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HAZARD IDENTIFICATION PROCESS IMPLEMENTATION INSELECTED ANALYSIS DOMAIN OF THE MAINTENANCE SYSTEM OF THE MULTIROLE F-16 AIRCRAFT

In this article authors researched maintenance system of the multirole F-16 aircraft. For the study purposes, the F-16 maintenance system model has been created. From this model, the main analysis domain was derived, comprising „Minor aircraft objects discrepancies removal" process. Considering such an analysis domain, on the basis of the schematic diagram of the hazard identification process, authors presented the following procedures: tools preparation for the hazard sources identification, hazard sources identification, hazard sources grouping and hazards formulation. The main goal of this article was to provide hazard identification process results as hazard specifications, which include: a group of hazard sources, hazards formulation and the most probable/predictable consequences, severities and losses/harms of the hazard activation.

Keywords: hazard source, hazard, hazard identification, risk management, F-16 multirole aircraft, maintenance system

1. INTRODUCTION

The multirole F-16 aircraft which is now being in service in Polish Air Forces inventory is a modern and very advanced weapon system. This multi-purpose jet is used during various flying missions. Due to high readiness requirement, tactical air force bases set-up maintenance systems to provide the highest reliability index for this aircraft.

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Such a high airworthiness of the polish F-16s, is a result of the special safety policy which is implemented and being monitored in all air force bases. This safety policy requires high variety of the procedures, processes and models of the risk and hazard identification methods. One of the main processes in risk management method is the hazard identification process – HIP, which allows us to specify hazards, which can become while being activated, the source/cause of the harm or loss. A certain implementation trend can be identified in the hazard identification process resulting from the order in which the process components are being identified. One of the hazard identification trends results from so called *forward reasoning*. On the basis of this authors [Gill and Kadziński 2016] introduced concept of *forward hazard identification process* – F-HIP. Identification process of the single hazard consists of the following processes: hazard source identification, and hazard specification (Fig. 1).

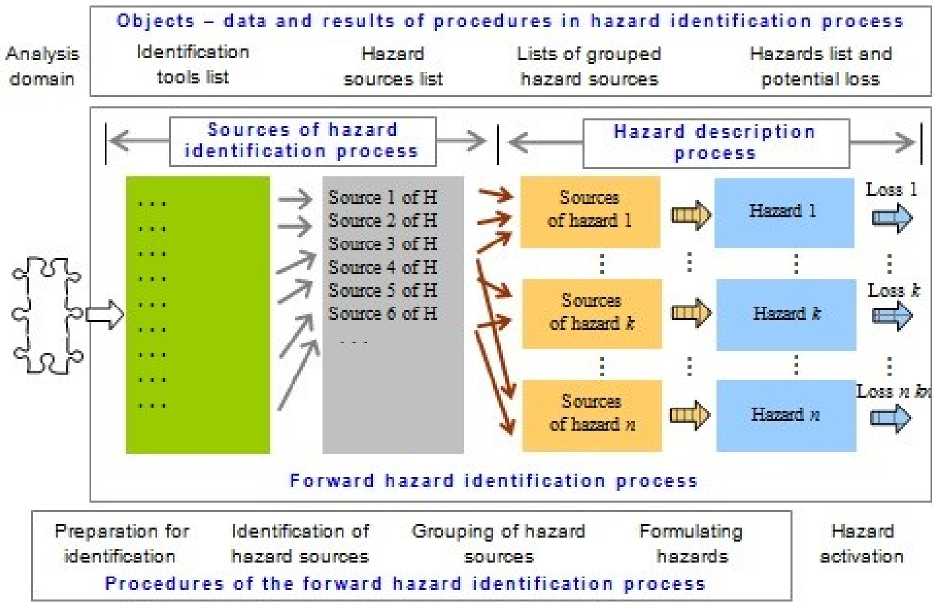

Fig. 1. Concept diagram of the hazard identification process realised with the application of forward reasoning (F-HIP) [Kadziński 2013, Gill and Kadziński 2016]

Hazard sources identification is being conducted in accordance with the following procedures (Fig. 1): search and identification tools preparation for the analysis domain and hazard sources identification. In order to thoroughly search analysis domain many different methods could be used such as: checklists, „brainstorm" and experts opinion method. As a result of these methods we are able to get outcomes, which are our primary tool to identify hazard sources.

Hazards specification process relies on presenting in the analysis domain (on the basis of the list of the already identified hazard sources) one or more hazard sources which being activated simultaneously could generate such an analysis domain status, which developed could result in specified harm or loss. Hazard specification process is conducted in accordance with procedures (Fig. 1): hazard sources grouping, hazards identification and determining the quantity of the harm or loss, which could be the result of the specified hazard activation, as well as scenario which results in undesirable effect.

The main goal of this article is to present how to apply forward hazard identification method with the inductive approach to the domain analysis being a selected part of the maintenance system of the multirole F-16 aircraft.

2. THE MULTIROLE F-16 AIRCRAFT MAINTENANCE SYSTEM MODEL AS A AGRREGATED ANALYSIS DOMAIN

F-16 maintenance system is based on three following maintenance levels [Biuletyn Eksploatacyjny 2006, Szczegółowe zasady, Technical Manual]:

- first maintenance level (organizational level maintenance),
- second maintenance level (intermediate level maintenance),
- third maintenance level (depot level maintenance).

The first (lowest) maintenance level is usually performed in the flightline squadrons. The main maintenance personnel duty at this level is to support flying missions planned by flying personnel. The most important processes to fulfill tasks are:

- flightline maintenance and servicing (preflight, thruflight and postflight inspections),
- aircraft preventive maintenance (hourly and calendar inspections),
- minor aircraft objects discrepancies removal,
- aircraft combat status restoration,
- configuration changes for specific missions.

A technical squadron maintenance personnel usually performs the second level maintenance processes. List of the main tasks is as follows:

- F-16 and other maintenance equipment phased inspections,
- time compliance technical orders of the aircraft and aircraft objects,
- major discrepancies of the aircraft and its objects removal,
- intermediate level repairs and overhauls of the aircraft components, parts and objects,
- F-100PW-229 engine repairs and module overhauls.

Third and the highest maintenance level comprises depot overhauls of the F-16 aircraft components, parts, objects and time change items. This levels maintenance processes are performed in the highly specialized backshops in the technical squadron as well as factories and manufacturers in Poland and abroad.

Authors of this article researched maintenance system and treated this area of interest as a combination of three elements: human-hardware-environment. Considering all the relations between these elements we could identify single or multiple hazard sources. In this case the maintenance system has been presented as an aggregated analysis domain model in order to implement procedures into the hazard identification process. Schematic diagram of the aggregated domain is presented in Fig. 2. This aggregated analysis domain is a combination of the three domains (Fig. 2), where hazards sources could be generated as a result of the maintenance processes performed at different levels of the F-16 maintenance system.

For the research purposes, analysis domain 1 has been selected, representing the first level of the F-16 maintenance system (organizational level maintenance). Previously, five of the maintenance processes have been presented. One of them is „minor aircraft objects[3] (meaning complex existence[4] or system) discrepancies removal". This process determines part of the analysis domain 1, which is an area of the hazard identification in this article. The selected process consists of the eleven following steps:

- faulty objects isolation in the aircraft structure,
- aircraft preparation for the discrepancy removal,
- support equipment and tooling preparation,
- aircraft maintenance documentation preparation,
- discrepancy troubleshooting,
- spare parts, consumables and expendables preparation,
- broken objects replacement,
- operational check aircraft preparation,
- operational check and follow-on maintenance,
- aircraft documentation fill-in,
- filling-in discrepancies details into the integrated maintenance data & support system.

A detailed schematic diagram of the aggregated analysis domain, and especially part of the analysis domain 1, which is our research area, has been shown in Fig. 3.

[3] *Object* – complex existence or system, where at the lower decomposition level we can define components (components/objects refurbished – system, assembly, components/objects not refurbished – subsystems, elements, element work surfaces) or subsystems. Mutual correlations between components/objects and subsystems create structures, e.g: construction structure, functional, reliability, diagnostic [Klir 2006, Młyńczak 2012].

[4] *Existence* – abstract expression used among others in philosophy, systems theory, and mathematical models in order to distinguish specific objects and phenomenon in the collection of other objects [Chmielecki 1999].

In this article, due to complexity of the multirole F-16 aircraft, authors took under consideration only one process of the minor aircraft flight control system objects discrepancies removal. The main reason for the following research was that pilots reported problem in the aircraft flight control system. Discrepancy symptom was the fault generated by the self-diagnostic aircraft system: FLCS MFL 072 (Flight Controls Maintenance Fault List).

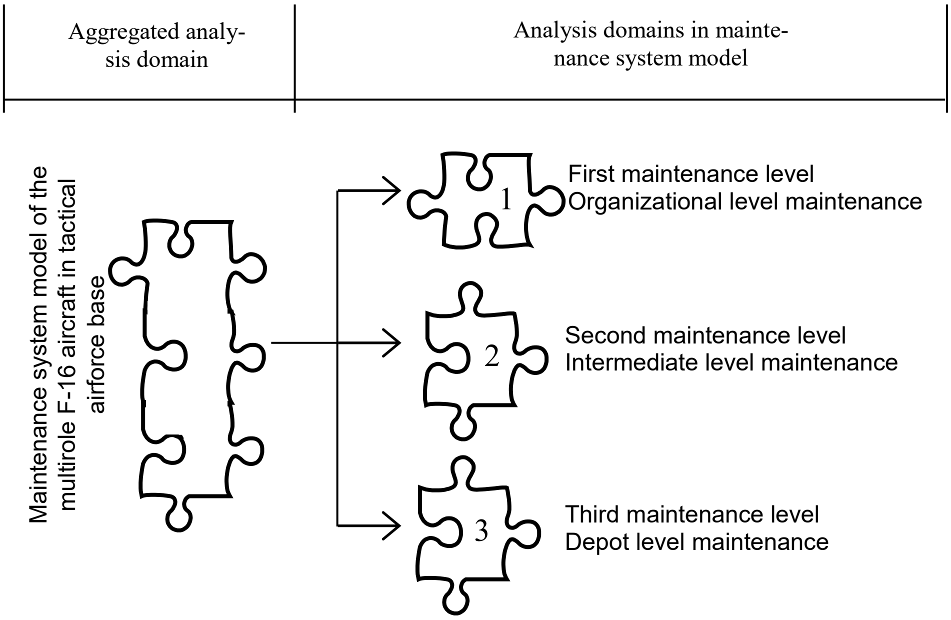

Fig. 2 . General schematic of the aggregated analysis domain of the maintenance system of the multirole F-16 aircraft

3. HAZARD SOURCES IDENTIFICATION

Hazard sources identification in analysis domains is being conducted in accordance with the procedures (Fig. 1): hazard sources and hazard identification checklist preparation.

Checklist preparation. For the research purposes, a set of the checklist has been selected as a tool to explore analysis domain 1, in order to identify hazard sources in it. This set has been divided into eleven separate checklists. Those lists have been created using search criteria of the following steps of the „minor aircraft discrepancies removal” process, which is a part of our analysis domain 1 in this

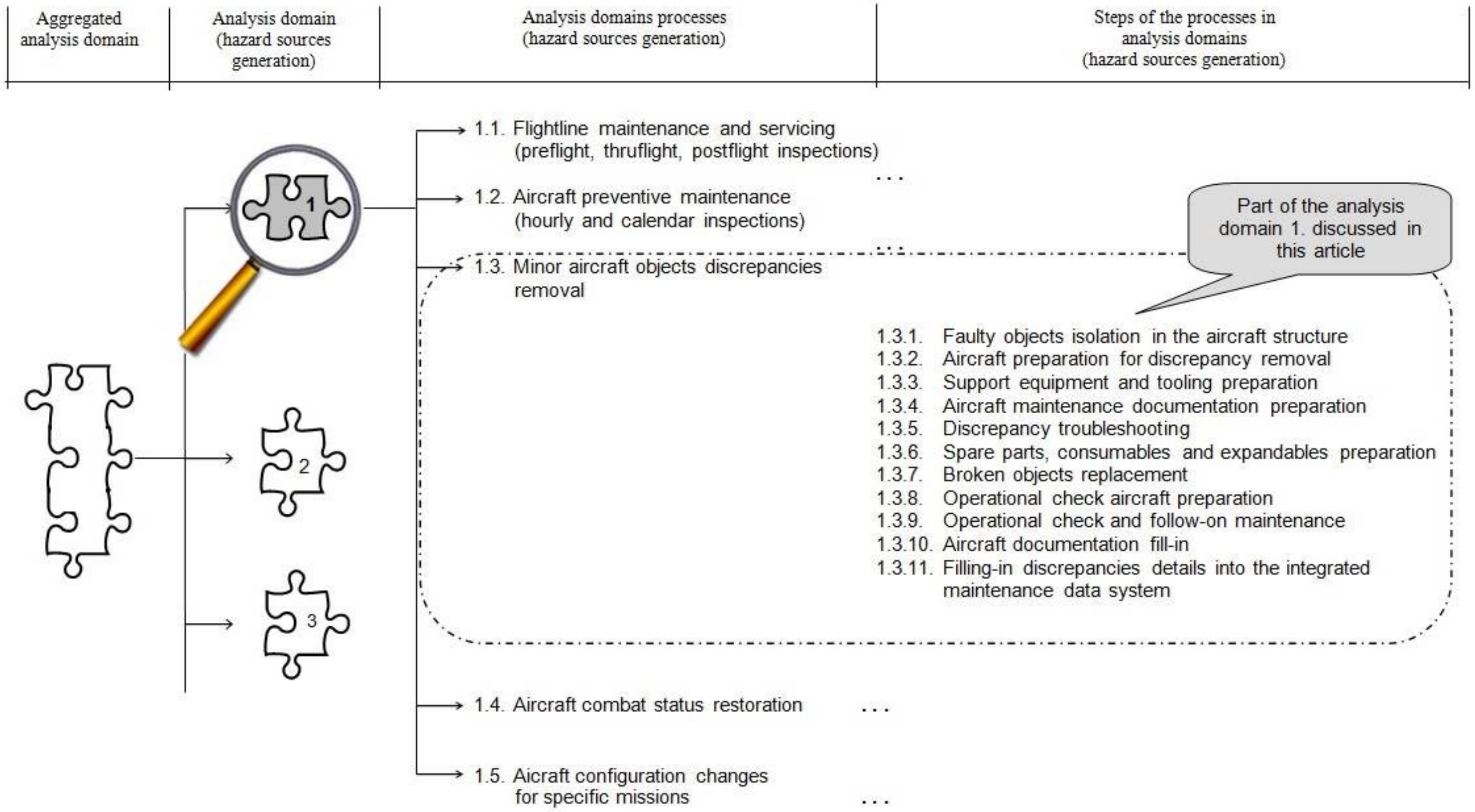

Fig. 3. Detailed schematic diagram of the aggregated analysis domain structure (detailed: Analysis domain 1. – first maintenance level performed at the organizational level) being the model of the maintenance system of the multirole F-16 aircraft

article (Fig. 3). Some of the hazard sources identification checklists are presented in Table 1.

Hazard sources identification. There is an answer for each specific question from the checklist, presented in columns 3 and 4. For each question from the checklist (Table 1) there has been assigned a critical field, which is distinguished in some specific way (e.g.: other than white background colour). Declaring answer for the question from the checklist (by marking it e.g. ✓) means hazard source identification, which relates to the question. Formal hazard sources identification procedure implementation – by declaring an answer to the question about hazard sources is presented in Table 1. On the basis on the answers to the questions from the checklist (Table 1) and considering the answers (outcomes), which were marked in critical fields, the list of the identified hazard sources in analysis domain 1, process 1.3 (minor aircraft objects discrepancies removal) has been created.

Table 1. List of the selected question checklists to identify hazard sources in analysis domain (First maintenance level) process 1.3 (minor aircraft flight control system objects discrepancies removal) – Fig. 2 and 3

No.	Checklist questions for hazard sources	Answer	
		Yes	No
1	2	3	4
1. LIST OF QUESTIONS CONCERNING STEP OF THE PROCESS 1.3.1 (Fig. 3)			
1.1	Is the MLG WOW Switch an object in the aircraft structure of the flight control system located in a place vulnerable to humidity?	✓	
1.2	Is it possible, that MLW WOW Switch being an object in the aircraft structure of the flight control system is working improperly in humid environment?	✓	
1.3	Is every technician assigned for the object discrepancy removal of the flight control system, capable to confirm diagnostic software results using aircraft maintenance documentation?		✓
1.4	Is it possible, that one of the aircraft objects is working improperly (e.g.: MLG WOW Switch), but the diagnostic software indicates computer (DFLCC – Digital Flight Control Computer) in the aircraft flight control system as broken?	✓	
1.5	Is it possible, that the flight control shop technician assigned for the object discrepancy removal in the F-16 structure performs this job while being affected by excessive fatigue and/or stress and/or distraction?	✓	
1.6	Is always the flight control technician identifying broken object in the F-16 structure using an updated diagnostic software EDNA (Enhanced Diagnostic Aid)?		✓
1.7	Is it possible, that technician performs broken object discrepancies identification does this in the conditions of the very low temperature?	✓	

Table 1cont.

1	2	3	4
1.8	Is it possible, that technician performs broken object discrepancies identification does this in the conditions of the very high temperature?	✓	
. . .	. . .		
	2. LIST OF QUESTIONS CONCERNING STEP OF THE PROCESS 1.3.2 (Fig. 3)		
2.1	Is it possible, that during aircraft discrepancy removal preparation, technician forgets to ground the jet?	✓	
. . .	. . .		
	3. LIST OF QUESTIONS CONCERNING STEP OF THE PROCESS 1.3.3 (Fig. 3)		
3.1	Is every technician assigned to replace broken object is using torque wrench to properly torque object nuts mounting it to the aircraft structure?		✓
3.2	Is every technician assigned to replace broken object is preparing and using new consumable self-locking nuts mounting an object to the aircraft structure?		✓
3.3	Is it possible, that technicians are using not calibrated/broken resistance meter?	✓	
. . .	. . .		
	4. LIST OF QUESTIONS CONCERNING STEP OF THE PROCESS 1.3.4 (Fig. 3)		
4.1	Is it possible that aircraft fault isolation documentation PL1F-16CJ-2-27FI-00-1 could have some errors generating problems in broken objects identification process?	✓	
. . .	. . .		
	5. LIST OF QUESTIONS CONCERNING STEP OF THE PROCESS 1.3.5 (Fig. 3)		
5.1	Is the flight control technician always trying to identify root cause/source of the aircraft object failure?		✓
5.2	Is it possible, that MLG WOW Switch is working improperly, but diagnostic software indicates DFLCC-Digital Flight Control Computer failure in the flight control system, when in fact DFLCC is working properly?	✓	
. . .	. . .		
	6. LIST OF QUESTIONS CONCERNING STEP OF THE PROCESS 1.3.6 (Fig. 3)		
6.1	Is it possible, that flight control technician for the aircraft discrepancy removal is preparing improper replaceable object (used on the older F-16 version)?	✓	
6.2	Is it possible, that flight control technician for the aircraft discrepancy removal is preparing to replace an object with exceeded calendar service life?	✓	
. . .	. .		

Table 1cont.

1	2	3	4
7. LIST OF QUESTIONS CONCERNING STEP OF THE PROCESS 1.3.7 (Fig. 3)			
7.1	Is the mechanic installing MLW WOW Switch in the aircraft flight control system always using nuts without self-locking thread?		✓
7.2	Is the technician assigned to remove object discrepancy in the flight control system always acting on the basis of the diagnostic software?	✓	
7.3	Is it possible, that mechanic splices wires in the flight control system not in accordance with the documentation, which might result in their breaking or disconnecting during aircraft flight?	✓	
7.4	Is it possible, that mechanic mounts objects vulnerable to humidity in the flight control system without any moisture protection?	✓	
7.5	Is the mechanic mounting objects in the aircraft flight control system always using torque wrench?		✓
7.6	Is it possible, that mechanic splicing wires in the harness leaves splicing tool in the main landing gear bay?	✓	
. . .	. .		
8. LIST OF QUESTIONS CONCERNING STEP OF THE PROCESS 1.3.8 (Fig. 3)			
8.1	Is the diagnostic equipment used by personnel, in the aircraft discrepancies troubleshooting always working properly?		✓
8.2	Is it possible, that the uploaded into the diagnostic equipment testing software version, which is required to verify aircraft object discrepancy removal, is incorrect?	✓	
8.3	Is it possible, that personnel verifying aircraft object discrepancy removal improperly builds diagnostic set?	✓	
8.4	Is it possible, that there is a communication problem between diagnostic equipment and digital flight controls computer as a result of improper connector applying to the aircraft?	✓	
. .	. . .		
9. LIST OF QUESTIONS CONCERNING STEP OF THE PROCESS 1.3.9 (Fig. 3)			
9.1	Are there any cases, that final object discrepancy removal requires aircraft taxing?	✓	
9.2	Are there any cases, that final object discrepancy removal requires operational check flight?	✓	
9.3	Are there any cases, that final object discrepancy removal verification and aircraft airworthiness could be performed only during taxing and/or in ops check flight?	✓	
9.4	Is it possible to sign-off aircraft flight control system object discrepancy even though it is still not airworthy?	✓	
9.5	Is it possible, that mechanic assigned to replace broken MLG WOW Switch for the new one, is working in a hurry, and does not verify its installation?	✓	
9.6	Is it possible, to sign-off MLG WOW Switch installation inspection in the aircraft flight control system, while it not installed properly?	✓	

Table 1cont.

1	2	3	4
9.7	Does the supervisor inspect every aircraft discrepancy removal?		✓
9.8	Is it possible, that technician superficially verifies aircraft object discrepancy removal due to the fact that acts in the lack of time and/or under supervisors' pressure?	✓	
9.9	Is the flight control shop chief always verifying aircraft object discrepancy removal by himself?		✓
9.10	Is the technician capable of verifying flight control system airworthiness in other conditions than on the ground?		✓
. .	. . .		
10.1	Is it possible, that mechanic does not sign-off aircraft discrepancy in the documentation after its removal?	✓	
. .	. . .		
11.1	Is it possible, that personnel supervising aircraft object discrepancy removal neglects filling-in information about discrepancy removal into the integrated maintenance data and support system?	✓	
. .	. . .		

Table 2. List of the selected identified hazard sources in the analysis domain (first maintenance level) within process 1.3 (minor aircraft flight control system objects discrepancies removal) – Fig. 2 and 3

No.	Identified hazard sources
1	2
1. HAZARD SOURCES LIST– STEP OF THE PROCESS 1.3.1 (Fig. 3)	
<1.1>	An object in the aircraft structure MLG WOW Switch being a part of the aircraft flight control system is located in the place vulnerable to humidity.
<1.2>	MLG WOW Switch being an object in the aircraft structure of the flight control system is working improperly in a humid environment.
<1.3>	Technician assigned to remove object discrepancy of the aircraft flight control system is unable to confirm test software results with the aircraft documentation.
<1.4>	Specific aircraft object (MLG WOW Switch) is working improperly, but diagnostic software indicates failure of the Digital Flight Controls Computer DFLCC, while in fact, it is airworthy.
<1.5>	Flight control technician assigned to identify broken objects in the technical structure of the F-16, performs this job while being affected by excessive fatigue and/or stress and/or distraction.

Table 2 cont.

1	2
<1.6>	Flight Control technician identifying broken objects in the F-16 structure is using an outdated diagnostic software EDNA (Enhanced Diagnostic Aid).
<1.7>	Technician performs broken object discrepancies identification, does this in the conditions of the very low temperature, which results in deviations from the real value of the resistance showed by resistance meter.
<1.8>	Technician performs broken object discrepancies identification, does this in the conditions of the very high temperature, which results in deviations from the real value of the resistance showed by resistance meter.
. . .	. . .
2. HAZARD SOURCES LIST– STEP OF THE PROCESS 1.3.2 (Fig.3)	
<2.1>	Technician does not ground the jet, during aircraft discrepancy removal preparation.
. . .	. . .
3. HAZARD SOURCES LIST– STEP OF THE PROCESS 1.3.3 (Fig.3)	
<3.1>	Technician assigned to replace broken object does not use torque wrench to properly torque object nuts mounting it to the aircraft structure (MLG WOW Switch mounting nuts).
<3.2>	Technician assigned to replace broken object does not prepare and use new consumable self-locking nuts mounting an object (e.g. MLG WOW Switch) to the aircraft structure.
<3.3>	Technician are using not calibrated/broken resistance meter (it indicates incorrect resistance values in MLG WOW Switch connector).
. . .	. . .
4. HAZARD SOURCES LIST– STEP OF THE PROCESS 1.3.4 (Fig.3)	
<4.1>	Aircraft fault isolation documentation PL1F-16CJ-2-27FI-00-1 has some errors generating problems in broken objects identification process (fault isolation tree indicates DFLCC failure instead of MLG WOW Switch).
. . .	. . .
5. HAZARD SOURCES LIST– STEP OF THE PROCESS 1.3.5 (Fig.3)	
<5.1>	Flight control technician does not try to identify root cause/source of the aircraft object failure (MLG WOW Switch).
<5.2>	Flight control technician does not identify root cause/source of the reason why the aircraft diagnostic software indicates DFLCC-Digital Flight Controls Computer failure in the flight control system, while in fact it is airworthy.
. . .	. . .

Table 2 cont.

1	2
6. HAZARD SOURCES LIST– STEP OF THE PROCESS 1.3.6 (Fig. 3)	
<6.1>	Flight control technician for the aircraft discrepancy removal is preparing improper replaceable object with the wrong P/N (Part Number) (MLG WOW Switch used on the older F-16 version).
<6.2>	Flight control technician for the aircraft discrepancy removal is preparing to replace an object with exceeded calendar service life.
. . .	. . .
7. HAZARD SOURCES LIST– STEP OF THE PROCESS 1.3.7 (Fig. 3)	
<7.1>	Mechanic installing MLG WOW Switch in the aircraft flight control system does not use nuts with self-locking thread.
<7.2>	Technician assigned to remove object discrepancy in the flight control system, acting on the basis of the diagnostic software, replaces DFLCC instead of MLG WOW Switch.
<7.3>	Mechanic splices wires in the flight control system not in accordance with the documentation, resulting in their breaking or disconnection during aircraft flight.
<7.4>	Mechanic mounts in the aircraft flight control system MLG WOW Switch without any water/moisture protection.
<7.5>	Mechanic mounts in the aircraft flight control system MLG WOW Switch not using torque wrench.
<7.6>	Mechanic splicing wires in the MLG WOW Switch harness leaves splicing tool in the main landing gear bay
. . .	. . .
8. HAZARD SOURCES LIST– STEP OF THE PROCESS 1.3.8 (Fig.3)	
<8.1>	Diagnostic equipment necessary to perform troubleshooting process confirmation, used by personnel verifying aircraft discrepancy removal is working improperly.
<8.2>	The uploaded into the diagnostic equipment (VIPER MLV) testing software version, which is required to verify aircraft object discrepancy removal, is incorrect.
<8.3>	Personnel verifying aircraft object discrepancy removal improperly builds diagnostic set connected to the jet.
<8.4>	There is a communication problem between diagnostic equipment and digital flight controls computer DFLCC as a result of improper connector applying to the aircraft.
. . .	. . .
9. HAZARD SOURCES LIST– STEP OF THE PROCESS 1.3.9 (Fig. 3)	
<9.1>	The final object discrepancy removal requires aircraft taxing.

Table 2 cont.

1	2
<9.2>	The final object discrepancy removal could be performed only in operational check flight.
<9.3>	The final object discrepancy removal verification and aircraft airworthiness could be performed only during taxing and/or in ops check flight.
<9.4>	Aircraft flight control system object discrepancy removal verified positively even though it is still not airworthy (due to the fact, that verification is being done by assigned senior mechanic not experienced senior technician).
<9.5>	Mechanic assigned to replace broken MLG WOW Switch for the new one is working in a hurry, and does not verify its installation.
<9.6>	Positive verification of the MLG WOW Switch installation in the flight control system, while it is installed improperly (due to the fact, that verification is being done by assigned senior mechanic not experienced senior flight control technician).
<9.7>	Aircraft object discrepancies removal is not verified by supervisors.
<9.8>	Technician superficially verifies aircraft object discrepancy removal due to the fact, that acts in the lack of time and/or under supervisors' pressure.
<9.9>	Flight control shop chief does not verify aircraft object discrepancy removal by himself.
<9.10>	Technician positively verify flight control system airworthiness on the ground.
. . .	. . .
10. HAZARD SOURCES LIST– STEP OF THE PROCESS 1.3.10 (Fig. 3)	
<10.1>	Mechanic does not sign-off aircraft discrepancy in the documentation after its removal.
. . .	. . .
11. HAZARD SOURCES LIST– STEP OF THE PROCESS 1.3.11 (Fig. 3)	
<11.1>	Personnel supervising aircraft object discrepancy removal neglects filling-in information about discrepancy removal into the integrated maintenance data and support system.
. . .	. . .

4. HAZARDS SPECIFICATION

Hazards specification process is conducted in accordance with the following procedures (Fig.1): hazards sources grouping, hazards formulation.

Hazard sources grouping. The source of the information for the grouping procedure is the earlier created list of the hazard sources (Tab. 2) Not every selected source of the hazard from the list, and not every combination of the greater number of the hazard sources, generates analysis domain status (in the article – steps of the minor aircraft flight control system discrepancies removal process), where the developed scenario could result into loss/harm. In this case, when the developed scenario does not result into loss or harm, we do not formulate hazard, meaning description of the conditional possibility of the loss/harm effect. The main goal of the "hazard sources grouping" procedure in the process of the hazards specification is the creation of the list of the grouped hazard sources (Fig.1). The assignment process of the hazard sources to each hazard sources group is conducted in accordance with the following rule: "being a source of the hazard (single source or any combination of the several hazard sources) necessary to generate analysis domain status, where the developed scenario could result into loss/harm. Results of the hazard sources grouping procedure – on the basis of the identified hazard sources from tab. 2 – is presented in table 3 (segment: „Group of the hazard sources…").

Hazard formulation with the potential loss/harm presentation while activated. The source of the information for the hazard formulation procedure is the list of the grouped hazard sources, created as a result of the hazard sources grouping procedure. As it was previously mentioned, a group of the hazard sources creates a certain analysis domain status, where the developed scenario results into the loss/harm. According to the one of the hazard definitions („it is the analysis domain status which might result into the loss/harm"), hazard formulation (meant as: name, term, description, title, etc.) should express „fear" of the potential loss/harm (caused by undesired side effects like for instance: repeated aircraft object discrepancy removal, aircraft emergency landing, mission cancelling) being the result of the certain analysis domain status presented by the group of the hazard sources. Some proposed results of the hazard formulation procedure, with the potential loss caused by their activation – on the basis of the results of the hazard sources grouping procedure (Tab. 3 – segment: „Hazard sources group…") – are presented in table 3, in the following segments: „Hazard formulation…", „Predicted loss/harm caused by hazard activation…".

All segments in Table 3 comprise some proposed final results of the selected hazards specification process generated in analysis domain 1, within process 1.3 (minor aircraft flight control system object discrepancies removal).

Table 3. Final results of the selected hazards specification process generated in analysis domain 1, within process 1.3 (minor aircraft flight control system object discrepancies removal). Own elaboration

Hazard H1
Hazard sources group H1 1. Mechanic installing MLG WOW Switch in the aircraft flight control system does not use nuts with self-locking thread. <7.1> 2. Mechanic assigned to replace broken MLG WOW Switch for the new one is working in a hurry, and does not verify its installation. <9.5>
Hazard formulation H1 Hazard of loss resulting from the fact, that MLG WOW Switch is installed in the aircraft flight control system and not being secured against its separation from the jet during flying operations. **or** The chance of loss resulting from the fact, that MLG WOW Switch is installed in the aircraft flight control system and not being secured against its separation from the jet during flying operations.
Predicted loss/harm during hazard activation H1 Loss resulting from the fact, that MLG WOW Switch must be removed and replaced again.
Hazard H2
Hazard sources group H2 1. Airworthy MLG WOW Switch is installed in the aircraft flight control system and not being secured against its separation from the jet during flying operations. <HN1>: <7.1>&<9.5> 2. Positive verification of the MLG WOW Switch installation in the flight control system, while it is installed improperly (due to the fact, that verification is being done by assigned senior mechanic not experienced senior flight control technician). <9.6> 3. The final object discrepancy removal could be performed only in operational check flight. <9.2>
Hazard formulation H2 Hazard of loss resulting from the fact, that MLG WOW Switch separates from the jet during flying operations and caused by its improper installation. **or** The chance of loss resulting from the fact, that MLG WOW Switch separates from the jet during flying operations and caused by its improper installation.

Table 3cont.

Predicted loss/harm during hazard activation H2 Loss resulting from the aircraft emergency landing procedure.
Hazard H3
Hazard sources group H3 1. An object in the aircraft structure MLG WOW Switch being a part of the aircraft flight control system is located in the place vulnerable to humidity. <1.1> 2. MLG WOW Switch being an object in the aircraft structure of the flight control system is working improperly in a humid ambience. <1.2> 3. Flight control technician does not identify root cause/source of the reason why the aircraft diagnostic software indicates DFLCC-Digital Flight Controls Computer failure in the flight control system, while in fact it is airworthy.<5.2> 4. Technician assigned to remove object discrepancy of the aircraft flight control system is unable to confirm test software results with the aircraft documentation. <1.3> 5. Technician assigned to remove object discrepancy in the flight control system, acting on the basis of the diagnostic software replaces DFLCC instead of MLG WOW Switch. <7.2> 6. Aircraft flight control system object discrepancy removal verified positively even though it is still not airworthy (due to the fact, that verification is being done by assigned senior mechanic not experienced senior technician). <9.4> 7. The final object discrepancy removal verification and aircraft airworthiness could be performed only during taxing and/or in ops check flight. <9.3>
Hazard formulation H3 Scheduled flying mission cancelling hazard due to incorrect indications by the aircraft built-in diagnostic software and incorrect identification of the broken object during aircraft flight control system discrepancy removal. **or** The chance of scheduled flying mission cancelling due to incorrect indications by the aircraft built-in diagnostic software and incorrect identification of the broken object during aircraft flight control system discrepancy removal.
Predicted loss/harm during hazard activation H3 Loss due to fact, that scheduled flying mission cannot begin, or has to be aborted.
Hazard H4
Hazard sources group H4 1. Flight control technician assigned to identify broken objects in the technical structure of the F-16, performs this job while being affected by excessive fatigue and/or stress and/or distraction.<1.5> 2. Flight control technician does not try to identify root cause/source of the aircraft object failure (MLG WOW Switch). <5.1> 3. Technician positively verify flight control system airworthiness on the ground. <9.10>

Table 3 cont.

Hazard formulation H4 Loss hazard due to scheduled flying mission cancelling as a result of discrepancy duplication during aircraft launch procedures.
Predicted loss/harm during hazard activation H4 Loss (polish airspace violation including unauthorised penetration of the polish airspace by foe aircraft), due to the scheduled flying mission cancelling.
Hazard H5
Hazard sources group H5 1. Mechanic mounts in the aircraft flight control system MLG WOW Switch without any water/moisture protection. <7.6> 2. Flight control shop chief does not verify aircraft object discrepancy removal by himself. <9.9>
Hazard formulation H5 Loss hazard due to main landing gear retraction failure during launch procedures and landing gear lowering during aircraft landing.
Predicted loss/harm during hazard activation H5 Material losses/damage due to the aircraft emergency landing on the nose landing gear only.

5. CONCLUSIONS

The main goal of the risk management methods is the continuous improvement of the selected domains from the perspective of the hazards generated inside those domains. In this article, the analysis domain is the part of the aggregated domain presenting maintenance system model of the multirole F-16 aircraft.

For the selected analysis domain, on the basis of the schematic diagram of the hazard identification process, were presented procedures: tool preparation for the hazard sources identification, hazard sources identification, hazard formulation, predicted loss/harm caused by hazard activation. All the information included in the hazard specification is the foundation for the risk model selection or creation.

Presented in this article,the idea of the hazard identification process with the inductive approach(F-HIP), (used by authors for the analysis domain being a selected part of maintenance system model of the multirole F-16 aircraft) is successfully used in many analysis domains located in land transport branches [Kadziński, Juszczak and Kobaszyńska-Twardowska 2010, Gill and Kadziński 2012, Kadziński 2013, Gill and Kadziński 2016a].

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REALIZACJA PROCESU IDENTYFIKACJI ZAGROŻEŃ W WYBRANEJ DOMENIE ANALIZ SYSTEMUOBSŁUGI SAMOLOTU WIELOZADANIOWEGO F-16

Streszczenie

W pracy obszarem rozważań jest system obsługi samolotu wielozadaniowego F-16. Zbudowano model systemu obsługi samolotu wielozadaniowego F-16. W ramach tego modelu wyróżniono domenę analiz obejmującą proces „Usuwanie drobnych niezdatności obiektów samolotu". Dla przyjętej domeny analiz, na tle schematu ideowego procesu identyfikacji zagrożeń, zaprezentowano procedury: przygotowywania narzędzi do rozpoznawania źródeł zagrożeń, rozpoznawania źródeł zagrożeń, grupowania źródeł zagrożeń i formułowania zagrożeń. Podano końcowe efekty procesu identyfikacji zagrożeń w postaci charakterystyk zagrożeń, na które składają się: grupa źródeł zagrożenia, sformułowanie zagrożenia, przewidywane straty / szkody będące wynikiem aktywizacji zagrożenia.

Słowa kluczowe: źródło zagrożenia, zagrożenie, identyfikacja zagrożeń, zarządzanie ryzykiem, samolot wielozadaniowy F-16, system obsługi