Minimizing the Negative Impacts of Airport Construction

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Airfield infrastructure projects are critical to ensure facilities are safe, in good condition and meet current standards. However, these airfield construction and reconstruction activities are usually conducted on an active airfield, which impose operational and human factors challenges for all users, including pilots, air traffic controllers, airport operations personnel, construction workers, and emergency responders. FAA recognizes the potential safety challenges, and provides supporting guidance and regulation as described in AC 150/5370-2G, Operational Safety on Airports During Construction. While this guidance is valuable and enhances safety, there remain human factors issues that are worthy of investigation and discussion.

Introduction

Airport infrastructure is critical to ensure mobility and safety for passengers and cargo in the US and worldwide. To ensure adequate infrastructure, capacity, current standards and condition, airfield construction (including reconstruction and maintenance) is vitally important. The National Plan for Integrated Airport Systems (NPIAS) identifies airport development that is needed and includes $34.3 billion dollars for projects related to reconstruction, standards, safety and capacity for 2021 through 2025 (2020). These allocations demonstrate the ongoing need for airfield construction related projects to ensure the integrity and reliability of our aviation system. Airfield construction is critical to our aviation system, however, it can create operational challenges for stakeholders, since aeronautical activities typically need to continue throughout construction. This paper presents a literature review regarding the impacts of construction, data related to airfield safety, and a discussion of the human factors considerations and mitigation measures that may be appropriate.

Literature Review

FAA recognizes the potential safety challenges, and provides supporting guidance and regulation as described in AC 150/5370-2G, Operational Safety on Airports During Construction (2017). This document provides information to support the development of a plan for safety throughout each phase of construction (referred to as Construction Safety and Phasing Plans, CSPP), checklists for daily inspections for airport operations personnel, examples of operational issues that my result from construction activities, and signs and barricades to identify the construction area.

There is limited information in the literature regarding safety during airport construction activities. There are a few publications related to construction safety at Denver International Airport, where there were 2,843 construction contracts and 4,634 injuries and illnesses (Glazner et al, 2005). These studies emphasize the significance of injuries for construction workers during airport construction activities. Despite this fact, these findings have limited applicability to most airport construction since this reflects construction at a new airport site rather than construction at an active airport.

Airfield construction may have operational and safety considerations that affect numerous airport stakeholders, including pilots, Air Traffic Control (ATC), airport operations, tenants, flight training, and emergency response. There are numerous characteristics of construction that have an impact, including the number of personnel, the kind of material and equipment being used, the nature of the construction

activities, and the location of the construction site, material storage location, and access points. These characteristics may change throughout the project, and will affect the operations, safety, security (Khalafallah & El-Rayes, 2008) and cost. Activities not only affect the stakeholders, but also affect airport hazards such as wildlife (Khalafallah, & El-Rayes, 2006) and foreign object debris (FOD) (Khalafallah, & El-Rayes, 2006). Other issues that have been mentioned in the literature related to airside construction include security escort requirements, night work, short closures, segmenting of work, provision of barricades and fencing, maintaining operational surfaces free of FOD, maintaining operational surface zoning requirements, protecting workers from jet blast, the need for flexibility to adapt to changing circumstances, unusual weather and labor disputes (Stewart, 2001). Other considerations mentioned in the literature include construction contracts (Stewart, 2001), the benefits of partnering to reduce claims and improve schedules (Mollaoglu, et al, 2021), and the importance of communication and well defined roles and responsibilities (Stewart, 2001).

The limited analysis and publication regarding the safety impacts due to airport construction contrasts with other sectors, such as the roadway sector, where there have been numerous studies of the costs, risks, and characteristics associated with crashes in work zones (e.g., Saha, 2020; Schrock et al, 2014; Chen and Tarko, 2012; Li and Bi, 2009).

Results and Discussion

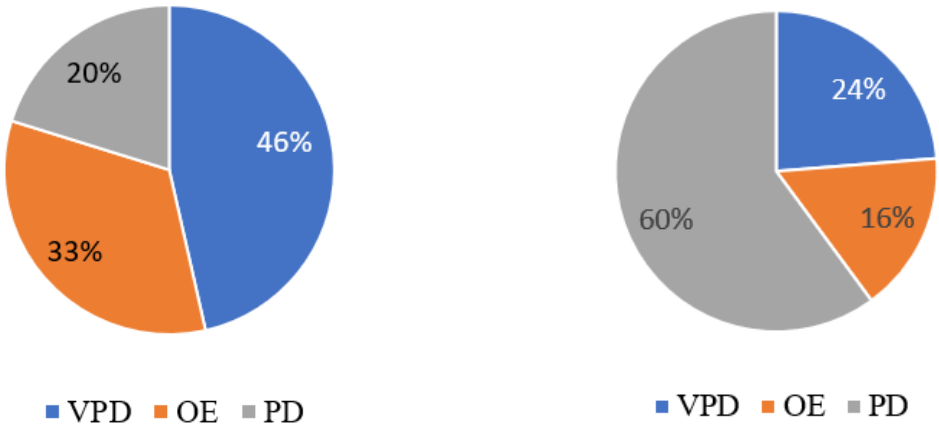
One way to assess the impact of airside construction activities is to investigate the incidence and cause of runway incursions when there are airside construction activities. Analysis of the FAA Runway Incursion Database indicates that there were 612 runway incursions that had "construction" in the narrative from 2001 to 2020. The associated incident type for construction related runway incursions and all runway incursions are shown in Figure 1. For construction events, 46% are vehicle or pedestrian deviations (VPD), 33% are operation error (OE, caused by ATC) and 20% are pilot deviation (PD). VPD and OE are much more likely for events with "construction" in the narrative than for all runway incursion events, which are dominated by pilot deviations (60%). This suggests that while we need to maintain the strong focus on ensuring operational safety for aircraft, there may be a need to provide additional consideration to the impact of runway construction on ATC, construction, and airport operations.

Additional information about the construction related runway incursions is shown in Table 1. Fortunately, severe runway incursions (A and B), are a rare event and represent only 1.4% of all construction runway incursions. Most of the runway incursions pose no risk of collision, with 15% Type C and 32% Type D incursions; approximately half of the construction runway incursions did not have a designated severity. Of the 612 construction runway incursions, 266 indicated a vehicle and 32 indicated a pedestrian (in the aircraft flight code columns); this suggests that vehicles may be a greater concern than pedestrians during airfield construction activities.

Figure 2 illustrates a barricade used to designate the construction area. The airfield construction barricade and construction signs are orange, which is consistent with the colors used in the roadway sector for signs and barricades, which provides consistency and reinforces cues associated with information presentation, which enhances performance through effective and consistent design, including colors. The low barricades (an evolution from railroad ties) provide a visual cue but do not present a hazard to aircraft.

Examples of Potential Impacts and Increased Risk Due to Airfield Construction

There are numerous ways to frame a discussion of human factors. One traditional framework for human factors in aviation is the ICAO SHELL model. The name is derived from the components Software, Hardware, Environment, and Liveware (International Civil Aviation Organization, 2012). This is a useful framework for the analysis of a single activity that is focused on a single unit or person (the central liveware).



"Construction" in narrative (n = 612) All events (n = 25,584)

Figure 1. Distribution of Incident Type for Runway Incursions from 2001 to 2020.

Table 1.
Characteristics of Runway Incursion Events with "Construction" in Narrative.

Severity	Total Number	Percent of all Events*	PD	OE	VPD
A	4	0.6%	100%	0%	0%
B	5	0.8%	20%	20%	60%
C	94	15.4%	38%	20%	41%
D	197	32.2%	28%	6%	66%
All events	612		20%	33%	46%

**Note*. All events is greater than the sum of A, B, C and D since many events did not indicate a severity rating. (Source: FAA Runway Incursion Database, https://www.asias.faa.gov/apex/f?p=100:28:::NO)

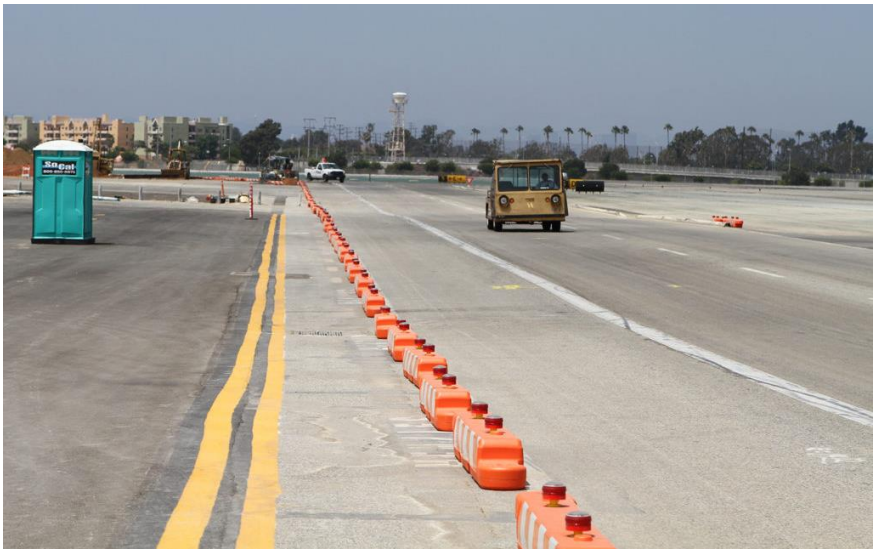


Figure 2. Low profile construction barricades provide a visual cue but may not prevent passage of pedestrians or vehicles (Source: OTW Safety, 2020).

Airfield construction is much more complex, with many people, activities, and organizations involved. Mapping out each of the required activities in the context of the SHELL model would be very challenging and may not support a comprehensive context for the wide variety of ongoing activities.

Another context for a discussion of the challenges associated with airfield construction is to consider the human factors areas as defined by FAA (2012). In this context, the impact of airfield construction may be considered both in general and as it may affect different users as shown in Table 2. The human factors focus areas related to the environment, error, situational awareness, workload, and staffing may be especially relevant for many affected users. Work space and safety and health are most relevant for constructors. An examination of these areas in the context of airfield construction suggest that some areas may be more relevant than others, especially considered in the context of standard practices, which reflect the fact that construction activities are of a limited duration at many airports. Example implications are provided in Table 2, and may be positive (+), negative (-) or neutral (o)in terms of the expected impact. Although not shown in Table 2, the human factors areas of documentation, training, and information are all supported by the development of the Construction Safety and Phasing Plan (CSPP).

Conclusion and Recommendations

The potential impacts of airfield construction are significant and the limited amount of relevant literature indicates that this may be an area that warrants further study. One of the challenges is access to relevant data, however, it may be possible to investigate the topic using case studies, considering data published by OSHA, through the use of the narratives associated with runway incursions, investigation of aircraft incidents and accidents, and development of a construction database by FAA. A better understanding of the most important issues related to airfield construction may provide insights that will translate to other airfield activities, including airport operations activities and construction activities in other sectors, such as the roadway sector.

While timing construction activities to occur when aeronautical activity is lower may be one possible strategy, other scheduling and contracting approaches are recommended for future investigation. Potential approaches to consider include accelerated construction schedules, and incentives for early completion of construction work, an approach that is commonly used in other sectors.

Table 2.
Human Factors Areas, Examples and Affected Users for Airfield Construction

Human Factors Area	Example	Affected Users				
		Pilots	ATC	Airport Ops	Constructors	Emergency Response
Environment	- Greater safety risks associated with construction at night or during low visibility conditions o Conducting construction activities at night may reduce impacts on and by aircraft operations, but may introduce additional hazards due to darkness	X	X	X	X	X
Workload	- Increased workload for pilots and emergency response due to changes associated with construction (e.g., different paths and routes) - Increased workload for controllers due to visual clutter associated with construction - Increased workload for airport ops due to additional inspection requirements - Increased workload for construction workers due to additional risks and distractions in airfield environment	X	X	X	X	X
Human Error	- Increased workload (and associated fatigue) may increase human error - Numerous NOTAMS at many airports may reduce the effectiveness of construction related NOTAMS for pilots	X	X	X	X	
Staffing	- Ops workers are often required to conduct additional construction inspections and other duties although additional staffing is usually not provided except at the largest airports			X		
Situational Awareness	+ Enhanced by visual cues such as signs and barricades + Enhanced by automated runway incursion warning systems	X	X	X	X	
Work Space	- Construction workers are in constrained environment - Space constraints affect material storage area, which may introduce additional risks associated with requirements for material movement o Although pilots may be required to land in a constrained space (e.g., a shorter runway), minimums ensure that the runway length is adequate				X	
Safety and Health	+ Construction workers use required PPE (e.g., safety vests and hearing protection) + Barricades around construction area with barricades supports worker health and safety.				X	
Information Presentation	- Changing taxiway nomenclature during construction violates consistency for pilots and air traffic control. + Use of standard construction signs and markings on all airfields	X				
Procedures	+ Construction inspection procedures support airport ops + Escort procedures help ensure safety for construction contractors			X		

References

Chen, E., & Tarko, A. P. (2012). Analysis of crash frequency in work zones with focus on police enforcement. *Transportation Research Record, 2280*(1), 127-134.

Endsley, M. R., & Garland, D. I. (2000). Pilot situation awareness tralnlng in general aviation. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 44*(11), 357–360. https://doi.org/10.1177/154193120004401107

Federal Aviation Administrain (FAA) (2020, September). National Plan of Integrated Airport Systems 2021-2025. https://www.faa.gov/airports/planning_capacity/npias/current/media/NPIAS-2021-2025-Narrative.pdf

FAA (2017, December 13). Operational Safety on Airports During Construction. AC 150/5370-2G. https://www.faa.gov/documentLibrary/media/Advisory_Circular/150-5370-2G.pdf.

FAA (2012, June). Human Factors Acquisition Job Aid.

Federal Aviation Administrain (FAA). (n.d.). RWS search form. http://www.asias.faa.gov/pls/apex/f?p=100:28:0::NO:28::

Glazner, J., Bondy, J., Lezotte, D. C., Lipscomb, H., & Guarini, K. (2005). Factors contributing to construction injury at Denver International Airport. *American Journal of Industrial Medicine, 47*(1), 27-36.

International Civil Aviation Organization (2012). *Safety Management Manual (SMM)*. Doc 9859. Third Edition.

Li, Y., & Bai, Y. (2009). Highway work zone risk factors and their impact on crash severity. *Journal of Transportation engineering, 135*(10), 694-701.

Kennedy, J. (2016). Dublin Airport's runways are now on Google Street View. Retrieved February 11, 2017, from https://www.siliconrepublic.com/play/dublin-airport-street-view

Khalafallah, A., & El-Rayes, K. (2008). Minimizing construction-related security risks during airport expansion projects. *Journal of Construction Engineering and Management, 134*(1), 40-48.

Khalafallah, A., & El-Rayes, K. (2006). Minimizing construction-related hazards in airport expansion projects. *Journal of Construction Engineering and Management, 132*(6), 562-572.

Mollaoglu, S., Sparkling, A. E., Garcia, A., & Polkinghorn, B. D. (2021). Collaborative Partnering for Airport Construction Projects: State-of-Practice. *Journal of Management in Engineering, 37*(3), 04021003.

OTW Safety (2020). The invention of Low-Profile Airport Barricades. https://otwsafety.com/blog/low-profile-airport-barricades-invention/ .

Saha, P. (2020). An optimization model to determine an appropriate budget for improving work zone safety. *IATSS Research*.

Schrock, S. D., Fitzsimmons, E. J., Lindheimer, T., Wang, M. H., & Bai, Y. (2014). Work zone positive protection policy guidance: Synthesis of devices and state of practice. In *Transportation Research Board 93rd Annual Meeting* (No. 14-5574).

Stewart, C. (2001). Airfield Safety: Developing Operational Procedures and Schedules for Airside Construction Projects. In *Advancing Airfield Pavements* (pp. 309-321).