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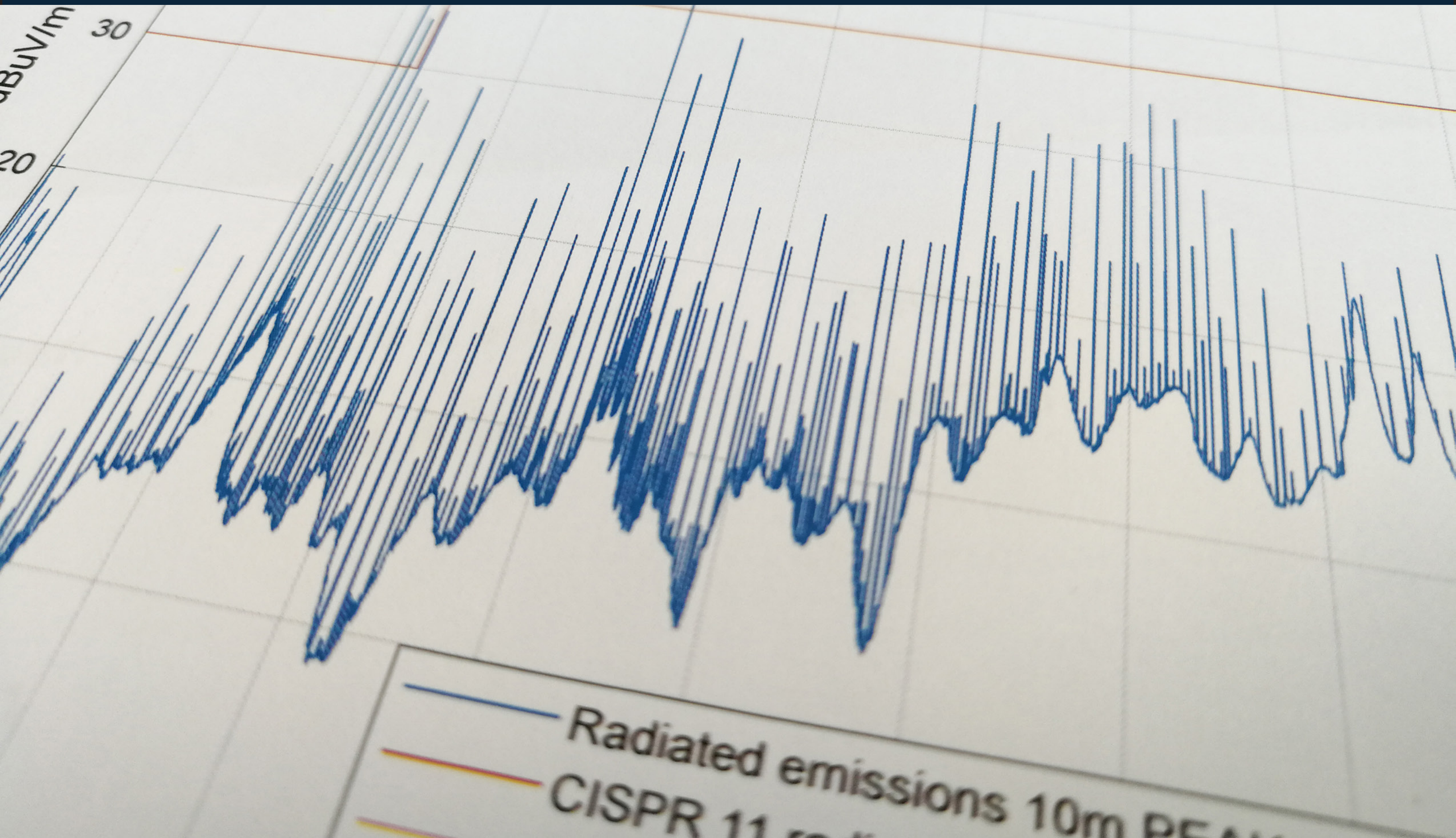
White Paper

The Importance of EMC Testing for Industrial Machinery



The ultimate goal of engineers overseeing electromagnetic emissions in manufacturing, energy, telecom, aerospace and other heavy industrial operations is to ensure equipment function remains stable.

What is electromagnetic compatibility?

Per International Electrochemical Commission (IEC) criteria, a device that produces electromagnetic emissions can only be formally classified as having achieved EMC if it functions effectively alongside other electromagnetic devices without disrupting their operation.

If an electromagnetic emission does interrupt other systems, it becomes Electromagnetic Interference (EMI). If it detrimentally affects inert matter or harms any living thing, the interference constitutes an electromagnetic disturbance.

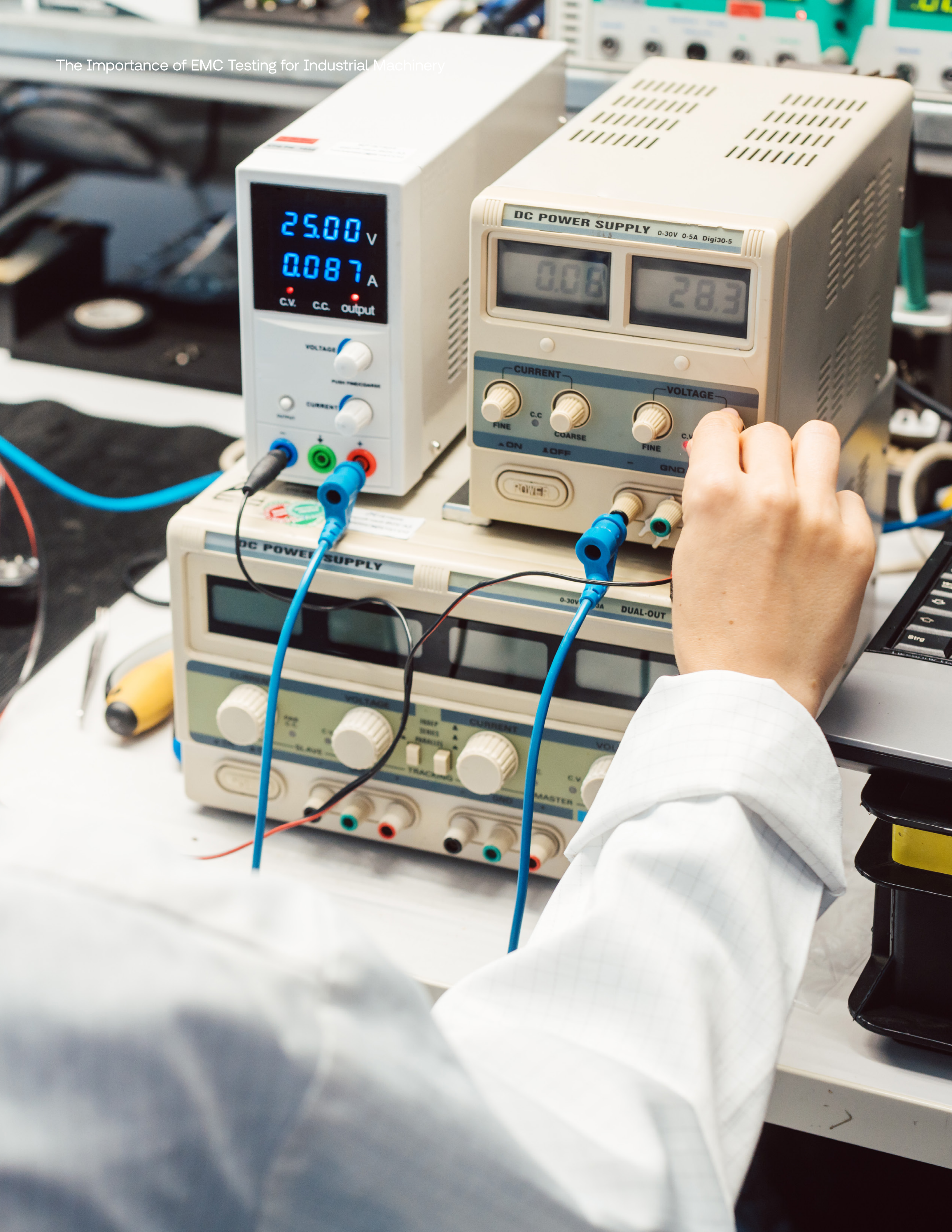
Furthermore, if unwanted electromagnetic emissions contain any elements within the radio-frequency (RF) spectrum (lower than 3,000 GHz), they're also classifiable as RF interferences or disturbances.

Common interference sources in industrial settings

Effectively, any machine that emits or receives electromagnetic emissions and radio waves (or both) is capable of causing problematic interference. That said, there are several particularly common sources:

- Switching power supplies
- Programmable logic controllers (PLCs)
- Variable speed drives (VSDs) for motor-driven equipment
- RF transceivers or transmitters
- Devices operating on the industrial, scientific and medical (ISM) radio band, such as ultrasonic equipment, electrodeless lamps, welding machinery and other industrial heating tools

All of those sources can also be victimized by EMI. Interference usually enters through devices' enclosure, power, signal or I/O ports, and although active circuitry is usually localized, interface cables often act as unintentional interference amplifiers.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COARSE
FINE
C.C
ON
OFF
GND
POWER
DC POWER SUPPLY
DUAL-OUT
CURRENT
MASTER
TRACKING

Major EMC Hazards

Certain EMI incidents cause little more than brief irritation for workers and engineers. But if these occur with any regularity, the downtime adds up. Even more seriously, it forebodes future disturbances that could endanger employees or equipment.

These are the most notable EMC disruptions to consider:

Electrostatic discharges

Most electrostatic discharges (ESDs) come from the enclosure port at high frequencies and amplitudes. These events pose a severe failure risk to any susceptible circuitry in the vicinity, particularly logic circuitry. More alarmingly, discharge sparks can cause an electric shock to human workers and potentially trigger explosions in industrial settings where gas is present. Bonding circuit connections and insulating (or isolating) them are common strategies for mitigating ESD risks, along with grounding and instituting safety procedures for employees to follow.

Electrical bursts

A burst is similar to a discharge in that it’s high-frequency, high-amplitude and disruptive to logic circuits or other susceptible surgery. However, bursts typically affect interfacing rather than enclosure ports. In theory, transient voltage suppression (TVS) devices should mitigate bursts, but their frequency is much higher than the surges TVS are designed for.

Power surges

Often the result of lightning strikes, surges are perhaps the least predictable EMI event. A surge transient manifests as a high-amplitude transient received by a main AC or DC port, or possibly a signal I/O port interfacing with a cable directly connected to outside power lines.

Sudden surges can catastrophically damage unprotected or underprotected circuits and even cause machine failure, facility outages and data loss. In addition to TVS devices that help keep surges isolated, backup systems (either physical or cloud) must be in place to safeguard data.

Electromagnetic field modulation

Based on the principle of reciprocity, if a machine tends to radiate or conduct unintentional internal RF along its interface conductors, it will be equally receptive to unwanted external RF (and resultant disturbances). This is known as electromagnetic susceptibility (as opposed to immunity, which is the EMC ideal engineers strive for).

While this is among the less dangerous and most common forms of EMI, it can still disrupt data processing or routing and interrupt logic circuitry, causing frustrating downtime. Audio signals are also likely to break up. Devices with high susceptibility should, as much as possible, be isolated from power supply lines, machines that generate RF on the ISM band or any other devices prone to RF or electromagnetic noise. Filtration can also help reduce noise levels.

Basic EMC Standards

Regulations dictate how organizations should go about ensuring their machinery helps preserve EMC, but these can vary between jurisdictions:

- In the U.S., the goal of testing is to receive Federal Communications Commission (FCC) certification per the tenets of 47 CFR Part 15 Subpart B. American National Standards Institute (ANSI) C63.4 is also considered but lacks the FCC-enforced rule's legal weight.
- Organizations located in EU member states must adhere to two rules in the EN/IEC 61000 EMC regulation family: 61000 6-2 stipulates what constitutes electromagnetic immunity in heavy industrial environments, while 61000 6-4 pertains to electromagnetic emissions in such settings. The IEC also established the International Special Committee on Radio Interference (CISPR) standards8 to specifically address RF disturbances
- Numerous other jurisdictions follow versions of the IEC 61000 and CISPR standards, including (but certainly not limited to) South Korea, Australia, New Zealand, Japan, the U.K. and Canada. However, countries may have specific requirements in addition to the harmonized IEC guidelines, so it's critical to be aware of any such variances when exploring new markets.

Why testing matters

EMC testing is mandatory in most countries and regions. While you're only legally required to meet whatever standards apply in your jurisdiction, this bare-minimum approach may not be enough to significantly mitigate EMI risks.

Failure to take EMI seriously enough to incorporate it into risk management strategies and address it through voluntary EMC testing can be disastrous. Equipment or facility failure, product recalls, financial losses, regulatory fines and penalties and mandatory government-conducted assessments are just a few possible consequences.

The right approach to EMC testing

EMC testing must take place in an authorized setting: ideally, a laboratory compliant with ISO/IEC 17025:2015 standards or recognized by a relevant national regulator, e.g., Nationally Recognized Testing Laboratories (NTRLs) designated by the U.S. Occupational Standards and Health Administration (OSHA).

If a lab setting isn't possible, authorized testing personnel can conduct tests *in situ* - with the machine installed as desired by its end user - or at the device manufacturer's facility before the product goes to market.

An EMC investigation may involve one, two, several or all of the following assessments:

Unintentional radiated and conducted emissions

To assess radiated emissions, an engineer uses an antenna and other supporting equipment (e.g., a conductive ground plane made of an electromagnetically absorbent metal) to examine a typical frequency range from 30 MHz to 6 GHz. (This is subject to change based on the highest RF initially measured.) For conducted emissions, a set of line impedance stabilization networks (LISNs) and grounding plane is used, or alternatively, a voltage probe.

ESD test

This assessment simulates the results of an ESD on the EUT devices - assuming a normal work environment - to determine how much damage such a transient event would cause and how much must be done to increase device immunity. If the EUT surface isn't electrically conductive, the test simulates a discharge that directly contacts the surface, while an air-discharge simulation is used if surfaces are conductive.

Power frequency magnetic field testing

This test is critical for determining the magnetic-field influence of power lines in close proximity to the EUT. For lab testing of smaller devices, a coil surrounds the equipment to generate a uniform magnetic field. In on-site EMC investigations or those involving large equipment, testers use the coil to form a perimeter around the EUT and determine what level of electromagnetism will cause interference.

Radiated and conducted RF susceptibility

Testers create an electromagnetic field with an RF generator, RF power amplifier, transmitting antenna and various other instruments to measure the reaction of EUT to the suddenly radiated RF. They also examine how cables, internal circuitry, EMI shielding and enclosures are affected by the external frequency and determine "susceptibility thresholds" at which EUT stops functioning normally due to EMI.

For conducted susceptibility, testers check the EUT's power mains and any interfacing ports that support cables greater than three meters to gauge the conductivity levels at which interference occurs. Test personnel use a signal generator connected to a bulk current injection clamp (BCIC) alongside an RF amplifier with analysis tools and software to measure susceptibility thresholds.

Electrical fast transient and surge testing

As with the conducted RF assessment mentioned above, this test focuses on power mains and interfacing ports for large cables. Testers generate a fast transient and use a coupler-decoupler network (CDN) to ensure the simulation doesn't send an excessively strong signal back into the building's power network. A grounding plane further ensures stability in the testing environment.

Functionally, the lightning surge test is almost identical to its fast-transient counterpart, but the event being simulated is far more powerful and potentially recurrent. As such, it can be necessary to generate multiple strokes or burst pulses of current to accurately measure EUT susceptibility to lightning.

How TÜV SÜD can help

The best strategy for ensuring a commitment to maintaining EMC in your industrial environment is to let expert testing professionals from TÜV SÜD conduct the full spectrum of essential EMC tests. In addition to the procedures mentioned above, we can also test for antenna immunity, induced voltage immunity, power supply conditioning and much more.

TÜV SÜD labs in the U.S. are all OSHA-accredited NRTLs compliant with ISO/IEC 17025:2015. We can simulate EMI incidents in multiple settings (including 3- and 10-meter EMC chambers). But we recognize that in-lab testing isn't always feasible, and we also offer on-site and in situ testing.

In addition to EMC-specific testing, TÜV SÜD provides a wide range of electrical and industrial safety tests and is accredited to confer UL, CE, CSA, UKCA and other regional safety certifications.

Reach out to us to learn more.

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