Mitigating the Impact of False Alarms and No Fault Found Events in Military Systems

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False Alarms (FAs) and No Fault Founds (NFFs) impose a devastating impact on aircraft systems. An entire aircraft can be grounded because of a single avionic for which there are insufficient spares available. If an FA or NFF causes a particular Line Replaceable Unit (LRU) to be called out incorrectly, that same LRU could be called out in many aircraft, possibly shutting down the entire fleet. We will mention results of the studies in the literature addressing the various aspects and impacts of the FA and NFF phenomena. There are multiple and complex causes for FAs and NFFs and it is beyond the scope of technicians to come up with mitigating solutions. Military systems are experiencing these NFF phenomena as well. In this paper, we explore the NFFs experienced by Turkish Air Force (TurAF) F-16 avionics, which are causing problems for maintenance and increase operational costs and aircraft downtimes. As is the case with many avionics repair facilities, whether military or civilian, the NFF issue requires closer scrutiny for the root-causes and evaluation of its impact on cost and aircraft operational time. We will discuss the impact of FAs and NFFs on TurAF F-16 avionics maintenance activities and evaluate measures that could or should be taken to improve the effectiveness of maintenance personnel in light of these complex events. We will conclude with recommendations that could assist in mitigating FAs and NFFs in military systems.

Background

Test professionals are primarily concerned with finding faults in a unit under test (UUT). Most test program sets (TPSs) and built-in [self] tests (BI[S]Ts) are considered effective when they find all or nearly all faults that exist, and test quality metrics are generally based on percentage of faults or failures detected. It is less clear what happens when non-existent faults are found in addition to or instead of existing ones.

An LRU that is sent for repair after it has been removed from the aircraft for what appears to be a failure is unwisely assumed to be faulty. That presumption neglects to take into account other possibilities for the failure indication. False alarms (FAs) are indications to the end user – customer, industrial machine operator, or pilot – that a failure has occurred when either:

- It did not occur - generally called an FA, false pull or ambiguity, or
- The failure was due to intermittent failures that occurred during operation, which cannot be observed or repeated in the next level of repair, or
- We cannot confirm or locate the failure at the next level of repair because the test equipment, the test program or the test strategy did not take the event into account and such failures escape the test. Inappropriate test accuracy ratios (TARs) can also bring about misconstruing a faulty UUT as good.

At the repair depot, such events are normally called No Fault Found (NFF), No Trouble Found (NTF) or Retest OK (RTOK). Some confuse RTOKs with cannot duplicates (CNDs), but CND designation is only appropriate when a test is run multiple times at the same level of repair.

Fig. 1 shows the possible outcomes of system failures [1]. Persistent faults are those that will indicate a failure on the test equipment in the repair facility. Sorensen predicted that 50% of the outcomes would be persistent faults [2]. The other 50% would result in NFF. It is not clear, however, whether the NFFs he considered were only those from intermittent failures or whether they also included system level FAs and units removed because of ambiguity at the system level.

Causes for intermittent failures have been detailed in [3] using a fishbone cause and effect diagram. A similar fishbone cause and effect diagram was made for false alarms [1] and is included later as Fig. 2.

Ungar predicted that FAs play a greater role in sending (perfectly good) UUTs to the repair facility [1], [4]. The results

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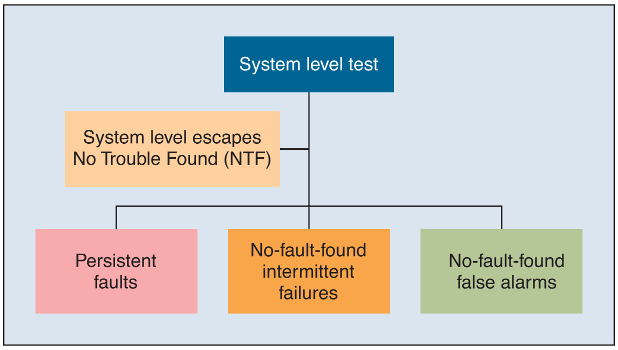

Fig. 1. Outcomes of failures found at system level [1].

in Table 1 indicate that we should only expect 14.3% of LRUs showing up at the repair facility to have a *persistent* (actual and detected) fault that a technician can readily repair. In the remaining 85.7% of the cases, NFFs are expected. Yet many repair technicians are supposing exactly the opposite.

When technicians come across an NFF, they are confused about what to do. Should they return it to the field, should they repair it anyway, and if so, what exactly should be that repair? Since the concepts of FA and NFF are complex, many in management are unable to give proper direction on how to handle the NFF event.

Whether we are looking at NFF rates of 85% or 50% or less, the decisions made on how to mitigate them are important financially, operationally and organizationally.

In this paper, we will analyze data from the TurAF F-16 avionics maintenance operations to improve the management of NFF events. The lessons learned can save depots and repair facilities large sums of money, while maintaining system availability. We describe the TurAF avionics maintenance operations and the results found for F-16 aircraft LRUs. Rather than detailing the specific LRUs which experienced NFFs, we classify them by their technology, namely as RF, Digital, Analog, and Mixed. The data provides us with important information that helps make recommendations to mitigate the impact of NFF events. Later, we detail observations of technician activities and correlate them with what the data indicates, offer specific recommendations, and summarize and draw some important conclusions.

Turkish Air Force Avionics Testing Results

Avionics Maintenance Operations

TurAF has a large fleet of F-16 aircraft of various types, called blocks. Most of its fleet has recently gone through an extensive avionics modernization program. The F-16s are operated from different bases spread across Turkey. At each base, maintenance units have special testers called the Improved Avionics Intermediate Shop (called AIS) for the Intermediate (I)-level maintenance of the F-16 avionics. The Turkish Air Force utilizes Automatic Test Equipment (ATE) and TPSs for its testing of F-16 LRUs, which are the same as those used by the United States Air Force (USAF).

TurAF has adopted a 3-level maintenance concept for the F-16 ever since its inception. First is the *flight line* or *Organizational level (O-level)*, where the LRUs, the building blocks of the aircraft's avionics systems, are removed and replaced based upon the aircraft built-in test (BIT) results. The second level of maintenance is called base or *intermediate level (I-level)* maintenance, where the faulty LRUs are tested automatically by ATE like IAIS. At this stage, sub-units of electronic cards called Shop Replaceable Units (SRUs) that are suspected of being faulty are removed and replaced. Finally, these SRUs are sent to their manufacturers or to *depot level* maintenance where they are tested and repaired by component replacement.

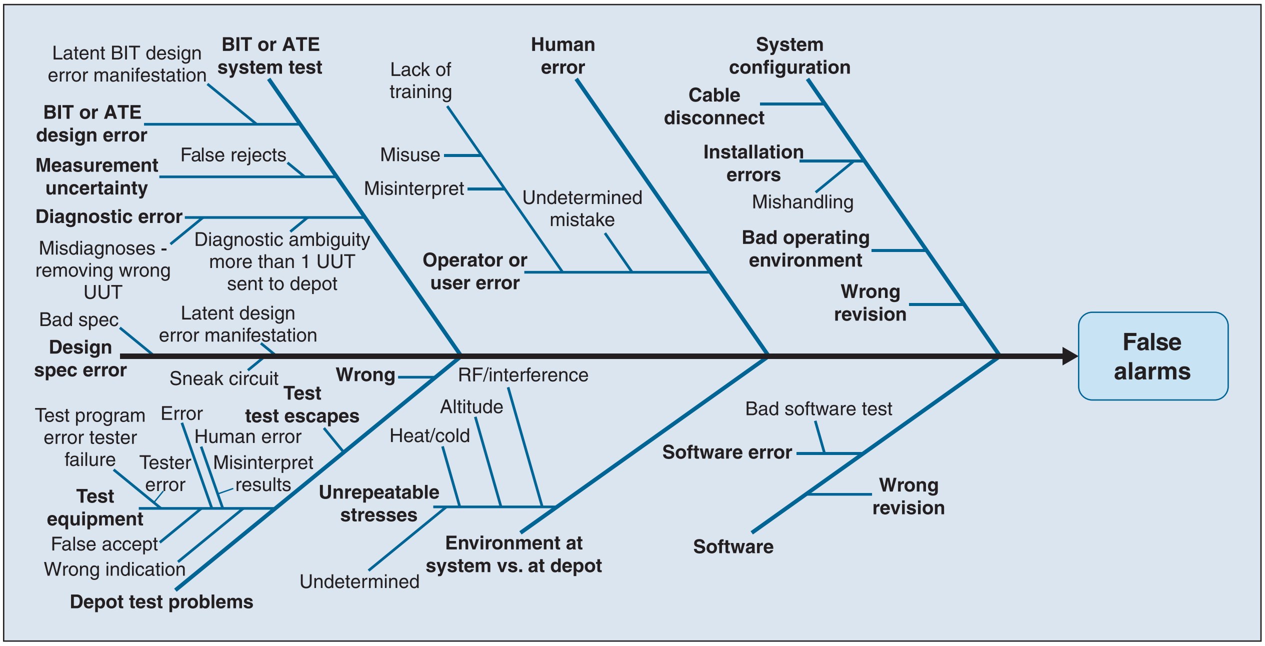

Fig. 2. Ishikawa fishbone diagram of false alarms (FAs) in electronic assemblies [1].

Table 1 – UUT distribution expected at depot repair [1]	
Fault Type	**Probable UUT Distribution**
Persistent Faults (PFs)	14.3%
No Fault Found Intermittent Faults (NFF IFs)	14.3%
No Fault Found False Alarms (NFF FAs)	71.4%

Many faulty units (mostly SRUs and some LRUs) from TurAF F-16 bases are sent to the USA for depot level maintenance, which normally costs more than local repair. Most RF LRUs are repaired at a local company named HAVELSAN. The technicians from F-16 bases, under the coordination of the TurAF Air Logistics Command (ALC) and the 1st Air Supply & Maintenance Center Command (which is the TurAF depot and technical authority for F-16 weapon systems) attend an annual avionics conference to discuss the issues associated with the maintenance activities. The United States Air Force organizes a similar meeting at a global scale coordinated by the F-16 Technical Coordination Group (TCG) in Utah, USA with participation from F-16 operating countries from all over the world.

When we look at the data compiled from that meeting, it is clear that the TurAF has been experiencing NFF rates of 30% to 63% depending on unit types. Even though they are lower than the expected rates in the literature we cited earlier, they are significant enough to look for better ways to deal with them.

NFFs Experienced at the TurAF I-Level Maintenance

Table 2 summarizes the NFF events experienced at TurAF avionics maintenance facilities in 2013-2014. Initially, the data was divided into different air base facilities, but there was no substantial difference in the overall results from one base to another. Rather than tabulate the results by LRU, we decided instead to combine LRUs by technology type. Similar results were found for the available data covering the 2014-2015 year, but since the 2013-2014 period had more complete data, we chose to use it.

Table 2 indicates that the overall distribution of NFFs is about 45%, with analog LRUs having the highest rate of NFFs at 63%. Though a substantial number of RF LRUs were returned for repairs, less than 30% of them experienced NFF. We believe that the low number of NFFs may have something to do with the fact that they are repaired at a local facility with much easier communication between the maintenance levels. Another reason may be that the RF LRUs were part of systems undergoing modernization during the subject time frame with a more mature and upgraded hardware that incorporated all the engineering changes of the past. Still another possibility is that the local contractor attending to these LRUs was more likely to attempt repairs even if the initial test resulted in NFF. Once repair was initiated, it could no longer be said that it was an NFF event.

Observations Based on the NFF Results

Table 2 indicates that NFFs are a regular part of the avionics maintenance. Ranging between 30% and 63%, the TurAF F-16 may in fact be experiencing less NFF than others. This could be the result of better test equipment, more attempts at repairs of NFFs by technicians, or something peculiar to the reporting process. Nonetheless, NFFs are a fact of life and while the repair technicians cannot fix NFFs, they need guidance on how to deal with them. In the case of the TurAF, costs are amplified when LRUs have to be returned to the USA for repairs. They also create an availability issue for the aircraft. For that reason, there is a natural, however unintended, pressure on repair technicians to fix the problem.

Management Perspective of NFFs

At the TurAF ALC avionics conference we referred to above, we found a recurring topic directly related to the high NFF rates already cited by others [5], [6]. Requests are frequently made to improve contact with vendors and USAF depots and to take measures to reduce the NFF rates of certain avionics units. Another item that was indirectly related to the NFF problem was the one requiring the AIS technicians at the bases to be careful and sensitive to take more time and be specific when filling out forms (printed or on-line) regarding fault history of the LRUs and the actions taken. This was considered very important for dealing with the problems created by NFF LRUs.

One interesting point from the minutes of the last avionics meeting was that, without exception, all of the bases were requesting that the ALC provide the AIS shops with the full serviceable set of avionics LRUs to be used as reference units during AIS tests, specifically for better troubleshooting and fault isolation. This is an indication that technicians experience high NFF rates and have a difficult time troubleshooting and isolating the faulty SRUs. Since they do not want to send the NFF LRU back to the flight line until it is fixed, they are attempting to use the reference LRUs as a *golden unit*. They may go as far as using the aircraft as a test bed to prevent another failure on the aircraft during a flight. Returning a unit that has

Table 2 – NFF distribution at TurAF 2013-2014			
Technology type	**All returns**	**NFFs**	**%NFF**
RF	319	94	29.5%
Mixed	232	130	56.0%
Digital	368	175	47.6%
Analog	54	34	63.0%
TOTAL	973	433	44.5%

failed before, and having it fail again would be viewed as a *repeat type failure* and result in a bad mark for the operational performance of the base.

Repeat is defined as the maintenance event at the flight line operations and is used as a parameter to evaluate the operational performance of the maintenance squadron (expressed in number of repeats per a certain period-of-time). In the case of a "repeat failure," quality assurance personnel get involved and maintenance people are tasked with finding the root cause of the event. The suspect LRU is then named as a "bad actor" and tracked closely with its serial number. Bad actor LRUs are those that fail repeatedly at one level (flight line) but pass all of the tests at the next maintenance level (I-level).

Technicians Dealing with NFFs

As just stated, we believe that in order to circumvent the NFF issue, technicians are using golden units as reference LRUs for station self-tests and calibration to make sure that the test stations are reliable and can be used for testing the avionic LRUs. In effect, the technicians are testing the veracity of the testers themselves. They also appear to be using other LRUs to overcome fault isolation ambiguity problems and to identify the faulty cards (SRUs) properly.

It is interesting to note that, even though the bases were experiencing high NFF rates, they were reporting no bad actors. The lack of bad actors can be the result of the TurAF's "*no tolerance policy"* for repeat and abort type aircraft failures that cause flight incidences. Such results would be serious maintenance problems requiring the involvement of quality assurance and flight safety branches of the base, as well as technical management authority outside the base in the cases with deficiency reported units. This would be a bad mark for the maintenance performance of the base as well. With such pressure on the avionics technician at the AIS shop trying to fix an avionics LRU in the middle of the night to make one more aircraft available for the next day, the technician has no good options to *repair* an LRU that passes all the tests. It is no surprise that the technician would resort to a shot-gun maintenance approach based on his experience by removing and replacing all the SRUs until he is satisfied that it will likely work on the aircraft.

Another option, if the technician does not succeed, is to call the unit Non-Repairable in This Shop (NRTS) and submit it to the logistic system of TurAF. In such cases, no one would blame or even question the technician for his decision. It is even the recommended approach according to the local operational procedures and regulations of the base. Since the NRTS designation may result in having the LRU sent to the USA at a much higher cost and because it will impact aircraft availability, most technicians still feel a need to avoid this path.

Some AIS technicians may not realize that NFF is the norm rather than the exception, and therefore, they may be trying to repair something that probably is not broken. If there is an ambiguity on locating the problem on the aircraft, which could result in removal of more than one LRU, it is almost guaranteed that at least one of them would be NFF at the AIS. In the case of a repeat or abort type event, there may be multiple LRUs removed from the aircraft unnecessarily and sent to AIS for testing. They would likely come back as NFF or as functional because a technician at AIS (due to repeat pressure) removed and replaced one or more of the SRUs, even though they cannot know for sure if the LRUs are, in fact, now good. If SRUs are repeatedly replaced, it increases the NFF rates at the depot and increases the financial toll as well.

Another point that supports the no bad actor *LRU* case is that the TurAF is using a web-based data base program developed by a local avionics technician to keep track of all the actions performed on the LRUs (per their serial number). This allows the AIS technicians at the other bases to see the maintenance history of a specific LRU and decide accordingly. When they see the maintenance history of an NFF LRU and discover that it caused a lot of NFF induced maintenance problems at one base, the AIS technicians at that base will not spend too much time and energy to deal with that bad actor LRU. They will just make that LRU an NRTS and thereby avoid new repeat/abort type problems on the aircraft.

This policy could help reduce the headache of technicians and the operational stress on the local managers, but it increases the already heavy financial toll for the TurAF, as NRTS labeled LRUs and the failed SRUs at the AIS shops are sent overseas to the USA for higher cost depot level repair.

When the pool of spare LRUs/SRUs gets consumed rapidly, and the number of aircraft awaiting parts increases, the system managers at the TurAF Logistics Command get pressured by the heavy workload created for the depot level maintenance. To reduce the number of aircraft waiting for replacement avionics and to reduce the added cost of sending units to the USA for repair, managers coordinate with the AIS shops of other bases to exhaust all possibilities to attempt repairs locally. If the LRU is actually faulty, its serviceable parts could perhaps be used for *shot-gun maintenance* and *cannibalization* to fix other LRUs. This is possibly the reason for what we found to be heavy cross-service LRU traffic between the bases. This is an interesting mitigation effort to reduce the burden of NFF and should be the subject of a future study on the NFF phenomena.

Recommendations to Mitigate FAs and NFFs

Reducing FAs and NFFs is a complex issue related to the design of the LRU and its test philosophy. It is far beyond the capacity of any repair technician to tackle this concern. Here we will offer some general recommendations to the industry on how to reduce conditions that lead to NFFs.

Separately, we offer some recommendations to the military on how best to combat this unavoidable difficulty entering the avionics maintenance environment. AIS technicians are not the offenders and NFFs are in no way their doing. Moreover, everyone in the organization needs to understand that the AIS technicians are limited in what they can do to mitigate this issue, and this fact has to be made clear to everyone involved in the maintenance track.

Mitigating False Alarms at the Flight Line

FAs occur at systems level, possibly during flight. Fig. 2 provides a cause and effect diagram [1]. If FAs result in a maintenance action, they are major contributors to NFF events at avionics maintenance facilities. Moreover, the resulting NFF indication that the LRU is good probably means it is in fact good, or at least a failure is not apparent at this test stage. Therefore, any action taken by technicians to attempt repair is futile, costly, and ill advised. FAs are a major source of NFFs. NFFs resulting from FAs need to be mitigated *prior* to the UUT's arrival at the repair facility. In fact, it appears that many of the issues need to be resolved at the design stage. Design for testability (DFT) would go a long way in mitigating many of the FAs. Below, we discuss some causes for FAs and suggest some mitigating actions.

System Level BIT or ATE Test Error

BIT errors at the system level or ATE errors at the I-Level may disagree on what is faulty. If the BIT says it is faulty but the ATE says it is not, an NFF will result. The cause may also be a measurement uncertainty or a diagnostic error.

To mitigate these types of FAs, it is important to coordinate BIT and ATE tests. It is best when specifications are specific and accurate, as we discuss next.

Design Specification Error

This occurs when specifications have either not been correctly incorporated in the tests or they have changed. In an ideal situation, a test must verify or negate a *specified* condition. If the condition is not specified, *no test* should be performed for it. If a test exists for a condition that is not part of the specification, that test can fail without any corresponding failure anywhere in the system. This can result in FAs and misleadingly sending one or more LRUs to repair.

To mitigate this condition, there should be periodic reviews of the conformity of tests to specifications, especially when specifications change.

Human Errors

One important contributor to FAs is human misinterpretation of *normal* and *specified* functions. This is often the case when an LRU is first used. The end user may misinterpret the actions of the LRU and conclude (incorrectly) that the LRU is faulty. This is due to a lack of proper training, and while it diminishes over time, it substantially adds to the NFF problem. Proper training, documentation and human interfacing are the best ways to eliminate these types of FAs and their resulting NFFs. In a survey conducted in [6], 'Unfamiliarity' was the top NFF contributor in new aircraft types and the second highest in types older than five years. Despite this, only 22% of the respondents provide NFF training for technicians.

System Configuration Errors

Since FAs are system level issues, there are a number of configuration issues at the system level that can be incorrectly interpreted as a need to remove and replace LRUs. They include cable disconnects, installation errors, wrong revisions, and operator mishandling.

The only mitigating solution to such problems is to make system level technicians more careful not to indiscriminately remove LRUs. All reasons for removals should be properly documented so that when NFFs are found, the causes can be determined.

Software Errors

Software errors may exhibit themselves in many forms. Some occur only under certain circumstances and may be constant or show up intermittently. It is easy to mistake software errors for hardware faults, and LRUs may be removed and sent to repair when no hardware fault exists.

To mitigate software errors, the flight line technician needs to document all apparent causes for the failure. Similar failures can eventually point to software errors and such FAs can eventually be eliminated.

Environmentally Induced Failures

Some failures are real but occur only under certain environments. For example, we may have failures that occur at 30,000 feet elevation but not at lower altitudes. We may have electromagnetic interference but only in certain locations. We may have certain failures that occur at accelerations of 2G or greater, for example.

The removal of such LRUs will result in NFFs. To mitigate such NFFs, we need to know at I-level maintenance under what conditions the LRU failed in the system. Then we may be able to environmentally stress the LRU in the avionics maintenance facility in an attempt to repeat the symptoms. Without this prior knowledge, however, it could be expensive and probably futile to subject all of the LRUs to stresses in the hope of exposing a failure that is not apparent at benign environments. The stresses can cause reliability issues as the remaining life of the UUT will be impaired. Considering that only a small percentage of NFFs are actually environmentally affected, there may be more harm than good that would come from this type of *repair.*

The best way to mitigate such failures is to have BIT test for failures *in situ*. Knowing when a failure occurred during normal operation can be useful information at I-Level maintenance. This, of course, must be planned and incorporated during design and DFT.

Fault Isolation of LRUs

As we have stated earlier, one of the major contributors of NFF events at the avionics maintenance facility is that due to a single failure, more than one LRU was replaced. This happens when a failure is found but there is ambiguity between which LRU is causing the fault. As a result, two or more LRUs may be replaced. Actually, the situation is even worse. Since cables are not considered to be LRUs in a one-to-one connection between two LRUs, a failure may be due to either the LRU or the cable. Since the cable is not an LRU and it is considered a high reliability item, it is either not removed, or removed as part of one of the LRUs. While cables seldom break (compared to LRUs comprised of electronics components), they can easily get disconnected. If that happens, it is entirely possible that all LRUs removed were in fact good and all the LRUs will result in NFFs.

The impact of fault isolation on NFFs is profound. In a typical O-Level (flight line) BIT specification, fault isolation to a single LRU is required in 90% of the cases; to two or less LRUs in 95% of the cases; and to three or less LRUs in 100% of the cases. If we assume that only a single LRU is faulty, then in 10% of the cases an additional LRU is also sent to repair, and in 5% of the cases, a third LRU is also included. Thus, for each faulty LRU, 115% LRUs are sent to repair, which will add 15% NFFs. In many systems, such as the F-16, O-Level BIT fault isolation requirement to a single LRU may only be 80%, thereby adding more than 20% NFFs to the returned LRU population.

To mitigate this, the maintenance technician should be able to pair up all of the LRUs that are removed together. This information is available and can help to gain confidence that certain LRUs are in fact good. If the maintenance technician finds that one of the two or three LRUs removed together is faulty, he can safely assume the other LRUs with NFFs are probably good.

Mitigating NFFs at the TurAF Maintenance Shop

Table 2 indicates that NFFs are a significant issue for maintenance at the TurAF as in other maintenance organizations. Compared to the expected rates of Table 1, TurAF has somewhat lower rates of NFFs than we would have expected. Nonetheless, it is a costly problem that needs to be reduced further. In the previous sections we explored how NFFs caused by FAs can be mitigated by system designers, system test developers, and flight level maintenance personnel. Reducing FAs would have reduced the number of NFFs that exist at the I-level.

The prevailing policy at the TurAF correctly calls for avionics maintenance technicians not to attempt to repair NFFs. Rather, they are told to mark such units as NRTS. Additionally, technicians are asked to report and keep current maintenance histories for LRUs. In some cases, they are allowed to use the aircraft as a test bed to ensure that repairable NFFs are not returned to the aircraft.

Despite these actions, there is room for improvement. It is possible that the low numbers of NFFs are due to repairs initiated on NFFs by overenthusiastic technicians who feel they can repair the unit based on their experience. Once repairs are initiated, they undoubtedly will be documented it as a *fault found*. If after *repairs*, the LRU passes the test, it is considered a good fix rather than an NFF *over fix*. There is no way outside the avionics maintenance facility for anyone to know. We need to examine the documentation requirements by the technicians to learn how or whether such cases can be monitored.

Rather than monitoring technician decisions, it would be more prudent and cost effective for management personnel to appreciate and share the true nature of NFFs with maintenance personnel. Technicians' attitudes towards NFFs are influenced by the actual expectations of management that include no tolerance for returning faulty units to the aircraft and by economic considerations for sending NRTS units to the USA. All of these *imply* that the technician is expected to make sure NFFs do not become bad actors. Given this conflicting mandate, the technicians and their shop managers do not wish to ignore all NFFs and in some cases will attempt repairs. Once repairs are attempted, such units are no longer NFFs and the data is skewed. NFFs should be mitigated; however, first and foremost, they must be identified as such. It is important therefore, that policy must be such that technicians freely and correctly identify some units that are NFFs as (probably) not faulty.

Once identified as NFFs, there may be certain prudent procedures that can be taken before the units wind up in a costly NRTS. For example, if data exists to repair multiple LRU removals, then, one LRU confirmed faulty will allow the technician to call the other LRU(s) *confirmed NFF* or *likely fault free*. Similarly, any information about the LRU's behavior in the system can help decide whether the NFF is a product of intermittent failures or FAs. Such information can lead to decisions about the *probability* that an LRU experiencing NFF is good or faulty.

Most importantly, the goal must remain clear. In most cases, the technician alone is powerless against NFFs. Only if there are mitigating factors or information available should a technician attempt repairs. At no time should the technician feel compelled to attempt repairs on NFFs unless specifically directed to do so. Even then, the technician should freely and accurately record that the first test yielded NFF.

Summary and Conclusions

We examined the FA and NFF issues, gathered existing NFF data from the TurAF F-16 fleet, analyzed it, and found that though better than expected, there is room for improvements. We suggested that FAs and NFFs can be reduced by utilizing some corrective procedures.

The local managers and the system/item managers do not always know the philosophy of automated test and the nature of NFF. This makes things worse for the maintainers because it triggers blame easily and increases the worry about *repeat problems* that may occur in the field. Training on automated test and the nature of NFFs is very important for them as well. They should be aware of the fact that an NFF is a test-engineering problem and the avionics technicians should not be expected to fix such an LRU.

The tools and methodology developed by TurAF to tackle the NFF issue can be summarized as follows:

- Reporting on the forms (printed forms that travel with the LRU and the on-line database) detailed maintenance history of LRUs and the actions taken,
- Making use of reference LRUs and using the aircraft as a test bed for shot-gun maintenance,
- Labeling LRUs experiencing NFF as NRTS,
- Sending the NRTS labeled LRUs to other bases (cross-service) for verification before sending them to the USA for depot level maintenance, where repair costs will be higher than local repair costs, and

- Realizing that to apply a "zero-tolerance" policy on aircraft repeat and abort type failures, results in a conflicting mandate on the technicians who should not be expected to fix LRUs experiencing NFF.

These actions will help lower the TurAF NFF rates for F-16 avionics LRUs but may still increase maintenance cost. The cost impact needs to be addressed in a future study.

To mitigate NFFs, we need to look outside the avionics maintenance shop. FAs are main contributors to sending perfectly good LRUs to I-level maintenance. More focus should be placed on the flight line and beyond; including the LRU supplier as well as the BIT on the aircraft. Those are the true sources of NFFs that are beyond the scope or capabilities of the AIS technicians who should not even try to deal with NFFs. While there may be instances that NFFs can be repaired at the I-level maintenance – according to Table 1, only 14.3% of the I-level ATE tests will actually find faults and another 14.3% that are faulty will mascaraed as NFFs – attempts to initiate repairs on NFFs need to be specifically ordered by higher management. There are clues when such repairs may be effective, and it is worthwhile for engineers and managers to locate and identify such cases. Information learned from the behavior of correctly identified NFFs can be used to mitigate many of the FAs that are sent to the I-level in the first place.

As we must react to smoke alarms going off in a room where there is no smoke or fire, we must also remove LRUs from an F-16 when a fault – albeit false – is indicated. However, we must be careful that our subsequent actions are aimed at the primary goal of keeping aircraft flying their missions safely.

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