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Partial Discharge Testing Guide for Tropical & ASEAN Grids

Why humidity, heat and aging networks make PD monitoring a
maintenance priority — and how to build a practical testing program

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Contents

1. The Case for PD Testing in Tropical Climates
2. How Humidity and Heat Accelerate Insulation Degradation
3. PD Mechanisms Most Common in ASEAN Substations
4. Testing Methods: TEV, UHF, HFCT and AE
5. Building a Testing and Monitoring Program
6. Online Monitoring for Critical Assets
7. HUWOR Solutions Overview
8. Getting Started

This guide is written for asset managers, maintenance engineers and consultants working with transmission and distribution networks in Southeast Asia. All methods referenced follow IEC 60270 measurement principles.

1. The Case for PD Testing in Tropical Climates

Southeast Asia is one of the fastest-growing power markets in the world, with rapid load growth, an aging asset base, and the fastest renewable build-out of any region. These three forces converge on a single point: insulation systems are being stressed harder than ever, in a climate that accelerates their deterioration.

Partial discharge (PD) is the earliest measurable symptom of insulation degradation in switchgear, GIS, cables and transformers. It appears weeks or months before breakdown. Testing for PD — either periodically or continuously — is therefore the single most effective condition-monitoring investment a utility can make in tropical conditions.

70–90%

typical ambient RH in ASEAN
coastal and monsoon regions

1990s–2000s

vintage of many ASEAN
substations approaching insulation
end-of-life

>20 GW/yr

new solar and wind capacity added
across ASEAN markets

2. How Humidity and Heat Accelerate Insulation Degradation

Tropical climates attack insulation through four mechanisms that temperate-climate maintenance manuals rarely account for:

2.1 Moisture Ingress

Water vapor migrates into cable terminations, joints and switchgear barriers through imperfect seals. Once moisture reaches the insulation screen, it initiates water-treeing in cables and surface tracking on busbar insulation. Both processes generate measurable partial discharge months before failure.

2.2 Condensation Cycling

Day–night temperature swings in high-humidity air produce condensation inside outdoor and semi-outdoor switchgear. Repeated condensation creates conductive tracking paths and accelerates aging in a feedback loop.

2.3 Thermal Cycling

Frequent load changes and solar heating cause expansion–contraction cycles in terminations and joints. Repeated cycling promotes void growth in epoxy and rubber insulation — a primary source of internal discharge.

2.4 Contamination

Salt spray in coastal substations (from Peninsular Malaysia to Indonesian islands) and dust in industrial zones deposit conductive layers on insulator surfaces, driving surface discharge and tracking.

3. PD Mechanisms Most Common in ASEAN Substations

Mechanism	Typical Location	Best Detection Method	Failure Mode
Surface discharge / tracking	Barrier boards, bushings, cable terminations	TEV	Flashover, busbar fault
Internal voids	Epoxy insulators, GIS spacers, transformer bushings	UHF (GIS), HFCT (bushings)	Insulation puncture
Cable water-treeing	MV cable insulation, joints	HFCT online / oscillating wave offline	Cable failure under load
Corona	Sharp edges, fittings, damaged screens	AE, TEV	Gradual degradation
Floating electrodes	Loose screens, poorly grounded fittings	UHF	Localized heating, failure

4. Testing Methods: TEV, UHF, HFCT and AE

Method	Principle	Application	Deployment	Key Strength
TEV (Transient Earth Voltage)	Detects discharge-induced voltage pulses on earthed metal enclosures	MV metal-clad switchgear	Portable screening	Fast coverage of many panels
UHF (300 MHz–3 GHz)	Captures electromagnetic radiation from internal discharges	GIS, enclosed busbars, cable terminations	Portable or permanent	Highest sensitivity; online-capable
HFCT (High-Frequency Current Transformer)	Couples PD pulses on cable earths and bushing grounds	Cable circuits, transformer bushings	Clamp-on, online-capable	Non-invasive, no outage
AE (Acoustic Emission)	Detects structure-borne vibration from discharges	GIS, transformers, panels	Portable	Defect location accuracy

The strongest programs use a combination: TEV and AE for broad screening and location, UHF and HFCT for sensitive detection and continuous monitoring.

5. Building a Testing and Monitoring Program

Step 1 — Baseline Survey

Screen every panel and bay with portable instruments to establish a network baseline. Rank assets by discharge level and defect type. The baseline becomes the reference against which all future data is compared.

Step 2 — Risk-Based Frequency

Asset Category	Recommended Frequency	Rationale
Distribution switchgear (healthy)	Quarterly TEV screening	Surface discharge develops over weeks
Distribution switchgear (flagged)	Monthly + online sensor on critical bays	Track rate of change
Transmission GIS	Continuous UHF monitoring	Internal defects invisible without it
Cable circuits (critical)	Online HFCT + annual oscillating wave test	Moisture-driven defects are seasonal
After storm / flood / switching events	Immediate screening	Events accelerate existing defects

Step 3 — Trend Review, Not Just Alarms

Alarms catch high levels; trends catch developing problems. Review discharge levels and phase-resolved patterns monthly, correlating with load, weather and switching events. A slow rising trend is often the most reliable warning.

6. Online Monitoring for Critical Assets

Permanent sensors convert selected bays from periodic snapshots to continuous visibility. Typical architecture:

- **Sensors:** UHF (GIS), TEV (MV panels), HFCT (cables) mounted without outage
- **Local aggregation:** a monitoring unit per substation collects and pre-processes signals
- **Gateway:** an IoT gateway transmits data securely to the cloud platform
- **Platform:** dashboards with real-time levels, trends, phase-resolved patterns and alarms
- **Integration:** Modbus and IEC 61850 options for SCADA connection

Online monitoring is not a replacement for portable testing — it is the alarm layer. Portable instruments remain essential for fleet-wide coverage, defect confirmation and location.

7. HUWOR Solutions Overview

Product Family	Description	Typical Use
Handheld PD Detector	TEV + HFCT + AE in one instrument, IEC 60270 based	Screening, commissioning, troubleshooting
PD Sensors (3-in-1 / 4-in-1)	Combined TEV / UHF / HFCT sensing	Permanent MV panel monitoring
Built-in UHF Sensors	Permanent UHF couplers for GIS apertures	GIS online monitoring
Cable Oscillating Wave Tester	Damped AC testing with defect location	Offline cable commissioning and ranking
IoT Gateway + Cloud Platform	Data aggregation, dashboards, alarms, SCADA integration	Fleet-wide online monitoring
Surge Arrester Monitoring	Leakage current and counter monitoring	Arrester health tracking

All HUWOR products support OEM/ODM customization — product specifications, branding, software platforms and packaging — for utilities and partners standardizing on their own requirements.

8. Getting Started

1. Run a baseline screening campaign on 2–3 representative substations.
2. Install permanent sensors on the highest-risk bays identified.
3. Review three months of trend data before expanding the program.
4. Train local engineers on measurement practice and pattern interpretation.
5. Expand fleet-wide using the evidence from the pilot.

HUWOR supports every step — instruments, sensors, platform, training and remote diagnostics. For a deployment discussion, contact our export team.