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# Managing Counterfeit and Fraudulent Items in the Nuclear Industry

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# MANAGING COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY

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IAEA NUCLEAR ENERGY SERIES No. NP-T-3.26

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# FOREWORD

One of the IAEA's statutory objectives is to "seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world." One way this objective is achieved is through the publication of a range of technical series. Two of these are the IAEA Nuclear Energy Series and the IAEA Safety Standards Series.

According to Article III.A.6 of the IAEA Statute, the safety standards establish "standards of safety for protection of health and minimization of danger to life and property". The safety standards include the Safety Fundamentals, Safety Requirements and Safety Guides. These standards are written primarily in a regulatory style, and are binding on the IAEA for its own programmes. The principal users are the regulatory bodies in Member States and other national authorities.

The IAEA Nuclear Energy Series comprises reports designed to encourage and assist R&D on, and application of, nuclear energy for peaceful uses. This includes practical examples to be used by owners and operators of utilities in Member States, implementing organizations, academia, and government officials, among others. This information is presented in guides, reports on technology status and advances, and best practices for peaceful uses of nuclear energy based on inputs from international experts. The IAEA Nuclear Energy Series complements the IAEA Safety Standards Series.

Counterfeit and fraudulent items are a growing concern worldwide, and this is particularly true for nuclear facilities. They can pose immediate and potential threats to worker safety, facility performance, the public and the environment, and they can negatively impact facility costs.

These concerns extend beyond the equipment or component level to the raw materials used in facility construction, and the chemicals and other substances used in a facility. Even when equipment is bought from an original equipment manufacturer, there is a possibility that the materials or components used by the manufacturer may be counterfeit or fraudulent. Supply chain and procurement processes have a role in detecting and preventing the introduction of such counterfeit or fraudulent items, or indeed any non-conforming substandard item, into nuclear facilities.

Experience has shown that a lack of control of the processes involved in the sourcing, receipt, use or disposal of items can lead to the introduction of counterfeit or fraudulent items into a nuclear facility. This has led in some cases to plants being shut down until the impacts of such materials can be assessed and mitigated as required.

This publication is an update and expansion of IAEA-TECDOC-1169, published in 2000, and provides more detail on counterfeit or fraudulent items than is present in IAEA Nuclear Energy Series No. NP-T-3.21, published in 2016, on procurement engineering and supply chain guidelines. Current practices for addressing counterfeit or fraudulent items, and special implications for nuclear facilities, are documented. This information is intended to help all involved directly or indirectly in ensuring the safe operation of nuclear facilities and to provide a common technical basis for dialogue between plant operators and regulators when dealing with procurement issues.

The target audience of this publication is primarily technical experts from nuclear facilities and from regulatory, plant design, manufacturing, supply, transportation and technical support organizations dealing with procurement.

The IAEA would like to thank all those who contributed to the drafting and review of this publication. Their work and that of the authors of IAEA-TECDOC-1169 is greatly appreciated. The IAEA officers responsible for this publication were K.S. Kang and J.H. Moore of the Division of Nuclear Power.

## CONTENTS

# 1. INTRODUCTION

## 1.1. BACKGROUND

Many factors contribute to the growing number of counterfeit or fraudulent items (CFIs) entering the marketplace. Concerns about CFIs extend beyond the component or equipment level to raw materials. Even when the equipment is purchased from the original equipment manufacturer (OEM), there is a possibility that the materials or components used by the manufacturer may be counterfeit or fraudulent. Nuclear facilities and their suppliers should be aware of the issues and implement measures to detect and prevent the introduction and use of CFIs, including raw materials and components. The infiltration into the global supply chain of CFIs is a growing concern worldwide. CFIs can pose immediate and potential threats to worker safety, plant or facility performance, the public and the environment and can negatively impact facility costs. Suppliers risk losing profit, intellectual property and reputation, and workers risk losing their jobs. Therefore, each nuclear facility's senior management should be knowledgeable about, and actively support, mitigating CFI risks.

CFIs may have been inadvertently procured and already installed in nuclear facilities. CFIs need to be identified as early as practicable, and their individual impact on safety, costs and work schedules needs to be evaluated to determine an appropriate course of action. This includes communicating and documenting information internally and sharing the resulting lessons learned with the entire nuclear industry.

It is important to raise awareness of the hazards presented by CFIs. Some States, trade associations and commercial nuclear operators may not recognize the risk of CFIs. The hazards can be reduced by the effective implementation of a management system, as described in IAEA Safety Standards Series No. GSR Part 2, Leadership and Management for Safety [1], and of the procurement guidelines in IAEA Nuclear Energy Series No. NP-T-3.21 [2], coupled with the CFI specific information in this publication and other national and international CFI related publications and consensus standards.

Engineering and procurement personnel also face challenges related to the increasing number of CFIs being introduced into the supply chain. These challenges can stem from items from the original manufacturer no longer being available or the manufacturer no longer being willing to support the rigorous testing and documentation or material certification processes needed for some items. Engineering and procurement personnel thus often rely on commercial grade items because the nuclear grade compliant items are not available. Unfortunately, these conditions are well suited to vendors that are willing to intentionally supply CFIs to increase their profit margins.

Some vendors can take advantage of weaknesses in the processes used to prevent or address CFI issues. There may be poorly defined procurement specifications, weak or absent procurement clauses prohibiting CFIs, weak or absent vendor qualification processes, weak or absent receipt inspection acceptance criteria, lack of consequences if CFIs are discovered in shipments, or lack of information sharing about non-conforming vendors among nuclear facility operators.

The discovery, identification and disposition of CFIs can usually be achieved using existing nuclear facility processes for managing and controlling non-conforming items. New processes or implementing procedures may thus not be required. 'Disposition' in this context is the final settlement of the matter related to the CFI in question; that is, the making of a decision on how to proceed with the particular issue.

A robust safety culture throughout the organization promotes openness and transparency for communicating potential problems and lessons learned, including the incorporation of new processes and applications. The potential for CFIs to enter nuclear facilities can be lowered by adopting a strong safety culture.

When abnormal conditions are identified that involve a product or service, the item should be considered suspect until a subsequent investigation or test demonstrates the item to be genuine, non-conforming, counterfeit or fraudulent. Figure 1 shows the relationship between these terms, and Table 1 and this publication's glossary provide definitions of each.

The terminology and abbreviations surrounding CFIs have not been fully standardized within the nuclear industry. This publication uses the abbreviation CFSIs to refer to 'counterfeit, fraudulent or suspect items' that may, in fact, be genuine and CFIs to refer to 'counterfeit or fraudulent items' that are confirmed as such (i.e. they are confirmed as non-genuine).

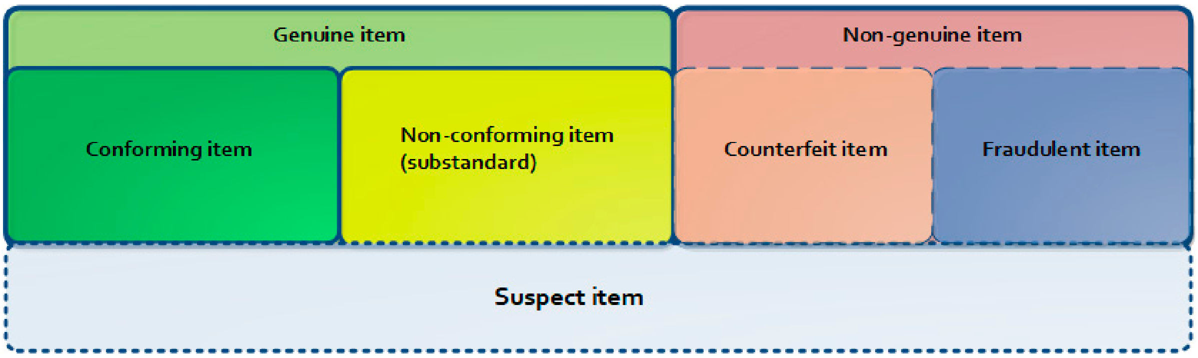


*FIG. 1. Relationships between terms related to counterfeit or fraudulent items.*

TABLE 1. TERMINOLOGY ASSOCIATED WITH COUNTERFEIT OR FRAUDULENT ITEMS *(adapted from table 23 of Ref. [2])*

| Term | Definition |
|---|---|
| Genuine | Products that are produced and certified without the intent to deceive. |
| Non-genuine | Products that are produced and certified with the intent to deceive. |
| Non-conforming (substandard) | Products that do not meet intended requirements or functions. They may be provided by legitimate suppliers without the intent to deceive.<br>All non-genuine items (CFIs) are considered non-conforming, as are genuine items that do not meet intended requirements or functions. |
| Suspect | Products for which there is an indication or suspicion that they may not be genuine. |
| Fraudulent | Products that are intentionally misrepresented with the intent to deceive. Fraudulent items include items provided with incorrect identification or with falsified or inaccurate certification. They may also include items sold by entities that have acquired the legal right to manufacture a specified quantity of an item but produce a larger quantity than authorized and sell the excess as legitimate inventory. |
| Counterfeit | Products that are intentionally manufactured, refurbished or altered to imitate original products without authorization, in order to pass them off as genuine. |

**Note:** CFI — counterfeit or fraudulent item.

Some publications use the ‘S’ in CFSI to refer to a ‘substandard’ item, but in this publication such items are referred to as simply ‘non-conforming’ (see Table 1). Other abbreviations in common use are S/CI (used in previous IAEA publications to refer to a ‘suspect/counterfeit item’) and NCFSI (used by the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD/NEA) to refer to ‘non-conforming, counterfeit, fraudulent and suspect items’).

From a legal perspective, counterfeiting is a subset of all fraudulent activities; however, most industry publications tend to treat the items separately, with the term ‘counterfeiting’ concentrating on the physical attributes of the item and the term ‘fraud’ concentrating on misrepresentations of certifications or other related paperwork.

## 1.2. OBJECTIVE

The objective of this publication is to assist organizations in improving and implementing policies, programmes, procedures, processes and practices to:

— Eliminate the hazards created by CFIs that are present in nuclear facilities;
— Prevent any further introduction, installation or use of CFIs;
— Ensure that items and services meet specified requirements;
— Ensure the detection, control, reporting and disposition of CFIs;
— Provide training and inform managers, supervisors, engineers and workers about CFI processes and controls.

## 1.3. SCOPE

The methods and processes described in this publication may be applied to items important to safety and to non-safety-related items that are installed or procured for nuclear facilities during their entire life cycle. Similar processes could also be applied to tools and equipment related to occupational health and safety at nuclear facilities (e.g. portable firefighting equipment, fall arrest and rescue harnesses, confined space entry kits, life jackets) owing to their impact on personal safety.

The intended users of this publication include the managers and staff of nuclear facilities and their supplier organizations whose work involves the following or other relevant functions:

— Asset management;
— Engineering;
— Procurement;
— Inspection and testing;
— Training;
— Quality assurance;
— Assessment;
— Maintenance;
— Operations;
— Construction;
— Regulatory affairs;
— Public relations;
— External communication.

Regulatory bodies may also consider the approaches in this publication for their oversight strategies in areas that can be adversely affected by the introduction of CFIs. The methods and processes described in this publication are based on practical experience, lessons learned and the current guidance of the referenced IAEA publications. Additional or alternative methods may be acceptable if they adequately ensure worker and public safety as well as product quality. Guidance provided here, describing good practices, represents expert opinion but does not constitute recommendations made on the basis of a consensus of Member States.

## 1.4. STRUCTURE

This report is broken down into sections, followed by additional material such as references, a glossary and detailed background material found in the appendices. Section 2 covers international experience with CFIs in nuclear and non-nuclear industries. Section 3 presents details on programmes, processes and tools used to address CFIs. Sections 4–6 provide details on preventing, identifying, managing and controlling CFIs, and Section 7 provides details on sharing information related to them. Section 8 provides information on the signs that might suggest that an item is a CFI.

Appendix I provides examples from various jurisdictions of CFI issues and procedures; Appendix II provides specific examples of international experience with CFIs, mainly derived from Ref. [2].

# 2. INTERNATIONAL EXPERIENCE

Experience shows that CFIs include a wide range of items, such as threaded high strength fasteners, piping, mechanical components, and electrical and electronic components. Bulk materials and chemicals can also be of concern, including those provided to top level or tier 1 suppliers by their sub-suppliers. Recently, there have been documented cases within the nuclear industry related to fraudulent material or testing certifications and fraudulent records associated with the delivery of services.

CFIs are more likely to appear when:

— There is significant financial benefit for the counterfeiter;
— The items are difficult to verify or not typically verified;
— Procurement requirements (technical specifications) are poorly defined;
— Methods or criteria for verifying that procurement requirements are met are inadequate;
— Urgent replacement of an item is required (i.e. there are schedule pressures);
— Supplier qualifications are expedited;
— The item is supplied from a single source with unreliable or unverified performance;
— There is not a strong safety culture within the organizations involved.

Reference [2] reports on documented experiences in the nuclear and other industries related to the increase in CFIs. Sections 2.1–2.6 and Appendix II of this publication contain these and other examples of international experience with CFIs as well as some sample national regulations and documents related to the subject. Much of the text is based on or taken directly from Ref. [2] but has been expanded to incorporate additional information obtained since that publication was written.

## 2.1. GENERAL COMMERCIAL ENVIRONMENT

The US Department of Commerce has reported a 140% increase in counterfeit incidents among suppliers of industrial parts to the US Department of Defense from 2006 through 2009 [3]. The value of counterfeit goods seized by the Royal Canadian Mounted Police in Canada increased by 500% in less than a decade, according to 2012 intellectual property crime statistics [4]. The European Union Intellectual Property Office (formerly known as the Office for Harmonization in the Internal Market) reported in 2015 that the sale of fake clothing, shoes and accessories had had a dramatic impact on the sector, resulting in annual losses of 518 000 jobs and €43.3 billion in sales [5].

Governments in many jurisdictions have been active in this area, with one example being an anticounterfeiting trade agreement negotiated between Australia, Canada, the European Union, Japan, the Republic of Korea, Mexico, Morocco, New Zealand, Singapore, Switzerland and the United States of America.

The Electric Power Research Institute (EPRI) has documented cases of counterfeiting in the nuclear and other industries [6], some of which have resulted in deaths. Although large increases in confirmed instances of counterfeiting have not been seen in the commercial nuclear power industry, general industry and nuclear power share many of the same types of component, and significant increases in counterfeiting are viewed with concern and suspicion.

Some industries, notably aerospace and defence, have characteristics similar to those of nuclear power. Their products have long life cycles, and thus the industry needs to deal with obsolescence issues as their equipment ages. Some models of aeroplane (e.g. DC-3, B-52) have been in service for over 60 years [7]. Such industries have been actively developing countermeasures against CFIs (see Ref. [7]) on the basis of growing industry trends and the risks associated with the use of CFIs in their equipment.

Certain nuclear operating organizations have created awareness and training programmes for supply chain and other personnel on the subject of CFIs (early detection and what to look for), and this is expected to be a growing trend.

## 2.2. COUNTERFEIT CONSTRUCTION MATERIALS

The Construction Industry Institute reports that steel items (plates, pipes, fasteners and valves) are the most counterfeited items, followed by electrical devices and then rotating equipment [8]. The National Electrical Manufacturers Association has identified counterfeit electrical products that have included conduit fittings, circuit breakers, control relays, control switches, electrical connectors, electrical receptacles, fuses, high voltage surge arrestors and lamps [9].

A common method of counterfeiting fasteners is to change the bolt-head markings present on low grade fasteners (the markings that indicate fastener capability) to indicate their production to a higher standard. Raised marks are usually preferred by manufacturers because these can only be added during the forging process, whereas depressed marks can be subsequently added (often via hand stamping). Many standards also require manufacturer company identification to be present on bolt-heads, although in some cases such identification has also been counterfeited (with either a legitimate code or a meaningless code applied on a counterfeit product). Reference [10] provides some detailed information on recognizing some known examples of such counterfeit fasteners, and Fig. 2 shows a typical example of bolt-head marking by a legitimate manufacturer.

Some photos of documented counterfeit articles used in construction and other industries are shown in Figs 3–7. Additional examples are available in Sections 2.3 and 2.4, Appendix I and Refs [6, 10].


*FIG. 2. Typical bolt-head marking indicating capability (the six lines indicate a Society of Automotive Engineers grade 8 bolt) and the manufacturer (manufacturer code for the Lewis Bolt & Nut Company). (Courtesy of Lewis Bolt & Nut Company.)*

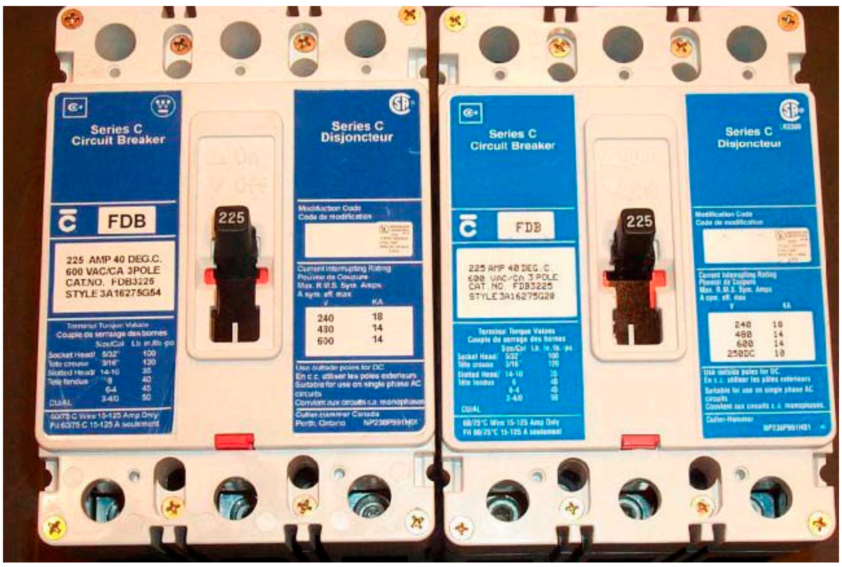


*FIG. 3. Counterfeit (left) and legitimate breaker (right) supplied to a hospital in Montreal, Canada. (Reproduced from Ref. [11] with permission courtesy of Canadian Standards Association Group Inc.)*

*FIG. 4. Flanges received as 'new' at Savannah River, South Carolina. Note clamp marks and different rivet sizes. (Reproduced from Ref. [10] with permission courtesy of US Department of Energy.)*


*FIG. 5. Square D QO counterfeit breaker characteristics. (Courtesy of Schneider Electric.)*

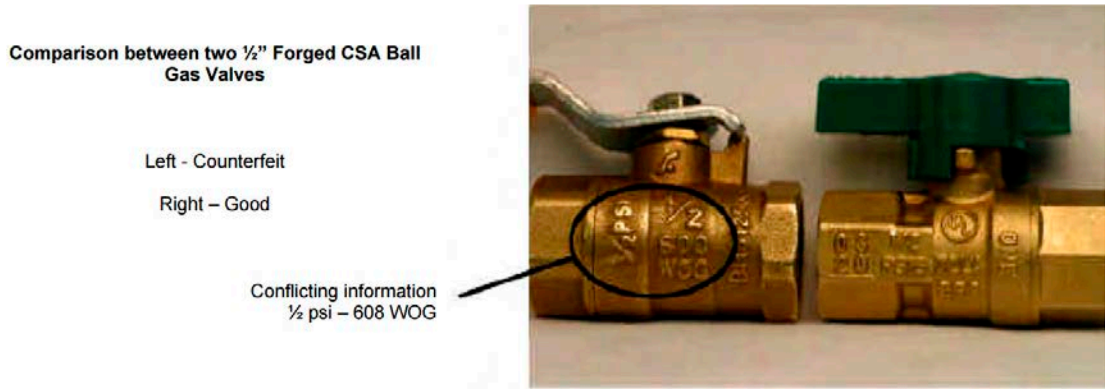


*FIG. 6. Forged Canadian Standards Association ball valves. (Reproduced from Ref. [10] with permission courtesy of US Department of Energy.)*


*FIG. 7. Cloned batteries simulating a trademarked product. (Reproduced from Ref. [10] with permission courtesy of US Department of Energy.)*

## 2.3. ELECTRONICS COUNTERFEITING

Electronic parts are increasingly subject to counterfeiting. Global trade in recycled electronics parts is enormous and growing rapidly, driven by a confluence of cost pressures, increasingly complex supply chains and huge growth in electronic waste sent for disposal around the world. It is estimated that 80–90% of counterfeit parts in circulation are recycled. The remainder includes parts that are made in authorized production runs but fail testing and are sold anyway, instead of being destroyed; excess inventory intended for scrap that is not disposed of properly; and some parts that are simply phoney and do not work [12]. Industries such as nuclear and defence are particularly vulnerable to recycled parts owing to the long service lives of installed equipment (when compared with, for example, the consumer electronics industry) and their need to address the obsolescence of parts that may no longer be in production.

Sophisticated computer integrated circuits or software can be targeted for intellectual property theft or industrial or military espionage. Conspirators may in some cases even offer to produce fake integrated circuits to replace genuine items stolen from inventory [13].

The harvesting process used by electronics recyclers can involve heating circuit boards to high temperatures (sometimes up to 400°C) to melt the solder that attaches items to the boards, with little concern for how components will later be used. Recyclers may then strike the boards repeatedly against a hard object to dislodge the parts, which they clean and sort by size, package style, number of pins, part number and manufacturer name [12].

Electronics counterfeits, hidden within products and systems, are not easy to detect. Receipt inspectors can scrutinize packages for signs that pins have been straightened or indications that labels have been sanded or repainted. Advanced detection techniques such as X ray, scanning electron, or acoustic imaging are increasingly becoming available from specialized companies to enable more detailed analyses to be performed or components to be internally examined for such things as improper placement of a chip within its package. Electrical behaviour can also be evaluated, with statistical analysis of signal path delays and other attributes being a method of counterfeit detection.

Some examples of electronic counterfeits are shown in Figs 8 and 9. A system for detecting electronics counterfeiting is shown in Fig. 10.

## 2.4. COUNTERFEIT CERTIFICATIONS AND SERVICES

### 2.4.1. Certifications

Counterfeit certifications are of increasing concern for nuclear facilities. They include material or item test certificates that indicate that an item has certain properties (e.g. chemical composition), has undergone certain processes (e.g. heat treatment) or has been tested to confirm certain parameters (e.g. specific resistance values, operating times, passing of an agreed-to inspection and test plan). Certificates may be delivered to a nuclear facility operating organization by a vendor along with delivery of a product, may come from third party testing laboratories contracted by the operating organization, or may be delivered to a component vendor or manufacturer from its material sub-suppliers (e.g. mill, steel supplier, cable supplier). Welding certifications have also been falsified to pass off work as having been inspected when in fact it was not (see section 4.2.6 of Ref. [6]).

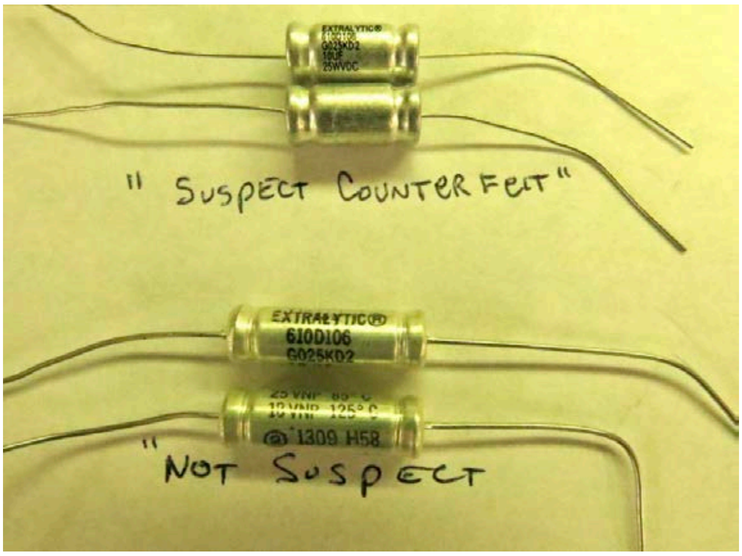


*FIG. 8. Suspected counterfeit capacitors intercepted as a result of awareness training. (Reproduced from Ref. [14] with permission courtesy of EPRI.)*

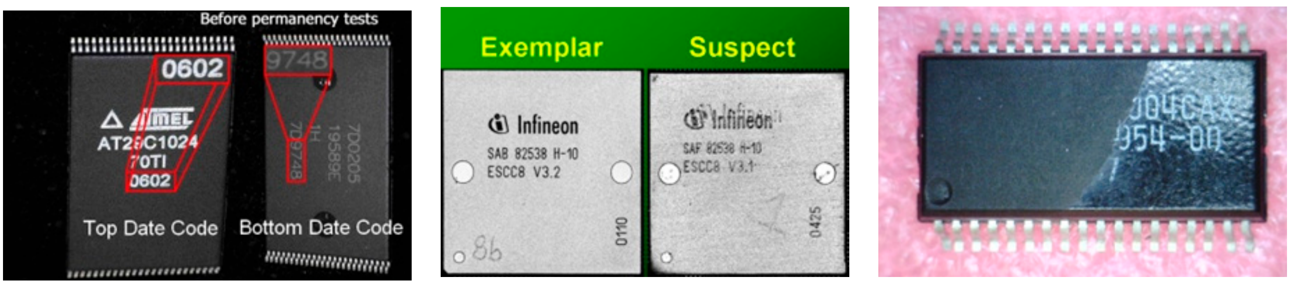


*FIG. 9. Electronic counterfeit examples (left: date code changes; centre: tampering detected via acoustic microscope; right: blacktopping detected by heated solvent test). (Courtesy of SMT Corp.)*

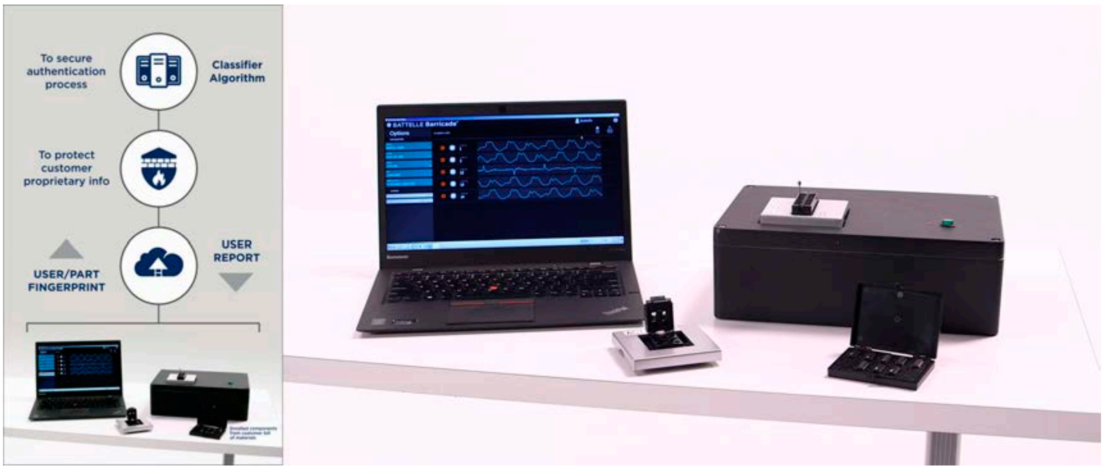


*FIG. 10. Battelle Barricade integrated circuit authentication system. (Reproduced from Ref. [15] with permission courtesy of Battelle Memorial Institute.)*

There have been documented examples of sub-suppliers or vendors knowingly providing falsified certifications to nuclear facilities [16–19]. Such cases cause operating organizations to immediately assess the potential operability or safety concerns of such items on an urgent basis. Depending on the extent of condition, these situations can lead, and have led, some nuclear power plants to shut down until the situation can be rectified.

A case in the Republic of Korea has been estimated to have cost the industry approximately US $2 billion in lost generation and mitigation costs [20]. In November 2012, two units in the Republic of Korea were shut down and two experienced extended outages to replace many parts supplied with fraudulent certifications. The items had been procured over the preceding ten years. Some suppliers had provided commercial grade items with a certification fraudulently stating that they had been successfully dedicated. The items included fuses, relays, diodes and switches. In May 2013, two additional nuclear units were shut down owing to falsified test reports for installed safety related control cables. Outages at four additional reactors were extended to replace installed cables that failed the testing. Figure 11 shows some examples of the commercial grade items supplied with falsified quality certificates.

Product certification marks (e.g. UL, CSA, FM, CE, DIN, GS mark, VDE, TUV, BSI, Nemko, ENEC, JIS, PSE, GOST, Bureau Veritas, NOM, INMETRO, S mark, CCC, EK mark) are visible indicators, on product labels, that a product or component meets applicable standards for safety and/or performance for the applicable region. Figure 12 shows selected product certification marks. The region of applicability for multinational standards organizations is often indicated by adding a region code to their standard label. The Canadian Standards Association (CSA) logo in Fig. 12, for example, shows that the product is certified for both Canada (the 'C' code) and the United States of America (the 'US' code).

Instances have been reported in which product certification marks have been missing, falsified or altered.

### 2.4.2. Services

Although not typically identified as a fraudulent 'item', there have been documented cases within the nuclear industry related to the fraudulent delivery of services. The unscrupulous behaviour (i.e. willingness to sign off on something as successfully done when it has not in fact been done) is very similar to that encountered for fraudulent certifications, with the main difference being that it is the owner–operator who is the direct customer of the service, as opposed to a tier 1 or lower level supplier relying on the service as a part of the provision of a physical product.

Cases include falsified records associated with the performance of fire watch rounds, falsified field measurements, forged signatures and cheating on training exams [21, 22]. Construction or maintenance contractors can also inadvertently substitute non-conforming or non-genuine parts into systems if they are not aware of the consequences of doing so. Many of the methods described in this publication to address counterfeit and fraudulent parts apply to such services, as does having strong contract management oversight processes as described in Ref. [2].

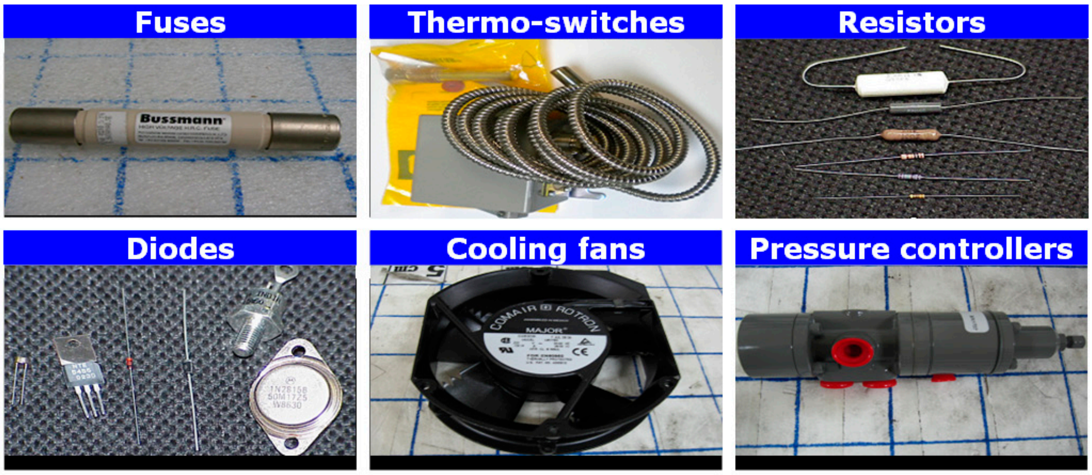


*FIG. 11. Example commercial grade items supplied with falsified quality certificates. (Courtesy of Korea Institute of Nuclear Safety.)*


*FIG. 12. Selected product certification marks.*

## 2.5. OECD NUCLEAR ENERGY AGENCY EXPERIENCE

The OECD/NEA has issued a report on nuclear power plant operating experience related to CFIs [3]. Appendix II documents a number of these and other issues that have become public in the nuclear industry. Appendix II also lists additional CFI incidents reported in IAEA-TECDOC-1169 [23] in 2000 and some lessons learned. Reporting mechanisms for such issues are not consistently well developed throughout the industry, and not all national regulators have specific requirements in place to address CFI reporting, especially for those items that were identified before installation or those with no safety related implications.

A separate OECD/NEA report on regulatory oversight related to CFIs [24] identified several latent causal factors that are contributing to the increase in CFIs in the supply chain. These factors included:

— Major changes in the nuclear supply chain towards globalization, relocation of manufacturing capacities and international consolidation, together with increased complexity and length of supply chains;
— Growing economic pressure challenging nuclear facilities to reduce production and operating costs owing to competition;
— Unavailability of components from the original manufacturer or the manufacturer not being willing to support the rigorous testing and documentation required;
— New materials, design principles, manufacturing technologies or standards;

— Sharp increase in demand for nuclear components caused by ageing and obsolescence of existing equipment, refurbishment, life extension and planned new builds;
— The pursuit of increased profit margins by manufacturers.

### 2.6. INSTITUTE OF NUCLEAR POWER OPERATIONS AND WORLD ASSOCIATION OF NUCLEAR OPERATORS EXPERIENCE

In 2014, the Institute of Nuclear Power Operations (INPO) published a number of principles for excellence in nuclear supplier performance (document INPO 14-005 [25]). The document describes the essential principles and attributes that support achieving excellence in the services and products provided by nuclear suppliers. This publication is applicable to suppliers that support the nuclear industry in areas such as nuclear facility design, procurement, fabrication, construction, inspection and operations. Among these principles are some specifically related to CFIs:

> "Nuclear suppliers [should] have robust quality controls to detect and eliminate suspect or counterfeit items from entering the supply chain.
>
> .......
>
> "Nuclear suppliers should have an established program and industry best practices to ensure that counterfeit, fraudulent or suspect items (CFSI) are identified and captured in their performance improvement programs. Additionally, nuclear suppliers need to have a method for sharing any CFSI-identified parts, including any operating experience gained" [25].
>
> Additionally,
>
> "Nuclear suppliers and customers at all levels in the supply chain should be aware of the existence of counterfeit or fraudulent items in the global marketplace. Nuclear suppliers employ procurement practices, supplier selection, receipt inspection, testing, and other quality control practices in an effort to prevent the introduction of counterfeit, fraudulent, or suspect items (CFSI) into the supply chain" [25].

In 2016, the World Association of Nuclear Operators (WANO) performed an analysis of events caused by deficient parts on the basis of information in its operating experience database [26]. In total, 53 event reports were extracted for the period 2012 to early 2016 and binned into three categories:

— Incorrect part or material selection: 22 events;
— Manufacturing deficiencies: 21 events;
— Counterfeit or fraudulent parts: 10 events.

Eight of the ten CFI related event reports were from WANO Atlanta Centre plants. WANO reported that it is likely that plants in other WANO regional centres have experienced similar issues with counterfeit parts that have not been reported. Two of the counterfeit part events were categorized as significant and one as noteworthy on the basis of the potential impact to nuclear safety and the common cause failure potential.

Counterfeit items from recent WANO operating experience have included circuit breakers, valves, O rings, cables, electrolytic capacitors and pressure gauges. Digital devices and software components are also considered vulnerable to counterfeiting, but events have not been reported to date.

On the basis of its analysis, WANO has identified the following weaknesses that appear to have contributed to some of the counterfeit part issues:

— Some manufacturers knowingly produced fraudulent or counterfeit products, indicating a lack of safety culture.
— In several events, quality assurance programmes were ineffective in preventing the procurement and use of counterfeit parts.

— In one plant, inadequate supervision of contractors during maintenance performed in a vendor shop led to not identifying the installation of counterfeit injector O rings in an emergency diesel generator (EDG), which resulted in fuel leaks and EDG inoperability. This was a potential common mode failure for a second EDG.
— Falsified documents contributed to four events. In one significant event, falsified test reports were discovered for installed safety related cables in several operating units. The testing agency manipulated the test results to show passing results for components that had failed the test. In another event, the test certificates for 1228 valves and components were found to be counterfeit.
— At one plant, 16 counterfeit circuit breakers were identified. Fortunately, the fraudulent breakers were identified during the receipt inspection process. The breakers were not purchased through a certified distributor of either an OEM or an original component manufacturer.
— Pressure gauges installed in a plant were identified as counterfeit. The gauges had an unauthorized modification made by the distributor.
— During an inspection, counterfeit circuit breakers were found installed at seven electrical panels at a plant's emergency power supply station. Counterfeit breakers were installed during initial construction in 1991, indicating a historical lack of awareness of the issue.
— During construction of a new unit, counterfeit lashing hooks were used to transport plant equipment. Although the certificates showed the hooks were load tested and acceptable, further investigation found the hooks to be made of counterfeit material. The suspect hooks had the potential to fail while in use and could have resulted in injury to personnel or damage to the equipment. The hooks were commercially available equipment not part of the nuclear power plant proper; however, they were important to ensuring the safety of plant personnel.

WANO found that some plants have either no policy or a policy that is too weak to provide sufficient focus on preventing counterfeit parts in the supply chain, and that procurement personnel are challenged by obsolete equipment. As the number of replacement parts from new sources increases, unaware and unsuspecting suppliers can unknowingly purchase and use substandard or counterfeit materials or subcomponents in the manufacture of larger components. WANO recommended a number of key elements to guard against CFIs, which are consistent with those identified elsewhere in this publication:

— Take a proactive approach to the prevention and early detection of counterfeit components.
— Establish processes and governing procedures with requirements for detecting and managing counterfeit spare parts. Revise existing guidelines or procedures that address CFIs to include inspection requirements and actions to be performed when a CFI is identified.
— Train applicable plant personnel on CFI prevention techniques, including personnel from the utility's supply chain, procurement, engineering and work planning departments. Also, train personnel who prepare technical specifications and procurement documentation for new units before and during construction. Training should be conducted on the requirement to look for counterfeit parts and the impact on nuclear safety and reliability. Sources of training materials regarding CFI prevention are publicly available.
— Obtain parts directly from the original component manufacturer or the OEM whenever possible, as this will result in the lowest risk of purchasing counterfeit components.

# 3. PROGRAMMES, PROCESSES AND TOOLS

## 3.1. COUNTERFEIT OR FRAUDULENT ITEM PROGRAMMES AND PROCESSES

Paragraph 3.32 of IAEA Safety Standards Series No. SF-1, Fundamental Safety Principles [27], indicates that having "materials of high quality and reliability" is essential to nuclear defence in depth. The procurement process touches on all parts of a nuclear facility's life, and provisions for preventing the introduction of CFIs need to be part of the facility management systems. Section 2 of Ref. [2] describes necessary procurement management systems that are based on IAEA safety standards, such as GSR Part 2 [1]; IAEA Safety Standards Series No. GS-G-3.1, Application of the Management System for Facilities and Activities [28]; and IAEA Safety Standards Series

No. GS-G-3.5, The Management System for Nuclear Installations [29]. Table 2 provides some sample nuclear regulations and related information specific to CFIs.

GSR Part 2 incorporates a systemic approach to safety and includes a specific requirement (Requirement 11) about management of the supply chain. Requirement 11 requires an organization to "**put in place arrangements with vendors, contractors and suppliers for specifying, monitoring and managing the supply to it of items, products and services that may influence safety**" [1]. Addressing CFIs is part of such arrangements.

The scope of concern for CFI programmes can extend beyond safety and security related items and can include non-safety-related and non-plant items, such as lifting, rigging, scaffolding or firefighting equipment, which have been counterfeited in the past.

To address counterfeit and fraudulent items, facility management system programmes need to include measures to:

— Prevent CFIs from entering the nuclear facility;
— Identify, investigate and deal with suspected CFIs;
— Manage, monitor and control identified CFIs;
— Share information with other potentially affected facilities, regulators and other industry participants.

These four sets of measures are necessarily interrelated. For example, sharing of information can contribute to prevention and identification activities at facilities. Each of these sets of measures is discussed in more detail in Sections 4–7 of this publication.

It is good practice for operating organizations to have a clear policy related to the identification and prevention of CFIs in their installations. Such a policy can be as part of the overall procurement policy for the organization (see section 2.2 of Ref. [2]).

## 3.2. TOOLS TO ADDRESS COUNTERFEIT OR FRAUDULENT ITEMS

Section 7 of Ref. [2] identifies a number of tools for counteracting CFIs. These are reproduced in Table 3 (re-sorted to align with this publication) and are discussed in the section of this publication indicated in the table.

## 3.3. MESSAGES FOR NEWCOMER COUNTRIES (FIRST BUILD NUCLEAR POWER PLANT)

Member States embarking on their first new build nuclear power plant should take particular note of the development of their internal capabilities to manage their suppliers and mitigate the risk of CFIs for their procurement of goods and services during the operations and maintenance phase. Governments should support this by ensuring an appropriate legal framework is in place to protect intellectual property, minimize the potential for CFIs and effectively prosecute violators.

Member States also need to satisfy themselves, typically through audits and specific requirements in their contract documents, that their proposed nuclear power plant vendor has similar adequate controls for the purchasing of goods and services from sub-suppliers as part of the new build nuclear power plant project. Sections 4.1, 4.2, and 4.4–4.6 are thus of particular importance in these early stages.

Depending on the new build contractual model chosen, there may be more or less involvement of the eventual operating organization's staff in the nuclear power plant supplier's procurement activities. More involvement allows operating organization staff to become familiar with the supply chain participants (tier 1 and lower suppliers) and the procurement processes used by the nuclear power plant supplier to qualify vendors, audit quality programmes and otherwise manage its supply chain. Specific clauses in the nuclear power plant contract ensure an adequate level of involvement. Additional consideration in the contract can be given to arranging for specific classroom training of local procurement personnel on methods of detecting and managing CFIs.

Further information on procurement processes for newcomer countries is included in section 8 of Ref. [2].

TABLE 2. SELECTED REGULATIONS AND RELATED INFORMATION SPECIFIC TO COUNTERFEIT OR FRAUDULENT ITEMS

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| Canada | REGDOC-3.1.1: Reporting Requirements for Nuclear Power Plants [30] | Licensee is required to report on the discovery of CFSIs during the conduct of licensed activities. | Requires all discoveries to be reported to the regulator (not just those installed in the plant). |
| | CSA N299: Quality Assurance Program Requirements for the Supply of Items and Services for Nuclear Power Plants [31–34] | New (2016) series of standards for nuclear power plant supply/purchasing. Contains requirements for the prevention and detection of CFSIs and makes tier 1 and 2 suppliers subject to audits. | CFSIs are being incorporated into nuclear quality programme standards related to procurement. |
| Finland | Regulation YVL A.3: Management System for a Nuclear Facility [35] | Item 640 requires the licensee to have in place procedures to reliably prevent the purchasing of counterfeit and fraudulent products. | New regulation added in 2014. |
| OECD/NEA | CNRA regulatory guidance booklet The Nuclear Regulator’s Role in Assessing Licensee Oversight of Vendor and Other Contracted Services (NEA/CNRA/R(2011)4) [36] | Booklet aimed at all types of contracted services; however, prevention of CFIs and other substandard items is part of this overarching topic. | As contracted services change and licensees modify their oversight and procurement practices, regulators must also continually adapt to maintain effectiveness in the assessment of licensees’ contracting practices in an increasingly international supply market. |
| OECD/NEA | Regulatory Oversight of Non-conforming, Counterfeit, Fraudulent and Suspect Items (NCFSI) (NEA/CNRA/R(2012)7) [24] | Provides insights that should be useful to regulators and others in the nuclear safety community for addressing the issue of CFIs within the nuclear industry’s supply chain. | Each supply chain tier relies on preceding suppliers to verify and document item quality before the item is passed along. Each tier, in turn, performs a receipt inspection to ensure the item meets the tier’s technical and quality requirements. Accompanying documentation plays a vital role in these decisions, but item quality can only be achieved through verification. The more the validity and capabilities of the supply chain are verified, the more trust can be given to documentation. When any of these processes is violated, as is the case with CFIs, the trust that has become inherent to the programme is lost and the risk the item will not perform its intended functions, either in service or during a postulated event, is increased. Unquestionably, a distinction exists between poor performance from a conscientious supplier and a wilful intent to deceive the purchaser from an unscrupulous one. It is precisely for this reason that the non-conformance process must take two equally distinct resolution paths. Regulators should consider the impact of CFIs on their current regulations, and revise them if necessary, and they should consider methods for inspecting CFI controls (adapted from conclusions of Ref. [24]). |

TABLE 2. SELECTED REGULATIONS AND RELATED INFORMATION SPECIFIC TO COUNTERFEIT OR FRAUDULENT ITEMS (cont.)

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| United Kingdom | Procurement of Nuclear Safety Related Items or Services, NS-TAST-GD-077 [37] | Requires purchasers to have processes in place, and the support of suppliers, to investigate examples found of non-conforming suspected fraudulent items. | An example of national regulations related to CFIs. |
| United States of America | 10 CFR 21, Reporting of Defects and Noncompliance [38] | Requires reporting of defects, including CFIs (although not specifically mentioned), discovered in safety related items that could create a substantial safety hazard. Applies both to nuclear power plant operating organizations and to suppliers. Requires 10 CFR 21 provisions in procurement documents to be referred to when applicable. | Defect reporting requirement applicable to suppliers as well as owners/operating organizations. |
| United States of America | SECY 89-010: Advance Notice of Proposed Rulemaking “Acceptance of Products Purchased for Use in Nuclear Plant Structures, Systems, and Components” [39] and SECY-94-277: Withdrawal of Advance Notice of Proposed Rulemaking “Acceptance of Products Purchased for Use in Nuclear Plant Structures, Systems, and Components” [40] | SECY-89-010 requested public comment on whether or how NRC regulations should be revised to provide increased assurance that counterfeit or misrepresented vendor products are not installed in nuclear power plants. It was withdrawn in 1994 (via SECY-94-277) with the conclusion that:<br>“the nuclear industry has made significant progress toward improving its procurement and commercial grade dedication programs. The staff will continue to monitor the industry’s progress through the inspection process.<br>“The staff believes that problems identified with respect to the quality of items dedicated for use in safety-related applications are adequately addressed by the requirements of 10 CFR Part 50, Appendix B” [39]. | Ongoing regulatory interest in CFI related issues. |
| United States of America | Regulatory Issue Summary 2015-08: Oversight of Counterfeit, Fraudulent, and Suspect Items in the Nuclear Industry [41] | Issued to heighten awareness in NRC licensees, certificate holders, contractors and vendors that supply basic components, of the existing US regulations and how they apply to CFIs. Covered three general areas:<br>— Nuclear reactors;<br>— Nuclear materials;<br>— Radioactive waste. | Focuses on codified quality assurance and reporting requirements. Notes that the NRC’s Safety Culture Policy Statement is applicable to all NRC licensees and certificate holders, as well as vendors, suppliers and others involved in NRC regulated activities. |

**Note:** CFI — counterfeit or fraudulent item; CFSI — counterfeit, fraudulent or suspect item; CNRA — Committee on Nuclear Regulatory Activities; NRC — Nuclear Regulatory Commission; OECD/NEA — Nuclear Energy Agency of the Organisation for Economic Co-operation and Development.

TABLE 3. TOOLS TO ADDRESS COUNTERFEIT OR FRAUDULENT ITEMS IN NUCLEAR FACILITIES [2]

| Tools available | Section of this publication in which tool is addressed |
|---|---|
| Training programmes on recognizing counterfeit parts | 4.2 |
| Engineering involvement in procurement and product acceptance | 4.3 |
| Detailed knowledge of suppliers, including reducing use of independent distributors and parts brokers and effective supplier audits | 4.4, 4.4.1, 4.4.2 |
| Questions regarding CFI identification methods and programmes within supplier audit checklists | 4.4.2 |
| Bid evaluation processes accounting for CFI concerns | 4.4.3 |
| Identification of at-risk procurement | 4.5.1 |
| Clear and complete procurement requirements | 4.5.2 |
| Procurement clauses and contract language addressing CFIs | 4.5.3 |
| Zero tolerance policies for vendor counterfeiting | 4.6 |
| Protection of intellectual property | 4.7 |
| Scrap and disposal policies | 4.8 |
| Human performance tools | 4.9 |
| Use of difficult to counterfeit, positive identification tools | 4.10 |
| Design rules and practices that emphasize diversity of supply | 4.11 |
| Thorough receipt inspections | 5.2.2 |
| Contractual arrangements for independent testing | 5.2.4 |
| Procedures for addressing suspected CFI incidents, which include engagement of OEMs | 6.2 |
| Mandatory reporting to regulators of discovered items | 7.1 |
| Industry databases of incident data | 7.31 |
| Participation in industry peer groups | 7.3.2 |
| Whistle-blower protection and rewards | 7.4 |

**Note:** CFI — counterfeit or fraudulent item; OEM — original equipment manufacturer.

# 4. PREVENTION

An organization requires operational policies, strategies and management to effectively coordinate its supply chain management activities. Preventive measures to mitigate the risks of CFIs entering facilities should be a part of these arrangements. An effective management system is essential to prevent the introduction and installation of CFIs in a nuclear facility.

Prevention can be based on a multilayer process by addressing the following key aspects:

- Management responsibility;
- Training;
- Engineering involvement;
- Supplier selection and oversight;
- Procurement management (risk management and identifying procurement requirements).

Other activities that can assist in CFI prevention include establishing policies for dealing with vendor counterfeiting, establishing scrap and disposal policies, using human performance tools such as pre-job briefings to assist in CFI awareness, using advanced technologies for product identification and establishing design rules that emphasize the diversity of supply. These items are discussed in the remainder of Section 4.

## 4.1. MANAGEMENT RESPONSIBILITY

Top management needs to be aware of the risks associated with the introduction of CFIs into nuclear facilities and needs to create and implement a policy to address these risks. Training can assist management personnel in gaining an understanding of expectations regarding CFIs and to ensure that (Fig. 13):

- Personnel are made aware of CFI processes, and procurement and other procedures designed to preclude entry of, identify, dispose of, report and control CFIs;
- Training is provided to appropriate personnel involved in design, procurement, supplier oversight, source inspection, receiving inspection, commissioning and maintenance related to the prevention and discovery of CFI issues;
- Management systems contain requirements related to the impact of discovered CFIs;
- Appropriate corrective and preventive actions are established to prevent the introduction of CFIs into nuclear installations, including sharing of the discovery of CFIs and the lessons learned.

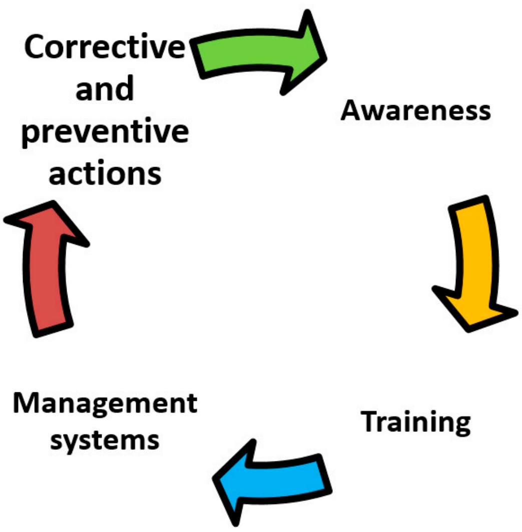


*FIG. 13. CFI management responsibility functions.*

The communication of concerns related to CFIs by management to appropriate individuals and departments in the operating organization is important so that appropriate measures are taken. Processes need to be put in place for identified CFIs that include control, tracking and reporting, training, communication, and information sharing, as well as non-conformance reporting and engineering involvement in the disposition of CFIs.

## 4.2. TRAINING

The IAEA has published a number of guidance publications related to training, including IAEA Safety Standards Series No. NS-G-2.8, Recruitment, Qualification and Training of Personnel for Nuclear Power Plants [42], and recommends that a systematic approach to training be employed as described in IAEA Technical Report Series No. 380 [43].

Typical training related to CFIs includes general employee orientation training (covered in Section 4.2.1), associated refresher training, and position specific training for those roles directly involved in supply chain and installation processes. Ethics training is a related topic pertinent to CFIs, since unethical behaviour is at the heart of most CFI issues.

Position specific training can include education and training of designers; buyers; source inspectors; quality control receiving inspection personnel; warehouse staff; transportation staff; maintenance staff; production personnel; in-process inspection, testing and commissioning personnel; trade or craft personnel; on-site contractors; and individuals responsible for reporting and experience sharing. Off-site personnel outside of the operating organization, such as suppliers, fabricators and contractors, can also benefit.

The following sections describe some particular training aspects to be covered for many of these roles at a nuclear facility.

A large number of providers offer training in CFI detection that can be incorporated into an organization’s training programme. EPRI, for example, has produced a computer based course [44], and the Nuclear Regulatory Commission has produced a list of potential training suppliers for the US market [45]. The US Department of Energy has produced a publicly available training manual on CFIs [10] that provides many example cases.

### 4.2.1. General employee training

An important barrier to the introduction of counterfeit or fraudulent products into nuclear installations is the recognition of these products before they enter the system. The probability that CFIs will be identified increases significantly when personnel are familiar with the types of item known to be counterfeited and the technical characteristics that indicate that items or associated documentation may not be genuine. This recognition requires that personnel involved in the various phases of a product life cycle know the features and functions of the original product and have the necessary CFI awareness training to help them detect attempts at fraud and to help them take appropriate action when such products are found.

To ensure this awareness throughout all levels of operating organizations, these organizations increasingly include CFIs as a specific topic area for general employee orientation training. The training raises the profile of CFIs as an important issue for personnel and provides basic knowledge to individuals who may not be directly involved in procurement or installation activities but who may be able to detect CFIs through the course of their duties. For example, a field operator may notice that one item looks different than others in the plant and trigger an investigation.

To the extent possible, both theoretical and practical examples from the organization and outside industry should be included in general training. Practical examples can include photographic and (when possible) hands-on examples of CFIs so that personnel can develop a tactile appreciation for the differences (or lack thereof) when examining the items. Section 8 of this publication identifies signs that an item might be a CFI.

Such orientation training also covers the risks associated with CFI introduction into a nuclear facility. This would include the potential impacts on nuclear safety, industrial safety, plant production and economics. The costs associated with addressing the consequences of an incident or accident incurred by inadvertently using a counterfeit or fraudulent product or service are significantly greater than the cost to prevent its introduction into the facility.

#### 4.2.2. Ethics training

Fairness and ethics in the procurement process are discussed in section 2.5 of Ref. [2]. Unethical practices such as bribery, corruption, preferential contract awards, conflicts of interest, releasing of confidential intellectual property or overlooking of forged documents can result in CFIs entering the facility. The individuals involved can be either external to or internal to the facility's regular staff.

Operating organizations typically will include business ethics training and refresher activities as part of their overall training programmes. Such training typically covers the organization's business code of conduct; ways to protect the resources and information of the company, clients and fellow employees; methods to avoid conflicts of interest; ways to manage organizational finances honestly and fairly; the necessity of adhering to all laws and regulations governing the organization; and how to report observed or suspected instances of unethical behaviour. Case studies that detail how to react to typical business situations are a useful part of such training.

#### 4.2.3. Engineering personnel training

Engineering and other technical staff can benefit from training specific to CFIs. Role specific training can include instructions on how to more readily identify at-risk procurements, specify the enhanced inspections and testing necessary to reasonably ensure that items purchased are authentic, address CFI concerns upfront as part of the specification process, and recognize CFIs in the field when participating in source and receipt inspections.

Engineers (typically designers) who are involved in the technical disposition of non-conformance reports need training in developing technical justifications for CFIs to remain on the site (and be accepted 'as is' or repaired as necessary). Such justifications would provide assurance that the item or component will perform its intended safety function.

#### 4.2.4. Procurement personnel training

Personnel who prepare purchasing documentation, play a role in contract negotiation or are purchasing agents need to be familiar with the issue of CFIs.

These individuals are the primary interface with suppliers and should be trained to:

— Recognize and identify at-risk procurements;
— Follow processes or procedures to ensure that the appropriate organization considers imposing precautions such as enhanced inspection or testing for at-risk procurements;
— Ensure procurement requirements related to CFIs (e.g. requirements that the product should not contain CFIs and that the facility will not accept or pay for identified CFIs) are passed down to supply chain participants;
— Screen commercial suppliers to determine if they are aware of and take precautions against CFIs;
— Communicate concerns about CFIs to every supplier;
— Request that suppliers provide information about known incidents of CFIs involving products they provide;
— Preferentially award procurements to authorized distributors or OEMs whenever possible;
— Look for signs that suppliers may be providing CFIs, such as bids that are significantly lower than other bids or the item's historical average unit cost.

#### 4.2.5. Quality assurance, quality control, audit and inspection personnel training

Personnel who perform audits, surveys, and source inspection or surveillance of tier 1 and sub-tier suppliers need training in CFI detection, in the types of questions that should be asked when conducting CFI process review and inspection activities and in identifying suppliers as 'at risk' when concerns are identified. Specific questions (or checklists) should be developed for this purpose, such as:

— Do you have a specific programme for addressing CFIs?
— How do you document CFI activity?
— How do you control confirmed or suspected CFI inventory?
— Do you include anti-CFI clauses or conditions in purchase orders?

— Do you have appropriate training for your staff?

Supplier audit checklists are further discussed in Section 4.4.2.

#### 4.2.6. Receiving inspection personnel training

Receiving inspectors and warehouse personnel play a key role in preventing the introduction of CFIs and other substandard products. These individuals should be:

— Familiar with the guidance included for identifying CFIs.
— Trained to follow processes or procedures for procurements identified as 'at risk' and ensure that appropriate precautions, such as enhanced inspection or testing, are conducted for them.
— Trained to identify abnormalities in packaging, labelling, product marking, workmanship or certification that may indicate that items are counterfeit or fraudulent.
— Trained to identify physical signs evident on hardware that may indicate that items are counterfeit or fraudulent.
— Trained to examine and recognize both legitimate and suspicious manufacturer markings, trademarks, logos, nationally recognized testing laboratory certification marks or symbols, and so on, that may indicate whether items are counterfeit or fraudulent.
— Aware of where and how to report CFIs or items suspected of being counterfeit or fraudulent (such as the plant non-conformance system).
— Trained to follow a consistent plan of action every time items suspected of being counterfeit or fraudulent are identified, including quarantining and controlling items (see Section 6.2). Careful consideration should be given to the appropriate actions pertaining to contacting external organizations (e.g. the OEM), retaining the item, preventing its re-entry into the supply chain, and documenting correspondence.
— Trained to check existing operating experience, OEM trademark databases or other sources of data on CFIs to the extent practical when receiving items (see Section 7).

#### 4.2.7. Maintenance and construction personnel training

Scrutiny by maintenance personnel, maintenance contractors or construction trade staff on the site may be the last opportunity for the detection and the prevention of installation of CFIs. These individuals are often in a position to visually compare the item being removed with the replacement item and to identify any differences between the two items in orientation, labelling, configuration or other characteristics. Personnel who plan and assess work for such staff can also benefit from CFI training.

These individuals should attend periodic training in which operating experience and examples of CFIs specific to their discipline are presented for hands-on examination along with their genuine counterparts. A general awareness of the CFI issue along with experience gained through handling actual examples of CFIs will greatly increase the probability that CFIs will be identified before installation.

In addition, the following types of concept can be communicated:

— Including CFI precautions in pre-job briefings and assessed work packages when appropriate;
— Communicating the importance of identifying any discrepancies between the field installed item and its replacement item;
— Obtaining confirmation of the acceptability of replacement items before their installation.

#### 4.2.8. Supplier training

Suppliers (fabricators, distributors or manufacturers) and service providers (laboratory, testing and calibration service providers; technical support organizations; and construction and maintenance service providers) can benefit from CFI related training. Such training can be formally incorporated into these organizations' documented quality programmes or management systems. Information held by operating organizations about training offerings should be shared.

Training developed by suppliers and OEMs often contains detailed information about their products as well as feedback provided by their entire customer base. This training can enhance operating organizations' product specific knowledge and can be included as part of internal employee training.

## 4.3. ENGINEERING INVOLVEMENT IN PROCUREMENT AND PRODUCT ACCEPTANCE

### 4.3.1. Areas of engineering involvement

Engineering staff are involved in all stages of the procurement process. This includes sourcing of suppliers, specification of requirements (including any inspections and testing required during the manufacturing and receipt of the product), review of inspection and tests results, acceptance of products, authorization and disposition of deviations or non-conformances, and failure investigations. As such, engineering staff are in an ideal position to help mitigate the risk of CFIs entering a facility.

Engineering involvement in procurement activities may include the following:

- Developing technical specifications that contain the functional and technical requirements that are required to be transferred to procurement documents.
- Describing critical attributes and safety functions. Critical characteristics of purchased items should be specified in procurement documents. Those characteristics should be selected for verification during source inspection (e.g. hold, review, witness points) or receipt inspection (i.e. before use).
- Reviewing and accepting deliverables (e.g. drawings, manuals, software code) provided by suppliers as part of design activities.
- Reviewing technical changes to and deviations from procurement documents.
- Determining specific verification testing requirements and methods applicable to the acceptance of products. The extent of verification testing should be based on the history of misrepresentation of the item, supplier past performance, the sample size value of the item or service, and the item's safety function or criticality.
- Evaluating and accepting test results.
- Evaluating and characterizing CFSIs. This includes characterizing the item as genuine, non-conforming, counterfeit or fraudulent by analysing compliance to item applicable specifications.
- Documenting the technical justification for the resolution of CFI issues.
- Developing compensatory measures (e.g. special inspection or acceptance criteria, special field marking) to allow suspect items to be used in their currently installed application until they can be more permanently addressed.
- Participating in audits, surveillance activities and source inspections or tests to help select or verify the technical performance of items or suppliers.
- Providing technical support to product receipt and acceptance processes.
- Specifying proper storage environments and in-storage maintenance requirements for items (e.g. in the warehouse before long term or spare part storage).
- Performing engineering work associated with parts substitutions, plant modifications or design changes to address obsolescence issues (see section 5.3 of Ref. [2]).
- Documenting or evaluating operating experience to be used as feedback for other facilities.

The extent of engineering involvement in procurement is commensurate with the risk, complexity, special nature and intended application of the item (i.e. a graded approach). See IAEA-TECDOC-1740 [46] for further information on graded approaches.

Engineering activities associated with product acceptance are discussed further in Section 5.2 of this publication.

### 4.3.2. Commercial grade dedication

The use of commercial grade replacement items is one of the avenues for the introduction of CFIs into nuclear facilities. Inadequate engineering involvement in the commercial grade dedication (CGD) process is a common weakness in procurement programmes. Some nuclear facilities use the CGD or an engineering equivalency process to ensure that the applicable commercial items meet the technical and quality requirements for safety related end uses in a nuclear facility. Both internal and external engineering staff can play a key role in this CGD or engineering equivalency evaluation and need to be familiar with the measures described in this publication to prevent the introduction of CFIs.

#### 4.3.3. Procurement engineering

Engineering staff should closely collaborate with their organization's supply chain or procurement department. Some nuclear organizations have set up a specific procurement engineering function to facilitate these links. Such a function typically plays a key role in the specifying of product requirements, the sourcing of procurement suppliers, the evaluation of item equivalency, the acceptance of products, the review of inspection and test results, and the resolution of instances of deviation from specified requirements, which may include a review of suspected CFIs. These relationships and activities are further discussed in Ref. [2].

### 4.4. SUPPLIER SELECTION AND OVERSIGHT

Requirement 11 of GSR Part 2 [1] covers management of the supply chain and specifically indicates that "**The organization shall put in place arrangements with vendors, contractors and suppliers for specifying, monitoring and managing the supply to it of items, products and services that may influence safety.**" Paragraph 4.34 of GSR Part 2 [1] requires organizations to implement an 'informed customer' role to ensure that they have a "clear understanding and knowledge of the product or service being supplied" and are able to "specify the scope and standard of a required product or service, and subsequently to assess whether the product or service supplied meets the applicable safety requirements." Ensuring that suppliers meet safety requirements is also necessary, and para. 4.36 of GSR Part 2 [1] requires organizations to "make arrangements for ensuring that suppliers of items, products and services important to safety adhere to safety requirements and meet the organization's expectations of safe conduct in their delivery."

Operating organizations thus need to have management system processes for the oversight of suppliers and their contracted work. The oversight methods used during the work are established as appropriate to the grade of product and service and would include reviews of supplier methods to mitigate the risk of CFIs entering the supply chain.

Detailed knowledge of a supplier's operations and practices is important in gaining confidence in its ability to avoid CFI issues. Such knowledge is obtained via a process of assessments and audits, regular communication (including requesting CFI data from suppliers), and experience with the supplier over a period.

Procedures should be in place to assess, approve and provide oversight of safety or production significant products and services. The procedures should cover a product or service's entire supply chain and its life cycle phases and include necessary activities for preventing CFIs from entering the supply chain.

The following sections discuss the initial steps necessary to manage the supply chain in the context of CFIs. These steps include careful supplier identification, evaluation, selection, assessment and audits, as well as bid evaluation processes. Supplier oversight is further discussed in Section 5.2 of this publication related to the item inspection acceptance process. Sections 3.7, 3.16 and 4 of Ref. [2] discuss supplier oversight in more general terms.

#### 4.4.1. Supplier identification, evaluation and selection

Operating organizations need to define the requirements and criteria for the selection of suppliers and maintain a list of which suppliers are approved to supply which types of item or service. Before ordering a product or service, the supplier's ability to deliver the product or service in compliance with the requirements needs to be evaluated. This includes evaluating whether a supplier and its sub-suppliers are aware of CFIs and the risks of CFIs entering the supply chain. Operating organizations may need to implement training and guidance for their suppliers to foster their knowledge about CFIs (see Section 4.2.8).

Efforts to minimize the number of suppliers that a nuclear facility deals with can make such efforts more practical, as can reducing the use of independent distributors and parts brokers. Using only original manufacturer approved distributors whenever practical is helpful, as is verifying supplier provided data, such as address, International Organization for Standardization (ISO) certification and authorized distributor status.

If operating organizations are buying items from suppliers that are not qualified on the basis of the standards that were applied during the design of the facility, special attention is needed to ensure that the items will satisfy the design requirements. The criteria used to qualify suppliers that provide commercial grade catalogue items for use in non-safety-related applications should also be the subject of supplier qualification.

When the design specifies the use of commercial grade items in safety systems, organizations need to ensure that the item will perform the intended function and will meet design requirements applicable to the replaced item and its application. The acceptance process used by the purchaser to provide sufficient confidence that the items meet specified requirements will need to include inspections, tests or analysis by the purchaser or a third party dedicating entity, supplemented after delivery as necessary by one of the following:

— Commercial grade surveys;
— Product inspections or witnessing of hold points at the manufacturer's facility;
— Analysis of historical records for acceptable performance;
— Assurance that documentation, as applicable to the item, was received and is acceptable.

Additional guidance for verifying the acceptability of commercial grade items in safety applications may be found in GS-G-3.5 [29], Ref. [2], EPRI Report 3002002982 [47], and American Society of Mechanical Engineers (ASME) NQA-1 [48].

Qualifying authorized distributors and agents and limiting purchases to these proven and experienced vendors can aid in preventing CFIs. There have been instances of fraudulent declarations of 'authorized' distributor or agent status, and such status should be confirmed through the OEM.

EPRI recommends regular communication with suppliers [6], for example, periodically transmitting a letter or brief survey to suppliers to determine if they are aware of CFIs and are taking precautions to avoid them and to request feedback if a CFI incident impacts products that have been purchased.

Some jurisdictions (e.g. the Republic of Korea) require that operating organizations report to the regulator all supply contracts made for safety related items, including those made down the supply chain to sub-tier vendors. This allows the regulator to consider such vendors for regulatory inspection activities [20].

#### 4.4.2. Supplier assessment and audits

Supplier audits should be used as one of the tools in the supplier evaluation process, at least for suppliers that provide components important to safety. When necessary, a follow-up audit should be used to ensure the supplier's capability to deliver a product compliant with the requirements before the commencement of manufacturing. A clear part of the audit and possible follow-up audit should be the evaluation of the supplier's risk reduction measures to prevent CFIs. Audit checklists need to include questions regarding the supplier's CFI identification and notification procedures and methods, and its personnel training programme as it relates to CFIs. Internal and external past performance data should be considered as part of the evaluation of the supplier's ability.

A good practice when first requesting that suppliers have CFI programmes in place (i.e. before the first audit covering the topic) is to send formal letters to them to request the development and implementation of such a programme. Such letters can define the requirement to have a documented process to prevent, detect and deal with suspected CFIs, state the requirement to provide personal awareness or detection training for staff, and provide suppliers with industry guidelines to support the development of a CFI programme.

Supplier return policies are of interest during audits. Such policies need to include inspections of returned items for the potential addition of CFIs and prohibitions on returning greater quantities than were purchased (which might indicate items that have come from an unknown, fraudulent or non-traceable source).

Evaluations need to cover the supplier's measures for assessing its sub-suppliers, including the procedures or processes used to mitigate the risks of CFIs, and the supplier's process used to oversee its sub-suppliers. A supplier needs to confirm that its reporting systems include a requirement to report the discovery of CFIs to the purchaser.

Increasingly, operating organizations are becoming more intrusive in the area of supplier assessment and auditing of sub-suppliers, since many supply chain issues (including CFIs) seem to develop at the lower tiers of the supply chain. Vendor inspections are becoming more intrusive and are covering lower tiers of the supply chain and more technical subject matter (not just quality management systems). In some cases, audit results are being posted on publicly accessible web sites.

Ontario Power Generation, for example, has instituted a process for the planned oversight of major suppliers, which can include [49]:

- Oversight of selected sub-supplier audits;
- Oversight of selected sub-supplier source inspections;
- Review of selected sub-supplier purchase orders to ensure that technical and quality requirements are specified;
- Witnessing of receiving inspection by spot-checking products supplied by sub-suppliers.

Suppliers are also increasingly interested in overseeing their sub-suppliers. In some jurisdictions, joint sub-supplier auditing programmes have been set up to save on audit costs and to ensure that a consistent methodology is applied. An example of such a programme for the Canada deuterium–uranium (CANDU) reactor industry is the CANDU Industry Audit Committee, which was set up in 2016 for CSA Z299 or N299 series suppliers. An older (1994) example is the Nuclear Industry Assessment Committee for 10 CFR 50, appendix B, or equivalent US Department of Energy quality programme suppliers. A standard Nuclear Industry Assessment Committee checklist (with CFI related questions) is available on the committee's web site (http://niac-usa.org). The Nuclear Industry Assessment Committee CFI specific assessment area items are listed in Box 1. A similar assessment used by Sellafield Ltd for its supplier score-cards with a three point grading scale is shown in Fig. 14.

Supplier audits are discussed in sections 3.4.3 and 7.4.3 of Ref. [2]. Some specific supplier evaluation questions are included in Ref. [6].

#### 4.4.3. Bid evaluation processes accounting for counterfeit or fraudulent item concerns

As described in Section 4.5.3, operating organizations should incorporate a clause in procurement contracts that requires suppliers to establish and implement a CFI prevention process. Contracts should also contain a statement that notifies the supplier that delivery of CFIs is a considerable concern to the customer.

The method and criteria used to evaluate suppliers' proposals should be assessed. Price has become increasingly important and is often the most heavily weighted factor in determining which supplier is awarded a purchase order. In addition, performance incentives for personnel involved in the purchasing and contracting processes often include criteria based on total savings. Policies that require the selection of lowest cost bids can contribute to more at-risk procurement scenarios and CFI incidents. Counterfeit items are often associated with the least expensive bids, so large gaps in pricing should be cause for further investigation. Bid evaluation criteria should include consideration of the type of supplier (e.g. Internet, broker, authorized distributor, original manufacturer), the level of experience with the supplier, the willingness of the supplier to certify that the items are genuine, and the identified sub-suppliers and their historical performance.

**BOX 1. STANDARD PUBLIC NUCLEAR INDUSTRY ASSESSMENT COMMITTEE AUDIT CHECKLIST, ASSESSMENT AREA QUESTIONS RELATED TO CFIs [50]**

"7.6 Verify that the supplier has assessed and described inspection/testing processes (such as those used during receipt/in process/final inspection or testing) for identifying suspect (including counterfeit/fraudulent) material, items or components that may not be those ordered, with indications such as:

- Altered manufacturer's name, logo, serial number or manufacturing date
- Items differing in configuration, dimensions, fit, finish, colour or other attributes from that specified
- Markings on items or documentation are missing, unusual, altered or inconsistent with that expected
- Markings or documentation from country other than that of the sub-supplier
- Items sold as new, exhibit evidence of prior use
- Performance inconsistent with specifications or certification or test data furnished
- Documentation that appears altered, incomplete or lack expected traceability, UL or manufacturer's markings"

**Management of Suspect and Counterfeit Products**

Quality Grade 01 02 03

11.3 The Contractor shall ensure that processes are in place to mitigate the risk of Suspect and Counterfeit products being deployed to Sellafield Ltd. The processes shall include identification of Suspect and Counterfeit products, assurance of product source, selection of suppliers and verification that purchased products meet the specified requirements.

11.4 In the event of suspect or counterfeit products being found the Contractor shall immediately notify the Customer in case a similar item is in use, and initiate the Non Conformity process as described in section 8

11.5 The Contractor shall ensure that processes are in place to control and document the disposition of products identified as Suspect. Sellafield Ltd shall be provided records of the dispositions of Suspect products, as agreed at the opening up meeting.

*FIG. 14. Sellafield Ltd's supplier grading system related to CFI management [51].*

Proposal evaluation and incentive policies that promote the selection of the lowest cost proposal should be reviewed to ensure that they do not result in the selection of the lowest cost bid without evaluating other criteria, such as the following:

— Is the supplier an OEM approved distributor?
— Does the supplier have proven capabilities?
— Is the supplier willing to certify that the items are genuine?
— Does the purchasing organization understand which sub-suppliers will be used and what their CFI processes are?

Bid evaluation is covered in more detail in section 3.6 of Ref. [2].

## 4.5. PROCUREMENT MANAGEMENT

### 4.5.1. Recognizing at-risk procurement

Staff within procurement organizations need training, experience and process controls to assist in recognizing at-risk procurement scenarios. Such scenarios are those known to have a higher than normal risk of receiving a CFI from a vendor. Additional prevention or detection measures, such as additional inspections and oversight actions, can be initiated for these cases.

A process of formal supplier risk assessment can be employed to help. This process might be implemented in conjunction with supplier assessments and audits as described in Section 4.4.2. SAE International, for example, has produced Standard SAE ARP6178 [52] on performing CFI related risk assessments of electronics distributors.

A procurement can be identified as 'at risk' if the purchasing agent, material analyst, procurement or quality engineer or other personnel is aware of exposure to risk factors known to be associated with CFIs. Table 4 provides examples of such factors.

Figure 15 shows a sample risk table used by one operating organization. By policy, the organization requires that, whenever possible, procurement should be from low risk sources as specified in the table to avoid receipt of CFIs.

Enhanced inspection and testing acceptance criteria are normally specified for items that are procured through at-risk procurements.

TABLE 4. AT-RISK PROCUREMENT EXPOSURE FACTORS

| Exposure area | Exposure risk factor | Comment |
|---|---|---|
| Product characteristics | Product is known to be susceptible to counterfeiting. | Construction materials, electrical devices, past experience, etc. |
| | Product is a commodity or commercial grade item known to be susceptible to counterfeiting. | Commercial products have wider sales potential and thus are more likely to be counterfeited than, for example, a specially produced engineered product. |
| | Operating experience has identified receipt of suspected CFIs of similar type. | Similar manufacturer/supplier and part/model number combinations. |
| | Product has long been considered unavailable on the open market. | For example, a like for like replacement has suddenly become available for an obsolete part. |
| | Scrapping or rework of non-conforming product will be extremely costly for the supplier. | Supplier may attempt to provide fraudulent certificates to make the product appear to be conforming. |
| | Product is difficult to detect as counterfeit during receipt inspection. | Applies particularly to products with many subcomponents, any one of which may be counterfeit. This includes electronics and complex electrical, mechanical and hydraulic devices. |
| Supplier characteristics | Supplier will not accept a purchase order. | For example, supplier permits only credit card orders. |
| | Supplier is new (without an established record) or changes its source of supply. | New supplier may have different safety culture and may use the counterfeit product to save on costs. |
| | Supplier is an unknown or unverified supplier, equipment broker, independent distributor or Internet exclusive supplier. | |
| | Supplier is not the OEM or is not authorized by the OEM to provide the items being purchased (authorization is critical for items such as lifting/rigging, safety and fire protection equipment). | Authorized distributors typically employ a rigorous process for ensuring component authenticity. A statement on a supplier’s web site or advertisement indicating that they are an OEM authorized distributor is normally not considered adequate confirmation of the supplier’s current status; it is better to verify directly with the OEM. Procurement from an authorized distributor may, however, need to be considered ‘at risk’ if the authorized distributor is sourcing the item from an entity other than the OEM. This includes identical and similar items from sources other than the OEM. |
| | Supplier takes exception to anticounterfeiting or fraud language in the purchase order. | |
| | Supplier takes strong exception to requirements, including refusing to offer a traceable source of supply or to provide or be accountable for product certification. | |
| | Supplier is dismissive or non-responsive to purchaser concerns and inquiries regarding supplier protections against and experience with CFIs. | |
| | Items being ordered are known to originate from regions known to provide counterfeit items of that type. | |

TABLE 4. AT-RISK PROCUREMENT EXPOSURE FACTORS (cont.)

| Exposure area | Exposure risk factor | Comment |
|---|---|---|
| Supplier characteristics | Drop shipping is planned, whereby a supplier arranges for the item to be shipped directly to the customer from a third party, usually a wholesaler or manufacturer, without first receiving and inspecting the item at the supplier's facility. | A bypassed inspection step can increase the likelihood of receiving a CFI. |
| | Supplier is in a poor or declining financial position. | Supplier may have an incentive to use counterfeit products to save on costs. |
| | Supplier has had a change in ownership. | New supplier ownership may apply pressure to use counterfeit products to save on costs. |
| Price characteristics | Cost per unit quoted is significantly lower than other quotes or previous purchase prices (on orders imposing similar requirements). | |
| Schedule pressures | Procurement process is on an expedited schedule (e.g. critical path for an outage or major project). | Supplier or internal staff may feel pressure to cut corners. |

**Note:** CFI — counterfeit or fraudulent item; OEM — original equipment manufacturer.

These precautions might include the following, commensurate with the item's criticality:

— Performing inspections and tests to confirm critical performance attributes of the item.
— Performing OEM recommended inspections (as part of the receipt inspection process) to authenticate the item. Recommended inspection requirements and acceptance criteria related to authenticating an item would be determined by contacting the OEM directly.

EPRI has developed a risk mitigation document [6] and self-assessment checklist [53] to provide utilities with a means to assess existing anticounterfeiting measures and a tool to identify opportunities to improve anticounterfeiting measures in existing processes and programmes. The checklist can be shared with all supply chain tiers to raise awareness of the counterfeiting issue and communicate effective means of minimizing risks.

#### 4.5.2. Establishing clear procurement requirements

Clear procurement requirements are important to avoid CFIs and to ensure that a product meeting all other requirements is received. As such, a process needs to be established to ensure that each characteristic required for a product to be used in nuclear facilities is properly identified and transmitted to potential suppliers.

Procurement processes need to ensure that all requirements that should be met by a product flow down in procurement documents to the suppliers, and the suppliers should prove or demonstrate by past performance that they can achieve them. Supplier management systems thus need to ensure that suppliers are able to provide products and achieve control in all stages of implementation from technological design to fulfilment, packaging and transfer to the buyer. Processes should ensure that relevant requirements are also imposed on sub-suppliers. Individuals involved with source or receipt inspection should be aware of and have ready access to these requirements and associated acceptance criteria.

Descriptions included in procurement documents for critical items should identify critical or important characteristics as opposed to simply referencing a part or model number. Such documentation allows inspections at receipt to include verification of the complete item description as well as the part or model number. This is particularly important when procuring from an ISO certified supplier. ISO 9001 [54] requires that a supplier ensure that requirements specified by the customer can be met before the commitment is made to supply the product. If the procurement documents only refer to the part or model number, the procuring organization will not necessarily

| Counterfeit risk cause likelihood | How likely is the risk cause to occur? | Source |
|---|---|---|
| High | It is highly likely to occur<br>Performance data show evidence of an inability to meet the contractual requirements<br>The material is extremely difficult to obtain | Supplier or distributor with a history of providing suspect counterfeit parts, fraudulent activity |
| Moderate | It is probable or likely to occur<br>No data available to show supplier's ability to meet the contractual requirements<br>The material is somewhat difficult to obtain | Open market purchase |
| Low | It is unlikely to occur<br>Performance data show evidence that the contractual requirements will be met<br>It is a common material and not difficult to obtain | Approved supplier list of original equipment manufacturer |

*FIG. 15. Matrix of likelihood of risk of receiving counterfeit or fraudulent items by source. (Courtesy of Ontario Power Generation.)*

receive the ISO 9001 assurance for the critical or important characteristics not specified in the procurement documents.

Contractual requirements pertaining to disposal of rejected and surplus items (Section 4.8), communication of actions that will be taken if CFIs are provided (Section 4.6), provision of product certifications, and use of escrow payments, when appropriate, are desired. Contracts should also include clear, detailed descriptions of the item and the applicable standards and acceptance criteria.

### 4.5.3. Standard procurement clauses and contract language addressing counterfeit and fraudulent items

Contractual requirements that address CFIs should be included in procurement documents. The purpose of contractual requirements is to notify the supplier that CFIs are a concern and that actions may be taken against the supplier if the items provided are identified as suspect or are determined to be counterfeit or fraudulent.

Standard procurement clauses should relay the operating organization's expectations of the vendor or supplier regarding CFIs and supplier management system requirements and should raise the profile of the issue with suppliers.

Examples of acceptable clauses are in section V.22 of Ref. [2] and appendix B to EPRI Report 3002002276 [6]. The EPRI report contains further examples from the aerospace industry and the US Department of Energy.

In some cases, it is necessary to provide design information to suppliers to ensure that the correct replacement items are furnished. In such cases, care should be taken to legally safeguard the design information, particularly when the information is being provided to organizations other than the OEM, original equipment supplier or entity with rights to manufacture the items in question. This may involve limiting distribution of design information to a need to know basis and obtaining non-disclosure (or other appropriate) agreements before disclosing the information.

The supplier should demonstrate that materials or subcomponents to be incorporated into the initial product are controlled and resources are checked to prevent the inclusion of CFIs in the manufacturing chain. The supplier should also demonstrate how requirements are transmitted to and controlled by sub-suppliers.

A programme of collaboration should be established between the supplier of products and the organization that operates the nuclear installation to ensure the detection of any non-conformance and the solving of such issues in a timely manner. This will create confidence on both sides and, ultimately, constitute an important barrier to the possibility of introducing counterfeit products into the nuclear facility.

The most obvious method of reducing exposure to CFIs is to communicate with suppliers about this topic to identify concerns and expectations. The exchange of information can be fruitful for both parties.

Suppliers are under significant pressure to reduce prices; in some situations, a supplier may unintentionally sell an item that is not acceptable to its customer. To ensure that the supplier is aware of important requirements, clear and concise specifications and item descriptions should be included in procurement documents for each item included in the scope of concern.

## 4.6. ZERO TOLERANCE POLICIES FOR VENDOR COUNTERFEITING

Zero tolerance policies by utilities, regulators, standards organizations or governments are designed to ensure that unscrupulous suppliers understand that if they are discovered, the parties will prosecute illegal activities to the fullest extent of the law.

When a tier 1 supplier has been a victim of counterfeiting or fraudulent activity by a sub-supplier, owner–operators typically have policies to discontinue procurement from such tier 1 suppliers until appropriate corrective actions have been taken. This includes the assurance that the supplier is properly trained and competent in detecting CFIs and preventing them from entering their supply chain.

Prosecution of counterfeiting or fraudulent activity requires an appropriate legal framework within the jurisdiction involved, which can be an issue in some locations. Governments, however, are increasingly addressing the issue, and an appropriate legal framework that protects intellectual property is necessary for new build nuclear power plant projects to proceed.

Some testing organizations work with governmental agencies to facilitate identification of CFIs. Underwriters Laboratories, for example, has established a team dedicated to counterfeiting issues that is improving Underwriters Laboratories marks to make them harder to counterfeit, training US customs and border protection agents to identify counterfeit Underwriters Laboratories marks before they can enter the marketplace, educating manufacturers and retailers to help them identify counterfeit products, providing real time support for customs and law enforcement officials, and producing detailed enforcement manuals and reference materials [55].

## 4.7. INTELLECTUAL PROPERTY PROTECTION

Inappropriate use or distribution of intellectual property related to products or services can contribute to the production of CFIs. Access to intellectual property received by operating organizations from suppliers and OEMs for the purpose of nuclear facility operation (e.g. drawings, manuals, specifications, capability curves) should be controlled on a need to know basis by physical and electronic means. Not only is this good and lawful business practice, but it also helps prevent this information from falling into the hands of counterfeiters [2].

Operating organizations should have processes in place for reporting to the appropriate organizations detected violations of intellectual property rights. The appropriate organizations might include the company whose rights may have been violated, industry bodies and, potentially, law enforcement. Section 7.1 of this publication provides more detail on reporting.

Country specific risks related to intellectual property protection can be a concern. An International Property Rights Index is published regularly that contains specific ratings by country regarding the levels of intellectual property protection typically present in those jurisdictions (see http://internationalpropertyrightsindex.org/). Organizations dealing in countries with typically low levels of protection are advised to take additional precautions.

Suppliers also have their own responsibilities to not transfer any technical information they receive to any third parties without the written consent of the original manufacturer and to comply with applicable trade control laws and regulations related to the import, export, re-export or transfer of goods, services, software and technology, including the restriction of access to unauthorized parties.

## 4.8. SCRAP AND DISPOSAL POLICIES

Unscrupulous individuals may attempt to obtain scrapped, disposed of or non-conforming items and offer them as new or refurbished certified parts. Operating organizations are advised to have scrap and disposal policies in place to minimize the potential for such items to fall into the hands of these parties.

Such requirements should also be imposed on supply chain participants, when practical, so that ‘seconds’, production overruns and defective items do not fall into the hands of potential counterfeiters. The proper destruction and disposal of all unsalable or unusable items, surplus, and scrap by suppliers, distributors and end users can help reduce their unauthorized reuse [2].

## 4.9. HUMAN PERFORMANCE TOOLS

As described in Ref. [2], nuclear industry human performance tools [56, 57] can be used to help in the detection of CFIs. Pre-job briefings for receipt inspectors, warehouse staff and maintenance staff, for example, can cover CFI detection. Encouraging a questioning attitude or stopping when unsure, can facilitate individuals stopping jobs when they are concerned that an item to be installed may not be genuine. Procedure use and adherence can encourage staff to fully complete any checklists, processes or other activities designed to assist in CFI detection or prevention. Other human performance tools can be used or adapted to assist.

## 4.10. USE OF DIFFICULT TO COUNTERFEIT, POSITIVE IDENTIFICATION TOOLS

Using advanced marking and positive identification tools throughout a supply chain can reduce the potential for the introduction of CFIs. The National Electrical Manufacturers Association, for example, has produced a publication [9] listing certain anticounterfeiting and authentication technologies that can be used in industry. These include (a) security inks and coating (e.g. intaglio inks that provide a distinctive feel, like on a passport; inks only visible under ultraviolet, fluorescent, polarized or infrared light or when heated; optically variable inks; pearlescent varnishes; inks tagged with microscopic or nanoscopic particles; machine readable inks; conductive inks; photochromatic inks), (b) difficult to mimic or photocopy security printing (microtext, nanotext or guilloche), (c) security paper (designed for tamper resistance or containing security threads, fibres, or other embedded features), (d) optical technologies (holograms, films, etc.), (e) chemical and molecular tags and nanotechnologies and (f) electronic tracking and tracing systems (barcodes, radiofrequency identification tags, etc.) that can track an item through the supply chain. Existing inventory can be backfitted with such markings if they are not already applied [2].

Many of these new technologies can be applied covertly, so that they are not visible to the naked eye but require simple tools or specialized equipment for authentication. These technologies include invisible barcodes that can only be read with specialized scanners (Fig. 16), barcodes with embedded anticounterfeit or copy prevention features that ensure an illegally reproduced label is detectable, and some of the other printing and tagging methods described above.

Anti-tampering features (shrink wraps, irreparable sealing materials, tamper evident labels and coatings, etc.) can also provide assurance that items were not tampered with during shipment and can reduce the potential for the receipt of CFIs. Devices installed in shipment containers such as tilt indicators, accelerometers and environmental condition measurement labels or devices (for temperature, humidity, etc.) can assist in ensuring that shipping conditions were appropriate and provide some additional confidence that no tampering has occurred. An example label with tamper evident coatings is shown in Fig. 17.

Sophisticated vendors now can offer digital authentication and tracking services to customers as an additional layer of brand protection. Through the use of two dimensional barcodes, smartphones and cloud based technologies, companies can be provided with unit-level identification, authentication, traceability and business intelligence throughout their entire supply chain. Customers can get increased immediate assurance that a product received is authentic by scanning an item’s two dimensional quick read barcode, while legitimate suppliers can more easily locate and identify counterfeiting, product diversions and gray market activity.

## 4.11. DESIGN RULES AND PRACTICES THAT EMPHASIZE DIVERSITY OF SUPPLY

Although not implemented specifically to address CFI issues, nuclear defence in depth design practices that emphasize diversity of suppliers when designing critical systems have been in place for many years. For example,


*FIG. 16. Covert barcode. (Reproduced from Ref. [58] with permission courtesy of Brady Corporation.)*


*FIG. 17. Tamper evident two dimensional barcode label, with coatings sensitive to excessive heat or water contact. A — non-activated; B — heat indicating; C — water indicating; D — heat and water indicating. (Reproduced from Ref. [58] with permission courtesy of Brady Corporation.)*

suppliers of equipment for a primary reactor shutdown system would not be considered to supply equipment related to a secondary shutdown system. Such practices could be extended into the broader supply chain, with single distributors or service suppliers not being considered for all critical supply functions [2].

Such practices can provide nuclear facilities with some protection from the impacts of a single CFI related incident but do not lessen the need for a strong response to such detected incidents.

# 5. IDENTIFICATION, INVESTIGATION AND DISPOSITION

Early identification of CFIs is essential to minimize the impact on safety, costs and work schedule and prevent any impact on the environment and the population.

Operating organizations should establish processes for the prompt identification of abnormal conditions for further investigation and non-conformance processes for substandard items (items or services that are unacceptable). CFIs can be identified and dealt with through existing corrective action or non-conformance processes if staff are aware of the risks and mitigation measures associated with CFIs.

When identification of an abnormal condition occurs and involves a substandard product or service, the item should be considered suspect until a subsequent investigation demonstrates the item to be genuine, non-conforming, counterfeit or fraudulent.

Formal processes for sharing information with outside organizations at the earliest possible opportunity are encouraged. Preliminary information based on reasonable certainty (e.g. based on OEM information related to suspect items) can be shared even before a definitive determination of the item being counterfeit or fraudulent is made. Such information sharing provides the widest possible protection for the industry in stopping the spread of CFIs.

Organizations need to be aware, however, of the commercial implications of their decisions and the reputational damage that could be caused by the publication of inaccurate or incomplete information related to a supplier's products or services. Care thus needs to be taken regarding what is shared, with whom it is shared, and how the applicable issue is characterized.

## 5.1. COUNTERFEIT OR FRAUDULENT ITEM IDENTIFICATION AND DISPOSITION

CFIs are not restricted to certain categories of component, equipment or service. Civil, structural, mechanical, electrical and electronic components all may be affected. Items may have been made from counterfeit or fraudulent materials, assemblies, subassemblies or components or may have been tested or certified in a fraudulent manner.

Generally, inspection personnel involved in the organization's supply chain quality assurance (source inspectors, receipt inspectors, etc.) are most likely to identify suspect items. Staff associated with product design, specification, procurement, manufacturing, storage, installation, operation and even decommissioning are also able to identify such items.

When faced with unusual situations or abnormal conditions related to a procured product, actions should be initiated through a suspect item management process. A sample process is described in Section 6.2 (Fig. 18).

Although existing (graded) non-conformance arrangements will be in place for procured items, staff should be trained specifically on the risks associated with CFIs, CFI detection methods and the need for prompt reporting, disposition, and disposition implementation or corrective actions for CFIs. A list of CFIs, installed or stored as spares, should be compiled and kept current.

## 5.2. INSPECTION AND ACCEPTANCE TESTING

Before a product's acceptance, implementation or commissioning, its conformity needs to be assured by inspection and testing. Inspection and testing are in most cases necessary because product verification based on quality classification and certification documentation alone may not be sufficient to ensure the quality of the purchased product. Inspection and acceptance testing are part of a purchaser's management system oversight process for the items being purchased and have a key role in helping to prevent CFIs from being installed in a facility.

It is most beneficial (least cost to the purchaser) to detect CFIs before shipment, that is, before their delivery to the nuclear facility. After shipment, receipt inspection, site acceptance testing and pre-installation inspections become the final barriers to CFIs entering the facility. At whatever point a potential CFI is suspected, a formal process for dealing with it should be invoked. An example process for this is described in Section 6.2.

### 5.2.1. Factory inspections

Having appropriately trained (see Section 4.2), technically knowledgeable personnel perform factory inspections in the supplier's production or manufacturing facilities, where materials, subcomponents and the assembled product are located, constitutes a good (and low cost) opportunity to locate CFIs. For maximum impact and to ensure that observed activities are 'typical', an inspection programme can include elements of scheduled, random (unexpected) and night shift or weekend inspections. Increasingly, organizations are expanding the scope of their inspection activities to include sub-tier suppliers.

These inspections may occur at various major manufacturing steps, at the point of final inspection and testing before shipment (e.g. factory acceptance tests), or both. They may include visual inspections, inspections of material controls in the facility and reviews of quality records. More detailed inspection of components can also be considered, including destructive or non-destructive tests of material coupons (to help confirm traceability and material properties). For critical items, this testing can be performed by or repeated by independent laboratories.

Inspections should be conducted in accordance with the complexity of the product (including the novelty of the production process) and its importance for safety or reliability. In the context of CFIs, consideration is also given to the specific risks associated with CFI occurrences. For mass produced items, random sampling throughout the batch production of product to make comparisons against a recognized statistical sampling standard can assist quality surveillance. IAEA-TECDOC-1740 [46] provides further information on the application of grading.

When CFIs are discovered during inspection or sampling, the entire lot is normally considered to be suspect. The potential for CFIs in other items obtained from the same supplier should then be considered.

For products that have specific quality requirements, the supplier typically prepares a quality inspection and test plan and establishes points (witness, review or hold points) to check the manufacturing process. In the context of CFIs, inspection and test plans can also include checks for any signs of attempted fraud or counterfeiting. These checks focus on meeting acceptance criteria and associated quality records that demonstrate the origin of the products, their status and the results of the various checks. Section 3.5.1.2 of Ref. [2] contains more information on inspection and test plans.

As shown by international experience, manufacturing inspections need to check that traceability records are kept accurately and that unique identification numbers are properly transferred to products as they proceed through manufacturing (i.e. through materials procurement and through material/item cutting and joining processes and lot/batch separation to the final product).

Inspection checks are based on the observation of manufacturing steps but also heavily on certification documentation (e.g. certified material test reports). Engineering attributes and quality assurance criteria specified in the procurement documents should be verified throughout the essential steps of manufacturing, final acceptance tests and product final reception. As CFIs can hide behind fraudulent documentation, such inspection alone is not sufficient to verify the quality of purchased items.

Organizations may be faced with obsolescence issues in which replacement identical (like) parts or materials are not available anymore in the marketplace. When initial products will have to be replaced, this change may be an opportune way to introduce CFIs. Necessary tools and techniques (inspection processes) that were applied throughout the initial inspection should be used.

### 5.2.2. Receipt inspection

Preventive actions against CFIs should be developed as part of an operating organization's receipt inspection processes. Receipt inspection is the review of received material when it is delivered into the operating organization's care and control at its warehouse. Receipt inspection is a key barrier at which a CFI can be identified and stopped from entering the facility for installation if it does not have necessary assurances that quality and technical requirements have been met [2]. Receipt inspections are thus an essential activity and should be performed with great care. Additional attention should be provided for procurement scenarios that were identified as 'at risk' (see Section 4.5.1), particularly when purchasing from suppliers that are neither the original manufacturers nor authorized distributors and for whom there is no past performance information.

Receipt inspection can include such tasks as confirming the identity of the incoming item, checking for shipping damage, checking that the appropriate quantities have been received, confirming that certification or other paperwork and manuals have been received, and performing specific inspections or verification tests based on the item's critical characteristics. If discrepancies are noted, the items should be physically separated or quarantined from any 'good' stock to prevent their inadvertent use until the issue can be resolved.

Receipt inspectors should be trained in and aware of things to look for in detecting potential CFIs. Section 8 provides some specific signs to look for that may indicate a CFI. Such signs may include altered or incomplete labelling, obvious attempts at beautification, evidence of hand-cut materials, poor fit with items from the same manufacturer and documentation discrepancies or illegibility. Warehouse and other facility staff should receive specific training in the detection of such items.

For at-risk procurement scenarios (see Section 4.5), enhanced receipt inspection may be appropriate. Enhanced receipt inspection can include (a) requesting inspection and testing criteria from the original component or equipment manufacturer, (b) using photographs of authentic items to aid authentication when performing receipt inspection (e.g. verifying that manufacturer and certification organization markings are correct), (c) consulting available industry data on known counterfeits and (d) for electronics, implementing the guidance in SAE AS5553 [59] and IDEA-STD-1010-B [60].

Positive material identification (PMI) is increasingly being used as part of advanced receipt inspection and can be used to detect CFIs or other non-conforming products. As described in section 3.5.2.3 of Ref. [2], PMI can include the use of "special test and inspection equipment such as metal alloy analysers..., hardness testers and equipment for dimension checks, among others." Simple magnets can also be used to differentiate some materials (e.g. to differentiate carbon steel from many types of stainless steel); chemical analysis of received commodities (e.g. oils, liquids, chemical products) is also used, as (occasionally) is some destructive testing. Such tests can confirm that the item or material received is in fact what was ordered.

Typical tools for PMI metal alloy analysis include X ray fluorescence and optical emission spectrometry based instruments. A common application of PMI is alloy testing of carbon steel piping for chromium content. High chromium content steel is more resistant to flow accelerated corrosion and is now commonly specified for areas within power plants sensitive to this type of corrosion. A simple to use handheld tool can confirm chromium concentrations in pipework and fittings in seconds in a receipt inspection environment. Such tools are highly accurate at determining the chemical composition of virtually any alloy. Moreover, they do so within a matter of five seconds or less for most steel grades, without significant sample preparation.

The PMI tools can also be applied as part of final material installation in a facility to provide verification that the correct material was installed. Such a process has been adopted by the petrochemical industry as part of American Petroleum Institute Standard RP 578 [61] to help reduce the risk of catastrophic failures or accidents associated with piping systems.

### 5.2.3. Pre-installation checks and post-installation or site acceptance testing

Once an item is withdrawn from the warehouse, it is provided to construction or maintenance staff for installation in the facility and testing. At a minimum, the items are visually inspected; however, some sort of testing or commissioning process is usually completed. This testing may include post-installation or site acceptance testing that completes the inspection and test programme for the applicable items received. PMI testing as described in Section 5.2.2 can also be considered as part of the installation process.

The staff involved in these activities are the final barrier to CFIs entering the facility. Like other individuals involved in the process, these staff members typically require training and awareness regarding the things to look for in detecting potential CFIs.

### 5.2.4. Contractual arrangements for independent testing

Contracting for the independent testing of equipment and components can be a barrier to the introduction of CFIs. Typically, equipment manufacturers supply equipment with test certifications for such items as environmental or seismic qualification or with certifications of material properties. In some instances, unscrupulous manufacturers have shipped items with falsified certification paperwork. When independent testing agencies are directly contracted by an operating organization, this risk is reduced. The cross-checking of results from different laboratories can help validate their accuracy.

After the certification falsification scandals in the Republic of Korea in 2012, the regulator mandated that testing and certifying of parts and items could only be done by institutes that the regulator designated. These changes were an attempt to reduce the potential for corruptive relationships between manufacturers and test organizations [20]. The Korea Foundation of Nuclear Safety was set up in 2015 to manage this nuclear equipment qualification management programme. The scope of activities within the programme includes:

— Thermal ageing analysis or testing;
— Thermal fatigue testing;
— Temperature and humidity testing;

— Radiation ageing analysis or testing;
— Vibratory ageing testing;
— Loss of coolant accident testing;
— Pipe rupture accident testing;
— Flame testing;
— Electromagnetic obstacle or endurance testing;
— Seismic testing or analysis;
— Pump performance testing;
— Valve performance testing.

### 5.3. DISPOSITION AND DECISION MAKING RELATED TO IDENTIFIED COUNTERFEIT OR FRAUDULENT ITEMS

Even though a multilayered process may be in place to prevent CFIs, it is possible that eventually some CFIs may enter an organization's procurement process. Experience shows that CFI detection is far more difficult than dealing with CFIs when detected.

Procedures should address any CFI installed in the plant in items both important to safety and not important to safety. This is necessary to ensure that CFIs do not migrate from one system to another as well as to reduce any other hazards that could impact health and the environment.

If CFIs create a potential safety hazard, an engineering evaluation should determine whether the item or plant system containing the CFI should be removed from service immediately, locked out and tagged out until the CFI has been replaced with acceptable items or whether the item or plant system can be used (with or without limitations on operation) until the item can be replaced. Plant configuration and control documentation needs to be updated as appropriate for installed CFIs.

A sensible (but not always the most practical) way to handle CFIs is to dispose of them if not installed or to remove them from the field if they have been installed. Some additional precautions are needed to prevent the introduction of a similar (or the same) CFI at a later stage of production in usable inventory. When products are still within the supplier manufacturing line, it is important to monitor the scrapping of CFIs. Some contractual or insurance procedures may require deficient CFIs be sent back to the supplier. Some measures may be used to fully advertise a CFI (e.g. permanent special marking, disabling of product). Furthermore, when CFIs are detected during the initial stage of manufacturing, immediate action is needed to stop the manufacturing of the CFI and check that upcoming products would not suffer from the same kind of deviation.

The organization may be faced with other situations in which complete disposal or removal is not immediately possible. In that case, nuclear facilities may have to operate with such a CFI installed. Appropriate marking should be made on the product to identify its CFI status. An engineering technical justification for this situation will have to be prepared on a risk informed basis. Depending on the situation, some additional actions may be implemented to make use of the CFI safer, such as modifying the product to lessen the consequences of deviation, installing a real time monitoring device during product operation or performing regular checks of product operating parameters.

A replacement operation should be planned to remove CFIs at the earliest opportunity (e.g. a maintenance outage) to limit their operation.

If the product is already in an organization's warehouse but not yet installed, quarantine measures may be necessary to prevent its installation during the CFI disposition process. Dispositions of CFIs should always consider the extent of the non-conformance and include an action to verify if there are spare parts or warehouse stores with the same or similar items affected by the identified CFI.

Removed CFIs should be permanently and irrevocably altered or marked so that they cannot be reused. Examples of alteration include melting, shredding or destroying the threads on fasteners; crushing circuit breaker casings; and embedding fasteners in concrete or other media, rendering them useless.

Disposition may include the need to retain the CFI for further analysis, material properties testing, development of preventive actions, or training for CFI identification, or to pursue any financial or legal remedy with the supplier. The CFI should also be disposed of in accordance with Member State environmental requirements. In any case, every effort should be made to prevent the CFI from being reintroduced into the supply chain.

### 5.4. INVESTIGATION

After the determination that a suspect item is not genuine, careful consideration should be given to investigating the circumstances surrounding the procurement, acceptance or installation of the item. Actions are typically put in place to prevent reoccurrence. These actions are normally taken as part of the organization's standard corrective action process.

# 6. MANAGING, MONITORING AND CONTROL

### 6.1. GENERAL

Lessons learned from CFI control within the nuclear industry have shown the following good practices and characteristics:

— Specific requirements for purchased items and purchasing conditions should be clearly defined in the contract or procurement documents, including the definition of a supplier's responsibilities in cases of CFI detection, as well as the applicable sanctions and refunds, and a requirement for the supplier's cooperation in investigations and analysis of potential CFIs.
— Special attention should be devoted to items delivered to and accepted at the warehouse as enclosed or sealed products. Inspections by the purchaser at the supplier's facility before packaging (at the place of item final assembly and packing) should be provided for and granted by the supplier in the contract.
— Effective source inspection, receipt inspection and testing programmes should be implemented and conducted.
— Comprehensive, engineering based programmes should be implemented for the review, testing and dedication of commercial grade products for suitability of use in safety systems. Details on CGD can be found in section 5.1.4 of Ref. [2].

### 6.2. PROCESS FOR SUSPECTED COUNTERFEIT OR FRAUDULENT ITEMS

When a suspected CFI is encountered, it is important to ensure that the item is not inadvertently used in the facility and that a full investigation is undertaken. Such a process needs to be set up in advance so that staff members do not take action that could adversely impact the investigation.

Processes should ensure that staff members report such incidents and quarantine suspect items and their packaging and supporting documentation. This allows for a full and effective investigation with the OEM, the supplier and, potentially, law enforcement authorities.

Steps for handling a suspected CFI would typically include:

— Quarantine the suspect item.
— Record the incident in the organization's corrective action programme.
— Assess the immediate safety and operability implications, and perform an extent of condition review.
— Notify the appropriate internal organizations.
— Gather information.
— Consider reporting preliminary findings to industry databases.
— Contact the appropriate supply chain participants for information about related incidents or any ongoing investigations. Careful consideration should be given to the choice of companies (e.g. OEM, tier 1 supplier, sub-supplier) to be contacted and to whom the suspect item may be returned for analysis. Such contact may tip off unscrupulous counterfeiters, who may destroy evidence.
— Inspect, test, review or take other actions as required to determine if the item is genuine and/or non-conforming.
— Physically dispose of a confirmed CFI.

— Share lessons learned and actions with regulators, industry, law enforcement and other appropriate agencies as required.

A general flow chart for addressing CFSIs is given in Fig. 18. Suspect items should be considered suspect until confirmed to be genuine, non-conforming, counterfeit or fraudulent. The confirmation process is started when a nuclear facility is faced with an unusual situation or abnormal condition related to a procured product. This can occur during the procurement process; on item receipt; during installation, commissioning or maintenance; or after unexpected failures or malfunctions of in-service items.

Adequate measures (including preventing CFIs from returning to the supply chain) should be taken to enhance the supplier management system (supply chain) procurement processes, with feedback made for use in training and reporting.

Controls should be established to identify CFIs during the receipt, installation or investigation of degraded performance or failure. If an item is suspected of being counterfeit or fraudulent, it should be controlled to prevent future use and considered for further investigation and disposition. An organization's planned response to a CFI should be documented in written procedures. Existing processes for responding to a CFI should be assessed against this publication and updated as appropriate.

Key elements for managing, monitoring and controlling suspect items are discussed in the remainder of Section 6.

### 6.2.1. Quarantine (segregate) the suspect item

Suspect items should be physically separated, or if it is impractical to segregate the items, then they should be removed from the available inventory and clearly marked as non-usable. If possible, shipping containers, packaging and all shipped documents should be retained and kept with the suspect item. Processes and procedures should include instructions for how to physically identify, control, segregate and tag out the suspect items so that they are kept away from the available inventory.

If the CFI is found installed (i.e. in an operating system), a prompt engineering evaluation will be needed to determine the necessary interim actions, as described in Section 6.2.2.

### 6.2.2. Add incident to facility corrective action programme

The management of CFIs should be integrated with the facility's standard procedures for handling non-conformances and corrective actions. Such processes include evaluations of the extent of condition and extent of cause, as applicable, and the sharing of lessons learned internally within the operating organization and via industry information channels. These processes are also used to formally document, monitor and resolve the incident.

Requirement 13 of GSR Part 2 [1], paras 6.50–6.75 of GS-G-3.1 [28] and paras 6.42–6.69 of GS-G-3.5 [29] discuss corrective actions. IAEA Nuclear Energy Series No. NG-T-2.7 [57] discusses corrective actions surrounding human performance and behaviours, which can contribute to some CFI related events. Publications from various organizations and individuals contain information on the elements of a typical corrective action programme, including those in Refs [62–67].

In the context of CFIs, such processes typically include requirements for:

— Documenting the item identification and details of the deficiency;
— Tracking and monitoring the item;
— Documenting disposition for item non-compliance and actions to accomplish disposition (i.e. scrap, use 'as is', repair or rework);
— Determining the extent of condition and the extent of cause if required;
— Conducting tracking and trending;
— Identifying and tracking actions to prevent recurrence based on severity;
— Reporting internally and externally (to regulatory or law enforcement authorities).

When in-service items fail, staff should explicitly consider the possibility of counterfeiting or fraud being a cause of the failure. Staff involved in assessing failures should be trained in recognizing CFIs (see Section 4.2) and in the risks and implications of their being installed in a facility.

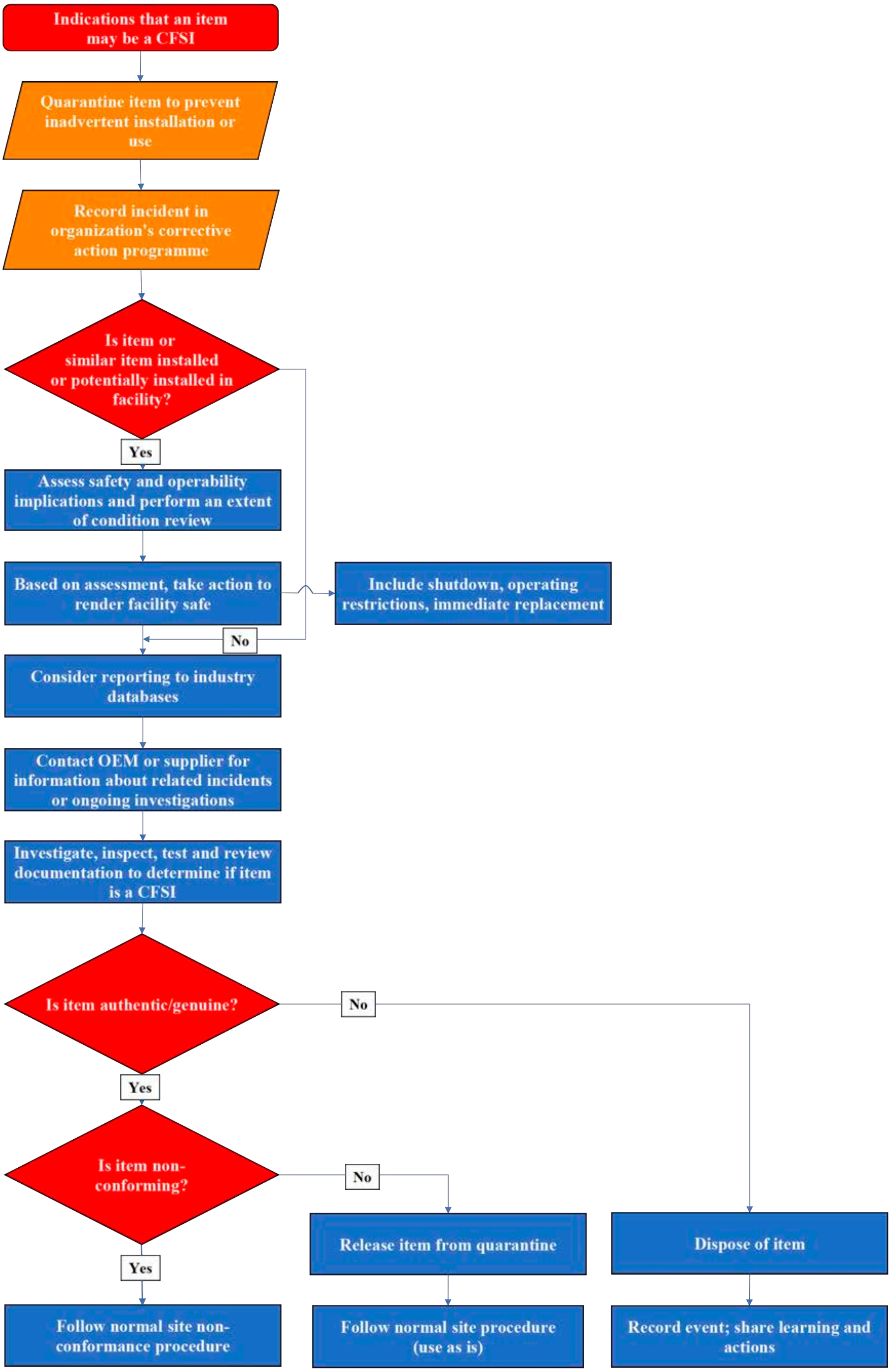


*FIG. 18. Process for counterfeit, fraudulent or suspect items (CFSIs). OEM — original equipment manufacturer.*

### 6.2.3. Notify appropriate internal organizations

Appropriate organizations internal to the operating organization should be informed at an early stage about the suspected CFI. Appropriate internal organizations would include purchasing, engineering, operations and maintenance. Such notifications can sensitize staff to potential similar occurrences at the facility and assist in the evaluation of the extent of condition. Operations and engineering can identify any immediate operability or safety concerns and take any necessary interim actions, such as shutting down, tagging out or otherwise removing the affected components from service as required.

### 6.2.4. Gather information to investigate the incident

Information should be collected to document the incident and determine whether the suspect item is authentic. If the process of gathering information determines that the item is no longer suspect, the incident should be handled in accordance with existing non-conformance processes. It may be important to gather the following types of information:

— Lot, batch and serial number;
— Date of identification;
— How the condition was identified;
— OEM;
— Original equipment supplier;
— OEM part or model number;
— Original equipment supplier part or model number, if different from OEM part or model number.

### 6.2.5. Consider reporting to industry databases

Depending on the preliminary knowledge and severity of the issue, consideration should be given at this stage to reporting the incident in a preliminary fashion to industry databases. This can assist other operating organizations in avoiding similar issues or in holding their own investigations until a final investigation of the event can be completed.

### 6.2.6. Contact the original equipment manufacturer or the original equipment supplier

The original manufacturer or supplier of the CFI will normally be in the best position to provide information regarding the authenticity of a particular item. They may also have knowledge of any known instances of counterfeiting or fraudulent activity related to the item within the general industry and any ongoing investigations. Contact should be made with these companies at an early stage to facilitate the investigation.

### 6.2.7. Consider contacting immediate sub-supplier

The immediate sub-supplier of the CFI may or may not have been acting in good faith in providing the product to the nuclear facility. At this stage of the investigation, a decision needs to be made regarding the advisability of making contact with this supplier and whether to return the item as part of the investigation, taking into consideration the need to secure the item from being reintroduced into the supply chain. Unscrupulous suppliers may consider destroying evidence or altering or disposing of the returned product, which can hamper further investigations and any future legal action. Scrupulous suppliers can, however, greatly assist the operating organization in furthering the investigation.

### 6.2.8. Determine if the item is genuine and/or non-conforming

Suspected counterfeit, fraudulent or substandard items are investigated and classified as genuine or not (i.e. a genuine item or a CFI) and as meeting requirements or not (i.e. conforming or non-conforming/substandard).

Appropriate action is then taken depending on the item categorization. Items that are genuine are handled by standard facility non-conformance processes or site procedures.

Each organization should describe its investigation process.

#### 6.2.9. Share information and notify appropriate organizations

Operating organizations and their suppliers have an important responsibility to prevent the intrusion of CFIs into nuclear facilities. Sharing information and notifying appropriate organizations is an essential part of this responsibility. The desire to promptly notify a supplier may conflict with other aspects of responding to a CFI incident, including manufacturer and law enforcement efforts to eliminate counterfeiting. Notifying a fraudulent supplier makes the supplier aware that its practices are in question. In certain jurisdictions, returning the CFI effectively constitutes returning evidence of a crime. Therefore, careful consideration should be given to notifying the supplier or returning the suspect item. In most cases, it is advisable to notify the OEM before notifying the supplier.

Lost revenue and damaged reputation are two of the biggest impacts of CFIs on original manufacturers. OEMs generally appreciate notification when their products are fraudulently represented or fail to operate properly. When contacting a manufacturer, inquire about how to determine if the suspect item is genuine, the performance of the supplier of the suspect item and whether the supplier should be notified. Suspect items should not be returned to the supplier unless the supplier is an authorized distributor for the manufacturer.

Notification should be made in accordance with applicable regulatory or law enforcement requirements (this will depend on each State's requirements).

Communicate the incident as operating experience to appropriate databases. The timely communication of CFI information is an important element of preventing a recurrence. As appropriate, CFI incidents should be reported to operating experience databases maintained by WANO and INPO.

Information sharing and reporting are covered more fully in Section 7 of this publication.

#### 6.2.10. Physically dispose of suspect items

The appropriate means of physically disposing of CFIs will depend on the type of item, the supplier and the circumstances of the CFI incident. In some cases, it may be appropriate to destroy the item and permanently remove it from the supply chain. In other situations, the item should be returned to the manufacturer or supplier for further investigation, as was discussed in Section 6.2.6. Lastly, consideration should be given to providing the item to law enforcement authorities. In all cases, decisions regarding the disposition of CFIs should be documented in detail to justify the actions taken and provide records for future evaluation.

### 6.3. TRACKING

Any suspected CFI (even in cases in which the item may later be confirmed as a genuine item) should be documented and tracked, and feedback should be considered and provided to supply chain participants when appropriate.

A database that records all CFIs, their physical location, the applications they are used in and their disposition status will assist in item tracking, monitoring, status reporting (refer to Section 7) and follow-up with suppliers. The database will also help to reduce the risk of reoccurrences, prevent unintentional reuse of the item and help ensure that corrective actions are completed when required and that lessons learned are documented. The capability to sort or filter reports by commodity group (e.g. electrical components, machine parts, chemical substances) or risk importance is useful.

Such a database can also include external CFI related operating experience, including updates on CFI suppliers, lists and bulletins issued by regulatory bodies and inspection authorities, information from outside organizations, and facility experience of stored and installed CFIs.

Access to this database would normally be granted to all relevant internal departments.

### 6.4. OVERSIGHT INVESTIGATIONS AND EVALUATIONS

#### 6.4.1. Management assessment

Managers should periodically review and assess the effectiveness of CFI processes and actions in identifying and resolving CFI incidents, as part of normal management assessment activities.

#### 6.4.2. Oversight of counterfeit or fraudulent item process

Organizations should document and implement a process for the oversight of the CFI process within their management system. Oversight could consist of assessments, surveillance, investigations, evaluations, trending analyses, audits, and so on. Oversight should evaluate the adequacy and effectiveness of the organization's processes for the prevention and elimination of CFI issues. The oversight process should include contractors who perform work for the facility and who could introduce or install CFIs into the facility. The oversight process can assess the following areas:

- Adequacy of the documented process;
- Effectiveness of the implementation;
- Effectiveness in identifying CFI issues;
- Effectiveness in tracking, monitoring and trending instances of CFIs;
- Overall effectiveness of the organization's ability to prevent, identify, resolve and eliminate CFI issues;
- Resource allocation (especially for supplier qualification and receipt inspection);
- Use of available sources of CFI information;
- Procurement process integrity;
- Regulatory interface;
- Employee awareness;
- Engineering involvement and participation;
- Identification of installed CFIs;
- CFI related training;
- Disposition of CFIs.

Personnel performing CFI oversight should be trained and competent in the requirements of the CFI prevention process.

## 7. INFORMATION SHARING AND REPORTING

One of the IAEA's nuclear energy basic principles (Principle 8) is in the area of continual improvement. It indicates that "*The use of nuclear energy should be such that it pursues advances in technology and engineering to continually improve safety, security, economics, proliferation resistance, and protection of the environment*" [68]. Information sharing among industry participants is a key prerequisite for any improvement activities.

Each organization should develop, document and implement a CFI prevention and detection process per the organization's requirements to protect the safety and integrity of the facility and the safety of workers and the public. This process should include a requirement to collect and document all pertinent data and information for all CFI issues and ensure the necessary data and information is available and retrievable. The documented process should include controls for information sharing and requirements for regulatory reporting.

## 7.1. REPORTING

Industry organizations are encouraged to maintain lists of CFIs identified in their field of activity, disseminate them to interested stakeholders and initiate measures to prevent or limit the manufacturing, import or sale of CFIs.

Although some States do not yet have specific CFI reporting requirements, many jurisdictions are increasingly requiring mandatory reporting of all discovered CFIs to regulators or other central organizations. The Canadian Nuclear Safety Commission, for example, starting in 2015 in its REGDOC-3.1.1 has mandated that licensees report to the regulator all cases of the “discovery of counterfeit, fraudulent or suspect items during the conduct of licensed activities” [30]. A detailed event report is required to be submitted within 60 days. This is in contrast to those regimes that only require the reporting of items that may have been installed in the facility and have had a nuclear safety consequence.

The Republic of Korea has extended its mandatory reporting requirements in its Nuclear Safety Act for non-conformances related to safety related equipment. Previously, only the licensee had to report any such non-conformances; now, suppliers need to report them as well.

Another example of a reporting requirement is in the United States of America, where contractors subject to the Cost Accounting Standards under Section 26 of the Office of Federal Procurement Policy Act (41 USC 422) and that supply electronic parts or products which include electronic parts must establish and maintain a counterfeit electronic part detection and avoidance system. The rule contains flow-down provisions requiring that all subcontractors at all tiers establish and maintain counterfeit electronic part detection and avoidance systems. This includes subcontractors for commercial items and commercial off the shelf items.

In addition to national regulators, Member States are encouraged to report CFI incidents to the IAEA through the International Reporting System for Operating Experience [69]. The International Reporting System for Operating Experience reporting code 5.7.6 is available for this purpose (see Section 7.3.1). Similar reports should go to other industry bodies, such as INPO and WANO.

Such practices allow for wider information sharing among utilities and other industrial participants and help to better protect all participants involved by making it harder for unscrupulous suppliers to ‘shop’ their CFIs around. Regardless of any mandatory requirements in a State, to reduce the risk of other organizations being impacted by the counterfeiter, consideration should be given to notifying the regulator regarding the issue at the earliest opportunity. It may also be beneficial or required to involve the regulator in plans to assess the extent of the problem and the evaluation and disposition activities.

## 7.2. COMMUNICATION WITHIN THE ORGANIZATION

Communication surrounding CFI issues and incidents within an organization is important to reduce a company’s overall risk of having initial or repeat events or of inadvertently using a CFI that should be under quarantine. When new incidents are detected, they need to be promptly identified to senior management and shared with facility personnel and other facilities within the same corporate fleet as soon as practical via regular communications channels. Such channels can include facility bulletins, newsletters, corporate intranet web pages, regular telecommunications channels, daily briefings, safety meetings and planning meetings. These methods can also communicate the impacts of any CFIs on the affected organizations (internal and external operating experience). The organization should consider sharing information externally at the earliest practical opportunity (see Section 7.3). As was discussed in Section 6.3, an internal database of CFIs is a useful tool for maintaining related information in a centralized manner and sharing detailed information efficiently.

## 7.3. EXTERNAL INFORMATION SHARING

Significant benefits can be realized by sharing all instances of CFIs with outside organizations in the nuclear industry and with the wider industrial community.

Suppliers, operating organizations and regulators within the commercial nuclear industry have long recognized the value of collecting and sharing operating experience information. Use of shared CFI information saves both personnel and financial resources. For instance, learning of CFIs from a shared information source can assist the facility operator to identify any possible instances and their locations at the nuclear facility. This would save inspection time and the time required to rectify any performance problems should the CFI fail in service. Engineering evaluation time and effort can also be reduced through shared testing or shared analytical results. A number of organizations currently maintain systems with information on operational events, receipt inspection discoveries and other problems that could be useful to others for future CFI identification.

Although it is not always practical to fully investigate CFI incidents, the timely sharing of information is essential. Further, it is beneficial to share CFI related information at local, national and international levels. If effectively populated, reporting systems can be powerful means of promoting organizational learning, sharing information on CFIs and reducing overall risk.

EPRI has produced a generic template for reporting CFI incidents (appendix D to Ref. [6]) that can be used as guidance for operating organizations. It is divided into five parts as follows:

— Information on the suspected CFI (type of item, original manufacturer, original supplier, original manufacturer and current supplier part numbers, what prompted the discovery, current (counterfeit) lot or batch serial number or date code, etc.);
— Reporting information (organizations that have been informed of the incident, whether the suspect supplier is an approved distributor or agent, etc.);
— Whether the item has been confirmed to be counterfeit or fraudulent;
— Contact information for follow-up;
— Incident description and photographs.

Consideration can be given to highlighting CFIs as an issue at regular meetings and conferences of supply chain participants from different organizations. Trade shows, supplier days or similar events are a good opportunity for operating organizations to highlight CFI prevention and detection processes and help to align the efforts of the various parties. As discussed in Section 4.4.2, assessments of a supplier's CFI performance should be included in supplier score-cards and communicated regularly.

### 7.3.1. Databases related to counterfeit or fraudulent items

Incident data related to CFIs have been recorded by a number of organizations, both inside and outside the nuclear industry. Regular review of and contribution to such databases can lower risks associated with inadvertent purchases of CFIs.

Examples of relevant databases for sharing information on CFIs include those maintained by the IAEA (the International Reporting System for Operating Experience [69]), OECD/NEA [3], WANO and INPO (significant operating experience reports and event databases), technology specific user groups (e.g. the CANDU Owner's Group Information Exchange System) or regionally based groups (e.g. the database of the European Clearinghouse for Operational Experience Feedback, the United States of America's National Intellectual Property Rights Coordination Center).

The IAEA's International Reporting System for Operating Experience database is designed to complement national schemes for reporting, evaluating and analysing information about safety significant unusual events, lessons learned, good practices or findings important for the international community. A unique reporting code, 5.7.6 'CSFI — Counterfeit, Suspect, Fraudulent Items' has been established to facilitate reporting CFI incidents to the international nuclear community.

A number of non-nuclear-specific research and commercial supplier organizations also maintain information and databases on CFIs. Some of these sources of information are shown in Table 5.

### 7.3.2. Industry peer groups

Industry peer groups consisting of suppliers, purchasing organizations, standards organizations, specific organizations tackling counterfeiting and intellectual property issues and others can help raise awareness and share knowledge and experience related to CFIs on a regional basis. Besides those identified in Table 5, some industry focused groups in operation include EPRI's Joint Utility Task Group on procurement engineering, the Nuclear Procurement Issues Committee, the Suppliers Evaluation Group in Spain, the EKG (electrical component group)

TABLE 5. SOURCES OF INFORMATION RELATED TO COUNTERFEIT OR FRAUDULENT ITEMS *(adapted from table 27 of Ref. [2])*

| Organization | Topic covered | Comment |
|---|---|---|
| Canadian Standards Association | General | Ability to submit incident reports on possible counterfeit marks. |
| Electric Power Research Institute | General | CFSI database being developed. Will be available to and receive input from EPRI members. |
| Electronic Resellers Association International | Electronics | Provides ability to report and search for electronic CFIs. |
| Electronics Systems Community Anti-Counterfeiting Forum | Electronics | Source of best practices and a database of CFIs. |
| Factory Mutual | General | Statement on counterfeiting and news and product alerts (including known items bearing counterfeit Factory Mutual certifications). |
| Government–Industry Data Exchange Program | General | For US or Canadian organizations that directly or indirectly provide products or services to the US or Canadian Governments. Maintains database with the ability for members to submit data for the exchange of technical information (including on CFIs) with other GIDEP participants. |
| National Electrical Manufacturers Association | Electrical | News postings on CFIs plus other resources. |
| National Intellectual Property Rights Coordination Center | General | US Government's clearinghouse for investigations into counterfeiting and piracy. Features an easy method to report instances of intellectual property theft, including CFIs. |
| Underwriters Laboratories | General | Anticounterfeiting programme information. |
| US Consumer Product Safety Commission | General | General US consumer site reporting product recalls including CFIs. |

**Note:** CFI — counterfeit or fraudulent item; CFSI — counterfeit, fraudulent or suspect item; EPRI — Electric Power Research Institute; GIDEP — Government–Industry Data Exchange Program.

suppliers organization in Finland and Sweden, and the Canadian Nuclear Industry Assessment Committee and the Organization of CANDU Industries in Canada. Organizations listed on the Global Anti-Counterfeiting Network member list web page (www.gacg.org/Members-Partners) and the Inter-American Association of Intellectual Property web site (www.asipi.org) are also useful sources of knowledge.

The voluntary reporting of incidents to any centralized databases managed by such peer groups and further sharing with the international community is good practice (as described in Section 7.3.1).

## 7.4. WHISTLE-BLOWER PROTECTION

The identification of fraudulent or counterfeit activities can be difficult for some individuals if their company cultural environment does not support such identification. Those who report wrongdoing may be subject to retaliation, such as intimidation, harassment, dismissal or violence by their colleagues or superiors. In some countries, whistle-blowing is even associated with treachery or spying.

Typical whistle-blower protection features enacted in regulations related to nuclear facilities can include prohibiting managers or organizations from retaliating against employees or members of the public who provide information they reasonably believe provides evidence of:

— Violation of any law, rule or regulation;
— Gross mismanagement;
— Gross waste of funds;
— Abuse of authority, including harassment, intimidation, retaliation and discrimination related to raising safety concerns;
— Substantial and specific danger to public health and safety.

Typically, an anonymous reporting channel and impartial ombudsman are features of such an arrangement.

Some jurisdictions have additionally provided monetary rewards that cover the reporting of concerns such as counterfeit, fraudulent or unethical activities within their nuclear industries. The Republic of Korea, for example, has instituted a leniency programme that includes financial rewards for nuclear whistle-blowers in the amount of ₩1 billion (approximately US $1 million) [70].

The OECD has provided a useful guidance document on establishing whistle-blower protection and on encouraging reporting [71].

# 8. SIGNS THAT AN ITEM IS POTENTIALLY COUNTERFEIT OR FRAUDULENT

CFIs can encompass a broad range of items, such as:

— Threaded fasteners;
— Electrical/electronic components: switches, circuit breakers, computer components, semiconductors, printed circuit boards, current and potential transformers, fuses, resistors, electrolytic capacitors, switch gear, overload and protective relays, motor control centres, heaters, motor generator sets, direct current power supplies, alternating current inverters, transmitters, cables, and so on;
— Piping components: fittings, flanges, valves and valve replacement products, couplings, plugs, spacers, nozzles, pipe supports, and so on;
— Diesel generator speed governors and pumps;
— Cooling fans;
— Spare and replacement kits from suppliers other than OEMs;
— Preformed metal structures, elastomers, O rings, seals, weld filler material and chemical supplies;
— Documentation related to the authenticity, quality or testing of the supplied items.

CFIs have been discovered throughout industry in a variety of locations, such as:

— Cranes, elevators and forklifts and critical load paths of lifting equipment;
— Aircraft: engines and attachments, wings, tails and landing gear;
— Vehicles: engines, brakes and steering mechanisms;
— Facilities: valves, compressors and vessels used to contain radioactive fluids or high temperature/high pressure steam or fluids, cable tray rooms with high fire risk, and other hazardous material or systems supporting safe operation or shutdown of a facility or process;
— Safety and personal protective equipment: hard hats, fall arrest equipment, scaffolding and fire extinguishers.

Table 6 provides a listing of signs that an item might potentially be a CFI. The list is divided into general or generic symptoms, documentation related symptoms and symptoms related to particular classes or types of item (e.g. piping, electrical).

# 9. SUMMARY AND CONCLUSIONS

CFIs are an increasing problem for industry. Nuclear facilities need to be aware and put processes in place to detect and report suspected CFIs. These processes could include ensuring good knowledge among supply chain participants, putting processes in place to transmit requirements down the supply chain, and monitoring and evaluating supply chain performance.

Generally, counterfeiters go after recognized, high demand items to maximize their profit. CFIs of concern to nuclear facilities are those that look nearly identical to original items but contain substandard, poorly assembled or aged components or material. Such items can be difficult to detect by standard industrial quality assurance inspections but can cause catastrophic failures or loss of functional capability. The infiltration of CFIs into industry could also lead to loss of legitimate firms from the marketplace, with an associated loss of jobs and revenue. Nuclear supply chains might have a decreased ability to deliver genuine products when needed, with potential negative impacts on facility reliability, economics and safety.

This publication provides preventive and control measures that senior management and facility personnel should apply to effectively protect their nuclear facilities against the introduction and use of CFIs. These preventive and control measures include prevention; identification, investigation and disposition; management; monitoring and control; and information sharing and reporting.

TABLE 6. SIGNS THAT AN ITEM IS POTENTIALLY COUNTERFEIT OR FRAUDULENT *(adapted from table 26 of Ref. [2])*

| Category | Signs |
|---|---|
| General | Nameplates, labels or tags are altered, photocopied, silk-screened, painted over, not secured well or missing, or show incomplete data. Preprinted labels will normally show typed entries. |
| | Obvious attempts at beautification have been made, such as excess painting or wire brushing, hand painting (touch-up), painted stainless steel, or clean and bright non-ferrous metals (copper, brass, bronze, etc.), indicating recent polishing. |
| | Handmade parts are evident, such as rough cut gaskets, shims and thin metal part edges showing evidence of cutting or dressing by hand tools (e.g. filing, hacksaw marking, use of tin snips or nippers). |
| | Hand tool marks are evident on fasteners or other assembly parts (e.g. upset metal exists on screw or bolt-head), or parts are dissimilar (e.g. seven of eight bolts of same material, one of different material). |
| | Assembled items fit poorly. |
| | Configuration is not consistent with other items from supplier or varies from supplier literature or drawing. |
| | There is inconsistency between vendor name on the item and on the shipping container. |
| | Nameplates are attached with inconsistent fasteners, such as screws instead of rivets or rivets and screws. |
| | Nameplates are attached in a different location than normal. |
| | Nameplates appear old or worn, have paint on them or look newer than the component. |
| | Metallic items are pitted or corroded. |
| | Nameplates are missing manufacturer's standard markings, stamps or logos or have irregular stamping or inconsistent type style. |
| | Items in the same shipment look different from one another. |
| | Properly identified items (e.g. struts, fittings) are mixed with unmarked items (e.g. no manufacturer name, logo, part numbers, load capacity). |
| | Boxing and packaging of the item is ususual. Packaging is inconsistent with supplier's normal packaging or documentation requirements. |
| | Dimensions of item are inconsistent with specifications requested on purchase order and those provided by supplier at time of shipment. |
| | There is evidence of previous bolt-head scoring on back sides of flanges or evidence that area has been ground. |
| | Fasteners are loose or missing. |
| | There is evidence of marring, tool impressions, traces of Prussian blue or lapping compound, or other evidence of previous attempts at fit-up. |
| | Heat discolouration is evident. |
| | Dissimilar materials are carelessly in contact. |
| | Item cleanliness is poor. |
| | Price of item is unusually low. |
| | Supplier is not a factory authorized supplier. |

TABLE 6. SIGNS THAT AN ITEM IS POTENTIALLY COUNTERFEIT OR FRAUDULENT *(adapted from table 26 of Ref. [2])* (cont.)

| Category | Signs |
|---|---|
| Documents | Use of correction fluid or correction tape is evident. Type style, size or pitch change is evident. |
| | Ink smudges consistent with printing via inkjet printer are present. |
| | There is date inconsistency (e.g. on test certificates, validity pre-dates issue date of certificate; certificate date does not match standard, code or ISO certification it is issued under). |
| | Document is not signed or initialled when required, is excessively faded or unclear (indicating multiple, sequential copying), or is missing data. |
| | Name of document approver or title cannot be determined, or typed approval name does not match signature. |
| | Signatures that are required to be original appear to be electronically added to the document (e.g. added as an image file). |
| | Technical data are inconsistent with code or standard requirements (e.g. no impact test results are provided, but impact testing is required; physical test data indicate no heat treatment, but heat treatment is required; chemical analysis indicates one material, but physical tests indicate another). |
| | Chemical alloy composition does not total 100% (or >99.75%) as shown on certified material test report. |
| | Heat and lot numbers are the same for different materials in the same order (6010 and 7018 weld wire, for example, cannot be manufactured from the same heat and lot of material). |
| | Certification or test results are identical for different items when normal variations should be expected. |
| | Unusual disclaimers or denials of responsibility for the accuracy of test results are included. |
| | Document traceability is not clear. Documentation should be traceable to items procured. |
| | Documentation is not delivered as required by purchase order or is provided in an unusual format. |
| | Documents are photocopied when originals would be expected. |
| | Corrections are not properly scored through, initialled and dated. |
| | Text on page ends abruptly and number of pages conflicts with transmittal. |
| | Required watermarks are missing. |
| | There is inconsistent configuration between product and product literature or between other items from the same supplier. |
| | Lines on forms are bent, broken or interrupted, indicating that data have been deleted or exchanged (physically cut and pasted). |
| | Data on a single line are located at different heights. |
| | Item or component matches description of one that is on a Member State list of CFIs. |
| Valves | |
| Paint | Valve appears freshly painted, and valve stem has paint on it. |
| | Wear marks or scratches are present on any painted surface. |
| | Valve stem is protected, but protection has paint on it. |
| | Paint does not match standard OEM colour. |
| | There is exterior evidence of attempted repairs (e.g. brush marks to repair spray paint). |
| | There are inconsistent shades on painted surfaces. |
| Tags | Tags have been attached with different method (e.g. screws instead of rivets) or in different location than normal. |
| | Tags appear old, worn or newer than valve. |
| | Tags have paint on them. |
| | Tags have no part numbers. |
| | Tags have irregular stamping. |
| | Tags do not have manufacturers' logos. |
| | Tag attachment screws are marred from use. |

TABLE 6. SIGNS THAT AN ITEM IS POTENTIALLY COUNTERFEIT OR FRAUDULENT *(adapted from table 26 of Ref. [2])* (cont.)

| Category | Signs |
|---|---|
| Handwheels | Handwheel appears older than valve.<br>Handwheel looks sandblasted or newer than valve.<br>There are different types of handwheel on valves from the same manufacturer. |
| Bolts and nuts | Bolts and nuts have a used appearance (e.g. wrench marks on flats).<br>Improper bolt and nut material has been used (e.g. a bronze nut on a stainless steel stem).<br>Bolts have different size or grade markings. |
| Body | There is a ground-off casting mark, with other markings stamped in the area (OEM markings are nearly always raised, not stamped).<br>Signs of weld repair are evident.<br>Item has incorrect dimensions.<br>Item has a freshly sandblasted appearance, encompassing eye bolts, grease fittings, stem, etc.<br>There is evidence of previous bolt-head scoring on back sides of flanges or evidence that the area has been ground to remove such marks.<br>On a stainless valve, there is an unusually shiny finish, indicating bead-blasting, or an unusually dull finish, indicating sand-blasting. Finish on a new valve should be in between. |
| Manufacturer's logo | Logo is missing.<br>Logo plate looks newer than valve.<br>Logo plate shows signs of discolouration from previous use. |
| Other | There is foreign material inside valve, or there are signs of rework (e.g. metal shavings, dirt, lapping compound, Prussian blue).<br>Valve stem packing that shows all the adjustments has been rubbed out.<br>In gate valves, gate is off centre when checked through open end of valve.<br>There are obvious differences between valves in the same shipment.<br>There is a poor fit between assembled parts.<br>Improper materials have been used (e.g. bronze nut on a stainless steel stem; stainless steel valve showing characteristics of carbon steel, such as rust blooms and magnetism).<br>There are wrench marks on valve packing, glands, nuts and bolts. |
| Fasteners | Head markings are marred, missing or appear to have been altered.<br>Threads show evidence of dressing or wear (threads should have uniform colour and finish).<br>Head markings are inconsistent within a heat lot or appear to have been impression stamped after production.<br>Mixed grade is evident on manufacturer head marks in same lot or shipment.<br>Bolts are not identified or marked as such.<br>Bolts are hand stamped to indicate they meet a different standard.<br>Eyebolts either have no manufacturer's markings or have markings indicating that the parts are made in a country other than specified.<br>Eyebolt dimensions do not meet specifications, or material types are indeterminate.<br>Metric and SAE stamping appears on same fastener.<br>Fastener (tests): Fails to meet material specification requirements for chemistry.<br>Fastener (tests): Fails to meet material specification requirements for mechanical or physical limits. |

TABLE 6. SIGNS THAT AN ITEM IS POTENTIALLY COUNTERFEIT OR FRAUDULENT *(adapted from table 26 of Ref. [2])* (cont.)

| Category | Signs |
|---|---|
| Electrical devices (general) | Connections show evidence of previous attachment (e.g. metal upset or marring, screwdriver marks). |
| | Electrical leads are of different lengths or are not as long as stated in the vendor product catalogue. |
| | Connections show arcing or discolouration. |
| | Item appears to have signs of painting or smoke. |
| | Metal colour inconsistencies are evident. |
| | Plastic parts have different colours. |
| | Contacts or lugs are pitted, worn, broken or damaged. |
| | Contact surfaces do not mate properly. |
| | Solder terminations are broken, sloppy or damaged. |
| | There are different screw types or items on terminals. |
| | Terminals are missing. |
| | Rough metal edges are evident. |
| | Lubrication appears to be old. |
| | Fasteners are loose, missing or show metal upset. |
| | Products requiring testing by an independent authority are missing labels, or labels appear to be photocopied. |
| | Manufacturer's labels are discoloured or faded, indicating they may have been photocopied. |
| | Items are not in original manufacturer's container (e.g. are in plain packaging) and/or have no manufacturer barcode. |
| | Item shows evidence of wear or prior use. |
| | Item has scratches or nicks in factory paint or coating. |
| | Tags are handwritten or typed, rather than stamped. |
| | Nameplates have been modified or re-stamped. |
| | There is insufficient nameplate information. |
| | Nameplates have been improperly fastened. |
| | Rivets are missing, screws have been used where rivets are normally used or rivets appear to have been reused. |
| | Calibration stickers (internal and external) are past due. |
| | Motor control circuit breakers, switches or disconnects are not easily opened or closed with compartment door closed. |
| | Compartment doors open, exposing buswork. |
| | Fuse labels are missing or weathered. |
| | Electrical approval markings are missing on devices. |
| | Bases show evidence of wear. |
| | Electrical device (tests): Fails to meet operating requirements such as actuation at specified condition, binding of mechanisms, or other adverse motion, or fails to meet resistance test. |

TABLE 6. SIGNS THAT AN ITEM IS POTENTIALLY COUNTERFEIT OR FRAUDULENT *(adapted from table 26 of Ref. [2])* (cont.)

| Category | Signs |
|---|---|
| Circuit breakers | Case is cracked or appears used. |
| | Laboratory product testing authority label/mark or the original manufacturer's label/mark shows signs of alteration or copying (e.g. black and white, poor legibility). |
| | Circuit breaker rating shows signs of alteration (e.g. rating painted on instead of being impressed into the case), or contradictory amperage ratings appear on different parts of same refurbished breaker. |
| | Moulded case circuit breakers are not consistent with manufacturer provided checklists for detecting substandard or fraudulent breakers. |
| | Moulded case circuit breakers are shiny or appear painted with lacquer. |
| | Rivets or other connectors used to hold case together are not proper type or size, or rivets have been removed. Case may be held together with wood screws, metal screws, or nuts and bolts. |
| | Certificates are copied or show evidence of falsification (whenever possible, original certificates should be obtained from the distributor). |
| | Style of breaker is no longer manufactured or is old. |
| | There is a different short circuit rating. |
| | Breaker comes in cheap, generic packaging (e.g. bulk packaged in plastic bags, brown paper bags, or cardboard boxes with handwritten labels) instead of manufacturer's original boxes. |
| | Data on carton or label have been altered or are inconsistent. |
| | Moulded case circuit breakers are labelled with the refurbisher's name, rather than the label of a known manufacturer. |
| | Labels do not indicate the country of origin. |
| | Logos are printed on, appear to be etched or are missing. |
| | Manufacturer's seal across the two halves of the case breaker is broken or missing. |
| | Manufacturer's date code is not stamped on breaker. |
| | Wire lugs show evidence of tampering. |
| | Surface of circuit breaker is nicked or scratched yet has a high gloss (refurbishers often coat them with clear plastic to produce a high gloss that gives the casual observer the impression that it is new). The plastic case of new moulded case circuit breakers often has a dull appearance. |
| | Rating stamp is in wrong place. |
| | There are third party markings on the item. |
| | There are terminal lugs on both ends. |
| | Terminal hardware is the wrong size or type or is mismatched. |
| | Cover screw seals are missing, rough or poorly resealed. |
| | Square D circuit breakers do not have the amperage rating painted in white on the breaker's toggle switch. |
| Relays | Coil lead solder joints are sloppy. |
| | Relay base grommets are painted (they are normally clean). |
| | Terminal strips are fastened with eyelets. |
| | Painted rivets fasten terminal strips to relay housings. |
| | Termination screws are in brown paper bags (they should be in clear, heat sealed plastic bags). |
| | Inner bell surface of relays has been repainted. |
| | Date codes, inspection stamps or test stamps are missing or inconsistent. |
| | Shaft relay cover clearance is incorrect; there is shaft play or no bearing lubricant. |
| | Tops of rotor shafts are painted a colour other than black. |
| | Non-uniform numbers are stamped on contact decks, indicating decks are made up from various relays. |
| | Incorrect coils are installed (e.g. a 125 V direct current relay with a 200 V direct current coil). |

TABLE 6. SIGNS THAT AN ITEM IS POTENTIALLY COUNTERFEIT OR FRAUDULENT *(adapted from table 26 of Ref. [2])* (cont.)

| Category | Signs |
|---|---|
| Capacitors | Polished surfaces are scratched or dented. |
| | Termination lugs are scarred. |
| | There is a buildup of debris and dirt in the termination guards. |
| | Packaging is plain (e.g. has no manufacturer barcodes). |
| Electronic components | Electrolytic capacitors are not marked with a date code. |
| | Electrolytic capacitors have different dimensions. |
| | Fairchild phototransistor optocouplers are smaller in size, packaged incorrectly or have a date code that indicates that the suspect device was manufactured after the genuine device was discontinued by the OEM. |
| | Integrated circuit board chip altered to make it appear newer than it is. |
| Rotary machinery and valve internal parts | Machinery or parts show marring, tool impressions, wear marks, traces of engineer's or Prussian blue or lapping compound, or other evidence of previous attempts at fit-up or assembly. |
| | Heat discolouration is evident. |
| | There is evidence of erosion, corrosion, wire drawing or 'dimples' (inverted cone shaped impressions) on valve discs or seats or pump impellers. |
| Piping and piping components | Item has a used component appearance. |
| | Item has unusual or inadequate packaging. |
| | Foreign newspapers have been used as packaging. |
| | Scratches are evident on component's outer surface. |
| | There is evidence of tampering on body, screws, tags or nameplates. |
| | Components have no markings. |
| | Pitting or corrosion is evident. |
| | External weld or heat indications are visible. |
| | Questionable or meaningless numbers are present. |
| | Item has typed labels. |
| | There is evidence of handmade parts. |
| | Item has painted stainless steel, freshly painted parts or mismatched colours. |
| | Ferrous metals are clean and bright. |
| | Excess wire brushing or painting is evident. |
| | Item has ground-off casting marks with stamped marks in the vicinity. |
| | There are signs of weld repairs. |
| | Threads show evidence of wear or dressing. |
| | There is inconsistency between labels. |
| | Nameplates are old or worn. |
| | Nameplates look newer than the component. |
| | Manufacturer's standard markings and logos are missing. |
| | There are traces of Prussian blue. |
| | Markings are not legible. |
| | There is evidence of restamping. |
| | There is no specification number. |
| | There is no size designation. |
| | Pressure class rating is missing. |
| | Material is thinner than expected. |

TABLE 6. SIGNS THAT AN ITEM IS POTENTIALLY COUNTERFEIT OR FRAUDULENT *(adapted from table 26 of Ref. [2])* (cont.)

| Category | Signs |
|---|---|
| Piping and piping components | There are disclaimers on certifications that disclaim any obligation or liability for non-conformances or failure of items to conform to government specifications or standards.<br>Metal flanges are stamped as forgings when other markings on the face of the flange indicate that parts were cold rolled.<br>Metal flanges are part of fabricated assemblies without any required markings on the flanges, such as the manufacturer, material type, specification or dimension. |
| Fire protection equipment | Fire extinguisher handles are made from improper materials or are an improper colour (e.g. products from OEMs have aluminium handles that are silver in colour, but counterfeits have black or red plastic handles).<br>Bottom of fire extinguisher has a different configuration or design features, for example:<br>— Thicker, rolled or curved bottoms instead of authentic straight, flush bottoms;<br>— No stamped date code;<br>— Lighter weight material construction;<br>— Poor quality welding or welding in multiple or different locations, particularly around the base;<br>— Pressure gauges that look different or are the wrong colour, or gauges that are improperly assembled or do not function;<br>— Cylinder contents that drop to the top when cylinders are turned upside down.<br>There are issues with a fire extinguisher’s labels, for example:<br>— Label background is not the same colour or shade as an authentic label.<br>— Label is screen printed, and identical serial numbers are used on different cylinders. (The easiest method to find these counterfeits is to check the serial numbers. If more than one cylinder has the same serial number, it can be assumed that all the cylinders are counterfeit.)<br>— There are improper certification marks (e.g. improper Underwriters Laboratories label information).<br>— Label or instructions contain misspelled words or incorrect font type.<br>— Anticounterfeiting features, such as circles, letters or symbols, have been printed on the labels instead of being cut into the labels.<br>— Logos or manufacturers’ symbols are incorrect (e.g. slightly different colours are used, or the sizes or shapes of logos are different). |
| Lifting devices | Lifting devices have been visibly altered (e.g. overstamping or striking through original information and adding new markings).<br>Item has a used appearance (e.g. strings appear worn, hook has indications of previous use).<br>Documentation is incomplete or missing.<br>Polyester lifting slings without red core yarns are visible or otherwise contrary to the information received with the slings. |

**Note:** CFI — counterfeit or fraudulent item; ISO — International Organization for Standardization; OEM — original equipment manufacturer; SAE — Society of Automotive Engineers.

## Appendix I

## DETAILED EXAMPLES OF COUNTERFEIT OR FRAUDULENT ITEMS

### I.1. FRAUDULENT BAUMER PRESSURE GAUGES (CANADA)

A Baumer pressure gauge was identified as suspect during a receipt inspection in January 2014. The part number on the gauge did not match the purchase order and packing slip, and the gauge markings were not consistent with those on authentic Baumer gauges. Further examination conducted by the licensee revealed poor quality printing on the faceplate (Fig. 19) and an adhesive paper on the dial face. In comparison, the authentic product would have had a silkscreen painted face and clean, crisp graduations.

From a sample of pressure gauges sent to Baumer for further examination, Baumer concluded that one was fraudulent. Packaging labels were poorly drawn, the blowout safety plug was old and the faceplate was reversed with a 0–60 psi silk-screened faceplate facing inward and adhesive paper printed with '−100 to +300 kPa' facing outward. In total, 18 fraudulent Baumer gauges were discovered in stock, all of which had been used, subsequently modified and sold as new.

The licensee took the following actions:

— Removed several distributors from the approved suppliers list;
— Obtained a list of authorized distributors from Baumer;
— Worked with Baumer to determine the extent of condition and key areas for procurement inspection;
— Notified the regulatory body, the Nuclear Procurement Issues Committee and the CANDU Nuclear Procurement Audit Committee.

### I.2. FRAUDULENT MATERIAL TEST REPORTS FOR NEWMAN HATTERSLEY VALVES (CANADA)

On 26 February 2015, Ontario Power Generation was notified by a valve supplier located in Canada that materials contained in valve assemblies (connectors, discs, bonnets, plugs and stems) and component parts supplied by the vendor did not meet the required nuclear material specifications. On 3 March 2015, a similar letter was received by Ontario Power Generation from a second valve supplier located in the United Kingdom. The valve supplier in Canada was purchasing valve parts from the valve supplier in the United Kingdom.

Hundreds of valve assemblies and parts with misrepresented results in material test reports were supplied and installed in CANDU nuclear power plants in multiple countries (e.g. Argentina, Canada, China, the Republic of Korea, Romania), as well as in some nuclear facilities in the United Kingdom and Finland [26, 72]. The systems affected included containment isolation, emergency coolant injection, liquid zone control, primary heat transport, emergency filtered air discharge, and moderator and shutdown cooling.

Misrepresentations were identified in some material test certificates that had been provided for some parts in Newman Hattersley Ltd nuclear class valves manufactured between 2001 and 2011. Discrepancies in material properties, material composition and heat treatment stated on certain material test reports were identified.


*FIG. 19. Fraudulent Baumer gauge face.*

A third party material supplier altered certain material test results to pass the required ASME Boiler and Pressure Vessel Code material requirements. Moreover, in some cases, the material had not been sent for external testing as required; the third party material supplier populated the material test reports itself using a certificate duplicated from the Internet, with a company logo not in use since the 1990s.

On the basis of the valve manufacturer's and the licensees' assessments, it was determined that these materials no longer met the material certification requirements of ASME Boiler and Pressure Vessel Code, section III, NCA 3862 certification of material.

The licensees were notified by their supplier about the discrepancies in the material test certificates provided by the third party.

Figure 20 shows the relationship between the various companies involved and the chain of certifications associated with the order. Only one of the three certifications was fraudulent: the fraudulent claim by vendor 3 that the steel had been tested to ASME standards as nuclear material when in fact it had only been produced to British standards as commercial material.

Engineering assessments were performed by vendor 1 and vendor 2, and it was concluded that there was no safety risk associated with the continuous use of the valves and parts. It was determined that there was sufficient design margin associated with the valve design stresses. Analysis demonstrated that the stresses were conservative under worst case conditions. The performance of the installed base and the 1.5× cold working pressure hydrostatic test and functional testing before shipping provided more validation of the design. The valve design had always incorporated sufficient design margin associated with the stresses imposed on these parts.

The licensees took the following actions:

— Worked together to determine the extent of condition.
— Submitted reports to the regulatory body.
— Quarantined all suspect components in storage to prevent installation.
— Identified affected systems.
— Conducted detailed engineering assessments and determined that:
    • There was sufficient design margin associated with the stresses imposed on these parts in the valve design;
    • Stresses were very conservative under worst case conditions;
    • All valves and parts were acceptable to be used 'as is';
    • There were no operability or safety concerns.

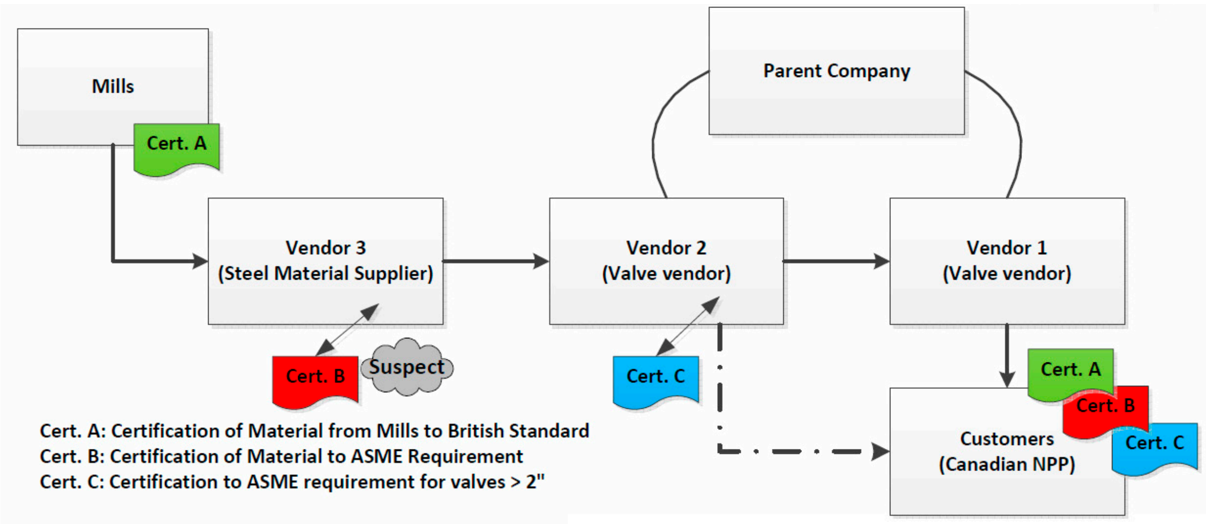


*FIG. 20. Chain of certificates associated with valve order. ASME — American Society of Mechanical Engineers; NPP — nuclear power plant. (Reproduced from Ref. [73] with permission courtesy of the Canadian Nuclear Safety Commission.)*

## I.3. COUNTERFEIT BURR-BROWN OPERATIONAL AMPLIFIERS (CANADA)

In January 2007, a nuclear facility unknowingly purchased 50 CFI operational amplifiers through a third party supplier that had purchased them from an unauthorized distributor. Coincidentally, that same month, Texas Instruments, which acquired Burr-Brown in 2000, issued a letter warning customers that if the electronics were not purchased from Texas Instruments authorized sources, there would be no assurance as to their authenticity.

From January to July 2008, five CFI operational amplifiers were put into service. In September 2008, one of the amplifiers failed a safety system test conducted every three weeks. A neutron overpower amplifier in shutdown system 1 with a normal trip point of 119.5% was tripping at 121.8%. Roughly one month after the event, the cause of the failure was attributed to the operational amplifier, which was subsequently identified as counterfeit. Examples of the operational amplifiers are shown in Fig. 21.

The licensee took the following actions:

— Replaced the faulty neutron overpower amplifier in shutdown system 1 after being unable to determine why it failed testing and after unsuccessful attempts to recalibrate it;
— Documented the event as per its corrective action programme;
— Identified the cause of the failure as the counterfeit operational amplifier;
— Identified 50 operational amplifiers as counterfeit, and removed the four that remained installed on systems from service;
— Communicated the event to the CANDU Owners Group, WANO and INPO;
— Temporarily removed the third party supplier from the approved suppliers list.

## I.4. LADISH STOP-CHECK VALVE (UNITED STATES OF AMERICA)

NRC Information Notice 2008-04 [74] documents an incident in which a Ladish stop-check valve (Fig. 22) was installed in the main generator stator cooling water system (a non-safety-related application) in Hatch Nuclear Power Plant. In 2007, an additional two counterfeit 5 in. (127 mm), 150 lb (68 kg) Ladish stop-check valves were discovered; one was installed and the other was in warehouse inventory. Visual inspection of the genuine and fraudulent valves depicted in Fig. 22 suggests that the ‘L’ cast into the valve body of the genuine valve was added to the body of the fraudulent valve by welding and grinding.

In September 2007, personnel investigating a malfunctioning stop-check valve in the main generator stator cooling water system at Pilgrim Nuclear Power Station discovered that the valve installed was not a genuine Ladish 5 in. (127 mm) stop-check valve. Pictures of the suspected counterfeit valve were sent to the Ladish Valve Company, where it was confirmed that the installed valve was not a Ladish valve. This was a non-safety-related purchase, and vendor oversight and documentation controls were insufficient to identify a substandard part before its installation.

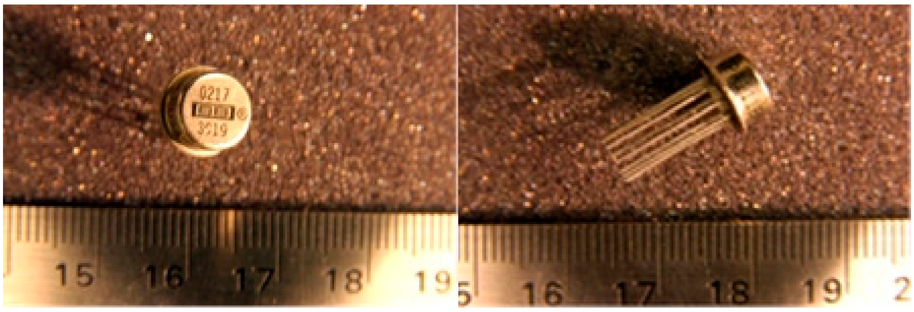


*FIG. 21. Counterfeit Burr-Brown operational amplifiers.*


*FIG. 22. Genuine (left) and counterfeit (right) Ladish check valves. (Reproduced from Ref. [6] with permission courtesy of EPRI.)*

## I.5. FLOWSERVE GLOBE VALVES (UNITED STATES OF AMERICA)

The Farley Nuclear Power Plant determined in 2006 that a supposedly stainless steel Flowserve globe valve (Fig. 23) in its warehouse was in fact manufactured from carbon steel [3, 6]. Further investigation with the OEM (Flowserve) identified that incorrect material had been used and that the certification provided was incorrect.

## I.6. COUNTERFEIT SCAFFOLDING (UNITED STATES OF AMERICA)

In April 2014, a US Department of Energy programme reported a suspect scaffolding tube (Fig. 24). Although the scaffold tube showed no external signs of damage, cracking or corrosion, the fitting had failed internally. The metallic face of the break was significantly discoloured over the vast majority of the surface. The pole was stencilled in black, indicating that it was produced in China for the Stepup Scaffolding Company. Random scaffold poles with similar markings were cut to expose the end fitting, and several of the castings were found to be out of round or cracked. This item was categorized as a suspect item, and further investigation was needed. Although this item was not safety related, its discovery was important to ensure the safety of workers. Therefore, this item was brought to the attention of the US Department of Energy.

## I.7. INAPPROPRIATE PARTS INSTALLED ON EMERGENCY DIESELS BY MAINTENANCE CONTRACTORS (MEXICO)

An event occurred at the Laguna Verde plant in Mexico in 2012 in which an EDG failed and caught fire, which necessitated emergency shutdown of the EDG, activation of the on-site fire brigade and actuation of automatic fire protection systems [26, 75, 76]. The most probable cause was a failure of the piston bearing coating material in the internal components of the EDG. The piston bearing had a silver coating, and when this material began to degrade, the lubricating veins were also damaged; this left the material without proper lubrication. The silver coating wear caused the obstruction of a piston hole and, finally, the total loss of lubrication to power assembly cylinder 8. Some pictures from the event are shown in Fig. 25.

The EDG in question had been recently repaired on an urgent basis by an outside repair company using urgently acquired materials. The installed piston pin bearings had a slightly different design but had been acquired with the same part number.

In 2014, with the unit in a refuelling outage, the evaluation to determine the apparent causes of the abnormal wear in EDG 2's power pack piston pins determined that different materials had been used in the construction of the components installed in EDG 1–3. An extent of condition review resulted in declared inoperability of EDGs 1

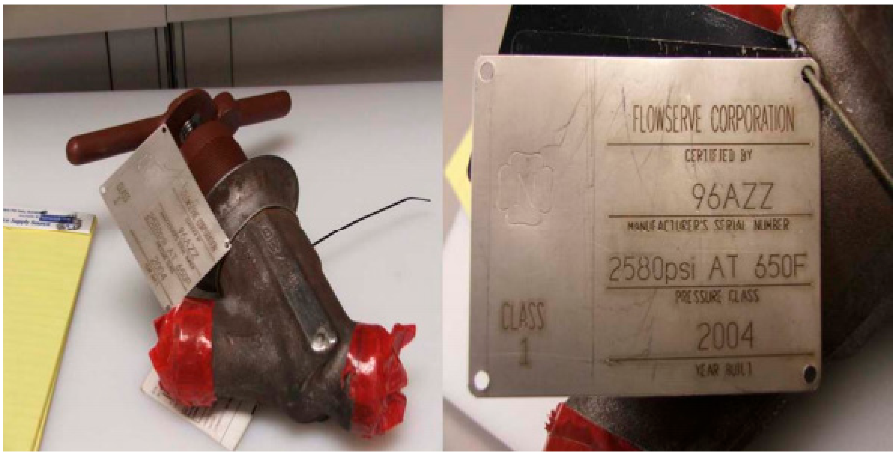


*FIG. 23. Carbon steel globe valve certified and sold as stainless steel. (Reproduced from Ref. [6] with permission courtesy of EPRI.)*


*FIG. 24. Suspected fraudulent scaffolding. (Courtesy of US Department of Energy.)*

*FIG. 25. Laguna Verde emergency diesel generator 3 failure. (Reproduced from Ref. [75] with permission courtesy of Comisión Federal de Electricidad.)*

and 3 and a 23 day outage extension. A result of this subsequent event was a workshop designed to create an administrative process or procedure to establish requirements for the detection and management of CFIs [26].

These events point to the need for strict attention to detail in each stage of the procurement process and the difficulty of classifying items as non-conforming, counterfeit or fraudulent. In this case, the parts installed were clearly non-conforming to the original design (inappropriate substitutions were made) but were not necessarily intentionally installed in a fraudulent or counterfeit manner. The final classification would depend on the intent of the installation contractor, the source of the non-conforming parts and the intent of the part supplier.

# Appendix II

## INTERNATIONAL EXPERIENCE WITH COUNTERFEIT OR FRAUDULENT ITEMS

This appendix contains examples of international experience with CFIs. Table 7 contains a listing of event descriptions and reports related to CFIs in the nuclear industry; Table 8 contains lessons learned for specific items that were compiled at the time of the original publication of IAEA-TECDOC-1169 (published in 2000) [23]. Specific regulations are documented earlier in Table 2 of this publication.

TABLE 7. SELECTED STATE AND INTERNATIONAL ORGANIZATION EXPERIENCES AND REPORTS ON COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY *(adapted from table 24 of Ref. [2])*

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| Canada | Presentations at IAEA Technical Meetings [73, 77] | Five counterfeit Burr-Brown operational amplifiers were installed in two reactors in shutdown and regulating systems in 2008. The items were discovered by the licensee when one amplifier failed calibration.<br>Regulatory reporting was delayed (regulator was informed by a whistle-blower). See also Section I.3. | Expectations for the reporting of CFIs should be clear for licensees. |
| | Presentations at IAEA Technical Meetings [73, 77] | Receipt inspection identified a Baumer gauge as suspect when the part number on the gauge did not match the purchase order, the packing slip and gauge markings were not consistent with Baumer gauges, and the faceplate had poor printing. The conclusion was that the gauge had been modified from imperial to metric units by unknown persons. See also Section I.1. | OEMs should be involved with part modifications.<br>Importance of careful inspection of received items was highlighted. |
| | CNSC Public Meeting 7 April 2016 [17] and presentation at IAEA Technical Meeting [73] | Materials in valve assemblies installed in all Canadian nuclear power plants were identified by a valve supplier as not meeting required nuclear material certifications. A steel supplier had populated test data onto duplicated certificates, indicating that the material met all specification requirements, even though the material had not been sent for testing. In other cases, a number of test certificates that had shown a failure had been modified to achieve a pass. In total, 740 valves had been installed in nuclear power plants; 376 were in warehouses and were quarantined. All needed to be assessed by licensees to allow continued use. Vendors, licensees and CANPAC completed supplementary audits; the valve supplier removed the offending steel supplier from approved vendor lists, implemented measures to complete PMI on raw materials received, and increased material supplier audits. The CANDU Owners Group is working on the set-up of a joint audit mechanism for second and third tier suppliers. See also Section I.2.<br>Note: The company involved with certification modifications was the same one that impacted test certificates in Finland (next entry in this table). | Nuclear power plants can be vulnerable to the actions of second and third tier material suppliers towards tier one vendors.<br>Need to increase oversight and audit activities for sub-suppliers.<br>A single supplier has the potential to impact multiple nuclear power plants in different countries. |

TABLE 7. SELECTED STATE AND INTERNATIONAL ORGANIZATION EXPERIENCES AND REPORTS ON COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY *(adapted from table 24 of Ref. [2])* (cont.)

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| Finland | Counterfeit material test certificates [26, 72] | A material supplier to a valve manufacturer systematically fabricated some material certificates during the time period 2001–2009. The valve manufacturer informed the plant about the situation during summer 2015.<br>Test certificates for 1228 valves and components were discovered to be counterfeit. In 204 cases, specifications could not be guaranteed owing to fabricated certificates. Four valves could not be verified after additional checks. Two valves assembled at the plant were replaced, and two valves were quarantined. Another 200 valves were verified to fulfil specifications.<br>Note: The company involved with certification modifications was the same one that impacted test certificates in Canada (previous item in this table). | Weaknesses in the supply chain were identified, and the need to oversee lower tier suppliers was recognized.<br>Issues with relying on certificates issued by third parties were identified.<br>A single supplier has the potential to impact multiple nuclear power plants in different countries. |
| France | Three cases of document falsification by manufacturers [78] | Cases included:<br>— Deliberate use of a calibration block that had not undergone the required heat treatment and purposeful deception to make the block look like it had been heat treated.<br>— Forged products with falsified chemical and metallurgical certificates. Over the period 2009–2015, a few dozen certificates from different laboratories were falsified, including valves and primary pump components installed on operating plants.<br>— Inconsistencies, modifications or omissions concerning manufacturing parameters or test results in the production files from a forge and foundry specializing in heavy components (some issues went back to 1965). | Continued diligence with respect to certification documentation is needed. |
| IAEA | This publication and section 7 of Ref. [2] | These publications present examples of known CFIs for specific types of component, and lessons learned after their identification, as of the year 2000. Operating experience is provided for fasteners, refurbished circuit breakers, metal struts and fittings, steels, pump shafts, throttle valves and piping, rubber gasket, swing type check valves, seal injection filters, reactor vessel guide studs, reactor coolant pump seal housing bolts, chemical waste drain tank, flange bolts of tank, electrical instrumentation and control cables, fire retardant, transformers, electronic cards in logic loops, liquid relief valves, and identification and markings. | See Table 8. |

TABLE 7. SELECTED STATE AND INTERNATIONAL ORGANIZATION EXPERIENCES AND REPORTS ON COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY *(adapted from table 24 of Ref. [2])* (cont.)

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| Republic of Korea (KHNP) | Managing the supply chain: Challenges and overcoming in Korean nuclear industry [16] | In November 2012, KHNP confirmed that some suppliers had supplied items by falsifying foreign dedication entities' quality certificates for commercial grade items, such as fuses, relays and diodes.<br>Comprehensive inspections were expanded to all Q class quality verification document items supplied to KHNP over the past 10 years for Korean nuclear power plants while investigating certificates for CGD. Permission was given for restart in January 2013. | Do not be overconfident and complacent if experiencing excellent nuclear power plant performance for a long time period.<br>Be transparent and open in quality and procurement activities (this can be a challenge in the nuclear industry, owing to its nature).<br>Encourage anonymous reporting (counterfeits were revealed by an anonymous tip). |
| | Managing the supply chain: Challenges and overcoming in Korean nuclear industry [16] | In May 2013, the equipment qualification certificates of control cables supplied to Shin-Kori 1–4 and Shin-Wolsong 1 and 2 were falsified. Their safety related function in severe environments, such as a loss of coolant accident or fire, was called into question.<br>KHNP immediately shut down the affected nuclear power plants to replace the related parts. Regulator investigations were expanded to all Korean nuclear power plant equipment qualification certificates. Safety related items purchased within last six years in 23 operating units and eight units under construction were investigated.<br>Components with falsified certificates were replaced or retested. Untraceable certificates were treated as if falsified. The Nuclear Safety and Security Commission permitted restart of the plants in January 2014.<br>Six nuclear engineers and equipment suppliers were handed prison sentences. | Do not be overconfident and complacent if experiencing excellent nuclear power plant performance for a long time period.<br>Be transparent and open in quality and procurement activities.<br>Encourage anonymous reporting (counterfeits were revealed by an anonymous tip). |
| Mexico | Inappropriate parts installed on emergency diesels by external maintenance contractor [26, 75, 76] | Inappropriate parts (e.g. wrong metallic composition) had been installed on emergency diesels of Laguna Verde 2 Nuclear Power Plant by maintenance contractors. This resulted in a fire in 2012 and an outage extension in 2014. See also Section I.7. | Strict attention to detail is needed in each stage of the procurement process (including parts usage by external contractors).<br>Difficulty, in some cases, of classifying items as non-conforming, counterfeit or fraudulent was identified. |

TABLE 7. SELECTED STATE AND INTERNATIONAL ORGANIZATION EXPERIENCES AND REPORTS ON COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY *(adapted from table 24 of Ref. [2])* (cont.)

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| OECD/NEA | CNRA regulatory guidance booklet The Nuclear Regulator's Role in Assessing Licensee Oversight of Vendor and Other Contracted Services (NEA/CNRA/R(2011)4) [36] | See Table 2. | See Table 2. |
| | Operating Experience Report: Counterfeit, Suspect and Fraudulent Items (NEA/CNRA/R(2011)9) [3] | State by State operating experience on CFIs and processes in place in OECD Member States is provided. | |
| | Regulatory Oversight of Non-conforming, Counterfeit, Fraudulent and Suspect Items (NCFSI) (NEA/CNRA/R(2012)7) [24] | See Table 2. | See Table 2. |
| United Kingdom | Falsification of pellet diameter data in the mixed oxide demonstration facility at the BNFL Sellafield site [18, 19] | On 20 August 1999, a quality control team member identified similarities between the secondary pellet diameter data for successive lots of mixed oxide fuel pellets. After further investigations, BNFL reported that some of these secondary pellet diameter checks on the fuel manufactured for a Japanese customer appeared to have been falsified by copying some data between spreadsheets. One example of falsification has been found dating back to 1996. Safety performance of the fuel was unaffected. It was not possible to establish the motive for this falsification, but the poor ergonomic design of this part of the plant and the tedium of the job seem to have been contributory factors. The lack of adequate supervision provided the opportunity. The regulator concluded that a systematic failure allowed the event to happen, but in a plant with the proper safety culture, the events could not have occurred. | Importance of safety culture and managerial oversight was highlighted. |
| | Lifting bolts for module found to conform to lesser grade standard [79] | As part of preparations for the installation of a module at Sellafield, unsatisfactory quality documentation prompted independent testing of lifting bolts to confirm their mechanical properties. The bolts, stamped as grade 10.9, failed and were found to conform to a grade 8.8 standard. The substandard bolts did not align with the information declared on the documentation and could be categorized as an example of a CFI. | Counterfeiting of generic items, such as bolts, was highlighted. |

TABLE 7. SELECTED STATE AND INTERNATIONAL ORGANIZATION EXPERIENCES AND REPORTS ON COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY *(adapted from table 24 of Ref. [2])* (cont.)

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| United Kingdom | Counterfeit electronic parts identified by a Sellafield Ltd supplier [79] | Re-manufacture of quality grade 3 printed circuit boards required the use of an obsolete component. During receipt, the delivered component was found to be counterfeit. When looking at the parts, there appeared to be two clear differing textures to the top surfaces, with evidence of potential blacktopping and remarking. | Potential for the introduction of CFIs when addressing obsolescence issues was identified. |
| United States of America (CII) | Product Integrity Concerns in Low-Cost Sourcing Countries: Counterfeiting within the Construction Industry [8] | This document reported that the consensus of 187 industry and government leaders from eight countries interviewed was that the magnitude of the counterfeiting problem had grown from ‘big’ to ‘very big’. | CII identified the following lessons:<br>— Maintain integrity of supply chain.<br>— Adopt a zero tolerance policy.<br>— Train/educate procurement, quality management and field personnel on dangers of counterfeit goods.<br>— Train/educate customs officials and other law enforcement agency personnel.<br>— Establish more stringent supply chain activities.<br>— Use effective positive materials identification processes.<br>— Put more emphasis on documenting the quality and integrity of the sourcing of raw materials and commodity items. |
| United States of America (Energy Facility Contractors Group) | DOT ratchet type tie-down suspect/counterfeit bolt issue [80] | Issues were identified with suspected counterfeit bolts/fasteners that were part of DOT ratchet strap load tie-down devices. The devices were used to secure loads, including hazardous waste and radioactive materials, on trucks. Lack of bolt-head markings had caused many items to be suspected as counterfeit, although only high strength fasteners of grade 5 or above actually required such marking.<br>The primary recommendation of the investigation was to provide a clearer purchasing specification for the devices, most specifically the required breaking strength of the straps and information about bolt-head markings if necessary. Additionally, a receipt inspection process was recommended for the assemblies before their use, and it was recommended that vendors of the devices be qualified and placed on an approved vendor list. | Importance of a clear purchasing specification and receipt inspection for important purchases, even for commercial type products, was recognized. |

TABLE 7. SELECTED STATE AND INTERNATIONAL ORGANIZATION EXPERIENCES AND REPORTS ON COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY *(adapted from table 24 of Ref. [2])* (cont.)

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| United States of America (EPRI) | Plant Support Engineering: Counterfeit and Fraudulent Items [6] | In 2008, counterfeit integrated circuits and electrolytic capacitors were discovered at Millstone Nuclear Power Plant. Integrated circuits were discovered when the portal monitor could not be calibrated. Capacitors were discovered through dimensional checks and subsequent investigation.<br>In 2013, capacitors identified with no date code and purchased through an OEM supplier-recommended broker were found to be counterfeit. | Electronic counterfeiting is becoming an issue. |
| | Plant Support Engineering: Counterfeit and Fraudulent Items [6] | In 2009, a nuclear power plant instrument manufacturer questioned the validity of phototransistor optocouplers used in timers for several nuclear power plant customers. Date codes on the devices were after the OEM had stopped production of the item. | Electronic counterfeiting is becoming an issue. |
| United States of America (NUMARC) | NUMARC 90-13: Nuclear Procurement Program Improvements [81] | This document recommended putting more emphasis on verifying product quality than on relying on supplier documentation. | Recommendations were made to:<br>— Increase engineering involvement.<br>— Increase awareness of CFIs.<br>— Share information via industry operating experience forums.<br>— Procure items from OEMs or authorized distributors whenever possible.<br>— Establish performance via traceability with OEM or authorized distributor.<br>— Establish acceptance criteria for items at the start of the procurement process. |
| United States of America (NRC) | ABB Capacitors, October 2008 [3] | Suspect capacitors were identified during CGD activities. Capacitors were procured from a commercial distributor. No actual failures or damage occurred. | |
| | NRC Information Notice 83-01 [82] and NRC IE Bulletin 83-07 [83] (including supplements) | Apparently fraudulent products were sold. Unauthorized substitutions or modifications were made to a variety of materials (e.g. welded pipe substituted for seamless; standard grades of stainless steel substituted for low carbon; foreign-made stainless steel substituted for domestic). | |

TABLE 7. SELECTED STATE AND INTERNATIONAL ORGANIZATION EXPERIENCES AND REPORTS ON COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY *(adapted from table 24 of Ref. [2])* (cont.)

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| United States of America (NRC) | NRC Compliance Bulletin 87-02 [84] (with supplements) | Fastener testing was performed to determine conformance with applicable material specifications. Over several years, counterfeit fasteners had been identified throughout various industries, associations and US federal agencies. Fasteners had been mismarked to indicate a material content and composition different from actual bolt content. This bulletin requested that nuclear power plants review their receipt inspection requirements and internal controls for fasteners and independently determine, through testing, whether fasteners (studs, bolts, cap screws and nuts) in stored facilities meet required mechanical and chemical specification requirements. | Counterfeiting of fasteners had reached a point at which countrywide review of the situation was warranted. |
| | NRC IE Bulletin 88-05 [85] (with supplements) | Non-conforming material was supplied by two companies. A number of test reports were apparently used to certify that commercial grade, foreign steel met ASME requirements by using a domestic forging company's letterhead. This bulletin required that nuclear power plants submit information regarding materials supplied by the two companies and request actions be taken to ensure that materials comply with ASME code and design specification requirements or are suitable for their intended service, or replace such material. | |
| | NRC IE Bulletin 88-10 [86] (with supplement 1) | This case involved non-conforming moulded case circuit breakers and is related to NRC Information Notice 88-46 [94]. This bulletin requested that nuclear power plants take actions to provide reasonable assurance that moulded case circuit breakers, including circuit breakers used with motor controllers and purchased for safety related applications without verifiable traceability to the circuit breaker manufacturer, can perform their safety functions. Untraceable circuit breakers were required to be tested or replaced (see specific details in the bulletin). | Issues with refurbished moulded case circuit breakers had reached a point at which countrywide action was warranted. Refurbished circuit breakers may not have been refurbished under controlled conditions to conform to a proven design, thus destructively testing selected breakers would not make it possible to infer anything about other refurbished circuit breakers. |
| | Cooper Bussmann [3] | In October 2009, CGD activities were identified and associated with a lot/batch of fuses. Affected fuses contained an underlying defect consisting of a missing internal fuse link. | Importance of CGD activities was recognized. |

TABLE 7. SELECTED STATE AND INTERNATIONAL ORGANIZATION EXPERIENCES AND REPORTS ON COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY *(adapted from table 24 of Ref. [2])* (cont.)

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| United States of America (NRC) | DeKalb Y Globe Valve [3] (see also Ref. [6] and Section I.5) | In October 2006, a DeKalb Y Globe Valve, ¾ NPS Class 1500 was discovered in a nuclear power plant warehouse. The valve, reportedly made of stainless steel, exhibited extensive rust blooms and magnetic properties. The valve was in fact constructed of carbon steel. No additional counterfeits were detected. | Importance of personnel training in detection of CFIs was recognized. |
| | NRC Generic Letter 89-02 [87] | In this letter, actions were provided to improve detection of counterfeit and fraudulently marketed products. The letter focused on the effectiveness of CGD programmes and shared NRC perspectives on ways to address concerns with dedication and counterfeit products. | Three characteristics of an effective procurement and dedication plan were identified:<br>— Involvement of engineering in procurement and acceptance process;<br>— Effective source inspection, receipt inspection and testing programmes;<br>— Thorough engineering based programmes for testing and dedication of CGD products for suitability in safety related applications. |
| | NRC Generic Letter 89-09 [88] | Utilities were experiencing difficulties in obtaining replacements for components originally constructed to ASME Section III standards (companies were not holding on to their nuclear certificates of authorization). The letter stated that consideration may be given to the procurement of replacements from an OEM to avoid an adverse impact on existing components or systems. However, it would be necessary to obtain objective evidence that the quality of the replacement is adequate. | Decline in the number of qualified nuclear suppliers is impacting nuclear power plants. |
| | NRC Generic Letter 91-05 [89] | A number of failures in CGD programmes were identified during 13 inspections. In a number of cases, nuclear power plants had failed to maintain programmes as required to ensure the suitability of commercial grade items for their safety related applications. Some equipment of indeterminate quality was also found installed. This letter was intended to further clarify information provided in NRC Generic Letter 89-02 [88]. | A reduction in number of qualified nuclear grade vendors and an increasing number of commercial grade replacement parts being used in safety related applications was increasing the importance of CGD programmes. |

TABLE 7. SELECTED STATE AND INTERNATIONAL ORGANIZATION EXPERIENCES AND REPORTS ON COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY *(adapted from table 24 of Ref. [2])* (cont.)

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| United States of America (NRC) | NRC Information Notice 83-07 [90] and NRC IE Bulletin 83-06 [91] | These documents concerned non-conformities in materials. The items were found to have been shipped from an unapproved nuclear source, not having had proper heat treatment and not meeting ASME code requirements for non-destructive examination. A sub-supplier had purchased material from foreign stock material suppliers without an appropriate quality assurance programme and had not performed the required heat treatment. | Sub-supplier performance is important to nuclear quality. |
| | NRC Information Notice 84-52 [92] (including supplement 1) | This notice concerned inadequate material procurement controls on the part of licensees and vendors. NRC inspections unveiled a large number of quality related supplier deficiencies, such as:<br>— Improper certification of stock materials as being fabricated or upgraded in accordance with ASME code requirements;<br>— Inadequate inspection of materials received;<br>— Failure to ensure satisfactory performance of required mechanical testing and non-destructive examination;<br>— Inadequate or incomplete survey and audit records;<br>— Breakdown of procurement controls with respect to requirements of 10 CFR 21, appendix B to 10 CFR 50, and the ASME code.<br>Licensee deficiencies included:<br>— Inadequate specification of code requirements on purchase orders and other documents;<br>— Failure to develop and monitor an approved vendor list;<br>— Inadequate inspection of materials and components when received;<br>— Inadequate survey and auditing of vendor quality assurance programmes;<br>— Failure to perform adequate internal audits of the procurement process;<br>— Inadequate training of personnel who procure nuclear materials under requirements of 10 CFR 21, appendix B to 10 CFR 50, and the ASME code;<br>— Insufficient management attention to procurement activities. | Attention of suppliers and purchasers is important. |

TABLE 7. SELECTED STATE AND INTERNATIONAL ORGANIZATION EXPERIENCES AND REPORTS ON COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY *(adapted from table 24 of Ref. [2])* (cont.)

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| United States of America (NRC) | NRC Information Notice 88-19 [93] | The certification of class 1E components supplied to Wolf Creek Nuclear Power Plant was questionable. Supplier records did not support the statement on the certificate of compliance that all purchase order requirements had been met. | Importance of review of supplier documentation provided with order was emphasized. |
| | NRC Information Notice 88-46 [94] (including supplements) | Licensee reported defective refurbished circuit breakers. Surplus or refurbished electrical equipment, such as circuit breakers or circuit breaker parts, was supplied to nuclear power plants but was portrayed as new. Some physical identifying differences were noted (e.g. photocopied labels; rough, worn appearance). | Importance of receipt inspection programmes to catch potential CFIs was emphasized. |
| | NRC Information Notice 88-48 [95] (including supplement 1) | Report was made of defective refurbished 2 in. (51 mm) valves (leaking steam at bonnet and packing) at Diablo Canyon Nuclear Power Plant. The valves were purchased from a local supplier. The OEM reviewed and indicated that valves were likely counterfeit and not refurbished. | Knowledge of suppliers and source of supply is needed. |
| | NRC Information Notice 88-97 [96] (including supplement 1) | Valve internals at Palisades Nuclear Power Plant were found not to be manufactured by an authorized manufacturer (65 questionable valve internals were identified). The issue was first identified by an OEM field service representative. The valves had been refurbished at an OEM authorized facility using parts from Palisades Nuclear Power Plant stores. The parts had been procured as non-safety related from an OEM authorized sales representative. The parts were found to be dimensionally and, in some cases, metallurgically incorrect. The nuclear power plant and the supplier both failed to adequately verify that the parts would perform their function. | Substandard items can enter nuclear power plant stores. Suppliers need good control over sub-supplier activities. |
| | NRC Information Notice 89-03 [97] | Possible electrical equipment problems were identified. Inspection findings showed that counterfeit, substandard or questionable electrical equipment or components had been used in nuclear power plants. Several electrical suppliers were identified as refurbishing and selling defective equipment components to nuclear and non-nuclear industries. | CFI issue is not confined to the nuclear industry. Licensees were asked to review procurement procedures and practices, especially in areas such as purchase orders, materials requirements, vendor qualifications and receipt inspections, to ensure quality control and compliance. |

TABLE 7. SELECTED STATE AND INTERNATIONAL ORGANIZATION EXPERIENCES AND REPORTS ON COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY *(adapted from table 24 of Ref. [2])* (cont.)

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| United States of America (NRC) | NRC Information Notice 89-39 [98] | This notice contains a list of parties excluded from US federal procurement or non-procurement programmes. Information is provided on a database of parties (manufacturers, vendors and contractors) excluded from receiving federal contracts or assistance owing to a variety of practices, including poorly manufactured or fraudulent/counterfeit parts being used in the nuclear industry. | Having an up to date database of acceptable and unacceptable suppliers is important. |
| | NRC Information Notice 89-45 [99] (with supplements) | Defects — including missing, non-standard and substandard parts and improper assembly and maladjustments — were discovered in metalclad, low voltage power circuit breakers at Quad Cities Nuclear Power Plant. Deficiencies were discovered when breakers were shipped to the OEM facility for overhaul and some devices were found to have failed in service or during testing. Items were purchased as commercial grade, had been taken from a non-OEM supplier from supposedly 'new' stock and had been maintained in the meantime by Quad Cities staff. It had not been determined who was responsible for circuit breaker condition at Quad Cities or why the conditions remained undetected during maintenance activities. Other nuclear power plants were found to have defective equipment from this supplier. | Proper control around commercial grade material is important, as is knowledge of suppliers. |
| | NRC Information Notice 89-56 [100] (with supplements) | Questionable certification of material was supplied to the Department of Defense by nuclear suppliers. Corporate officers for PVN and Alloy were indicted and later pleaded guilty for their roles in selling commercial grade steel as military grade steel, which was used to build and repair US Navy submarines and surface ships. Suppliers had provided steel to some nuclear power plants, and audits revealed issues with these suppliers. | |
| | NRC Information Notice 89-59 [101] (with supplements) | This notice provided addresses and names of suppliers and/or manufacturers of suspected counterfeit fasteners that were identified in NRC Bulletin 87-02 [84]. | See entry on Bulletin 87-02 [84] above. |

TABLE 7. SELECTED STATE AND INTERNATIONAL ORGANIZATION EXPERIENCES AND REPORTS ON COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY *(adapted from table 24 of Ref. [2])* (cont.)

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| United States of America (NRC) | NRC Information Notice 89-70 [102] | The notice concerned possible indicators of misrepresented vendor products in response to an increased number of instances of misrepresented vendor products being supplied to the nuclear industry.<br>General indications may be found early in the procurement process, beginning with price quotes and scheduled delivery time. Some factors that can indicate a misrepresented product include:<br>— Vendor name: vendor is not an authorized distributor of the products supplied.<br>— Price: quoted prices are significantly lower than those of the competition.<br>— Delivery schedule: the delivery time is shorter than that of the competition.<br>— Source of item: drop shipment of items may increase risk of misrepresentation. In several cases, the quoting supplier subcontracted the order to another company and had that company ship the product directly to the purchaser. The quoting supplier never saw or verified the quality of the product, which in some cases was substandard. | At receipt inspection, labels being in the wrong location or appearing different, or tags being attached with screws rather than rivets are potential indicators of a CFI.<br>Measurement and testing during receipt inspection is important. |
| | NRC Information Notice 90-46 [103] | This notice concerned the criminal prosecution and conviction of wrongdoing of suppliers of moulded case circuit breakers and related components. Two individuals pleaded guilty to two counts of directing their corporations to use counterfeit circuit breaker labels for companies such as General Electric and Square D to deceive buyers of those circuit breakers and switches, some of which were sold to nuclear power plants. | |
| | NRC Information Notice 90-57 [104] (with supplement 1) | This notice concerned substandard refurbished Potter and Brumfield relays being represented as new. The company had modified and/or refurbished 22 rotary, non-latching MDR-type Potter and Brumfield relays and supplied them to Harris Nuclear Power Plant and the US Department of Defense for use on submarines. The company president had directed employees to make the relays appear new and affix counterfeit labels. The president was fined $7500 and ordered to make restitution to the US Government of $350 000. The company had to pay $30 000 ($10 000 for each count) and restitution of $2 501 000, less the amount paid by the president. | |

TABLE 7. SELECTED STATE AND INTERNATIONAL ORGANIZATION EXPERIENCES AND REPORTS ON COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY *(adapted from table 24 of Ref. [2])* (cont.)

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| United States of America (NRC) | NRC Information Notice 90-60 [105] | This notice concerned the availability of failure data in the Government–Industry Data Exchange Program. The NRC provided information relative to the availability of data on engineering, metrology, material problems (failure experience) and reliability/maintainability through the Government–Industry Data Exchange Program. | Databases prepared on a national, industry or international basis related to CFIs are useful. |
| | NRC Information Notice 91-09 [106] | This notice concerned counterfeiting of Crane valves. Valves purchased for a chemical plant near Houston, Texas, were found to be counterfeited.<br>Note: After the investigation, there was no evidence of valves from the supplier ending up in a nuclear facility, although the supplier did have some contracts within the nuclear industry. | Items can go through two or more distributors before reaching an end user facility. Nuclear power plants could buy a commercial grade item from a distributor for the purpose of dedicating the item for safety related use.<br>Establishment and verification of procedures to trace procured equipment and material to the OEM is important to meaningful inspection and testing during the dedication process.<br>Inadequate verification of traceability of procured equipment may result in counterfeit or fraudulent equipment being installed. |
| | NRC Information Notice 92-22 [107] | This notice concerned the criminal prosecution and conviction of wrongdoing of a commercial grade valve supplier. The president of the company that supplied counterfeit valves, as outlined in NRC Information Notice 88-48 [95] (see above), pleaded guilty to charges that the company sold counterfeit valves ultimately installed at Diablo Canyon and Vogtle Nuclear Power Plants and a US Marine Corps military base in Quantico, Virginia. The individual was sentenced to three years' imprisonment, and the company was ordered to pay restitution of $213 825.03 to NRC licensees. | Knowledge of suppliers and source of supply is needed. |
| | NRC Information Notice 92-56 [108] | This notice concerns counterfeit valves in the commercial grade supply system. The supplier purchased approximately 7500 nameplate labels from a label manufacturer, which were imprinted with several valve manufacturers' names (including Crane, Pacific, Walworth, Powell and Lunkenheimer). The company was confirmed to have supplied two counterfeit commercial grade valves to Indian Point 2. | |

TABLE 7. SELECTED STATE AND INTERNATIONAL ORGANIZATION EXPERIENCES AND REPORTS ON COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY *(adapted from table 24 of Ref. [2])* (cont.)

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| United States of America (NRC) | NRC Information Notice 92-68 [109] (with supplements) | This notice concerned potentially substandard slip-on, welding neck and blind flanges. Numerous reports were made of flanges that contained cracks, inclusions and slugged weld repairs and were constructed from two pieces of material. These flanges were reported to have been supplied to US suppliers through several trading companies. Neither welding nor the two-piece construction would be detected during a visual inspection. The flanges all had ASTM Standard A-105 markings. One foreign manufacturer was confirmed to have shipped more than 100 000 kg of flanges to the United States of America. Instances of flanges at two US nuclear power plants were confirmed: at Seabrook, one flange had been installed in a safety system and 20 had been installed in non-safety-related applications; at Browns Ferry, flanges were caught at the receipt inspection stage. | It is possible for a nuclear power plant to install potentially substandard or defective equipment or material if it does not adequately verify that the product can be traced to the original manufacturer. |
| | NRC Information Notice 93-43 [110] | This notice concerned the use of inappropriate lubrication oils in safety related applications. The supplier affixed an incorrect label on a drum of lube oil, and as a result, a different/wrong type of oil was used in safety related equipment (18 of 33 samples taken).<br>The nuclear power plant had not sampled the oil when it was delivered to verify that the plant had received the oil it had ordered. | Receipt inspection activities to confirm critical characteristics, including chemical composition, are important. |
| | NRC Information Notice 93-73 [111] | This notice concerned the criminal prosecution of nuclear suppliers for wrongdoing. Cases were documented of the prosecution of owners of companies engaged in the provision of counterfeit circuit breakers and valves. Much of the equipment was found to have been sold in unsatisfactory condition or to contain substandard parts, manufacturing processes or workmanship. | |
| | NRC Information Notice 95-12 [112] | This notice concerned potentially non-conforming fasteners. The company had provided substandard fastener products obtained from foreign suppliers and falsely certified such products. Company records systems were in disarray and documentation available was not adequate to support the material certifications issued. | Supply chain audits to validate records management practices of suppliers are important. |

TABLE 7. SELECTED STATE AND INTERNATIONAL ORGANIZATION EXPERIENCES AND REPORTS ON COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY *(adapted from table 24 of Ref. [2])* (cont.)

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| United States of America (NRC) | NRC Information Notice 2007-19 [113] | This notice documented fire protection equipment recalls and counterfeit notices issued by various manufacturers. Counterfeit sprinkler heads were manufactured with a slot-head screw instead of a hex-head screw and, in a separate case, without a date code or identification number. | Receipt inspection activities are important. |
| | NRC Information Notice 2008-04 [74] and Ref. [3] | This notice documented cases of supplying counterfeit parts to nuclear power plants (e.g. Ladish stop-check valves at Hatch Nuclear Power Plant discovered in a non-safety-related system during maintenance activities on a similar valve in the vicinity of installed counterfeit (see also Ref. [6]); possibly counterfeit Square D circuit breakers removed from the warehouse at Catawba Nuclear Station (see also Ref. [6])). | Three characteristics of an effective procurement and dedication plan were identified:<br>— Involvement of engineering in procurement and acceptance process;<br>— Effective source inspection, receipt inspection and testing programmes;<br>— Thorough engineering based programmes for testing and dedication of CGD products for suitability in safety related applications. |
| | NRC Information Notice 2012-22 [45] | This notice concerned CFSI training offerings and provided a list of available training. | Regulator interest in training for detection of CFIs was emphasized. |
| | NRC Information Notice 2013-02 [114] (also Ref. [6]) | This notice concerned issues potentially affecting nuclear facility fire safety. Counterfeit single-jacketed fire hose, fire extinguishers, fire pipe hangers and sprinklers were discovered in non-nuclear applications in US industry. The notice was issued to warn the US nuclear industry about the issue. Eight items in total were discussed, and none were reported to have been discovered within US nuclear facilities, although two potential matches were investigated. | Several points were emphasized:<br>— The existence of CFIs in industry;<br>— The potential for nuclear safety impacts;<br>— The importance of information sharing. |

TABLE 7. SELECTED STATE AND INTERNATIONAL ORGANIZATION EXPERIENCES AND REPORTS ON COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY *(adapted from table 24 of Ref. [2])* (cont.)

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| United States of America (NRC) | NRC Information Notice 2013-15 [21] | This notice documented several incidences of records falsification at and related to US nuclear power plants, including a case of an owner/president of a supplier directing an employee to switch a broken display on a Peach Bottom Nuclear Power Plant steam leak detector monitor with a working display unit from Brunswick Nuclear Power Plant. Before its shipment, the owner also instructed an employee to file down the serial number on the substitute display to conceal its identity and to ship the working display to Peach Bottom without informing that site of the switch. The president was prosecuted and pleaded guilty to the offence. | Licensees and suppliers need to implement an effective nuclear safety culture. |
| | Waterford Steam Electric Station — Confirmatory Order, NRC Inspection Report 05000382/2016007 and NRC Investigation Report 4-2014-017 [22] | Nuclear plant contractors falsified ten months of fire inspection records (fire watch tours) at Waterford 3. | Service contractor oversight processes are important. |
| | Summary of event and plant conditions (as of 16 May 2013) [115] | San Onofre Units 2 and 3 shut down owing to steam generator leaks. Unit 2 steam generators were replaced in January 2010, Unit 3 steam generators in January 2011. Each replacement steam generator experienced severe leakage during its first cycle of operation. The plant was eventually permanently shut down owing to the cost of replacement. | There is a risk of substandard major components being installed, even when provided by experienced vendors. |
| | Part 21 (non-conformance) report 1997-06-0: Limitorque counterfeit component [116] | A counterfeit component was installed in a nuclear power plant in a non-safety-related Limitorque actuator purchased from a ‘surplus’ market. | The surplus parts market has a greater chance of including CFIs. |
| | Part 21 (non-conformance) reports 1995-21-2 [117] and 1996-06-4 [118] Aerofin Cardinal Industrial Products capscrews | This report concerned inadequate heat treatment resulting in bolt mechanical properties below required minimums (used in a safety related cooler at Palisades Nuclear Power Plant). An initial bolt problem had been identified by a different customer, and the supplier reported the issue to other customers and the NRC. Investigation and testing traced the problem to a heat treating furnace at the manufacturing facility. | Records and regulatory processes for reporting supplier defects are important. |

TABLE 7. SELECTED STATE AND INTERNATIONAL ORGANIZATION EXPERIENCES AND REPORTS ON COUNTERFEIT AND FRAUDULENT ITEMS IN THE NUCLEAR INDUSTRY *(adapted from table 24 of Ref. [2])* (cont.)

| State/source | Document | Issue | Lessons learned/comment |
|---|---|---|---|
| United States of America (NRC) | SECY 89-010: Advance Notice of Proposed Rulemaking "Acceptance of Products Purchased for Use in Nuclear Plant Structures, Systems and Components" [39] and<br>SECY-94-277: Withdrawal of Advance Notice of Proposed Rulemaking "Acceptance of Products Purchased for Use in Nuclear Plant Structures, Systems and Components" [40] | See Table 2. | See Table 2. |
| | SECY-11-0154: An Agencywide Approach to Counterfeit, Fraudulent, and Suspect Items [119] | This document identified 19 actions to respond to challenges associated with CFIs, categorized in the following areas:<br>— Endorsement of industry process enhancements and best practices;<br>— Developing or clarifying regulatory guidance;<br>— Communication;<br>— Training;<br>— Inspecting for effective industry oversight in detecting and preventing CFIs. | |
| | SECY-15-0003: Staff Activities Related to Counterfeit, Fraudulent, and Suspect Items [120] | This document informed the NRC of the staff's activities regarding CFSIs as they relate to NRC regulated activities. | |
| | NRC Regulatory Issue Summary 2015-08: Oversight of Counterfeit, Fraudulent, and Suspect Items in the Nuclear Industry [41] | See Table 2. | See Table 2. |
| | Walworth Manual Globe Valves, 1.5 in. (38 mm), June 2010 [3] | The values were identified as suspect by plant receipt inspector after a comparison was made to similar valves in inventory. The OEM confirmed that the valves were counterfeits. | |

**Note:** ASME — American Society of Mechanical Engineers; ASTM — American Society for Testing and Materials; BNFL — British Nuclear Fuels Limited; CANPAC — CANDU Nuclear Procurement Audit Committee; CFI — counterfeit or fraudulent item; CFSI — counterfeit, fraudulent or suspect item; CGD — commercial grade dedication; CII — Construction Industry Institute; CNRA — Committee on Nuclear Regulatory Activities; CNSC — Canadian Nuclear Safety Commission; DOT — Department of Transportation; EPRI — Electric Power Research Institute; KHNP — Korea Hydro and Nuclear Power; NRC — Nuclear Regulatory Commission; NUMARC — Nuclear Management and Resources Council; OECD/NEA — Nuclear Energy Agency of the Organisation for Economic Co-operation and Development; OEM — original equipment manufacturer; PMI — positive material identification.

TABLE 8. ITEM SPECIFIC LESSONS LEARNED, BY TYPE OF COUNTERFEIT OR FRAUDULENT ITEM

| Type of item | Issue | Lessons learned |
|---|---|---|
| Fasteners | CFI high strength bolts were evaluated as being acceptable in applications in which, normally, lower strength bolts were used but were not identified or marked as such, leading to the potential that they could be reused in applications in which genuine high strength bolts were required. Stainless steel bolts were hand stamped to indicate they met a different standard.<br>Solution: Not applicable. | Method of identifying bolts allowed for raised or depressed head markings, which would enable someone to add stamping after production. Reliance on head stamping to identify bolts could lead to potential problems without manufacturer certification. |
| Circuit breakers | Refurbished moulded case electric circuit breakers continue to be widely counterfeited and misrepresented as new. Moulded case circuit breakers should not be taken apart and serviced or refurbished except by the original manufacturer or qualified supplier.<br>Solution: Not applicable. | Refurbished moulded case circuit breakers should not be accepted without original manufacturer or qualified suppliers' certification. |
| Metal struts and fittings | Vendors have been found to mix unmarked substitute struts and fittings with properly identified products and ship the parts in the original manufacturer's box. This practice misrepresents the product as being from the original manufacturer.<br>Solution: Not applicable. | Facilities should use metal strut materials purchased for structural applications from reputable manufacturers that will have the manufacturer's name, logo or part number on the part for ease of identification. Markings also identify the load capacity that the part is designed and rated to withstand. |
| Steels | Steels were ordered to a specific standard but were supplied to another standard, for financial gain. Suspicion was aroused when material test reports were checked.<br>Solution: Additional Charpy impact tests were performed, absorbed energy met the original acceptance criteria, and the steels manufactured to the other standard were accepted. | Receipt inspection should be performed thoroughly to detect suspect items.<br>Supplier should be monitored and controlled more strictly |
| Pump shafts | Items were used for spare parts of fire protection pumps, procured during operation. Suspicion was aroused when the run-out check of the pump shafts was performed at the receiving inspection.<br>Solution: Engineering decision was made to discard the shafts and purchase new ones. | Receipt inspection should be performed thoroughly to detect suspect items.<br>Run-out of pump shaft should be checked before installation because misalignment or run-out of pump shaft can be induced by improper handling, shipping, transportation or manufacturing. |
| Throttle valves and piping | Items were used in the rear side of component cooling water heat exchangers, procured during construction and installed. Suspicion was aroused when throttle valves and rubber-lined piping was damaged by cavitation as a result of sudden throttling during the commissioning test.<br>Solution: To avoid cavitation and optimize the efficiency of the heat exchanger, the design was changed by installing a cone type orifice in the rear side of the throttle valve and changing the valve size; damaged valves and pipes were replaced with larger ones. | Anticavitation design should be considered in the throttle line.<br>Experience and design changes were incorporated into next plant design. |

TABLE 8. ITEM SPECIFIC LESSONS LEARNED, BY TYPE OF COUNTERFEIT OR FRAUDULENT ITEM (cont.)

| Type of item | Issue | Lessons learned |
|---|---|---|
| Rubber gaskets | Items were used on a fuel handling pit gate, procured during construction and installed. Suspicion was aroused when a leakage from the gate was detected; the leakage came through a damaged gasket as a result of inappropriate installation of a clamp to fix the gasket and unexpected ageing of the gasket.<br>Solution: Damaged parts of the gasket were repaired and leak tested. | Installation should adhere to the technical specification.<br>Spare parts inventory was updated to consider replacing the suspect items more frequently.<br>Preventive maintenance methods were established and implemented as follows: daily check for leakage of gasket; visual inspection of the gasket during annual outages; detailed checks every five years in accordance with manufacturer's instruction. |
| Swing type check valves | Items were procured during construction and installed next to the orifice of the discharge side of motor operated auxiliary feed water pumps. During preventive maintenance, it was discovered that the disc bolt was ruptured and the detached bolt, nut, washer and fixing pin had disappeared into the feed water system.<br>Solution: Eddy current testing and engineering evaluation were performed to assess the effect of loose parts on the steam generator, the disc bolt was replaced with a thicker one, and weak parts of the valve were reinforced. | Similar valves supplied by the same supplier should be checked periodically during annual outages or, if necessary, normal operation. |
| Seal injection filter | Items were used on front side of reactor coolant pump, procured during construction and installed. Suspicion was aroused when seal injection flow 'low' signal alarm was initiated as a result of blocking of seal injection flow by a buildup of filtering material in seal housing of reactor coolant pump.<br>Solution: Impurities in seal housing and system were removed by flushing; the location of the differential pressure gauge was moved to a low radiation area by design change to allow frequent check of differential pressure. | Filtering material should be replaced periodically, taking into account any unforeseen ageing effect caused by use in a differential pressure environment, regardless of manufacturer's instructions.<br>Differential pressure of filter should be checked frequently. |
| Reactor vessel guide studs | Items were used when assembling and disassembling reactor vessel, procured for construction in accordance with thread type design and installed. Suspicion was aroused when threads of guide stud and stud hole were damaged during commissioning tests.<br>Solution: Design change from thread type to sleeve type was made, damaged thread of guide stud was discarded and stud hole thread was bored. | Experience and design change was incorporated into next plant design |
| Reactor coolant pump seal housing bolts | Items were procured during construction and installed. During annual outage, suspicion was aroused when leakage between the seal housing and the bolt ring of a reactor coolant pump was detected. The disassembly of the seal housing revealed that all bolts were corroded or rusted by boric acid that had leaked into the seal housing.<br>Solution: Corroded bolts were replaced with new bolts, non-destructive and engineering evaluations on rusted bolts were performed, and a leakage check was performed after bolting. | Maintenance procedure for reactor coolant pump seal housing was revised to prevent inflow of boric acid into the seal housing.<br>Periodic check performed to identify leakage. |

TABLE 8. ITEM SPECIFIC LESSONS LEARNED, BY TYPE OF COUNTERFEIT OR FRAUDULENT ITEM (cont.)

| Type of item | Issue | Lessons learned |
|---|---|---|
| Chemical waste drain tank | Items were used in liquid radioactive waste system, procured during construction. Suspicion was aroused when non-destructive evaluation was not carried out on nozzle welds as a result of misinterpretation of the non-destructive evaluation requirements in the procurement specification.<br>Solution: Liquid penetrant examination was performed in accordance with specification, and tank was accepted. | Receipt inspection should be performed thoroughly to ensure that all tests have been carried out in accordance with procurement specifications. |
| Flange bolts of tank | Items were procured during construction and installed. Suspicion was aroused when quality surveillance identified that flange bolts were not fully engaged with nuts.<br>Solution: All bolts were replaced with longer ones to allow full engagement. | Receipt inspection should be performed thoroughly to check full bolt engagement in nuts on assemblies. |
| Electrical and instrumentation and control cables — fire retardancy | Items were procured during construction; they were supplied from the warehouse of a nuclear power plant from a utility in another State. Suspicion was aroused when test certificates were checked (cable specifications and tests were in accordance with State's national standards). Supply was accepted owing to financial benefits and impact on work schedules.<br>Solution: Tests were repeated to current standards, cables were installed in unit, and engineering assessment established compensatory measures (fire detection system, sprinklers for extinguishing fires, protection of structural steel with intumescent paints, and fire barriers on cable trays). | Some documents sent with items might also be suspect; documents confirming the design features of an item should be signed by a neutral evaluator.<br>Use of suspect items is permissible if appropriate compensatory measures are taken. |
| Transformers | Items were procured during construction and were stored for a long time in conditions (variable temperatures and humidities) that were not strictly controlled; possible insulation/paper degradation occurred. The items were then installed in a unit. Suspicion was aroused when several transformers failed during commissioning (short circuits, fires).<br>Solution: New transformers were ordered (insulation: moulded resin) and stored on the site in suitable conditions, to enable immediate replacement of failed transformers in future. | Evaluation/inspection of item status should be carried out before installation to assess the effect of storage conditions on the item.<br>Spare part and component inventory should take into account the need to replace any installed suspect items when they fail. |
| Electronic cards in logic loops | Items were procured during construction and installed. Suspicion was aroused when spurious trip signals were generated in some pins on the card when the card failed (the situation generated a reactor trip during commissioning tests). The manufacturer confirmed the failure as being generic in nature, after a request by the nuclear power plant to carry out an investigation.<br>Solution: Modification implemented in loops that used such pins and that had an impact on other similar logic; the balance of the cards was kept unchanged. | Approach to the disposition of suspect items should be related to the importance of the item for safety or for plant availability.<br>Any suspicions should be identified at an early stage, during commissioning tests if possible (schedule special tests for CFIs).<br>Information and clarification should be requested from the supplier, together with an investigation on any faults identified in order to simplify the engineering evaluation. |

TABLE 8. ITEM SPECIFIC LESSONS LEARNED, BY TYPE OF COUNTERFEIT OR FRAUDULENT ITEM (cont.)

| Type of item | Issue | Lessons learned |
|---|---|---|
| Liquid relief valves | Items were used in a degasser–condenser, operating in tandem with the pressurizer, procured for construction (in accordance with the standard design) and installed. Suspicion was aroused through feedback that suggested that other nuclear power plants of the same design replaced these valves with new ones with better dampening features. Suspicion was confirmed during a transient, when unit was shut down and the valves operated but did not close properly (they ‘chattered’), generating heavy water losses.<br>Solution: Valves were repaired (for the short term); new valves were ordered, similar to those used by other nuclear power plants, with installation to occur during annual outage. | Database of CFIs should be permanently monitored to take into account the operating experience of other nuclear power plants.<br>The replacement of such items should be considered as an important part of annual outage work.<br>The replacement of suspect items could be implemented with the cooperation of other nuclear power plants interested in such work. |
| Identification and markings | The following are examples of CFIs that were discovered as a result of improper markings:<br>— Metal flanges stamped as forgings when other markings on the face of the flange indicated that parts were cold rolled.<br>— Metal flanges as part of fabricated assemblies without any required markings on the flanges, such as manufacturer, material type, specification or dimension.<br>— Metal eyebolts either with no manufacturer’s markings or with markings indicating that parts were made in a country other than specified. Eyebolt dimensions did not meet specifications and material types were indeterminate.<br>— Metal piping and pipefittings requested from national manufacturers and received from foreign manufacturers.<br>— Lifting devices purchased with procurement credit cards had been visibly altered, as evidenced by overstamping or striking through original information and adding new markings.<br>Solution: Not applicable. | |

**Note:** CFI — counterfeit or fraudulent item

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# GLOSSARY

**counterfeit.** Products that are intentionally manufactured, refurbished or altered to imitate original products, without authorization, in order to pass them off as genuine.

**fraudulent.** Products that are intentionally misrepresented with the intent to deceive. Fraudulent items include items provided with incorrect identification or with falsified or inaccurate certification. They may also include items sold by entities that have acquired the legal right to manufacture a specified quantity of an item but produce a larger quantity than authorized and sell the excess as legitimate inventory.

**genuine.** Products that are produced and certified without the intent to deceive.

**non-conforming.** Products that do not meet intended requirements or functions. They may be provided by legitimate suppliers without the intent to deceive.

All non-genuine items (counterfeit or fraudulent items) are considered non-conforming, as are genuine items that do not meet intended requirements or functions.

**non-genuine.** Products that are produced and certified with the intent to deceive.

**product.** An item offered for sale. It can be a service or an object. Items can be physical or in virtual or cyber form.

**suspect.** Products for which there is an indication or suspicion that they may not be genuine.

# ABBREVIATIONS

| | |
|---|---|
| ASME | American Society of Mechanical Engineers |
| CANDU | Canada deuterium–uranium |
| CFI | counterfeit or fraudulent item |
| CFSI | counterfeit, fraudulent or suspect item |
| CGD | commercial grade dedication |
| CSA | Canadian Standards Association |
| EDG | emergency diesel generator |
| EPRI | Electric Power Research Institute |
| INPO | Institute of Nuclear Power Operations |
| ISO | International Organization for Standardization |
| OECD/NEA | Nuclear Energy Agency of the Organisation for Economic Co-operation and Development |
| OEM | original equipment manufacturer |
| PMI | positive material identification |
| SAE | Society of Automotive Engineers |
| WANO | World Association of Nuclear Operators |

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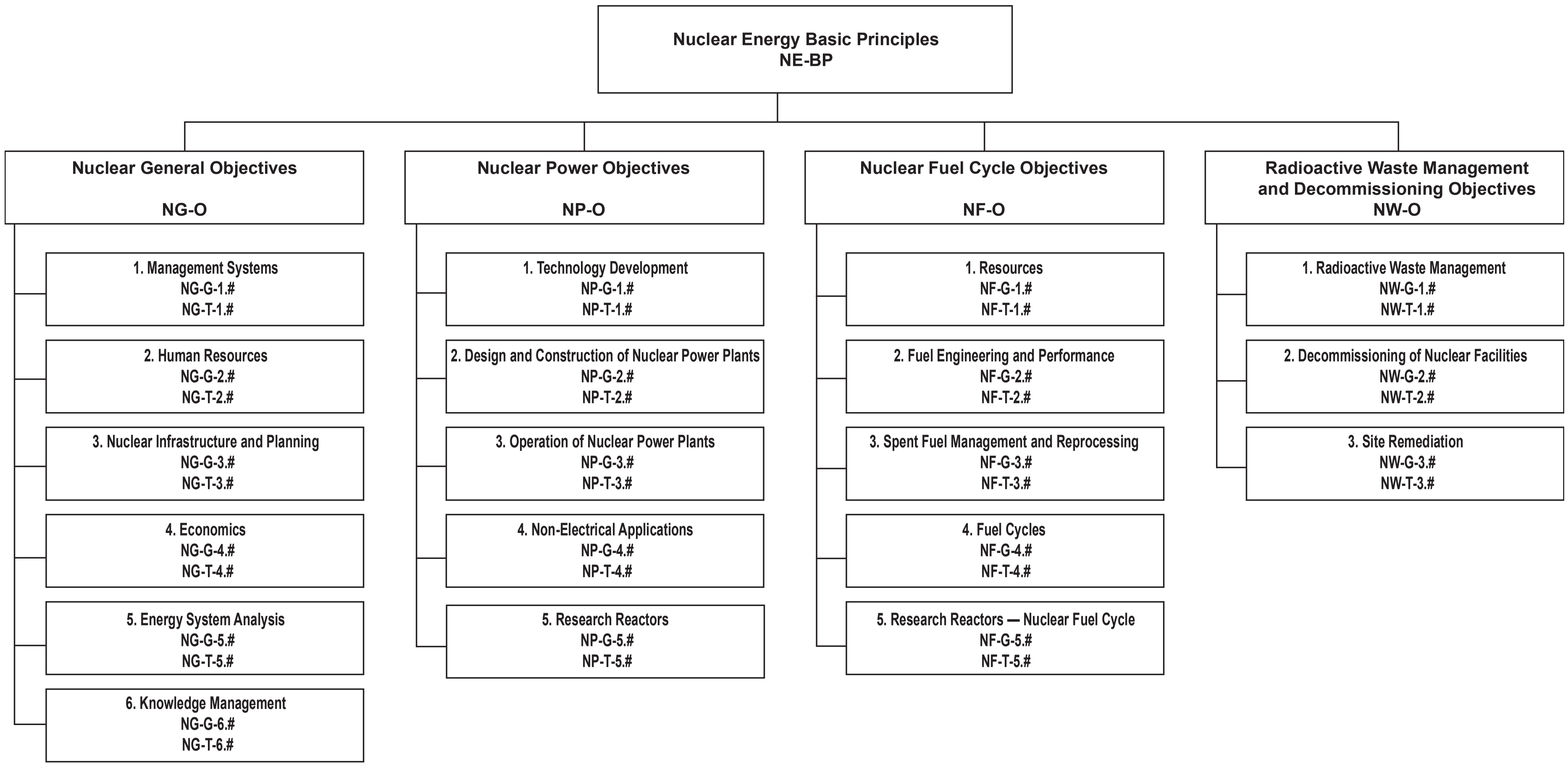


*Key*

| | |
|---|---|
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