Runway Incursion Joint Safety Analysis Team (JSAT)

Results & Analysis
August 11, 2000

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1. EXECUTIVE SUMMARY

The Commercial Aviation Safety Team (CAST) and the General Aviation Joint Steering Committee (GAJSC) are the sponsors of this joint commercial and general aviation Runway Incursion Joint Safety Analysis Team (RI JSAT). The RI JSAT was chartered by the CAST to review and analyze accident and incident data for the purpose of developing and recommending intervention strategies that will reduce the potential for runway incursion events. This report summarizes the analysis and results of the RI JSAT.

The process used by the RI JSAT is similar to that of previous JSATs in that it combines a detailed case study methodology, a high-level data analysis, and expert judgement. The detailed case study employs an event-sequence analysis, whereas the high-level approach involves statistical data and data from other sources. In addition to being the first joint CAST/GAJSC JSAT, the primary difference between this JSAT and previous JSATs is the significant number of incident reports included in the data analysis. The experienced and diverse membership of the JSAT provides for the expert judgement. In its process, the RI JSAT used the detailed and high-level data analysis to develop specific intervention strategies, and then relied on its members' expert judgement to group related interventions. Because no single intervention strategy can provide a comprehensive solution, these groupings of related interventions are necessary in order to address the complexities of aviation accidents. Since related interventions complement and enhance each other, their combined effect provides greater safety leverage and addresses the underlying problems more effectively than any single intervention.

In a general review of all the reports analyzed, the JSAT concluded that many, if not all, of the events which occur in a sequence of events associated with an accident or incident classified as a runway incursion will also be found in reports of incidents which are not classified as runway incursions. These latter reports are not officially classified as runway incursions only because there may not have been a conflict with an aircraft using that runway or they occurred at a non-towered airport. However, many of these reports contain valuable data, which can be analyzed for the purpose of preventing runway incursions. Therefore, for purposes of gathering reports for its analysis, the RI JSAT has defined a report of interest as "Any report of an occurrence at a towered or non-towered airport, involving an aircraft, vehicle or pedestrian within the runway safety area, that creates a real or potential collision hazard with an aircraft taking off, intending to takeoff, landing or intending to land."

During the initial evaluation of the various data sets identified as having potential value to the RI JSAT the following facts were identified:

➢ There is no standard definition of a runway incursion event across these data sets.
➢ There is no standard analysis methodology across these data sets.
➢ Within the data sets there is a wide disparity in data detail between reports, which make up the data set.
➢ Many of the data sets had to be entirely eliminated for consideration by the RI JSAT due to a lack of data necessary to follow the CAST data analysis process.

➢ Some of the data sets selected for use by the RI JSAT were found to contain reports of events that lacked sufficient data for analysis purposes.
➢ Within the FAA data sets there is a significant difference in the amount and quality of information. Further, different analysis techniques are utilized by the agency.

Based on the CAST methodology, the RI JSAT has developed the following categories of recommendations. These recommendations represent the most effective broad-base actions to reduce the number of runway incursion accidents and incidents. All recommendations require the regulators to participate actively. However, because the RI JSAT reviewed historical data, some intervention strategies are in the process of implementation. Such participation may include developing technical standards, approving procedures, or overseeing implementation. In addition to the regulators, each of the following recommendations identifies other members of the aviation community that must take action if the recommendation is to be fully implemented. These eight groups of interventions are presented in a non-prioritized order and include the most significant recommendations derived from data analysis for each group. There are also 4 categories of recommendations derived from the groups expert opinion (pages 10&11) see Appendix D for the listing of all intervention strategies.

1. Training

The importance of training all the participants in the aviation/airport environment cannot be overstated. In order to increase the effectiveness of individual, team and scenario training and to reduce the safety risk involved in on-the-job training:

1.1 ATC

➢ Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators. (Future)(770)
➢ Airlines/operators and FAA/air traffic service providers should increase training for pilots and controllers on progressive taxi instructions. (Near Term) (701)

1.2 Pilot

➢ Airlines/operators[1] should ensure that their training/standardization programs emphasize the importance of adequate preflight planning. (Near Term)[2] (113)
➢ Airlines/operators and FAA/air traffic service providers should increase training for pilots and controllers on progressive taxi instructions. (Near Term) (701)

2. Situational Awareness (Environment)

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[1] The RI JSAT uses the word "operators" to define all other categories of aircraft owners and operators which are not airlines.
[2] Near term = can be implemented within 3 years; Mid-term = can be implemented within 3 to 5 years; Future = can be implemented within 5 or more years

Due to the fast-paced and complex operating environments surrounding surface movements, including takeoffs and landings, all participants in the operation must maintain a high level of situational awareness at all times.

2.1 ATC

➢ Air traffic service providers shall immediately develop and implement national standard operational procedures for tower positions to ensure uniform, effective and sustained situational awareness practices relating to surface operations. (Near Term) (707,709)

2.2 Pilot

➢ Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft position. (Near Term) (47, 75, 710, 712, 711)

3. Procedures

3.1 ATC

Appropriate, unambiguous, and effective ATC procedures that effect ground operations are essential for preventing unsafe surface operations from occurring.

➢ The FAA shall immediately initiate the regulatory and procedural process needed to delete the last sentence in the current FAR 91.129(i)[3]. (Near Term) (717)
➢ To assist the pilot, ATC taxi instructions should identify all runway crossings required to reach the clearance limit. (Near Term) (718)
➢ The FAA should review "Reduces Separation of Final" and LAHSO procedures including critical analysis of risk, methods of ATC technique training, and local implementation to determine the effect on surface movements and runway incursions. (Near Term) (719, 720, 721)
➢ Regulators should review multiple landing clearance procedures including critical analysis of risk and methods of ATC technique training. (Near Term) (716)

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[3] This sentence reads, "A clearance to "taxi to" any point other than an assigned takeoff runway is clearance to cross all runways that intersect the taxi route to that point."

3.2   Pilots

Studies have shown that procedural non-compliance is a highly significant problem in accidents and incidents. The RI JSAT also found that the development, implementation, training, and use of standard operating procedures (SOPs) are all equally important elements of this problem. The RI JSAT believes that a template for SOPs for ground operations should be developed. Specifically:

➢   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions. (Near Term) (729, 99, 110, 342)
➢   Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (Near Term) (82, 17, 727, 728)
➢   Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices. (Near Term) (95, 207, 730)
➢   FAA should include a recommendation in the AIM for Part 91 operations to use "sterile cockpit" procedures that are intended to focus attention on ground. (Near Term) (731, 732, 733)

4.   Equipment/Facilities

There are many technology applications which, if applied properly, could significantly reduce the potential for runway incursions.

4.1   ATC

Technology can raise controller situational awareness (SA) or mitigate the consequences of a loss of situational awareness.

➢   FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e., AMASS, SMA, ATIDS (tags). (Future) (735, 736, 737)

4.2   Aircraft

Heads-up guidance systems (HGS), graphic cockpit displays that include taxi route and clearance limit, and an alerting device to warn of deviations from a taxi clearance would reduce runway incursions.

➢ Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles. (Mid Term) (734)

➢ Air traffic service providers, airlines/operators, and manufacturers develop and install anti-blocking technology for voice communications. (Mid Term) (738)

➢ Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits. (Future) (740, 739, 741).

➢ Regulators and industry should ensure that new technologies implemented to prevent runway incursions include: proper annunciation of equipment failures or incorrect settings; design logic that reduces nuisance warnings; and the ability to annunciate impending system failures. (Future) (45, 438, 738, 103)

➢ Regulators require air carrier aircraft be equipped with an operational taxi light to adequately illuminate the surface area immediately ahead of the aircraft without "blinding" other pilots. (Future) (742, 743)

4.3 Airports

Airports can use a blend of new and existing technologies to improve pilot and controller situational awareness.

➢ Regulators and airport operators develop and install lighting to indicate runway exit and taxi route. (Mid Term) (744, 742)

➢ Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway. (Mid Term) (745, 753, 754)

➢ FAA should require implementation of SMGCS plans at airports during low visibility (RVR<1200) operations. (Near Term) (750)

➢ Regulators and airport operators develop and install runway vacated guidance. (Mid Term) (746, 747)

5. Controller/Flight Crew Resource Management (CRM)

The JSAT considered CRM skills important for both ATC controllers and pilots.

5.1 ATC

➢ Air traffic service providers should develop and implement an Air Traffic Control Resource management (ATCRM) program. (Near Term) (757)

5.2 Pilot

➢ Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b). (Near Term) (308, 758, 759)

➢ Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PN and PNF tasks. (Near Term) (135)

6. Safety Cultures

When airline/operator culture is an issue, safety appears to compete with other operational factors, like on-time departures and arrivals or ATC system capacity.

➢ Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture). (Near Term) (143, 22)

COMMUNICATIONS

7. ATC/Pilot/Vehicle Communications

Several accidents/incidents resulted from inadequate or misunderstood clearances between ATC and the flight crew, including phraseology, readback, and hearback problems.

7.1 ATC

➢ Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology. (Mid Term) (42, 106, 760, 763, 241, 765, 766, 762)

7.2 Pilot Vehicle Operator

➢ To reduce the possibility of error, confusion and workload increase related to ATC clearances, regulators should require and operators should ensure that flight crews utilize proper phraseology and readbacks. (Near Term) (240, 761, 88, 764)

7.3 Datalink

Use of Datalink for ATC instructions and clearances could significantly improve ATC/pilot/vehicle communications and reduce incidents related to inadequate or misunderstood communications.

> Air traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications. (Future) (122, 28, 94)

8.   <u>Human Physiological Limitations</u>

Human physiological limitations can be a causal factor in runway incursions.

    8.1   Air Traffic Service Providers:

> Air traffic service providers should review requirements for the training and use of memory aids in the tower. (Near Term) (767)
> Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities. (Near Term) (768)
> Regulators should create and promote to air traffic service providers a list of best controller practices for memorization and distraction management. (Near Term) (769)

    8.2   Pilots:

> Airlines/operators should ensure that flight crews are trained in operations involving low light and poor visibility on wet or otherwise contaminated runways, and with the presence of optical and physiological illusions, before they are assigned line duties. (Near Term) (312)
> Regulators should update flight time/duty time regulations to counteract present commercial aviation environmental stressors. (e.g. crew rest requirements). (Near Term) (315)

The following list of recommendations, presented in non-prioritized order, was developed through use of the experience and expert judgement provided by the diverse membership of the JSAT.

1.   <u>Data</u>

During the RI JSAT process, it became apparent that standardized data collection, analysis, and dissemination processes would have to be utilized in order to develop the most effective intervention strategies for the prevention of runway incursions.

> FAA/Industry should define standard data requirements for reports of events, which may be classified as runway incursions.
> FAA/Industry should define standard data analysis methodologies for reports of events that may be classified as runway incursions.

> ➢ FAA/Industry should adopt the portion of the CAST-approved data analysis process which includes event sequences, problem statements and intervention strategies in order to satisfy the aforementioned recommendation.
> ➢ On an interim basis, or until the above recommendations are satisfied, the runway incursion reporting program recommended by CAST to FAA should be employed (see Appendix H).

The RI JSAT recognized the value of employing the National Aviation and Space Administration's (NASA) Aviation Safety Reporting System (ASRS) to provide the detailed information needed for report analysts determine causal factors. A plan to so employ the ASARS was discussed but not implemented during the course of the JSAT. The RI JSAT supports use of the NASA ASRS Program for the purposed of runway incursion reporting by all parties (flight crews, air traffic controllers, vehicle operators, and pedestrians) involved in an incursion. The ASRS system has been in place for many years and is operated by aviation safety experts. Numerous additional benefits would be realized:

> ➢ Those involved in an incursion would be far more likely to participate providing details of the event without fear of reprisal.
> ➢ Analysis coordination of information from all group of participants would be possible.
> ➢ This method would result in maximum use of resources at the lowest cost thus eliminating the need for additional employees to perform interviews and administrative tasks.

The FAA should utilize the NASA ASRS facility to perform and analyze runway incursion reports submitted by flight crews, air traffic controllers, vehicle operators, and pedestrians involved in the reported incursion.

2.   ATC Supervision

Leadership is an integral part of any team and the importance of good supervision within the workplace cannot be overlooked. Persons providing supervision must be operationally competent. They should stay situationally aware in order to make timely flow and staffing decisions to avoid excessive workload and disruptions.

> ➢ The FAA should examine and refine the roles and responsibilities of supervisory positions in order to ensure direct and unimpeded oversight of the ATC operation.
> ➢ The FAA should ensure that facility managers provide the necessary support to persons providing supervision to fulfill their responsibilities.

3.   Runway Incursion Awareness Campaign

> ➢ Experience has demonstrated that short-term reductions in the number of runway incursion events can be achieved through awareness campaigns directed at pilots, controllers, and vehicle operators.
> ➢ FAA/industry should embark upon a multi-faceted awareness program that focuses on safe airport surface operating practices.

4. Airport Capacity

Although runway incursion incidents and accidents have occurred at low density airports, the majority of serious incidents or fatal accidents occur at locations that have capacity issues. The JSAT believes that FAA and the industry should address airport capacity as one of the key influencers in increasing runway safety.

Radio frequency congestion at high density traffic airports is mentioned by pilots and controllers as a factor in creating confusion and diminished situational awareness. The inability to verify clearances and read back/hear back errors are symptoms of airport capacity problems. Analysis of runway incursion data indicates that airport configuration is a major incursion factor, especially where aircraft are required to cross runways to and from the terminal.

2. BACKGROUND AND INTRODUCTION

The worst aviation disaster on record worldwide occurred as a result of a runway incursion in 1977 at Tenerife, Canary Islands, Spain, when two B747s collided, causing the loss of 583 lives. Since 1990, there have been five fatal runway incursion-caused accidents involving commercial airline aircraft – each of these events received extensive media coverage and caused public debate about the safety of U.S. aviation. Hundreds of runway incursions occur each year in the U.S., most of which involve no damage to aircraft or vehicles nor injury or loss of life. However, when a runway incursion occurs, a loss of separation or collision hazard between two aircraft or an aircraft and a vehicle or pedestrian, has taken place at an ATC-controlled airport. The fact that no collision resulted does not diminish the need to address the seriousness of these surface deviations.

The FAA defines a runway incursion as "Any occurrence at an airport involving an aircraft, vehicle, person or object on the ground that creates a collision hazard or results in a loss of separation with an aircraft taking off, intending to take off, landing, or intending to land." [4]

The FAA counts three distinct types of events as incursions when they transpire at FAA-towered airports, where specific separation rules are applicable and enforced. Those events are: pilot deviations (PDs); operational errors (OEs, or controller errors); and, vehicle/pedestrian deviations (VPDs). FAA officially recorded 322 runway incursions in CY 1999, none of which resulted in an accident.

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[4] 1998 Airport Surface Operations Safety Action Plan to Prevent Runway Incursions and Improve Operations, p. 3.

Since the publication of its first Runway Incurison Plan in 1991, the FAA has devoted considerable resources to reducing the potential for incursions. That plan, and amendments to it, published in 1993, 1995 and 1998, details numerous projects and programs designed to reduce the potential for runway incursions. Other FAA and industry initiatives aimed at addressing runway incursions have included: the Runway Incursion Task Force conducted in 1990-1991; Mitre Corporation studies on incursions based on interviews with pilots and controllers (1993-1998); the Research, Engineering & Development Advisory Committee's Subcommittee on Runway Incursions (1998-1999); and numerous Runway Incursion Action Teams at the local airport level conducted since 1991.

Creation of the RI JSAT

The Commercial Aviation Safety Team (CAST) chartered the Runway Incursion Joint Safety Analysis Team (RI JSAT) October of 1998 and its revision April of 1999 (reference Appendix A). The RI JSAT was the third one chartered; CAST had previously chartered a JSAT for accidents involving controlled flight into terrain and another one for approach and landing accidents. Similarly, the Joint Steering Committee for General Aviation had chartered a JSAT for accidents involving controlled flight into terrain and another one for weather accidents. Because of the differences in flight operations, separate JSATs were conducted for commercial and general aviation accidents involving controlled flight into terrain.

Given the substantial history of joint government and industry efforts to examine the incursion problem and make recommendations pertaining thereto, one of the initial concerns expressed by some RI JSAT members was whether this effort was actually needed. A consensus quickly developed, however, that this effort should be more valuable than previous exercises for three principal reasons: (1) it would be based on a detailed analysis of incidents and accidents, unlike other less academic examinations of the incursion problem, (2) it would necessitate government and industry agreement on needed improvements, and (3) the interventions agreed to should be effective in reducing the potential for incursions since they are developed from analysis of actual events.

Another area of initial concern was the FAA definition of incursions, which is stated above. If this definition was used by the JSAT, it would of necessity exclude those events which occurred at non-towered airports and those in which there was no loss of separation or no collision hazard, but a deviation had occurred. In lieu of writing a new definition, and after discussion both internally and with CAST, the JSAT decided to review those events meeting the following criteria: any occurrence at a towered or non-towered airport, involving an aircraft, vehicle, or pedestrian within the runway safety area, that creates a real or potential collision hazard with an aircraft taking off, intending to take off, landing, or intending to land.

JSAT Differences

There are notable differences between this JSAT and previous ones. It is important that the reader be aware of these differences since it affected the charter of this JSAT, the data that was analyzed in this

effort, and, ultimately, some of the intervention strategies that were developed. These facts are elaborated upon elsewhere in this report.

This JSAT was the first to look at incidents and accidents of both commercial and general aviation aircraft. This approach was reasonable because the accidents examined by the previous JSATs each involved a single aircraft; consequently the accident aircraft was either a commercial aircraft or a general aviation aircraft. By contrast, this JSAT examined events that involved, or could have involved, two aircraft. This resulted in the possibility that both aircraft were commercial operators, or both aircraft were general aviation operators, or one aircraft was a commercial operator while the other was a general aviation operator.

Each of the previous JSATs had numerous accidents to review to determine which would be selected for extensive analysis and determination of causal factors. By contrast, this JSAT could only identify 34 runway collision accidents in the United States during the period of 1990 through 1997. Only five of these 34 accidents involved at least one commercial aircraft, but all five involved fatalities. The remaining 29 accidents each involved two general aviation aircraft. Only two of these 29 accidents involved fatalities. Of the 34 accidents, 27 occurred at airports without operating air traffic control towers.

Because of the limited number of accidents, the JSAT decided to expand its analysis to include incidents that could have been potential collisions. The incidents used for analysis were based upon information contained in the FAA's pilot deviation data base, the FAA's operational error data base, and internal reports made by pilots of individual airlines.

Limitations and other particulars on the accident and incident data used by the JSAT are discussed further in Section 3 of the report.

General Aviation and Commercial Aviation Events

The JSAT was chartered to examine both commercial and general aviation accidents, thus making it the first joint CAST/GAJSC JSAT. However, all the direction to the JSAT came from the CAST. The Joint Steering Committee on General Aviation was given an opportunity to provide a co-chair for the JSAT but decided not to make such an appointment. Although it did not have a general aviation co-chair, representatives of the general aviation community served as valuable members of the JSAT.

The CAST direction, coupled with the limited number of fatal accidents involving two general aviation aircraft, resulted in the JSAT having a predominant focus on commercial aviation. Although the general aviation operator may benefit from some of the JSATs intervention strategies and recommendations, many are oriented to the commercial and business operators and may not be applicable to the light general aviation aircraft community. It is envisioned that the JSIT will determine the segments applicable to the various segments of the industry.

Relationship of the JSATs work on FAA's efforts to reduce runway incursions

Implementation of the JSATs intervention strategies and recommendations should result in a reduction in events that the FAA classifies as runway incursions. However, there are some aspects of runway incursions that may not be affected by the JSATs work.

The FAA's data reveals that most runway incursion incidents resulting from pilot deviations occur during the day in VMC weather. By contrast, runway incursions resulting in accidents occur primarily at night and/or in periods of reduced visibility. (Four of the five accidents involving commercial operators that the JSAT analyzed occurred at night or in reduced visibility. Operational surveillance surface radar was not available for all five accidents.) Many of the incidents that were analyzed by the JSAT occurred during daytime, visual meteorological conditions.

The FAA's runway incursion database also includes incidents involving aircraft, vehicles and pedestrians. However, FAA data on vehicles and pedestrians was judged not to be useable due to the inadequacy of that information to determine what happened and why. In the course of reviewing operational errors, the JSAT did review some events that involved vehicles, and the group developed one intervention strategy that is directed at vehicle operators. Regardless, some of the JSATs intervention strategies and recommendations are so broad in scope that, if implemented, they may also reduce the risk of incursions by vehicle operators and pedestrians.

3. DESCRIPTION OF THE ANALYSIS PROCESS

The JSAT followed the Process for Conducting Joint Safety Analysis Teams, Revision A. Additional refinements were developed to yield a better, more robust effectiveness evaluation and to provide the JSIT with additional information about the relative strengths and weaknesses of each intervention.

The JSAT charter calls for the inclusion of incident data in the JSAT analysis. Furthermore, accidents are rare and cannot be considered as a representative sample of routine operations. A critical assumption in the JSAT approach has been the notion that the problems underlying accidents' unique events are in fact common problems, and that resolving these problems will lead to the prevention of incidents as well as accidents.

The JSAT methodology analyzes a limited number of accidents/incidents in great depth in order to document and gain a rich understanding of complex causal chains that cannot be obtained when working with automated databases and discrete data fields. However, to achieve this information, the methodology sacrifices the statistical inferences that can be gained from analyzing a much more broadly based but somewhat static data set.

The RI JSAT created four subgroups to analyze different data sets (see Appendices B, H and I). Each of the four subgroups developed a common event sequence database along with associated characteristics and indicators for each of their assigned reports. Each event in the database was analyzed to determine if it contained sufficient information to determine the event cause. Problem statements were formulated for those events determined to have contributed to the accident. The

problem statements were then analyzed for their contributing factors and potential intervention strategies were developed to address the associated problems. A detailed explanation of each of the above process steps is given below:

- An **event sequence** is a timeline of the events leading up to an accident or incident. An event is defined as a decision made (by the crew, ATC, regulators, etc.), an action taken (or omitted), a system or equipment failure, etc., that contributed to the accident or incident or helps explain the situation. The event sequence is used to structure the review and analysis of the selected accident and incident reports. It also serves to bring all the team members to a common understanding of what occurred.

- The **characteristics/indicators** contained in the JSAT Master Collector Document of Problem Statements, Interventions, and Characteristics/Indicators (MCD) was used as a guide by this JSAT. It was determined that this list contained items of little or no value for ground operations (e.g., weather radar equipped) and was missing items that are of value (e.g., airport signage quality). As a result, each Group of the RI JSAT reviewed the MCDs list of characteristics/indicators and proposed RI JSAT-specific changes. The recommendations were consolidated and a RI JSAT list of characteristics/indicators was developed. Each event was then analyzed and the characteristics/indicators were listed.

- **Problem statements** are defined as those statements that describe what went wrong and why it went wrong; that define an overall deficiency, or that describe a potential reason something did or did not occur. Problem statements could reflect inappropriate crew responses, equipment failures, maintenance or ATC errors, latent failures in management, policy or procedures at the organization or regulatory agency level, etc.

  Events that contributed to the accident or incident were assigned a Standard Problem Statement from the MCD. If a problem statement could not be applied, a new Problem Statement was developed and included in the RI JSAT-specific list of problem statements.

- **Contributing factors** are defined as elements of events that influence the crew's environment and/or personal lives that help shape the basic makeup of a defined problem. Contributing factors for a given problem statement, when taken together, provide the basis for an explanation of "why" the inappropriate response was made or the latent failure occurred or developed. Thus, contributing factors identify what can be fixed or modified and, if specific enough, can provide excellent guidance on how to go about fixing the problem (i.e., developing an intervention strategy).

- **Intervention strategies** are designed to prevent or mitigate a given problem or contributing factor. The group looked at each problem statement and either assigned a standard intervention strategy or wrote a new one. One or more interventions were identified for each problem statement and/or contributing factor. The intervention strategies followed the conventions established by the JSAT Process Handbook.

Evaluation of Intervention Effectiveness

Per the process document, the JSAT prioritized the intervention strategies as they were proposed in order to assist the industry and the regulatory agencies in determining the most advantageous courses of action to take. The group followed the conventions of the JSAT Process Handbook in formulating the priorities of the intervention strategies to determine the overall effectiveness of each strategy. This process allowed evaluating the effectiveness of interventions at four levels:

- Against specific problems or contributing factors within an accident/incident
- The effectiveness of the intervention with respect to the accident/incident as a whole
- The overall effectiveness of the intervention with respect to the entire accident/incident data set
- Across all JSAT data sets

The following three rating factors were developed to prioritize the interventions: Power (P), Confidence (C), and Future Global Applicability (A).

Power: This factor indicates the degree to which implementing the intervention would have prevented the particular accident, if everyone/everything performed as the intervention intended.

Confidence: This factor relates to the JSATs expectations that everyone and everything would perform as intended. The Confidence factor brings in an assessment of the real world, where interventions do not always have the desired effect.

Future Global Applicability: This factor indicates how frequently the problem(s) being addressed by the specific intervention will continue to be present in future operations. The Applicability factor provides a bridge from the specifics of the particular accident being analyzed to expected future operations.

Each sub-team used these factors to rate their interventions. Through expert judgment and consensus, the interventions were numerically rated against each factor. Initially no attempt was made to rank or order the interventions. To be consistent with other sub-teams' assessments and to utilize the entire JSAT membership expertise, the JSAT conducted a final P/C/A evaluation in which each sub-team presented its P/C/A ratings to the entire JSAT. Any questions concerning ratings were openly discussed until a JSAT consensus was reached. Applicability ratings did not include any consideration for frequency of use for each intervention. Subsequently, the JSAT adjusted applicability based on the number of times each intervention was used. Higher frequency raised applicability; lower frequency reduced applicability. After agreeing upon the P/C/A ratings for each intervention, a mathematical formula was applied to determine overall effectiveness.

Due to the large variation in the number of incidents analyzed by each group, using frequency to modify applicability will skew the overall effectiveness calculation for interventions derived from small data sets: i.e., small data sets produce lower frequencies of interventions and, consequently, lower global applicability values. Although the applicability adjustments based on frequency only affected a few

interventions, these displacements in overall effectiveness could downgrade critical strategies. This is especially true of small but "rich" data sets, such as NTSB accident data. Adjusting applicability up or down according to frequency assumes the frequencies and associated applicability values are statistically significant. Further, since applicability is an attempt to quantify future relevance, adjusting applicability for frequency assumes future accidents and incidents will conform with the data analyzed. This may not be a valid assumption. Since the statistical significance was not tested, using frequencies to adjust applicability is an educated guess. Users should consider these effects when evaluating relative overall effectiveness values.

To organize the intervention strategies and assist in the development of recommendations, the team developed functional categories and assigned interventions to categories. Within each category, interventions were grouped for synergy and prioritized by overall effectiveness. Based on the above, recommendations were formulated to mitigate runway incursions.

4. SELECTION AND ANALYSIS OF DATA

This JSAT is the first to have analyzed incident data; the previous two efforts (namely, the CFIT and Approach and Landing JSATs) relied on well-documented accident reports. The reason for using incident data is two-fold: there are only five NTSB "blue book" accident reports from 1990-1999 which pertain to runway incursions; secondly, the FAA records hundreds of these events each year, most of which do not result in harm to either people or aircraft. These incidents are, however, a very useful "barometer" of the safety of ground operations in this country that cannot be ignored.

CASTs guidance for conducting JSATs is aimed at the successful review and analysis of well-document accident reports. As such, this group was required to develop analytical procedures and methods for incidents that had not been previously considered. Contained in this report are recommendations to CAST for amending its Process document for the benefit of future groups that analyze incidents.

The JSAT reviewed data from several different sources, as the reports from each group below detail. During our review, we determined that some of the reporting mechanisms are inadequate to readily determine why a particular incident occurred. Recommendations to standardize and improve data collection and analysis efforts are included in Sections 6 and 7.

Following are the reports of the four subgroups of the RI JSAT.

4.1 Group 1 Report, NTSB "Blue Book Accident Reports"

Data Selection Process:

The JSAT determined at the outset of its work that it would analyze accidents and incidents dating from 1990 to the present. There are only five NTSB runway incursion-related accident reports within this timeframe, which the JSAT reviewed at one of its earliest meetings. Initially,

Group 1 decided that it would select three of these accidents which were representative of the various types of circumstances described by the five.

Later, however, the JSAT decided that its overall efforts would benefit from examining all five events in order to capture any differences between them. Another reason for doing so is the limited number of such thorough accident reports; none of the other data sets are nearly as detailed or informative as the NTSB reports. Accordingly, Group 1 reviewed all five accidents and then assigned individuals to analyze and become the "expert" on one report apiece. The report analyzer developed the event sequences, problem statements, intervention strategies and characteristics and indicators. After doing so, each individual presented their work to the Group for purposes of reaching consensus on their findings.

Following is the list of NTSB accident reports and a synopsis of each.

Date: 1/18/90
Location: Atlanta-Hartsfield International Airport
Synopsis: Beech King Air cleared for ILS runway 26R approach behind Continental flight 9687, then Eastern Airlines 727 was cleared for the same approach behind the King Air. After landing, flight 9687 had a radio problem and the tower controller had difficulty communicating with the crew; meanwhile, the King Air landed and the aircraft was taxied to the right side of the runway near taxiway D. The Eastern 727 landed with the King Air still on the runway; the 727 crew did not see the King Air until moments before their right wing struck the King Air from behind.

Date: 12/3/90
Location: Detroit-Metro Wayne County Airport
Synopsis: Northwest flight 1482, a DC-9, and Northwest flight 299, a B-727, collided near the intersection of runway 9/27 and 3C/21C in dense fog at DTW. The 727 was cleared from the terminal area ahead of the DC-9 to takeoff on runway 3C; the DC-9 was given the same taxi clearance, but the crew failed to navigate properly and eventually taxied onto 3C at its intersection with 9/27 by mistake, and parked. The 727 crew successfully navigated to the end of 3C and took off, striking the DC-9 almost head-on during the takeoff roll.

Date: 2/1/91
Location: Los Angeles International Airport
Synopsis: Skywest Airlines SA-227 cleared to taxi via intersection 45 onto runway 24L for position and hold. Local controller forgot about the SA-227 and cleared a USAir B737 for landing on runway 24L. The 737 landed behind the SA-227 and ran over it; both aircraft slid down the runway into an unoccupied fire station. The crew of the B737 did not see the SA-227 until they were virtually on top of it. Tower operating procedures did not require flight progress strips to be processed through the local ground control position. Because this strip was not present, the local controller misidentified an airplane and issued a landing clearance.

Date: 11/22/94
Location: Lambert-St. Louis International Airport
Synopsis: A Cessna 441 was cleared to taxi into position at the end of runway 31. The pilot erroneously taxied into position on runway 30R for an intersection takeoff instead, apparently on a preconceived idea that he would depart on the same runway on which he had landed a few minutes earlier. The local controller did not maintain visual contact with the Cessna after it taxied from the ramp area into the runway/taxiway environment. The local controller did not ensure that the runway was clear before issuing a takeoff clearance to a TWA MD-82 on runway 30R. As a result, the MD-82 struck the Cessna from behind during the airliner's takeoff roll.

Date: 11/19/96
Location: Quincy Municipal Airport, IL
Synopsis: Great Lakes (United Express) Beech 1900 crew opted to land on runway 13, but active runway was 4. The 1900 crew announced intentions to land on runway 13. At least one of the Beech crew's radio transmissions was intercepted by a low-time private pilot who transmitted erroneously and created a misimpression that the King Air crew was knowledgeable of the United Express crew's intentions. A highly experienced King Air pilot, and lesser experienced right seat pilot to whom the PIC was giving instruction, took off on runway 4, apparently without monitoring the unicom frequency or making proper radio calls. The aircraft collided at the intersection of runways 13 and 4; both crews apparently saw the other aircraft just before the collision.

Data Quality:

The NTSB Accident (Blue Book) data was the best source of data reviewed by the JSAT by far. The investigation process is of such a quality and scope that almost all data necessary is available for analysis. The event sequence analysis process is easily accomplished with the use of the NTSB data. The overall quality is considered excellent.

Data Analysis Process:

After developing event sequences from these five accident reports, Group 1 compiled several standard Problem Statements from the Master Collector Document (MCD) and wrote two new ones. The Group wrote more than 20 new Intervention Strategies, but was unable to use any of the Standard Intervention Strategies due to their inapplicability to ground operations.

4.2 Group 2 Report, FAA/MITRE Operational Errors

Background:

An operational error is specific to the air traffic control environment. An operational error is defined as:

An occurrence attributable to an element of the air traffic control system which results in (1) less than the applicable separation minima between two or more aircraft, or between and aircraft and terrain or obstacles and obstructions as required by Handbook 7110.65 and supplemental instructions. Obstacles include: vehicles/equipment/personnel on runways, or aircraft landing or departing on a runway closed to aircraft operations after receiving air traffic authorization.

When an operational error occurs an investigation of the incident is initiated at the facility level. This investigation results in the completion of the "final operational report" for that incident. These reports are reviewed at the regional level and submitted to the air traffic quality assurance organization with a copy going to the Air Traffic Planning, Information, and Analysis Division, ATX-400. The final operational error report is reviewed for completeness and entered into National Aviation Incident Management System (NAIMS) data base.

During the last nine years, runway incursion-related operational errors have averaged 81.5 annually. However, they have grown from the historical low of 65 RI OEs in 1995 to 92 in 1998. The 1998 count is the highest number of RI OEs since 1990 when 100 RI OEs were counted. This is a growth of 41% from the 1995 all time low.

Data Selection Process:

A listing of all runway incursion operational errors for fiscal years 1997 and 1998 was compiled. A statistical sample of 50 operational errors was randomly selected from this total population of 178. The final operational error reports were acquired for these selected 50 operational errors. During the initial analysis of these incidents, the sample was reduced by one because the team determined that the incident was an operational deviation instead of an operational error. The team used the remaining 49 incidents as the basis its analysis.

Data Quality:

Although none of the selected reports were discarded due to poor quality, the quality of the data varied greatly. This variance was primarily the result of the quality of the investigation accomplished in the facility. Good investigations invariably resulted in higher quality reports and therefore more useful data.

Data Analysis Process:

The OE team followed the JSAT analytical process as closely as possible. Once the team validated the sample data set, the team cooperatively developed the sequence of events for each incident. The individual team members then reviewed each event and identified problems

where applicable. The team used standard JSAT problem statements where applicable and developed new statements as needed. These problem statements were based on the documents detailing the training requirements for an air traffic controller.

Once the team collectively agreed upon the problem statements, specific intervention strategies were developed for each problem. Once again, where applicable, "standard" intervention strategies from previous JSATs were used. The team developed 12 new intervention strategies and used three (3) standard intervention strategies.

4.3 Group 3 Report, NTSB General Aviation Accident Data, FAA Pilot Deviations, FAA Vehicle/Pedestrian Deviations, and ASRS Data

Data Selection Process:

The group analyzed data from two different data bases:

➢ National Transportation Safety Board's Accident Data Base.
➢ Federal Aviation Administration's Pilot Deviation Data Base.

In addition, the group examined data in two other databases, the FAA's Vehicle/Pedestrian Database and the NASA's Aviation Safety Database but decided not to use the data from either of them for reasons explained below in this section.

The information contained in each database for determining the root cause of runway incursions was limited. A description of each database and its limitations follows. Information on the number of events considered in each database is also provided along with a summary of findings for the events.

National Transportation Safety Board's Accident Data Base

The National Transportation Safety Board is responsible for determining the probable cause of aviation accidents occurring in the United States. This database contains information gathered during the Board's investigation of each accident, their analysis, findings, and recommendations. The JSAT limited its query of this database to accidents involving the collision of two aircraft on the runway from 1990 through 1997. Five accidents where at least one of the aircraft was a commercial carrier and another 29 accidents where both aircraft were general aviation were found. The five accidents involving the commercial carriers were the subject of extensive investigations by the Board and resulted in "blue book" reports. Group 1 of this JSAT analyzed these five accidents.

The data set of 29 collisions involving only general aviation aircraft include three that occurred at airports with operating control towers. All three of these were eliminated from further consideration since they were considered anomalies for the following reasons:

➢ One involved a formation flight of warbirds failing to adhere to their established procedures for exiting the runway.

➢ One occurred at a fly-in where a landing aircraft collided with the preceding aircraft that had not yet vacated the runway.

➢ The last occurred at an airport that had established a temporary tower for a one-day air show.

The remaining 26 accidents occurred at airports without operating control towers and have the following groupings: 10 of these accidents involved aircraft operating in the same direction on the same runway; nine involved aircraft on crossing runways; two involved aircraft operating in opposite directions on the same runway; two involved collisions with aircraft back taxiing on the runway; and three involved aircraft landing or taking off and colliding with an aircraft taxiing across the runway. Two of these accidents resulted in three fatalities. All of the accidents involved damage to the aircraft and some also involved injuries to the occupants.

In view of the low number of fatalities, the group initially concluded that this was not an area which was necessary to investigate further. However, after consultation with CAST, the co-chairs asked the group to select a sample of these accidents for further analysis.

In making this selection the group eliminated accidents involving grass strips and air shows. It is important to understand the limitations presented by these accident reports. Unlike "blue book" reports that result from extensive field investigations and analysis by the Board, the accidents in this data set are mainly the result of "desk top" investigations. Consequently, these reports do not contain the detail or event sequence that one would find in a "blue book" report. Often there is conflicting information in the statements provided by the witnesses (primarily the pilots involved in the accident) concerning what was done and when it was done. Typical causes determined by the NTSB for these accidents include:

➢ Failure of both pilots to provide adequate visual lookout.
➢ Failure to use radios or make proper radio calls.

After reviewing the selected accidents in further detail, the group was unable to develop a meaningful event sequence for any of the accidents because of the lack of detail contained in the reports. However, the group concluded that every one of the accidents could have been prevented if the pilots involved followed the recommended procedures for operating at uncontrolled airports that are contained in the AIM.

Federal Aviation Administration's Pilot Deviation Database

Background:

The Federal Aviation Administration (FAA) maintains a database of pilot deviations. A pilot deviation is an action by a pilot that results in a violation of a Federal Aviation Regulation. Pilot deviations involving a pilot's use or attempt to use a runway (land, takeoff, or taxi) that results in a loss of separation or a collision hazard with another aircraft or vehicle are runway incursions according to the FAA's definition. The JSAT looked at 21 pilot deviations classified as runway incursions in the FAA's database.

All the events occurred at airports with operating control towers. This is to be expected since a controller is usually the initiator of a preliminary report of the pilot deviation. The preliminary report provides details on the deviation, contains a narrative explaining what happened, and usually includes statements from the controller. The deviation is then investigated by a FAA Flight Standards inspector to determine whether the event was actually a deviation. In the course of the investigation, the FAA inspector will attempt to talk with the pilot involved in the incident. However, many pilots either cannot be contacted or refuse to talk to the inspector since the statements provided can be used in enforcement actions taken against the pilot. If radio communications are a factor in the deviation, the inspector can obtain a tape of communications between the pilot and the tower. At the end of the investigation the inspector issues a final report with a determination of whether a pilot deviation has occurred.

Data Selection Process:

A listing of all runway incursion pilot deviations for fiscal years 1997 and 1998 was compiled. A statistical sample of 50 pilot deviations was randomly selected from this total population of 324. The final pilot deviation reports were acquired for these selected 50 pilot deviations. During the initial analysis of these incidents, 29 reports were discarded because the team determined that the reports contained inadequate information for analysis. During the initial analysis of the remaining reports, 9 were rejected for a lack of meaningful event sequences. The team used the remaining 12 incidents as the basis for the detailed JSAT analysis

Analysis Process:

The team followed the JSAT analytical process as closely as possible. Once the team validated the sample data set, the team cooperatively developed the sequence of events for each incident. The individual team members then reviewed each event and identified problems where applicable. The team used previously JSAT problem statements where available and developed new statements where applicable.

Once the team collectively agreed upon the problem statements, specific intervention strategies were developed for each problem. Once again, where applicable, "standard" intervention strategies from previous JSATs were used.

Quality of Data:

There are several limitations to this database. The database provides good information on events that occurred, however, it rarely contains information on why the deviation occurred. For example, a pilot may be cited for failing to hold short of a runway after being instructed to do so by air traffic control. The fact that the pilot passed the hold position is clearly stated in the report, but the report usually fails to contain information as to why this occurred. In this case the failure to hold short could be attributed to several things, including a misunderstood clearance, being lost on the airfield, distractions, or an obscured holding position marking or sign.

In many cases, the reports do not contain sufficient information to permit investigators to develop a meaningful event sequence or determine root causes. Of the 21 pilot deviations examined by the JSAT, nine were discarded because of the lack of information needed to develop a meaningful event sequence. For the remaining 12 reports, the JSAT was able to develop an event sequence but had to depend on the collective experience of its members to surmise why an event happened.

The use of this conjecture-derived data by itself could lead to inappropriate and unsubstantiated conclusions. However, the data is valuable in confirming information obtained from other sources, such as the NTSB "blue books" and air carrier pilot reports examined by the JSAT. Unfortunately, the information in both of these sources are based primarily upon air carriers. The general aviation input from these sources is limited to **two "blue book" accidents – one of which occurred at a controlled airport at night and the other occurred at an airport without an operating control tower.

During the last few years, the growth in runway incursions can be attributed mainly to general aviation pilots during daytime, VMC conditions. Some of the JSATs analysis of air carrier operations and related intervention strategies will be applicable to the general aviation community. However, the JSAT lacked sufficient data to analyze the causes of runway incursions involving general aviation pilots.

Other Databases Evaluated and Rejected

1. Federal Aviation Administration's Vehicle/Pedestrian Deviation Database

This database contains reports from controllers about vehicles and pedestrians that enter or operate on the movement area, including the runways, without a proper clearance. Except for some identifying information, the reports in the database are prose. The amount of detail is left

to the discretion of the reporter. Also, a follow up investigation is not documented in the database. After looking at several reports, the group decided that the information contained in the database did not lend itself to an event sequence and consequently decided against its use.

It should be noted that in the fall of 1999, the FAA adopted two new forms for the reporting and investigation of V/PD's. The information on these new forms should help in the analysis of this data.

2. National Aeronautics and Space Administration's Aviation Safety Reporting
   System

This data system allows an individual to anonymously report an event or situation. Since the report is anonymous, it is expected that the reporter will be candid as to the causes of the particular event. However, the drawback to this database is that the report only represents the perspective of the reporter and is not subject to independent verification or validation.

Although the database is open to all facets of the industry, the individuals reporting are usually either pilots or controllers. The vast majority of pilot reports come from air carrier pilots. In this regard the group believed the data in the database was similar to the pilot reports being examined by Group 4. Consequently a decision was made not to use the data in the NASA system.

4.4 Group 4 Report, Pilot Report Data

Data Selection Process:

The data set for Group 4 was the largest due to the volume of data that was collected. This data set was composed of pilot reports from air carriers and included comments and recommendations from incident investigators. Several air carriers volunteered runway incursion and related records from proprietary databases. These reports spanned the time from 1994 through July 1999. Initial screening of the database resulted in 665 reports covering U.S. and foreign airports that warranted further scrutiny. Of these 665 reports, 136 were initially chosen for analysis because these appeared to be the only reports containing enough incident details for a valid analysis. Further review of these 136 reports revealed 13 reports that had insufficient data needed for analysis. The reports that were discarded were either lacking information needed to complete the analysis of the event or were found to be outside the definition of "runway incursion" as it was applied by this JSAT. The resultant 123 reports made up the core database that was used for analysis by Group 4. The analysis of the 123 reports allowed a statistically significant look at the entire data set.

The rationale for the data selected evolved from discussions of data validation concerns involving the data set. The team discussed at length the concern that in many cases there was simply not enough data to properly employ the JSAT process. This prompted discussion as to

what constituted "sufficient data" in a formal analysis, taking into consideration time limitations imposed by CAST, and those data limitations inherent in analyzing incident vs. accident data. All agreed that the objective was to develop intervention strategies derived from data driven analyses, and that at best, there would remain an element of speculation.

Data Analysis Process:

The group followed the modified JSAT analysis process overview in this section.

Data Quality:

As described in the data selection process, the overall quality of the reports was only adequate. Because of the manner in which the data is collected, it did not easily fit into the JSAT event sequence process.

5. RECOMMENDATIONS DERIVED FROM DATA ANALYSIS

Due to the large amount of data, each of the four working groups of the RI JSAT developed event sequences, problem statements, and intervention strategies independently of each other. The individual group efforts were then combined to produce a list of problem statements and interventions with global PCA values representing the entire teams' analysis. After reviewing the sorted interventions, the working group decided that although the top 10 interventions were important, these interventions did not adequately address or prioritize the team's final recommendations (see Appendix I).

In response to advice provided by CAST, the RI JSAT classified the recommendations and associated interventions contained in this section as follows:

- Near Term: Can be implemented within 3 years
- Mid Term: Can be implemented within 3 to 5 years
- Future: Can be implemented within 5 or more years

Further, the JSAT did not take cost or political considerations into account when assigning the above classifications. Also, recommendations and associated interventions which utilize available technology and/or require only procedural changes may be classified as either near or mid term depending on complexity or development issues. Research and/or development issues are normally associated with future classifications.

5.1 Recommendations – Training

The importance of training all the participants in the aviation/airport environment cannot be overstated. Numerous incidents could have been avoided if emphasis on aspects of runway movement procedures for pilot, controller, or vehicle operators had been effectively accomplished. Training recommendations and subsequent intervention strategies have been

categorized for controllers and pilots to facilitate identification of the responsible organization and to help in the execution of the intervention strategies.

In order to increase the effectiveness of individual, team and scenario training and to reduce the safety risk involved in OJT:

5.1.1 ATC

➢ Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators. (770)

➢ Air traffic service providers shall increase the emphasis of anticipating separation during OJT training. (774)

➢ Air traffic service providers shall apply special emphasis on prioritization of control actions during OJT. (775)

➢ Airlines/operators and air traffic service providers should increase training for pilots and controllers on progressive taxi instructions. (701)

➢ Air traffic service providers should ensure standardization of flight strip handling. (726)

5.1.2 Pilot

➢ Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning. (113)

➢ Airlines/operators should develop simulator training scenarios that require flight crews to learn multi-tasking abilities and appropriate prioritization abilities in concert with CRM skills (see Red Flag LOFT scenarios). (314)

➢ Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency. (114)

➢ Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is reviewed during recurrent training. (20)

➢ Airlines/operators develop surface movement simulator training to address factors contributing to runway incursions. (e.g. pavement configuration, closely spaced parallel runways, holding position visual aids, etc.) (703)

➢ Regulators mandate flight crew training for ground operations, especially with regard to runway crossing or occupancy clearances. (702)

➢ Regulators should require a specific checkout for pilots at those airports which are known to have confusing layouts and/or operations. (704)

➢ Regulators/industry should explore and implement more effective ways to educate pilots on recommended practices (procedures, communications, traffic patterns, etc.) at non-towered airports. (706)

- ➢ Airlines/operators should use cockpit simulators to provide pilots with low-visibility taxi training. (705)
- ➢ Airlines/operators and air traffic service providers should increase training for pilots and controllers on progressive taxi instructions. (701)
- ➢ Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training. (111)
- ➢ Airlines/operators and regulators should require training/standardization programs to include training regarding physiological effects on aircrew performance, (e.g. low blood sugar). (141)
- ➢ Airlines/operators should provide training scenarios that match realistic situations (i.e. stall recoveries during approach, in landing configuration at flight idle with the autopilot on (in simulator)). (165)
- ➢ Airlines/operators should ensure that flight crews are trained to think in terms of "I will go-around unless" rather than "I will land unless". Regulatory policy should support this approach. (328)
- ➢ Airline/operators should include in their training programs the awareness of potential safety risks due to crew complacency when operating at a very familiar airport (e.g. home base). (162)

5.2 Recommendations – Situational Awareness

Due to the fast-paced and complex operating environments surrounding surface movements, including takeoffs and landings, all participants in the operation must maintain a high level of situational awareness at all times. A loss of situational awareness, by controllers and/or pilots, was the main causal factor in many of the incidents reviewed. The recommendations revolve around proper training, procedures, and the use of new technologies to provide aids to situational awareness.

5.2.1 ATC

- ➢ Air traffic service providers shall immediately develop and implement national standard operational procedures for tower positions to ensure uniform, effective and sustained situational awareness practices relating to surface operations. (707)
- ➢ Air traffic service providers should require training/standardization programs for controllers which teach situation awareness to include knowledge of timely and accurate instructions to flight crews. (709)
- ➢ Air traffic service providers shall immediately review and redefine the course curriculum and procedural influences affecting scanning techniques. (708)
- ➢ Air traffic service providers should emphasize in ATC training the controllers' potential in assisting the flight crew in improving their situation awareness. (12)

5.2.2   Pilot

➢ Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft position. (47)

➢ Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position. (75)

➢ Air traffic service providers should require training/standardization programs for controllers which teach situation awareness to include knowledge of timely and accurate instructions to flight crews. (710)

➢ Regulators should encourage (through the AIM, pilot safety seminars, brochures, etc.) pilots to identify themselves to ATC controllers as being unfamiliar with an airport. (712)

➢ Airlines/operators should train crews to stop taxing and request ATC assistance anytime they are unsure of their position on the airport surface. (711)

➢ Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilots surroundings, including aircraft systems, and the pilots intentions.) (147)

➢ To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists. (296)

➢ Regulators and airport operators establish standardized airport diagram depiction and information requirements. (713)

➢ Airlines/operators should adopt, implement and train a risk assessment tool to enhance flight crew awareness of hazards associated with all approaches and airports (see risk analysis tactical checklist). (300)

5.3 Recommendations – Procedures

5.3.1 ATC

Appropriate, unambiguous, and effective ATC procedures that effect ground operations are essential for preventing unsafe surface operations from occurring. Accident and incident data analysis reveals that inadequate and/or confusing ATC procedures have contributed to surface incidents and runway incursions. FAA and industry should review and initiate appropriate changes to identified ATC procedures affecting the safety of surface operations.

➢ The FAA shall immediately initiate the regulatory and procedural process to delete the last sentence in the current FAR 91.129(i). (Near Term) (717)

➢ Air traffic control taxi instructions should identify all runway crossings required to reach the clearance limit. (Near Term) (718)
➢ The FAA should review "Reduced Separation on Final" and LAHSO procedures including critical analysis of risk, methods of ATC technique training, and local implementation to determine the effect on surface movements and runway incursions.(719)
➢ The FAA should review "Taxi into Position and Hold" procedures including critical analysis of risk, methods of ATC technique training and local implementation. (720)
➢ Air traffic service providers should perform a risk analysis of intersection departures and position and hold procedures to determine their effect on surface movements and runway incursions. (721)
➢ Air traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures. (124)
➢ Regulators should review multiple landing clearance procedures including critical analysis of risk and methods of ATC technique training. (716)
➢ Regulators and industry should agree to limit ATC instructions during high workload phases of flight to safety of flight information. (724)
➢ Local air traffic service management should design specific procedures to be implemented when a runway(s) is used as a taxiway(s). (722)
➢ Air traffic service providers should perform a risk analysis of shared runway operations (departures and arrivals on the same runway) to determine their effect on surface movements and runway incursions. (723)
➢ Air traffic service providers should reevaluate ATC-related SOPs for ground operations to ensure the SOPs continued relevancy and effectiveness. (725)

5.3.2 Pilot Procedures

Studies have shown that procedural non-compliance is a highly significant problem in accidents and incidents. The RI JSAT also found that the development and implementation of training for and use of standard operating procedures (SOPs) are all equally important elements of this problem. In addition to developing procedures for ground operations where none exist, the RI JSAT found that particular emphasis should be placed on pilot flying (PF) versus pilot not flying (PNF) duties, ensuring that non-essential tasks are completed during low workload phases of operations, and visual scanning prior to entering an active runway.

The RI JSAT believes that a template should be developed for SOPs concerning ground operations. Specifically:

➢ Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions. (Near Term) (729)

- ➢ Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced. (99)
- ➢ Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rational behind those procedures. (110)
- ➢ Airlines/operators should establish an SOP to ensure that flight crews do not begin the approach until adequate briefing is completed for the expected runway. (342)
- ➢ Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (82)
- ➢ Airlines/operators should ensure that their training/standardization programs emphasize the importance of all flight-related briefings. (17)
- ➢ Airlines/operations should review non-essential flight crew tasks to ensure tasks are accomplished during low workload phases of flight. (727)
- ➢ Airlines/operators should emphasize the importance of visually clearing final approach and/or the runway prior to entering any active runway. (728)
- ➢ Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices. (95)
- ➢ Airlines/operators should develop procedures to specify how transfer or control is formally accomplished. (207)
- ➢ Airlines/operators develop better procedures for providing flight crews timely and accurate manifest revisions, passenger counts, and weight and balance information so that distractions during ground movement operations are minimized or eliminated. (730)
- ➢ FAA should include a recommendation in the AIM for Part 91 operations to use "sterile cockpit" procedures that are intended to focus attention on ground. (731)
- ➢ FAA should create and publish in the AIM a recommended mnemonic for radio and scan procedures prior to initiating takeoff. (732)
- ➢ FAA should amend the AIM to emphasize the special nature of operations at non-towered airports with intersecting runways. (733)

5.4 Recommendations - Equipment/Facilities

There are many technology applications which, if applied properly, could significantly reduce the potential for runway incursions. Some of these applications are specific to airports, ATC facilities, or to aircraft while others can be applied to one or more of the aforementioned categories.

5.4.1 ATC

Technology can raise controller situational awareness (SA) or mitigate the consequences of a loss of situational awareness. Loss of SA by ATC has been implicated in many surface incidents and runway incursions. To help controllers maintain or build SA, the FAA should develop and install technologies that enhance ATC awareness of aircraft and vehicle surface movements.

➢ FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e., AMASS, SMA, ATIDS (tags). (735)
➢ Air traffic service providers shall install surface surveillance systems. (736)
➢ Air traffic service providers should provide airport surface surveillance equipment with conflict alerting capability at all air traffic control towers. (737)

5.4.2 Aircraft

Technology can eliminate or mitigate some of the precursors to an accident or incident. Heads-up guidance systems (HGS), graphic cockpit displays that include taxi route and clearance limit, and an alerting device to warn of deviations from a taxi clearance would reduce runway incursions. To achieve maximum effect from the technology, equipment failures and inappropriate settings must be annunciated. The RI JSAT recommends:

➢ Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles. (734)
➢ Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that would depict taxi routes and clearance limits. (740)
➢ Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations. (739)
➢ Air traffic service providers and industry develop and implement technology to alert ATC and/or flight crews to deviations from taxi clearance. (741)
➢ Manufacturers should ensure that all equipment failures or inappropriate settings that may affect the safe operation of the flight are properly annunciated to the flight crew by use of dual source sensing. (45)
➢ Manufacturers should ensure that design logic for warnings and equipment failures to be annunciated to the crew do not cause nuisance warnings, which would contribute to crew complacency. (138)
➢ Air traffic service providers, airlines/operators, and manufacturers develop and install anti-blocking technology for voice communications. (738)
➢ Manufacturers should develop and implement system failure annunciation capabilities to alert flight crews of pending failures (e.g. HUMS). (103)

- ➢ Regulators require air carrier aircraft be equipped with an operational taxi light to adequately illuminate the surface area immediately ahead of the aircraft without "blinding" other pilots. (742)
- ➢ Regulators should assess and require changes to aircraft lighting to ensure aircraft conspicuity, particularly from behind the aircraft. (743)

5.4.3 Airport

Airports can use a blend of new and existing technologies to improve pilot and controller situational awareness. Airport operators should concentrate on equipment that eliminates ambiguities in the movement areas and reduces pilot confusion about taxi routes, runway entrance and exit, holding areas, etc.

- ➢ Regulators and airport operators develop and install lighting to indicate runway exit and taxi route. (744)
- ➢ Regulators and airport operators should ensure that runway entrances and taxi routes are clearly marked, signed, lighted, and maintained to prevent inadvertent runway entry during all meteorological conditions for which the runway and routes are intended to be used. (752)
- ➢ Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway. (745)
- ➢ Regulators and airport operators install in-pavement stop bars or runway guard lights to serve holding positions where a runway is used as a taxi route to a departure runway. (753)
- ➢ Regulators and airport operators install runway holding position signs along runways used as taxiways. (754)
- ➢ Regulators and airport operators develop standards for surface markings under all conditions, including wet pavement and low visibility. (748)
- ➢ Regulators and airport operators should develop and install a sign(s) to indicate the location of the threshold of a runway to be used for takeoff wherever there is potential for pilot confusion as to its location (e.g., stop ways, displaced thresholds, closed runway sections, etc.). (751)
- ➢ Regulators should require airports to comply with international standards for airport construction. (334)
- ➢ Regulators should require airports to comply with international standards for marking and lighting. (749)
- ➢ FAA should require implementation of SMGCS plans at airports during low visibility (RVR<1200) operations. (750)
- ➢ Regulators, industry, and airport operators develop and install a visual signal for aircraft on final approach to indicate runway is occupied (e.g. PAPI modified to flash or pulse when the runway is occupied). (746)
- ➢ Regulators and airport operators develop and install runway vacated guidance. (747)

> ➤ Regulators require airport operators to equip each air carrier LAHSO runway approach end with PAPI. (755)

5.5 Controller/Flight Crew Resource Management (CRM)

The JSAT considered CRM skills important for both ATC controllers and pilots. Controller CRM failures included lack of teamwork and coordination; failure to complete the proper coordination; and inadequate coordination.

At least one prior FAA study has concluded that there is a strong correlation between teamwork, or more precisely a lack of teamwork, and the occurrence of operational errors. The same study, which focused on facilities that had "evidenced a high number of operational errors," reported a "noticeable breakdown in teamwork" at those facilities. Teamwork is an essential element of a safe flight operation, and its implementation by flight crews is supported through formal crew-resource-management training. Teamwork is equally essential to a safe ATC operation. The FAA should expand on the current Air Traffic Teamwork Enhancement Program (ATTE) and implement a robust Air Traffic Control Resource Management (ATCRM) program. The use of a tower simulator would be critical to effective initial and recurring training for ATCRM.

Flight crew CRM issues were apparent in several areas. Crews failed to adequately communicate with each other and voice concerns about the chosen course of action or the aircraft position. Copilots were hesitant or slow to correct captains' errors or omissions. Inadequate or nonexistent SOPs for ground operations undermined the crew's ability to effectively manage and prioritize tasks during ground movement.

5.5.1 ATC

> ➤ Air traffic service providers should develop and implement an Air Traffic Control Resource Management (ATCRM) program. (Near Term) (757)

5.5.2 Pilot

> ➤ Airlines/operators should ensure their formal CRM training emphasized the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC 120-51b). (308)
> ➤ Regulators should ensure airlines/operators training, SOPs, and CRM incorporate visually acquiring and verbalizing the location of conflicting traffic. (758)
> ➤ Airlines/operators should emphasize low-visibility operations in CRM training. (759)

> Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PN and PNF tasks. (Near Term) (135)

> Airlines/operators should ensure that their training/standardization program emphasizes the importance of the team concept, cross-cultural issues, evaluation of options and the obligation of the FO to effectively communicate any concerns (CRM). (131)

5.6   Safety Culture

The RI JSAT examined the safety culture of controllers, pilots, airlines/operators, and airports. When industry culture is an issue, safety appears to compete with other operational factors, like on-time departures and arrivals or ATC system capacity.

> Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture). (143)

> Airlines/operators should encourage a culture that emphasizes safe arrivals over timely arrivals. (22)

> Regulators should discontinue on-time arrival tracking for airlines. (37)

5.7   Communications

One of the weakest areas of the modern aviation system is the industry's continued reliance on a relatively archaic method of communicating information, specifically, via one-at-a-time radio transmissions. These transmissions are rather frequently garbled, "stepped on," blocked, and otherwise difficult, if not impossible, to understand. This situation is definitely a causal factor in numerous runway incursions.

Several accidents/incidents resulted from inadequate or misunderstood clearances between ATC and the flight crew, including phraseology, readback, and hearback problems. The JSAT focused on intervention strategies using current technology and improved procedures to reduce these occurrences.

Several incidents identified combined controller positions and controller simulcasting as factors in reducing pilot situational awareness or creating confusion. Intervention strategies consider technology and procedures for reducing errors due to simulcasting and position combinations.

5.7.1   ATC

> Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology. (Near Term) (42)

- ➤ Air traffic service providers should train and monitor ATC adherence to established communications procedures including hearback problems. (106)
- ➤ Regulators and air traffic service providers should review phraseology used for surface movement operations to delete or change unnecessary and or confusing phraseology. (760)
- ➤ Air traffic service providers should ensure controllers request the aircraft call sign if pilots do not provide it as part of a readback. (763)
- ➤ To eliminate hearback errors, ATC should reexamine and implement improvements to address hearback problems.(241)
- ➤ Air traffic service providers review procedures for combining positions and simulcasting on multiple frequencies to reduce confusion to flight crews listening to partial communications. (765)
- ➤ Regulators and manufacturers explore technology to allow ATC position combination without simulcasting to aircraft operating on different frequencies. (766)
- ➤ Regulators should require a readback for entering a specific runway, holding short of a specific runway, and all taxi-into-position and hold instructions. (762)
- ➤ Air traffic service should provide real time (most current) radio communication of critical airport and weather information. (93)

5.7.2   Pilot

- ➤ To reduce the possibility of error, confusion and workload increase related to ATC clearances, regulators should require and operators should ensure that flight crews utilize proper phraseology and readbacks. (Near Term) (240)
- ➤ FAA shall immediately prepare and distribute material informing aircraft and vehicle operators of surface movement instructions requiring a readback. (761)
- ➤ Airlines/operators should train and monitor flight crew compliance with established communication phraseology guidelines. (88)
- ➤ Regulators and airlines/operators should review procedures for avoiding similar call signs. (764)

5.7.3   Datalink

The RI JSAT believes that use of datalink for ATC instructions and clearances could significantly improve ATC/pilot/vehicle communications and reduce incidents related to inadequate or misunderstood communications.

- ➤ Air traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications. (122)

- ➢ Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft. (28)
- ➢ Implement real time (digital) transmission of airport and weather information to the aircraft. (94)

5.8 Recommendations – Human Physiological Limitions

The teams analysis of accidents and incidents demonstrated that human physiological limitations could be a causal factor in runway incursions. Investigators identified problems with memory lapses by pilots and controllers as one such factor, but there are no specific intervention strategies for pilot memory problems because they are incorporated in other recommendations. Technology should be used to minimize the reliance of pilots and controllers on their memorization abilities. Other human limitations include optical illusions and vision restrictions due to poor lighting and/or weather phenomena. (e.g. fog) and pilot fatigue.

5.8.1 ATC (Memory)

Controllers, like all others, are susceptible to forgetfulness, a condition that is compounded when traffic is very busy. Although the FAA emphasizes memory training in ATC controller curriculums, accidents and incidents continue to occur because of forgetfulness.

- ➢ Air traffic service providers should review requirements for the training and use of memory aids in the tower. (Near Term) (767)
- ➢ Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities. (Near Term) (768)
- ➢ Regulators should create and promote to air traffic service providers a list of vest controller practices for memorization and distraction management. (Near Term) (769)

5.8.2 Pilots

Pilots are less likely to encounter complications that arise from forgetfulness than are controllers, due to the different nature of their work environment. However, they must successfully cope with other types of human performance limitations in order to be safe during ground operations.

- ➢ Airline/operators should ensure that flight crews are trained in operations involving low light and poor visibility on wet or otherwise contaminated runways, and with the presence of optical and physiological illusions, before they are assigned line duties. (Near Term) (312)

➢ FAA should update its flight time/duty time regulations to counteract present commercial aviation environmental stressors. (e.g. crew rest requirements) (Near Term) (315)

➢ Regulators should require airline/operators to train flight crews to recognize and counteract acute and chronic fatigue. (316)

6. RECOMMENDATIONS DERIVED FROM EXPERT OPINIONS

6.1.   Future Data Collection, Analysis and Dissemination

During the course of the RI JSAT process, it became apparent that data collected regarding runway incursions did not always indicate why the event occurred. To formulate intervention strategies that effectively address runway incursions, it is imperative that the data contain this information. A continuation of the RI JSAT analysis process with FAA, ASRS, ASAP, and NTSB data would be very beneficial in assessing the effectiveness of RI JSAT recommendations and identifying future issues requiring additional strategies not presented in the current analysis. The RI JSAT also recognized the benefit of promoting and facilitating the voluntary collection and sharing of safety information regarding runway incursions. A runway incursion should never occur because information that would have prevented it was not shared.

The FAA collects surface incident data via the agency's official Pilot Deviation (PD), Operational Error (OE), and Vehicle/Pedestrian Deviation (VPD) report forms. These forms are designed to collect information to help the FAA decide if an enforcement action is warranted. Because of this, pilots, controllers, and vehicle drivers are inclined to provide only information about what happened and not why it happened. For FAA to effectively address and mitigate surface incidents, especially runway incursions, information about why these events are occurring is essential. The RI JSAT recognized this shortcoming very early in its analysis of runway incursion data and proposed a systematic, wide-ranging study of runway incursions (see Appendix H). This proposal was forwarded to CAST as a recommendation for immediate action on the part of FAA. CAST adopted this recommendation and forwarded the proposed data collection to FAA Air Traffic Operations and Flight Standards.

The RI JSAT analyzed PD, OE, ASRS, pilot report and NTSB surface incident/runway incursion data. As prescribed in the JSAT Process Document, each selected runway incursion incident/accident was analyzed to determine the nature of the problem(s) and what intervention strategy(s) will effectively prevent runway incursion from reoccurring. Because of the diversity of data used, the RI JSAT found it necessary to create its own standard database format for storing this information (see Appendix H). In the course of its analysis, the RI JSAT made use of the standard problem statements and intervention strategies developed by previous JSATs (i.e., CFIT & Approach and Landing), but also developed its own set of problem statements and intervention strategies. Since the RI JSAT could only analyze a limited amount of data, it recommends that a continuation of the data collection and analysis process would be very

beneficial for assessing the effectiveness of RI JSAT recommendations, trending, and determining future issues requiring additional strategies not presented in the current analysis.

The FAA's National Airspace Incident Monitoring System (NAIMS) continuously collects Pilot Deviation (PD), Operational Error (OE), and Vehicle/Pedestrian Deviation (VPD) surface incidents. For the purpose of data analysis directed toward the prevention of runway incursions the following definition for selection of event reports should be used: "A report which describes any occurrence at a towered or non-towered airport, involving an aircraft, vehicle or pedestrian within the runway safety area, that creates a real or potential collision hazard with an aircraft taking off, intending to take off, landing or intending to land." The RI JSAT recommends that for each surface incident report determined to fall within this definition, the FAA should develop a sequence of events with associated problem statements and intervention strategies. In a similar manner, industry together with FAA, should select ASAP and NASA ASRS "call back" reports which meet the afore-mentioned report definition for further analysis. This will serve to further the analysis process developed by the JSAT for runway incursions, thereby assuring necessary feedback while continuously addressing the RI issue.

The Federal Aviation Administration (FAA) first proposed a Global Analysis and Information Network (GAIN) in May 1996 for the worldwide collection, analysis, and dissemination of safety information to help the aviation community reach the goal of zero accidents. GAIN was envisioned by the FAA as a privately owned and operated international information infrastructure that would use a broad variety of worldwide aviation data sources together with comprehensive analytical techniques to assist in identifying emerging safety concerns.

As the aviation community exchanged ideas on the GAIN concept over the first 2½ years since its announcement, a variety of descriptions were applied to GAIN by various segments of the aviation community. The GAIN Steering Committee considered various comments and recommendations on GAIN and agreed upon the following description of GAIN in January 1999:

> *"GAIN promotes and facilitates the voluntary collection and sharing of safety information by and among users in the international aviation community to improve safety."*

The Steering Committee also changed the meaning of the GAIN acronym to "Global Aviation Information Network" to better define the program.

The RI JSAT supports the GAIN concept of voluntary collection and sharing of information to improve safety, especially with regard to runway incursions. The RI JSAT recognized early in their analysis that some of the best information for getting at the root causes of runway incursions is voluntary in nature and non-punitive. The RI JSAT sees great potential for

reducing the incidence of runway incursions through sharing with airlines, airports, pilots, controllers, and airport vehicle drivers, information about the root causes of runway incursions.

6.2.   ATC Supervisors

The RI JSATs review of accident and incident data, reports, studies, and associated previous recommendations identified supervision and staffing as two issues that should be addressed in the following manner.

Persons providing supervision must, above all, be operationally competent, and stay ahead of the "game" by making timely decisions to avoid excessive workloads and disruptions. They provide assistance and added oversight of the entire operation and direct monitoring of the most critical areas of the operation thus enhancing safety. The person providing supervision should be among the first to become aware that a potentially dangerous situation is developing, and should provide backup to the control positions as needed. If necessary, they intervene in order to prevent a loss of separation.

Persons providing supervision should be a source of knowledge and ATC wisdom. They encourage self and team assessment to identify and address areas of needed improvement and to ensure that all team members fully understand individual and team roles and responsibilities.

The FAA should ensure that the controller and supervisory staff is adequate to support actual operational needs as well as ensure that facility management provides supervisory staff with the support necessary to fulfill their responsibilities,

6.3   Runway Incursion Prevention Awareness Campaign

Experience has shown that short-term reductions in the number of runway incursions occur after various awareness initiatives. One of the main benefits of these efforts is that they help to overcome complacency.

The RI JSAT believes that the FAA and industry should embark upon a multi-faceted awareness program which focuses on airport surface operating practices and the reduction of runway incursions.

This program should include training directed at air traffic controllers, general aviation and air carrier pilots and vehicle operators. For each of these groups, training modules should include initial, refresher and remedial sections. Follow-up activities should also be conducted to ensure that awareness is maintained.

7. JSAT PROCESS – LESSONS LEARNED

During the RI JSAT effort, lessons were learned that could help future JSATs. The major areas in which these lessons were grouped are JSAT process flexibility, data issues, analysis issues, and team issues.

The JSAT process, and the application of same, must evolve to meet the variations and foci of the different groups performing JSAT work. Much of the team's efforts in the early part of the RI JSAT deliberations revolved around how to adapt the JSAT process to the use of diverse data sources, large data sets, data of varying quality, proprietary data, and data orientation. Additionally, since the team had a charter to analyze both commercial and general aviation incidents, the complexity of the work was greatly increased due to efforts to integrate the analysis of these diverse portions of the aviation community.

The JSAT process should be used as a guide, not as the "bible" for safety analysis. If the process is destined to be used in analyses of data other than "pristine" NTSB accident reports, then flexibility must allow for the variations in quality, size, security, and sources of data. The process of event sequence or event chain becomes difficult to apply unless the data supports that type of analysis. Other analysis techniques and tools should be evaluated for use in the JSAT environment.

The concept of using a team of experts from the aviation industry, government, and subject matter consultants is one of the foundation blocks of the JSAT process. However, the use of a team can have significant drawbacks that must be addressed to assure success of future JSATs.

The JSAT cannot function as a leaderless team – the relatively short time frame in which the team interacts and the diverse nature of the team mandates that strong leadership be present and that a common understanding of the team's purpose and goal are understood by all members. It is important that the JSAT leadership has experience in the application of the process and be able to adjust the process as necessary to meet the challenges presented to the team. The leadership must be committed to the effort and provide direction and vision during the effort.

The length of the JSAT effort can have a major impact on the team. Since the average JSAT effort is approximately 12 months, it is important that team members be committed to participation for the duration of the team's effort. This commitment must also be borne by the member's organization. It is unfair and unproductive to spend large portions of the team's relatively short time together bringing new or occasional attendees up to speed.

The length of time expected to complete the project should also play in the determination of the scope of the JSATs work. If the scope is too large, the significant amount of time and effort required of the various members will result in an increased level of attrition, absenteeism and focus, which can result in low team productivity and inferior analysis.

The team must also have a clear understanding of the work it is expected to perform. If the team cannot visualize and focus on the objective, it will spend excessive time in unnecessary and unproductive work. The CAST must clearly define team expectations in the JSAT charter.

8. APPENDICES

A. Charter for the Runway Incursion JSAT

B. Data Set Statistics

C. Problem Statements

D. Intervention Strategies

E. Categorization of Intervention Strategies

F. Intervention - Sorted by Calculated by Overall Effectiveness

G. Problem Statements with Associated Interventions

H. Runway Incursion Study

I. Data Evolution

J. Team Members

K. Characteristics and Indicators

Appendix A

**Runway Incursion Joint Safety Analysis Team (JSAT) Charter for
Commercial and General Aviation**

I.   Purpose: To review and analyze data focusing on commercial and general aviation runway incursion, including accidents and incidents, as well as any other data which may be related to runway incursion; and identify potential intervention strategies.

II.   Team Sponsors: Commercial Aviation Safety Team (CAST) and General Aviation Joint Steering Committee (GAJSC) are the sponsors of this joint commercial and general aviation Runway Incursion Joint Safety Analysis Team.

III.   Background: Government and industry have agreed to work together to identify and implement a data driven, benefit focused, safety enhancement program designed to continuously improve our safe commercial and general aviation system. To that end, the CAST and GAJSC were formed. The CAST and GAJSC have further agreed that cooperatively and selectively pursuing the critical few high leveraged safety intervention strategies will maximize the safety benefit to the flying public through a focused application of industry and government resources. To achieve this goal, the CAST and GAJSC have agreed to charter a working group called the "Runway Incursion (RI) Joint Safety Analysis Team (JSAT)".

IV.   Tasks:

    A.   The team shall acquire available data, including prior studies and analyses. The team shall define its assumptions based on the amount and extent of data considered, including, for the purposes of its work, a definition of runway incursion.

    B.   The team shall use the process in the JSAT Process Report to identify and document problem statements, casual analysis, potential intervention of strategies, and evaluation of their effectiveness.

    C.   That process shall include a technical review. Results of the technical review will be presented to the JSAT for consideration prior to final report submittal to CAST and GASC.

V.   Products: The deliverables include reports to the CAST and GASC providing a summary of data analysis, possible intervention strategies, and an evaluation of the effectiveness of each strategy.

VI.   Membership: The team will include representatives with the appropriate technical background provided by industry and government.

VII. **Resources:** Participating organizations agree to provide the financial, logistic, and personnel resources to carry out this charter.

Appendix B
Data Set Statistics

1. **Group 1 (NTSB)**

   - **5 Runway Incursion Accidents** (1990-Present)

2. **Group 2 (Operational Errors)**

   - 178 FAA Final Reports (1997-98)
   - 50 Reports selected at random
   - 1 Rejected (Operational Deviation vs. Operational Error)
   - **49 Reports analyzed**

3. **Group 3 (Pilot Deviations)**

   FAA Vehicle/Pedestrian Deviation (VPD)   Rejected for quality of data

   NASA Aviation Safety Reporting System   Rejected for quality of data

   NTSB Accident Data Base – Airports without an operating control tower

   - 29 Accidents – all general aviation (1990-97)
   - 3 Accidents eliminated (occurred at airports with an operating control tower)
   - **26 Accidents analyzed** – all general aviation, all at airports without an operating control tower

   FAA Pilot Deviations (PD)

   - 324 FAA Final Reports (1997-98)
   - 50 Reports selected at random
   - 29 Reports rejected for inadequate information
   - 21 Reports for initial analysis
   - 9 Reports rejected for lack of meaningful event sequence
   - **12 Reports analyzed**

4. **Group 4 (Pilot Reports)**

   - 665 Pilot Reports with sufficient data for initial analysis (3 U.S. air carriers, 1994-99)
   - 136 Reports with sufficient data for final analysis
   - 13 Reports eliminated for definition or data problems
   - **123 reports analyzed**

Runway Incursion JSAT
Problem Statements - Sorted by Problem Number

Problem
Number

2
Problem Statement: Flight Crew - Failure to follow Procedures (Communications)

Description: Failure of the flight crew to provide complete responses (callbacks, position reports, etc.) using standard phraseology in accordance of established procedures (FAA, ICAO, company, etc.).

4
Problem Statement: ATC - Insufficient English Language Skills

Description: Inability of ATC to understand and communicate English language instructions.

5
Problem Statement: ATC / Flight Crew Inadequate Communications

Description: Inability of ATC and the flight crew to effectively communicate.

6
Problem Statement: ATC - Failure to Follow Procedures (Communications)

Description: Failure of ATC to provide instructions/information/clearances using standard phraseology in accordance with appropriate regulatory directives.

7
Problem Statement: ATC - Inadequate Situation Awareness (Horizontal)

Description: Failure of ATC to correctly identify aircraft position over the ground.

8
Problem Statement: ATC - Failure to Follow Procedures (SOP)

Description: Failure of ATC to follow established procedures.

9
Problem Statement: Airline Operations - PF/PNF Flying Procedures (Increased Workload at a Critical Phase)

Description: Airline/operator procedures caused a disruption in crew activities and contributed to an increased flight crew work load during a critical phase of flight.

10
Problem Statement: Flight Crew - Failure to Follow Procedures (SOP)

Description: Failure of flight crew to follow established procedures.

12

Problem Statement: Flight Crew - Inadequate Situation Awareness (Horizontal)

 Description: Failure of flight crew to correctly identify aircraft position over the ground.

14

Problem Statement: Aircraft Equipment - Equipment Failure

 Description: Failure of instrument and/or warning system during critical phase of flight (approach/landing).

16

Problem Statement: Flight Crew - CRM Failure

 Description: Lack of CRM training or failure to follow CRM practices.

17

Problem Statement: Airline Operations - Lack of Standardized Procedures

 Description: Failure of the airline/operator to provide adequate standard operating procedures that address situations and environments that the flight crews operate in.

20

Problem Statement: Airline Operations - Lack of Training (Flight Crew)

 Description: Airline/operator training failed to adequately address operational requirements necessary for the flight crew to safely operate the airplane.

21

Problem Statement: Flight Crew - "Press-On-itus"

 Description: Flight crew disregard of, or failure to recognize cues to terminate current course of action or maneuver.

22

Problem Statement: Flight Crew - PNF Duties Not Performed

 Description: Pilot Not Flying (PNF) failed to perform monitoring function and other PNF responsibilities.

24

Problem Statement: Flight Crew/Airline Operations - Aeromedical - Crew Medical / Fatigue Concerns

 Description: Disregard of aeromedical factors (fatigue, medications, alcohol, etc.).

28

Problem Statement: Air Traffic System - Inadequate Infrastructure (Equipment / Design)

 Description: The ATC system lacked equipment that might have helped prevent the accident (DME, radar, etc.).

32

Problem Statement: Airline Operations - Inadequate Information Dissemination

Description: Failure of or inadequate airline/operator procedures for disseminating flight-critical information within the organization.

33

Problem Statement: Air Traffic System - Inadequate Information Dissemination

Description: Failure of or inadequate air traffic system procedures for disseminating flight-critical information.

34

Problem Statement: Flight Crew - Failure to Exercise Command (Captain) Responsibility

Description: Failure of captain to exercise command authority.

38

Problem Statement: Flight Crew Inappropriate Task Prioritization Under Time Constraints

Description: Flight crew preoccupation with inappropriate tasks or failure to correctly prioritize the critical tasks under time constraints.

43

Problem Statement: Flight Crew - Home Aerodrome Complacency

Description: Flight crew failure to recognize and counteract complacency that may exist when operating at home aerodrome.

46

Problem Statement: Air Traffic System - Procedures that Compromise Safety.

Description: Air Traffic system procedures that may compromise safety or increase flight crew workload (e.g. noise abatement procedures, slam dunk approaches, inappropriate taxi routes during low visibility operations, etc).

54

Problem Statement: ATC/Flight Crew - Actions/Inaction's Contributed to Increased Workload

Description: Flight crew actions or inactions contributed to increased workload (e.g. missed checklist items causing a rushed).

55

Problem Statement: Airline Operations - Burdened Flight Crew with Non-Flight Related Tasks

Description: Airline operator policies burdened flight crew with non-flight related tasks (e.g. paperwork requirements while flying; communication with dispatch and/or ARTC request for info not related to safe flight and landing).

57

Problem Statement: Aircraft Equipment - Design Shortcomings

Description: System design was not appropriate for conditions encountered.

102

Problem Statement: Flight Crew - Inadequate Planning/Briefing

Description: Inadequate planning/briefing by the flight crew.

103

Problem Statement: Air Traffic System - Inadequate Weather Information Provided to the Flight Crew

Description: Inadequate weather information provided to the flight crew by air traffic services.

106

Problem Statement: Flight Crew - Failure to Recognize the State of the Airplane

Description: Flight crew failure to recognize the state of the airplane (speed, energy state, power setting, pitch attitude, relevant elements of the pilot surroundings, including aircraft systems and the pilot's intentions).

107

Problem Statement: Flight Crew - Failure to Use All Available Information Resources

Description: Flight crew failure to use all available information resources.

204

Problem Statement: Flight Crew - Not adequately Prepared for the Task

Description: Flight crew not adequately prepared for the task (inadequate briefing, inadequate assessment of weather factors and not mentally prepared).

303

Problem Statement: Flight Crew - Failure to Process and Interpret Available Relevant Data

Description: Flight crew failure to process and interpret available relevant data.

410

Problem Statement: Flight Crew - Inappropriate Task Prioritization Under Time Constraints

Description: Flight crew preoccupation (with other ((inappropriate)) tasks) or failure to correctly prioritize the critical tasks to the detriment of primary (flight) tasks.

701

Problem Statement: ATC - Control Methods (Scanning).

Description: Failure to scan or inadequate scanning.

702

Problem Statement: ATC - Control Methods (Local Procedures).

Description: Failure to adhere to local procedures.

703

Problem Statement: ATC - Progressive Taxi Instructions.

Description: Failure to provide complete taxi instructions.

704

Problem Statement: Flight Crew - Failure to follow recommended Procedures for traffic Pattern Entry at Uncontrolled Airport.

Description: Failure to enter traffic pattern, make proper radio calls, and/or visually acquire other traffic in accordance with recommended procedures.

705

Problem Statement: ATC - Control Methods (Vehicle Identification).

Description: Failure to establish and/or maintain positive vehicle identification.

706

Problem Statement: ATC - Control Methods (Memory Aids).

Description: Failure to use or improper use of memory aids.

707

Problem Statement: ATC- Control Judgement (TIPH).

Description: Injudicious use of taxi into position and hold (TIPH).

708

Problem Statement: ATC - Control Judgement (Anticipated Separation).

Description: Failure to correctly anticipate separation.

709

Problem Statement: ATC-Control Judgement (Prioritization).

Description: Failed to correctly prioritize control actions.

710

Problem Statement: ATC - Inadequate Situation Awareness (Surface).

Description: Failure to correctly identify aircraft position on the airport surface.

711

Problem Statement: Flight Crew - Inadequate Situation Awareness (Environment).

Description: Failure to maintain or recognize a loss of an adequate level of attentiveness and surveillance, including the pilot environment aircraft/crew status and an understanding of current and potential conditions and outcomes.

712

Problem Statement: Charting Authority - Airport Approach Chart Fails to Contain Accurate/Pertinent Information.

Description: Mislabeling or failure to label specific information, i.e. proper radio frequency for arrival/departure runway, geographic.

713

Problem Statement: Flight Crew - Task Saturation/Workload Management Anomaly.

Description: Failure to recognize/avoid task saturation and/or properly manage workload resulting in degradation or non-performance of necessary duties.

714

Problem Statement: Flight Crew - Failure to Follow ATC Instructions.

Description: Failure to follow ATC instructions.

715

Problem Statement: Regulators - Negative Regulatory Influences (Procedures).

Description: Taxi clearance includes clearance to cross intervening runways.

716

Problem Statement: ATC - Practices/Procedures Increased Flight Crew Workload During a Critical Phase (Communications/Procedures)

Description: ATC practices/procedures caused a disruption in crew activities and contributed to an increased flight crew workload during a critical phase of flight.

717

Problem Statement: Regulators - Failure to Consider and Publish LAHSO Missed Approach Procedures

Description: Regulators failed to consider and/or publish missed approach procedures for LAHSO.

718

Problem Statement: ATC - Control Methods (Aircraft Identification).

Description: Failed to establish/maintain positive identification of aircraft.

719

Problem Statement: ATC - ATC/Pilot Communication.

Description: Failed to request required readback.

720

Problem Statement: Airline Operations - Lack of SOP for Ground Operations

Description: Failure of airlines/operators to ensure clear, accurate, and appropriate standard operating procedures, (SOPs), are established for all aircraft operations.

721

Problem Statement: Flight Crew - Failure to Clarify Clearance or Situation Where a Doubt Exists

   Description: Flight crew failure to clarify clearance or situation where a doubt exists.

722

Problem Statement: Aircraft Equipment - Identification of Mechanical Failures

   Description: Failure to annunciate or inability to identify equipment failure through normal crew or maintenance duties.

723

Problem Statement: Airline/operators & Regulators - Failure to Require Suitable and Adequate Equipment for Ground Operations.

   Description: Airlines/operators and/or regulators failed to require or provide suitable and adequate equipment for ground operations.

724

Problem Statement: Airport Operator - Failure To Provide and/or Maintain Adequate Visual Aids for Ground Movement.

   Description: Failure to provide and/or maintain adequate surface markings, signage, and/or lights.

725

Problem Statement: Regulators - Failure To Require Runway Vacated Guidance.

   Description: Failure to require airports to provide reliable indication that the aircraft is clear of the runway safety area after runway.

726

Problem Statement: Charting Authority- Inadequate Airport Diagram Chart

   Description: Airport diagram fails to provide readily understandable information needed for surface operations, e.g. absence or poor depiction of runway holding point areas.

727

Problem Statement: Regulators - Prohibition of the Use of Full Landing Flaps.

   Description: Regulators modified aircraft certification to prohibit use of full landing flaps to comply with noise abatement concerns.

728

Problem Statement: Regulators and Airport Operators - Failure to Require and/or Provide Visual Vertical Guidance for LAHSO Runway

   Description: Failure to require and/or provide PAPI for LAHSO where aiming point and visual situation awareness are critical.

729

Problem Statement: ATC - Coordination.

   Description: Failed to correctly perform coordination. In controllers handbook.

730

Problem Statement: ATC - ATC/Pilot Communications ("Hearback").

    Description: Misheard pilot readback (i.e. "hearback" error).

731

Problem Statement: Flight Crew - Failure to Correctly Identify Call Sign

    Description: Failure to differentiate among similar-sounding call signs (i.e. call sign confusion).

732

Problem Statement: ATC - Failure to Maintain Correct Call Sign Identification

    Description: ATC used incorrect call sign or failed to differentiate among similar-sounding call signs (I.e. call sign confusion).

733

Problem Statement: ATC - Human Memory Anomaly

    Description: Memory failure including forgotten items, oversights, etc.

734

Problem Statement: Flight Crew - Human Memory Anomaly

    Description: Memory failure including forgotten items, oversights, etc.

735

Problem Statement: ATC-Failure to Provide Adequate Separation.

    Description: Controller caused aircraft to violate separation through improper and/or inadequate clearance.

Runway Incursion JSAT

Intervention Strategies - Sorted by Intervention Number

Intervention
Number

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12 *Description:* Air Traffic service providers should emphasize in ATC training the controllers' potential in assisting the flight crew in improving their situation awareness.

   Category: Situational Awareness-Environment-ATC

17 *Description:* Airlines/operators should ensure that their training/standardization programs emphasize the importance of all flight-related briefings.

   Category: Procedures-Pilot

20 *Description:* Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for

   monitoring is reviewed during recurrent training.

   Category: Training-Pilot

22 *Description:* Airlines/operators should encourage a culture that emphasizes safe arrivals over timely arrivals.

   Category: Safety Culture-Airline/Operator

28 *Description:* Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

   Category: Communications-Datalink

37 *Description:* Regulators should discontinue on-time arrival tracking for airlines.

   Category: Safety Culture-Airline/Operator

Intervention
Number

-

42 *Description:* Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology.

    Category: Communications-ATC/Pilot/Vehicle

45 *Description:* Manufacturers should ensure that all equipment failures or inappropriate settings that may affect the safe operation of the flight are properly annunciated to the flight crew by use of dual

    source sensing.

    Category: Equipment/Facility-Aircraft

47 *Description:* Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft position.

    Category: Situational Awareness-Environment-Pilot

75 *Description:* Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position.

    Category: Situational Awareness-Environment-Pilot

82 *Description:* Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (see 135)*

    Category: Procedures-Pilot

88 *Description:* Airlines/operators should train and monitor flight crew compliance with established communication phraseology guidelines.

    Category: Communications-ATC/Pilot/Vehicle

93 *Description:* Air Traffic service should provide real time (most current) radio communication of critical airport and weather information.

    Category: Communications-ATC/Pilot/Vehicle

Intervention
Number

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94 *Description:* Implement real time (digital) transmission of airport and weather information to the aircraft.

   Category: Communications-Datalink

95 *Description:* Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.

   Category: Procedures-Pilot

99 *Description:* Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

   Category: Procedures-Pilot

103 *Description:* Manufacturers should develop and implement system failure annunciation capabilities to alert flight crews of pending failures (e.g. HUMS).

   Category: Equipment/Facility-Aircraft

106 *Description:* Air Traffic service providers should train and monitor ATC adherence to established communications procedures including hearback problems.

   Category: Communications-ATC/Pilot/Vehicle

110 *Description:* Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

   Category: Procedures-Pilot

111 *Description:* Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training.

   Category: Training-Pilot

Intervention
Number

113*Description:* Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.

   Category: Training-Pilot

114*Description:* Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency.

   Category: Training-Pilot

122*Description:* Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

   Category: Communications-Datalink

124*Description:* Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.

   Category: Procedures-ATC

131*Description:* Airlines/operators should ensure that their training/standardization program emphasizes the importance of the team concept, cross-cultural issues, evaluation of options and the obligation of the FO to effectively communicate any concerns (CRM).

   Category: CRM-Pilot

135*Description:* Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PN and PNF tasks.

   Category: CRM-Pilot

*Intervention
Number*

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138*Description:* Manufacturers should ensure that design logic for warnings and equipment failures to be annunciated to the crew do not cause nuisance warnings, which would contribute to crew complacency.

Category: Equipment/Facility-Aircraft

141*Description:* Airlines/operators and regulators should require training/standardization programs include training regarding physiological effects on aircrew performance, (e.g. low blood sugar).

Category: Training-Pilot

143*Description:* Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture).

Category: Safety Culture-Airline/Operator

147*Description:* Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings, including aircraft systems, and the pilots intentions.)

Category: Situational Awareness-Environment-Pilot

162*Description:* Airline/operators should include in their training programs the awareness of potential safety risks due to crew complacency when operating at a very familiar airport (e.g. home base).

Category: Training-Pilot

165*Description:* Airlines/operators should provide training scenarios that match realistic situations (I.e. stall recoveries during approach, in landing configuration at flight idle with the autopilot on (in simulator)).

Category:

Intervention
Number

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207*Description:* Airlines/operators should develop procedures to specify how transfer or control is formally accomplished.

Category: Procedures-Pilot

240*Description:* To reduce the possibility of error, confusion and workload increase related to ATC clearances, regulators should require and operators should ensure that flight crews utilize proper phraseology and readbacks.

Category: Communications-ATC/Pilot/Vehicle

241*Description:* To eliminate hearback errors, ATC should reexamine and implement improvements to address hearback problems.

Category: Communications-ATC/Pilot/Vehicle

296*Description:* To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.

Category: Situational Awareness-Environment-Pilot

300*Description:*   Airlines/operators should adopt, implement and train a risk assessment tool to enhance flight crew awareness of hazards associated with all approaches and airports (see risk analysis tactical checklist).

Category: Situational Awareness-Environment-Pilot

308*Description:* Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b).

Category: CRM-Pilot

Intervention
Number

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312*Description:* Airline/operators should ensure that flight crews are trained in operations involving low light and poor visibility on wet or otherwise contaminated runways, and with the presence of optical or physiological illusions, before they are assigned line duties.

Category: Human Factors-Pilot

314*Description:* Airlines/operators should develop simulator training scenarios that require flight crews to learn multi-tasking abilities and appropriate prioritization abilities in concert with CRM skills (see Red Flag LOFT scenarios).

Category: Training-Pilot

315*Description:* Regulators should update flight time/duty time regulations to counteract present commercial aviation environmental stressors. (e.g. crew rest requirements)

Category: Human Factors-Pilot

316*Description:* Regulators should require airline/operators to train flight crews to recognize and counteract acute and chronic fatigue.

Category: Human Factors-Pilot

328*Description:* Airlines/operators should ensure that flight crews are trained to think in terms of "I will go-around unless" rather than "I will land unless". Regulatory policy should support this approach.

Category: Zero PCA

334*Description:* Regulators should require airports to comply with International standards for airport construction.

Category: Equipment/Facility-Airport

Intervention
Number

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342 *Description:* Airlines/operators should establish an SOP to ensure that flight crews do not begin the approach until adequate briefing is completed for the expected runway.

Category: Procedures-Pilot

701 *Description:* Airlines/operators and air traffic service providers should increase training for pilots and controllers on progressive taxi instructions.

Category: Training

702 *Description:* Regulators mandate flight crew training for ground operations, especially with regard to runway crossing or occupancy clearances.

Category: Training-Pilot

703 *Description:* Airlines/operators develop surface movement simulator training to address factors contributing to runway incursions. (e.g. pavement configuration, closely spaced parallel runways, holding position visual aids, etc.)

Category: Training-Pilot

704 *Description:* Regulators should require a specific checkout for pilots at those airports which are known to have confusing layouts and/or operations.

Category: Training-Pilot

705 *Description:* Airlines/operators should use cockpit simulators to provide pilots with low-visibility taxi training.

Category: Training-Pilot

Intervention
Number

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706 *Description:* Regulators/Industry should explore and implement more effective ways to educate pilots on recommended practices (procedures, communications, traffic patterns, etc.) at non-towered

airports.

Category: Training-Pilot

707 *Description:* Air traffic service providers shall immediately develop and implement national standard operational procedures for tower positions to ensure uniform, effective and sustained situational

awareness practices relating to surface operations.

Category: Situational Awareness-Environment-ATC

708 *Description:* Air Traffic service providers shall immediately review and redefine the course curriculum and procedural influences affecting scanning techniques.

Category: Situational Awareness-Environment-ATC

709 *Description:* Air Traffic service providers should require training/standardization programs for controllers which teach situation awareness to include knowledge of timely and accurate instructions to

flight crews.

Category: Situational Awareness-Environment-ATC

710 *Description:* Regulators, airlines, and operators should encourage (through training, the AIM, pilot safety seminars, brochures, etc.) pilots to use airport charts for all surface operations.

Category: Situational Awareness-Environment-Pilot

711 *Description:* Airlines/operators should train crews to stop taxiing and request ATC assistance anytime they are unsure of their position on the airport surface.

Intervention
Number

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712 *Description:* Regulators should encourage (through the AIM, pilot safety seminars, brochures, etc.) pilots to identify themselves to ATC controllers as being unfamiliar with an airport.

   Category: Situational Awareness-Environment-Pilot

713 *Description:* Regulators and airport operators establish standardized airport diagram depiction and information requirements.

   Category: Situational Awareness-Environment-Pilot

716 *Description:* Regulators should review multiple landing clearance procedures including critical analysis of risk and methods of ATC technique training.

   Category: Procedures-ATC

717 *Description:* FAA shall immediately initiate the regulatory and procedural process to delete the last sentence in the current FAR 91.129(i).

   Category: Procedures-ATC

718 *Description:* Air traffic control taxi instructions should identify all runway crossings required to reach the clearance limit.

   Category: Procedures-ATC

719 *Description:* The FAA should review "Reduced Separation on Final" and LAHSO procedures including critical analysis of risk, methods of ATC technique training, and local implementation to determine the effect on surface movements and runway incursions.

Intervention
Number

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720*Description:* FAA should review "Taxi Into Position and Hold" procedures including critical analysis of risk, methods of ATC technique training, and local implementation.

   Category: Procedures-ATC

721*Description:* Air traffic service provider should perform a risk analysis of intersection departures and position and hold procedures to determine their effect on surface movements and runway incursions.

   Category: Procedures-ATC

722*Description:* Local air traffic service management should design specific procedures to be implemented when a runway(s) is used as a taxiway(s).

   Category: Procedures-ATC

723*Description:* Air traffic service providers should perform a risk analysis of shared runway operations (departures and arrivals on the same runway) to determine their effect on surface movements

   and runway incursions.

   Category: Procedures-ATC

724*Description:* Regulators and industry should agree to limit ATC instructions during high workload phases of flight to safety of flight information.

   Category: Procedures-ATC

725 *Description:*   Air traffic service providers should reevaluate ATC-related SOPs for ground operations to ensure the SOPs' continued relevancy and effectiveness.

Category: Procedures-ATC

Intervention
Number

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726*Description:* Air Traffic service providers should ensure standardization of flight strip handling.

   Category: Procedures-ATC

727*Description:* Airlines/operators should review non-essential flight crew tasks to ensure tasks are accomplished during low workload phases of flight.

   Category: Procedures-Pilot

728*Description:* Airlines/operators should emphasize the importance of visually clearing final approach and/or the runway prior to entering any active runway.

   Category: Procedures-Pilot

729*Description:* Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

   Category: Procedures-Pilot

730*Description:* Airlines/operators develop better procedures for providing flight crews timely and accurate manifest revisions, passenger counts, and weight and balance information so that distractions

   during ground movement operations are minimized or eliminated.

   Category: Procedures-Pilot

731**Description:** FAA should include a recommendation in the AIM for Part 91 operations to use "sterile cockpit" procedures that are intended to focus attention on ground.

Category: Procedures-Pilot

Intervention
Number

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732*Description:* FAA should create and publish in the AIM a recommended mnemonic for radio and scan procedures prior to initiating takeoff.

  Category: Procedures-Pilot

733*Description:* FAA should amend the AIM to emphasize the special nature of operations at non-towered airports with intersecting runways.

  Category: Procedures-Pilot

734*Description:* Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

  Category: Equipment/Facility

735*Description:* FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e. AMASS, SMA, ATIDS (tags).

  Category: Equipment/Facility-ATC

736*Description:* Air traffic service providers shall install surface surveillance systems.

  Category: Equipment/Facility-ATC

737*Description:* Air Traffic service providers should provide airport surface surveillance equipment with conflict alerting capability at all air traffic control towers.

Intervention
Number

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738*Description:* Air traffic service providers, airlines/operators, and manufacturers develop and install anti-blocking technology for voice communications.

    Category: Equipment/Facility

739*Description:* Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.

    Category: Equipment/Facility-Aircraft

740*Description:* Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

    Category: Equipment/Facility-Aircraft

741*Description:* Air traffic service providers and industry develop and implement technology to alert ATC and/or flight crews to deviations from taxi clearance.

    Category: Equipment/Facility-Aircraft

742*Description:* Regulators require air carrier aircraft be equipped with an operational taxi light to adequately illuminate the surface area immediately ahead of the aircraft without "blinding" other pilots.

    Category: Equipment/Facility-Aircraft

743*Description:* Regulators should assess and require changes to aircraft lighting to ensure aircraft conspicuity, particularly from behind the aircraft.

    Category: Equipment/Facility-Aircraft

Intervention
Number

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744*Description:* Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

   Category: Equipment/Facility-Airport

745*Description:* Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

   Category: Equipment/Facility-Airport

746*Description:* Regulators, industry, and airport operators develop and install a visual signal for aircraft on final approach to indicate runway is occupied (e.g. PAPI modified to flash or pulse when the

   runway is occupied).

   Category: Equipment/Facility-Airport

747*Description:* Regulators and airport operators develop and install runway vacated guidance.

   Category: Equipment/Facility-Airport

748*Description:* Regulators and airport operators develop standards for surface markings under all conditions, including wet pavement and low visibility.

   Category: Equipment/Facility-Airport

749*Description:* Regulators should require airports to comply with international standards for marking and lighting.

Category: Equipment/Facility-Airport

Intervention
Number

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750 *Description:* FAA should require implementation of SMGCS plans at airports during low visibility (RVR<1200) operations.

    Category: Equipment/Facility-Airport

751 *Description:* Regulators and airport operators should develop and install a sign(s) to indicate the location of the threshold of a runway to be used for takeoff wherever there is potential for pilot confusion as to it's location (e.g., stop ways, displaced thresholds, closed runway sections, etc.).

    Category: Equipment/Facility-Airport

752 *Description:* Regulators and airport operators should ensure that runway entrances and taxi routes are clearly marked, signed, lighted, and maintained to prevent inadvertent runway entry during all

meteorological conditions for which the runway and routes are intended to be used.

    Category: Equipment/Facility-Airport

753 *Description:* Regulators and airport operators install in-pavement stop bars or runway guard lights to serve holding positions where a runway is used as a taxi route to a departure runway.

    Category: Equipment/Facility-Airport

754 *Description:* Regulators and airport operators install runway holding position signs along runways used as taxiways.

    Category: Equipment/Facility-Airport

755 *Description:* Regulators require airport operators to equip each air carrier LAHSO runway approach end with PAPI.

Category: Equipment/Facility-Airport

Intervention
Number

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757*Description:* Air traffic service providers should develop and implement an Air Traffic Control Resource Management (ATCRM) program.

Category: CRM-ATC

758 *Description:* Regulators should ensure airlines/operators training, SOPs, and CRM incorporate visually acquiring and verbalizing the location of conflicting traffic.

Category: CRM-Pilot

759*Description:* Airlines/operators should emphasize low-visibility operations in CRM training.

Category: CRM-Pilot

760*Description:* Regulators and air traffic service providers should review phraseology used for surface movement operations to delete or change unnecessary and/or confusing phraseology.

Category: Communications-ATC/Pilot/Vehicle

761*Description:* FAA shall immediately prepare and distribute material informing aircraft and vehicle operators of surface movement instructions requiring a readback.

Category: Communications-ATC/Pilot/Vehicle

762*Description:* Regulators should require a readback for entering a specific runway, holding short of specific runway, and all taxi-into-position and hold instructions.

Category: Communications-ATC/Pilot/Vehicle

Intervention
Number

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763*Description:* Air traffic service providers should ensure controllers request the aircraft call sign if pilots do not provide it as part of a readback.

   Category: Communications-ATC/Pilot/Vehicle

764*Description:* Regulators and airlines/operators should review procedures for avoiding similar call signs.

   Category: Communications-ATC/Pilot/Vehicle

765*Description:* Air traffic service providers review procedures for combining positions and simulcasting on multiple frequencies to reduce confusion to flight crews listening to partial communications.

   Category: Communications-ATC/Pilot/Vehicle

766*Description:* Regulators and manufacturers explore technology to allow ATC position combination without simulcasting to aircraft operating on different frequencies.

   Category: Communications-ATC/Pilot/Vehicle

767*Description:* Air traffic service providers should review requirements for the training and use of memory aids in the tower.

   Category: Human Factors-ATC (memory)

768*Description:* Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

Intervention
Number

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769 *Description:* Regulators should create and promote to air traffic service providers a list of best controller practices for memorization and distraction management.

Category: Human Factors-ATC (memory)

770 *Description:* Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators.

Category: Training-ATC

774 *Description:* Air traffic service providers shall increase the emphasis of anticipating separation during OJT training.

Category: Training-ATC

775 *Description:* Air traffic service providers shall apply special emphasis on prioritization of control actions during OJT.

Category: Training-ATC

Categorization of Intervention Strategies
(Prioritized by OE within Categories)

The JSAT categorized intervention strategies to aid in developing and organizing recommendations. The categorization process grouped intervention strategies into eight major categories. Each intervention strategy was assigned to one primary category even though it might be possible to show connectivity to several categories (e.g., situational awareness training could fit in "training" or "situation awareness"). The team's intent was to place intervention strategies in the most appropriate category to aid in recommendation development. Within each category, intervention strategies with a common theme or supporting role were grouped together. Finally, the intervention strategies were prioritized by Overall Effectiveness (OE) within each category: interventions are listed in descending OE value, from left to right and top to bottom.

1. Training
Note: Intervention 701 specifies training for pilots and controllers. Consequently, 701 is listed in Categories 1.1 and 1.2.

1.1. ATC
770
774, 775
701
726

1.2. Pilot
113
314
114
20
703, 702, 704, 706, 705
701
111
141
165
328
162

2. Situational Awareness (Environment)

2.1. ATC
707, 709
708
12

2.2. Pilot
47, 75, 710, 712, 711
147
296
713
300

3. Procedures

    3.1. ATC

717, 718
719, 720, 721
124
716
724
722
723
725

    3.2. Pilot

729, 99, 110, 342
82, 17, 727, 728
95, 207, 730
731, 732, 733

4. Equipment/Facilities

    4.1. ATC

735, 736, 737

    4.2. Aircraft

740, 739, 741
45, 138, 738, 103
742, 743

    4.3. Airport

744, 752
745, 753, 754
748, 751
334, 749, 750
746, 747
755

5. Crew Resource Management (CRM)

    5.1. ATC

757

    5.2. Pilot

308, 758, 759
135
131

6. Safety Culture

143, 22
37

7. Communications

7.1. ATC	42, 106, 760, 763, 241, 765, 766, 762	
	93	

7.2. Pilot/Vehicle	240, 761
	88
	764

7.3 Datalink	122, 28, 94

8. Human Factors

8.1. ATC (Memory)	767
	768
	769

8.2. Pilot	312
	315
	316

Note: Pilot memory issues are addressed by intervention strategies assigned to other categories (2.2. Situational Awareness, 3.2. Procedures, etc.).

Runway Incursion JSAT
Interventions - Sorted by Calculated Overall Effectiveness

Calculated Overall Effectiveness	PCA			Intervention Number	Description
4.17	5	5	6	729	Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.
4.17	5	5	6	734	Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground
4.17 (charts, ATC,	6	5	5	47	Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources inter/intra crew) to establish aircraft position.
4	6	4	6	740	Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.
3.33	5	4	6	99	Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.
3.33 management,	5	4	6	308	Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)
3.33	6	5	4	113	Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.
3.33 link	6	5	4	122	Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer as opposed to voice communications.
3.33	6	5	4	735	FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e. AMASS, SMA, ATIDS (tags).

Calculated Overall Effectiveness	*PCA*			*Intervention Number*	*Description*
3.33	6	5	4	739	Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.
3.33	6	5	4	744	Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.
3.33	6	5	4	745	Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.
2.78	5	4	5	110	Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.
2.78 controllers	5	4	5	770	Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower in high-fidelity tower simulators.
2.67	6	4	4	707	Air traffic service providers shall immediately develop and implement national standardized requirements for tower positions to ensure uniform, effective and sustained situational awareness practices relating to surface operations.
2.5	6	5	3	736	Air traffic service providers shall install surface surveillance systems.
2.22	5	4	4	82	Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (see 135)*
2.22	5	4	4	135	Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PN and PNF tasks.
2.22 techniques.	5	4	4	708	Air Traffic service providers shall immediately review and redefine the course curriculum and procedural influences affecting scanning

Calculated Overall Effectiveness	PCA			Intervention Number	Description
2.08 understanding of the	5	3	5	147	Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and relevant elements of the pilot surroundings, including aircraft systems, and the pilots intentions.)
2.08	5	5	3	28	Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.
2.08 towers.	5	5	3	737	Air Traffic service providers should provide airport surface surveillance equipment with conflict alerting capability at all air traffic control
2	6	4	3	717	FAA shall immediately initiate the regulatory and procedural process to delete the last sentence in the current FAR 91.129(i).
2	6	4	3	718	Air traffic control taxi instructions should identify all runway crossings required to reach the
1.67 phraseology.	5	4	3	42	Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO
1.67	5	4	3	75	Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position.
1.67 with	5	4	3	95	Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency expected procedures or practices.
1.67 uncertainty	5	4	3	296	To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever exists.
1.67 prioritization	5	4	3	314	Airlines/operators should develop simulator training scenarios that require flight crews to learn multi-tasking abilities and appropriate abilities in concert with CRM skills (see Red

93

Calculated Overall Effectiveness	PCA			Intervention Number	Description

1.67   5   4   3   752   Regulators and airport operators should ensure that runway entrances and taxi routes are clearly marked, signed, lighted, and maintained to prevent inadvertent runway entry during all meteorological conditions for which the runway and routes are intended to be used.

Calculated Overall Effectiveness	PCA			Intervention Number	Description

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1.67   5   4   3   768   Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

1.67   6   5   2   767   Air traffic service providers should review requirements for the training and use of memory aids

1.39   5   5   2   114   Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency.

1.39   5   5   2   334   Regulators should require airports to comply with International standards for airport constructions.

1.39   5   5   2   748   Regulators and airport operators develop standards for surface markings under all conditions, including wet pavement and low visibility.

1.33   4   4   3   20   Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is reviewed during recurrent training.

1.33   6   4   2   719   The FAA should review "Reduced Separation on Final" and LAHSO procedures including critical analysis of risk, methods of ATC technique training, and local implementation to determine the effect on surface movements and runway incursions.

1.33   6   4   2   774   Air traffic service providers shall increase the emphasis of anticipating separation during OJT

1.11	5	4	2	106	Air Traffic service providers should train and monitor ATC adherence to established communications procedures including hearback problems.
1.11	5	4	2	240	To reduce the possibility of error, confusion and workload increase related to ATC clearances, regulators should require and operators should ensure that flight crews utilize proper phraseology
1.11 configuration,	5	4	2	703	Airlines/operators develop surface movement simulator training to address factors contributing to runway incursions (e.g. pavement closely spaced parallel runways, holding

Calculated Overall Effectiveness	PCA			Intervention Number	Description
1.11	5	4	2	713	Regulators and airport operators establish standardized airport diagram depiction and information requirements.
1.11	5	4	2	727	Airlines/operators should review non-essential flight crew tasks to ensure tasks are accomplished during low workload phases of flight.
1.11	5	4	2	728	Airlines/operators should emphasize the importance of visually clearing final approach and/or the runway prior to entering any active runway.
1.11	5	4	2	749	Regulators should require airports to comply with international standards for marking and lighting.
1.11	5	4	2	757	Air traffic service providers should develop and implement an Air Traffic Control Resource Management (ATCRM) program.
1.11	5	4	2	775	Air traffic service providers shall apply special emphasis on prioritization of control actions during
1	4	3	3	124	Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.
0.89	4	4	2	143	Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture).
0.83 knowledge	5	3	2	709	Air Traffic service providers should require training/standardization programs for controllers which teach situation awareness to include of timely and accurate instructions to flight
0.83	6	5	1	45	Manufacturers should ensure that all equipment failures or inappropriate settings that may affect the safe operation of the flight are properly annunciated to the flight crew by use of dual source
0.83	6	5	1	701	Airlines/operators and air traffic service providers should increase training for pilots and controllers on progressive taxi instructions.

Calculated Overall Effectiveness	PCA			Intervention Number	Description
0.83	6	5	1	702	Regulators mandate flight crew training for ground operations, especially with regard to runway crossing or occupancy clearances.
0.83	6	5	1	716	Regulators should review multiple landing clearance procedures including critical analysis of risk and methods of ATC technique training.
0.83	6	5	1	746	Regulators, industry, and airport operators develop and install a visual signal for aircraft on final approach to indicate runway is occupied. (e.g. PAPI modified to flash or pulse when the runway is
0.69	5	5	1	17	Airlines/operators should ensure that their training/standardization programs emphasize the importance of all flight-related briefings.
0.69	5	5	1	93	Air Traffic service should provide real time (most current) radio communication of critical airport and weather information.
0.69	5	5	1	111	Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training.
0.69	5	5	1	131	Airlines/operators should ensure that their training/standardization program emphasizes the importance of the team concept, cross cultural issues, evaluation of options and the obligation of the FO to effectively communicate any concerns (CRM).
0.69 nuisance	5	5	1	138	Manufacturers should ensure that design logic for warnings and equipment failures to be annunciated to the crew do not cause warnings, which would contribute to crew
0.69	5	5	1	747	Regulators and airport operators develop and install runway vacated guidance.
0.69	5	5	1	751	Regulators and airport operators should develop and install a sign(s) to indicate the location of the threshold of a runway to be used for takeoff

wherever there is potential for pilot confusion as   to it's location (e.g. stopways, displaced thresholds, closed runway sections, etc.).

Calculated Overall Effectiveness	PCA			Intervention Number	Description
0.67	4	2	3	769	Regulators should create and promote to air traffic service providers a list of best controller practices for memorization and distraction management.
0.56	4	5	1	328	Airlines/operators should ensure that flight crews are trained to think in terms of "I will go-around unless" rather than "I will land unless". Regulatory policy should support this approach.
0.56	5	4	1	22	Airlines/operators should encourage a culture that emphasizes safe arrivals over timely arrivals.
0.56	5	4	1	88	Airlines/operators should train and monitor flight crew compliance with established communication phraseology guidelines.
0.56	5	4	1	103	Manufacturers should develop and implement system failure annunciation capabilities to alert flight crews of pending failures (e.g. HUMS)
0.56	5	4	1	141	Airlines/operators and regulators should require training/standardization programs include training regarding physiological effects on aircrew performance, (e.g. low blood sugar).
0.56 at	5	4	1	165	Airlines/operators should provide training scenarios that match realistic situations (i.e. stall recoveries during approach, in landing configuration flight idle with the autopilot on (in
0.56 contaminated	5	4	1	312	Airline/operators should ensure that flight crews are trained in operations involving low light and poor visibility on wet or otherwise runways, and with the presence of optical or physiological illusions, before they are assigned line duties.
0.56	5	4	1	315	Regulators should update flight time/duty time regulations to counteract present commercial aviation environmental stressors. (e.g. crew rest requirements)
0.56	5	4	1	316	Regulators should require airline/operators to train flight crews to recognize and counteract acute and chronic fatigue.

Calculated Overall Effectiveness	PCA			Intervention Number	Description
0.56	5	4	1	720	FAA should review "Taxi Into Position and Hold" procedures including critical analysis of risk, methods of ATC technique training, and local implementation.
0.56	5	4	1	738	Air traffic service providers, airlines/operators, and manufacturers develop and install anti-blocking technology for voice communications.
0.56	5	4	1	750	FAA should require implementation of SMGCS plans at airports during low visibility (RVR<1200)
0.56 taxi	5	4	1	753	Regulators and airport operators install in-pavement stopbars or runway guard lights to serve holding positions where a runway is used as a route to a departure runway.
0.56 unnecessary	5	4	1	760	Regulators and air traffic service providers should review phraseology used for surface movement operations to delete or change and/or confusing phraseology.
0.56	5	4	1	761	FAA shall immediately prepare and distribute material informing aircraft and vehicle operators of surface movement instructions requiring a readback
0.56 crews	5	4	1	765	Air traffic service providers review procedures for combining positions and simulcasting on multiple frequencies to reduce confusion to flight listening to partial communications.
0.5	3	3	2	724	Regulators and industry should agree to limit ATC instructions during high workload phases of flight to safety of flight information.
0.5	6	3	1	754	Regulators and airport operators install runway holding position signs along runways used as

0.5   6   3   1   763   Air traffic service providers should ensure controllers request the aircraft call sign if pilots do not provide is as part of a readback.

Calculated Overall Effectiveness	PCA			Intervention Number	Description
0.5	6	3	1	764	Regulators and airlines/operators should review procedures for avoiding similar call signs.
0.44 situation	4	4	1	12	Air Traffic service providers should emphasize in ATC training the controllers' potential in assisting the flight crew in improving their awareness.
0.44	4	4	1	207	Airlines/operators should develop procedures to specify how transfer or control is formally
0.44	4	4	1	241	To eliminate hearback errors, ATC should reexamine and implement improvements to address hearback problems.
0.44	4	4	1	722	Local air traffic service management should design specific procedures to be implemented when a runway(s) is used as a taxiway(s).
0.44 the	4	4	1	742	Regulators require air carrier aircraft be equipped with an operational taxi light to adequately illuminate the surface area immediately ahead of aircraft without "blinding" other pilots.
0.44	4	4	1	743	Regulators should assess and require changes to aircraft lighting to ensure aircraft conspicuity, particularly from behind the aircraft.
0.44	4	4	1	755	Regulators require airport operators to equip each air carrier LAHSO runway approach end with
0.44	4	4	1	758	Regulators should ensure airlines/operators training, SOPs, and CRM incorporate visually acquiring and verbalizing the location of conflicting traffic.
0.44	4	4	1	766	Regulators and manufacturers explore technology to allow ATC position combination without simulcasting to aircraft operating on different frequencies.

| 0.42 a | | 5 | 3 | 1 | 162 | Airline/operators should include in their training programs the awareness of potential safety risks due to crew complacency when operating at very familiar airport(e.g. home base). |

Calculated Overall Effectiveness		PCA		Intervention Number	Description
0.42 charts	5	3	1	710	Regulators, airlines, and operators should encourage (through training, the AIM, pilot safety seminars, brochures, etc.) pilots to use airport for all surface operations.
0.42 determine	5	3	1	723	Air traffic service providers should perform a risk analysis of shared runway operations (departures and arrivals on the same runway) to their effect on surface movements
0.42	5	3	1	762	Regulators should require a readback for entering a specific runway, holding short of specific runway, and all taxi-into-position and hold instructions.
0.33	3	2	2	732	FAA should create and publish in the AIM a recommended mnemonic for radio and scan procedures prior to initiating takeoff.
0.33	3	4	1	342	Airlines/operators should establish an SOP to ensure that flight crews do not begin the approach until adequate briefing is completed for the expected runway.
0.33	4	3	1	704	Regulators should require a specific checkout for pilots at those airports which are known to have confusing layouts and/or operations.
0.33	4	3	1	706	Regulators/industry should explore and implement more effective ways to educate pilots on recommended practices (procedures, communications, traffic patterns, etc.) at non-towered
0.33	4	3	1	712	Regulators should encourage (through the AIM, pilot safety seminars, brochures, etc.) pilots to identify themselves to ATC controllers as being unfamiliar with an airport.
0.33 on	4	3	1	731	FAA should include a recommendation in the AIM for Part 91 operations to use "sterile cockpit" procedures that are intended to focus attention ground operations.

Calculated Overall Effectiveness	PCA			Intervention Number	Description
0.33	4	3	1	759	Airlines/operators should emphasize low-visibility operations in CRM training.
0.28	5	2	1	711	Airlines/operators should train crews to stop taxiing and request ATC assistance anytime they are unsure of their position on the airport surface.
0.25	3	3	1	37	Regulators should discontinue on-time arrival tracking for airlines.
0.25	3	3	1	705	Airlines/operators should use cockpit simulators to provide pilots with low-visibility taxi training.
0.22	4	2	1	730	Airlines/operators develop better procedures for providing flight crews timely and accurate manifest revisions, passenger counts, and weight and balance information so that distractions during ground movement operations are minimized or eliminated.
0.22	4	2	1	741	Air traffic service providers and industry develop and implement technology to alert ATC and/or flight crews to deviations from taxi clearance.
0.17	2	3	1	726	Air Traffic service providers should ensure standardization of flight strip handling.
0.17	3	2	1	94	Implement real time (digital) transmission of airport and weather information to the aircraft
0.17	3	2	1	721	Air traffic service provider should perform a risk analysis of intersection departures and position and hold procedures to determine their effect on surface movements and runway incursions.
0.11	2	2	1	300	Airlines/operators should adopt, implement and train a risk assessment tool to enhance flight crew awareness of hazards associated with all approaches and airports (see risk analysis tactical

| 0.11 | 2 | 2 | 1 | 725 | Air traffic service providers should reevaluate ATC-related SOPs for ground operations to ensure the SOPs continued relevancy and effectiveness. |
| 0.11 | 2 | 2 | 1 | 733 | FAA should amend the AIM to emphasize the special nature of operations at non-towered airports with intersecting runways. |

Problems Statements with Associated Interventions

Problem

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2   Flight Crew - Failure to follow Procedures (Communications)

  Failure of the flight crew to provide complete responses (callbacks, position reports, etc.) using standard phraseology in accordance with established procedures (FAA, ICAO, company, etc.).

Intervention

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20   Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is
reviewed during recurrent training.

22   Airlines/operators should encourage a culture that emphasizes safe arrivals over timely arrivals.

28   Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

37   Regulators should discontinue on-time arrival tracking for airlines.

42   Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology.

47   Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft
position.

88   Airlines/operators should train and monitor flight crew compliance with established communication phraseology guidelines.

95   Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.

99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

110   Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and
identify the rationale behind those procedures.

122   Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

143   Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture).

147   Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

240   To reduce the possibility of error, confusion and workload increase related to ATC clearances, regulators should require and operators should ensure that flight crews utilize proper
phraseology and readbacks.

296   To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning,
communication, situational awareness, advocacy, etc. (IAW AC120-51b)

703   Airlines/operators develop surface movement simulator training to address factors contributing to runway incursions (e.g. pavement configuration, closely spaced parallel runways, holding
position visual aids, etc.).

704   Regulators should require a specific checkout for pilots at those airports which are known to have confusing layouts and/or operations.

706   Regulators/industry should explore and implement more effective ways to educate pilots on recommended practices (procedures, communications, traffic patterns, etc.) at non-towered airports.

718   Air traffic control taxi instructions should identify all runway crossings required to reach the clearance limit.

719 The FAA should review "Reduced Separation on Final" and LAHSO procedures including critical analysis of risk, methods of ATC technique training, and local implementation to determine the effect on surface movements and runway incursions.

729 Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

731 FAA should include a recommendation in the AIM for Part 91 operations to use "sterile cockpit" procedures that are intended to focus attention on ground operations.

732 FAA should create and publish in the AIM a recommended mnemonic for radio and scan procedures prior to initiating takeoff.

733 FAA should amend the AIM to emphasize the special nature of operations at non-towered airports with intersecting runways.

734 Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

737 Air Traffic service providers should provide airport surface surveillance equipment with conflict alerting capability at all air traffic control towers.

740 Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

744 Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

745 Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

749 Regulators should require airports to comply with international standards for marking and lighting.

762 Regulators should require a readback for entering a specific runway, holding short of specific runway and all taxi-into-position and hold instructions.

768 Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

770 Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators.

Problem

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4   ATC - Insufficient English Language Skills

Inability of ATC to understand and communicate English language instructions.

Intervention

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42   Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology.

88   Airlines/operators should train and monitor flight crew compliance with established communication phraseology guidelines.

122   Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

124   Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.

240   To reduce the possibility of error, confusion and workload increase related to ATC clearances, regulators should require and operators should ensure that flight crews utilize proper phraseology and readbacks.

296   To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.

Problem

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5   ATC / Flight Crew Inadequate Communications

Inability of ATC and the flight crew to effectively communicate.

Intervention

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12   Air Traffic service providers should emphasize in ATC training the controllers' potential in assisting the flight crew in improving their situation awareness.

28   Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

42   Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology.

47   Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft position.

88   Airlines/operators should train and monitor flight crew compliance with established communication phraseology guidelines.

95   Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.

99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

106   Air Traffic service providers should train and monitor ATC adherence to established communications procedures including hearback problems.

122   Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

124   Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.

147   Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
      including aircraft systems, and the pilots intentions.)

240   To reduce the possibility of error, confusion and workload increase related to ATC clearances, regulators should require and operators should ensure that flight crews utilize proper phraseology and readbacks.

241   To eliminate hearback errors, ATC should reexamine and implement improvements to address hearback problems.

296   To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

701   Airlines/operators and air traffic service providers should increase training for pilots and controllers on progressive taxi instructions.

709   Air Traffic service providers should require training/standardization programs for controllers which teach situation awareness to include knowledge of timely and accurate instructions to flight
      crews.

717   FAA shall immediately initiate the regulatory and procedural process to delete the last sentence in the current FAR 91.129(i).

718   Air traffic control taxi instructions should identify all runway crossings required to reach the clearance limit.

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

734   Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

738   Air traffic service providers, airlines/operators, and manufacturers develop and install anti-blocking technology for voice communications.

739   Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.

740   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

744   Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

745   Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

749 Regulators should require airports to comply with international standards for marking and lighting.

752 Regulators and airport operators should ensure that runway entrances and taxi routes are clearly marked, signed, lighted, and maintained to prevent inadvertent runway entry during all meteorological conditions for which the runway and routes are intended to be used.

765 Air traffic service providers review procedures for combining positions and simulcasting on multiple frequencies to reduce confusion to flight crews listening to partial communications.

766 Regulators and manufacturers explore technology to allow ATC position combination without simulcasting to aircraft operating on different frequencies.

Problem

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6   ATC - Failure to Follow Procedures (Communications)

Failure of ATC to provide instructions/information/clearances using standard phraseology in accordance with appropriate regulatory directives

Intervention

--

28   Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

42   Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology.

88   Airlines/operators should train and monitor flight crew compliance with established communication phraseology guidelines.

94   Implement real time (digital) transmission of airport and weather information to the aircraft

95   Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.

106   Air Traffic service providers should train and monitor ATC adherence to established communications procedures including hearback problems.

122   Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

124   Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.

240   To reduce the possibility of error, confusion and workload increase related to ATC clearances, regulators should require and operators should ensure that flight crews utilize proper phraseology and readbacks.

296   To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.

707   Air traffic service providers shall immediately develop and implement national standardized requirements for tower positions to ensure uniform,   effective and sustained situational awareness
practices relating to surface operations.

708   Air Traffic service providers shall immediately review and redefine the course curriculum and procedural influences affecting scanning techniques.

709   Air Traffic service providers should require training/standardization programs for controllers which teach situation awareness to include knowledge of timely and accurate instructions to flight
crews.

717   FAA shall immediately initiate the regulatory and procedural process to delete the last sentence in the current FAR 91.129(i).

718   Air traffic control taxi instructions should identify all runway crossings required to reach the clearance limit.

720   FAA should review "Taxi Into Position and Hold" procedures including critical analysis of risk, methods of ATC technique training, and local implementation.

723   Air traffic service providers should perform a risk analysis of shared runway operations (departures and arrivals on the same runway) to determine their effect on surface movements and
runway incursions.

725   Air traffic service providers should reevaluate ATC-related SOPs for ground operations to ensure the SOPs continued relevancy and effectiveness.

735　FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e. AMASS, SMA, ATIDS (tags).

745　Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

760　Regulators and air traffic service providers should review phraseology used for surface movement operations to delete or change unnecessary　　and/or confusing phraseology.

761　FAA shall immediately prepare and distribute material informing aircraft and vehicle operators of surface movement instructions requiring a readback

767　Air traffic service providers should review requirements for the training and use of memory aids in the tower.

770　Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators.

Problem

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7　ATC - Inadequate Situation Awareness (Horizontal)

Failure of ATC to correctly identify aircraft position over the ground.

Intervention

--

28　Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

42　Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology.

47　Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft position.

95　Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.

106　Air Traffic service providers should train and monitor ATC adherence to established communications procedures including hearback problems.

110　Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

122　Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

124　Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.

147　Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

240　To reduce the possibility of error, confusion and workload increase related to ATC clearances, regulators should require and operators should ensure that flight crews utilize proper phraseology and readbacks.

296　To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.

709　Air Traffic service providers should require training/standardization programs for controllers which teach situation awareness to include knowledge of timely and accurate instructions to flight
crews.

728　Airlines/operators should emphasize the importance of visually clearing final approach and/or the runway prior to entering any active runway.

729　Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

734　Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

735 FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e. AMASS, SMA, ATIDS (tags).

737 Air Traffic service providers should provide airport surface surveillance equipment with conflict alerting capability at all air traffic control towers.

739 Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.

740 Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

744 Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

745 Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

765 Air traffic service providers review procedures for combining positions and simulcasting on multiple frequencies to reduce confusion to flight crews listening to partial communications.

768 Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

769 Regulators should create and promote to air traffic service providers a list of best controller practices for memorization and distraction management.

Problem

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8   ATC - Failure to Follow Procedures (SOP)

   Failure of ATC to follow established procedures.

Intervention

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12   Air Traffic service providers should emphasize in ATC training the controllers' potential in assisting the flight crew in improving their situation awareness.

28   Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

42   Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology.

88   Airlines/operators should train and monitor flight crew compliance with established communication phraseology guidelines.

99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

106   Air Traffic service providers should train and monitor ATC adherence to established communications procedures including hearback problems.

113   Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.

114   Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency.

122   Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

124   Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.

147   Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

240   To reduce the possibility of error, confusion and workload increase related to ATC clearances, regulators should require and operators should ensure that flight crews utilize proper phraseology and readbacks.

296   To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

334   Regulators should require airports to comply with International standards for airport constructions.

709   Air Traffic service providers should require training/standardization programs for controllers which teach situation awareness to include knowledge of timely and accurate instructions to

flight
crews.

723 Air traffic service providers should perform a risk analysis of shared runway operations (departures and arrivals on the same runway) to determine their effect on surface movements and
runway incursions.

724 Regulators and industry should agree to limit ATC instructions during high workload phases of flight to safety of flight information.

726 Air Traffic service providers should ensure standardization of flight strip handling.

734 Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

737 Air Traffic service providers should provide airport surface surveillance equipment with conflict alerting capability at all air traffic control towers.

743 Regulators should assess and require changes to aircraft lighting to ensure aircraft conspicuity, particularly from behind the aircraft.

745 Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

763 Air traffic service providers should ensure controllers request the aircraft call sign if pilots do not provide is as part of a readback.

765 Air traffic service providers review procedures for combining positions and simulcasting on multiple frequencies to reduce confusion to flight crews listening to partial communications.

768 Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

769 Regulators should create and promote to air traffic service providers a list of best controller practices for memorization and distraction management.

770 Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators.

Problem

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9   Airline Operations - PF/PNF Flying Procedures (Increased Workload at a Critical Phase)

Airline/operator procedures caused a disruption in crew activities and contributed to an increased flight crew work load during a critical phase of flight.

Intervention

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20   Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is
reviewed during recurrent training.

47   Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft
position.

82   Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (see 135)*

99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

110   Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

113   Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.

135   Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and   distribution of PN and PNF tasks.

147   Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot

surroundings,
including aircraft systems, and the pilots intentions.)

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

314   Airlines/operators should develop simulator training scenarios that require flight crews to learn multi-tasking abilities and appropriate prioritization abilities in concert with CRM skills (see Red Flag LOFT scenarios).

724   Regulators and industry should agree to limit ATC instructions during high workload phases of flight to safety of flight information.

727   Airlines/operators should review non-essential flight crew tasks to ensure tasks are accomplished during low workload phases of flight.

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

730   Airlines/operators develop better procedures for providing flight crews timely and accurate manifest revisions, passenger counts, and weight and balance information so that distractions during ground movement operations are minimized or eliminated.

740   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

744   Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

Problem

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10   Flight Crew - Failure to Follow Procedures (SOP)

Failure of flight crew to follow established procedures.

Intervention

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47   Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft position.

82   Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (see 135)*

95   Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.

99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

110   Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

147   Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

207   Airlines/operators should develop procedures to specify how transfer or control is formally accomplished.

296   To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

717   FAA shall immediately initiate the regulatory and procedural process to delete the last sentence in the current FAR 91.129(i).

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

741   Air traffic service providers and industry develop and implement technology to alert ATC and/or flight crews to deviations from taxi clearance.

745   Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

Problem

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12   Flight Crew - Inadequate Situation Awareness (Horizontal)

Failure of flight crew to correctly identify aircraft position over the ground.

Intervention

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47   Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft position.

82   Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (see 135)*

99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

110   Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

135   Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PN and PNF tasks.

147   Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

701   Airlines/operators and air traffic service providers should increase training for pilots and controllers on progressive taxi instructions.

703   Airlines/operators develop surface movement simulator training to address factors contributing to runway incursions (e.g. pavement configuration, closely spaced parallel runways, holding
position visual aids, etc.).

710   Regulators, airlines, and operators should encourage (through training, the AIM, pilot safety seminars, brochures, etc.) pilots to use airport charts for all surface operations.

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

734   Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

739   Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.

740   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

744   Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

745   Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

753   Regulators and airport operators install in-pavement stopbars or runway guard lights to serve holding positions where a runway is used as a taxi route to a departure runway.

754   Regulators and airport operators install runway holding position signs along runways used as taxiways.

Problem

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14   Aircraft Equipment - Equipment Failure

   Failure of instrument and/or warning system during critical phase of flight (approach/landing)

Intervention

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45   Manufacturers should ensure that all equipment failures or inappropriate settings that may affect the safe operation of the flight are properly annunciated to the flight crew by use of dual source sensing.

147   Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

Problem

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16   Flight Crew - CRM Failure

   Lack of CRM training or failure to follow CRM practices

Intervention

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20   Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is
reviewed during recurrent training.

21   Airlines/operators should encourage a culture that emphasizes safe arrivals over timely arrivals.

47   Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft position.

75   Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position.

82   Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (see 135)*

95   Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.

99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

110   Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

113   Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.

131   Airlines/operators should ensure that their training/standardization program emphasizes the importance of the team concept, cross cultural issues, evaluation of options and the obligation of
the FO to effectively communicate any concerns (CRM).

135   Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and
distribution of PN and PNF tasks.

147   Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

207   Airlines/operators should develop procedures to specify how transfer or control is formally accomplished.

296   To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

314   Airlines/operators should develop simulator training scenarios that require flight crews to learn multi-tasking abilities and appropriate prioritization abilities in concert with CRM skills (see Red Flag LOFT scenarios).

703   Airlines/operators develop surface movement simulator training to address factors contributing to runway incursions (e.g. pavement configuration, closely spaced parallel runways, holding
position visual aids, etc.).

724   Regulators and industry should agree to limit ATC instructions during high workload phases of flight to safety of flight information.

727   Airlines/operators should review non-essential flight crew tasks to ensure tasks are accomplished during low workload phases of flight.

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

740   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

744   Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

746   Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

Problem

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17   Airline Operations - Lack of Standardized Procedures

Failure of the airline/operator to provide adequate standard operating procedures that address situations and environments that the flight crews operate in

Intervention

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22   Airlines/operators should encourage a culture that emphasizes safe arrivals over timely arrivals.

99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

110   Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

113   Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.

114   Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency.

124   Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.

143   Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture).

147   Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

162   Airline/operators should include in their training programs the awareness of potential safety risks due to crew complacency when operating at a very familiar airport (e.g. home base).

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

334   Regulators should require airports to comply with International standards for airport constructions.

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

740   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

Problem

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20   Airline Operations - Lack of Training (Flight Crew)

   Airline/operator training failed to adequately address operational requirements necessary for the flight crew to safely operate the airplane.

Intervention

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99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

113   Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.

114   Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency.

124   Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.

143   Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture).

147   Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

162   Airline/operators should include in their training programs the awareness of potential safety risks due to crew complacency when operating at a very familiar airport (e.g. home base).

165   Airlines/operators should provide training scenarios that match realistic situations (I.e. stall recoveries during approach, in landing configuration at flight idle with the autopilot on (in simulator)).

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

334 Regulators should require airports to comply with International standards for airport constructions.

729 Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

739 Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.

740 Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

758 Regulators should ensure airlines/operators training, SOPs, and CRM incorporate visually acquiring and verbalizing the location of conflicting traffic.

Problem

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21   Flight Crew - "Press-On-itus"

Flight crew disregard of, or failure to recognize cues to terminate current course of action or maneuver

Intervention

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20   Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is
reviewed during recurrent training.

22   Airlines/operators should encourage a culture that emphasizes safe arrivals over timely arrivals.

37   Regulators should discontinue on-time arrival tracking for airlines.

82   Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (see 135)*

95   Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.

99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

110   Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

135   Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PN and PNF tasks.

143   Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture).

296   To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

734   Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

739   Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.

740   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

744   Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

745   Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

748   Regulators and airport operators develop standards for surface markings under all conditions, including wet pavement and low visibility.

752   Regulators and airport operators should ensure that runway entrances and taxi routes are clearly marked, signed, lighted, and maintained to prevent inadvertent runway entry during all meteorological conditions for which the runway and routes are intended to be used.

Problem

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22   Flight Crew - PNF Duties Not Performed

Pilot Not Flying (PNF) failed to perform monitoring function and other PNF responsibilities

Intervention

--   47   Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft position.

75   Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position.

82   Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (see 135)*

95   Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.

99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

110   Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

113   Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.

135   Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PN and PNF tasks.

147   Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

207   Airlines/operators should develop procedures to specify how transfer or control is formally accomplished.

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

314   Airlines/operators should develop simulator training scenarios that require flight crews to learn multi-tasking abilities and appropriate prioritization abilities in concert with CRM skills (see Red Flag LOFT scenarios).

703   Airlines/operators develop surface movement simulator training to address factors contributing to runway incursions (e.g. pavement configuration, closely spaced parallel runways, holding
position visual aids, etc.).

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

734   Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

740　Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

745　Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

Problem

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24　Flight Crew/Airline Operations - Aeromedical - Crew Medical / Fatigue Concerns

Disregard of aeromedical factors (fatigue, medications, alcohol, etc.)

Intervention

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111　Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training.

141　Airlines/operators and regulators should require training/standardization programs include training regarding physiological effects on aircrew performance, (e.g. low blood sugar).

308　Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

315　Regulators should update flight time/duty time regulations to counteract present commercial aviation environmental stressors. (e.g. crew rest requirements)

315　Regulators should require airline/operators to train flight crews to recognize and counteract acute and chronic fatigue.

Problem

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28　Air Traffic System - Inadequate Infrastructure (Equipment / Design)

The ATC system lacked equipment that might have helped prevent the accident (DME, radar, etc.)

Intervention

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28　Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

47　Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft position.

95　Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.

122　Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

147　Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

240　To reduce the possibility of error, confusion and workload increase related to ATC clearances, regulators should require and operators should ensure that flight crews utilize proper phraseology and readbacks.

296　To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.

717　FAA shall immediately initiate the regulatory and procedural process to delete the last sentence in the current FAR 91.129(i).

718   Air traffic control taxi instructions should identify all runway crossings required to reach the clearance limit.

723   Air traffic service providers should perform a risk analysis of shared runway operations (departures and arrivals on the same runway) to determine their effect on surface movements and

        runway incursions.

728   Airlines/operators should emphasize the importance of visually clearing final approach and/or the runway prior to entering any active runway.

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

734   Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

735   FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e. AMASS, SMA, ATIDS (tags).

737   Air Traffic service providers should provide airport surface surveillance equipment with conflict alerting capability at all air traffic control towers.

738   Air traffic service providers, airlines/operators, and manufacturers develop and install anti-blocking technology for voice communications.

739   Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.

740   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

743   Regulators should assess and require changes to aircraft lighting to ensure aircraft conspicuity, particularly from behind the aircraft.

744   Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

745   Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

768   Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

769   Regulators should create and promote to air traffic service providers a list of best controller practices for memorization and distraction management.

Problem

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32   Airline Operations - Inadequate Information Dissemination

   Failure of or inadequate airline/operator procedures for disseminating flight-critical information within the organization

Intervention

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729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

730   Airlines/operators develop better procedures for providing flight crews timely and accurate manifest revisions, passenger counts, and weight and balance information so that distractions during ground movement operations are minimized or eliminated.

Problem

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33 Air Traffic System - Inadequate Information Dissemination

Failure of or inadequate air traffic system procedures for disseminating flight-critical information

Intervention

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93 Air Traffic service should provide real time (most current) radio communication of critical airport and weather information.

94 Implement real time (digital) transmission of airport and weather information to the aircraft

124 Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.

709 Air Traffic service providers should require training/standardization programs for controllers which teach situation awareness to include knowledge of timely and accurate instructions to flight
crews.

723 Air traffic service providers should perform a risk analysis of shared runway operations (departures and arrivals on the same runway) to determine their effect on surface movements and
runway incursions.

725 Air traffic service providers should reevaluate ATC-related SOPs for ground operations to ensure the SOPs continued relevancy and effectiveness.

734 Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

735 FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e. AMASS, SMA, ATIDS (tags).

Problem

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34 Flight Crew - Failure to Exercise Command (Captain) Responsibility

Failure of captain to exercise command authority

Intervention

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20 Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is
reviewed during recurrent training.

99 Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

110 Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

300 Airlines/operators should adopt, implement and train a risk assessment tool to enhance flight crew awareness of hazards associated with all approaches and airports
(see risk analysis tactical checklist).

308 Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning,
communication, situational awareness, advocacy, etc. (IAW AC120-51b)

328 Airlines/operators should ensure that flight crews are trained to think in terms of "I will go-around unless" rather than "I will land unless". Regulatory policy should support this approach.

Problem

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38   Flight Crew Inappropriate Task Prioritization Under Time Constraints

Flight crew preoccupation with inappropriate tasks or failure to correctly prioritize the critical tasks under time constraints.

Intervention

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12   Air Traffic service providers should emphasize in ATC training the controllers' potential in assisting the flight crew in improving their situation awareness.

20   Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is
reviewed during recurrent training.

47   Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft position.

75   Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position.

82   Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (see 135)*

99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

110   Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

113   Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.

114   Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency.

135   Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PN and PNF tasks.

143   Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture).

147   Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

162   Airline/operators should include in their training programs the awareness of potential safety risks due to crew complacency when operating at a very familiar airport (e.g. home base).

241   To eliminate hearback errors, ATC should reexamine and implement improvements to address hearback problems.

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

314   Airlines/operators should develop simulator training scenarios that require flight crews to learn multi-tasking abilities and appropriate prioritization abilities in concert with CRM skills (see Red Flag LOFT scenarios).

724   Regulators and industry should agree to limit ATC instructions during high workload phases of flight to safety of flight information.

727   Airlines/operators should review non-essential flight crew tasks to ensure tasks are accomplished during low workload phases of flight.

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

730   Airlines/operators develop better procedures for providing flight crews timely and accurate manifest revisions., passenger counts, and weight and balance information so that distractions during ground movement operations are minimized or eliminated.

734   Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

739   Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.

740   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

744   Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

745   Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

Problem

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43   Flight Crew - Home Aerodrome Complacency

  Flight crew failure to recognize and counteract complacency that may exist when operating at home aerodrome.

Intervention

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   99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

  113   Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.

  114   Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency.

  143   Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture).

  162   Airline/operators should include in their training programs the awareness of potential safety risks due to crew complacency when operating at a very familiar airport (e.g. home base).

  308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

Problem

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46   Air Traffic System - Procedures that Compromise Safety.

  Air Traffic system procedures that may compromise safety or increase flight crew workload (e.g. noise abatement procedures, slam dunk approaches, inappropriate taxi routes during low visibility
  operations, etc).

Intervention

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   12   Air Traffic service providers should emphasize in ATC training the controllers' potential in assisting the flight crew in improving their situation awareness.
   28   Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

  122   Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

  721   Air traffic service provider should perform a risk analysis of intersection departures and position and hold procedures to determine their effect on surface movements and runway
incursions.

  722   Local air traffic service management should design specific procedures to be implemented when a runway(s) is used as a taxiway(s).

  734   Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

765 Air traffic service providers review procedures for combining positions and simulcasting on multiple frequencies to reduce confusion to flight crews listening to partial communications.

766 Regulators and manufacturers explore technology to allow ATC position combination without simulcasting to aircraft operating on different frequencies.

768   Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

769 Regulators should create and promote to air traffic service providers a list of best controller practices for memorization and distraction management.

Problem

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54 ATC/Flight Crew - Actions/Inaction's Contributed to Increased Workload

Flight crew actions or inactions contributed to increased workload (e.g. missed checklist items causing a rushed approach).

Intervention

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20 Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is
reviewed during recurrent training.

28 Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

82 Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (see 135)*

99 Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

110 Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

135 Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PN and PNF tasks.

308 Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

314 Airlines/operators should develop simulator training scenarios that require flight crews to learn multi-tasking abilities and appropriate prioritization abilities in concert with CRM skills (see Red Flag LOFT scenarios).

724 Regulators and industry should agree to limit ATC instructions during high workload phases of flight to safety of flight information.

727 Airlines/operators should review non-essential flight crew tasks to ensure tasks are accomplished during low workload phases of flight.

729 Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

740 Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

744 Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

Problem

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55 Airline Operations - Burdened Flight Crew with Non-Flight Related Tasks

Airline operator policies burdened flight crew with non-flight related tasks (e.g. paperwork requirements while flying; communications with dispatch and/or ARTC request for info not related to safe flight and landing).

Intervention

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20 Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is
reviewed during recurrent training.

82 Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (see 135)*

99 Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

110 Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

135 Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and   distribution of PN and PNF tasks.

147 Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

308 Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

314 Airlines/operators should develop simulator training scenarios that require flight crews to learn multi-tasking abilities and appropriate prioritization abilities in concert with CRM skills (see Red Flag LOFT scenarios).

727 Airlines/operators should review non-essential flight crew tasks to ensure tasks are accomplished during low workload phases of flight.

729 Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

Problem

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57 Aircraft Equipment - Design Shortcomings

System design was not appropriate for conditions encountered.

Intervention

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723 Air traffic service providers should perform a risk analysis of shared runway operations (departures and arrivals on the same runway) to determine their effect on surface movements and
runway incursions.

737 Air Traffic service providers should provide airport surface surveillance equipment with conflict alerting capability at all air traffic control towers.

743 Regulators should assess and require changes to aircraft lighting to ensure aircraft conspicuity, particularly from behind the aircraft.

Problem

102   Flight Crew - Inadequate Planning/Briefing

Inadequate planning/briefing by the flight crew.

Intervention

99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

113   Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.

114   Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency.

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

334   Regulators should require airports to comply with International standards for airport constructions.

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

738   Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.

739   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

Problem

103   Air Traffic System - Inadequate Weather Information Provided to the Flight Crew

Inadequate weather information provided to the flight crew by air traffic services

Intervention

93   Air Traffic service should provide real time(most current) radio communication of critical airport and weather information.

124   Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.

Problem

106   Flight Crew - Failure to Recognize the State of the Airplane

Flight crew failure to recognize the state of the airplane (speed, energy state, power setting, pitch attitude, relevant elements of the pilot surroundings, including aircraft systems and the pilot's

intentions).

Intervention

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111   Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training.

141   Airlines/operators and regulators should require training/standardization programs include training regarding physiological effects on aircrew performance, (e.g. low blood sugar).

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

315   Regulators should update flight time/duty time regulations to counteract present commercial aviation environmental stressors. (e.g. crew rest requirements)

316   Regulators should require airline/operators to train flight crews to recognize and counteract acute and chronic fatigue.

Problem

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107   Flight Crew - Failure to Use All Available Information Resources

Flight crew failure to use all available information resources.

Intervention

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20   Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is
reviewed during recurrent training.

28   Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

47   Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft
position.

75   Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position.

82   Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (see 135)*

99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

113   Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.

122   Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

131   Airlines/operators should ensure that their training/standardization program emphasizes the importance of the team concept, cross cultural issues, evaluation of options and the obligation of
the FO to effectively communicate any concerns (CRM).

135   Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PN and PNF tasks.

147   Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

300   Airlines/operators should adopt, implement and train a risk assessment tool to enhance flight crew awareness of hazards associated with all approaches and airports (see risk analysis tactical checklist).

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

312   Airline/operators should ensure that flight crews are trained in operations involving low light and poor visibility on wet or otherwise contaminated runways, and with the presence of optical or
physiological illusions, before they are assigned line duties.

314   Airlines/operators should develop simulator training scenarios that require flight crews to learn multi-tasking abilities and appropriate prioritization abilities in concert with CRM skills (see Red Flag LOFT scenarios).

334   Regulators should require airports to comply with International standards for airport constructions.

718   Air traffic control taxi instructions should identify all runway crossings required to reach the clearance limit.

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

734   Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

740   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

744   Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

745   Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

749   Regulators should require airports to comply with international standards for marking and lighting.

Problem

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204   Flight Crew - Not adequately Prepared for the Task

Flight crew not adequately prepared for the task(inadequate briefing, inadequate assessment of weather factors and not mentally prepared).

Intervention

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47   Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft position.

75   Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position.

113   Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.

147   Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

300   Airlines/operators should adopt, implement and train a risk assessment tool to enhance flight crew awareness of hazards associated with all approaches and airports (see risk analysis tactical checklist).

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

312   Airline/operators should ensure that flight crews are trained of operations involving low light and poor visibility on wet or otherwise contaminated runways, and with the presence of

optical or
physiological illusions, before they are assigned line duties.

334 Regulators should require airports to comply with International standards for airport constructions.

729 Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

Problem

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303 Flight Crew - Failure to Process and Interpret Available Relevant Data

Flight crew failure to process and interpret available relevant data.

Intervention

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20 Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is
reviewed during recurrent training.

28 Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

47 Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft
position.

95 Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.

110 Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

122 Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

147 Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

718 Air traffic control taxi instructions should identify all runway crossings required to reach the clearance limit.

728 Airlines/operators should emphasize the importance of visually clearing final approach and/or the runway prior to entering any active runway.

729 Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

734 Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

739 Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.

740 Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

744 Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

745 Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

749 Regulators should require airports to comply with international standards for marking and lighting.

768 Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

769 Regulators should create and promote to air traffic service providers a list of best controller practices for memorization and distraction management.

Problem

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410   Flight Crew - Inappropriate Task Prioritization Under Time Constraints

Flight crew preoccupation (with other ((inappropriate)) tasks) or failure to correctly prioritize the critical tasks to the detriment of primary (flight) tasks.

Intervention

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113   Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.

135   Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PN and PNF tasks.

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

Problem

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701   ATC - Control Methods (Scanning).

Failure to scan or inadequate scanning.

Intervention

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707   Air traffic service providers shall immediately develop and implement national standardized requirements for tower positions to ensure uniform, effective and sustained situational awareness
practices relating to surface operations.

708   Air Traffic service providers shall immediately review and redefine the course curriculum and procedural influences affecting scanning techniques.

709

719   The FAA should review "Reduced Separation on Final" and LAHSO procedures including critical analysis of risk, methods of ATC technique training, and local implementation to determine the effect on surface movements and runway incursions.

735   FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e. AMASS, SMA, ATIDS (tags).

736   Air traffic service providers shall install surface surveillance systems.

767   Air traffic service providers should review requirements for the training and use of memory aids in the tower.

768   Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

770   Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators.

775   Air traffic service providers shall apply special emphasis on prioritization of control actions during OJT.

Problem

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702   ATC - Control Methods (Local Procedures).

   Failure to adhere to local procedures.

   Intervention

--   707   Air traffic service providers shall immediately develop and implement national standardized requirements for tower positions to ensure uniform, effective and sustained situational awareness practices relating to surface operations.

          708   Air Traffic service providers shall immediately review and redefine the course curriculum and procedural influences affecting scanning techniques.

          735   FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e. AMASS, SMA, ATIDS (tags).

          757   Air traffic service providers should develop and implement an Air Traffic Control Resource Management (ATCRM) program.

          767   Air traffic service providers should review requirements for the training and use of memory aids in the tower.

          770   Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators.

          774   Air traffic service providers shall increase the emphasis of anticipating separation during OJT training.

Problem

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703   ATC - Progressive Taxi Instructions.

   Failure to provide complete taxi instructions.

   Intervention

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          701   Airlines/operators and air traffic service providers should increase training for pilots and controllers on progressive taxi instructions.

          717   FAA shall immediately initiate the regulatory and procedural process to delete the last sentence in the current FAR 91.129(i).

Problem

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704   Flight Crew - Failure to Follow recommended Procedures for traffic Pattern Entry at Uncontrolled Airport.

   Failure to enter traffic pattern, make proper radio calls, and/or visually acquire other traffic in accordance with recommended procedures.

   Intervention

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          706   Regulators/industry should explore and implement more effective ways to educate pilots on recommended practices (procedures, communications, traffic patterns, etc.) at non-towered airports.

Problem
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705   ATC - Control Methods (Vehicle Identification).

Failure to establish and/or maintain positive vehicle identification.

Intervention

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707   Air traffic service providers shall immediately develop and implement national standardized requirements for tower positions to ensure uniform,   effective and sustained situational awareness
practices relating to surface operations.

735   FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e. AMASS, SMA, ATIDS (tags).

736   Air traffic service providers shall install surface surveillance systems.

767   Air traffic service providers should review requirements for the training and use of memory aids in the tower.

768   Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

770   Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators.

Problem

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706   ATC - Control Methods (Memory Aids).

Failure to use or improper use of memory aids

Intervention

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707   Air traffic service providers shall immediately develop and implement national standardized requirements for tower positions to ensure uniform,   effective and sustained situational awareness
practices relating to surface operations.

708   Air Traffic service providers shall immediately review and redefine the course curriculum and procedural influences affecting scanning techniques.

735   FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e. AMASS, SMA, ATIDS (tags).

767   Air traffic service providers should review requirements for the training and use of memory aids in the tower.

768   Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

770   Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators.

Problem

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707   ATC- Control Judgement (TIPH).

Injudicious use of taxi into position and hold (TIPH).

707 Air traffic service providers shall immediately develop and implement national standardized requirements for tower positions to ensure uniform,   effective and sustained situational awareness
practices relating to surface operations.

708 Air Traffic service providers shall immediately review and redefine the course curriculum and procedural influences affecting scanning techniques.

720 FAA should review "Taxi Into Position and Hold" procedures including critical analysis of risk, methods of ATC technique training, and local implementation.

735 FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e. AMASS, SMA, ATIDS (tags).

736 Air traffic service providers shall install surface surveillance systems.

767 Air traffic service providers should review requirements for the training and use of memory aids in the tower.

768 Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

770 Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators.

775 Air traffic service providers shall apply special emphasis on prioritization of control actions during OJT.

Problem

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708 ATC - Control Judgement (Anticipated Separation).

Failure to correctly anticipate separation.

Intervention

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707 Air traffic service providers shall immediately develop and implement national standardized requirements for tower positions to ensure uniform,   effective and sustained situational awareness
practices relating to surface operations.

708 Air Traffic service providers shall immediately review and redefine the course curriculum and procedural influences affecting scanning techniques.

716 Regulators should review multiple landing clearance procedures including critical analysis of risk and methods of ATC technique training.

719 The FAA should review "Reduced Separation on Final" and LAHSO procedures including critical analysis of risk, methods of ATC technique training, and local implementation to determine the effect on surface movements and runway incursions.

735 FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e. AMASS, SMA, ATIDS (tags).

770 Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators.

774 Air traffic service providers shall increase the emphasis of anticipating separation during OJT training.

Problem

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709 ATC-Control Judgement (Prioritization).

Failed to correctly prioritize control actions

Intervention

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707   Air traffic service providers shall immediately develop and implement national standardized requirements for tower positions to ensure uniform,   effective and sustained situational awareness

practices relating to surface operations.

708   Air Traffic service providers shall immediately review and redefine the course curriculum and procedural influences affecting scanning techniques.

716   Regulators should review multiple landing clearance procedures including critical analysis of risk and methods of ATC technique training.

719   The FAA should review "Reduced Separation on Final" and LAHSO procedures including critical analysis of risk, methods of ATC technique training, and local implementation to determine the effect on surface movements and runway incursions.

720   FAA should review "Taxi Into Position and Hold" procedures including critical analysis of risk, methods of ATC technique training, and local implementation.

735   FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e. AMASS, SMA, ATIDS (tags).

736   Air traffic service providers shall install surface surveillance systems.

760   Regulators and air traffic service providers should review phraseology used for surface movement operations to delete or change unnecessary   and/or confusing phraseology.

768   Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

770   Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators.

774   Air traffic service providers shall increase the emphasis of anticipating separation during OJT training.

775   Air traffic service providers shall apply special emphasis on prioritization of control actions during OJT.

Problem

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710   ATC - Inadequate Situation Awareness (Surface).

    Failure to correctly identify aircraft position on the airport surface.

Intervention

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711   Airlines/operators should train crews to stop taxiing and request ATC assistance anytime they are unsure of their position on the airport surface.

721   Air traffic service provider should perform a risk analysis of intersection departures and position and hold procedures to determine their effect on surface movements and runway incursions.

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

737   Air Traffic service providers should provide airport surface surveillance equipment with conflict alerting capability at all air traffic control towers.

743   Regulators should assess and require changes to aircraft lighting to ensure aircraft conspicuity, particularly from behind the aircraft.

752   Regulators and airport operators should ensure that runway entrances and taxi routes are clearly marked, signed, lighted, and maintained to prevent inadvertent runway entry during all meteorological conditions for which the runway and routes are intended to be used.

759   Airlines/operators should emphasize low-visibility operations in CRM training.

768   Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

769   Regulators should create and promote to air traffic service providers a list of best controller practices for memorization and distraction management.

770   Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators.

Problem

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711   Flight Crew - Inadequate Situation Awareness (Environment).

    Failure to maintain or recognize a loss of an adequate level of attentiveness and surveillance, including the pilot environment, aircraft/crew status and an understanding of current and potential conditions and outcomes.

Intervention

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12   Air Traffic service providers should emphasize in ATC training the controllers' potential in assisting the flight crew in improving their situation awareness.

17   Airlines/operators should ensure that their training/standardization programs emphasize the importance of all flight-related briefings.

20   Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is
reviewed during recurrent training.

22   Airlines/operators should encourage a culture that emphasizes safe arrivals over timely arrivals.

28   Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

42   Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology.

47   Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft

position.

75   Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position.

95   Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.

99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

106   Air Traffic service providers should train and monitor ATC adherence to established communications procedures including hearback problems.

110   Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and
identify the rationale behind those procedures.

113   Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.

114   Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency.

122   Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

124   Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.

135   Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PN and PNF tasks.

147   Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot
surroundings,
including aircraft systems, and the pilots intentions.)

241   To eliminate hearback errors, ATC should reexamine and implement improvements to address hearback problems.

296   To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.

300   Airlines/operators should adopt, implement and train a risk assessment tool to enhance flight crew awareness of hazards associated with all approaches and airports
(see risk analysis tactical checklist).

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning,
communication, situational awareness, advocacy, etc. (IAW AC120-51b)

312   Airline/operators should ensure that flight crews are trained in operations involving low light and poor visibility on wet or otherwise contaminated runways, and with the presence of optical or
physiological illusions, before they are assigned line duties.

314   Airlines/operators should develop simulator training scenarios that require flight crews to learn multi-tasking abilities and appropriate prioritization abilities in concert with CRM skills
(see Red Flag LOFT scenarios).

334   Regulators should require airports to comply with International standards for airport constructions.

342   Airlines/operators should establish an SOP to ensure that flight crews do not begin the approach until adequate briefing is completed for the expected runway.

702   Regulators mandate flight crew training for ground operations, especially with regard to runway crossing or occupancy clearances.

703   Airlines/operators develop surface movement simulator training to address factors contributing to runway incursions (e.g. pavement configuration, closely spaced parallel runways, holding
position visual aids, etc.).

705   Airlines/operators should use cockpit simulators to provide pilots with low-visibility taxi training.

713   Regulators and airport operators establish standardized airport diagram depiction and information requirements.

718   Air traffic control taxi instructions should identify all runway crossings required to reach the clearance limit.

724   Regulators and industry should agree to limit ATC instructions during high workload phases of flight to safety of flight information.

727   Airlines/operators should review non-essential flight crew tasks to ensure tasks are accomplished during low workload phases of flight.

728   Airlines/operators should emphasize the importance of visually clearing final approach and/or the runway prior to entering any active runway.

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

731   FAA should include a recommendation in the AIM for Part 91 operations to use "sterile cockpit" procedures that are intended to focus attention on ground operations.

732   FAA should create and publish in the AIM a recommended mnemonic for radio and scan procedures prior to initiating takeoff.

733   FAA should amend the AIM to emphasize the special nature of operations at non-towered airports with intersecting runways.

734   Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

737   Air Traffic service providers should provide airport surface surveillance equipment with conflict alerting capability at all air traffic control towers.

739   Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.

740   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

743   Regulators should assess and require changes to aircraft lighting to ensure aircraft conspicuity, particularly from behind the aircraft.

744   Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

745   Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

746   Regulators, industry, and airport operators develop and install a visual signal for aircraft on final approach to indicate runway is occupied (e.g. PAPI modified to flash or pulse when the runway is occupied).

748   Regulators and airport operators develop standards for surface markings under all conditions, including wet pavement and low visibility.

749   Regulators should require airports to comply with international standards for marking and lighting.

750   FAA should require implementation of SMGCS plans at airports during low visibility (RVR<1200) operations.

752   Regulators and airport operators should ensure that runway entrances and taxi routes are clearly marked, signed, lighted, and maintained to prevent inadvertent runway entry during all meteorological conditions for which the runway and routes are intended to be used.

758   Regulators should ensure airlines/operators training, SOPs, and CRM incorporate visually acquiring and verbalizing the location of conflicting traffic.

765   Air traffic service providers review procedures for combining positions and simulcasting on multiple frequencies to reduce confusion to flight crews listening to partial communications.

768   Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

769   Regulators should create and promote to air traffic service providers a list of best controller practices for memorization and distraction management.

Problem

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712   Charting Authority - Airport Approach Chart Fails to Contain Accurate/Pertinent Information.

    Mislabeling or failure to label specific information, i.e. proper radio frequency for arrival/departure runway, geographic gate, etc.

Intervention

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713   Regulators and airport operators establish standardized airport diagram depiction and information requirements.

Problem

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713   Flight Crew - Task Saturation/Workload Management Anomaly.

Failure to recognize/avoid task saturation and/or properly manage workload resulting in degradation or non-performance of necessary duties.

Intervention

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20   Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is
reviewed during recurrent training.

47   Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft
position.

75   Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position.

82   Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (see 135)*

99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

110   Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

113   Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.

135   Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and   distribution of PN and PNF tasks.

147   Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

314   Airlines/operators should develop simulator training scenarios that require flight crews to learn multi-tasking abilities and appropriate prioritization abilities in concert with CRM skills (see Red Flag LOFT scenarios).

724   Regulators and industry should agree to limit ATC instructions during high workload phases of flight to safety of flight information.

727   Airlines/operators should review non-essential flight crew tasks to ensure tasks are accomplished during low workload phases of flight.

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

734   Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

739   Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.

740   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

744   Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

745   Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

Problem

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714   Flight Crew - Failure to Follow ATC Instructions.

Failure to follow ATC instructions.

Intervention

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701   Airlines/operators and air traffic service providers should increase training for pilots and controllers on progressive taxi instructions.

710   Regulators, airlines, and operators should encourage (through training, the AIM, pilot safety seminars, brochures, etc.) pilots to use airport charts for all surface operations.

712   Regulators should encourage (through the AIM, pilot safety seminars, brochures, etc.) pilots to identify themselves to ATC controllers as being unfamiliar with an airport.

717   FAA shall immediately initiate the regulatory and procedural process to delete the last sentence in the current FAR 91.129(i).

740   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

Problem

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715   Regulators - Negative Regulatory Influences (Procedures).

Taxi clearance includes clearance to cross intervening runways.

Intervention

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20   Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is
reviewed during recurrent training.

28   Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

47   Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft
position.

82   Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (see 135)*

95   Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.

99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

110   Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

122   Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

135   Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PN and PNF tasks.

143   Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture).

147   Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,

including aircraft systems, and the pilots intentions.)

296   To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.

717   FAA shall immediately initiate the regulatory and procedural process to delete the last sentence in the current FAR 91.129(i).

718   Air traffic control taxi instructions should identify all runway crossings required to reach the clearance limit.

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

740   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

745   Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

Problem

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116   ATC - Practices/Procedures Increased Flight Crew Workload During a Critical Phase (Communications/Procedures)

  ATC practices/procedures caused a disruption in crew activities and contributed to an increased flight crew workload during a critical phase of flight.

Intervention

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20   Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is
reviewed during recurrent training.

28   Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

82   Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (see 135)*

99   Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

106   Air Traffic service providers should train and monitor ATC adherence to established communications procedures including hearback problems.

110   Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

122   Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

124   Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.

135   Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PN and PNF tasks.

308   Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

314   Airlines/operators should develop simulator training scenarios that require flight crews to learn multi-tasking abilities and appropriate prioritization abilities in concert with CRM skills (see Red Flag LOFT scenarios).

709   Air Traffic service providers should require training/standardization programs for controllers which teach situation awareness to include knowledge of timely and accurate instructions to flight
crews.

724   Regulators and industry should agree to limit ATC instructions during high workload phases of flight to safety of flight information.

727   Airlines/operators should review non-essential flight crew tasks to ensure tasks are accomplished during low workload phases of flight.

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

734 Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

740 Regulators and industry should develop and implement graphic cockpit displays(e.g. moving map) that depict taxi routes and clearance limits.

744 Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

768 Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

769 Regulators should create and promote to air traffic service providers a list of best controller practices for memorization and distraction management.

Problem

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717 Regulators - Failure to Consider and Publish LAHSO Missed Approach Procedures

 Regulators failed to consider and/or publish missed approach procedures for LAHSO.

Intervention

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219 719 The FAA should review "Reduced Separation on Final" and LAHSO procedures including critical analysis of risk, methods of ATC technique training, and local implementation to determine the effect on surface movements and runway incursions.

Problem

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718 ATC - Control Methods (Aircraft Identification).

 Failed to establish/maintain positive identification of aircraft.

Intervention

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707 Air traffic service providers shall immediately develop and implement national standardized requirements for tower positions to ensure uniform,   effective and sustained situational awareness
practices relating to surface operations.

708 Air Traffic service providers shall immediately review and redefine the course curriculum and procedural influences affecting scanning techniques.

717 FAA shall immediately initiate the regulatory and procedural process to delete the last sentence in the current FAR 91.129(i).

719 The FAA should review "Reduced Separation on Final" and LAHSO procedures including critical analysis of risk, methods of ATC technique training, and local implementation to determine the effect on surface movements and runway incursions.

735 FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e. AMASS, SMA, ATIDS (tags).

736 Air traffic service providers shall install surface surveillance systems.

757 Air traffic service providers should develop and implement an Air Traffic Control Resource Management (ATCRM) program.

760 Regulators and air traffic service providers should review phraseology used for surface movement operations to delete or change unnecessary   and/or confusing phraseology.

767 Air traffic service providers should review requirements for the training and use of memory aids in the tower.

768 Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

770 Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators.

774 Air traffic service providers shall increase the emphasis of anticipating separation during OJT training.

775 Air traffic service providers shall apply special emphasis on prioritization of control actions during OJT.

Problem

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719 ATC - ATC/Pilot Communication.

Failed to request required readback.

Intervention

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707 Air traffic service providers shall immediately develop and implement national standardized requirements for tower positions to ensure uniform,   effective and sustained situational awareness
practices relating to surface operations.

708 Air Traffic service providers shall immediately review and redefine the course curriculum and procedural influences affecting scanning techniques.

717 FAA shall immediately initiate the regulatory and procedural process to delete the last sentence in the current FAR 91.129(i).

735 FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e. AMASS, SMA, ATIDS (tags).

736 Air traffic service providers shall install surface surveillance systems.

760 Regulators and air traffic service providers should review phraseology used for surface movement operations to delete or change unnecessary   and/or confusing phraseology.

761 FAA shall immediately prepare and distribute material informing aircraft and vehicle operators of surface movement instructions requiring a readback

770 Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators.

775 Air traffic service providers shall apply special emphasis on prioritization of control actions during OJT.

Problem

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720 Airline Operations - Lack of SOP for Ground Operations

Failure of airlines/operators to ensure that clear, accurate, and appropriate standard operating procedures (SOPs) are established for all aircraft operations.

Intervention

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17 Airlines/operators should ensure that their training/standardization programs emphasize the importance of all flight-related briefings.

20 Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is
reviewed during recurrent training.

28 Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

47 Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft

position.

75	Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position.
82	Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (see 135)*
95	Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.
99	Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.
110	Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.
113	Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.
122	Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.
131	Airlines/operators should ensure that their training/standardization program emphasizes the importance of the team concept, cross cultural issues, evaluation of options and the obligation of the FO to effectively communicate any concerns (CRM).
135	Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PN and PNF tasks.
143	Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture).
147	Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings, including aircraft systems, and the pilots intentions.)
162	Airline/operators should include in their training programs the awareness of potential safety risks due to crew complacency when operating at a very familiar airport (e.g. home base).
241	To eliminate hearback errors, ATC should reexamine and implement improvements to address hearback problems.
296	To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.
308	Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)
312	Airline/operators should ensure that flight crews are trained in operations involving low light and poor visibility on wet or otherwise contaminated runways, and with the presence of optical or physiological illusions, before they are assigned line duties.

314 Airlines/operators should develop simulator training scenarios that require flight crews to learn multi-tasking abilities and appropriate prioritization abilities in concert with CRM skills (see Red Flag LOFT scenarios).

342 Airlines/operators should establish an SOP to ensure that flight crews do not begin the approach until adequate briefing is completed for the expected runway.

718 Air traffic control taxi instructions should identify all runway crossings required to reach the clearance limit.

724 Regulators and industry should agree to limit ATC instructions during high workload phases of flight to safety of flight information.

727 Airlines/operators should review non-essential flight crew tasks to ensure tasks are accomplished during low workload phases of flight.

728 Airlines/operators should emphasize the importance of visually clearing final approach and/or the runway prior to entering any active runway.

729 Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

734 Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

737 Air Traffic service providers should provide airport surface surveillance equipment with conflict alerting capability at all air traffic control towers.

739 Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.

740 Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

744 Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

745 Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

748 Regulators and airport operators develop standards for surface markings under all conditions, including wet pavement and low visibility.

749 Regulators should require airports to comply with international standards for marking and lighting.

752 Regulators and airport operators should ensure that runway entrances and taxi routes are clearly marked, signed, lighted, and maintained to prevent inadvertent runway entry during all meteorological conditions for which the runway and routes are intended to be used.

768 Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

769 Regulators should create and promote to air traffic service providers a list of best controller practices for memorization and distraction management.

Problem

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721 Flight Crew - Failure to Clarify Clearance or Situation Where a Doubt Exists

Flight crew failure to clarify clearance or situation where a doubt exists.

Intervention

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95 Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.

147 Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

296 To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.

308 Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

734 Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground

vehicles.

740   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

Problem

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722   Aircraft Equipment - Identification of Mechanical Failures

Failure to annunciate or inability to identify mechanical failure through normal crew or maintenance duties

Intervention

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45   Manufacturers should ensure that all equipment failures or inappropriate settings that may affect the safe operation of the flight are properly annunciated to the flight crew by use of dual source sensing.

103   Manufacturers should develop and implement system failure annunciation capabilities to alert flight crews of pending failures (e.g. HUMS)

138   Manufacturers should ensure that design logic for warnings and equipment failures to be annunciated to the crew do not cause nuisance warnings, which would contribute to crew complacency.

Problem

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723   Airline/operators & Regulators - Failure to Require Suitable and Adequate Equipment for Ground Operations.

Airlines/operators and/or regulators failed to require or provide suitable and adequate equipment for ground operations

Intervention

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742   Regulators require air carrier aircraft be equipped with an operational taxi light to adequately illuminate the surface area immediately ahead of the aircraft without "blinding" other pilots.

Problem

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724   Airport Operator - Failure to Provide and/or Maintain Adequate Visual Aids for Ground Movement.

Failure to provide and/or maintain adequate surface markings, signage, and/or lights.

Intervention

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17   Airlines/operators should ensure that their training/standardization programs emphasize the importance of all flight-related briefings.

20   Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is
reviewed during recurrent training.

22   Airlines/operators should encourage a culture that emphasizes safe arrivals over timely arrivals.

28 Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

42 Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology.

47 Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft

position.

75 Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position.

82 Airlines/operators should clearly define, train, and check the specific PF/PNF duties. (see 135)*

95 Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.

99 Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced.

106 Air Traffic service providers should train and monitor ATC adherence to established communications procedures including hearback problems.

110 Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

113 Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.

114 Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency.

122 Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

124 Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.

135 Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PN and PNF tasks.

143 Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture).

147 Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

162 Airline/operators should include in their training programs the awareness of potential safety risks due to crew complacency when operating at a very familiar airport (e.g. home base).

296 To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.

300 Airlines/operators should adopt, implement and train a risk assessment tool to enhance flight crew awareness of hazards associated with all approaches and airports
(see risk analysis tactical checklist).

308 Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

312 Airline/operators should ensure that flight crews are trained in operations involving low light and poor visibility on wet or otherwise contaminated runways, and with the presence of optical or
physiological illusions, before they are assigned line duties.

314 Airlines/operators should develop simulator training scenarios that require flight crews to learn multi-tasking abilities and appropriate prioritization abilities in concert with CRM skills
(see Red Flag LOFT scenarios).

334 Regulators should require airports to comply with International standards for airport constructions.

342 Airlines/operators should establish an SOP to ensure that flight crews do not begin the approach until adequate briefing is completed for the expected runway.

703 Airlines/operators develop surface movement simulator training to address factors contributing to runway incursions (e.g. pavement configuration, closely spaced parallel runways, holding
position visual aids, etc.).

713 Regulators and airport operators establish standardized airport diagram depiction and information requirements.

717 FAA shall immediately initiate the regulatory and procedural process to delete the last sentence in the current FAR 91.129(i).

718   Air traffic control taxi instructions should identify all runway crossings required to reach the clearance limit.

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

734   Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

739   Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.

740   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

744   Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

745   Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

748   Regulators and airport operators develop standards for surface markings under all conditions, including wet pavement and low visibility.

749   Regulators should require airports to comply with international standards for marking and lighting.

751   Regulators and airport operators should develop and install a sign(s) to indicate the location of the threshold of a runway to be used for takeoff wherever there is potential for pilot confusion
as to it's location. (e.g. stopways, displaced thresholds, closed runway sections, etc.)

752   Regulators and airport operators should ensure that runway entrances and taxi routes are clearly marked, signed, lighted, and maintained to prevent inadvertent runway entry during all meteorological conditions for which the runway and routes are intended to be used.

753   Regulators and airport operators install in-pavement stopbars or runway guard lights to serve holding positions where a runway is used as a taxi route to a departure runway.

753   Regulators and airport operators install runway holding position signs along runways used as taxiways.

Problem

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725   Regulators - Failure To Require Runway Vacated Guidance.

Failure to require airports to provide reliable indication that the aircraft is clear of the runway safety area after runway exit.

Intervention

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747   Regulators and airport operators develop and install runway vacated guidance.

Problem

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726   Charting Authority- Inadequate Airport Diagram Chart

Airport diagram fails to provide readily understandable information needed for surface operations, e.g. absence or poor depiction of runway holding point areas.

Intervention

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47   Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft position.

75   Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position.

713   Regulators and airport operators establish standardized airport diagram depiction and information requirements.

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

734   Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

739   Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.

740   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

744   Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

745   Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

747   Regulators and airport operators develop standards for surface markings under all conditions, including wet pavement and low visibility.

Problem

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727   Regulators - Prohibition of the Use of Full Landing Flaps.

Regulators modified aircraft certification to prohibit use of full landing flaps to comply with noise abatement concerns.

Intervention

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719   The FAA should review "Reduced Separation on Final" and LAHSO procedures including critical analysis of risk, methods of ATC technique training, and local implementation to determine the effect on surface movements and runway incursions.

Problem

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728   Regulators and Airport Operators - Failure to Require and/or Provide Visual Vertical Guidance for LAHSO Runway

Failure to require and/or provide PAPI for LAHSO where aiming point and visual situation awareness are critical.

Intervention

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755   Regulators require airport operators to equip each air carrier LAHSO runway approach end with PAPI.

Problem

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729   ATC - Coordination.

Failed to correctly perform coordination.

Intervention

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707   Air traffic service providers shall immediately develop and implement national standardized requirements for tower positions to ensure uniform,   effective and sustained situational awareness
practices relating to surface operations.

708   Air Traffic service providers shall immediately review and redefine the course curriculum and procedural influences affecting scanning techniques.

717   FAA shall immediately initiate the regulatory and procedural process to delete the last sentence in the current FAR 91.129(i).

719   The FAA should review "Reduced Separation on Final" and LAHSO procedures including critical analysis of risk, methods of ATC technique training, and local implementation to determine the effect on surface movements and runway incursions.

735   FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e. AMASS, SMA, ATIDS (tags).

736   Air traffic service providers shall install surface surveillance systems.

757   Air traffic service providers should develop and implement an Air Traffic Control Resource Management (ATCRM) program.

760   Regulators and air traffic service providers should review phraseology used for surface movement operations to delete or change unnecessary   and/or confusing phraseology.

770   Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators.

775   Air traffic service providers shall apply special emphasis on prioritization of control actions during OJT.

Problem

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730   ATC - ATC/Pilot Communications ("Hearback").

Misheard pilot readback (i.e. "hearback" error).

Intervention

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707   Air traffic service providers shall immediately develop and implement national standardized requirements for tower positions to ensure uniform, effective and sustained situational awareness
practices relating to surface operations.

708   Air Traffic service providers shall immediately review and redefine the course curriculum and procedural influences affecting scanning techniques.

735   FAA shall provide new technology tools for enhanced surveillance, information, and conflict detection, i.e. AMASS, SMA, ATIDS (tags).

760   Regulators and air traffic service providers should review phraseology used for surface movement operations to delete or change unnecessary   and/or confusing phraseology.

767   Air traffic service providers should review requirements for the training and use of memory aids in the tower.

770   Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators.

Problem

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731   Flight Crew - Failure to Correctly Identify Call Sign

Failure to differentiate among similar-sounding call signs (i.e. call sign confusion)

    Intervention

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    122   Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

    764   Regulators and airlines/operators should review procedures for avoiding similar call signs.

Problem

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732   ATC - Failure to Maintain Correct Call Sign Identification

ATC used incorrect call sign or failed to differentiate among similar-sounding call signs (i.e. call sign confusion).

    Intervention

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    122   Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

    764   Regulators and airlines/operators should review procedures for avoiding similar call signs.

Problem

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733   ATC - Human Memory Anomaly

Memory failure including forgotten items, oversights, etc.

    Intervention

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    28   Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

    47   Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft position.

    106   Air Traffic service providers should train and monitor ATC adherence to established communications procedures including hearback problems.

    122   Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

    124   Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.

147 Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

724 Regulators and industry should agree to limit ATC instructions during high workload phases of flight to safety of flight information.

728 Airlines/operators should emphasize the importance of visually clearing final approach and/or the runway prior to entering any active runway.

729 Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

734 Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

737 Air Traffic service providers should provide airport surface surveillance equipment with conflict alerting capability at all air traffic control towers.

739 Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.

740 Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

744 Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

768 Air traffic service providers shall provide training in the limitations of memory and the ways to supplement and/or help sustain memory capabilities.

769 Regulators should create and promote to air traffic service providers a list of best controller practices for memorization and distraction management.

Problem

----

734 Flight Crew - Human Memory Anomaly

Memory failure including forgotten items, oversights, etc.

Intervention

----

20 Airlines/operators should ensure that command oversight training for captains is provided during the upgrade process and in recurrent training and first officer responsibility for monitoring is
reviewed during recurrent training.

28 Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.

47 Airlines/operators should ensure that their training/standardization programs direct the flight crews to use all available resources (charts, ATC, inter/intra crew) to establish aircraft

position.

110 Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures.

122 Air Traffic service providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.

147 Airlines/operators should require training/standardization programs which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings,
including aircraft systems, and the pilots intentions.)

296 To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.

308 Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, advocacy, etc. (IAW AC120-51b)

718 Air traffic control taxi instructions should identify all runway crossings required to reach the clearance limit.

729   Airlines/operators and regulators should develop and implement SOPs with specific crew duties for ground operations conducted in all meteorological conditions.

734   Airlines/operators, manufacturers, airport operators, and regulators should develop and install traffic situation displays, with air/ground conflict information included, in aircraft and ground vehicles.

737   Air Traffic service providers should provide airport surface surveillance equipment with conflict alerting capability at all air traffic control towers.

739   Regulators and industry develop and implement heads-up guidance systems that display information appropriate for ground operations.

740   Regulators and industry should develop and implement graphic cockpit displays (e.g. moving map) that depict taxi routes and clearance limits.

744   Regulators and airport operators develop and install lighting to indicate runway exit and taxi route.

745   Regulators and airport operators should develop and install unambiguous visual aids to signal a clearance to enter an active runway.

749   Regulators should require airports to comply with international standards for marking and lighting.

Problem

--

735   ATC-Failure to Provide Adequate Separation.

Controller caused aircraft to violate separation through improper and/or inadequate clearance.

Intervention

--

770   Air traffic service providers should institute mandatory, recurrent, proficiency training related to reducing runway incursions for all tower controllers in high-fidelity tower simulators.

RUNWAY INCURSION STUDY

Runway incursions are a serious threat to aviation safety. The most serious accident in commercial aviation was a runway incursion accident. The potential for a recurrence of such an accident is always present. A systematic, wide-ranging study of runway incursions will assist in understanding the systemic, root cause of such events. It will also help to develop effective prevention methods and procedures.

It is essential for a runway incursion study to have acceptance, support, and participation from all affected parties and organizations. These include ALPA, AOPA, APA, ATA, FAA (Airports, Air Traffic, Flight Standards, and System Safety), NATCA, and RAA.

The airports selected for the study should generally be the 10 or 15 with the most runway incursion events reported over the previous several years. There may be valid reasons to select an airport that did not have a high number of reports but other information may indicate a need to include in the study.

A recent NASA Aviation Safety Reporting System Quick Response Study No. 307, An Analysis of Runway Incursion Incidents, August 12, 1999 listed the top 15 airports for runway incursion incidents, as reported to ASRS in the time period January 1996 to December 1998. These were, in descending order according to reports received: Cleveland, Pittsburgh, St. Louis, Chicago O'Hare, Miami, Boston, Los Angeles, Houston, Dallas/Ft. Worth, Washington National, Philadelphia, Las Vegas, Charlotte, JFK, and LaGuardia.

This list should be correlated with the FAA list of runway incursion incidents to arrive at the final selection of airports to be included in the study.

Purpose

The purpose of this study is to collect as much information on current operations associated and dealing with actual and potential runway incursions at the airports listed. The data collected will be used to identify and substantiate potential problems and justify any intervention strategies which have been instituted or may be necessary in the future.

Time

The study will be conducted for an 18-month period of active receipt of incident reports. Additional time will be required for initiation of the study, notification of participants, and analysis of the incidents.

Once a starting date is determined, it will be necessary to notify controllers at the involved airports and coordinate with airlines, and others, flying into those airports. Airline notification will also involve notification of the FAA Principal Operations Inspector.

Definition

The first step for the purpose of this study will be to apply a uniform definition of "runway incursion" so everyone will be operating from the same basis and will understand what is covered. We would recommend the NASA Aviation Safety Reporting System (ASRS) definition, which is:

> **A runway incursion (transgression) is an incident that involves the erroneous or improper occupation of a runway or its immediate environs by an aircraft or other vehicle so as to pose a potential collision hazard to other aircraft that could be using the runway,** *even if no such other aircraft were actually present*.

This definition will capture a larger event set than just those incidents where there is a traffic conflict and danger of collision. A great deal of information can be gleaned from incidents where corrective action on the part of a participant prevents a situation from developing into a danger of collision or loss of separation.

Other reportable incidents and items for data collection include, but are not limited to; go-arounds within 1 mile of the end of the runway, taxi-off the runway due to lack of spacing, misidentified aircraft, aircraft or vehicle lost on the airport, and any other events which could be potential runway incursions.

Reporting

Report forms will be used for both pilots and controllers. It is essential to capture these two perspectives for each reported incident. Report forms must be readily available to all participants, whether in airline operations areas, ATC facilities, or FAA offices for general aviation pilots. Incidents to be reported will include not only actual runway incursions but near incursions as well. A near incursion would occur when an aircraft actually impinges on an active runway but there is no collision threat, or when an aircraft is about to enter an active runway but is prevented by actions of a crewmember or controller, or other events that would have resulted in a Runway Incursion had no action been taken. The forms will provide a basis for initial reporting of an incident and Data gathering of other events. Follow-up action will be taken through additional contacts with persons involved in the incident.

Program Guidelines

It must be understood up front, and regularly reinforced, that participants in the program will have a waiver of disciplinary action for events that are covered under the study. Pilots will not be subject to enforcement action by the FAA and controllers will not face Disciplinary or rectification action by the FAA. Active participation and coordination with FAA's Flight Standards and Air Traffic Services will be required to provide for these waivers of disciplinary action.

Waiver of disciplinary action will only be available if the event is inadvertent and not deliberate, is not related to criminal activity, and does not involve an accident.

Anonymity

Once all information has been collected about the incident, the reporter's name and any identifying information will be purged or sanitized. At that time, there will be no way to connect a reporter to the incident.

Incident Investigation and Analysis

Reports should be submitted as soon as possible after an incident. There will be a comprehensive and detailed debriefing of all reported Incursions/incidents. This should be done face-to-face with the principals in attendance. There should be a mechanism to allow immediate procedural changes and/or non-jeopardy education of respective participants (pilots and/or controllers) in the event the need is demonstrated.

A Master Event Review Team (MERT) will be established to provide overall program guidance and oversight. This team will consist of representatives from FAA (Airports, Air Traffic, Flight Standards, and System), AAAE, ACI, ALPA, AOPA, APA, ATA, NATCA, and RAA, among others. The MERT will receive the results of the investigations of each of the runway incursions that are investigated during the program. The MERT will also recommend and approve corrective action.

An Event Review Team (ERT) should conduct debriefing of flight crews and controllers involved in a reported runway incursion. The ERT will be comprised of a representative from the airline's Flight Safety Department, a safety representative from the pilot's and controller's organizations, an airport representative, and a representative from the FAA Certificate Holding District Office (CHDO). The ERT should meet with and debrief the flight crew and controllers as soon as practical following a runway incursion. To facilitate this process, the ATC Facility where the runway incursion took place should forward all related information, including ATC communication tapes, to the responsible FAA CHDO as soon as practical following the runway incursion.

The purpose of the ERT debrief is NOT to assess blame, but is two fold. First, it is to enlist input from the flight crew and/or controllers involved, in order to discover as many facts as possible surrounding the runway incursion. And second, it is to afford the flight crew and controllers the opportunity to become familiar with all the facts surrounding the event, furthering their education and safety awareness regarding runway incursions.

If the runway incursion/event involves a general aviation aircraft, a representative from the ATC Facility and the geographically responsible FSDO, along with an AOPA and an airport Representative, should make up the ERT who will debrief the pilot/s. If it is not possible to debrief the general aviation pilot through an ERT, then the MERT may serve this purpose.

The results from these flight crew debriefs shall be forwarded to the MERT as soon as possible for evaluation. The MERT and ERT must be empowered to make recommendations to all participating organizations in order to prevent future runway incursions.

The process for debriefing ATC Controllers should be conducted under the same guidelines as the flight crew debriefs. The Controller ERT should be comprised of representatives from NATCA, the ATC Facility, and, if feasible, a Safety representative from the Airline involved or AOPA. Events shall be forwarded to the local ERT for compilation of the associated data as soon as possible after an event, before the end of the shift, so as to allow for any follow-up or review that may be necessary with the report.

Recognizing the FAA's congressional mandate to enforce the Federal Aviation Regulations, each flight crew involved in an inadvertent runway incursion at one of the designated airports, during the period of this study, will be afforded an enforcement-related incentive to report and participate in the ERT debriefings. The incentive will be to close out the FAA investigation with either No Action or Administrative Action. This incentive will not apply to deliberate acts. If a flight crew's report is a sole source report revealing the non-compliance with a FAR, the FAA investigation will be closed by issuing a Letter of No Action.

In like manner, Air Traffic Controllers who are involved in an inadvertent runway incursion at one of the designated airports during the period of this study, will also be offered an incentive to report and participate in the ERT debriefings. There will be no action taken against controllers for reporting any event or due to any information derived from the reporting. They will not be de-certified and will be offered non-jeopardy training. This process, including the debriefing, shall not inflict any monetary loss on the controller. If a controller's report is a sole source report then the FAA will take no action.

In the event that an ERT is not available for debriefing a reporter, whether their airline does not participate or the individual does not fly for one, then the individual will go directly to the MERT to be debriefed.

Note: This reporting and debriefing process was utilized very successfully during the U S Air Altitude Awareness Study conducted in 1990 and 1991.

Education

Extensive education of pilots, both air carrier and general aviation, must be undertaken prior to the implementation of this program, detailing the purpose and freedom to report any and all events without fear of reprisal or action. If possible face to face briefing of the Air Traffic Controllers at the designated facilities should be completed. This education effort serves to promote participation by pilots and controllers, as well as instill trust and confidence in the program.

Data Analysis

In addition to the Master Event Review Team, an independent analysis group will be employed to receive and analyze reports for information to be gleaned from individual incidents and the aggregate of events. The purpose is not only statistical analysis to see common trends across airports, but also the examination of causal factors and proposals for corrective action and the validation of newly implemented procedures intended to prevent future runway incursions.

The use of an independent analysis group is important. This should provide a measure of protection from Freedom of Information Act (FOIA) Requests.

Feedback

During the study, there will be provision for feedback from pilots and controllers to fine-tune the information gathering process. This will look at the adequacy of the information that is received and the incident review process. This should also include refinement of proposed remedial actions, or newly implemented procedures that may be designed to prevent runway incursions.

Industry Workshop

There will be a workshop of all industry representatives at the conclusion of the study. This workshop will cover a number of areas involved with the study to include monitoring of the effectiveness of newly implemented procedures, possible redesign of those procedures, and the address of any possible new interventions.

Continuing Industry Follow-up

It should be realized that this 18-month study will not eliminate runway incursions. There will be a need for continued industry analysis and follow-up of runway incursions, especially at the airports included in the study. This process will facilitate quick attention to any increase in runway incursion rates, and will afford the opportunity to take rapid and effective corrective action if necessary.

Runway Incursion Study
ATC Incident Report Form

Why You Should Fill Out This Form

This report will contribute to the understanding of runway incursions and potential events that could lead to possible incursions; why they occur, the individual and system circumstances that lead to them, and what can be done to prevent them.

When Should You Fill Out This Form?

This form should be filled out as soon as possible after a runway incursion or event occurs, or after a runway incursion is prevented (potential runway incursion). It is not necessary for a traffic conflict to occur.

What Else Will You Be Expected To Do?

This form solicits background information about the incident (actual or potential runway incursion or event). You can expect to be contacted shortly to obtain more detailed information. We are very interested in what you have to say regarding the incident/event and we want to give you an opportunity to express your opinions and ideas concerning it.

Anonymity

Once all the information has been collected about the incident/event, your name and any identifying information will be purged. At that time, there will be no way to connect you to your information.

Instructions

Please fill in the data boxes as indicated. When you are given a multiple choice, check the response that is most appropriate. If you need additional space for any of your responses or comments, please use the blank side of the last sheet or attach additional sheets, as necessary.

NO RECORD WILL BE KEPT OF YOUR IDENTITY.

Part I - Please fill all data blocks.
 This section will be purged once all information has been collected.

 1. ATC Facility: _____

 2. Name _____   _____ _____
            (First name)   (Last name)   (mi.)

Part II - Please check the appropriate response and fill in the data blocks as indicated.

1. Are you reporting a runway incursion or a potential runway incursion?
        Please Check One:
                [ ]-A runway incursion
                [ ]-A potential runway incursion
                [ ]-A Go-around within 1 mile of the runway
                [ ]-A Potential Hazard or Reporting some Other event
        Explain_____

2. Date of incident: _____/_____/____
                  (month) (day) (year)

3. Time of incident: _____
                  (24-hour clock, local time)

4. Aircraft (A) _____/_____
                Type/model
   Aircraft (B) _____/_____
                Type/Model

5. Identify the Runways and airport where this incident occurred,
        Facility ID. _____
        Runway(s) _____/_____

Does the airport have a perimeter road for vehicles? [ ]-Yes   [ ]-No

Describe the weather at the time of the incident:
[ ]-IFR   [ ]-VFR   [ ]-Marginal VFR

What is your operational status? Please Check One;
[ ]-FPL   [ ]-Developmental   [ ]-Supervisor   [ ]-TMU   [ ]-Other_____

How long have you been certified or working in the position indicated above? _____/____
                                             Years / Months
What position were you working?
[ ]-Local   [ ]-Ground   Other -Specify_____

What were the Flow rates into the airport at the time? Advertised_____ Actual_____
Do you have a TMC   [ ]-Yes [ ]-No

Does your facility have surface Radar [ ]-Yes [ ]No
        If the answer was Yes; Was it operational? [ ]-Yes   [ ]-No
        Would surface radar have prevented this incident [ ]-Yes [ ]-No
        Would Aircraft Tags on the ASDE have prevented the incident [ ]-Yes [ ]-No

What separation standards were being used on final?
[ ]-Visual   [ ]-Standard 3   [ ]-Heavy Jet   [ ]-757   [ ]-Waiver 2 1/2 inside marker
Other / Requested separation on final from approach; explain_____

Describe amount of traffic volume – [ ]-Heavy   [ ]-Moderate   [ ]- Light

Approximately, How many aircraft were within 10 miles of the airport? _____
Approximately, How many aircraft were moving around on the airport? _____
How many aircraft were on frequency? _____

Do you feel the flow rate was too high?   [ ]-Yes   [ ]-No

Describe the Complexity – [ ]-Extreme   [ ]- Difficult   [ ]-Moderate   [ ]-Normal
Explain if Necessary_____

Describe frequency congestion -   [ ]-Heavy   [ ]-Moderate   [ ]- Light
Explain if necessary_____

How many frequencies were combined to your position that you were listening to?_____

Please describe **how** you were monitoring/working the frequencies?
i.e.; (all in ear, one in ear-two on speaker) etc.. _____

How many positions were combined and **how** were they combined with your position? " List all positions combined you had responsibly for i.e.; (CIC, Local, Local assist, Ground) or (Flight data, Clearance Delivery, CIC, Ground) or (Local, Cab Coordinator, Radar, Ground) etc….
_____
_____
_____
_____

Please mark all that apply to this Event;

[ ]-Aircraft Go-Around
[ ]-Aircraft was in position
[ ]-Aircraft did not have landing clearance
[ ]-An unauthorized aircraft/vehicle was on the runway
[ ]-Aircraft or Vehicle crossed runway without clearance
[ ]-Mis-identified aircraft/vehicle crossed runway
[ ]-Arriving Aircraft was still on Runway(not clear)
[ ]-Aircraft did not exit runway at first intersection
[ ]-Aircraft did not cross runway at first available intersection
[ ]-Trying to hit hole that did not work
[ ]-Aircraft was taxied off runway due to limited spacing with arrival
[ ]-Insufficient arrival separation
[ ]-LAHSO was involved
[ ]-Intersecting Runway operation
[ ]-Crossing Taxiway operation
[ ]-TIPH was involved
[ ]-Progressive taxi instructions were being issued to an aircraft
[ ]-An unfamiliar aircraft was on frequency
[ ]-An Aircraft did not readback hold short instructions
[ ]-An aircraft was talking and I could not transmit
[ ]-Hitting holes with departures
[ ]-Unanticipated aircraft action
[ ]-Aircraft lost on the airport
[ ]-Vehicle lost on airport
[ ]-Vehicle involved could have used perimeter road
[ ]-Aircraft misunderstood taxi instructions or clearance
[ ]-Aircraft/vehicle took someone else's clearance
[ ]-I Misunderstood the aircraft's destination on airport
[ ]-I did not catch the readback
[ ]-Aircraft was on the wrong Frequency
[ ]-Frequency congestion
[ ]-I said "Follow" not "Cross"
[ ]-Working a flow not normally worked
[ ]-I was Working a Midshift
[ ]-I was alone in the Tower

Human Factors;

[ ]-I Got ahead of myself
[ ]-I Was too rushed
[ ]-I had a memory overload
[ ]-I was stressed out
[ ]-I was Distracted performing some other assigned duty
[ ]-I was coordinating
[ ]-I was Distracted. By what? _____
[ ]-I Forgot aircraft or vehicle on runway
[ ]-I Forgot coordination that was accomplished with local or ground
[ ]-I forgot aircraft was crossing
[ ]-I thought Aircraft/Vehicle was already across the runway

In your own words rate the level of background noise in the Cab at the time of the Event
_____
_____
_____

Explain your facilities memory aids_____

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In you opinion are the current Memory Aids sufficient   [ ]-Yes   [ ]-No
Do you use a writing tablet?   [ ]-Yes   [ ]-No

Have you seen or been associated with a Runway Incursion? [ ]-Yes [ ]-No

On which day of your workweek did this incident occur?
[ ]-1st   [ ]-2nd   [ ]-3rd   [ ]-4th   [ ]-5th   [ ]-6th   [ ]-Overtime day

Was this shift a quick turn (double back) for you? [ ]-Yes   [ ]-No

How much sleep between shifts/duty did you have? _____ hrs.

How much time does it take you to drive home? _____

What time of day did your shift start? _____
    (24-hour clock, local time)

[ ]- I was tired
[ ]- I was rested
[ ]- I just finished eating
[ ]- I was hungry
[ ]- I was sick or did not feel well

How long were you on position before the incident occurred? _____/_____
                                                          Hours/ Minutes

How many people were working with you, on shift, when the incident occurred? _____

Did you request help prior to the incident? [ ]-Yes   [ ]-No

If you answered "Yes" to the previous question, did you receive any immediate help? [ ]-Yes   [ ]- No

In your opinion was the shift "Short Staffed"? [ ]-Yes   [ ]-No

Have you had any ATTE / CRM / CART or any other type of Team Work Enhancement Training? [ ]-Yes [ ]-No Type_____ Where/
When _____/_____

Please provide a brief narrative description of the incident – include why you think it happened? Also, Include any extenuating circumstances
or causal factors you feel may have been pertinent.
_____
_____
_____
_____
_____
_____
_____
_____
_____

What do you think would have prevented or did prevent the incident from occurring?
_____
_____
_____
_____
_____
_____
_____
_____

Any Other comments to note;

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Runway Incursion Study
Flight Crewmember Incident Report Form

Why You Should Fill Out This Form

This report will contribute to the understanding of runway incursions; why they occur, the individual and system circumstances that lead to them, and what can be done to prevent them.

When Should You Fill Out This Form?

This form should be filled out as soon as possible after a runway incursion occurs, or after a runway incursion is prevented by a crewmember action (potential runway incursion). It is not necessary for a traffic conflict to occur.

What Else Will You Be Expected To Do?

This form solicits background information about the incident (actual or potential runway incursion). You can expect to be contacted shortly to obtain more detailed information. We are very interested in what you have to say regarding the incident and we want to give you an opportunity to express your opinions and ideas concerning it.

Anonymity

Once all the information has been collected about the incident, your name and identifying information will be purged. At that time, there will be no way to connect you to your information.

Instructions

Please fill in the data boxes as indicated. When you are given a multiple choice, check the response that is most appropriate. If you need additional space for your responses/comments, please use the blank side of the last sheet or attach additional sheets, as necessary.

Part I – Please fill out all data blocks. **NO RECORD WILL BE KEPT OF YOUR IDENTITY**. This section will be purged once all information has been collected.

1. Airline/Flight number: "   "   "   /"   "   "   "

2. Name
    "
    (last name)
    " " " " " " " " " " " " " " " " " "
    (first name)   (mi)

Part II – Please check the appropriate response and fill in the data blocks as indicated.

1. Are you reporting a runway incursion or a potential runway incursion?
    "   A runway incursion   "   A potential runway incursion

2. Date of incident: " " /" " /" " " "
                                      (month) (day)   (year)

3. Time of incident (24-hour clock, local time)   " " " "

4.   What was your duty position?
     "   Captain   "   First Officer   "   Second Officer   "   Other

5. Aircraft type/model: " " " " –" " "

6. Identify the airport where this incident occurred, e.g. IAD: " " "

7.   Describe the weather at the time of the incident:
     "   IMC   "   VMC   "   Marginal VMC

8.   How many hours into the individual <u>duty</u> day had elapsed at the time of the incident? (round off to the nearest hour)
     " "

9.   On which leg of the day did the incident occur? (enter digit from 1 to xx)
     " "

10. What was the total number of trip duty hours, for the entire trip, at the time of the incident? (round off to the nearest hour)
     " "

11. Phase of operation?
     "   Taxi for takeoff   "   Taxi after landing   "   Taxi to reposition

12. Which crewmember copied and acknowledged the taxi clearance?
     "   Captain   "   First Officer   "   Second Officer

13. Did another crewmember verify the taxi clearance? "   Yes   "   No

14. If yes, which crewmember? "   Captain   "   First Officer "   Second Officer

15. What was the cockpit workload when taxi instructions were received?
     "   Heavy   "   Moderate   "   Light

16. How would you assess the risk of an accident resulting from this incident?
     "   Very high   "   High   "   Medium   "   Low

Brief narrative description of the incident – Why do you think it happened?
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

What would have prevented/did prevent the incident from occurring?

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Appendix I
Data Evolution

As mentioned in the narrative, after establishing the data set, the JSAT divided into four groups of subject-matter experts to analyze the data. In each group, team members evaluated their data for quality, accuracy, and scope before including the data in the final analysis. The criteria for final acceptance varied among groups, due to the wide variance in the type and quality of each group's raw data. Data sets covered a spectrum in quality from NTSB "Blue Book" accident reports ("high": rich, accurate data with insights into the background and external factors influencing the accidents) to FAA Pilot Deviation reports ("low" to "marginal": lean, fact-oriented reports without the benefit of extensive background or corroboration). Appendix B, Data Set Statistics, details this winnowing process. Data selected for final analysis satisfied group members that sufficient detail existed to reconstruct an event sequence and draw some valid conclusions about the causes of the accident or incident.

Each group worked independently on its data. The level of detail and timing accuracy of the event sequences varied directly with the quality of the data. However, reports used in the final analysis contained sufficient detail to construct a meaningful event sequence. The team started with the list of Characteristics and Indicators (C&I) used by previous JSATs. These C&I were primarily focused on airborne or high-energy accidents. Consequently, many of the categories and potential responses ignored runway incursion issues. The team continually modified the list of C&I and appropriate responses. Group 3, Pilot Deviations, had weak data to work with and reported difficulty in applying C&I categories and responses. Group 4, Pilot Reports, had sufficient data in many cases to indicate the presence of a specific C&I, but the exact value either wasn't known or reported. Based on these limitations, it would be difficult or inappropriate to make comparisons between runway incursion C&I and C&I from previous JSATs.

After constructing event sequences, the groups independently developed problem statements and then intervention strategies for their event sequences. The groups started with the "standard" problem statements and interventions compiled from previous JSATs. Groups wrote new problem statements and interventions to address the unique aspects of their runway incursion analysis. This process differed from previous JSATs in the level of intuition required from some groups because of poor quality of their data. Group reservations about the validity of their interventions resulting from poor data quality were reflected in lower P/C/A values during the rating process.

Data housekeeping was a problem due to the large volume of data and the variance in data sets. Initially, each group developed a spreadsheet or worksheet that fit its individual data requirements. Merging the data from different groups was problematic. The team developed and standardized an electronic spreadsheet format and medium. After the groups completed their spreadsheets, the volume of merged data made an electronic spreadsheet cumbersome. Consequently, with contractor support,

the team developed and converted the data spreadsheets into a database containing all analysis. The C&I data from each group was not transferred to the database because of the problems previously noted. A team member is analyzing the C&I data separately for possible trends or supportable interventions. When CAST accepts the JSATs analysis, the final JSAT report and the database will be transferred to CD-ROM for distribution.

The groups verified the accuracy of their event sequences to ensure each intervention was associated with a problem statement. Several interventions could be associated with the same problem statement. Working backward, the groups verified that each problem statement was identified with a specific event in the event sequence. As with interventions, several problem statements could be associated with the same event in the sequence. Several groups developed interventions based on their analysis that could not be directly tied to an event in any accident/incident sequence. These interventions were not assigned P/C/A values during the rating process and were removed from the data-driven interventions for separate treatment.

Using the rating guidelines in the JSAT Process Handbook, dated September 10, 1999, the groups assigned P/C/A values to each intervention in a four-step rationalization process. To preserve the underlying P/C/A values during rationalization, Overall Effectiveness (OE) for each intervention was not calculated. Also, group members considered their reservations about data quality during the rating process. Typically, data weakness was reflected in lower values for Power (P) and Confidence (C). During the first step, each intervention was rated against a specific event in the sequence. In the second step, interventions that appeared more than once in the same accident/incident were reduced to a single P/C/A value representing that accident/incident. In the third step, the group reduced multiple P/C/A values for the same intervention from various accidents/incidents in its data set to one value for the group. The fourth step is a departure from the Process Handbook. Because each group developed interventions and assigned P/C/A ratings independently, the team reduced like P/C/A ratings to a single value representing the team consensus value for that individual intervention. At the completion of this rationalization process, the team had one consensus P/C/A value for each intervention. The original P/C/A value each group assigned in the first step of the rating process was preserved in the event sequence in the database.

Because each group developed problem statements and interventions independently, a working group edited the problem statements and interventions and recommended changes, combinations, and deletions. The revised problem statements and interventions were presented to the team for final approval. By agreeing to revised wording or an alternate intervention, the group agreed to transfer its P/C/A value to the new or revised intervention. If there were any doubts about the fit of the group's data and the revised problem statement or intervention, the original problem statement or intervention was retained.

All new or proposed modifications to existing problem statements and intervention strategies developed by the RI JSAT were reviewed by the CAST process team to avoid duplicative or similar problems on interventions. At this point, the team had a complete list of problem statements and interventions with global P/C/A values representing all the team's analysis.

A working group reviewed the methodology used by the Approach and Landing JSAT to compile its recommendations. Initially, the working group sorted all intervention in descending order of OE (Appendix F). After reviewing the sorted interventions, the working group decided that although the top ten interventions were important, these interventions did not adequately address or prioritize the team's final recommendations. Next, the working group reviewed the OE sort to identify natural breaks or clumping in the OE values. Again, the working group did not feel the OE distribution was representative of the team's analysis. Using a different approach, the working group developed categories that represented all the functional areas covered by the team's interventions (Appendix E). As noted in Appendix E, each intervention was assigned to only one primary category. Most interventions could fall into several categories; however, each intervention logically fell into a primary category based on its relevance to runway incursions. Using a process similar to the Approach and Landing JSAT, the working group aggregated like interventions into related clusters within each category. The process preserved OE integrity by arranging interventions in descending OE value both within the clusters and within the categories. The working group used the resulting clusters of interventions to draft recommendations. The entire team reviewed the working group process and draft

recommendations. Overall, the team felt that categorization was a logical organizational tool that preserved the value of OE ratings while improving the overall recommendations.

Finally, the team renumbered the problem statements and interventions based on categories (Appendices C and D). Although not required, the renumbering based on clusters within categories places similar problem statements and interventions in numerical order. This was based on the team's experience working with the "standard" problem statements and interventions from previous JSATs. Because the "standard" problem statements and interventions weren't grouped logically, team members had to sort through the entire list for all the problem statements or interventions related to a specific area (e.g., CRM). After renumbering by category, the team's problem statements and interventions should be arranged logically.

CAST reviewed the draft JSAT report and made recommendations about the presentation of the JSAT findings. One of CASTs principal objections dealt with the ranking of interventions by OE. Although the JSAT recognized this shortcoming and presented recommendations based on categorization rather than pure OE, CAST asked the JSAT to review the intervention rating process and methodology. Two team members met with JSAT process experts designated by CAST to discuss the JSATs understanding and application of P/C/A values during the intervention rating process. During discussions, the process experts agreed the JSAT applied ratings in accordance with current written guidance. However, two issues were apparent:

1. First, the current written guidance for JSAT process did not adequately address the nuances of the rating process, especially with respect to Confidence (C) and Applicability (A).
2. Second, the original JSAT process was designed for small databases (i.e., accident data) and was deficient when dealing with large databases resulting from incidents.

Consequently, the process experts and team members reviewed the JSATs data and identified the number of times each intervention was rated by the JSAT (i.e., frequency). Using a list of all interventions with frequency and associated P/C/A, the group identified a potential modifier for Applicability based on frequency. Using the following values, the group assigned adjusted Applicability ratings to each intervention based on its frequency.

Frequency	Applicability
100+	6
80-99	5
50-79	4
20-49	3
10-19	2
1-9	1

These adjusted Applicability values were used in place of the original JSAT values, OE was recomputed, and interventions were reordered based on the adjusted Applicability and OE. The group felt the resulting ranking and distribution of the interventions was more representative of the JSATs findings.

A working group consisting of members from each JSAT group reviewed the rational and methodology for adjusting Applicability based on frequency of the interventions. Although the working group approved the adjusted Applicability values and resulting OE, group members had the following reservations about the process:

1. Using frequency as the major component of Applicability was applied *after* the JSAT data was collected and analyzed. If the team members had known the significance of frequency, the JSAT could have balanced the data sources more evenly. For example, the group analyzing Operational Errors randomly selected only 50 of 178 possible reports.

2. Adjusting Applicability for frequency tends to favor interventions generated from large data sets (such as Pilot Reports) at the expense of interventions from small data sets (such as Pilot Deviations).

3. Small data set interventions that were extremely powerful may receive very low OE ratings due to small frequency values.

4. Finally, weighting OE by adjusting Applicability for frequency assumes frequency is a valid consideration in historical data and implies frequency will continue as a valid consideration in future incident data. Although the adjusted Applicability methodology seems logical, the premise was not tested.

After accepting the adjusted Applicability values and noting objections, the working group verified the resulting OE values. Both the original JSAT Applicability rating and the adjusted applicability rating were saved in the database. The working group sorted the interventions from highest to lowest OE. Using the prioritized interventions, the group then reordered and regrouped interventions into categories. Finally, the working group rewrote the draft JSAT report to reflect the adjusted intervention rankings and include an explanation of the frequency methodology and associated objections.

Team Members

Team Co-Chairs

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| Sue O'Brien | Runway Safety Program Manager | FAA |

Group 1

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Additional Team Members

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Appendix K
Global Review of Characteristics & Indicators

The JSAT Process Handbook includes the following steps to further investigate accident and incident data:

> "After all accidents and incidents covered by a JSAT have been reviewed, and problem statements and interventions have been developed, the characteristics /indicators for all accidents and incidents may be reviewed to identify trends that may not have been identified at the level of problem statements. These trends may be reported in the JSAT report.
>
> In addition, it again may be helpful to conduct a brainstorming activity to identify issues or problems that appear when viewing the dataset a whole. The "Why" list (Appendix J) may again be useful. Each team member should use this brainstorming time to capture "out of the box" thoughts that may turn out to be important in preventing or reducing the type of accidents or incidents being studied."

The Characteristics & Indicators (C&I) from each of the four JSAT-RI working groups were combined into a single database. Four working groups independently processed four different types of data sets, and each group adapted or extended a baseline set of C&Is which itself had been adapted from the C&Is developed by previous JSATs. This 'baseline C&I' group consisted of 109 areas. Group One analyzed five NTSB accident reports and populated these 109 C&I questions. The NTSB accident reports represented the most comprehensive data set available for this JSAT, and C&Is were identified for each aircraft involved in these accidents. Consequently, there are a total of ten entries in the combined database from the Group One analysis.

Group Two analyzed 50 Operational Error reports and developed an additional set of 18 C&Is which could be populated from the OE reports. Group Three analyzed 24 accidents/incidents from Pilot Deviation Reports and/or Aviation Safety Reporting System Reports and added 9 additional C&Is to the group. Group Four analyzed 58 Pilot Reports from several major air carriers and used the baseline 109 C&Is where data was available. The combined database thus is comprised of 142 records (10 from Group One, 50 from Group Two, 24 from Group Three, and 58 from Group Four) with 136 Characteristics and Indicators (109 + 18 + 9) possible for each of these records.

Because the data sources were not structured with consideration for their value as part of a comprehensive analysis, responses to most of the C&Is were unavailable from the reports. This was particularly true for Pilot Deviations (PDs), Aviation Safety Reporting System (ASRS) reports, and Operational Error (OEs) reports. The NTSB Accident Reports provided most of the C&Is. The table below shows the level of C&I data available from each of the four data sources:

Data Source	Number of Cases Analyzed	Number of Records	Possible number of Responses	Actual Number of Responses	% of Possible C&I Data Provided
NTSB Accident Reports	5	10	1360	698	51%
Operational Error Reports	50	50	6800	785	12%
Pilot Deviation Reports/ASRS Reports	24	24	3264	271	8%
Pilot Reports	58	58	7888	921	12%
All Sources Combined	**137**	**142**	**19312**	**2675**	**14%**

Table 1. Analysis of Characteristics and Indicators Data Available from Various Sources

When the C&I data was combined from all sources, there were 51 (37.5%) questions for which only one source provided any data at all. This suggests that the majority of C&Is based recommendations were addressed by the individual groups. Additionally, when there are less than 15 – 20 responses to a given C&I, the data does not possess adequate statistical significance to draw valid conclusions. For all data sources combined, there were 44 questions (32%) for which there were 15 or more responses and 38 questions (28%) for which there were 20 or more responses.

The chart below illustrates the sparse C&I data for each of the four data sources:

Potential vs. Actual Responses for Characteristics and Indicators
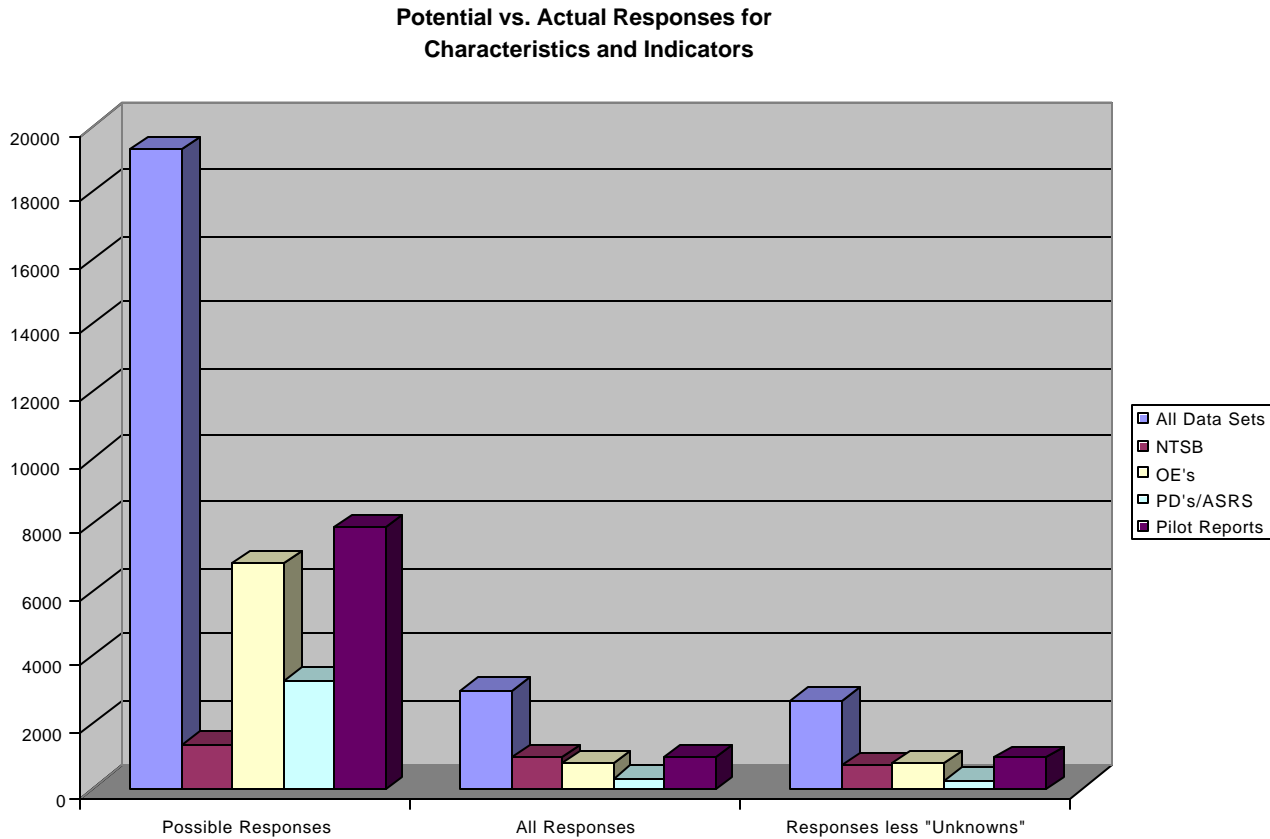
The next chart illustrates the percentage contributions from the various data sources and the sum of all those contributions. It can be seen from this chart that the total of all data sources represents about 15% of the total possible Characteristic and Indicator data set. Further, the NTSB data set contributes about 5% to the total; the OE data set about 4%; the PD/ASRS data set about 1%; and the Pilot Reports about 5%. For all data sources, the working groups provided ALL POSSIBLE C&I data to complete the table. An absence of data occurred because the available reports are not rich in C&I data.

Contribution of Each Data Source to Total Characteristics & Indicators Responses
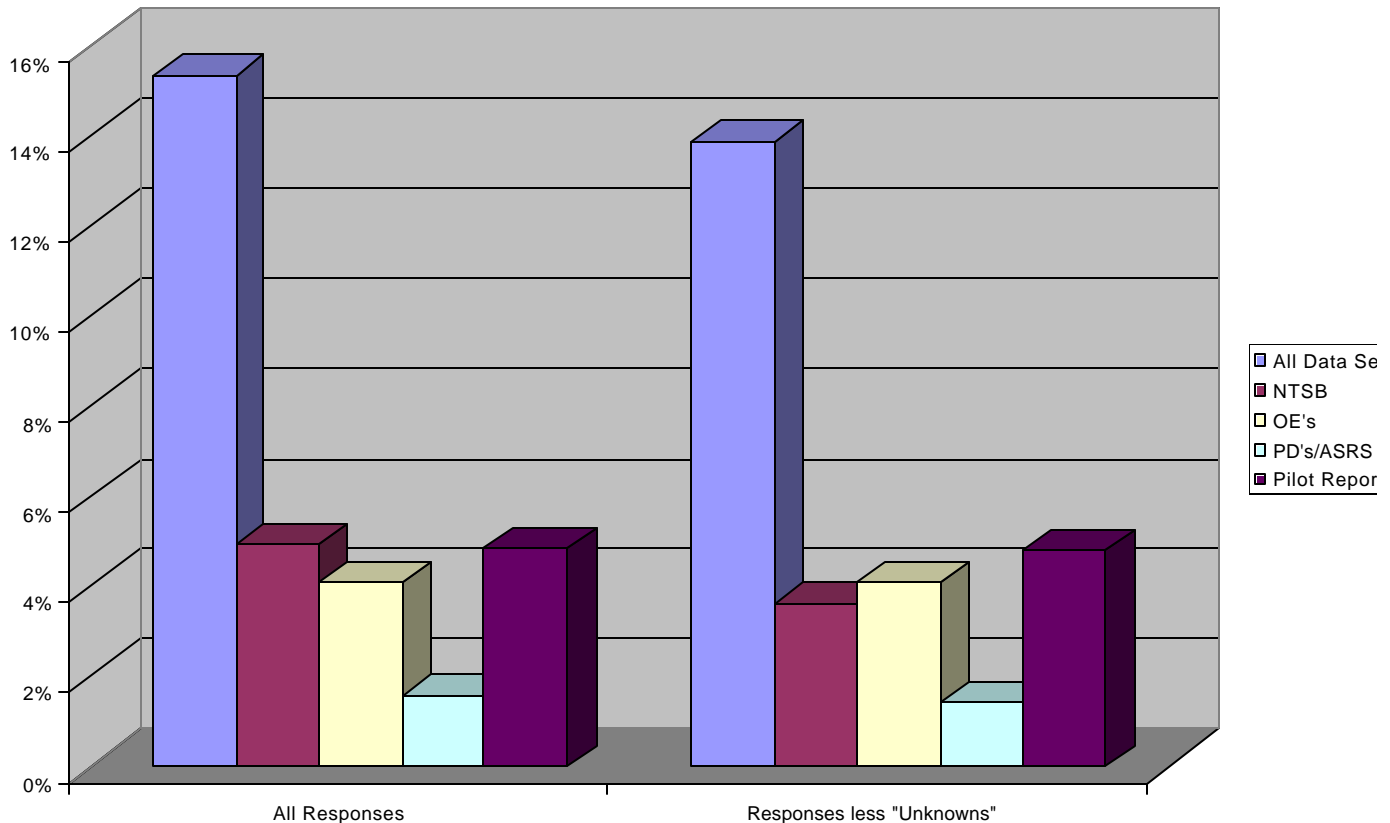
An analysis and a brainstorming session were conducted on the combined data sources. The outcomes of these sessions are as follow:

- The combined data is sparse (about 15% of the cells had responses.)
- The NTSB data set was the most complete.
- The Pilot Reports data set was good and provided some small confirmation of the findings from the NTSB group working with only its own data set.
- The Operational Error data set created C&Is that were largely independent of the other three data sources.

The Pilot Deviation and ASRS data sets created C&Is that were largely independent of the other three data sources.

- The combined C&I data sets clearly illustrated the source of data. The data sets clearly partitioned in this combined set. The additive nature of the data sets did not occur to a significant extent when the four data sets were combined. As a consequence, the findings and recommendations from the combined data set were the same as the individual working groups' findings and recommendations.

- The combined C&I data set did not support any new findings and recommendations for runway incursion causal factors or intervention strategies.
- Even where the number of responses for a specific Characteristic or Indicator might suggest a possible causal factor or intervention strategy, the definition of the C&I was such that incorrect conclusions might easily be concluded.

Even with the less than stellar outcome from this exercise, team members felt that this type of data could serve a useful purpose in discovering causal factors and thus lead to additional intervention strategies. For this to occur, the following changes are necessary:

- The definitions of the Characteristics and Indicators need to be more carefully defined so the statistically significant samples would result in valid conclusions.
- Once these new C&Is have been defined, the collection of the data should be streamlined so that the reporting mechanisms populate these standard definitions.