

THE ENGINEERING EQUIPMENT AND MATERIALS USERS' ASSOCIATION

A guide to risk-based procurement

Quality assurance of safety-critical engineering equipment and materials

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ENGINEERING EQUIPMENT AND MATERIALS USERS' ASSOCIATION

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- Promoting and presenting members' views, and encouraging the application of good sound engineering practices
- Developing user guides, specifications, training and competency schemes
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Executive Summary

Industrial users and procurers of engineering equipment have been reporting a significant increase in the number of cases in which equipment, components, fabricated items or materials have been found to be not fit for purpose. Problems that have been encountered include:

- the supply of counterfeit items or components;
- the supply of incorrect, defective or otherwise sub-standard items or components;
- the supply of incorrect or defective supporting documentation.

To address the problem the Engineering Equipment and Materials Users' Association (EEMUA) has consulted widely both within and externally to its membership and has also consulted with Inspection Bodies. A series of meetings with the Pressure Systems Group (PSG) of the Institution of Mechanical Engineers was also initiated to discuss the scale of the problem, particularly as it related to pressure equipment, identify any common issues and possible ways forward.

This EEMUA Publication, which builds on the above work, includes:

- a discussion of the root causes;
- suggested measures to assess risks;
- procurement recommendations and guidance;
- examples of some problems experienced.

Well-designed procurement processes underpin the mitigation of risks. Consequently measures to assess the potential risks, improve procurement processes throughout the supply chain and to enforce quality management are considered.

This Publication provides guidelines to minimise the risks and proposes ways in which early detection of problems may be made. It complements EEMUA Publication 218⁽¹⁾ which is specific to duplex stainless steel. Other EEMUA publications, such as EEMUA Publication 191 on 'Alarm Systems – A Guide to Design, Management and Procurement' also offer guidance on procurement of specialist engineering equipment and materials. A full list of EEMUA publications is given at the end of this Publication.

Improvements to processes are addressed in the context of a partnership between the purchasers of engineering equipment and materials, suppliers/vendors and the intermediaries associated with sourcing items of equipment, components, materials and fabrications from both new and established markets around the world.

1. Introduction

Industrial users and procurers of engineering equipment used on projects globally have reported a significant rise in the number of cases where whole items of equipment, components, materials for pressure equipment and fabricated items supplied from the newer, non-traditional markets around the world were either found to be incorrect, defective or the associated documentation appeared fraudulent. It is apparent, however, that the problem is not limited to these newer markets but is also not uncommon in the traditional western market. In the absence of industry wide data, the scale of the problem in global terms is of course uncertain. However, there have been a series of spectacular failures due to the use of counterfeit items of equipment and components or the use of so-called rogue materials in a wide range of industries including aviation, power, oil, and chemicals.

EEMUA Members have met on several occasions to discuss the issues and what might be done to address them. One action identified was to raise awareness. As part of this process, meetings were organised with other bodies; for example, the Pressure Systems Group (PSG) of the Institution of Mechanical Engineers (IMechE). Such meetings helped in determining the scale of the problem, identifying common issues, and more importantly, identifying approaches, processes and procedures that would reduce the risks of occurrence. These first steps were followed by a more wide ranging consultation process, involving not only the EEMUA membership but other users and purchasers of equipment worldwide.

Exchanges of experience in this process identified a wide variety of problems with the quality and documentation for equipment and materials purchased from markets that had not historically supplied European industry. It was apparent that from about 2003 the volume of material purchased from such markets had risen progressively. In the same period, the rate at which materials were found to be defective, or were not what had been specified, had increased markedly and was continuing to do so. Companies' shared experience recognised, however, that the phenomenon was not limited to the newer markets and, whilst the problem was perhaps not as pronounced nor, perhaps, a growing one, it was certainly not unknown in their traditional and established markets.

1.1 Scope

This EEMUA Publication provides a set of reasonable and practical guidelines for users, procurers and inspection bodies. The guidelines advise parties of the areas where problems can be expected when dealing with manufacturers, fabricators and vendors and what to look for. They also include measures that users and procurers can take to minimise the risk of buying counterfeit materials and equipment or receiving substandard documentation, including examples of useful checklists, procedures, and other processes.

1.2 Definitions

The terms below, when used in this publication, have the following meaning:

Contractor. An organisation responsible for providing all of the material, labour, equipment and services necessary for the construction of the project.

Counterfeit item. A counterfeit item is a suspect item that is a copy or substitute without legal right or authority to do so or one whose materials, performance, or characteristics are knowingly misrepresented by the vendor, supplier, distributor or manufacturer.

End-user. The organisation that uses the purchased items or materials on the plant for which they were purchased.

Rogue (Defective) Item. A rogue item or material is any item or material that does not meet the commercial standard or procurement requirements as defined by catalogues, proposals, procurement specifications, design specifications, testing requirements, or the like.

Stockist. An organisation that maintains stocks of items and materials purchased from vendors and then supplied to others for use or further fabrication.

Supplier. An organisation likely to be a stockist of various similar types of equipment, components, or materials purchased by others.

Surveillance level. An expression used to describe the level of inspection, testing, audit, etc. for a specific purchase order.

Vendor. An organisation that manufactures and sells individual (or multiple) item(s) of equipment, components, or material purchased by others.

1.3 Acronyms

ASTM	American Society for Testing and Materials
ALARP	As low as reasonably practicable
CR	Criticality rating
ESD	Emergency shut down
EU	European Union
HV	High voltage
ITP	Inspection and Test Plan
LV	Low voltage
Mcb	Miniature circuit breakers
MM	Miscellaneous materials
MOV	Motor operated valve
MV	Medium voltage
NDT	Non-destructive testing
PAU	Pre-assembled unit
PCN	Personnel Certification of Non-destructive testing
PED	Pressure Equipment Directive
PMI	Positive material identification/post manufacturing inspection
PTFE	Polytetrafluoroethylene
QA	Quality Assurance
QC	Quality Control
SHE	Safety, Health, and Environment
SIL	Safety integrity level
SLA	Service level agreement

2. Avoiding the Purchase of Rogue Equipment and Materials

2.1 Background

Counterfeit or defective materials, often discovered late in the procurement chain, during installation or worse still, not until the commissioning stage of a project, have had a major impact on the companies affected. For both users and their contractors, replacement of such items will have meant costly delays whilst alternatives are sourced. In some cases, had the problem not been discovered there would have been failure in-service with serious SHE or production consequences.

2.2 Range of Equipment and Material Affected

It is clear that a wide range of types of equipment, components or materials can be affected. The problem is most common with mechanical equipment such as castings and forgings; sheet materials in pressure vessels and pipes; and fasteners. However, the problem also extends to electrical power equipment and instrumentation.

Whilst some of the above examples could have been deliberate, others have simply been the result of poor, defective or even fraudulent vendor QA processes and a wide range of these quality problems have been reported by EEMUA Members.

Defects or issues associated with the supply of different types of equipment have included:

- parent material of supplied equipment that did not meet chemical specification, heat treatment, tensile strength, ductility, or creep requirements;
- instances of a specified material being substituted by another inappropriate material;
- castings, forgings, and welded fabrications that contained unacceptable defects or repairs;
- instances of reputable items of equipment being copied wholesale and passed off as genuine, or supplied with substandard or even missing internal components.

Defects or issues associated with QA processes and documentation have included:

- incorrect QA documentation and certificates containing copied, fabricated or fraudulent information;
- QA documentation not corresponding to the materials supplied because of substitution of the original material later in the supply chain.

Examples of the above equipment and QA documentation issues appear in Appendix A and Appendix B of this Publication.

2.3 Root Causes

Unsurprisingly there are many possible separate and interacting reasons why counterfeit or otherwise substandard equipment and materials can be supplied to

a project. A complex relationship exists between users, contractors, their sub-contractors, vendors and inspection bodies on a project giving many opportunities for counterfeit equipment to turn up on a project.

In researching this Publication with EEMUA members and others, the following separate and possibly interacting contributors to the problem emerged.

2.3.1 The Global Market

The equipment and material supply network is now truly global and there is no doubt that over the last decade or so the number of vendors (or access to them) particularly in emerging markets has greatly increased.

In a global situation contractors sometimes have to deal with greatly extended supply chains with sub, sub-sub, and even more extensive sub supply situations supplying component parts to a whole item. In these cases, control over QA and QC is at best difficult and often impossible.

Long supply chains can mean a lack of accountability to the end user, particularly if the end user had no representation on site or was not involved in the original contract. In some countries, for example the UK, the liability and legal responsibility of vendors of faulty goods to the ultimate end users, even when no legal or direct commercial contract exists, is an important principle established in law.

Many of these non-traditional or newer vendors operate at a much lower cost base to that of their more well-established competitors and therefore their products are attractive to buy. Some of these vendors, however, do not have adequate QA systems or experienced personnel to ensure that equipment meets the requirements of their customers.

Customers and contractors operate in a tough commercial environment and there are always pressures to reduce costs. In some cases, organisations have reduced their specialist purchasing and technical resource replacing their skills by reliance on vendor QA processes. Furthermore, there is increasing focus on the moral/ethical issues of brand reputation and no management team would wish to be seen as having poor supply chain management processes. The Guidance given in this Publication will assist in alleviating all these concerns.

2.3.2 Problems from Users' Requirements and Processes

There are several sources of problems:

- The move by customers to include 'local content' requirements and 'nominated preferred vendors' clauses in contracts.
- Government policy in some countries often makes local content requirements mandatory.
- Unclear or ambiguous requirements and specifications provided by customers.
- Reliance on national standards for materials that have not been updated for many years to align with modern practice.

2.3.3 Problems from Contractors' Procedures, Processes and Practices

In recent years, contractors have moved from using in-house (often expensive) inspection departments to a reliance on vendor QA and QC. Given the previously mentioned extended supply chains this has given rise to many problems:

- The failure of contractors to convert customer requirements and standards into clear and unambiguous specifications and standards to which vendors can work.
- Gaps in specifications leading to the possibility of substitution of materials. While some companies are providing very detailed specifications over and above the standards, others take the view that such detail could confuse vendors.
- Procurers or users providing short or abbreviated specifications for which the implied meaning is not appreciated by the supplier. The failure of contractors to communicate specifications and standards to vendors in general or in some cases to translate them into the local language. This issue is particularly important where changes to the specifications are required by the contractor or substitutions of materials are suggested by the vendor.
- The failure of contractors to segregate the procurement aspects (contractual and commercial) of a supply contract from technical specification issues leading to lack of understanding of the requirements by the vendor.
- The requirement for vendors and contractors to have processes verifying the authenticity of equipment or materials is often overlooked at the contractual stage of a project.
- The consequences for the vendor or contractor should the problem arise are not sufficiently covered when drawing up contracts.
- The failure of contractors to understand, identify and differentiate between the risks of potential problems in the supply of any particular piece of equipment in a project and apply appropriate mitigation processes.
- Inadequate auditing and approval of vendors leading to problems with equipment or materials being undiscovered until a late or crucial stage in a project.
- Poor contractor procurement or inspection procedures or poor practice in their execution leading to problems not being picked up until late in the execution of projects.
- Conventions and expectations that are well recognised in traditional markets not being translated or understood in non-traditional markets. ISO 9000⁽²⁾ accreditation has been found to not be in itself sufficient to guarantee quality.

In some circumstances associated with the above issues, there is a tendency for contractors to be over-reliant on the paperwork and data supplied for equipment without its authenticity being tested and validated.

2.3.4 Problems from Vendors' Competence, Processes and Practices

Experience has shown that the sorts of problems arising from vendors include:

- Manufacturers and fabricators simply do not have the capability to produce material and fabrications to the appropriate European standards of quality, even when using their best efforts.
- A lack of commitment to inspection and quality in a production-driven culture aggravated by environments driven by economic and cost considerations.
- Increasing preference for cheaper QA rather than expensive QC. QA processes, whilst initially difficult for the vendor to establish and gain certification for, rely on audit and other compliance processes that can deteriorate over time or be tampered with.
- The manufacturers' unfamiliarity with international standards and certification and the differences between national standards for materials arising from national practices and construction codes.
- Newer or non-traditional vendors relying on a relatively thin layer of qualified but experienced managers to interface with customers. These more qualified people are possibly supported by a greater number of enthusiastic, but inexperienced, support staff.

Cultural and language differences between representatives of the purchaser and the vendor can mask the ability of either party to identify problem areas. For example, saying 'no' in some cultures is unacceptable and results in loss of face. In these circumstances it is important for the purchaser to use locals who can act on its behalf and interpret the both words **and** the body language.

2.3.5 Problems Associated with Inspection Bodies

Inspection organisations recognise the problem of counterfeit or rogue equipment, materials and fabrications and have expressed concern. Inspection organisations in Europe are part of a global network and all have experienced the following sort of issues:

- Procurers and users perceive a lack of competence and commitment in some local statutory inspection bodies and international independent inspectorates and sometimes send their own representatives to oversee the manufacture of critical components. In the worst cases there has been the perception of a purposeful intent to deceive for monetary gain or other motives.
- Inspection organisations can themselves be victims of malpractice. Signatures are forged and certification is altered to imply a higher level of approval.
- Local agency inspectors not achieving the company's normal high standards and control.

- A high turnover rate of local agency inspection staff and a lack of local control.
- The practice of subcontracting inspections to agency staff thus weakening the supply chain.

There are very many global third party inspection organisations in existence and users and contractors may have arrangements with one or a group of them. In some cases they may be directed to use the user's arrangements. Unless adequate compliance and audit processes are in place, then users and contractors can suffer from inadequacies in these organisations.

The culture in some parts of the world makes raising issues with manufacturers and fabricators problematic. Communication and surveillance is more difficult when fabricators subcontract work and inspections to others. The role of the manufacturer under the European PED⁽³⁾ could be taken by a turn-key engineering contractor physically and organisationally remote from the actual fabrication. Traceability to source is a key issue. Equipment ordered from European suppliers often has parts manufactured elsewhere. Original certification for fasteners is frequently unavailable.

The approval of materials and of materials certificates is a difficult area, particularly when the original certificates are not available. There is a need to clarify which material certificates can be accepted and when they might be refused. In some instances there is a perceived difficulty with specifying the brief of inspection bodies by the procuring companies.

Overall and from the information available it would appear that the problem of counterfeit rogue equipment, components, materials and fabrications has its roots spread over a number of issues:

- the local and national situation and users' requirements;
- the quality of contractors' purchasing processes; and
- the quality of vendors and their QA and QC processes.

Encompassing all of these is the control of inspection of equipment, components, materials and fabricated equipment at different points in the supply chain. A clear process and standards for controlling inspection on site is required that is both practical and not prohibitively expensive. Accountabilities and responsibilities in the supply chain need to be clarified and strengthened so that there is a greater chance of detecting counterfeit and rogue materials and fabrications at an early stage.

The working practices of suppliers and fabricators are influenced by the local culture and customs. Generating a greater understanding of where these problems arise will help purchasers and users to mitigate them. Greater communications and personal contact throughout the supply chain are always beneficial, but require the necessary investment and effort in manpower and logistics.

2.4 Legal Considerations in the EU Associated with Pressure Systems

There is understandable concern within the pressure systems community that counterfeit or rogue equipment, components, materials and fabrication pose a serious issue for safety.

In many European countries and elsewhere, it is the user's legal duty to take all necessary measures to guard against and detect rogue materials and fabrications before they enter equipment in-service. This might include vendor vetting, more rigorous QA during fabrication, and post manufacturing inspections when there is a recognised potential risk that the material may be suspect. European suppliers of rogue pressure parts would be liable in law even if they were not the original fabricator. Where suppliers put their own brand name on products made elsewhere they take on the manufacturer's liability. For example, the UK Health and Safety at Work Act⁽⁴⁾ would allow the deficient suppliers to be pursued through the courts as far as the court's jurisdiction and ability to enforce judgement allows. It is difficult, however, to enforce judgments and penalties on suppliers outside the EU.

It is generally accepted that there are weaknesses in the ISO 9000 certification system. While under the PED there is a requirement for the fabricator's quality system to be approved by an inspection body established in the EU, some inspection bodies were not properly established in this way. This problem extends much wider than pressure equipment. The assurance of quality management that should be provided with ISO 9000 certification often does not exist.

Production of a piece of equipment to a particular national standard is not necessarily taken as evidence of being sufficiently fit for purpose in the event of a damaging failure. Similarly, certification alone is not accepted as automatic compliance with legislation. A level of due diligence of the user and supplier is expected commensurate with factors suggesting the possibility of a problem and the scale of hazards that would occur in the event of failure.

The European PED is largely seen as having achieved its objectives in ensuring a good market in pressure equipment in Europe. The wording of the Directive allows companies to market equipment without knowledge of material processes where a material manufacturer has an appropriate QA system certified by a Conformity Assessment Body established in the EU. Having undergone a specific approval for materials, certificates issued by the manufacturer were presumed to ensure conformity with the materials and quality section of the essential safety requirements. There are instances where there had been a withdrawal of approval without reinstatement.

2.4.1 NDT Certification Bodies

NDT certification bodies report that there is misinterpretation among some overseas fabricators about the scope of EN 473⁽⁵⁾. This is a Standard for bodies certifying NDT personnel qualification, not an NDT certification for individuals. Sometimes fabricators can self-certify NDT personnel under the so-called second party route but there are limits to the equipment that can be inspected by such individuals. Where equipment is inspected by NDT personnel holding personal

certification for NDT (PCN), it is possible to check their qualification relatively easily on-line.

Organisations that provide certification, testing, inspection and calibration services (i.e. those organisations with Certification Body or Notified Body status) are required in the European Union to be accredited against international Standards. As these organisations can be global and have local subsidiaries, it is difficult for the accreditation services (and even the inspection bodies themselves) to cover and guarantee every part of the organisation. While an organisation might have good procedures and intentions, there is sometimes an inadequate level of control and internal audit of remote operations, outstations and subsidiaries.

3. Risk-based Approach to Avoiding Counterfeit Equipment/Materials

3.1 Overview

Clearly the risk of being supplied with counterfeit, or otherwise incorrect, defective, or sub-standard items, components and/or documentation can arise from a great variety of potential sources.

Good procurement practices will guard against many of the risks and to a large extent the effects suffered from the problem depend on the type of equipment or material being bought, the criticality to the stakeholders in the project and at what stage problems are discovered. For example in general, and provided good technical, purchasing, and inspection practices are applied, with the purchase of large machines or specialist materials in a market where there are few vendors, the risks will be low.

Problems can be experienced, though, with the purchase of bulk items, valves, pipework, common electrical or instrumentation equipment, and even pressure vessels where there are many vendors, some of them remote in location or at the end of long supply chains. However, even when counterfeit or sub-standard equipment is supplied, the effect, whilst undoubtedly regrettable, might be overcome relatively easily depending upon when it is discovered in the life of the project.

The increasing profile of the problem, though, has led to a reassessment, by contractors, of processes to mitigate the risks.

Some customers and end users recognise the issue and the potential risk and are prepared to pay for enhanced inspection or other measures while others do not. Best practice, therefore, is to apply some form of risk-based approach at the early stage of developing a procurement strategy. The criticality of different items of equipment to the various stakeholders in the project is assessed and appropriate measures to the risk are applied.

Some of the aspects considered in Risk-based approaches are illustrated in Figure 1 although this is not a definitive list and others will also have to be assessed.

Good purchasing practice, vendor vetting, pre-qualification, preferred vendors' lists, etc., are all good if not best practice, but even with all these processes in place problems can still occur. A risk-based approach enables the user or contractor to judge what additional steps or processes are justified to apply against quantified risks to the project. Application of such processes could justify extreme levels of interaction with and surveillance of vendors including enhanced vendor selection and assessment processes through to establishing a permanent presence in the vendor's premises.

Clearly, the more stakeholders involved in the process, the more valuable the exercise will be and if the customer can be involved to add their perspective, that is better.