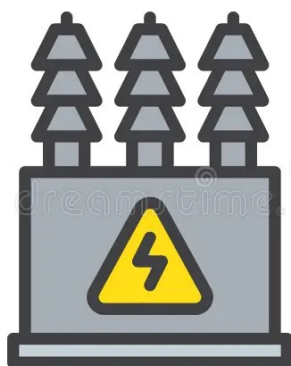




CIGRE UK March 2024 Technical Webinar – 20 March 2024



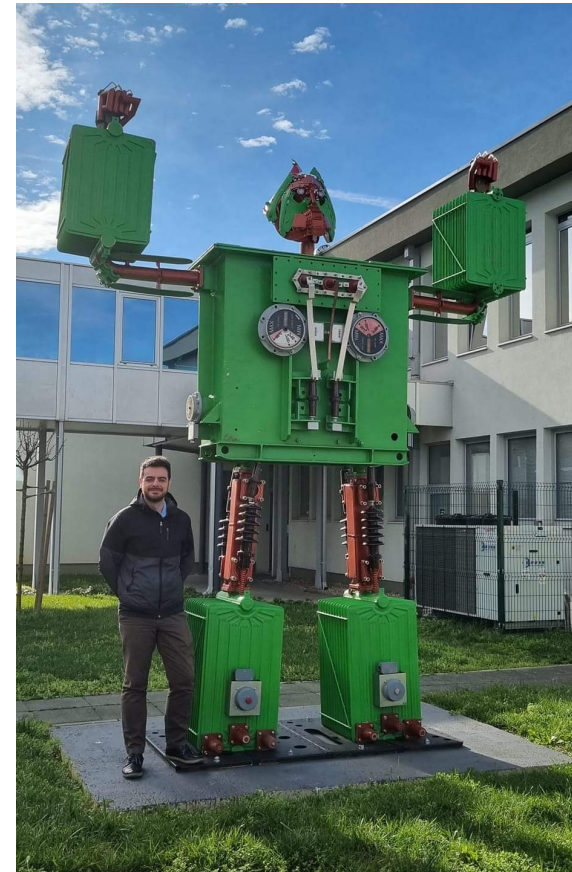
The importance of transformer specification and supplier selection in managing equipment, network and project delivery risks

Presenter: Jose Quintana

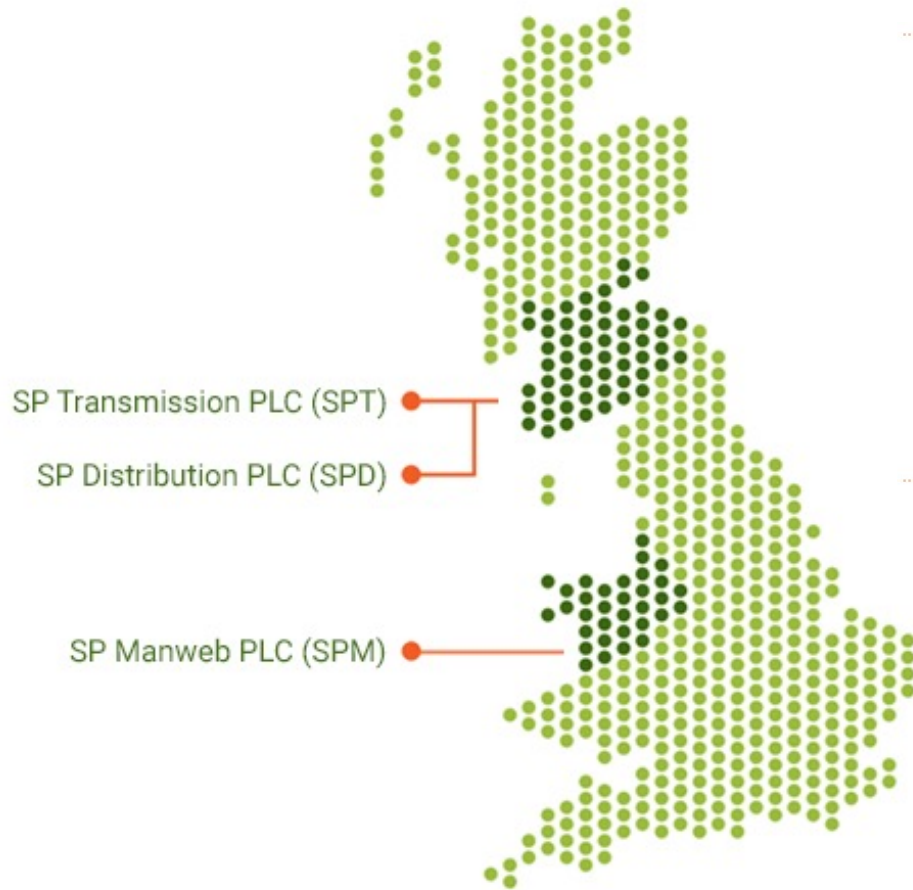
Jose obtained his degree in Industrial Engineering at the University of Zaragoza (Spain) in 2011 to then continue his studies with two MSc, first in Renewable energy and energy efficiency at the University of Zaragoza and second in Global Energy Management at Strathclyde Business School.

He joined SP Energy Networks in 2013 as a graduate engineer, joining the Substation Standards team on completion of his initial training. He is currently the Lead Transformer Engineer in SP Energy Networks with responsibilities over technical specifications, supplier qualifications, equipment assessment, quality assurance and technical support for distribution and power transformers and reactors.

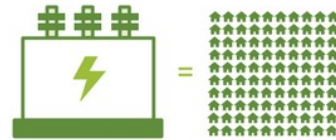
He currently holds the position of CIGRE A2 Technical panel secretary, is a member of WG A2.60, and also participates in several IEC 60076 series maintenance groups.



Sculpture: RoboTier-2; Artist: Danilo Baletić



Our distribution network has
30,000
substations;



Supplying
3.52m customers

40,000km
of overhead lines

That's enough to wrap once
around the world.

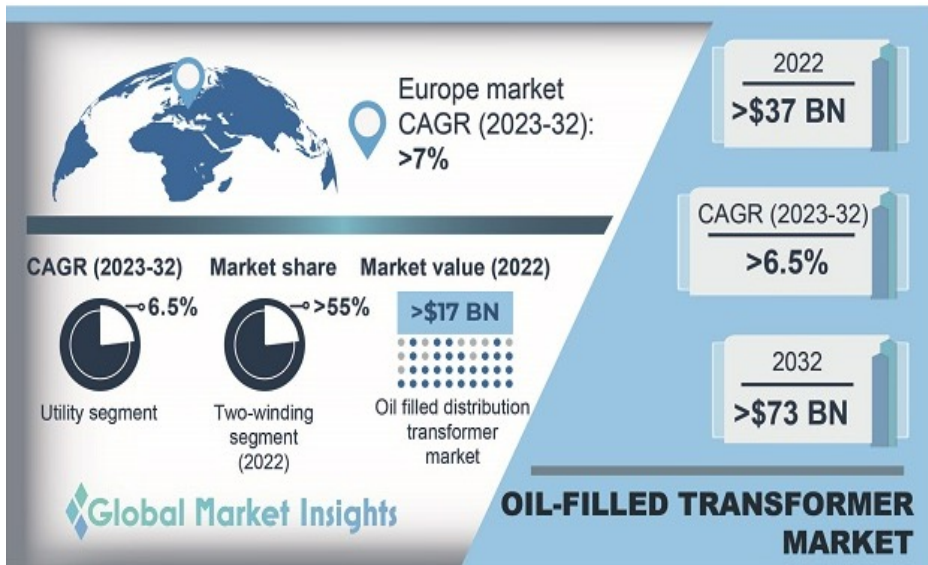


and
65,000km
of underground cables.

All to keep your electricity flowing.



Background and relevance



Source: GMI. Oil-filled transformer market report, Dec 2022



Source: GMI. Europe transformer market report, Sep 2023



Background and relevance

Transformers are **not catalogue items** / off the shelf products!

Transformers are made to order and are **bespoke** to customer requirements.

Detailed design phase starts after placement of order. Tender proposals are generally indicative.

A degree of national standardisation may exist in certain types of transformers (i.e. small distribution).

Lead times are reflective of the nature of the equipment, and presently further compounded by increased demand and challenges in the supply chain worldwide.



The rated power for each winding shall either be specified by the purchaser or the purchaser shall provide sufficient information to the manufacturer to determine the rated power at the enquiry stage.

Any specific requirements for loading beyond rated power, operation at higher external cooling medium temperatures or reduced temperature rise limits shall be specified by the purchaser in the enquiry and the contract. Any additional tests or calculations to verify compliance with these specific requirements shall also be specified by the purchaser or the manufacturer to determine the normal required to

shall comply with IEC

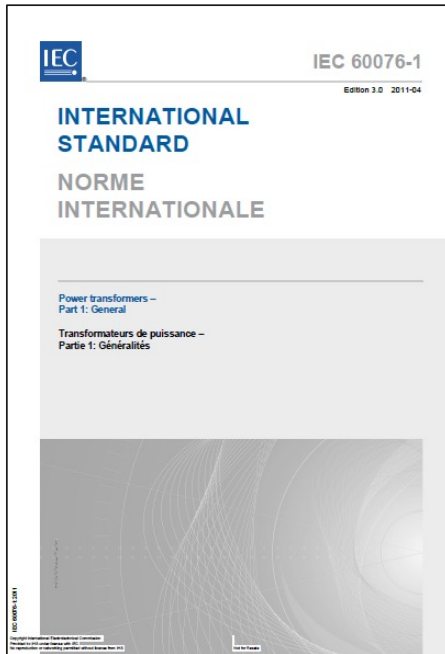
Unless otherwise specified by the purchaser, the voltage shall either be specified by the purchaser or the purchaser shall provide sufficient information to the manufacturer to determine the lowest applicable value corresponding to the voltage.

The purchaser shall identify in his enquiry any service conditions not covered by the normal service conditions. Examples of such conditions are:

If a transformer may be subject to DC currents, then the levels of these currents shall be stated by the purchaser in the enquiry together with any required limits on the consequences of these current levels. See also 4.11 of IEC 60076-8:1997.

The purchaser shall specify the requirements for tapping either according to 6.4.2 or 6.4.3. This should preferably be the guaranteed maximum sound level, expressed as a sound level.

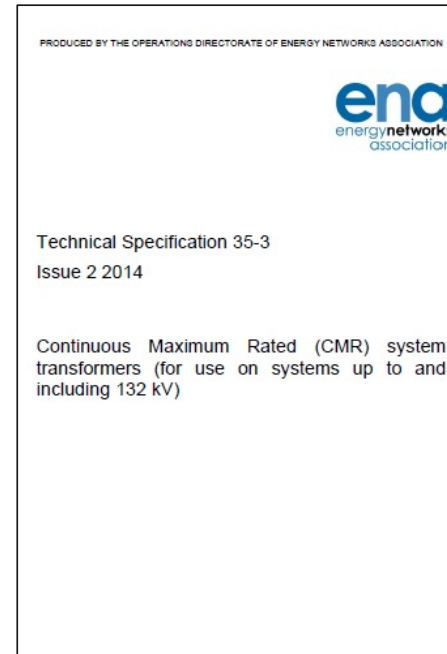
Transformer specifications



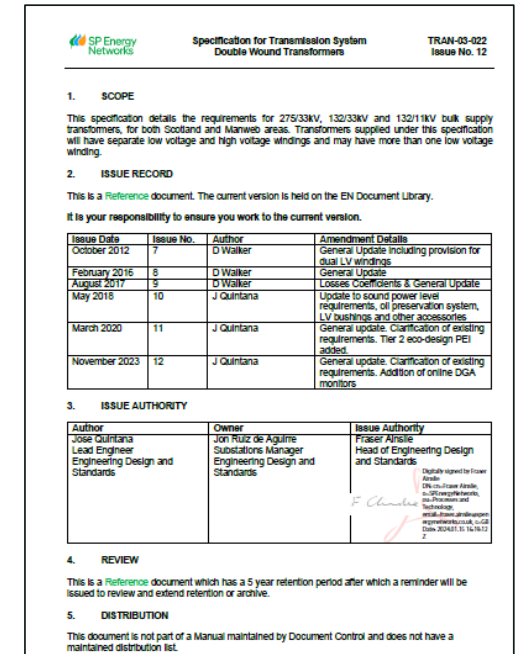
International Standards



Local / National Standards



National Specifications



Customer Specifications

System related parameters

- Rated voltage, frequency, rated power, vector group, short-circuit impedance, system short-circuit power, insulation levels, waveform quality, earthing arrangements...

Service conditions and environment

- Ambient temperature, altitude, corrosivity and pollution class, indoor/outdoor, seismic conditions, load duty cycle, overload requirements...

Contractual performance

- Legislative losses or efficiency, sound power levels, winding and oil temperature rises, tolerances, testing requirements...

Components, accessories and P&C

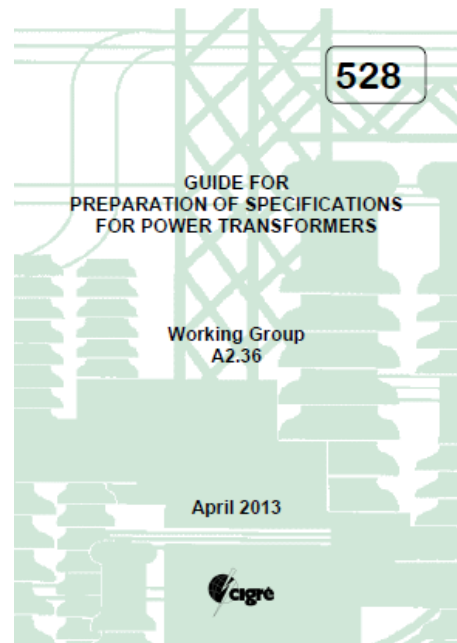
- Electrical protection, mechanical protection, operational interfaces, insulating liquids, detailed specification for critical components (tap changers, bushings, protection devices...), condition monitoring...

Site specific constrains

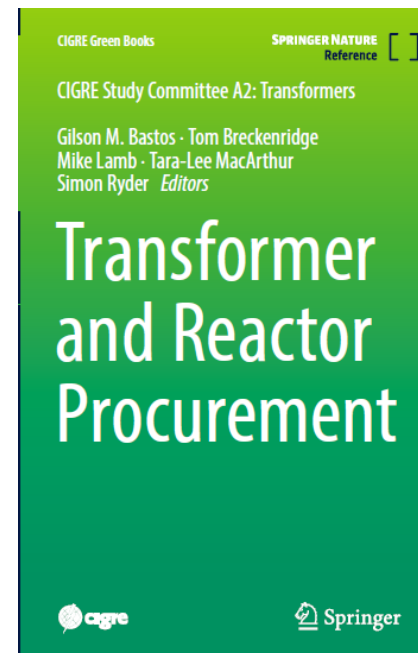
- Maximum as-built dimensions, maximum transport weights / dimensions, general layout considerations, type of terminals, fire risk mitigations, environmental considerations...

Commercial evaluation mechanisms

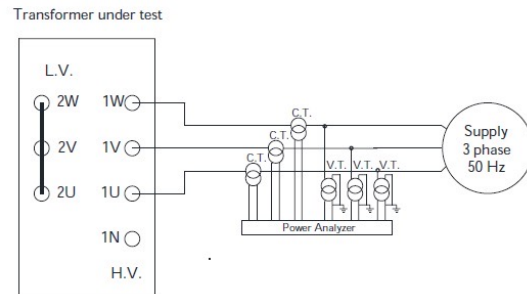
- Losses capitalisation, maintenance cost evaluation, footprint evaluation, lifecycle assessment...



CIGRE TB 528

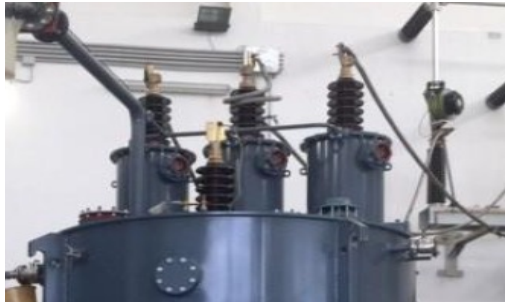


GREEN BOOK SC A2



- Requirement for a 275/33kV 120MVA transformer. Standard impedance specified.
- At design review meeting, it was identified the transformer this unit was replacing had a **non-standard impedance**.
- System studies conducted and confirmed non-standard impedance required and order needed amended
- The manufacturer carried out preliminary design and discovered the new requirements were **beyond their capabilities** (max. weight)
- Contract already in place. Cancellation or re-purpose?
- New tender exercise for non-standard impedance transformer
- What if... this was not identified at design stage?
- Standard **sound power levels** defined in the customer specification. Reflective of state-of-the-art and optimum technical/commercial requirement. Suitable for majority of sites.
- Re-confirmed suitable at each location by site specific noise study before tendering.
- Particular project where noise study was not completed at early stage.
- Transformer installed and energised and complaints received by adjacent receptors. **External mitigation** required
- What if... the transformer was not able to accommodate external mitigation?

Transformer specifications



- Requirement for a number of 33kV 60MVAR oil-immersed reactors. Neutral star point unearthed in service arrangement.
- As no specific requirement to bring individual phase neutral ends out, the manufacturer **deemed this not required** and a single temporary neutral bushing was designed.
- However, this arrangement did not allow for loss measurement to be carried out in full accord with the available test set-up at the manufacturer.
- An **alternative test method**, as reasonable as possible, needed to be agreed.
- What if... measurement of losses could not be carried out accurately with the consequent impact on the rise test?



- Standard corrosion protection requirements for all transformer in the network, i.e. C4 class.
- More onerous requirements possible for particular locations where deemed required.
- This may be difficult to manage for large volume items (i.e. distribution transformers) or where relocation of transformers may be possible (i.e. project delays, faults...).
- Standardisation to more onerous requirement may be advisable, subject to cost-benefit analysis.
- **Wrongly specified environment** may lead to early deterioration and reduced life expectancy.
- No what if... in this case, as unfortunately happened with a number of transformers in coastal locations needing early replacement due to severe corrosion.

“The manufacturer shall be ISO 9001 accredited”

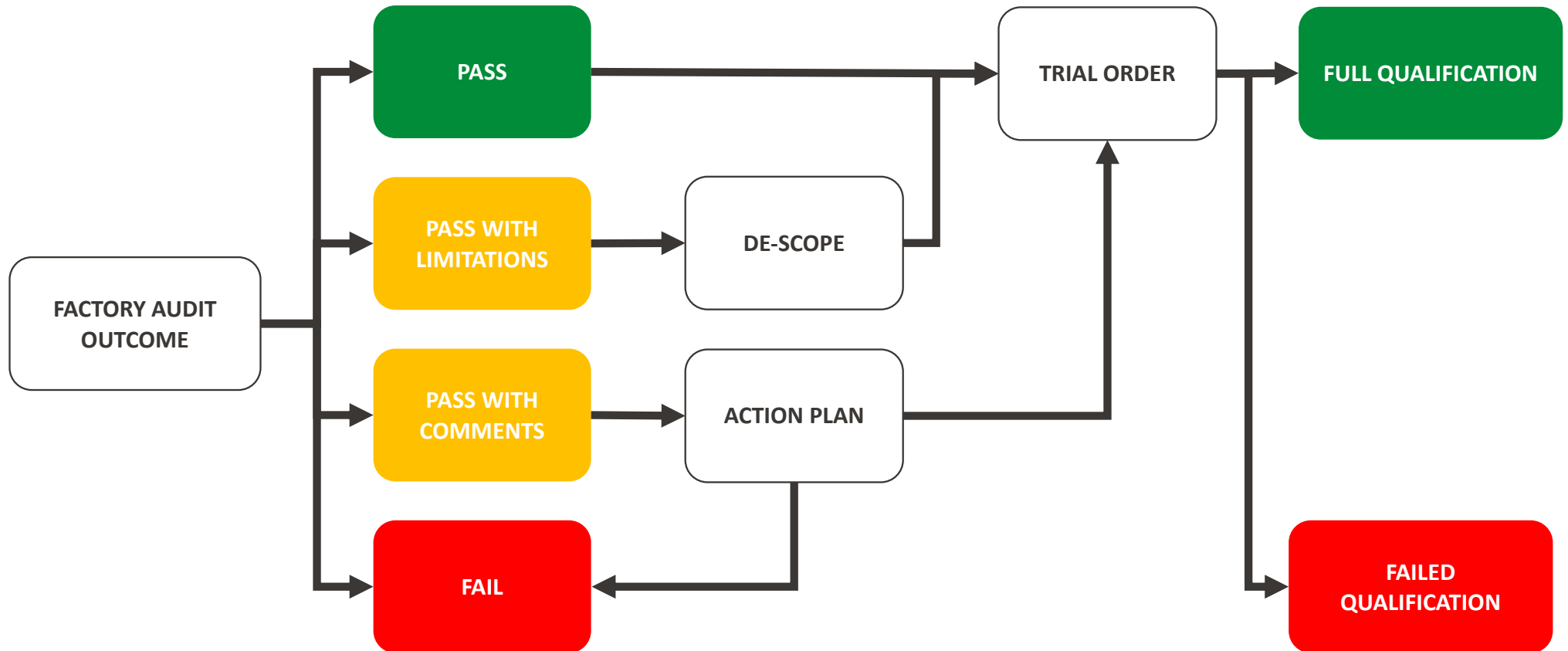
1 Scope

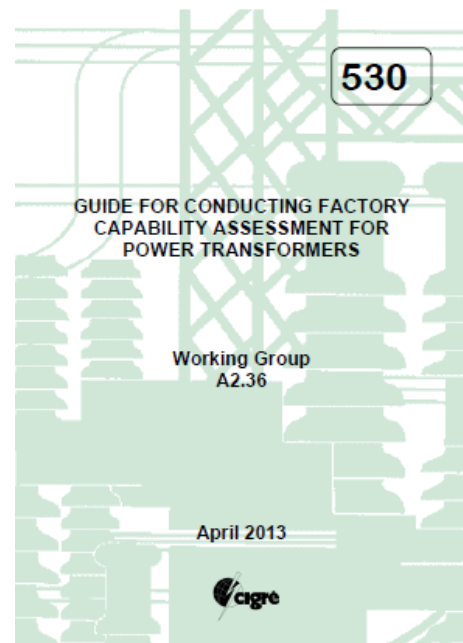
This International Standard specifies requirements for a quality management system when an organization:

- a) needs to demonstrate its ability to consistently provide products and services that meet customer and applicable statutory and regulatory requirements, and
- b) aims to enhance customer satisfaction through the effective application of the system, including processes for improvement of the system and the assurance of conformity to customer and applicable statutory and regulatory requirements.

All the requirements of this International Standard are generic and are intended to be applicable to any organization, regardless of its type or size, or the products and services it provides.

Quality management	<ul style="list-style-type: none">• Accreditations, responsibilities, resources, incoming goods, non-conformance reporting system, supply chain management, review of sub-supplier base, quality control during manufacturing, customer involvement and hold-points, KPIs...
Design	<ul style="list-style-type: none">• Resources and experience, design concept, technology partners, design methods and modelling capabilities, validation of design tools, approval of documentation, mechanical and electrical interface, involvement in R&D...
Manufacturing	<ul style="list-style-type: none">• Per manufacturing area: resources and experience, competence matrix, general H&S, tools and machinery, environment, working instructions, industry best-practices, lesson learnt communication, calibration of manufacturing equipment, maintenance plans...
Testing	<ul style="list-style-type: none">• Resources and experience, competence matrix, general H&S, test equipment, testing procedures, lesson learnt communication, calibration of testing equipment, approval of results, failure investigation process...
Contract management	<ul style="list-style-type: none">• Customer interface, anticipated methods of working, languages, timescales for contractual documentation, overall T&C acceptance, price escalation mechanisms...
Transport, installation and after-sales	<ul style="list-style-type: none">• Methods and partners, preferred routes, storage capabilities, installation and pre-commissioning procedures, approval of results, warranty and response times...
Alignment with customer CSR	<ul style="list-style-type: none">• Environmental management, H&S management, recruiting process, trade unions, equality policies, modern slavery policies, general welfare of employees...





CIGRE TB 530



GREEN BOOK SC A2



- New qualification of a manufacturer for 275kV voltage class transformers.
- Factory audit and capability assessment in line with CIGRE TB 530 with no major areas of concern until review of **testing capabilities**.
- Although the required types of transformer could be manufactured, the test laboratory did not have sufficient **reactive compensation** to perform load loss and temperature rise test in full accordance with IEC standard.
- References for this voltage class of transformers available, but to different impedance requirements
- What if... order was placed, transformers manufactured and only at testing stage realised it was not possible to conduct all type tests?



- New qualification of a manufacturer for 33kV voltage class transformers.
- During visit to works, it was identified that finished nested windings needed to be transported outdoors between winding and assembly shops. **Risk of contamination** (solid or moisture).
- Plans to cover the corridor between areas approved, but construction not completed in advance of potential new orders, if audit successful.
- **Action plan** developed for interim mitigation by use of transport enclosures for the nested windings.
- What if... no mitigation was implemented, winding contaminated and transformer failed dielectric tests?

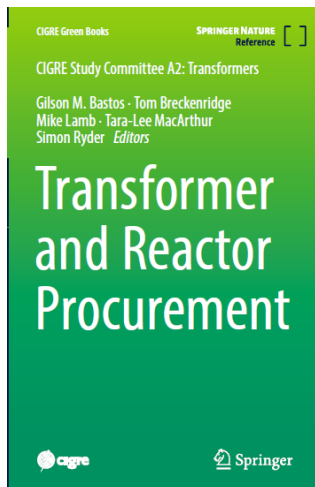
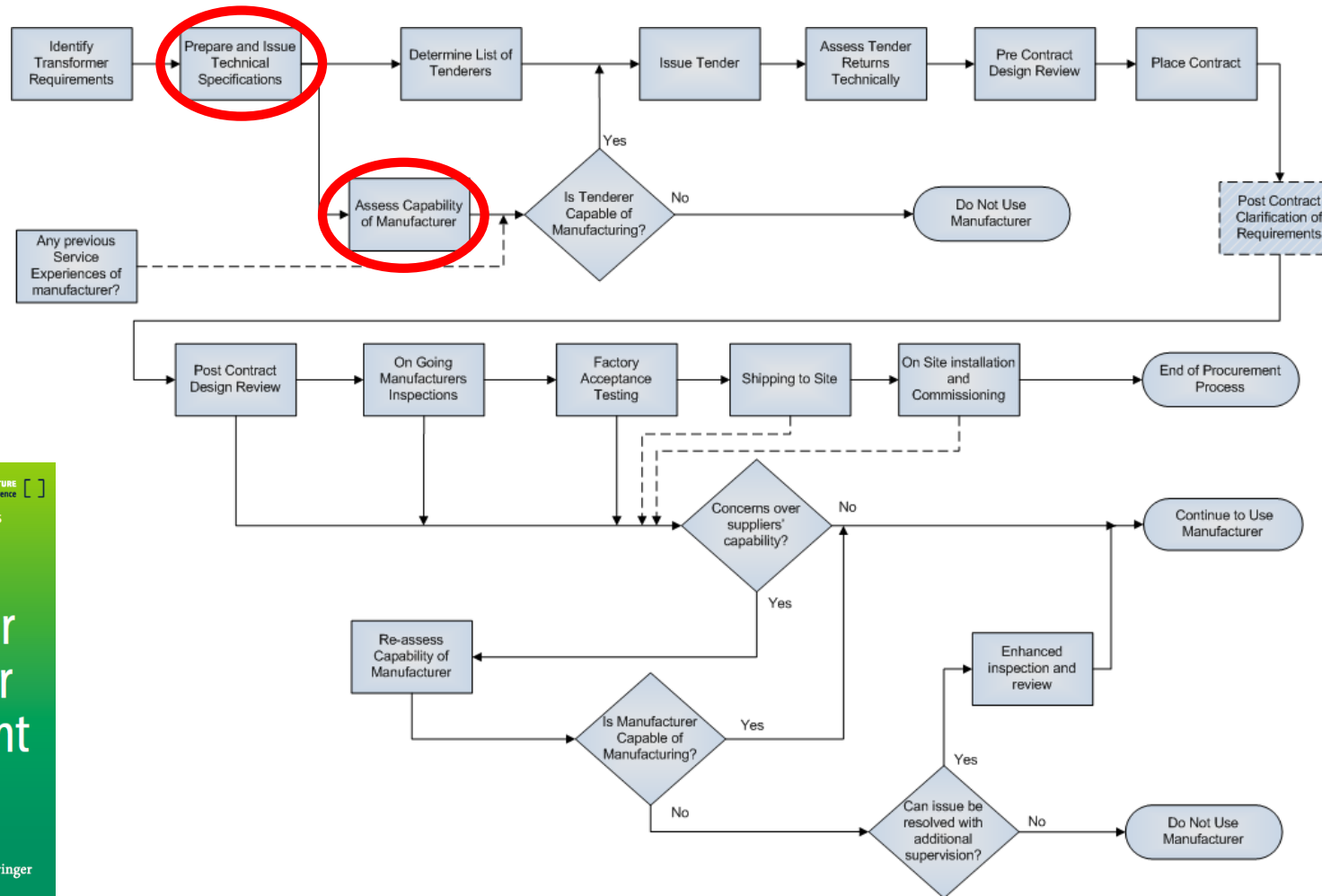


- New qualification of a manufacturer for 132kV voltage class transformers. Independent manufacturer, not part of larger group.
- During review of **design methodologies**, it was identified that no transformer design was previously subject to short-circuit withstand test.
- This implied their design tools and manufacturing practices had **never been validated** against this performance requirement.
- Further reassurances required and short-circuit testing of any potential order may be considered, with associated cost implications
- What if... transformer failed in service due to fault-through current due to inadequate clamping system?



- New qualification of a manufacturer for 11kV voltage class distribution transformers. Independent manufacturer focus on local market.
- **No factory audit** and capability assessment carried out as distribution transformers considered of low technical complexity.
- UK style ground-mounted distribution transformers are of a **different construction and layout** to mainland Europe (i.e. close-coupled arrangement, free breathing...)
- Lack of understanding of requirements and their implications into the design (i.e. misalignment, oil leaks...)
- No what if... in this case, as unfortunately happened due to lack of prior capability assessment

Transformer procurement process



Thanks for your attention!