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Research Article

Occupational Health and Safety Risks in Aircraft Arresting Barrier Systems

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Abstract:

Occupational health and safety is a fundamental objective for businesses and various organizations. It is a known fact that the aviation industry is a complex organization with high security. It is of great importance to determine the real risks encountered in aircraft arrest operations, which is a branch of the aviation industry. It is aimed to determine the risk factors on Aircraft Arresting Systems, which provide solutions to the stopping problems that occur as a result of hydraulic failures of fighter-type aircraft.In this study, the purposes and definitions of AASs were explained, their installation stages and working principles were examined and the hazards related to their impact on flights were identified. The risks that these hazards may pose have been meticulously identified in order to guide future studies. In this context, the study aims to identify the main hazards and the sector-specific vulnerabilities that these hazards may create, taking into account the differences in high-risk variables specific to the service sector. The primary objective of this study in the field of is to reduce workplace accidents and occupational diseases, thus contributing to social policy and security. In this context, the study aims to identify the main hazards and the sector-specific vulnerabilities that these hazards may create for AAS, taking into account the differences in high-risk variables specific to the service sector.

1. Introduction

The term “safety culture” was first used in the literature in the 1986 Chernobyl Accident Summary Report of the International Atomic Energy Agency to explain how the thoughts and behaviors of people in the organization responsible for safety at that nuclear power plant contributed to the disaster [1]. The concept of risk is a very important concept in the safe work approach and is one of the cornerstones of understanding why safe work problems occur. The concept uses the idea of danger, potential harm to the overall integrity of the worker or the work being done. However, one of the problems in using the concept is that the conceptualization of risk is often limited. It is also often quite difficult to see all its aspects. Risk, which is an extremely broad concept, includes hazards from every conceivable aspect in the work environment. In this context, when we give examples;

• Hazards arising from the physical work environment, such as equipment and machinery, noise or temperature levels, exposure to harmful chemicals, and the layout of the workplace,
• Hazards arising from the behavior of people in the workplace,
• Hazards arising from the way work is organized, including workflow, pace of work, hours of work, and flow of communication within the workplace,

Risk is the hazards that mostly arise from the interaction of any of the above examples or from the entire working system [2].

Occupational Health and Safety, which is seen as one of the basic indispensable issues for businesses and official institutions, is an important element of business life, but it is very difficult to fully implement, especially in complex organizations with high reliability. In this respect, many dangers in such businesses continue to pose a risk for employees and the devices/vehicles used.

It has been observed that more than 70% of the accidents that occur in the aviation sector in particular are due to “human errors” as the primary cause [3].

Although dozens of studies have been conducted on the four main causes of accidents defined as human, machine, environment and management in the occupational health and safety approach, it has been observed that the majority of these studies, especially in the aviation sector, are flight-oriented, but sufficient scientific studies on Aircraft Arresting Systems (AAS) have not been exhibited in the field of occupational health and safety.

As a result of the research conducted by Karadağ, it was determined that just as there are occupational accidents in civilian workplaces, there are also many occupational accidents in military areas, and 72.28% of military occupational accidents are caused by lack of education, negligence and carelessness [4].

The defense industry, in addition to being of indispensable importance to the entire world, is an indispensable element of maintaining our national existence as well as advancing technology within our country. Significant advances in military technologies have accelerated the transition to a modern defense industry. States support the defense industry in order to meet the needs of their armed forces with uniquely designed systems at minimum cost and to implement independent policies [5].

Although it is known that military organizations are organizations that work under intense stress and contain thousands of personnel within a very disciplined structural system, it is evaluated that occupational accidents can occur in these organizations just like in civilian organizations and that these rates can be reduced with the achievements to be made.

Airport activities, which are partially identified by international academic studies, are among the sectors where occupational accident risks should be minimized. It is evaluated that a sample analysis study on the Detection of Occupational Health and Safety Risks in Aircraft Stopping Barrier Systems and the Development of Precautions will be a source that should not be ignored in AAS activities.

Karagöz and Palaz examined the connection between defense expenditures and economic growth in Turkey in their analysis. Based on the results of their analysis, they suggested that there is a positive connection between economic growth and defense expenditures in the short term [6].

The concept of Occupational Health and Safety, unlike the concept of Worker Health and Safety, includes not only the prevention of hazards but also the anticipation and evaluation of risks and the work to be done to completely eliminate these risks or to minimize their damage.

Occupational Health and Safety in a universal sense; even when there is no danger yet or a malfunction in the business, it also brings with it the work of foreseeing the hazards and risks that may occur in the business and deciding whether these are acceptable or not, in other words, with the new concept, the old "reactive" approaches have given way to "proactive" approaches [5].

Mashaqbeh, A. et al. in their study titled A System Dynamics Simulation Model for Environmental Risk Assessment at Strategic Level in Power Plants considered that in a constantly changing business environment, a systematic approach is needed for risk assessment. They claimed that System Dynamics (SD) modeling technique can be applied as an effective approach to understand the dynamic behavior of a system over time. They presented a SD model to assess environmental risks in power plants. They conducted a survey and focus group interviews to understand the relationship between risks in terms of long-term behavior of the system and the model was validated with two power plants in the Middle East. The developed model highlighted the impact of environmental risks on the performance of power plants. Although the SD model focuses on risk assessment in power plants, it is claimed that it can be easily adapted to other industry sectors [7].

Aviation, which is considered an important part of the defense industry sector in Turkey, is an area where a significant portion of our national income is spent on this issue. According to the global military expenditure report for 2021, the Stockholm International Peace Research Institute (SIPRI) reported that Turkey's defense expenditures were around 15 billion dollars. [8] The basic element of aviation in the defense industry is fighter jets, and while the procurement of these aircraft has international sensitivities, their maintenance and operation also have a separate importance and cost. Therefore, it is of great importance to be able to keep the weapons and equipment procured in the inventory for a long time.

As is known, aircraft still require runways where they can reach a sufficient speed, after reaching that speed, they take off by activating their main structures that contain the basic aerodynamic elements they contain, and they complete their flight within the plan they will carry out and land on the runway again to fulfill their duties. The most important difference between aircraft used for military purposes and civil aircraft is that instead of performing a straight flight after taking off, they have to perform many sudden maneuvers compared to civil aircraft due to the conditions/duties. In the face of maneuvers that can be experienced with this sudden speed change (the expression of the acceleration experienced in terms of gravity), the extra G force they are exposed to causes the hydraulic systems of the fighter aircraft to be damaged and unfortunately to become incapacitated. This is exactly where AAS Barrier Systems come into play and ensure that fighter aircraft whose brake systems do not work during landing are stopped without being damaged within the runway boundaries. The AAS Barrier Systems in question are braking systems located at the beginnings/middles of the runway and are placed on special bases with the required strength on both sides of the runway [9]. If the AAS Barrier Systems were not used in the aviation sector, it is estimated that the life of the warplanes in question would be reduced by 80-90%. The maintenance and operation of the AAS Barrier Systems, which are of such great importance, are provided by personnel with experience and knowledge.

2. Material and Methods

In the Aviation Sector, becoming safer and away from the risks that may arise from the hazards in the working environment will reduce work accidents and occupational diseases, and will affect the person to feel safe and do their job more efficiently due to the creation of an orderly environment for the employees. In addition, it is known that Occupational Health and Safety approaches will provide positive developments in many points from the work life to the efficiency of the private life of our employees. Based on this point, it is aimed for AAS Barrier Systems to contribute to risk assessment studies by identifying the hazards in occupational health and safety, to classify the results and to manage the necessary precautions effectively. Parallel to the development of aviation, aircraft arresting systems that provide the aircraft arresting process have also developed in parallel. There are two basic methods of arresting the aircraft; the first is to connect the aircraft to the brake system by means of a hook mounted on the rear of the aircraft (Figure 1), and the second is to arrest the aircraft by wrapping it around the fuselage and wheel posts (Figure 2) and connecting it to the brake system. In order to perform the first method, a 1 or 1¼ inch thick steel rope that crosses the runway transversely must be laid on the runway on discs approximately 10 cm high along the runway.

Figure 1: *Hook (BAK-12) AAS barrier system.*

Figure 2: *Net type AAS barrier system.*

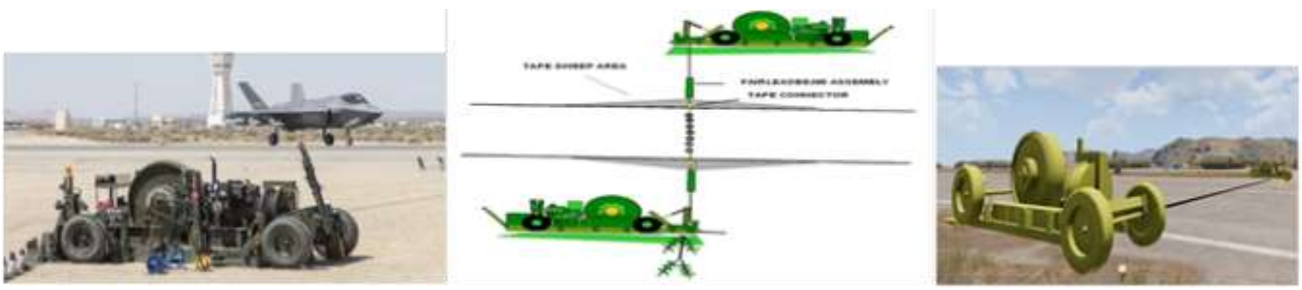

Figure 3: *Mobile (MAAS) AAS barrier system.*

The Mobile (MAAS) AAS Barrier System (Figure 3) functions by being installed, when necessary, at runway points where Network and Hook type AASs are not permanently deployed [10]. The second method uses a network system that wraps around the aircraft's fuselage and wheel struts to stop it with an energy-absorbing braking system.

2.1 Importance of the Research

In the Aviation Sector, becoming safer and far from the risks that may arise from the hazards in the working environment will reduce work accidents and occupational diseases, and will affect the person to feel safe and to do their job more efficiently due to the creation of an orderly environment for the employees. In addition, it is known that Occupational Health and Safety approaches will provide positive developments in many points from the work life to the efficiency of the private life of our employees. Based on this point, it is aimed for AAS Barrier Systems to contribute to risk assessment studies by identifying the hazards in occupational health and safety, to classify the results and to manage the necessary precautions effectively.

2.2 Why Are AAS's Needed?

Aircraft arresting systems primarily serve to save lives by preventing aircraft from overshooting runways in situations where the pilot is unable to stop the aircraft during landing or aborts take off operations. They also serve to save aircraft and prevent major damage [11].

Aircraft arresting systems primarily serve to stop life by preventing the pilot from eroding controlled runways during landings, where the aircraft cannot be stopped or takeoff operations are aborted. They also serve to save aircraft and repair major damage.

Fighter type warplanes maneuver more during flight compared to other passenger and transport aircraft, which causes more failures due to external pressure changes in their hydraulic systems. In cases where the brake systems do not work at all or work partially, these high speed aircraft may go off the runway and crash because they cannot stop even if they manage to land on the runway. This undesirable situation causes permanent damage to the aircraft, often causing it to explode or become unusable.

Fixed Hook Type AAS/BAK-12 is the standard military operational aircraft arresting system. This dual-direction system consists of two energy absorbers. Each energy absorber consists of two multi-disc rotary friction brakes mounted on each side of a nylon tape reel on a common shaft. In order to perform the first method, a 1 or 1¼ inch thick steel rope that crosses the runway transversely must be laid on the runway on disks approximately 10 cm high along the runway. Energy absorbers operate synchronously with this steel rope via the arresting tape. These are systems that stop the aircraft within the runway boundaries by connecting it to the arresting system via a hook mounted on the rear of the aircraft [11]. The second method is to arrest the aircraft by wrapping it around the fuselage and wheel posts (Figure 2) and connecting it to the brake system. In the second method, a 60-meter wide polyamide material net is used to grip the aircraft by wrapping it around the fuselage and wheel posts in order to ensure that it is stopped by the energy absorbing brake system.

Fighter type high speed warplanes, energy absorbing capture systems are mounted on mobile vehicles and thus can be installed in the desired area of the runway shoulder area. Systems in which the connection function with the aircraft is carried out by a steel rope or a polyamide net are called Mobile Type (Figure 4) Mobile (MAAS) AAS barrier system.

It is aimed to contribute to the reduction of the economic burden on the aviation sector by reducing the occupational accident rates targeted in the OSH policy document, and as a result, to reduce the financial burden on the country's economy.

It is thought that reducing the economic burden within the social structure will not only prevent waste of resources but also contribute to labor peace by taking steps towards achieving national targets and occupational safety targets for reducing work accidents. It is thought that the implementation of the policy analyses to be made will also reflect the improvement in other sectors where production and service applications of other official and very dangerous jobs/high-risk organizations are carried out.

It will contribute to the literature in terms of sustainability and the model used by revealing the safety culture policies as theoretical and practical service sectors in terms of future life safety and installation-operation safety in Turkey.

2.3 Working Steps of AAS Barrier Systems

Ready Position is ready for aircraft entry after the AASs are installed, checked and adjusted. They do not require any power source or manpower for operation. In the "Ready Position" situation, the arresting ropes supported by rubber support disks (discs that ensure that the rope is held at a certain height so that the aircraft hook can be attached to the steel rope) must be tensioned with a certain preload in order to maintain their tension along the runway. After the connection of the steel rope to the system from both ends is provided, the system must be

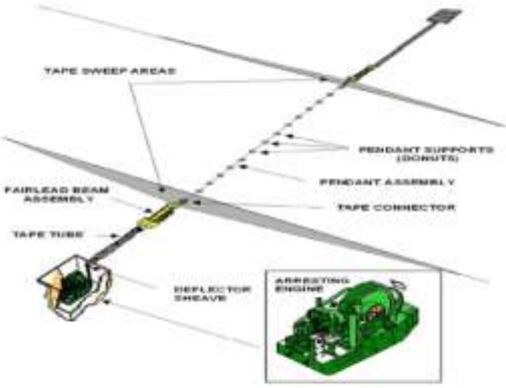

Figure 4: *AAS barrier system*

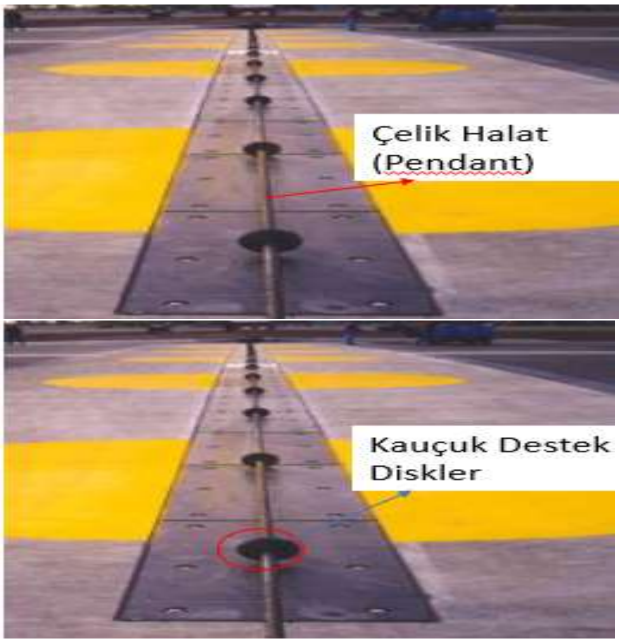

Figure 5: *Pendant (Steel rope)*

under approximately 2000 psi (~135 bar) tension when in the ready position. The tension must be maintained at all times until the moment of aircraft entry by means of friction brakes and hydraulic static pressure system. Proper arrest rope tension ensures that the aircraft wheels are in the correct position for the hook to be attached after passing over the pendant cable (Figure 5). Another important aspect of keeping the pendant cable taut is to ensure that the arrest tape (nylon tape) is tightly wound on the drum, thus minimizing the dynamic loads that may arise from the arrest tape slipping as the arrest tape is unloaded at the aircraft entrance. Arresting: Arresting is achieved when the pilot opens the aircraft hook before reaching the axis where the barrier systems are deployed, and the aircraft hook arrestes the steel rope while the aircraft is advancing on the runway. When the aircraft hook arrestes the arrest rope, the hydraulic system is activated and the aircraft is stopped. The entry may occur anywhere within the width of the runway.

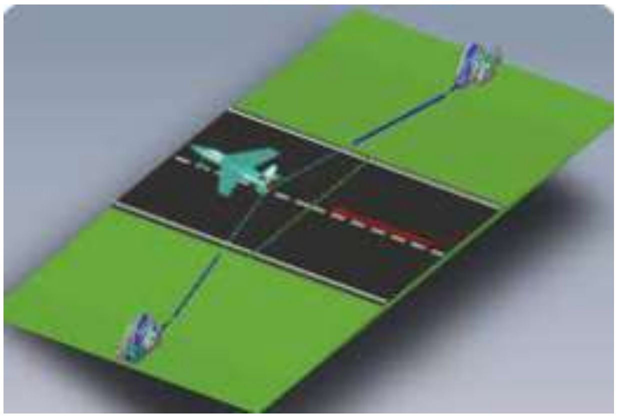

Figure 6: *Capture pendant (center entry)*

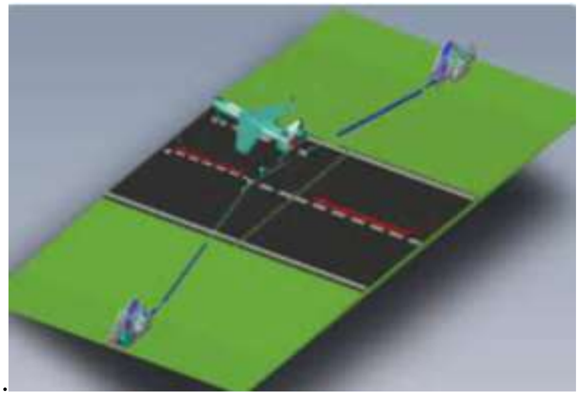

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Figure 7: *Capture pendant (off-center entry)*

In the case of a central entry (Figure 6), the aircraft will still be stopped at the centre with a properly calibrated and functional arresting system In off-center entries (Figure 7), since the energy absorbing unit that is closer will be exposed to more kinetic energy in proportion to the speed and weight of the aircraft, the hydraulic system will create more pressure than the energy absorbing unit on the far side, and will try to direct the aircraft it arrestes from its hook towards the center (in a way that prevents the aircraft from crashing) and, in a successful arrest, will be able to stop the aircraft within the runway boundaries. AAS Infrastructure Works: Whether they are Fixed Hook or Net type AASs, they definitely need bases suitable for their chassis at a certain distance from the runway center line (at the end of the shoulder). Even if not applied correctly, the slightest mistake in the base placements (Figure 8) will cause the aircraft to go off the runway after entering the barrier or to have an accident. Since the misalignment between the axes (Figure 9) or the faulty code level in the base foundations to be made will change the kinetic energy that will activate the energy absorber unit operating on one side, the energy absorber mounted on the faulty base will not be able to exhibit synchronized operation or will brake more or will prevent the aircraft from achieving its optimal stopping target due to less braking.

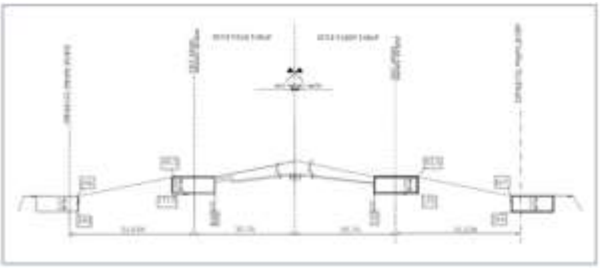

Figure 8: Fixed hook AAS layout sketch

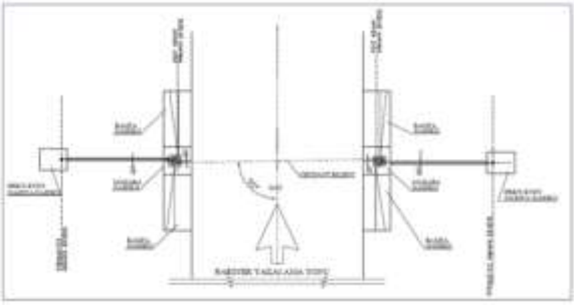

Figure 9: *Fixed hook AAS location axis sketch*

2.4 Findings

Site Survey

Each base project is specific to the location where it will be installed. Therefore, before the bases in question are built, it is mandatory to make topographic measurements (Figure 10) of the runway/field where the installation will be made. In Fixed Hook AASs, the basic approach is planned to a suitable axis that is 1200-1500 feet away from the runway head centerline and is free of obstacles (runway lighting cable passage manhole, taxiway, ILS (Instrument Landing System) elements (Figure 11), etc.).

AAS Base and Installation Steps

For the upper codes of the base, the runway shoulder slope is carried along the terrain. The aim is to create an angle compatible with the aircraft hook while at the same time creating a frictionless working environment between the runway edge rollers and energy absorbing units. In the AAS base construction stages, firstly base foundations suitable for the prepared projects are opened, the soil softened during the foundation excavation should be hardened with a suitable compactor, then the base sub-concrete should be poured (Figure 12). Then, mold works suitable for the base dimensions should be done. One of the mistakes seen in the manufacturing of bases is that the foundation molds are not sufficiently reinforced with the soil line in the mold work (Figure 13). This mistake, which is often thought to be sufficient, causes both the iron reinforcement and the concrete used to be wasted. Although the iron reinforcement assemblies to be placed in the base concrete can be prepared in the base pit (Figure 14), it has been seen through experience that unfortunately this work takes a very long time on runways where active flight is ongoing. Therefore, preparing the iron reinforcement connections in a place that does not affect the flight relatively from the runway and placing them in the base concrete with a carrier crane will provide significant time savings. However, the transportation and placement of a cage structure with dimensions of approximately 5x5x1.1 meters requires serious attention and precautions (Figure 15).

Figure 10: *Construction practices of pedestal foundations*

Figure 11: ILS systems ground antennas

Figure 12: *Concreting process of base foundations*

Figure 13: *Pedestal foundation concrete formwork controls*

Figure 14: *Iron-reinforcement manufacturing at the runway zero point*

Another mistake is that the upper beams of the iron reinforcement cages manufactured outside or inside the mold are not supported by sufficient stands. This situation will cause two major problems. The first is that the cage structure will deform during transportation, and the second is that the workers stepping on the reinforcement during the vibrator or surface screed operations during the concrete pouring will cause the reinforcement to collapse, which will later cause an irreversible error that cannot be corrected. Another thing to be careful about when placing the iron reinforcement into previously prepared molds is to pay attention to the surface rust margins (6-8 cm). If the rust margin in question is not given correctly, cracks and unwanted reinforcement marks on the surface after the concrete is poured are inevitable.

As mentioned before, the most important issue of substructure works is the axes and codes of the bases. In this process, before pouring the concrete, the upper codes of the formwork must be taken from several points on all sides, then the template arms must be fixed according to the anchors' position on the correct axis by pulling the construction rope according to the axis points to be determined on the formwork (Figure 16). Because the template arms bend and lose their rigid flatness after the first concrete pouring and removal process. After the base templates are fixed on the mold, the anchor bolts, which we call bolted (sleeved) type, are fixed to their places on the template. Since the bottom surface of the template will be the top surface of the base, the sleeve part of the bolts will remain in the concrete except for the upper limit of the throat. The reason for this is to increase the resistance of the area by filling the bolt perimeter, which will receive the first load coming from the energy absorber body during aircraft entry, with a construction chemical that is more resistant than C-25/30 concrete quality. Another issue to be considered in the installation of sleeved bolts is to direct the open end of the tail section, which comes out of the bottom of the sleeve and is 90° perpendicular, towards the outside of the runway, which is the exact opposite of the direction from which the load comes to the energy absorber. The reason for this is to prevent the bolt from stripping from the concrete. There are also important points to consider when pouring concrete. In runway edge pulleys and ramp bases where there is no problem in the concrete mixer approaching the base foundation, a sufficiently long bucket should be added to the concrete discharge part of the mixer (Figure 17). Discharging the concrete from a high level (not exceeding 50-70 cm) causes the aggregate and homogeneous structure in its content to deteriorate and settle to the bottom.

Figure 15: *Cage iron-reinforcement transportation process*

Figure 16: *Base templates*

Figure 17: *Correct concrete discharge*

Figure 18: *Slump test*

Figure 19: *Concrete casting process*

Figure 20: *Concrete irrigation*

Figure 21: *Assembly process*

The C-25/C-30 concrete consistency used should not have too much fluidity. Therefore, it would be appropriate to test the concrete for "slump" according to ASTM C143 before pouring. In this test process (Figure 18), the slump should not exceed 13 cm. In short, it would be appropriate to have a concrete that is difficult to work with and close to dry. In practice, in our country, masters who do mold-concrete work, even at the last moment, incorrectly add water to the mixer and turn it at a fast speed in order to make their work easier, thus disrupting the fluidity consistency in question.

Another important issue to be considered during concrete pouring is to plan the concrete to be carried out in one go during each base pour. Otherwise, there will be two different concrete masses called cold joints that do not integrate with each other, which will not be enough to withstand the loads transferred to the base concrete from the energy absorbing unit chassis during aircraft stopping. There should be a maximum of 15-20 minutes between two mixer discharges. In addition, the concrete vibrator process applied to prevent air pockets that may occur during the concrete pouring process is another point to be considered. During the process, the vibrator (Figure 19) hose should be inserted perpendicularly into each mesh eye up to the base foundation, but it should not be withdrawn for either a long or short time. Again, waiting for an average of 2-4 seconds will be sufficient to prevent the aggregate from settling to the bottom.

After pouring the concrete, the concrete should definitely be watered (Figure 20) in the morning and evening for the first 7 days and at sunset for the next 14 days, and it will be beneficial to cover the concrete with textile materials in places where there is extremely hot sun. In this way, the moisture formed after the irrigation will be prevented from evaporating too quickly. In addition, concrete pouring should not be planned for hours/days when there is heavy rain.

Whether it is an energy absorbing unit or other systems, as can be seen from the Figure 21, one of the most important problems is the use of PPE (Personal Protective Equipment), the work machine (Crane) approaching the work site in inappropriate numbers and with inappropriate directions, or even getting under the load, etc. After all system elements are fixed on the prepared bases and the necessary adjustments are made, the assembly process is completed.

The approaches that need to be considered in the installation processes in Fixed Hook AASs are similar in all net lifting systems, provided that they are suitable for their projects.

Whether it is a Network type or a Mobile AAS, since their operational purposes are the same and usage and activity controls are carried out by the same operators, it has been evaluated that it would be more appropriate to approach AAS (barrier systems) as equipment belonging to a single business by exhibiting a common approach in risk detection.

Identified Risks

In this part of the study, the occupational health and safety risks that arise and are likely to arise in Aircraft Arresting Barrier Systems are Table 1 presented.

3. Results and Discussions

Risk analysis and enterprise risk management have become a critical and important issue for businesses and corporate organizations in recent years. It should also be noted that any contribution to the aviation field will have a positive financial impact on the economy in the long term.

***Table 1:** Occupational health and safety risk assessments for areas of use of aircraft arrester barrier systems*

No	Risk Category	Identified Risk
1	Physical Risk	Excessive noise during aircraft entry and capture tape rewinding
2		Insufficient ambient lighting during night operations
3		Thermal comfort is insufficient in AAS cabins
4		Since the rewinding process is partially done manually, the operator is exposed to vibration.
5		Staff are physically strained due to insufficient staff for operations and maintenance
6		During the assembly process, personnel enter a life-threatening area during crane operation.
7		Maintenance personnel are not adequately controlled (personnel on the net) when the net lifting and lowering operations are performed from the tower

8	Mechanical Risk	The placement of personnel on duty at AAS aircraft test entrances is not appropriate at a safe distance.
9		Periodic checks are often done by filling out a checklist at a desk.
10		Expired materials continue to be used due to supply delays
11		Machine guards cannot be used
12		During rewinding, operators do not pay attention to the tape connectors coming at the same time to reduce the wear and buckling of the arrest tape.
13		Steel rope (pendant) preload tension (2000 psi/135bar) is often not controlled
14		Level and axis measurements are not controlled by different personnel during assembly operations.
15		The required time (2-4 seconds) is not taken into account in concrete vibrator operations.
16		Not enough supporting material is used in the manufacturing of iron reinforcement.
17	Ergonomic Risk	If the upper level in construction formwork processes is not adequately controlled, belt friction or rainwater accumulation occurs after assembly.
18		Pouring concrete incorrectly (a single bucket is placed behind the mixer) from a height, not enough irrigation is done/at the wrong hours.
19		AAS protective huts are too narrow and small
20		Working postures are not suitable due to the narrowness of the work area.
21		There are no tables or chairs in the barracks, the necessary forms cannot be filled in front of the device.
22		Monotonous work is being done
23		No breaks at regular intervals
24		Exposure to direct sunlight
25	Chemical Risk	Operators exposed to chemical brake pad dust
26		Operators exposed to chemical brake pad fumes
27		Operators exposed to aircraft exhaust fumes
28		Safe storage inside AAS protective shed is not possible
29		Material safety data sheets are not taken into account
30		Rewind motor exhaust connections missing or inadequate
31	Electrical Risk	Grounding control is not performed
32		There is no residual current relay
33		No precautions were taken on the panels located inside the AAS protective shed.
34		Batteries used in AAS, especially spare batteries, are not checked regularly
35		The mobile electrical equipment used in AASs is non-standard.
36		Not cutting off electrical power during maintenance and repair of damaged panels
37		Leaving panel covers open
38		Irregular placement of electrical cables on the floor
39	Administrative Risk	Adequate OHS training was not provided
40		No near-miss notification system has been established
41		No risk assessment has been made
42		OHS professionals do not follow
43		No/inappropriate use of PPE (especially in AAS assembly operations)
44		Machine/equipment periodic control records are kept on the desk.
45		After receiving AAS training during the school year, personnel working in different units are assigned to the system years later.
46		Health examinations/trainings are performed without assessing AAS risks (noise, vibration, chemical exposure, etc.)
47		Visitors/unauthorized persons are under control
48		Toilet and sink hygiene is not appropriate
49		The sections allocated for dressing/undressing purposes are insufficient.
50		Emergency response vehicles are not available/insufficient in many areas of use
51		Inadequate precautions were not taken against pests
52	Risk Related to General Order	The section for eating is separate from the general dining areas, so it is uncontrolled and does not have enough equipment.
54		There are no emergency exits in operators' waiting units
55		Shelves and cabinets are not fixed
56		Inadequate measures to prevent materials from falling from shelves

4. Conclusions

As a result, it is evaluated that the risks identified in the AASs can be a precursor and support for the strategies to be developed and other academic studies to be included in the literature in this field. While the study was being conducted, important risks that should be taken into consideration in similar studies to be conducted in the future were determined.

In future studies, special attention should be paid to data collection, recording and analysis processes. Risk determinations that are not based on reliable data will lead to misleading results. In future studies, including subject matter experts or relevant stakeholders in the analysis process may help to obtain more robust results. In this section conclusions of work should be given. The subject reported in this paper is interesting as there are a number of works also reported in the literature [12-25]

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper
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- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

References

[1] Kim, Y.H., Parkı, J., Parkı, M., (2016). Creating a Culture of Prevention in Occupational *Safety and Health Practice. Safety and Health at Work* 7(2);89-96 doi: 10.1016/j.shaw.2016.02.002.

[2] Feyer, A.M., Williamson, A., (1998). *Occupational Injury Risk, Prevention And Intervention.* https://doi.org/10.4324/9780203212493 eBook ISBN9780429218033

[3] Kılıç, F., (2017). Sivil ve Askeri Uçak Kazalarında İnsan Faktörü: Örnek Olay İncelemesi: Helios Airways Flight HCY522, Boeıng 737, *HEYS 2017 Sempozyumu*, Ankara.

[4] Eren, H., Kılıç, A., (2013). Örgütlerde Yenilikçilik Ortamı: Özellikli Bir Sektör Olarak Savunma Sanayiinde Durum, *Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi,* 27(3);221- 244.

[5] Özkılıç, Ö., (2005).İş Sağlığı ve Güvenliği Yönetim Sistemleri ve Risk Değerlendirme Metodolojileri, *TİSK Yayınları, Ankara.*

[6]Karagöz, E., Palaz, S.,(2004), Does Defence Expenditure Deter Economic Growth in Turkey? A Cointagration Analysis, *Defence and Peace Economics,* 15(3);

[7] Mashaqbeh, A., Munive-Hernandez, S. M., Khan, J. E., Khurshid, M. ve Khazaleh, A. (2020). A system dynamics simulation model for environmental risk assessment at strategic level in power plants. *International Journal of Reliability and Safety*, 14(1), 58. doi:10.1504/ijrs.2020.105902

[8]Gönültaş, B. (2021, Nisan 25). Küresel askeri harcamalar 2021'de ilk defa 2 trilyon doların üzerine çıktı. https://www.aa.com.tr/tr/ekonomi/kuresel-askeri-harcamalar-2021de-ilk-defa-2-trilyon-dolarin-uzerine-cikti/2572

[9] Advisory Circular AC. (2006). No: 150/5220-9B. U.S. *Department of Transportation Federal Aviation Administration.*

[10] Güngördü, G. (2009). Bariyer Ağı ve Ağ Kaldırma Sistemi Tasarımı. http://tez.yok.gov.tr/UlusalTezMerkezi/tezDetay.jsp?id=e92epH_WV13r379h6IFBPw&no=xsEAk6mGBP_kmWXWuXfL_Q.

[11] Facilities Criteria (FC),. (2015). Aır Force Aırcraft Arrestıng Systems Installatıon, Operatıon, And Maıntenance. *FC 3-260-18F.* https://www.wbdg.org/FFC/DOD/UFC/fc_3_260_18f_2015_c1.pdf.

[12]Bhanu Sekhar OBBU, & Zamrooda JABEEN. (2024). Integrated Fuzzy Cognitive Map and Chaotic Particle Swarm Optimization for Risk Assessment of Ischemic Stroke. *International Journal of Computational and Experimental Science and Engineering,* 10(4);867-878. https://doi.org/10.22399/ijcesen.540

[13]Suneetha Madduluri, & T. Kishorekumar. (2024). Multimodal Biometric Authentication System for Military Weapon Access: Face and ECG Authentication. *International Journal of Computational and Experimental Science and Engineering,* 10(4);952-961. https://doi.org/10.22399/ijcesen.565

[14]Sushma Polasi, & Hara Gopal Venkata Vajjha. (2024). Secure Drone Communications using MQTT protocol. *International Journal of Computational and Experimental Science and Engineering*, 10(4);1282-1289. https://doi.org/10.22399/ijcesen.685

[15]D, jayasutha. (2024). Remote Monitoring and Early Detection of Labor Progress Using IoT-Enabled Smart Health Systems for Rural Healthcare Accessibility. *International Journal of Computational and*

Experimental Science and Engineering, 10(4);1149-1157. https://doi.org/10.22399/ijcesen.672

[16]Ponugoti Kalpana, L. Smitha, Dasari Madhavi, Shaik Abdul Nabi, G. Kalpana, & Kodati , S. (2024). A Smart Irrigation System Using the IoT and Advanced Machine Learning Model: A Systematic Literature Review. *International Journal of Computational and Experimental Science and Engineering,* 10(4);1158-1168. https://doi.org/10.22399/ijcesen.526

[17]DANİŞMAZ, M., & DEMİRTAŞ, C. (2024). An Experimental Investigation of Clean Syngas Production from Waste Biomass by Gasification Method. *International Journal of Computational and Experimental Science and Engineering,* 10(3);314-322. https://doi.org/10.22399/ijcesen.361

[18]Küçük, İbrahim, Yağımlı, M., & Işıktaş, İsmail. (2024). Modeling the Effects of Safety Culture Affecting Safety Performance on Occupational Accidents with System Dynamics. *International Journal of Computational and Experimental Science and Engineering,* 10(3);403-419. https://doi.org/10.22399/ijcesen.419

[19]Sadiku, H., & Kamberi, M. (2024). Load testing of new Bridges with wireles sistem of equepement. *International Journal of Computational and Experimental Science and Engineering,* 10(3);350-357. https://doi.org/10.22399/ijcesen.366

[20]Kabashi, G., Kola, L., Kabashi, S., & Ajredini, F. (2024). Assessment of climate change mitigation potential of the Kosovo energy and transport sector . *International Journal of Computational and Experimental Science and Engineering,* 10(3);517-526. https://doi.org/10.22399/ijcesen.325

[21]V. Gokulakrishan, & S. Selvakumar. (2024). An efficient approach for detecting downsyndrome fetus images using deep learning method. *International Journal of Computational and Experimental Science and Engineering,* 10(4);1311-1319. https://doi.org/10.22399/ijcesen.705

[22]S.P. Lalitha, & A. Murugan. (2024). Performance Analysis of Priority Generation System for Multimedia Video using ANFIS Classifier. *International Journal of Computational and Experimental Science and Engineering,* 10(4);1320-1328. https://doi.org/10.22399/ijcesen.707

[23]Sushma Polasi, & Hara Gopal Venkata Vajjha. (2024). Secure Drone Communications using MQTT protocol. *International Journal of Computational and Experimental Science and Engineering,* 10(4);1282-1289. https://doi.org/10.22399/ijcesen.685

[24]Çağlan, A., & Dirican, B. (2024). Evaluation of Dosimetric and Radiobiological Parameters for Different TPS Dose Calculation Algorithms and Plans for Lung Cancer Radiotherapy . *International Journal of Computational and Experimental Science and Engineering,* 10(2);247-256. https://doi.org/10.22399/ijcesen.335

[25]DAYIOĞLU, M., & ÜNAL, R. (2024). Design and Economic Analysis of a Grid-Tied Microgrid Using Homer Software. *International Journal of Computational and Experimental Science and Engineering,* 10(3);276-281. https://doi.org/10.22399/ijcesen.239