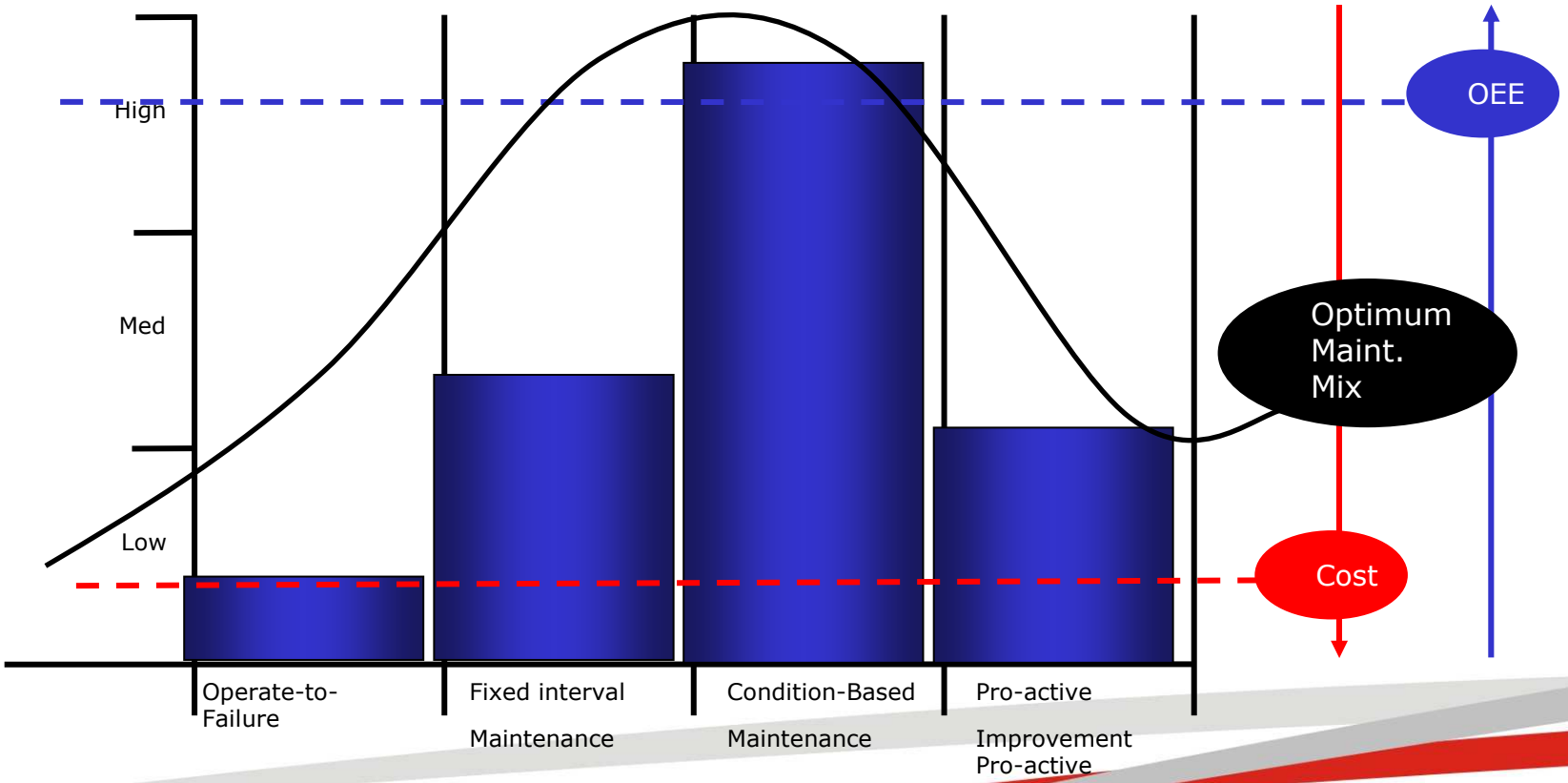
Financial Perspective of Asset Management



Maintenance methodologies



Maintenance mix



Condition Monitoring Root Map

Determination of the Risk Value

Risk Level	Consequences
Red = Extreme	**Safety:** Describe Negligible through to Disaster events
Amber = High	**Environmental:** Describe Negligible through to Disaster events
Yellow = Medium	**Reputation**: Describe Negligible through to Disaster events
Green = Low	**Financial:** Describe Negligible through to Disaster costs
Blue = Slight	**Other:** Describe Negligible through to Disaster events

Likelihood of Event	Event Count per Year		Negligible	Minor	Important	Major	Severe	Disaster
			1	2	3	4	5	6
Certain	10	5	**6**	**7**	**8**	**9**	**10**	**11**
Almost Certain	1	4	**5**	**6**	**7**	**8**	**9**	**10**
Possible	0.1 (once in 10 yrs)	3	**4**	**5**	**6**	**7**	**8**	**9**
Rare	0.01 (once in 100 yrs)	2	**3**	**4**	**5**	**6**	**7**	**8**
Very Rare	0.001 (once in 1000 yrs)	1	**2**	**3**	**4**	**5**	**6**	**7**

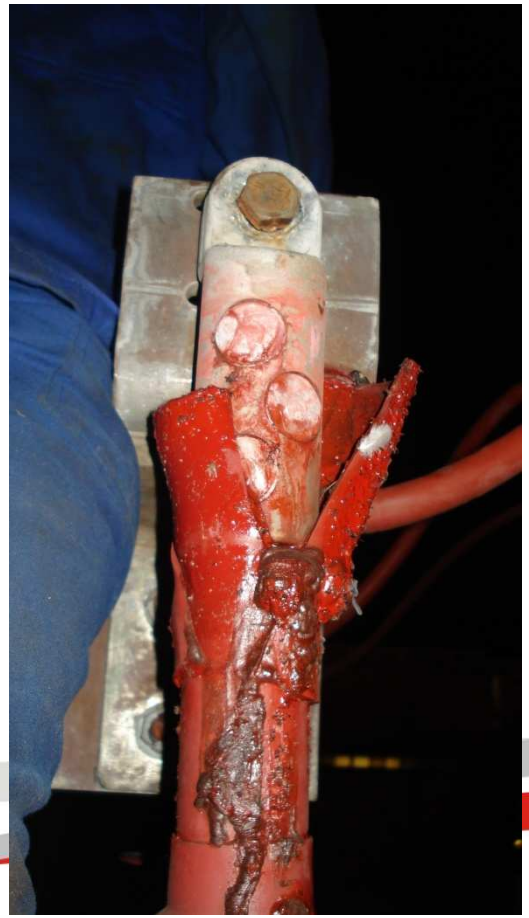
Condition Monitoring Techniques

Condition Monitoring Systems	What they detect	Applied to
Thermal Scanning	Overheating	Equipment
Dissolved Gas Analysis	Abnormal oil contents	Equipment & cables
Oil Pressure Monitoring	Low pressure	Cables
Distributed Temperature Sensing	Hot spots	Cables
Very Low Frequency Test	Low insulation	Cables
Partial Discharge Monitoring	Minute current leakage	Equipment & cables
Operating Mechanism Monitoring	Abnormal operation	Equipment

FAILURES AVERTED DUE TO CONDITION MONITORING

POTENTIAL FAILURE FOUND AT A SUBSTATION

IN 88/11kV YARD ON TRANSMISSION



LOOSE CONNECTION CAUSED EXCESSIVE HEAT
TERMINATION REPLACED

FAILURES AVERTED DUE TO CONDITION MONITORING

POTENTIAL FAILURE FOUND AT A SUBSTATION






MANY PREVIOUS FAULTS – MOSTLY FROM CABLE TERMINATION FAULTS
PANEL NOT BEEN CLEANED ADEQUATELY LEADING SECONDARY FAULTS

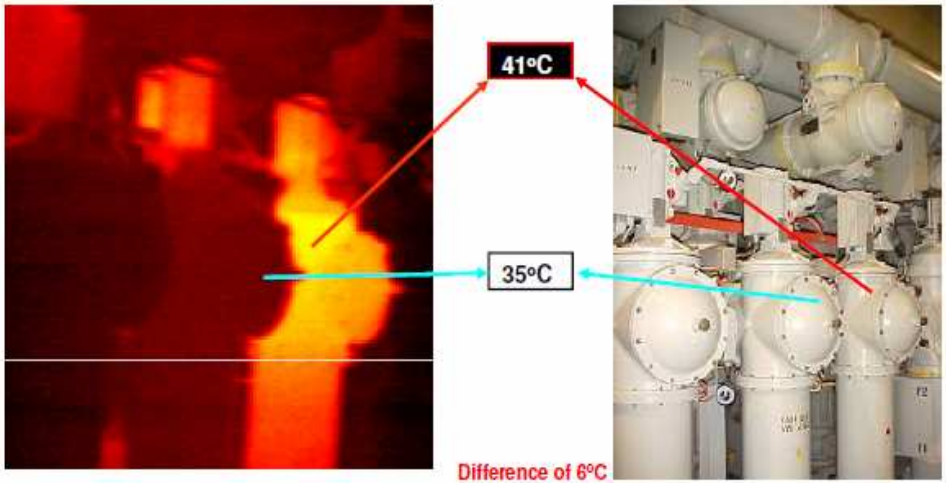
FAILURES AVERTED DUE TO CONDITION MONITORING

POTENTIAL FAILURE FOUND AT A SUBSTATION

COMPOUND FILLED TERMINATION REPLACED WITH HEAT SHRINK
INDEQUATE CLEARENCES AND CORE CROSSED

CONDITION MONITORING TECHNIQUES TO UTILIZED

- Ultrasonic, TEV monitors and Infrared camera – substations and overhead lines – on going
- Dissolved Gas Analysing and online monitors for transformers – on going
- Off load Partial Discharge(PD) diagnostic for cable systems – being investigated
- Live PD detection for GIS and AIS switchgear – being investigated
- Leakage current monitors for surge arresters – being investigated



FAILURES AVERTED DUE TO CONDITION MONITORING

POTENTIAL FAILURE FOUND AT A SUBSTATION

PARTIAL DISCHARGE DETECTED ON VT AND REPLACEMENT CT'S NOT INSTALLED CORRECTLY OEM DESIGN PROBLEM AND POOR WORKMANSHIP

Requirements to ensure maintenance of an acceptable standard is performed

Funding: Sufficient funding should be made available – international benchmark: 5 to 7% of asset replacement value on an annual basis

Skills: The "Right Skills at the Right time doing the Right thing Right"

Material availability: Making sure the correct parts are available and are used – no short cuts!

Other factors to be considered

- **History:** Keep a data base of maintenance performed – this will give a cost overview as well as compliance to OHS act
- **Down time:** What impact will down time have? Can the work be done after hours?
- **Maintenance Tactic:** Have the maintenance work in a task list format – this will ensure standards are met within a specified timeframe

Conclusion

Thanks for listening and sweat the assets but don't drive them into the ground(red).