



Hipot Testing Guide



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About This Guide

Hipot testing, short for high potential testing, is a withstand test. A voltage well above the operating voltage is applied to the insulation for a set time, and the item passes if no disruptive discharge occurs. This guide covers AC, resonant and DC withstand testing of switchgear, busbars, GIS and bushings on site, the test levels, safe set-up and how to judge the result.

What a Hipot Test Is

A dielectric withstand test, also called an HV withstand, high voltage or proof test. A defined voltage is held on the insulation for a defined time; the result is pass or fail.

When It Is Used

As a factory routine test, on site after erection and before energisation, after repair, and with partial discharge measurement as a diagnostic (IEC 60060-3:2006, Introduction).

Why It Matters

Insulation resistance and power factor cannot accurately predict breakdown voltage (as summarised by the US Bureau of Reclamation, FIST 3-1). A withstand test proves the insulation holds a defined overvoltage before the plant is connected to the network.

Guide at a Glance

Proves

That insulation holds a set voltage for a set time without disruptive discharge.

Sources

AC test transformer, series or parallel resonant AC, and DC.

Site Level

Switchgear 1 kV to 52 kV assembled on site: 80% of the routine value (AS/NZS 62271.200:2026, 8.104 a)).

Duration

60 s unless otherwise specified (AS/NZS IEC 60060.1:2026, clause 6).

Judged On

No collapse of the test voltage, then insulation resistance before and after, phase by phase.

Need the test done, or the test set to do it? Megavar tests HV plant across Australia and hires every test set in this guide.



Why Prove Insulation With a Withstand Test?

Hipot Testing in Four Numbers

28 kV

Routine power-frequency withstand, 12 kV switchgear (AS 62271.1, Table 1)

80%

Site test, site-assembled parts, share of routine value (AS/NZS 62271.200, 8.104 a))

60 s

Withstand duration unless otherwise specified (AS/NZS IEC 60060.1, cl 6)

1/10 to 1/40

Resonant set input power as a share of the test kVA (as summarised by Phenix)

Why a Withstand Test

A Proof, Not a Measurement

A defined overvoltage is applied for a defined time. The item passes if no disruptive discharge occurs on it (AS/NZS IEC 60060.1:2026, clauses 5 and 6).

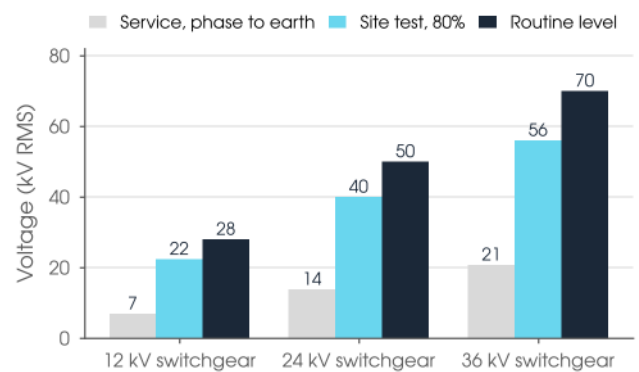
What Other Tests Cannot Tell You

Insulation resistance and power factor trend the condition of insulation but cannot predict the voltage it will hold (as summarised by USBR, FIST 3-1). The withstand test shows it holds the level.

Why on Site

Transport and erection can damage insulation. The site test shows the installed item still complies with the manufacturer's specification (IEC 60060-3:2006, Introduction).

Service Voltage and Test Levels



Phase-to-earth service voltage against the site and routine power-frequency test levels (AS 62271.1:2019, Table 1; AS/NZS 62271.200:2026, 8.104).

When to Test



Where Is It Used?

Items Tested

Item	What a failure points to	Site test level
Metal-enclosed switchgear, 1 kV to 52 kV	Damaged or contaminated insulators, site assembly faults, foreign objects	Site-assembled parts: 80% of the routine Ud (AS/NZS 62271.200:2026, 8.104 a))
Busbars assembled on site	Joint shrouds, clearances or partitions disturbed during assembly	As for the switchgear assembly they form part of (8.104)
Circuit breakers in metal-enclosed boards and GIS	Insulation damage after transport or site assembly	Per AS/NZS 62271.200 or IEC 62271-203 (AS/NZS 62271.100:2026, 11.3.102.3.1)
GIS above 52 kV	Particles, protrusions and voids (as summarised by OMICRON)	IEC 62271-203 and the manufacturer's site test programme
Bushings already in service	Puncture of a capacitance layer, flashover	85% of Table 3 (AS/NZS 60137:2020, 7.1)
Instrument transformers from service	Primary insulation damage	80% of Table 2, minimum Um (AS 61869.1:2024, 7.3.1)

Choosing the Test Level

Start From the Rating

The routine power-frequency value Ud comes from the rated voltage and insulation level: 28 kV at 12 kV, 50 kV at 24 kV, 70 kV at 36 kV (AS 62271.1:2019, Table 1).

Site Test, Switchgear

Parts assembled or filled on site: 80% of the routine value, each phase in turn, others earthed (AS/NZS 62271.200:2026, 8.104 a)). Routine tests not done in the factory are done in full. For 24 kV, $0.8 \times 50 = 40$ kV.

Transformers After Repair

80% to 100% of the original level; new parts at 100% (AS/NZS 60076.3:2017 Amd 1, clause 8).

Our Recommendation

Take the level from the equipment standard and the manufacturer's site test schedule, and agree it with the asset owner before the outage (AS 2067:2016, 9.4). Resolve any conflict between them in the approved test plan.

Higher or Lower Level

Why Not the Full Factory Level

The 80% condition check level reflects the insulation co-ordination margin for ageing, wear and normal deterioration, and the statistical nature of flashover (AS 62271.1:2019, 7.2.12 Note).

Why Not Lower

A lower level proves less than the standard asks. On-site tolerances and measuring uncertainty are also larger than in the factory (IEC 60060-3:2006, clause 1, Note 2).

Good to Know

Record the level in kV and as a percentage of the rated value, with the clause it came from.

Agree the level, duration and waveform in writing before the outage.

How Does It Work?

Three Ways to Make the Voltage

AC Test Transformer

A regulator and step-up transformer. Without reactive compensation the input equals the test kVA (as summarised by Phenix Technologies), so it suits low-capacitance items.

Series Resonant

An adjustable reactor in series with the capacitive item, tuned by inductance or frequency. On a discharge the follow-through current is low, so there is generally less damage (AS/NZS IEC 60060.1:2026, 6.1.2.3).

Parallel Resonant

Gives a steadier voltage on unstable items and full voltage with no load; series mode suits PD measurement and releases less energy on failure (as summarised by Phenix Technologies).

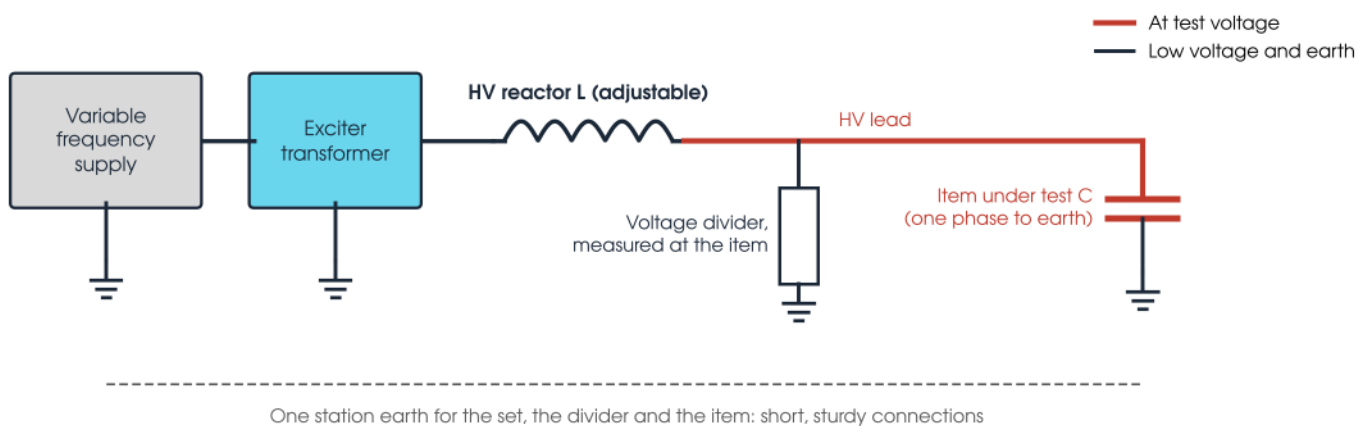
DC

A rectified source charges the item, then supplies only leakage and absorption current. The value is the arithmetic mean; ripple not more than 3% (AS/NZS IEC 60060.1:2026, clause 5).

Connection Arrangement

Series resonance: L is tuned against C so the voltage on the item builds far above the exciter voltage.

Resonant frequency $f = 1 / (2\pi\sqrt{LC})$. On a breakdown the circuit detunes and the voltage collapses.



Series resonant connection. The voltage is measured by a divider at the item, and the set, divider and item share one station earth.

Voltage Rules

Frequency and Value

AC test value is the peak divided by $\sqrt{2}$ (AS/NZS IEC 60060.1:2026, 3.7). On site the frequency is generally 10 Hz to 500 Hz (IEC 60060-3:2006, 6.3.1).

Ramp, Hold, Tolerance

Above 75% of U, raise at about 2% of U per second; hold 60 s if not specified; within 3% on site, 5% beyond 60 s (IEC 60060-3:2006, 6.3.2 and 6.6).

Measure at the Item

Measure with the item in the circuit, after an on-site performance check of the measuring system (IEC 60060-3:2006, 4.3 and 6.6).

Good to Know

AC, DC and other waveforms do not necessarily stress insulation equally (IEC 60060-3:2006, clause 1, Note 1). Use the waveform the equipment standard names.

How Do I Set Up Safely?

Permits, Isolation and Earthing

1 Access Permit

The permit covers everything the test energises, including remote cable ends, and any temporary removal of earths by the person the asset owner authorises.

2 Isolated, Proved Dead, Earthed

Each HV exposed part is earthed after it is de-energised (Safe Work Australia model Code of Practice: Managing Electrical Risks, 4.1).

3 Exclusion Zone

Barriers and signs around the set, the item and every remote end. Exclusion zones and permits are administrative controls under the Code (2.3).

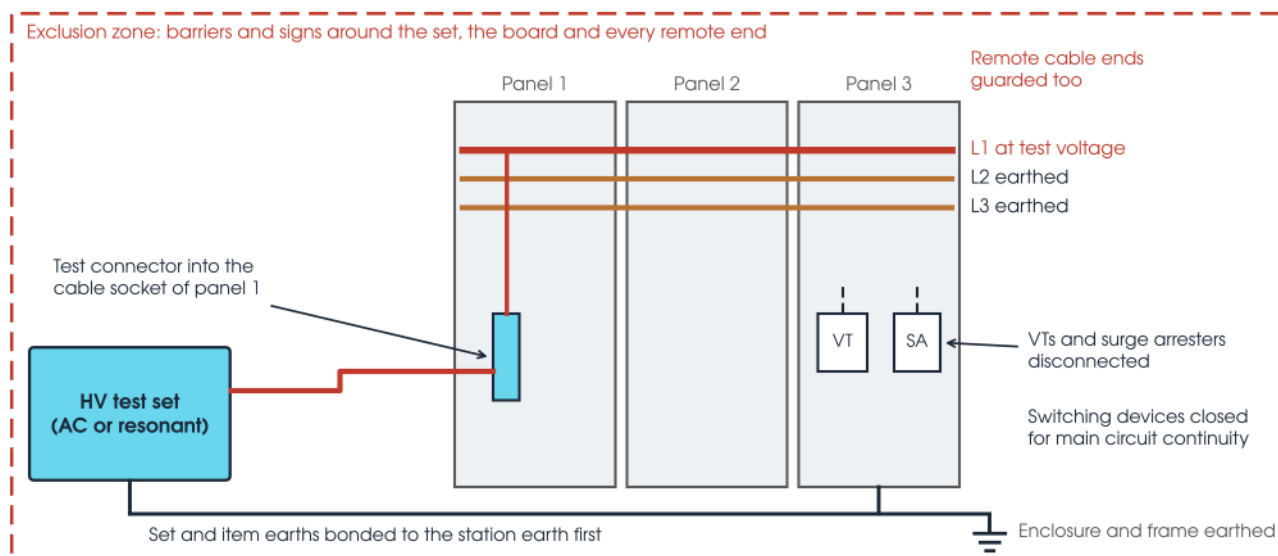
4 Earth First

Bond the set and the item to the station earth before any HV lead, with short, sturdy connections (IEC 60060-3:2006, 5.4.5).

Who Should Test

Only competent workers trained in HV electrical work (Code of Practice, chapter 9), under the asset owner's safety rules.

Set-Up on a Switchboard



One phase at test voltage, the other two and the enclosure earthed, VTs and surge arresters disconnected, and the exclusion zone around everything the test energises.

Important

This guide describes general practice for competent HV testing personnel. It is not a work procedure. Work under the asset owner's safety rules, the access permit and a site-specific safe work method statement. Manufacturer and asset owner criteria take precedence over the general guidance here.

Hazards Specific to a Withstand Test

Stored Charge

The item stays charged after the test, DC most of all. Discharge through the set's resistor, then earth solidly; USBR FIST 3-1 recommends at least 1 hour earthed for machine windings.

What Cannot Take the Voltage

Disconnect VTs unless the test frequency prevents core saturation, and disconnect overvoltage protective devices (AS/NZS 62271.200:2026, 8.2 and 8.104 a)).

Gas Compartments

Test at the specified gas pressure, after filling and gas quality checks (AS 62271.1:2019, 8.2; AS/NZS 62271.4:2026, 4.2).

Clearance

Keep extraneous structures at least 1.5 times the shortest discharge path away (AS/NZS IEC 60060.1:2026, 4.2).

How Do I Make the Measurement?

Eight Steps



Steps 1 to 4

1 Prepare

Confirm the agreed level, duration and waveform. Check the measuring system scale factor on site (IEC 60060-3:2006, 4.3).

2 Insulation Resistance

Run an IR test first to pre-qualify the insulation (as summarised by Megger, 2021). A poor reading stops the hipot.

3 Connect One Phase

HV lead to one phase; other phases and the enclosure earthed; switching devices closed for continuity (AS/NZS 62271.200:2026, 8.2).

4 Clear the Zone

Everyone outside the barriers, remote ends guarded, and the test supervisor confirms before energising.

Steps 5 to 8

5 Ramp Up

Start low and raise at about 2% of U per second above 75% of U (IEC 60060-3:2006, 6.6).

6 Hold

Hold for the specified time, 60 s if none is given. Watch the voltage and current.

7 Lower and Discharge

Reduce rapidly but do not interrupt suddenly (IEC 60060-3:2006, 6.6). Discharge and earth the phase.

8 Recheck and Restore

Repeat the IR test, then the next phase. Restore earths, VTs and arresters per the permit.

Good to Know

Record which phase was energised and which were earthed for every result.

Common Mistakes

VT Left Connected

Core saturation at power frequency and possible damage (AS/NZS 62271.200:2026, 8.104 a)).

Surge Arrester Left In

It conducts, the set trips and the test is invalid.

Gas Below Specified Pressure

The insulation is not tested in its rated condition.

Level Not From the Nameplate

The wrong row of the table is used and the test proves the wrong thing.

More Common Mistakes

Switching Off at Full Voltage

Switching transients can cause damage or erratic results (IEC 60060-3:2006, 6.6).

Long or Thin Earth Leads

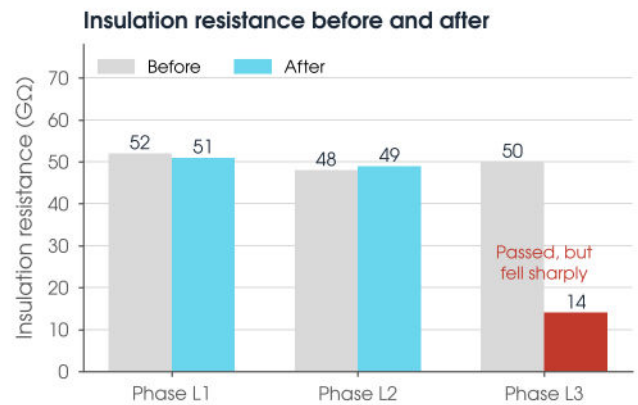
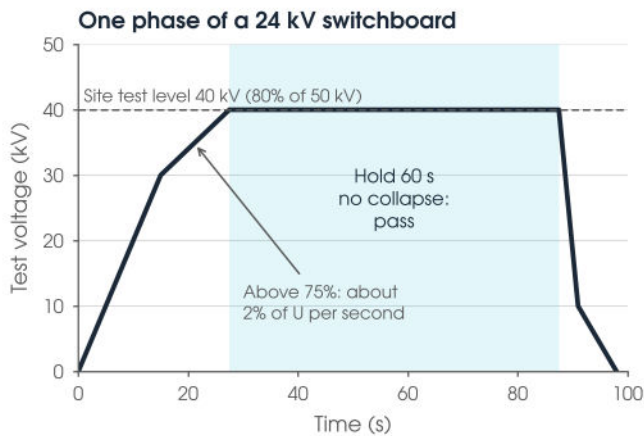
Voltage differences if a flashover occurs (IEC 60060-3:2006, 5.4.5).

AC Straight After DC

USB FIST 3-1 allows about 2 hours for absorption charge to dissipate before an AC test.

How Do I Read the Result?

The Test and the Check Either Side



Illustrative values

Every phase held 40 kV for 60 s. Phase L3 passed, but its insulation resistance fell sharply after the test. It warrants investigation before energisation.

Comparing the Result

Pass or Fail

Pass if no disruptive discharge occurs (AS/NZS IEC 60060.1:2026, clauses 5 and 6; AS 62271.1:2019, 7.2.5 a)).

Self-Restoring Insulation

In a wet test, one discharge on external self-restoring insulation allows a repeat (AS 62271.1:2019, 7.2.5 a)). A bushing flashover allows one repeat only (AS/NZS 60137:2020, 9.4.3).

Bushing Capacitance

Puncture is assumed if capacitance after the test rises by about one layer (AS/NZS 60137:2020, 9.4.3).

Before and After

Compare IR before and after, phase to phase and with the last test. A fall after a pass is a finding.

What a Bad Result Looks Like

Voltage Collapses

Disruptive discharge: a fail. Flashover runs along a surface, sparkover is through gas or liquid, puncture is through solid insulation and is permanent (AS/NZS IEC 60060.1:2026, 3.1).

Set Trips Before Full Voltage

A VT or arrester left in, the wrong item connected, or more capacitance than the set can supply.

Current Rising During the Hold

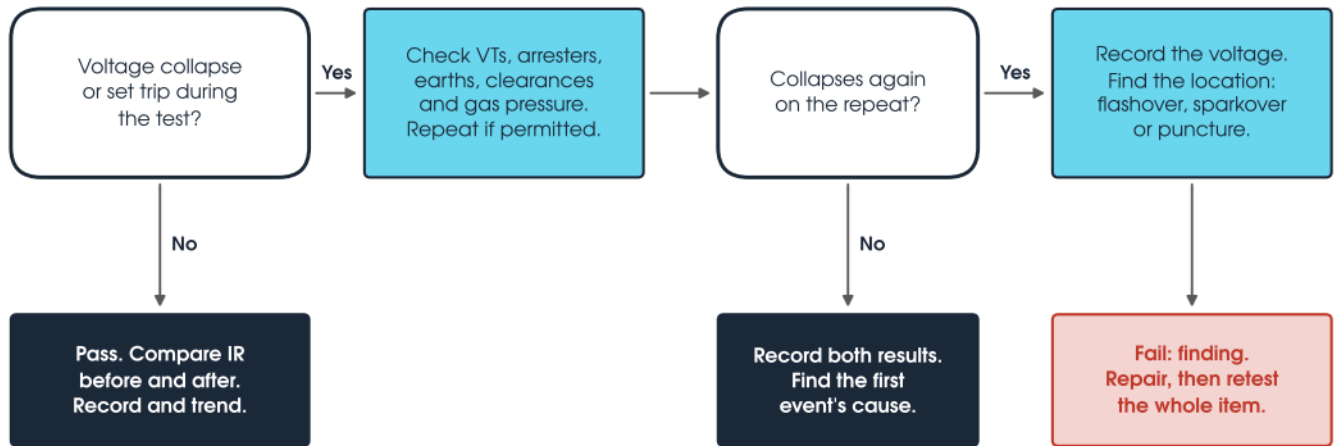
Rising leakage or discharge activity. On DC, an abrupt current increase means stop (USBR FIST 3-1).

Hissing, No Collapse

A non-disruptive discharge such as corona (AS/NZS IEC 60060.1:2026, 3.1.6). Measure PD to find it.

Is My Result OK?

Decision Path



Working Out the Test Voltage

For metal-enclosed switchgear on site (AS/NZS 62271.200:2026, 8.104 a)):

$$U_{\text{site}} = 0.8 \times U_d$$

Worked Example

A 24 kV switchboard has $U_d = 50$ kV (AS 62271.1:2019, Table 1). $U_{\text{site}} = 0.8 \times 50 = 40$ kV for 60 s, each phase in turn.

Sizing the Source

Test power = $2\pi fCU^2$. A 10 nF item at 40 kV and 50 Hz needs about 5 kVA; a resonant set supplies only the losses (as summarised by Phenix Technologies).

Good to Know

Repeating after a discharge is allowed only where the standard permits it, mainly for self-restoring insulation.

What to Report

The Level and Its Source

Test voltage, the standard, clause and percentage used, the waveform, frequency and duration.

For Each Phase

Pass or fail, current at test voltage, and IR before and after.

Conditions

Gas pressure, temperature and humidity; where atmospheric correction is applied, the actual conditions and factors (AS/NZS IEC 60060.1:2026, 4.3.3.1).

Traceability

Test set and divider serial numbers, calibration dates and the on-site performance check (IEC 60060-3:2006, 4.4).

Which Voltage Source Should I Use?

AC, Resonant or DC

AC Test Set

Simple, at power frequency. Best for low-capacitance items: switchgear panels, insulators, short bus sections.

Resonant Set

For high capacitance: GIS, long busbars, large bushings. Input is typically 1/10th to 1/40th of the test kVA; typical Q is 40 for SF6 switchgear (as summarised by Phenix Technologies).

DC

A small set, but DC stresses insulation differently from AC. Megger notes DC at the equivalent peak where capacitance makes AC impractical; use it only where the equipment standard or manufacturer allows.

Adding Partial Discharge

A Pass Is Not a Clean Bill

A withstand shows the insulation held, not that it is free of defects. PD measured with the test finds particles, protrusions and voids in GIS (as summarised by OMICRON).

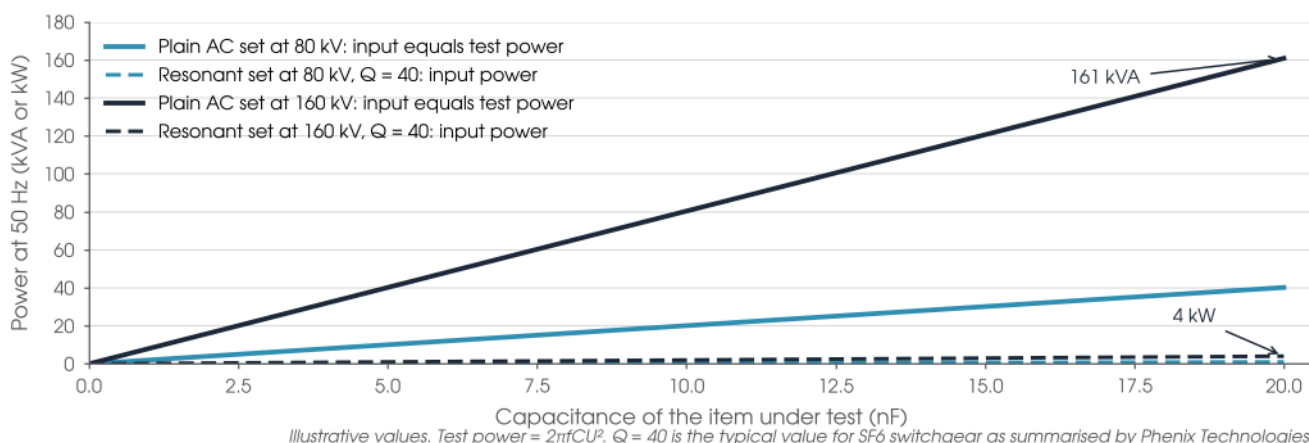
Switchgear PD on Site

Optional. Pick and record the Annex B.3 connection (phase-to-earth or phase-to-phase), pre-stress for at least 10 s, reduce to the measuring voltage and measure after 10 s. Agree acceptance values (AS/NZS 62271.200:2026, Annex B).

Good to Know

Cable withstand testing uses VLF or resonant AC and is covered in its own guide in this series.

Why Resonant Sets Exist



Recommended Solutions

Test set	Output	Best used for
Phenix 6CP50	50 kV AC	Withstand tests on MV switchgear, insulators and bushings; portable
Phenix BK130	130 kV AC	Higher test levels on switchgear, insulators and bushings
SUTE 300 kV resonant	300 kV, 25 to 300 Hz	Capacitive loads such as GIS; reactors in series or parallel
Phenix 500 kV resonant	500 kV, 45 to 300 Hz	Transmission GIS, large bushings and high test levels
PFISTERER CONNEX Size 2	Um 42 kV; 95 kV AC, 5 min	Touch-proof test connection into CONNEX sockets on switchgear

Every set is supplied with current calibration certificates, safety barriers and earthing leads, with Australia-wide delivery: [HV test equipment hire](#).

Frequently Asked Questions

Common Questions

What is the hipot test used for?

To prove insulation withstands a defined overvoltage: at the factory, on site before energisation, and after repair.

What is a dielectric withstand test?

Another name for a hipot test. The withstand voltage is the specified value that characterises the insulation (AS/NZS IEC 60060.1:2026, 3.2.2).

What is the difference between a hipot test and an insulation resistance test?

IR measures resistance at a modest DC voltage and trends condition; a hipot applies an overvoltage and is pass or fail. IR is run before and after.

What causes a hipot test to fail?

A disruptive discharge: damaged, contaminated or wet insulation, particles in GIS, or a set-up error such as a VT left connected.

Standards and References

AS/NZS IEC 60060.1:2026, High-voltage test techniques, Part 1.

IEC 60060-3:2006, On-site testing (AS 60060.3-2008 adoption withdrawn).

AS 60071.1:2024 and AS 60071.2:2024, Insulation co-ordination.

AS 62271.1:2019, AS/NZS 62271.100:2026, AS/NZS 62271.200:2026 and AS/NZS 62271.4:2026, HV switchgear.

AS/NZS 60137:2020, Bushings. AS 61869.1:2024, Instrument transformers.

AS/NZS 60076.3:2017 Amd 1:2020, Transformer dielectric tests. AS 2067:2016.

Phenix Technologies, Specification of HV Test Systems, 2013. Megger, Diagnostic Insulation Testing Above 1 kV, 2021. OMICRON, Diagnostic Testing of HV and MV Switchgear, 2026. USBR, FIST 3-1.

Safe Work Australia, model Code of Practice: Managing Electrical Risks in the Workplace.

More Questions

What test voltage should I use on site?

The equipment standard's level: for switchgear to 52 kV assembled on site, 80% of the routine value (AS/NZS 62271.200:2026, 8.104 a)), agreed with the asset owner.

How long does the test take?

The hold is 60 s unless otherwise specified (AS/NZS IEC 60060.1:2026, clause 6), per phase, plus set-up and IR checks.

Can a hipot test damage the insulation?

It can advance existing deterioration; USBR advises against the full test voltage on equipment that has been in service. Hence reduced site levels.

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