Considerations regarding the risk of using counterfeit products in the aerospace industry

Ilinca MARIN (SOARE)*[,1,2], Manuela RUSU[1,2], Valentin SOARE[2],
Sergiu TONOIU[1], Ovidiu BLAJINA[1]

*Corresponding author
[1]"POLITEHNICA" University of Bucharest,
Splaiul Independentei 313, Bucharest 060042, Romania,
sergiu_ton@yahoo.com
[2]INCAS – National Institute for Aerospace Research "Elie Carafoli",
B-dul Iuliu Maniu 220, Bucharest 061126, Romania,
soare.ilinca@incas.ro, rusu.manuela@incas.ro, soare.valentin@incas.ro

Abstract: *This paper aims to increase the level of awareness regarding the risk of using counterfeit parts in the aerospace industry. Manufacturing and selling counterfeit parts is a challenge that almost every business faces and that has an impact on retailers, distributors, and producers. Contrary to other businesses, counterfeiting could be fatal in the aerospace, defense, and automotive sectors. The risk of receiving counterfeit parts or assemblies with counterfeit parts will vary depending on the organization's role and position within the supply chain. The risk increases with the number of supply chain intermediaries (such as sub-tiers, distributors, customers, services, etc.) that incorporate parts into products or assemblies.*

Key Words: *counterfeit parts, risk, supply chain, SR EN 9100:2018/AS9100D*

1. INTRODUCTION

Many companies have been struggling recently with the problem of counterfeit parts being used in the aerospace industry. To try to solve this problem, they have developed ways to identify these components and make sure they are not used in their products. The quality management system standard SR EN 9100:2018/AS9100D includes requirements for aerospace companies regarding the prevention of counterfeit or suspect counterfeit part use and their inclusion in the product delivered to the customer.

Organizations shall plan, implement, and control processes, appropriate to their operations and the product for the prevention of counterfeit or suspect counterfeit parts use and their inclusion in product(s) delivered to the customer. This processes should consider:

- training of appropriate persons in the awareness and prevention of counterfeit parts; application of a parts obsolescence monitoring programme;
- controls for acquiring externally provided product from original or authorised manufacturers, authorised distributors, or other approved sources;
- requirements for assuring traceability of parts and components to their original or authorised manufacturers;

- verification and test methodologies to detect counterfeit parts;
- monitoring of counterfeit parts reporting from external sources;
- quarantine and reporting of suspect or detected counterfeit parts [1].

According to the SR EN 9100:2018/AS9100D standard, a counterfeit part is an unauthorized copy, imitation, substitute, or modified material, part, or component which is knowingly misrepresented as a specified genuine part of an original or authorized manufacturer. This includes used parts represented as new, or the false identification of grade, serial number, lot number, date code, or performance or material characteristics [1].

A suspect counterfeit part is a material, part, or component for which credible evidence (including, but not limited to, visual inspection or testing) provides reasonable doubt that the material, part, or component is authentic [12].

Counterfeit parts are a serious safety threat to organizations, their customers and end users of products. The golden rule to protect from counterfeit parts is to only use authorised suppliers. If you want to be sure that the products you buy are of the highest quality, it's recommended to use suppliers that are certified SR EN ISO 9001:2015 or SR EN 9100:2018/AS9100D. To reduce the potential harm caused by counterfeiting activities, the organizations need to take increased care and implement active control measures at all levels of their industrial supply chain.

The ability to understand the global supply chain and market trends is essential for companies looking to reduce the risk of counterfeit components. Many large companies have complex supply chains, and it is important for them to be aware of the key players in these chains, as well as any potential breaches that could allow counterfeit products to enter the system.

Companies can reduce the risk of counterfeits entering their supply chain by only purchasing from approved distributors or component manufacturers. However, it can prove difficult to avoid buying from the open market. This is especially true when supply chains are strained and parts are difficult to source. It is always recommend purchasing products from the original manufacturer or their franchised distributors, but if you are buying products on the open market, it's important to do a lot of research and check the components to make sure they are authentic.

2. PREVENTION OF COUNTERFEIT PARTS IN THE AEROSPACE SUPPLY CHAIN

The SR EN 9100:2018/AS9100D standard addresses „counterfeit" and „suspected counterfeit" parts. In reality, within an organization only suspected counterfeit parts will be identified, because proving that something is 100% counterfeit probably exceeds the organization's field of expertise [5].

To ensure compliance with requirement 8.1.4. Prevention of counterfeit parts from the SR EN 9100:2018/AS9100D standard, it is necessary to know and respect two other standards, depending on the field of activity in which the organization operates:

- SAE AS5553D:2022 - Counterfeit Electrical, Electronic, and Electromechanical (EEE) Parts; Avoidance, Detection, Mitigation, and Disposition.
- SAE AS6174A:2014 - Counterfeit Material: Assuring Acquisition of Authentic and Conforming Material.

SAE International is a professional association and standards development organization for the engineering industry, with a special focus on transport sectors such as automotive,

aerospace and commercial vehicles. The organization was originally established as the Society of Automotive Engineers [4].

The AS5553D:2022 - Counterfeit Electrical, Electronic, and Electromechanical (EEE) Parts; Avoidance, Detection, Mitigation, and Disposition is intended to be used by organizations that procure and integrate EEE parts. These organizations may provide EEE parts that are not integrated into assemblies (e.g., spares and/ or repair EEE parts). Examples of such organizations include, but are not limited to: original equipment manufacturers; contract assembly manufacturers; maintenance, repair, and overhaul organizations; value-added resellers; and suppliers that provide EEE parts or assemblies as part of a service. The requirements of this standard are generic. These requirements are intended to be applied (or flowed down as applicable) through the supply chain to all organizations that procure EEE parts and/ or systems, subsystems, or assemblies, regardless of type, size, and product provided. The mitigation of counterfeit EEE parts in this standard is risk-based and these mitigation steps will vary depending on the criticality of the application, desired performance and reliability of the equipment/hardware [2].

The AS6174A:2014 - Counterfeit Materiel: Assuring Acquisition of Authentic and Conforming Materiel standardizes requirements, practices, and methods related to: materiel management, parts management, supply chain management, procurement, inspection, test/evaluation to assure the authenticity and conformance of materiel being acquired, and response strategies when suspect or confirmed counterfeit materiel is discovered.
It is recommended to be used by all contracting organizations that procure materiel, whether such materiel is procured directly or integrated into assemblies or equipment. The requirements of this standard are generic and intended to be applied/ flowed down to all organizations that procure materiel, regardless of type, size, and product provided. The AS5553D:2022 standard pertains directly to electronic parts, and supplements the guidance of the AS6174A:2014 standard [3].

Despite having different names, the two standards mentioned above essentially lay out the same set of requirements. Those requirements match those of SR EN 9100:2018/AS9100D, leading to "plan, implement, and control processes" to both prevent suspect parts from getting into the final product, and to prevent purchasing them in the first place [5].

The main steps to prevent the use of counterfeit parts within an organization are illustrated in the figure below.

Figure 1. Steps to prevent the use of counterfeit parts [3]

Step 1 – Supplier selection and purchasing controls

All three standards - AS5553D:2022, AS6174A:2014, SR EN 9100:2018/AS9100D note from clause 8.1.4 - mention the need to implement controls to prevent the purchase of suspected counterfeit parts. To reduce the risk of buying counterfeit parts and to ensure quality products it is recommended to use known, reliable and well-known suppliers.

The strongest correlation between parts and its likelihood of being counterfeit is the trustworthiness of the supplier. Regardless of supply class, purchase price, or other likelihood factors, purchasing materiel from an untrusted supplier increases the likelihood of purchasing counterfeit materiel [10].

Risk assessment is generally achieved by weighing the likelihood that an event will occur against the consequence of the occurrence. The 'five by five risk cube' in figure 2 shows the interplay between the two factors.

The green, yellow, and red boxes have been modified from the standard risk chart to reflect counterfeit materiel risk and inspection/test reaction. For example, any obsolete integrated circuit would be considered high risk materiel [10].

For red risk level - Enhanced mitigation (inspection and test)

For yellow risk level - Standard mitigation (inspection)
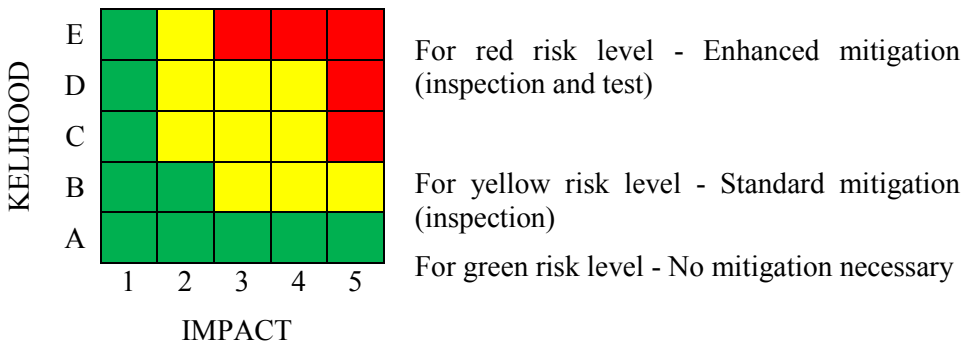
For green risk level - No mitigation necessary

Figure 2. Risk assessment matrix [10]

Table 1 explains how to select the likelihood rating (from A to E) based on supplier and type.

Table 1. – Likelihood Assessment [10]

Level	Supplier Type	Materiel Type
A	Authorized	All types
B	Unauthorized Approved	Low and medium risk materiel
C	Unauthorized Approved	High risk materiel
D	Unauthorized Unapproved	Low risk materiel
E	Unauthorized Unapproved	Medium and high risk materiel

Table 2 explains how to select the impact rating (from 1 to 5) based on system impact.

Table 2. – Impact Assessment [10]

Level	Impact
1	Minimal or no system impact
2	Minor system impact
3	Moderate system impact
4	Major system impact
5	Safety or mission impact

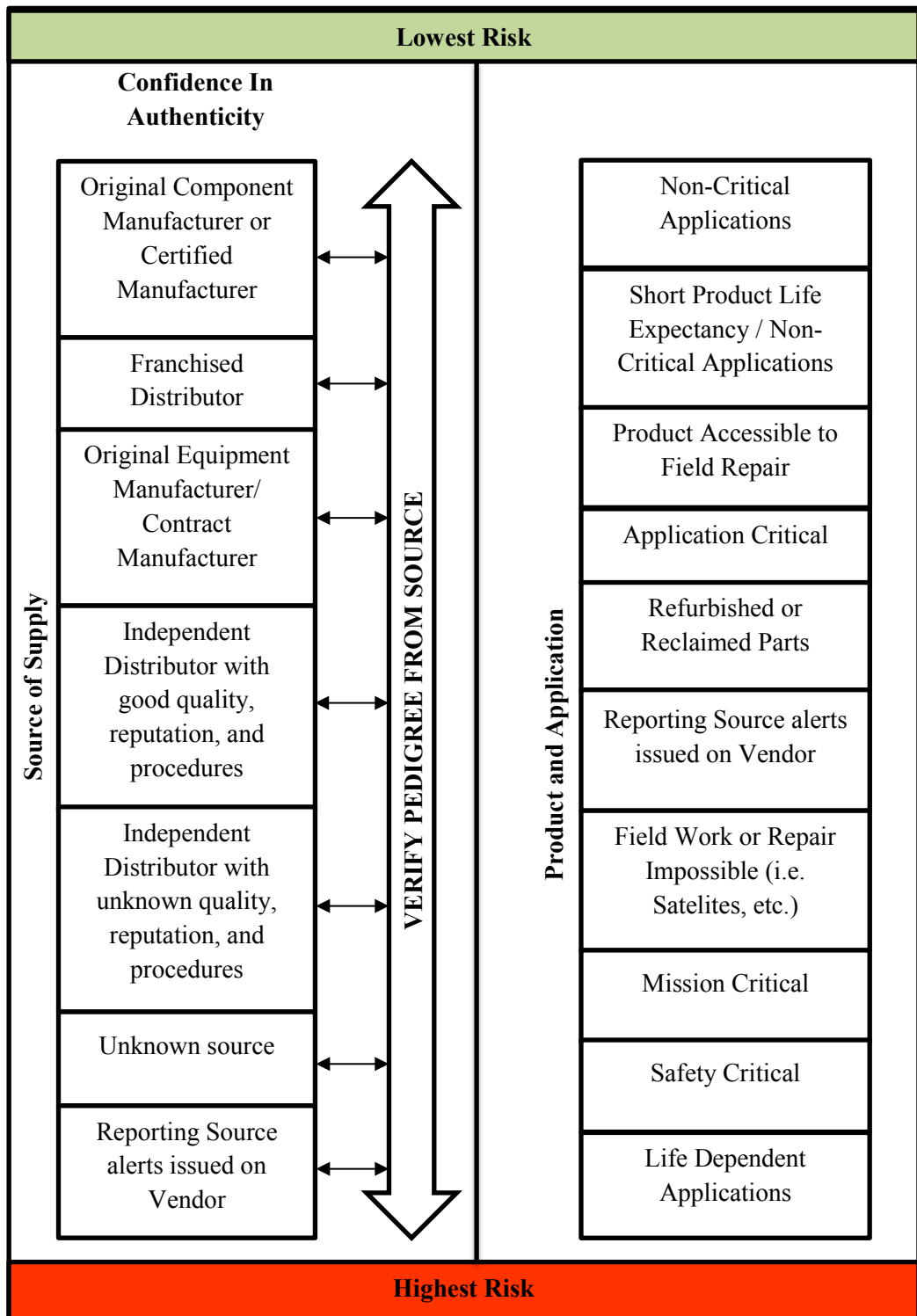Figure 3 illustrates the overall risk as a function of supplier reliability and item criticality.

Lowest Risk	
Confidence In Authenticity	
Original Component Manufacturer or Certified Manufacturer	Non-Critical Applications
Franchised Distributor	Short Product Life Expectancy / Non-Critical Applications
Original Equipment Manufacturer/ Contract Manufacturer	Product Accessible to Field Repair
	Application Critical
Independent Distributor with good quality, reputation, and procedures	Refurbished or Reclaimed Parts
	Reporting Source alerts issued on Vendor
Independent Distributor with unknown quality, reputation, and procedures	Field Work or Repair Impossible (i.e. Satelites, etc.)
	Mission Critical
Unknown source	Safety Critical
Reporting Source alerts issued on Vendor	Life Dependent Applications
Highest Risk	

Source of Supply — VERIFY PEDIGREE FROM SOURCE — *Product and Application*

Figure 3. Risk stack chart [3]

Figure 3 shows that risks of receiving counterfeit parts vary based on the supplier entity providing the parts. The risk ladder is a frame of reference for understanding the counterfeit risk hierarchy [6]. The organization can create a complex risk assessment tool to rank potential suppliers, or can use the figure above as a basic logic gate.

Procuring directly from the Original Component or Equipment manufacturer (OCM/OEM) is the lowest risk. Franchised distributors are the next lowest risk. OCM Authorized distributors have documented sales agreements with manufacturers [6].

Within the purchase order, the organization can require suppliers to use OCMs or their authorized sources for products that will be delivered [6].

The purchasing compartment must request the appropriate certificates along with each purchase order, regardless of the supplier's reputation, in order to have sufficient evidence to demonstrate the conformity of the supplied product. Such certificates can be certificates of analysis, certificates of conformity, heat lot certificates, test certificates, or anything else that proves that what was delivered by the supplier coincides with what was ordered.

In addition, clause 8.4.3 of the SR EN 9100:2018/AS9100D standard requires the organization to communicate the requirements for external suppliers regarding the need to prevent the use of counterfeit parts.: It is also very important for the organization to implement proactive processes that maximize availability of authentic, originally designed, and qualified parts throughout the product's life cycle, including, for example

- Control of parts obsolescence.
- Alternate/multiple sources.
- Acceptable product substitutions.
- System redesign.
- Inventory control, parts sparing, and/or lifetime buy practices.
- Planning for adequate procurement lead times in support of manufacturing and delivery schedules [7].

Step 2. Receiving and inspection

Detecting counterfeit parts early in the receiving process is critical to preventing them from entering the production process. The first place to start is to have an efficient process in place for visual inspection of the parts and documentation. Visual inspection during the receiving inspection process of both the part and the paperwork/documentation accompanying the part can be used to identify crude counterfeits.

Visual inspection of parts can detect flaws like the number of pins on a chip are wrong, the pin 1 position locater on an electronic chip is incorrect, the packaging is incorrect, the outlets on a hydraulic pump are in the wrong place or incorrect size fittings or the connectors on an electronic box is clocked wrong [11].

Most of the counterfeit products/material will be identified upon receipt into the organization premises.

The most important aspect regarding the receiving of purchased products is controlling the items so they do not enter into production or stores area to be used. The products/material may not be confirmed as counterfeit but it should be assumed that they are if there is any doubt and treat it as such. The parts/material would be classified as "suspect counterfeit" until it is confirmed either way.

The quality management system should already identify the controls required but the organization needs to ensure that the suspect parts/ material is clearly identified, preferably with some big red tags, and put into a secure area. Many organizations have a locked

quarantine cupboard which is your safest option for preventing the unintended use of a counterfeit product [8].

In order to make a determination that a possible counterfeit situation exists, a deliberate and thorough examination of the part and associated documentation should be conducted. There are various indicators to assist in the detection of potential counterfeit parts [11].

Fraud indicators may fall under three categories:
- document indicators of fraud;
- part (or physical) indicators of fraud;
- facility indicators of fraud.

Table 3 contains different types of significant indicators used for document fraud.

Table 3. – Significant indicators of document fraud [11]

Type	Significant Indicators of document fraud
False Documents	• False, stolen or wrong logo/letterhead • Vague certification • Facility not authorized to certificate the procedure or part • Signatures: ➢ unauthorized signatures ➢ signature of person who doesn't work there ➢ signature person of person who doesn't exist ➢ illegible signatures • Back-dated documents • Tests post-date shipment • Same ink, type-face, or writing when different entries are expected • Life-limits understated on documents • Double sets of non-identical records are kept • Document data inconsistent with part condition
Altered documents	• Cut and pasted documents • White outs on documents • Test results appear to be the same or consistently follow a pattern • Substituted dates, data, or serial numbers on documents • Military part number changed to civilian part number on documents
Incomplete documents	• Documents without signatures • Documents without a statement of certification • Illegible documents or documents with illegible signatures
Missing documents	• No originals • No repair history • No maintenance logs • No certifications • No test data
Other	• Cost and price data • Not enough documents to establish traceability on part

As presented in table 4, parts can have the following significant physical indicators of fraud: appearance, performance and other indicators.

Table 4. – Significant indicators of part fraud [11]

Type	Significant Indicators of part fraud
Appearance of Part	• Wrong logos • Wrong trademarks • Data plates (false or missing data plates, data plates attached incorrectly) ➢ Part and serial numbers (wrong, conflicting, obliterated, out of sequence, missing) • Markings (stamp overs, vibro-etched numbers, wrong location of marking compared to regular original equipment manufacturer methods, wrong style or form, missing)
Part performance	• Failure rate higher than normal • Rejection rate higher than normal
Other	• Packaging • Availability ➢ Unusual general appearance (color, finish, material) • Premature failures or high quantity of warranty returns

Finally, table 5 shows some types of significant indicators used for facility fraud.

Table 5. – Significant indicators of facility fraud [11]

Type	Significant Indicators of facility fraud

Facility purchases	• Facility has suspicious source of materials
	  ➢ commercial sources which lack PMA (Parts Manufacturer Approval) and produce parts for the non-aviation industries
	  ➢ unauthorized supplier or unapproved process, usually off-site
	  ➢ uncertified military surplus or scrap purchase of parts without certification

Equipment	• Lack of test equipment to perform required tests • Unauthorized possession of: stamps, data plates (including blanks), tags • Lack of tools or repair equipment to properly repair or manufacture parts/components for which the facility has the authority
Procedures and manuals	• Lack of manuals • Improper procedures • Altering test results • Not performing tests
Personnel	• Unauthorized personnel performing functions not authorized • Employee complaints of non-conformance (e.g. ignoring regulations) • Kick backs or bribes • Under-qualified personnel (e.g. not properly trained, no training, etc.)
Facility behavior	• Lots of scrap parts on hand • Selling scrap without rendering it useless • Excess stock of hard-to-get parts • Suspicious phone and address • Past violations • Widespread or systemic regulatory violations

Step 3. Control materiel identified as fraudulent/counterfeit

Suspect/ fraudulent/ counterfeit parts have no value and pose a serious threat. Therefore, these types of parts should be controlled to prevent their re-entry into the supply chain.

All materials deemed to be suspect, fraudulent, or confirmed counterfeit are segregated until determined authentic through further inspection and/or testing. When the organization suspects that counterfeit parts may have infiltrated into the system, are taken the following mitigation actions:

1. The involved parts are quarantined.
2. A nonconformance report is initiated.
3. Any parts in stock are located and ensure they are quarantined and clearly marked as nonconforming.
4. Any suspect items that may have left the organization are identified.
5. If applicable, the involved customers are notified in accordance with requirements.
6. An investigation and verification whether product is or is not counterfeit is performed.
7. Remediation /corrective action are taken [9].

Material that is confirmed counterfeit is reported to the supplier along with supporting documents and request for a corrective action.

Options will be discussed to determine disposition of the affected material to prevent re-entry into the supply chain. This may include:

- Destruction of the material by the organization or by its customer, to render it unusable in any form and documented evidence provided to the supplier when they are requested.
- The return of material to the supplier and request certificate of destruction to prevent re-entry into the supply chain [9].

Step 4. Report suspect or confirmed fraudulent/ counterfeit materiel

The counterfeit parts risk impacts all levels of the supply chain. By working together, original equipment manufacturers, distributors, customers, and suppliers become more aware of the problems and more effectively deal with counterfeits and counterfeiters.

Reporting suspect counterfeit parts helps limit the proliferation and use of counterfeit parts across the supply chain by:

- Alerting others of suspect counterfeit parts by part numbers and types and by lot or batch numbers if known.
- Identifying sources of counterfeit parts.
- Highlighting methods of counterfeiting.
- Sharing Inspection and testing used for identification and verification.
- Helping other players in the supply chain adequately assess risk and improve quality and reliability.
- Reducing the resources needed to maintain awareness of counterfeit issues by establishing a cooperative effort to exchange technical information.

Suppliers should have a process in place on how and where to report suspected or confirmed counterfeit parts or materials. This process should include who to contact and what (if any) organizations to report the information to. All appropriate personnel should be aware of the proper reporting process for suspect/ counterfeit Parts.

All counterfeit/ suspect counterfeit parts should be reported internally within the organization. The organization should ensure the reporting of suspect counterfeit parts across all appropriate business units and functions, including Legal/ Contracts.

Also, the customers should be notified of the discovery of any suspect/counterfeit parts. This is especially important if the discovery affects product which has already shipped. Customer requirements may specify the reporting methods and timeframe.

A best industry practice is to report suspect/counterfeit parts externally to the appropriate authorities/law enforcement agencies. It is the responsibility of all suppliers in the supply chain and benefits the entire aviation, space and defense industry. There may be national or local laws which require this reporting, for example:

- FAA (Federal Aviation Administration) - Suspected counterfeit component issues can be e-mailed to the Aviation Safety Hotline office. More details are presented here: https://www.faa.gov/aircraft/safety/programs/sups
- EASA (European Union Aviation Safety Agency) - issue Safety Information Bulletins (SIBs) on potential hazards which may include reporting of counterfeit or fraudulent components. More details can be found by accessing the link: http://easa.europa.eu/home.php.
- EU counterfeit reporting - Counterfeit reporting within the EU should be reported locally. The Europa webpage for the EU Taxations and Customs Union entitled „Counterfeit, piracy and other IPR (intellectual property rights) violations" provides details and forms for reporting counterfeit activities. These can be found by accessing the link: https://taxation-customs.ec.europa.eu/customs-4/prohibitions-and-restrictions/counterfeit-piracy-and-other-ipr-violations_en [12].

3. CONCLUSIONS

The performance, reliability, and safety of airframes and aircraft platforms are put at risk regardless of how counterfeit parts (whether electronic, mechanical, or other) enter the aviation and aerospace supply chain. Although organizations are aware that counterfeit parts infiltrate the aerospace supply chain, it cannot be forecasted when or where they will arrive.

In the aerospace sector, counterfeit products are a major issue, and the consequences could be catastrophic if they are placed on an aircraft. All the organizations from the aerospace sector need to be vigilant and fulfill their responsibilities in reducing the amount of counterfeit material in the industry.

As was mentioned above, it is not difficult to implement the requirements regarding the prevention of the use of counterfeit or suspect counterfeit parts and they can be incorporated into the standard supplier evaluation, purchasing, receiving, and inspection practices already in place within the organization.

ACKNOWLEDGEMENT

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