

Airlines today want shorter turnaround times at airports and zero ground accidents — aiming for ever more efficient ground-handling operations without compromising safety. Yet time pressures and associated factors they experience when handling an aircraft within the scheduled turnaround time keep creating safety challenges on airport aprons.¹ According to Flight Safety Foundation's Ground Accident Prevention program, ground accidents cost the airline industry billions of dollars per year, and industry leaders recognize human error as the main cause of these losses.

The apron environment is complex and requires a thorough analytical approach to risk management — a systems approach. In 2006, Det Norske Veritas (DNV), an independent foundation in Norway that provides international risk-management consulting services to many industries, conducted a risk analysis of the ground handling of fixed-wing and rotary-wing aircraft on the aprons at the five major airports in Norway operated by Avinor: Bergen, Stavanger, Trondheim, Bodø and Tromsø.

Anders Sætre, Avinor's safety manager for large airports, commissioned this 2006–2007 analysis as a step

toward improving apron safety and to complement efforts to enhance Avinor's organizational safety culture. DNV analysts defined ground handling as limited to stand preparation, parking, handling and pushback operations.

Apron Risk Management

“The apron is one of the most dangerous workplaces in the world, and workers on the apron are faced with a lot of challenges,” Sætre said. “We want to do our best to prepare each airport to implement a safe and efficient ground-handling process. We initiated this project to ensure safe operations airside on

Apron safety teams help five airports in Norway to parlay apron-risk analyses into localized safety solutions.

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Under New Management





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the apron and, in addition, to support a parallel ongoing safety culture-enhancement program.”

DNV and Avinor were not interested in calculating the exact costs of apron damage — they already knew the amount was very large. Nor was the objective to identify people to blame for apron hazards; this has not been found to be effective in reducing risk in the long term. Such generic approaches do not reduce apron risk.

Instead, DNV analyzed the apron processes from a system perspective with regard to human behavior, organizational issues, technical solutions and the interactions among these elements to reduce apron risk — a semi-quantitative man-technology-organization (MTO) approach.² They also wanted to find out what could be done to enhance the efficiency of ground-handling operations. To accomplish this, several broad questions were posed. Who are the actors in the system? What kind of human errors are committed? When do these errors occur? Why are these errors being committed? How can we avoid errors?

To answer these questions, a bottom-up approach was applied by placing front-line airport operations personnel at the core of the risk analysis.

Summary of Results

The main objective was to use the risk analysis to identify mitigating measures to cope with hazards on airport aprons. The airports then were able to consider in their planning processes this set of identified hazards and proposed risk mitigations. The project was considered innovative and constructive, yielding broad associated benefits. The position of apron safety on the agenda of each airport has been confirmed. Ground-handling operations have been modeled in detail with respect to roles, responsibilities and tasks. The risk picture of ground-handling operations at each airport has been developed with respect to the spheres of authority of Avinor, airlines and ground handlers. “Ownership” of responsibility to address airport safety challenges has been established.

Also, risk-based collaboration and related communication have been established among stakeholders at each airport through apron safety teams (ASTs) that continuously pursue risk reduction at each airport; increase the stakeholders' understanding and awareness of each other's responsibilities and everyday challenges in enabling safer and smoother turnarounds; initiate sharing of experiences and best practices across the airports; and clarify lines of communication and responsibilities.

“By admitting stakeholders to participate in the risk analysis for this project, we have been able to improve our safety culture,” Sætre said. “Participants will be more conscious of the risks and needs for the mitigating processes — to live and work by them — and more competent in managing the risks related to ramp operations, and also have a better understanding of the reasons for having well-known and documented processes and procedures.”

Safety Challenges

DNV analysts first had to address the key reasons for a typically high risk level on the airport aprons. Their analysis showed that safety was being put at risk by the time pressures created during

the turnaround, with a large number of factors contributing to this risk level. A selection of the critical factors included lack of collaboration among the companies working on the apron; lack of communication among these companies; inadequate winter preparations and operations (snow clearance, ground deicing chemicals, sanding, etc.); and climate and/or rapidly changing weather conditions (wind, sun, fog, snow, rain, etc.).

Simultaneous apron activities occurring in the vicinity of aircraft; flight operations occurring close to parked aircraft; a mix of aircraft of different sizes, airframe designs and engine configurations; and a mix of ground vehicles (different in length, height, weight and function) were found.

Facility-related factors included inadequate design/layout of the apron; inadequate facilities (e.g., lack of designated parking spaces for trolleys/carts and vehicles, refuse bins for foreign objects, designated places for chocks, etc.); inadequate measures for ensuring the safety of an increasing number of passengers present on aprons (linked to the demand for shorter turnaround times); insufficient apron lighting, markings and signs; and diverse types of apron parking (terminal, remote parking, helicopter parking).

Other critical factors were inadequate flight information service for aircraft crews; inadequate training of all personnel involved in apron operations; stringent and complicated security regulations that may influence safety procedures; inadequate meetings and other safety information-sharing activities; and nonexistent contracts/agreements between stakeholder companies (e.g., Avinor and ground handlers).

Ownership Through Participation

Given that most errors, in one way or another, are committed by the humans who work on the apron, the overall picture is a mix of both direct and indirect causes. DNV set out to challenge these front-line operational experts by having them participate in a risk analysis performed as a number of steps. The first was to identify all stakeholders, ultimately including Avinor personnel comprising central and local management, air traffic services, ground services, and aircraft rescue and fire fighting services; ground-handling companies representing ramp handlers, fueling service providers, caterers and cleaners; and aircraft operators, represented by pilots.

The second step was defining system boundaries for apron-risk analysis. The

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physical area and related operations were limited to the aircraft parking stand; therefore, operations and activities on the maneuvering area (i.e., during landing, taxiing, movement outside the gate entry area and takeoff) were defined as outside the scope of this analysis.

The third step was to identify and model every stakeholder organization's daily operations and work by applying a work process breakdown analysis. The entire ground-handling process for airplanes was broken down into manageable parts — called process elements — which were analyzed separately. Analyses for rotary-wing aircraft also had to be performed.

Each main process element in the ground-handling work consisted of several activities. In each work process, a stakeholder organization deals with technical solutions, passengers and the environment. All these are exposed to risks due to human error.

To analyze the whole system, DNV addressed four risk categories: injury to ground-handling personnel; injury to boarding/disembarking passengers; damage to aircraft, fixed/mobile equipment on the stand or apron vehicles; and environmental damage — mainly, the release of fluids.

The analysis used a traditional risk matrix with five classes for both probability and consequence, with one matrix for each of the four risk categories. All the risks were registered using DNV's software-based risk management tool, EasyRisk, to simplify data retrieval, systemization and analysis. Using this tool, each airport monitors risks and identifies and classifies new risks as they arise. The classifications of the work process step hazards then were divided into three categories and given different colors: green for low risk, yellow for medium risk and red for high risk.

The third process step, preparing for ground-handling the aircraft; the fourth step, handling the arriving flight; the fifth step, handling the departing flight; and the sixth step, preparing for pushback/powerback/taxi out (Figure 1, p. 46) were the operational phases that contributed the greatest shares of the total apron risk. Common risk factors during these work process steps included intense activity in close proximity to the aircraft being handled, the relatively large number of personnel simultaneously involved, and parallel diverse activities within the short turnaround time.

The analysis enabled numerous hazards to be identified and classified for the various work process steps using knowledge of the front-line subject matter experts. The same hazards could occur in several process elements, but with different classifications of probability. The same methodology could be used independently of airport size, geographical location or type of airport.

Identification and classification of hazards were based on DNV's information-gathering and analysis from 21 on-site workshops over 18 months. Three separate workshops — one on hazard identification, one on risk classification and one on identification of risk-reducing measures — were held at all five airports. The remaining six separate workshops covered apron safety for rotary-wing operations, with three each at Bergen and Stavanger.

Risk Mitigation

Another important result of the analysis was the identification of risk-reducing measures. This task was organized with the purpose of providing plans for how Avinor — alone or in cooperation with stakeholders — could make the ground-handling process safer and more efficient. The Avinor



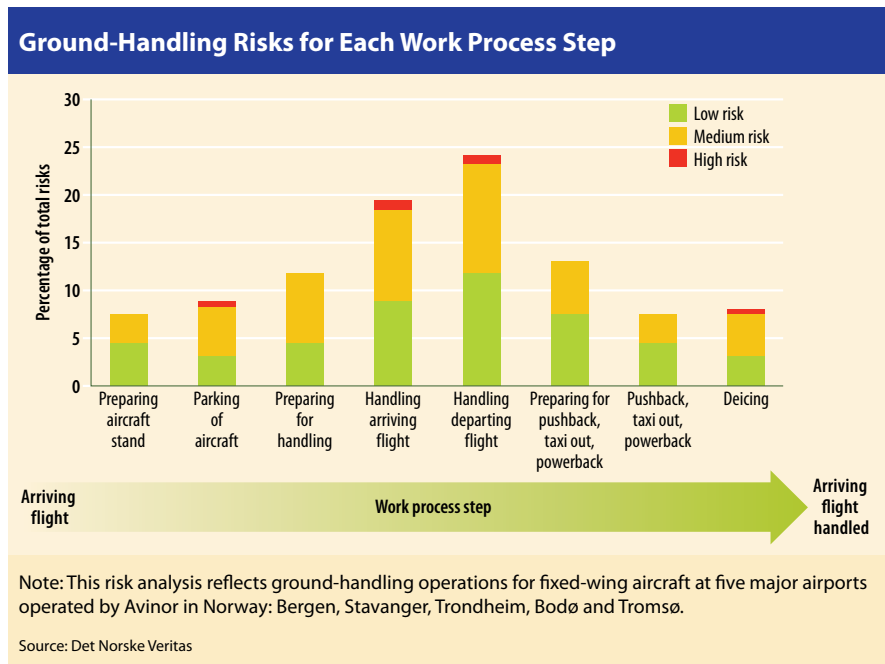


Figure 1

safety manager at each airport became responsible for further implementation of the defined risk-reduction measures.

Identifying risk-reduction measures beyond Avinor’s scope of responsibility as airport operator, however, was not part of this analysis. Nevertheless, ground-handling agents and airlines — fixed-wing and rotary-wing operators — were encouraged to use internally the reports as a basis for similar evaluations. The DNV analysis identified several hundred measures.

Several airport-specific measures were implemented. A driving path was reconstructed to make sure fuel trucks are not in conflict with personnel, passengers or rotary-wing aircraft at Bergen Airport Flesland. The rotary-wing ground-handling process was changed at Stavanger Airport Sola. Steps were taken for rebuilding Terminal B at Tromsø Airport. A lift was installed in Terminal A for transportation of persons with reduced mobility at Trondheim Airport Værnes. And, airside garbage-handling routines were established to avoid

foreign object debris being ingested into jet engines at Bodø Airport.

Other mitigating measures common to multiple airports were:

- Winter marking of lane lines for airplane stands and the deicing platform;
- Re-marking of stands and modification of terminal buildings due to the introduction of airplanes with winglets;
- Establishing routines to avoid simultaneous parking/handling of aircraft at adjacent stands;
- Providing designated areas for storing ground-handling equipment;
- Providing first aid equipment at each stand;
- Establishing routines for distributing information among airport personnel;
- Promoting routine collaboration among Avinor, airlines and ground-handling personnel for

more safe and efficient operations on the apron;

- Further developing e-learning courses for new employees with input from experienced employees;
- Establishing an overall sign and marking plan at each airport to comply with Norwegian and international rules and regulations;
- Better adjustment of lighting on the apron — e.g., more light in dark areas, reduced temporary blinding of pilots on the flight deck; and,
- Fluorescent marking of vehicles, chocks, cables, electric pylons, etc., to increase conspicuity in all light/weather conditions.

Apron Safety Teams

To achieve safer operation of airports, other forums and discussion arenas had been in place at Norway’s airports — for example, runway safety teams, airport safety committees, winter operations teams, etc. As a result of the DNV analysis, however, the need for another forum dedicated solely to apron safety became evident.

Among all the steps taken after the analysis, the introduction of an AST was regarded as the most significant. The AST was envisioned as a way to continue communicating about apron risks and collaborating using risk-analysis methodology.

“The implementing processes will have a great impact on safety culture and future safety levels on the aprons in Norway — especially using apron safety teams as one of our tools for achieving this at all airports,” Sætre said.

For proper management of ASTs, input and feedback from the apron operational personnel have been essential. Managers need direction and knowledge from them on how to succeed. If this

input is not received, it is difficult or even impossible to know the changing challenges and needs of the operational personnel. This may lead to dissatisfaction and distrust of the management, of the different companies, and the airport as a whole, and subsequently to higher risk.

To a large extent, airport management teams worldwide have established paper and/or computer-based systems for operational personnel to report accidents and incidents. But the reporting has not been comprehensive, leaving management without sufficient input for guidance. The persistence of this issue was confirmed by the DNV analysis. There are several reasons for such systems not to work as intended — for example, problems in the airport's safety culture, fear of losing jobs, not knowing current reporting routines (how to report, what to report), not enough time, etc.

Relying on this type of feedback for communication between management and staff may not be the optimal solution. A closer, more direct form of communication has proven necessary. Face-to-face meetings dealing with all aspects of safety make it possible to address more effectively problems that may arise.

Gaining Experience

Stavanger Airport Sola already has gained experience using the AST concept since its implementation in March 2008. "We want to transfer the good dialogue between the stakeholders at the airport that was established through the risk analysis," said Pål Ranestad, the airport's safety manager. "A common forum for operational personnel working on the apron will have a good effect on safety, enabling an increased understanding of the stakeholders' daily work and challenges."

A mandate for two ASTs through a specific procedure — designated as AST-F and AST-R, for fixed-wing and

rotary-wing aircraft, respectively — already has become an integral part of this airport's local regulations.

Participants in ASTs preferably should have operational experience — for example, in the case of Avinor, management and operational personnel from the airport operator; representative(s) from handling agents, catering, cleaning and fueling; and pilots from the fixed-wing aircraft and rotary-wing aircraft companies that use the airport.

"The initiatives resulting from the DNV risk analysis were very well received by the participants, as an AST had been requested by the various stakeholders for some time," said Ranestad.

Each AST has, among other responsibilities, the standing assignment to prepare a report based on the advice and proposals identified in meetings with the airport manager. The team members also are expected to propose measures within their own organizations. Each AST also is charged with the following tasks:

- Development of action plans for apron safety;
- Collection, analysis and dissemination of information about apron safety;
- Determination of whether the apron has adequate signs and markings, including whether these are visible for the drivers of apron vehicles, and proposing any relevant changes;
- Collection of information from operators and personnel related to airport conditions that may have a negative effect on apron safety, and proposing measures and actions to increase the level of safety;
- Review of safety-related occurrences, proposing risk-reduction

measures and ensuring transfer of experience across the stakeholder organizations; and,

- Serving as a hearing body in any cases, projects, processes or changes affecting apron safety. This includes, for example, changes in procedures, signs, markings and lighting during airport construction projects; acquisitions; and implementation of new technology at the airport.

"Shorter turnaround times demand faster and simultaneous operations," Ranestad concluded. "The challenge is to establish a smooth turnaround process that enables both parallel and sequential operations without compromising safety and regularity. Safety culture is built through proper forums for operational personnel. I see the apron safety team as the tool to communicate and contribute due to team members' standing as subject matter experts. I highly recommend that all airports establish an apron safety team." ➤

Notes

1. The International Civil Aviation Organization defines apron as "a defined area, on a land aerodrome, intended to accommodate aircraft for purposes of loading or unloading passengers, mail or cargo, fueling, parking or maintenance."
2. MTO essentially is a system-oriented analytical concept in human factors engineering that has been applied by Swedish nuclear regulators and by other industry safety models.

About the Authors

Magnus Bjelkerud and Espen Funnemark, both DNV senior consultants, in 2006 and 2007 conducted the apron risk analyses of the ground-handling operations at five Norwegian airports. They thanked Anders Sætre and Pål Ranestad of Avinor and DNV colleagues for their contributions to this article and reviews.