

The logo for NORED, featuring the word "NORED" in white capital letters on a red background. The letter "O" is stylized with horizontal lines.

Electricity For Development

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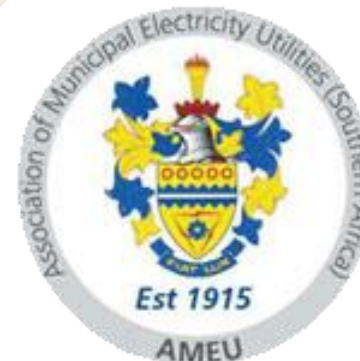
# Revenue Protection and Assurance [Meter Audits and Associated Benefits]

Walvis Bay

15-16 March 2023

AEDU Namibia Conference  
2023

“Building a resilient and  
harmonized distribution  
industry  
through  
innovation and technology”



# Presentation Outline



Introduction



Revenue Protection  
Standards and  
Requirements



Meter Audit Process



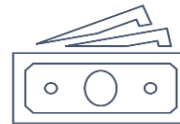
Audit Equipment



Common Errors



Remedies



Loss Recoveries



Case Studies





# Introduction

A resilient electricity distribution entity is one that **tracks and radically adopts technological advancements** within the fraternity.

**Resilience requires proper and failproof revenue streams** - and this is most critical, to sustain the business





## Revenue Protection:

A broad set of processes that utilities employ to prevent, detect, and respond to energy theft and other unaccounted for energy

- *Electric Power Research Institute*





# Revenue Protection Standards and Requirements

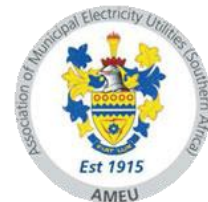
## NRS 057:2009 / SANS 474:2009- verification of the current transformers (CT) and voltage transformers (VT) i.e., Metering System

- “Subsequent recalibration of metering system components requires the same full laboratory process as for new components. On-site testing and calibration is acceptable for this purpose if the requirements of this code of practice are complied with” (NRS 057:2009; Ch. 4.4.3.4)
- “Metering system” consists of the energy meter(s) as well as the instrument transformer(s).

CUSTOMER LOAD	CT & VT ACCURACY	VERIFICATION INTERVAL
> 10MVA	class 0.2	5 years
100kVA to 10MVA	class 0.5	10 years
<100kVA	class 1	20 years



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# Revenue Protection Standards and Requirements

## **NRS 055:2011 : Revenue Protection :**

best practices in the field of revenue protection & outlines the basic procedures, resources and training for utilities to ensure good revenue protection.

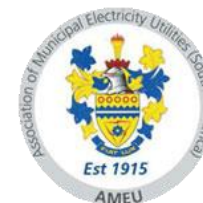


Revenue protection and credit control should be **ongoing processes** and not regarded as once-off actions



## **Auditing Process :**

process of verifying the integrity of a metering installation including the meter, the associated equipment, seals and data : best revenue protection tool to detect technical & non-technical losses including Tampering.





# METER AUDIT METHODOLOGY

Meter Audit Process is comprised of:



Acquisition & Inspection of  
Metering Point  
Documentation - / AMR  
DATA and Database setup as  
well as historic invoice /  
sample to site



Meter Board  
Access &  
Installation  
Verification –  
CRITICAL  
PLANNING FOR MV  
INSTALLATIONS



Metering Unit And  
Peripherals Test



Rectification  
& Re-test ON SITE



Rectification  
Reporting &  
Documentation ..

RECOVERY





# Equipment

To successfully conduct a meter audit, an entity must invest in quality equipment that conform to regulations and standards set out by governing bodies, namely;

Equipment used must conform to:

1. Measurement accuracy class higher than or equal to that of the test specimen (meter)
2. acceptable accuracy resolutions
3. measurement uncertainty levels as per governing regulations







## KoCos Metes 325

Field instrument specifically designed to cover all aspects of metering installation, commissioning and maintenance activities. Including the calibration of single and three phase energy meters, and meter installation audits.

**The Metes 325 allows for a non-intrusive meter and CT's accuracy verification.**



# Equipment

## METES 325



### Specifications

Accuracy: 0.05%

Voltage Range (direct connect): Standard: 65, 110, 230, 300 V ac Other ranges on request

Current Range (direct connect): Standard: 0.02, 0.1, 1, 2, 5, 10 A ac Other ranges on request

#### Measurement Information

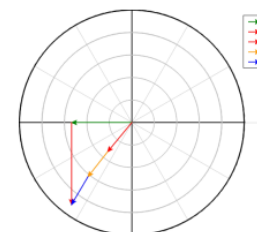
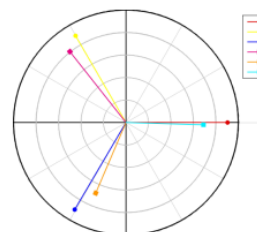
CT Ratio 400/5  
CT Measurement Primary  
VT Ratio 1/1  
Wire 4  
Voltage Ranges 230V, 230V, 230V  
Current Ranges 1000A (SP1000FLD), 1000A (SP1000FLD), 1000A (SP1000FLD)

#### Test Information

	Phase A	Phase B	Phase C
Vmag	224.28	221.17	222.77
Vang	0.00	120.19	-120.52
Imag	182.69	155.21	156.90
Iang	128.38	-113.21	-1.66

	Phase A	Phase B	Phase C	Total
P	-26420.18	-21492.19	-17942.70	-65855.06
Q	-31855.91	-27254.44	-30334.81	-89445.15
S	41159.34	34490.07	35078.78	110451.34
PF	0.64	0.62	0.51	0.60

Frequency (Hz) 50.00



#### Meter Error

##### Input A

Pulse Constant 10000 i/kWh  
Pulses 20  
Repeats 10  
Average Error (%) -32.90  
Min Error (%) -33.62  
Max Error (%) -31.92  
Uncertainty (%) 0.31

##### Input B

Pulse Constant 10000 i/kvarh  
Pulses 20  
Repeats 10  
Average Error (%) -31.61  
Min Error (%) -32.00  
Max Error (%) -31.29  
Uncertainty (%) 0.15

## KoCos METES 325 - (non-intrusive Tester) – LV Meters

- Multi phase Meter Calibration / Accuracy Verifier
- Accuracy class of 0.05%
- Test Reports fully ISO 17025 compliant
- Online CT Ratio verification functionality



## Process Overview:

POWER CONSULT		NORED	
3 PHASE METER AND DEMAND METER TEST SHEET 2022 10 05 02			
Customer Name	Date	Supply block / location	Seal No. 1
Town / Suburb (location)			Seal No. 2
Address (Box)			Seal No. 3
Install No.		Est no.	GPS Coordinates
Street Name (Map ref. ok?)			
Contact person (2020)	Technical		
Contact person (2020)	Administration		
INFORMATION (refer to standard SLI)			
Feeder Circuit Breaker	Make	Rating (A/MV)	DoL (Y/N)
CT connected if NOT DoL	Class	If NOT DoL	Class
Primary P1 to P2 (R/WB)	Y/N	Secondary S1 to S2 Earthed (or floating) (R/WB)	Y/N/Flood
Testblock (R/WB)	Y/N	Test-block secure	Earth bar on S1
Meter Type	Meter No (Serial No)	Year of Manufacture	Prim/Sec CT Ratio
ZM310			Prim VT
ZM405			Sec VT
ZM410			
Feeder cable	mm2	4x mm2	Neutral earthed
Wiring (if unreasonable/poor-needs attention)		Earth bar available	
Comment		CB labeled	
Meter Installation	3Phase/4Wire	Meter Voltage Input (Fuse/Protection (eg PCHM) none?)	
	2Phase/3Wire (Aron)	If NONE - mark CLEARLY for correction!	
	3 P-3 Wire Direct		
Meter Programming	TOU	High season	Low season
Registers (update as req)	1 Date Y	5 HS Peak TOU Y	LS Peak TOU Y
	2 Time Y	6 HS Standard TOU Y	LS Standard TOU Y
	3 Maximum Demand Y	7 HS Offpeak TOU Y	LS Offpeak TOU Y
	4 Export - Y	8 Cumulative kWh Y	
Meter Verification	Meter Utility Section / Tester (KoCos)		
complete as available	Meter	Verifier	% Error (Min/Max)
V1red [V] p-n			
V2white [V] p-n			
V3blue [V] p-n			
I1red [A]			
I2white [A]			
I3blue [A]			
Average Difference	Do values correspond? Y/N		
Utility section of meter	CT ratio		
others ...			
General Comments	Installation accepted: Y/N		
Tested By:		Conditionally accepted - refer to comments	Y/N
Signed off & Date			

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## Test sheet

- Meters - ZM305,405,410 Specific
- Provision for:
  - Customer Data
  - Meter Constants
  - Meter Registers







# Equipment – MV Meter Testing

## Omicron CPC100

Powerful testing device with a multitude of capabilities primary used in testing a wide range of electrical power equipment. Integrated into MV meter audit activities – test instrument transformers (VT's and CT's ).



**Customer supply disconnected when testing instrument transformers.**

This Instrument is a MUST for every Power Distributor



# Equipment Overview (cont.):

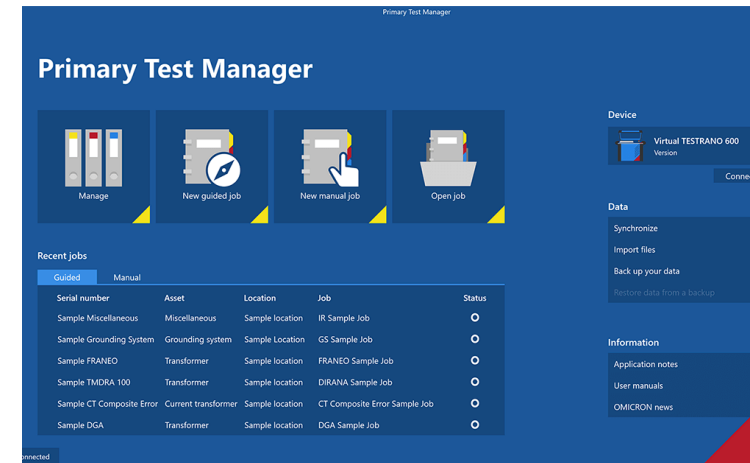
## CPC100- MV Metering Units

- CPC 100 – Complete
- Computer laptop
- Omicron Primary Test Manager (PTM) Software



## TEST

- CT Ratio Test
- VT Ratio Test
- Meter Secondary Verification i.e., METES 325





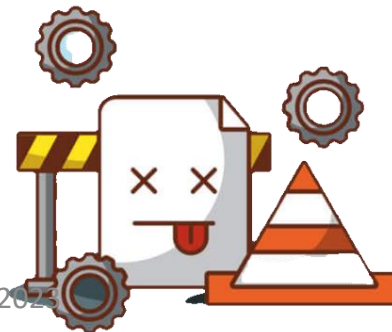
# Common Errors

## TECHNICAL ERRORS

- Meter failure
- Active meter protection (pkzm, fuses)
- CT Failure /retest after installation (verify equipment)

## NON-TECHNICAL ERRORS

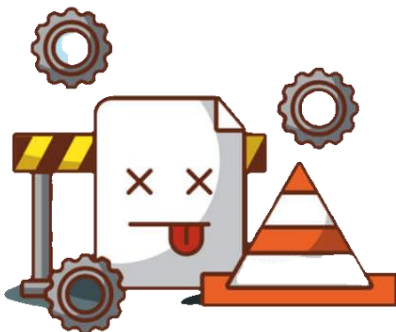
- Illegal connections
- Bypasses
- Human error
  - Incorrect meter programming (wrong CT ratios)
  - Installation of different CT ratios (for one installation)
  - Incorrect meter wiring
  - Incorrect installation of metering peripherals





# Remedies

## TECHNICAL ERRORS



- Test all metering equipment before dispatch to field
- Routine meter audit & inspection for older installations (<5 years).
- Test and Audit all new installations at commissioning

## NON-TECHNICAL ERRORS



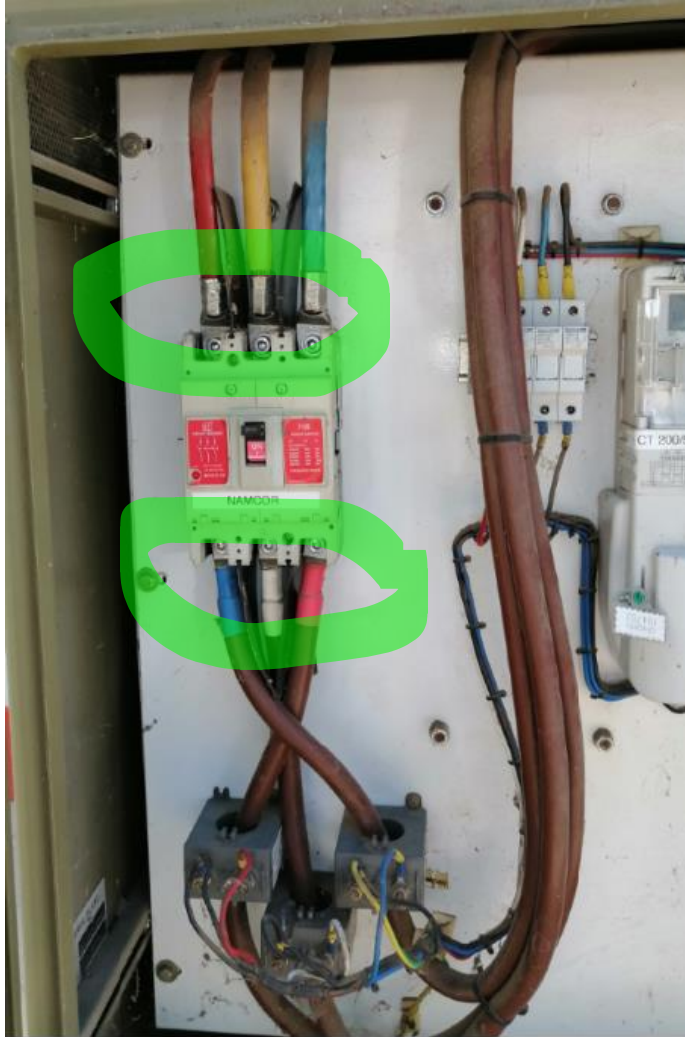
- Test and Audit all new installations at commissioning
- Carry out regular training on best systems installation practices

## CRITICAL EQUIPMENT

- KoCos 325
- Omicron CPC 100



# Typical Issues





# Case Studies

Meter Audits conducted in Namibia during period 2020 - 2022

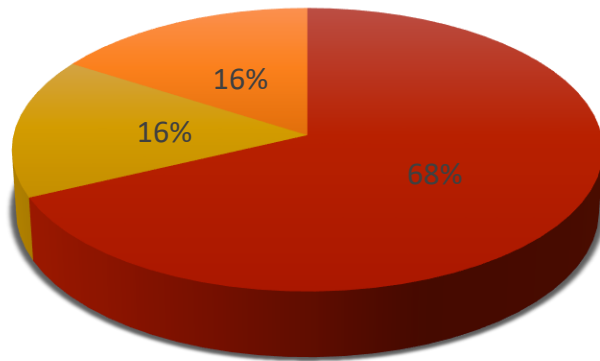
## Entity A:

Meters Audited : 244

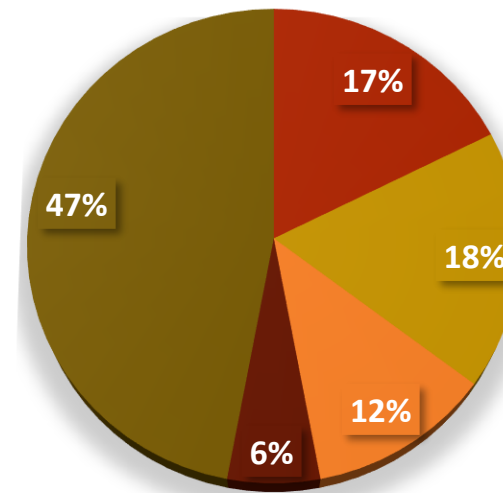
Pass Rate: 78%

Total Under-recovery: N\$ 8,9 million p.a.

Cause of Meter Failures



Meter Wiring Issues



- Incorrect phase rotation procedure
- CT Parallel Branching
- Swapped Meter Terminals
- Missing Terminal Connections
- Reversed CT's



■ Meter Wiring ■ Meter Programming ■ Equipment Failure

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# Case Studies

Meter Audits conducted in Namibia during period 2020 - 2022

## Entity B:

Meters Audited : 158

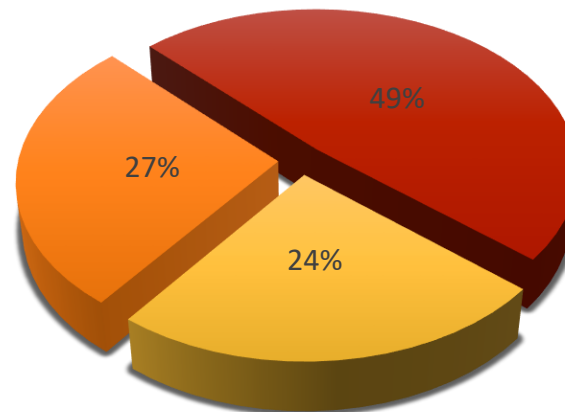
Pass Rate: 79%

Total Under-recovery: N\$ 9.2 million p.a.

**Statistical forecast on a national level ...**

**20% failure?  
Revenue?**

Cause of Meter Failures



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■ Meter Wiring

■ Meter Programming

■ Equipment Failure



# Issues and corrections

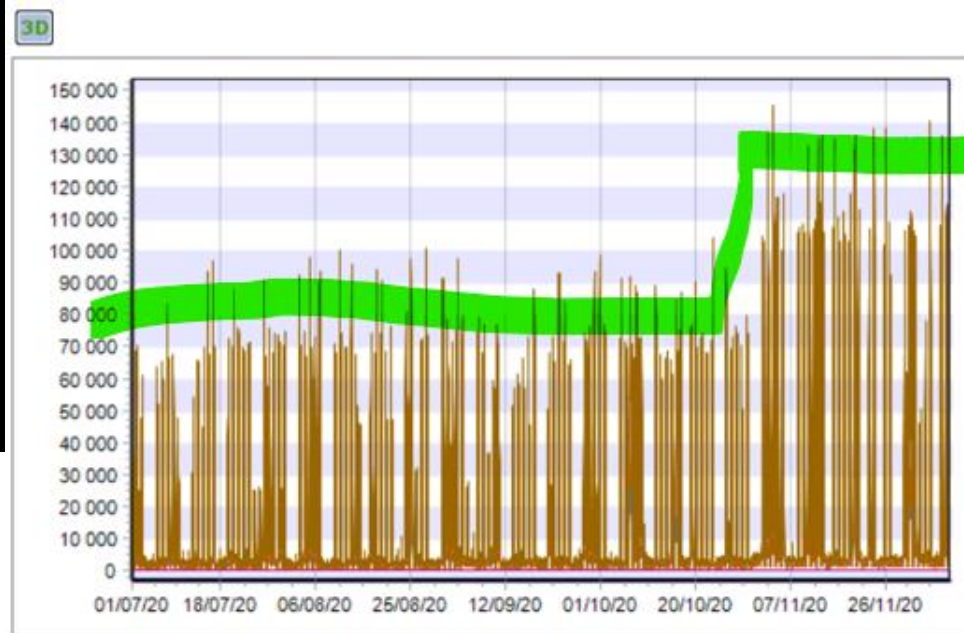
Error Description
Wrong CT ratio programmed into the meter. (300/5 but 150/5 CTs installed on site)
Blue phase CT reversed.
Meter input voltage phases B & C swapped.
1phase unmetered ( high load imbalance).
Parallel brige on metering CT curcuit - Current Division.
CT's installed in reverse direction, All voltages swapped.
Phase B CT faulty.
Phase A & B CT's reversed.
Faulty CT's (Phase A & Phase C)
Wrong CT ratio programmed into the meter. (400/5 but 600/5 CTs installed on site)
All 3 ph. CTs P1-P2 reversed and faulty.   CTs ratio not corresponding to class limit.
Wrong CT wiring. (Phase rotation not done correctly)
Phase Rotation not done correctly . Meter wrongly wired. Current & Voltage inputs to meter swapped.
CTs faulty. Ratio not corresponding.
Voltage Inputs to meter swapped.
Wrong CT ratio programmed into meter. 150/5 while 250/5 CTs installed on site.
CTs Incorrect wiring - Current division
Phase B CT (P1-P2) reversed. Export Observed on meter.
CTs reversed(K-L)/2. Voltage inputs to meter swapped
150/5 CT rasion programmed into meter while 500/5 CT installed on site
CTs wrongly wired/ In parallel, current to meter devides
Voltage inputs to meter swapped. (Phase rotation)
CT's reversed, Phase A , B & C voltage inputs swapped.
Voltage cuts on phases A & B (Meter Protection Fuses Blown)
CT's reversed, Phase A & C meter current inputs swapped - Phase A & B voltage inputs swapped.

ISSUE	ERROR	FACTOR
1 CT missing / Open	Error?	-33% (1/3) Correct with: 1.5
1 CT Reverse Polarity	Error?	-50% Correct with: 2
2 CTs Phase Swapped	Error?	100% Correct with: measure
2 CTs Reverse Polarity	Error?	export Correct with: -3
CT 1000/5 - one CT 800/5	Error?	fraction Correct with: 1.083333 $= (1/1 * ((1000/5)/(800/5)) + 2)$
One Voltage Only	Error?	-66% 3
SWER Installation	Error?	..
150/5 CT Programmed while 500/5 CTs installed.	Error?	calc 3.33
Meter Paralleling	Error?	calc 2

# Case Studies : Revenue Recovery

xxx – RED yyy

Phase 1- Loss Assessment –  
ANNUAL LOSSESS PREDICTED - increased revenue





# Loss Recoveries

Possible Audit Outcomes	Next Step
Installation Pass	Document, File
Customer Undercharge	Evaluate extend of undercharge and recover
Customer Overcharge	Evaluate extend of overcharge and reimburse customer



Republic of Namibia  
Annotated Statutes

## Prescription Act 68 of 1969 (RSA)

(RSA GG 2421)  
brought into force in South Africa and South West Africa  
on 1 December 1970 by RSA Proc. R.284/1970 (RSA GG 2922)  
(see section 21 of Act)

**APPLICABILITY TO SOUTH WEST AFRICA:** Section 21 states "This Act and any amendment thereof which may be made from time to time, shall apply also in the territory of South West Africa, including the Eastern Caprivi Zipfel referred to in section 38(5) of the South West Africa Constitution Act, 1968 (Act No. 39 of 1968)."

**TRANSFER TO SOUTH WEST AFRICA:** Although this Act makes no reference to any minister, because of its subject matter it probably fell under the Executive Powers (Justice) Transfer Proclamation, AG 33 of 1979, dated 12 November 1979. Support for this assumption can be found in the fact that this Act is one of the laws listed in the South African *Justice Laws Rationalisation Act 18 of 1996* (RSA GG 17129). If this assumption is correct, the only South African amending act after the date of transfer and prior to Namibian independence – the *Prescription Amendment Act 11 of 1984* (RSA GG 9087) – did not apply to South West Africa because it was not made expressly so applicable.

as amended by

**General Law Amendment Act 62 of 1973 (RSA)** (RSA GG 3947)

deemed to have come into force in relevant part  
on 1 December 1970 (section 41(2) of Act 62 of 1973)

**General Law Amendment Act 57 of 1975 (RSA)** (RSA GG 4760)

came into force in relevant part (section 31) on date of publication: 20 June 1975

**Native Laws Amendment Proclamation, AG 3 of 1979** (OG 3898)

deemed to have come into force in relevant part on 1 August 1978 (section 5 of AG 3 of 1979)

**Married Persons Equality Act 1 of 1996** (GG 1316)

# REVENUE RECOVERY



Recovery – guideline |  
implement forward

**Prescription Act 68 of 1969**,  
and engage client to enable  
repayment on favourable  
terms,  
e.g., discuss? no escalation or  
interest, 3 years payback etc.

Firm recovery as required by  
ECB (Electricity Control Board)  
guidelines.

Backdated revenue ... 20-30 Mio recoverable per client ....

## Completion of prescription postponed in certain circumstances

3. (1) If -

(a) the person against whom the prescription is running is a minor or is insane, or is a person under curatorship, or is prevented by superior force from interrupting the running of prescription as contemplated in section 4; or

[paragraph (a) amended by Act 1 of 1996]

(b) the person in favour of whom the prescription is running is outside the Republic (including the territory of South-West Africa), or is married to the person against whom the prescription is running, or is a member of the governing body of a juristic person against whom the prescription is running; and

(c) the period of prescription would, but for the provisions of this subsection, be completed before or on, or within three years after, the day on which the relevant impediment referred to in paragraph (a) or (b) has ceased to exist,

the period of prescription shall not be completed before the expiration of a period of three years after the day referred to in paragraph (c).

(2) Subject to the provisions of subsection (1), the period of prescription in relation to fideicommissary property shall not be completed against a fideicommissary before the expiration of a period of three years after the day on which the right of that fideicommissary to that property vested in him.

# MANAGE YOUR REVENUE STREAM – CRITICAL PATHS

## Structure

- Technical and Finance / Commercial Department interaction
- Agreements – all signed and available (incl. deposit payments)
  - Impacting: NET Meter installations/limitations
- Metering / QoS Department : REPORT to TECHNICAL TEAM
- METERING -> to BILLING
- Exception reports and validation
- BILLING – invoicing

## CRITICAL EQUIPMENT

- Installation verification – 3 Tier Process
- KoCos 325
- Omicron CPC 100



# RECOMMENDATIONS

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- Routine meter audit & inspection for older installations (<5 years) / SANS
- Training
- Standards
  - Installation standards
  - Minimum Requirement on meter installations / templates
  - Contractors Compliance pre-energizing
  - Access to meter-points by 3rd parties esp. PV installations pose a risk
- Installation Procedure
  - Installation
  - Verification
  - Audit



**3 LEVEL PROCESS**





THANK YOU

THE END



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