
Approach & Landing
Joint Safety Analysis Team
(JSAT)
Results and Analysis
September 10, 1999

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I. EXECUTIVE SUMMARY

In the summer of 1998, the Commercial Aviation Safety Team (CAST) chartered the Approach and Landing Joint Safety Analysis Team (JSAT) to review and analyze data for the purpose of developing and recommending interventions that will enhance commercial aviation safety during the approach and landing phase of flight by 2007. The JSAT's data included publicly available source information, accident reports, and other approach and landing studies.

The JSAT charter (Appendix A) explicitly directed the JSAT not to address the feasibility or costs of implementing the interventions. Instead, this report is intended for the Approach and Landing Joint Safety Implementation Team, which is responsible for assessing the feasibility of JSAT recommendations and then developing any appropriate implementation plans. This report summarizes the analysis and results of the Approach and Landing JSAT and presents seven broadly based recommendations to reduce landing and approach accidents.

The JSAT methodology combines detailed case studies, a high-level data analysis, and expert judgement. The case studies employ an event-sequence analysis, while the high-level approach involves statistical data and data from other sources. Based on the case studies and high-level data analysis, the JSAT developed interventions that addressed specific case-study accidents. Each intervention then was rated for three characteristics, from which the JSAT computed an "Overall Effectiveness" score (OE), ranging from 0.1 to 6.0. The list of individual interventions, prioritized by OE scores, may be found in Appendix C. This OE primarily reflects the estimated effectiveness of an individual intervention in preventing the particular case-study accident against which it was rated.

The JSAT recognized that singular and isolated interventions are generally less effective in reducing accidents than are approaches that integrate related interventions. Consequently, the JSAT combined the prioritized ranking of OE scores with the expert judgment of its diverse membership to build and

recommend seven broad strategies for reducing approach and landing accidents. The JSAT also included interventions that addressed organizational culture, systematic use of digital flight data, no-blame internal reporting systems, etc. Such interventions may not produce their full benefits by the 2007 target, or the analysis of past accidents may not adequately assess the full potential of some interventions to break complex causal chains in future accidents. Consequently, some recommended interventions were not assigned OE ratings.

The interventions that received the 10 highest OE ratings provide the foundation for the recommendations, each of which calls for several actions by operators, manufacturers, regulators, or others. In addition to those top 10 interventions, the recommended strategies include interventions that received a range of OEs. When combined with more powerful interventions that address the same target, a lower-ranked intervention often became either a logical necessity in the strategy, or its effectiveness increased due to the synergy offered by the broader strategy. Similarly, some interventions with fairly high OEs were not included in the recommendations. Though these interventions might have been very effective in preventing the studied accident(s), their effectiveness in preventing future accidents was deemed to be limited.

All recommendations require the regulators to participate actively. 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. The seven recommendations are presented below in a non-prioritized order, and each recommendation identifies its constituent interventions and their respective OEs.

1) Situation Awareness Technologies (Design Related)

To develop and implement technologies that enhance flight crew awareness of aircraft flight path and position relative to terrain, manufacturers, regulators and operators should:

- Install TAWS (EGPWS). (Intervention 35, OE 5.0)
- Develop and implement capabilities that will permit flight crews to operate in a day VMC-like environment regardless of visibility. (Intervention 85, OE 5.0)
- Develop displays that will portray the vertical situation and terrain. (Intervention 59, OE 4.2, Intervention 77 OE 4.2)
- Continue to develop, implement, and use HUD capability (Intervention 295, OE 2.2)

2) Stabilized Approaches

To minimize the occurrence of unstabilized approaches, manufacturers, regulators, operators, and airport authorities should:

- Develop and implement precision, or precision-like, approach capability (glidepath guidance) to all runways (Intervention 59, OE 4.2, Intervention 77 OE 4.2).

Until precision or precision-like approaches are available;

- Air traffic service providers should give priority to precision approaches when available and appropriate. (Intervention 126 OE 2.8)
- Operators should encourage flight crews to use precision approaches when available and appropriate. (Intervention 125 OE 2.1)
- Stabilized approaches. (Intervention 355 OE 0.4)

3) Go Around

To reduce the risk of accidents associated with unstabilized and rushed approaches, operators and regulators should:

- Establish policies, parameters and training to recognize unstabilized approaches and implement a go-around gate system. (Intervention 142 OE 4.0, Intervention 115 OE 1.7, Intervention 116 OE 2.8,

Intervention 157 OE 1.7, Intervention 162 OE 0.9, Intervention 163 OE 2.1, Intervention 165 OE 2.1)

- Institute a true no-fault go around policy. (Intervention 14, OE 2.8, Intervention 123 OE 2.1)
- Incorporate in initial and recurrent training ways to recognize cues that will require a go-around. This training should include the Flight Safety Foundation (FSF) definition of stabilized approach, the Controlled Flight into Terrain (CFIT) training aid, and the use of risk assessment tools and windshear training. (Intervention 329 OE 2.8, Intervention 96 OE 1.1, Intervention 300 OE 2.1, Intervention 350 OE 2.1)
- Train flight crews to think in terms of "I will go-around unless" rather than "I will land unless." (Intervention 328 OE 2.1, Intervention 311 OE 0.5)

Air Traffic Control (ATC) Services and Air Traffic Service Providers should:

- Base runway selection on the most current wind information available (Intervention 327 OE 2.8)
- and the performance characteristics of modern jet transports. (Intervention 13 OE 1.4, Intervention 157 OE 1.7)

4) Standard Operating Procedures

To ensure adherence to standard operating procedures, regulators and operators should:

- Ensure checklist designs prioritize critical items as recommended by NASA study, and that items are arranged in a manner to enhance checklist implementation. (Intervention 134 OE 5.0)
- Ensure that training/standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures. (Intervention 110 OE 2.1)

- Ensure that clear, concise, accurate and appropriate standard operating procedures are published and enforced. (Intervention 99 OE 1.4)
- Undertake research to better understand the underlying reasons/causes for procedural non-compliance. (Intervention 204 OE NR)

5) Safety Culture

To promote a culture that establishes, supports and enhances safety (Intervention 143 OE 3.5), all members of the aviation community should:

- Implement policies regarding crew pairing. (Intervention 24 OE 3.5)
- Incorporate a company self-audit process and develop a cost analysis tool detailing the high economic and psychological costs of accidents and serious incidents. (Intervention 348 OE NR, Intervention 318 OE NR)
- Emphasize safe arrivals over timely arrivals and discontinue on-time arrival tracking for airlines, adopt a “reward system” that does not penalize executing missed approaches, establish a true no-fault go-around policy, and develop a reward system that is not based on completion of a route segment. (Intervention 123 OE 2.1, Intervention 37 OE 0.6, Intervention 311 OE 0.5, Intervention 22 OE 0.4, Intervention 217 OE 0.3)
- Implement policies relative to flight crew medical viability (voluntary removal from flight status due to illness and/or emotional distress, crew-scheduling policy that considers fatigue and circadian rhythm). (Intervention 63 OE 0.1, Intervention 242 OE 0.1)
- Ensure that adequate CRM training is provided prior to line flying. (Intervention 132 OE 1.7, Intervention 131 OE 1.4, Intervention 308 OE 1.3, Intervention 25 OE 1.1, Intervention 314 OE 1.1, Intervention 349 OE 0.3, Intervention 237 OE NR)

- Adopt a program among parent airlines to ensure the same level of safety in partners. (Intervention 347 OE 0.2)

6) Operational Feedback: Identify and Correct Potential Problems

To monitor the health of the aviation system and correct potential safety problems operators and regulators should:

- Implement Flight Operations Quality Assurance (FOQA) programs. (Intervention 54 OE NR, Intervention 55 OE NR, Intervention 56 OE NR)
- Implement a no-blame safety reporting and data sharing process with appropriate protections from litigation and prosecution concerns. (Intervention 57 OE NR, Intervention 128 OE NR)
- Implement corrective action for identified safety problems. (Intervention 56 OE NR)

7) Fault Tolerant Technologies (Design Related)

To mitigate the consequences of human error, regulators, research organizations and manufacturers should:

- Continue to develop and implement systems that properly annunciate to the flight crew flight-critical equipment failures or inappropriate settings. (Intervention 45 OE 3.5, Intervention 103 OE 1.4)
- Design and develop an error-tolerant ground spoiler deployment system. (Intervention 304 OE 3.3)
- Design and require ground-sensing systems that are tolerant of adverse conditions without degrading in-flight safety features. (Intervention 332 OE 2.7)
- Establish criteria, evaluate, and improve the reliability and failure tolerance of flight systems (Intervention 49 OE 2.1)

The accomplishments of the Approach and Landing JSAT illustrate the ability of industry and government to work together effectively. The JSAT recommends continuing this joint activity. The team also recommends sharing this report with the commercial aviation community.

III. Background Information

The three most common types of aviation accidents are Controlled Flight into Terrain (CFIT), Approach and Landing accidents, and Loss of Control. This JSAT analyzed data and official reports on Approach and Landing accidents.

For the purposes of this analysis, the approach-and-landing phase of flight begins at descent and continues through the landing or missed approach procedure. Presently, there are about 15 fatal approach and landing accidents per year worldwide (excluding the Commonwealth of Independent States). Because of projected traffic growth, 23 fatal approach and landing accidents are forecast to occur per year by 2010. Although aviation is the safest form of transportation, this number will not be acceptable to the industry and the flying public.

IV. Purpose/Makeup of subteams

The Approach and Landing Joint Safety Analysis Team (JSAT) consisted of individuals representing a cross-section of the international commercial aviation community. Co-chairs from the FAA and industry directed the team. The Approach and Landing JSAT included individuals from CAST member organizations who represented a broad set of aviation expertise, including human factors specialists, line pilots, aeronautical engineers, regulators, data experts, safety analysts, air traffic controllers, and maintenance experts. See Appendix K for the complete list of members and participants.

JSAT members were divided into three working sub-teams. The co-chairs carefully reviewed the population of each sub-team to ensure the best distribution of expertise. To ensure that each sub-team would have access to all available expertise, meetings were held at a common location. The purpose of each sub-team was to analyze four approach and landing accident reports in accordance with the JSAT process (see Section VI. for a description of this process).

In addition to the three sub-teams, two additional teams, known as the East and West Coast teams were created. These two teams conducted their planning and analysis activities between the formal meetings.

The West Coast Team's primary function was to determine the analytical process used to rank and group the recommended interventions. The West Coast Team also organized and tracked new problem statements and new interventions developed by the sub-teams and integrated them into the existing problem statements and interventions developed during the Controlled Flight Into Terrain (CFIT) JSAT.

The East Coast Team was established to meet the Approach and Landing JSAT Charter requirement to coordinate JSAT efforts with the Flight

Safety Foundation Approach and Landing Reduction (FSF ALAR) Task Force. The East Coast Team was also asked by CAST to develop a means to use information made available through Flight Operational Quality Assurance (FOQA) programs in its analysis process. For more details about how FOQA and ALAR information were used, see the section describing the analysis process and Appendix I.

V. Analysis Data Set

Sixteen approach and landing accidents were selected as candidates for analysis; twelve accidents were used as the selected data set. Accident reports from the National Transportation Safety Board, the Aviation Accident Investigation Bureau, and other national authorities provided the "data-rich" information necessary to conduct the JSAT's analyses. Every accident and major incident contains a complex environment and chains of events that, in turn, offer numerous opportunities for interventions to prevent errors or to mitigate their consequences.

In accordance with CAST guidance, the JSAT selected twelve well-documented accident reports to analyze using the CAST JSAT process. The data set was selected to represent a broad range of aircraft types, operations, geographical areas, and environmental conditions. The Approach and Landing category of transport aircraft accidents has been extensively studied, most notably by the FSF ALAR team, therefore, it was not necessary for the JSAT to duplicate this entire body of work. The chosen accident data set provided an adequate sample to apply the CAST JSAT process and was corroborated by the results of the large-sample-size FSF study. The JSAT results identified very similar principal findings, which validate the appropriateness of the JSAT sample dataset and provide confidence that the primary recurring safety issues will be exhibited in most well documented accident case studies.

The analysis of the twelve well-documented accidents identified many contributory causes. The results of these analyses indicated numerous opportunities to break the accident chain. A synopsis of the accident data set is provided in Appendix B.

To complement these twelve case studies, and in accordance with the JSAT charter, the JSAT used the data available from the FSF ALAR study and compared the JSAT results with the FSF recommendations. The JSAT sought to identify other areas as potential sources of data by soliciting information from FOQA and the NASA Aviation Safety Reporting System (ASRS) databases.

VI. Description of the Analysis Process

The Approach and Landing 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 analyzed twelve approach and landing accident reports. Each of the three sub-teams (see Purpose/Makeup of sub-team section) was assigned four accident reports to analyze. Sub-teams developed an event sequence spreadsheet for each of their assigned accident reports. Each event in the spreadsheet was analyzed to determine if the event was a normal occurrence or a contributing factor leading to the accident. Problem statements were formulated for those events determined to have contributed to the accident. The problem statements were then analyzed for their contributing factors. Potential intervention strategies were developed to address the associated problems. This process yielded approximately 190 interventions. 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 how strongly the team believed that everyone and everything would perform as expected. 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 three factors to rate their interventions. Through expert judgement 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. After agreeing upon the P/C/A ratings for each intervention, a mathematical formula was applied to determine overall effectiveness (See Appendix C for a list of the interventions ranked by overall effectiveness, OE).

For a more detailed explanation of the process for rating factors and ranking the interventions see the Process for Conducting Joint Safety Analysis Team, Rev. B.

The JSAT methodology analyzes a limited number of accidents 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 rich understanding, the methodology sacrifices the statistical inferences that can be gained from analyzing a much more broadly based but somewhat static data set. Conscious of this tradeoff, CAST directed the JSAT to compare its work with the FSF ALAR report. This was a three-year study, released in 1998, based on a high-level data analysis of 287 accidents. The purpose of the coordination was to ensure that the results of the JSAT case studies were grounded in more broadly based data. The East Coast team, including two members who had participated in the ALAR study, conducted the comparison.

The problems addressed and interventions proposed by the JSAT correlated strongly to those in the FSF ALAR. Nevertheless, some differences were identified. Generally, the JSAT placed more emphasis on the roles of equipment and air traffic services in safe approach and landing operations and relied somewhat more on engineering interventions than did the ALAR. In contrast, ALAR relied a bit more on non-engineering interventions, though each report addressed both broad types of approaches at some length. Appendix I provides a more detailed summary of the comparison.

The JSAT charter also calls for the JSAT analysis to include incident data. 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. To test this assumption and to follow the JSAT charter, the Team decided to compare its results with data from airlines' Flight Operational Quality Assurance (FOQA) databases and from NASA's Aviation Safety Reporting System (ASRS). In addition, the CAST explicitly directed the Approach and Landing JSAT to examine FOQA data to determine whether it

could contribute to the analysis and understanding of approach and landing events.

Much to the Team's disappointment, both efforts were unsuccessful and for similar reasons. Both, the FOQA and ASRS databases use particular terminology and specific parameters for coding their data. These terms and parameters proved to be different from those used by the JSAT. Under the time and resource constraints placed on the JSAT, it was not possible to conduct a meaningful search of these valuable databases. As lessons learned for the sake of future JSATs, a discussion of these efforts is included in Appendix I.

To facilitate the work of the JSIT and to provide readers of this report with easy access to specific interventions of interest, the JSAT organized all its proposed interventions in a number of different ways. Appendix C ranks the interventions by their OE rating. In Appendix D, the interventions are sorted by their numerical order. Appendix E groups the interventions by their targeted problem area. In these three appendices, the individual interventions are given with their P/C/A ratings as well as their OE rating. Appendix F provides summaries as well as a grouping by targeted problem areas (different than given in the previous appendix) sorted alphabetically. Appendix G lists all the interventions that were proposed against each Standard Problem Statement, and Appendix H shows which Standard Problem Statement was referenced in which accident.

VII. Grouping of Interventions

The 10 interventions ranked highest by their overall effectiveness ratings address some of the most common underlying problems and contributing factors. To address each of these common problems most efficiently, the JSAT grouped those "top ten" interventions with other related interventions, independently of their OE rating. These groups provide additive strategies for mitigating the targeted problem and constitute the JSAT's recommendations. When combined with more powerful interventions that address the same target, a lower-ranked intervention often became either a logical necessity in the

strategy, or its effectiveness increased due to the synergy offered by the broader strategy.

Recommendation 4, which addresses the broad issue of adherence to standard operating procedures (SOPs), provides a good example of how this multi-path approach yields a more effective safety strategy than the implementation of any single intervention. Recommendation 4 is built on Intervention 134: "Ensure checklist designs prioritize critical items … and that items are arranged in a manner to enhance checklist implementation." Intervention 134 has a high OE score of 5.0, but Recommendation 4 groups several other interventions with lower OEs because they are a logical element of the broader strategy or because the broader strategy increases their utility. Recommendation 4 includes the following interventions, each of which has a moderate or low intervention.

Intervention 110 (OE 2.1) calls for the aviation community to "ensure that training, standardization and monitoring programs emphasize the importance of adherence to standard operating procedures and identify the rationale behind those procedures." This intervention would persistently emphasize the importance of SOPs throughout training programs and all flight monitoring programs. It also would take advantage of training programs to explain the rationale behind each SOP so that operational employees could understand the prudence of a given SOP. In isolation, intervention 110 likely would produce only a marginal benefit. However, when combined with intervention 134, an effort to design a prioritized checklist (intervention 134), both interventions suddenly have more promise.

Similarly, Recommendation 4 includes Intervention 99 (OE 1.4): " Ensure that clear, concise, accurate and appropriate standard operating procedures are published and enforced." Intervention 99 recognizes that approach and landing accidents frequently involve flight crews or maintenance crews who had to contend with SOPs that were unclear or even contradictory. Poorly stated or contradictory SOPs invite or even require crews to adapt ad hoc practices. As

those practices evolve, the practices may omit a prudent step or rationale, or they might inadvertently incorporate elements that increase risk.

By itself, this type of intervention might appear to be little more than a paternal admonition to communicate clearly; effectiveness might be marginal at best. However, if a more broadly based strategy calls for persistent emphasis on SOPs throughout an organization, complete with training and redesigned checklists, the organization first must ensure itself that its SOPs are appropriate, that they are clear and understood, and that they are published and available. In the end, developing and publishing "clear, concise and appropriate" SOPs becomes something much more than a paternal admonition when combined with intervention 134. Instead, it becomes a necessary and critical part of the broader strategy.

Finally, Recommendation 4 includes Intervention 204 (not rated): "Undertake research to better understand the underlying reasons and causes for procedural non-compliance. However, the intervention recognizes that both inadvertent and conscious non-compliance with SOPs are common factors in landing and approach accidents. If the aviation community is to undertake an effective effort to improve compliance with and understanding of SOPs, the community must improve its understanding of why SOPs sometimes are not followed. Only then can the community hope to develop "appropriate" SOPs, appropriate checklists, and appropriate training programs.

Again, in isolation, this type of research intervention might be overlooked. However, when it is understood to address a necessary knowledge base to support interventions 134, 110,and 99. The relative importance of intervention 204 increases significantly.

Likewise, Recommendation 5, pertaining to establishment of a “safety culture,” is a synergistic grouping of interventions that will produce a total effectiveness, if implemented together, that exceeds the effectiveness of the individual

interventions. Numerous studies have determined that the culture of an operator is a significant factor in overall operational safety.

VIII. Unrated Interventions

The team found that its rating system (based on power, confidence and future global applicability) could not be easily used for certain types of interventions. Those interventions include: data collection, research, survivability, and some of the interventions related to safety culture. Research and data collection in and of themselves cannot prevent accidents. Instead, they produce knowledge that could lead to effective interventions. Therefore, these interventions were not rated. For additional explanation see Appendix J.

For example, installing TAWS/EGPWS in all aircraft could clearly produce tangible, short-term benefits. Yet, in a number of accidents, GPWS was present and functioning, but flight crews ignored the GPWS warnings. This suggests that the full benefit from TAWS/EGPWS may not be realized without research designed to provide an understanding of why such warnings are ignored and how interventions could change that behavior. Consequently, the JSAT developed an intervention for research to understand the phenomena of procedural non-compliance. The results of such research could enable the industry to design better warning systems, but research without action does not produce tangible safety results. The unrated interventions appear at the end of Appendix C.

Data collection, research, and safety culture are not mutually exclusive; they complement each other. Although unrated, the JSAT recognized the role of these elements in any safety program. These elements constitute the JSAT recommendations five and six and are fundamental to the implementation of many of the other recommendations.

IX. Recommendations

A large group of possible interventions were identified and evaluated for effectiveness. This process resulted in a list of interventions shown in Appendix C in order of Overall Effectiveness (OE). Additionally, the interventions were compared with the results of the FSF ALAR Task Force. After analysis of the interventions, their effectiveness and their synergistic potential in various groupings, the Joint Safety Analysis Team makes the following recommendations to the Commercial Aviation Safety Team (CAST) as the highest leverage actions that can be taken at an industry level to reduce the number of Approach and Landing accidents.

These recommendations are not prioritized and contain short-term, as well as long-term intervention recommendations. Some of the recommendations are single interventions that have high effectiveness as a stand-alone approach. Other recommendations involve multiple interventions to address significant problems. This multiple-intervention approach is necessary because a single intervention is less likely to produce the desired effect (for example, training may not be effective because it is necessary to rely on individuals within the system for its internalization and application). The individual interventions in the following recommendations are referenced by their number, presented with their OE ratings, and are characterized as Currently Available, Near Term, or Future Prospect.

1. Recommendation – Situation Awareness Technologies (Design Related)

Recent history has demonstrated that, if properly used, new technological developments can mitigate the consequences of flight crew's loss of situation awareness. Loss of situation awareness has been implicated in many accidents. To enable flight crews to maintain terrain awareness, the industry should develop and implement technologies that enhance flight crew awareness of aircraft flight path and position geographically and relative to terrain;

- Manufacturers should install TAWS (EGPWS) in all new aircraft; airlines/operators should retrofit TAWS into the existing fleet and international regulators should require the installation of TAWS. (Intervention 35-OE 5.0). Currently Available
- The aviation industry should develop vertical situational and terrain displays that are capable of being retrofitted to the maximum number of the existing airplane fleet. (Intervention 59-OE 4.2 and Intervention 77-OE 4.2). Near Term
- The aviation industry should develop and implement synthetic vision capability that will permit flight crews to fly in day VMC-like operations regardless of visibility conditions (Intervention 85-OE 5.0). Future Prospect
- The aviation industry should continue to develop and implement HUD capability to enhance flight crew performance in low visibility operations (Intervention 295-OE 2.2). Future Prospect

2. Recommendation – Stabilized Approaches

The JSAT noted that unstable approaches were clearly precursors to many approach and landing accidents. Many of these accidents occurred while the flight crew was executing an approach that lacked vertical guidance. To address the problems of unstabilized approaches and loss of vertical situational awareness, the industry should develop and implement precision, or precision-like, approach capability (glidepath guidance) to all runways without established

precision approach procedures. (Intervention 59-OE 4.2 and Intervention 77-OE 4.2). Near Term

Additionally, until precision, or precision-like approaches, are available, the following actions should be taken:

- Airlines/operators and regulators should encourage flight crews to use precision approaches when available and appropriate. (Intervention 125-OE 2.1). Currently Available
- Air traffic service providers should prioritize the use of precision approaches when available and appropriate. (Intervention 126-OE 2.8). Currently Available
- Non-precision approaches should be conducted as constant angle, stabilized approaches. (Intervention 355-OE 0.4). Currently Available

3. Recommendation – Go Around

Accidents occurred because the flight crews failed to recognize the need to go around sufficiently early. Frequently flight crews feel internal and external pressures to continue an inherently unstable approach. To reduce the risk of accidents associated with unstabilized and rushed approaches, airlines/operators and regulators should:

- Establish policies, parameters and training to recognize unstabilized approaches and other factors and implement a go-around gate system (Intervention 142-OE 4.0). To increase the effectiveness of this intervention, it should be combined with Intervention 115-OE 1.7, Intervention 116-OE 2.8, Intervention 157-OE 1.7, Intervention 162-OE 0.9, Intervention 163-OE 2.1, Intervention 116-OE 2.8, and Intervention 165-OE 2.1. Near Term
- Institute a true no-fault go around policy (Intervention 123-OE 2.1) Near Term
- Incorporate in initial and recurrent training ways to recognize multiple cues that will require a go-around including the CFIT training aid, the FSF definition of stabilized approach, risk assessment tool and

windshear training (Intervention 329-OE 2.1). To increase the effectiveness of this intervention, combine with Intervention 96-OE 1.1, Intervention 300-OE 2.1, and Intervention 350-OE 2.1. Near Term

- 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 (Intervention 328-OE 2.1 and Intervention 311-OE 0.5). Near Term

And, air traffic service providers should:

- Enhance ATC training to emphasize the dangers of rushed approaches and the performance characteristics of modern jet transports (Intervention 13- OE 1.4 and Intervention 157-OE 1.7). Near Term
- Base runway selection on the most current wind information available (Intervention 327-OE 2.8). Currently Available

4. Recommendation – Standard Operating Procedures

Previous studies on approach and landing accidents, including the Flight Safety Foundation ALAR Report, have shown that procedural non-compliance is a highly significant problem in accidents. The JSAT also found procedural non-compliance to be prevalent in the data it analyzed. The majority of the interventions identified to address this problem require training as a corrective measure. The JSAT recognizes that there are major challenges in attempting to increase the effectiveness of training for operational procedures compliance. Further, the JSAT concludes that the implementation of a multiple intervention approach is necessary to resolve the procedural non-compliance problem.

The JSAT believes that a joint industry-government team should be established to develop a template for standard operating procedures best practices. The template should include guidance on what SOPs should cover, development

methodology, and how to train for, and monitor, procedural compliance. Specifically,

- Airlines/operators and regulators should ensure that clear, concise, accurate and appropriate standard operating procedures are published and enforced (Intervention 99-OE 1.4). Near Term
- 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 (Intervention 110-OE 2.1) Near Term
- Airlines/operators and regulators should ensure checklist designs prioritize critical items as recommended by the NASA study, and that items are arranged in a manner to enhance checklist implementation (Intervention 134-OE 5.0 and Intervention 305-OE 2.8). Near Term
- Research should be undertaken to better understand the underlying reasons/causes for procedural non-compliance (Intervention 204-OE NR). This research should allow the identification of non-traditional interventions. Future Prospect

5. Recommendation – Safety Culture

A work environment that promotes safety throughout its operations is essential to an effective accident prevention strategy. This concept has been supported in a number of studies of operational safety. Airlines/operators should and regulatory agencies must encourage a culture that enhances safety (Intervention 143-OE 2.5). While the JSAT believes that most airlines and operators strive for this type of safety culture, and although many of the JSAT recommendations are components of an effective Safety Culture, the JSAT believes the following recommendations deserve special emphasis:

- Incorporating a company self-audit process (Intervention 348-OE NR) and developing a cost analysis tool regarding the high economic and

psychological costs of accidents and serious incidents (Intervention 318-OE NR). Near Term

- Emphasizing safe arrivals over timely arrivals (Intervention 22-OE 0.4) and discontinuing on-time arrival tracking for airlines (Intervention 37-OE 0.6), adopting a "reward system" that does not penalize executing missed approaches (Intervention 311-OE 0.5), establishing a true no-fault go around policy (Intervention 123-OE 2.1), and developing a "reward system" that is not based on completion of a route segment (Intervention 217-OE 0.3). Near Term
- Implementing policies regarding flight crew medical viability (voluntary removal from flight status due to illness and/or emotional distress) (Intervention 63-OE 0.1), crew scheduling policy that considers fatigue and circadian rhythm (Intervention 242-OE 0.1). Near Term
- Implementing policies regarding crew pairing (Intervention 24-OE 3.5). Near Term
- CRM Training – Airline/Operators and regulators should establish a CRM Training program and regulators should require and ensure that the initial training is provided prior to line flying and require recurrent CRM training (Intervention 25-OE 1.1, Intervention 131-OE 1.4, Intervention 132-OE 1.7, Intervention 237-OE NR, Intervention 308-OE 2.3, Intervention 314-OE 1.1, and Intervention 349-OE 0.3). Near Term
- Parent Airlines/Operators should adopt a program to ensure the same level of safety in partners (Intervention 347-OE 0.2). Near Term

6. Recommendation – Operational Feedback: Identify and Correct Potential Problems

Many, if not all, of the contributing factors in each accident occur in routine operations, but go unnoticed. Collecting safety and operationally related data is not enough. The data has to be processed so useful information can be provided to different participants in the air space system. Most, and often all, of the links in the chain of events of any accident represent

known events, errors, and problems. When problems are reported and data are collected, proper action based on these data is often the best way to prevent future accidents. To enable airlines/operators to identify safety issues and trends, monitor procedural compliance, and initiate corrective actions prior to accident occurrence, the following interventions should be implemented:

- Airlines/Operators and regulators should implement Flight Operations Quality Assurance (FOQA) programs. (Intervention 54-OE NR, Intervention 55-OE NR and Intervention 56-OE NR). Near Term
- Airlines/operators and regulators and regulators should implement a "no-blame" safety reporting and data sharing process with appropriate protections from litigation and prosecution concerns (Intervention 57-OE NR and Intervention 28-OE NR). Near Term
- Implement corrective action for identified problems. (Intervention 56-OE NR). Near Term

7. Recommendation – Fault Tolerant Technologies (Design Related)

Human error is often cited as the primary cause or a major contributing factor in aviation accidents. However, human cognition has its limitations. To mitigate the consequences of human error, regulators, research organizations, and manufacturers should:

- Establish criteria, evaluate and improve the reliability and failure tolerance of flight systems (Intervention 49-OE 2.1). Near Term
- Design and require ground-sensing systems that are tolerant of adverse conditions without degrading in-flight safety features (Intervention 332-OE 3.3). Future Prospect
- Design and develop an error-tolerant ground spoiler deployment system (Intervention 304-OE 3.3). Future Prospect
- Continue to develop and implement systems that properly annunciate flight critical equipment failures or inappropriate settings to the flight crew (Intervention 45-OE 3.5 and Intervention 103-OE 1.4). Future Prospect

X. Final Recommendation

The Approach and Landing JSAT illustrates the ability of industry and government to work together effectively. The JSAT recommends continuing this type of joint activity. The team also recommends sharing this report with the commercial aviation community.

Appendix A

Approach and Landing Joint Safety Analysis Team (JSAT) Charter

Team Sponsors. Commercial Aviation Safety Team (CAST), which includes the aviation industry, FAA and NASA, are the sponsors of this commercial aviation Approach and Landing Joint Safety Analysis Team.

Background. The CAST has agreed to work together to implement a data driven, benefit focused, safety enhancement program designed to continuously improve our safe commercial aviation system. The CAST has further agreed that cooperatively and selectively pursuing a 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 has agreed to charter a Joint Safety Analysis Team (JSAT) to determine intervention strategies that will reduce the potential for airplane accidents during the approach and landing phase of flight. Although his phase of flight represents less than 10% of the flight time in an average flight, it is the phase of flight where over 45% of the hull loss accidents occur.

Objectives. To review and analyze data and make coordinated recommendations to implement intervention strategies that will enhance commercial aviation safety during the approach and landing phase of flight.

Team Tasks

A. The team shall acquire publicly available data, including prior studies and analyses. This will constitute the beginning point for review and analysis. The team will focus its analysis on part 25 commercial airplanes weighing 12,500 lbs. or more. In particular, the team shall coordinate with the Flight Safety Foundation (FSF) Approach and Landing Accident Reduction (ALAR) Task Force that has been investigating this issue for several years.

B. The team shall conduct an in-depth analysis of selected approach and landing accidents and incidents, using the process outlined in the JSAT Recommended Process Report.

C. The team shall develop and prioritize safety intervention strategies that will reduce the potential for airplane accidents during the approach and landing phase of flight. In addition to documenting its analysis results and recommended intervention strategies, the team shall document its assumptions regarding the amount and extent of data considered and

any changes made to the basic JSAT process. The team will build upon previous JSAT problem statements and intervention strategies.

Product. The deliverable is a report to the CAST documenting recommendations, including assumptions used in the analysis and safety intervention strategies. In addition, the team shall provide any recommended changes to the JSAT process.

Timing. The team will meet monthly for periods of approximately three days. It is expected that the final team report will be delivered to the CAST prior to 15 May 1999.

Constraints. The team shall utilize the recommended JSAT process to develop safety intervention strategies. The basic JSAT process can be modified by the team if necessary***;*** however, the concept of building on the problem statements and intervention strategies of previous JSATs shall be adhered to.

Process. Following the basic JSAT process, each team member will have equal authority and responsibility, and use their expertise, to develop and prioritize intervention strategies. In addition team members are expected to finish all of the homework assignments on time.

Membership. The team will include representatives with the appropriate technical background provided by industry and government. The co-chairpersons of the JSAT process shall provide a recommended team membership list to the CAST prior to September 9, 1998.

Resources. The signatories agree to provide the financial, logistic and personnel resources to carry out this charter

Appendix B

Data Set

The following is a synopsis of the accidents that were used by the Approach and Landing JSAT:

1. Air Uganda, Boeing 707-338C, October 16, 1988, Rome, Italy
   Aircraft made two unsuccessful night low visibility ILS approaches at Fiumicino Airport, Rome, Italy. On the third approach, there was a GPWS warning followed by impact with house roofs approximately 1500' from the approach end of runway 34L. The aircraft impacted three more buildings, broke into sections and caught fire. Seven crewmembers and 26 passengers were fatalities, 16 passengers had serious injuries and three had minor injuries.

2. US Air, Boeing 737-300, October 12, 1991, Los Angles, California
   (Dropped - Team decided that while this accident was technically a landing accident, it should be addressed by the Runway Incursion JSAT)

3. Cayman Air, Boeing 737-300, October 12, 1991, Grand Cayman, Cayman Islands
   Aircraft overran runway 08 at Owen Roberts International Airport after a steep fast approach in night VMC. The speedbrakes were not automatically or manually deployed and the thrust reversers were inhibited. The aircraft touched down with about 4000' runway remaining and that was insufficient to stop the aircraft using only wheel brakes. There were fatalities and no serious injuries in this accident.

4. Air Transport International, DC-8-63, February 15, 1992, Swanton, Ohio
   Aircraft crashed about three miles northwest of the Toledo Express Airport after executing a second missed approach to runway 7. The accident occurred in night IMC. The three-person flightcrew and a passenger received fatal injuries.

5. Cargolux Airlines, Boeing 747-228F, November 1, 1992, Luxembourg Airport, Luxembourg
   Aircraft made two CATII approaches to runway 24 at the Luxembourg Airport in night IMC. The first approach was unstable and resulted in a missed approach. During the second approach, the captain lost sight of the runway below the decision height and decided to continue. The right wingtip and number 4 engine dragged on the ground. Number 4 engine was torn from the airplane and there was a small fire. The crew was not injured.

6. American International Airways, DC-8-61, August 18, 1993, Guantanamo Bay, Cuba

   The aircraft impacted level terrain ¼ mile from the approach end of the runway at the U.S. Naval Air Station, Guantanamo Bay, Cuba. The crew was flying a visual approach in day VMC. The aircraft stalled while in a steep turn. All three crewmembers sustained serious injuries. The aircraft was destroyed.

7. Lufthansa, Airbus A-320, September 14,1993, Warsaw, Poland

   The aircraft landed on runway 11 at Okecie Airport, Warsaw, Poland in day IMC. The crew increased the approach speed to compensate for forecast windshear. The aircraft had a significant unreported tailwind at touchdown. The aircraft landed fast with one wing low. This inhibited actuation of the ground sense system which delayed deployment of the spoilers and reversers for 9 seconds, which in turn led to delayed aircraft braking. The aircraft departed the end of the runway. One crewmember and one passenger were fatally injured. The aircraft sustained substantial fire damage.

8. Valujet Airlines, DC-9-32, January 7, 1996, Nashville, Tennessee

   Ground spoilers deployed on short final and the aircraft touched down hard in the approach lights short of runway 2R at the Nashville International Airport in night IMC. After a go-around, the aircraft landed on runway 31. There was substantial damage to the nosewheel, the aft fuselage, flaps, slats and both engines. One flight attendant and four passengers received minor injuries.

9. Continental Airlines, DC-9-32, February, 19,1996, Houston, Texas

   Aircraft landed gear-up on runway 27 at Houston International Airport in day VMC. Hydraulic pressure was not set to the “HIGH” position necessary to lower the landing gear and to extend the flaps. There were 12 minor injuries to passengers and substantial damage to the airplane.

10. Delta Airlines, MD-88, October 19, 1996, LaGuardia Airport, New York

    (This accident was dropped from the data set because litigation is ongoing).

11. Atlantic Southeast Airlines, Embraer, EMB-120, April 5,1991, Brunswick, GA

    Aircraft crashed during a day VMC approach to runway 07 at Glynco Jetport, Brunswick, GA. A failure of a propeller control unit allowed the propeller blade angles to go below the flight idle position. Three crewmembers and all 20 passengers were fatally injured.

12. Northwest Airlink, Jetstream, BA-3100, December 1, 1993, Hibbing, MN

    Aircraft collided with terrain while on a localizer back course approach to runway 13 at Hibbing in night IMC. Two crewmembers and 16 passengers were fatally injured.

13. Atlantic Coast Airlines, Jetstream 4101, January 7, 1994, Columbus, OH
    Aircraft crashed 1.2 miles east of runway 28L at Port Columbus International Airport in night IMC. Three crewmembers and two passengers were fatally injured, two passengers received minor injuries and one passenger was uninjured.

14. American Eagle, Jetstream BA 3201, December 13, 1994, Morrisville, NC
    (Dropped – The JSAT requested CAST authorization not to analyze this accident because there was a clear indication that most significant approach and landing problems had been identified. The JSAT also stated that the Flight Safety Foundation ALAR study and FOQA data would be used to assure that, if there were any remaining unidentified problems, they would not be missed. The CAST concurred with the request.)

15. El Al, Boeing 747- 258F, October 4, 1992, Schiphol, Amsterdam Airport, Netherlands
    (Dropped – The JSAT requested CAST authorization not to analyze this accident because there was a clear indication that most significant approach and landing problems had been identified. The JSAT also stated that the Flight Safety Foundation ALAR study and FOQA data would be used to assure that, if there were any remaining unidentified problems, they would not be missed. The CAST concurred with the request.)

16. KLM Cityhopper, Saab 340B, April 4, 1994, Schiphol Amsterdam Airport, Netherlands
    Aircraft crashed 1800' right of runway 06 centerline just outside the airport boundary. The flight conditions were day VMC. Two passengers and one crewmember were fatally injured. One crewmember and eight passengers were seriously injured.

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Appendix C

Approach and Landing Interventions
Sorted by Overall Effectiveness

Int #	INTERVENTIONS	P	C	A	Overall Effect.
35	Manufacturers should install TAWS (EGPWS) in all new aircraft, airlines/operators should retrofit TAWS into the existing fleet and international regulators should require the installation of TAWS.	6	5	6	5.0
85	The aviation industry should develop and implement synthetic vision capability (e.g. Precision Approach Terrain Information (PATI)).	6	5	6	5.0
134	Airlines/operators and regulators should ensure check list designs prioritize critical items as recommended by NASA study, and that items are arranged in a manner to enhance checklist implementation	6	5	6	5.0
59	Implement precision approach capability (glideslope guidance) for all runways without established precision approach procedures (e.g. ILS, DGPS, etc.). (see 77)	5	5	6	4.2
77	Eliminate non-precision approaches where possible. (see 59)	5	5	6	4.2
142	Airlines/operators should establish policies, parameters, and training to recognize unstabilized approaches and other factors and implement a go-around gate system. (see FSF - "defined gates" p. 193) (see 116, 123)	6	4	6	4.0
24	Airlines/operators should implement procedures to ensure appropriate crew pairing. (reference FSF corporate crew scheduling and fatigue evaluation.)	5	5	5	3.5
45	Manufacturers should ensure that all impending 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. (see 103, 138)	5	5	5	3.5
304	Manufacturers should improve the design for an error tolerant ground spoiler deployment system.	6	4	5	3.3
14	Install aural warning devices on aircraft to alert flightcrew of arrival at MDA/DH.	5	4	5	2.8
80	Airlines/operators should ensure, and regulators should check, that operators who create their own AOM's include all procedures prescribed by original equipment manufacturers Airplane Flight Manual (AFM).	5	4	5	2.8
116	Airlines/operators should ensure that their training/standardization programs emphasize the dangers of high rate of descent and unstable approaches. (see 142)	5	4	5	2.8
126	Air Traffic service providers should prioritize the use of precision approaches (glideslope guidance) when available and appropriate.	5	4	5	2.8
153	Ensure that flight crews are adequately trained in a level D simulator for dynamic characteristics before assignment to the line. (see 312)	5	4	5	2.8
156	Require that autothrottles be used with all autopilot coupled approaches.	5	5	4	2.8
211	Airlines/operators should retrofit equipment to provide automatic altitude callouts on final approach. If unable, other altitude alerting or reminder systems (such as altimeter bugs) should be installed.	5	4	5	2.8
224	Airlines/operators should ensure that all airline operations include compliance with all/seasonal guidance from the OEM.	5	4	5	2.8
243	To prevent alerting overload, flight deck designs should consider smart alerting systems such as those with prioritization schemes or cancelable nuisance alerts.	5	4	5	2.8
250	To ensure test components are representative of the final product, manufacturers should test the final component and regulators should require this type testing.	5	4	5	2.8

305	Regulators should require airlines/operators to outfit aircraft with electronic checklists. If unable to install electronic checklists, use mechanical checklists or, at a minimum, develop a process to reinforce challenge and response checklists.	5	4	5	2.8
327	Air Traffic service runway selection policies should be based on the most current wind available.	5	4	5	2.8
329	Airlines/operators should incorporate in initial and recurrent training ways to recognize multiple cues that will require go-around. Including CFIT training aid 2.1.9, FSF definition of stabilized approach, risk assessment tool, and windshear training ai	5	4	5	2.8
256	To prevent loss of aircraft control in-flight, all propeller pitch control systems must be designed to positively feather in the event of pitch control loss. Propeller pitch control system malfunctions must be positively annunciated to the flight crew.	6	4	4	2.7
332	Manufacturers should design ground sensing systems that are tolerant to adverse conditions without degrading inflight safety features (e.g. which prevent deployment of ground spoilers and reverse in-flight). (see 16)	6	4	4	2.7
72	Air Traffic service providers should install MSAW-like capabilities world-wide with emphasis on high-risk airports.	6	3	5	2.5
143	Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture) (see 22, 63, 348)	5	3	6	2.5
158	Develop technology to provide real time assistance to flight crews with onboard system failures and diagnostics (e.g. data link transmittal to ground support) (see 103)	5	4	4	2.2
252	To prevent loss of control in flight, all changes to flight critical components, such as primary propeller pitch controller components, should be considered major changes.	5	4	4	2.2
295	To enhance flight crew performance in low visibility operations, the aviation industry should continue to develop and implement HUD capability. (see 149)	5	4	4	2.2
49	Regulators should establish criteria for, and manufacturers should evaluate and improve, the reliability and failure tolerance of flight systems. (see 332)	5	3	5	2.1
60	Avionics manufacturers should improve GPWS capability to reduce GPWS nuisance warnings. (See 243)	5	5	3	2.1
93	Air Traffic service should provide real time (most current) radio communication of critical airport and weather information.	5	3	5	2.1
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. (see 99)	5	3	5	2.1
111	Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training.	5	3	5	2.1
123	Airlines/operators should implement a true no-fault go around policy (learning vs. blame).	5	3	5	2.1
125	Airlines/operators should encourage flight crews to use precision approaches (glideslope guidance) when available and appropriate.	5	3	5	2.1
130	Regulators should account for realistic rest scenarios when developing and implementing crew rest requirements during travel segments. (see 31, 203, 257, 315, 316)	5	3	5	2.1
135	Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PF and PNF tasks. (see 82)	5	3	5	2.1

150	Regulators or other governing authorities should establish policies that ensure that surrounding lights are distinguishable from airport lighting in order to avoid confusion (safety process, policy).	5	3	5	2.1
163	Airlines/operators should ensure that their training/standardization programs address common misperceptions that could lead to unsafe practices (i.e. ATC always wants high energy approaches).	5	3	5	2.1
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)).	5	3	5	2.1
225	Airlines/operators and regulators should ensure necessary manuals (operational & maintenance) are complete, accurate, available and appropriately used.	5	3	5	2.1
238	To preclude conducting flight training during operational flights, when a need for training is identified, operators should conduct training in accordance with their approved training program.	5	3	5	2.1
248	To ensure adequate testing of equipment, manufacturers' testing should be conducted under worst case scenarios taking into account new technologies and testing under simulated flight realistic conditions.	5	3	5	2.1
249	To ensure the accuracy and safety of computer modeling used for design and failure analysis, the modeling must be adequately re-validated on a continuing basis to account for new technology.	5	3	5	2.1
254	To avoid the isolated incident syndrome and to ensure on-going assessment of flight critical control system reliability, a focused safety or risk assessment of all in-service failures or problems should be conducted to determine the need for immediate res	5	3	5	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 checklist).	5	3	5	2.1
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. (see 142, 311)	5	3	5	2.1
331	Airlines/operators and manufacturers should train crews to understand the capabilities and limitations of systems, conditions which would cause systems to not function as the crew anticipates, and how to detect those conditions (e.g. lack of brakes, spoil	5	3	5	2.1
350	Airlines/operators should ensure that adequate approach briefings are conducted that include descriptions of normal approach, non-normal conditions and the results of risk assessment analysis. (see 300)	5	3	5	2.1
145	Airlines/operators and regulators should establish appropriate operational restrictions when equipment is inoperative (MEL)	4	4	4	1.8
149	Manufacturers should install a HUD as standard equipment. (see 85)	4	4	4	1.8
151	Regulators should establish policies that require additional monitoring of flight crew members that have repeatedly failed check rides. (see 152, 335, 337)	4	4	4	1.8
319	Regulators should require a Special Qualification Airport Briefing guide be incorporated with approach charts. (Subject matter must include aircraft specific local operational procedures)	4	4	4	1.8
30	Airlines/operators should adopt the "delegated" approach to standard operating procedures. (e.g. monitored approach procedures)	5	3	4	1.7
61	Airlines/operators (and manufacturers in the airplane flight manual) should implement procedures that call for an immediate execution of the escape maneuver following a GPWS warning unless there is visual confirmation of terrain.	3	4	5	1.7

79	Airlines/operators should implement a reliable process to communicate information to the flight crew that may affect flight or aircraft operations.	5	3	4	1.7
100	Airlines/operators should ensure that their training/standardization programs emphasize the importance of adhering to MDA/DH.	6	2	5	1.7
115	Airlines/operators should ensure that their training/standardization programs emphasize the dangers of rushed approaches. (see 13, 157)	4	3	5	1.7
129	Regulators should establish criteria to ensure operators overall quality assurance and compliance procedures are effective rather than reliance on spot checks of individual components	4	3	5	1.7
132	Airlines/operators and regulators should ensure that disciplinary and prosecution policies don't adversely affect or countermand safety gains of good CRM practices. (see 308)	5	3	4	1.7
157	Airlines/operators, regulators, Air Traffic service providers should establish policies or programs to address rushed approaches, including elimination of rushed approaches, recognition and rejection of rushed approaches and training for those encountered	4	3	5	1.7
159	Manufacturers should incorporate an "input rudder" indicator or automatic yaw compensation to ensure that adequate yaw control is provided.	5	3	4	1.7
207	Airlines/operators should develop procedures to specify how transfer of control is formally accomplished.	5	3	4	1.7
232	Airlines/operators should ensure all nose gear struts are serviced for cold weather operation are in accordance with OEM recommendations.	6	5	2	1.7
246	To reduce pilot overload, airlines/operators policies should stress using the appropriate level of automation.	4	3	5	1.7
306	Regulators should require manufacturers to equip all new aircraft with electronic checklists.	5	3	4	1.7
309	Airlines/operators should require flight crews to fly precision instrument approach procedures during periods of reduced visibility and night operations. (see 59, 355)	5	3	4	1.7
322	Airlines/operators should develop and implement a ground school and simulator training program similar to the Advanced Aircraft Maneuvering Program.	5	3	4	1.7
342	Airlines/operators should establish an SOP to ensure that flight crews should not begin the approach until adequate briefing is completed for the expected runway. (see 17)	4	3	5	1.7
343	Airlines/operators should install radio altimeters in all aircraft and develop procedures for their use on approach as recommended by FSF ALAR.	5	3	4	1.7
253	To prevent loss of control, there should be redundancy and failure tolerance features for all flight critical components, such as dual path design, fail operational redundant systems, with fault annunciation.	6	3	3	1.5
7	Airlines/operators should ensure that their training/standardization programs emphasize review of approach and missed approach procedures. (see 329)	5	2	5	1.4
13	Air Traffic service providers should enhance ATC training to emphasize the dangers of rushed approaches and performance characteristics of modern jet transports. (see 115, 157)	5	2	5	1.4
23	Airlines/operators should ensure that regularly scheduled recurrent training (e.g. LOFT) emphasizes crew cooperation and working together to maximize safe operations. (see 308, 314)	5	2	5	1.4
64	Airlines/operators should ensure that their training/standardization programs direct the flight crews to regularly cross check all instrumentation.	5	2	5	1.4
99	Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced. (see 110)	5	2	5	1.4

103	Manufacturers should develop and implement system failure annunciation capabilities to alert flight crews of pending failures (e.g. HUMS). (see 45, 138)	5	2	5	1.4
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) (see 237)	5	2	5	1.4
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)	5	2	5	1.4
251	To preserve the original intended level of airworthiness, there should be a better definition and classification of subsequent in-service major and minor critical component changes. The definition of critical component should be more specific.	5	2	5	1.4
255	To prevent catastrophic failures, the manufacturers should issue immediate telegraphic information to all operators, and regulators should require an immediate mandatory action (AD), following the initial failure report of any critical component malfunction.	5	2	5	1.4
316	Regulators should require airline/operators to train flightcrews to recognize and counteract acute and chronic fatigue. (see 31, 130, 203, 257,315)	5	2	5	1.4
6	Regulators should establish standardized approach plate depiction/information requirements for approach plate publishers.	4	3	4	1.3
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 are reviewed during recurrent training.	4	3	4	1.3
89	Airlines/operators and regulators should ensure that the frequency and effectiveness of proficiency checks for non-precision approaches are adequate.	3	3	5	1.3
112	Airlines/operators and regulators should ensure that the frequency and effectiveness of proficiency checks for simulated instrument failures (partial panel) are adequate.	4	3	4	1.3
202	Airlines/operators should develop a quality assurance program to ensure compliance with regulations.(see 145, 146, 201)	4	3	4	1.3
213	Airlines/operators and regulators should provide additional inspectors/inspection of sub-contract activity. (see 201, 202)	3	3	5	1.3
223	Regulators should ensure POIs are properly qualified and trained to approve appropriate company operational procedures.	3	3	5	1.3
308	Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, and advocacy. (IAW AC120-51b). (See 133)	6	2	4	1.3
345	Ensure regulators have adequate funding, training and processes to accomplish their oversight responsibilities. (see 201)	4	3	4	1.3
19	Airlines/operators should implement a procedure to climb to a minimum safe altitude when position uncertainty exists by at least one crew member. Flight crew must advise ATC of intentions.	4	2	5	1.1
25	Airlines/operators should establish a CRM training program and regulators should require and insure that the initial training is provided prior to line flying and require recurrent CRM training. (see 131, 132, 349)	4	2	5	1.1
82	Airlines/operators should clearly define, train and check the specific PF/PNF duties. (see 135)	4	2	5	1.1
96	Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate approach preparation and contingency review prior to commencing an approach.	5	2	4	1.1

133	Airlines/operators training of Captains and Chief Pilots should include Management practices that promote team building and effective human relations (leadership training beyond current CRM programs). (see 308)	4	2	5	1.1
154	Airlines/operators should improve/increase training to increase awareness of icing effects on airplane type including dynamic simulator training.	2	4	5	1.1
227	Airlines/operators should ensure that their training/standardization program emphasizes the benefits of inter-crew/company communications. (see 131)	5	2	4	1.1
228	Regulators should require airlines/operators to modify their training to maximize benefits of inter-crew/company communications.	5	2	4	1.1
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).	4	2	5	1.1
315	Regulators should update flight time/duty time regulations to counteract present commercial aviation environmental stressors. (e.g. crew rest requirements) (see 31, 130, 203, 257, 316)	5	2	4	1.1
136	Airlines/operators should ensure that their training/standardization programs emphasize the importance of the sterile cockpit environment	3	3	4	1.0
310	Regulators should not allow noise abatement procedures that reduce the level of safety that existed prior to their implementation.	3	3	4	1.0
339	Regulators should require captains and first officers each have identical approach charts for reference.	4	3	3	1.0
15	Airlines/operators should ensure that their training/standardization programs instruct when to disengage automated systems and fly manually. (see 246)	4	2	4	0.9
17	Airlines/operators should ensure that their training/standardization programs emphasize the importance of all flight-related briefings. (see 342)	4	2	4	0.9
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. (see 45, 243)	4	2	4	0.9
146	Regulators should establish/enforce reasonable limitations on dispatch with safety related equipment inop. (MEL)	4	2	4	0.9
162	Airline/operators should include in their training programs the awareness of potential safety risks due to the complacency when operating at a very familiar airport (e.g. home base).	4	2	4	0.9
201	Regulators should develop adequate oversight as appropriate to ensure compliance with regulations.(see 145, 146, 202, 345)	4	2	4	0.9
214	Regulators should enforce timely incorporation of appropriate manufacturers recommendations. (see 98, 201)	4	2	4	0.9
219	Regulators should ensure company training program is in accordance with approved training program.(see 110, 201)	4	2	4	0.9
231	Regulators should require and airlines/operators should promptly close out all regulatory safety audit findings.	4	2	4	0.9
321	Regulators and Military agencies should ensure procedures are in place to share information pertaining to operations at joint use airports. (Special Use Airports)	4	2	4	0.9
325	Airline/operators should emphasize during initial and recurrent training the importance of maintaining systems status awareness during non-normal events and hazardous approaches (goal to avoid tunnel vision/narrowed attention)	4	2	4	0.9
124	Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.	3	2	5	0.8
144	Airlines/operators and regulators should ensure that their training/standardization programs clarify the differences between vertical and slant range visibility	3	2	5	0.8

152	Airlines/operators and regulators should raise standards (e.g. crew pairing, approach minimums, etc.) for flight crewmembers that meet minimum qualifications but have demonstrated specific weaknesses. (see 151, 335, 337)	5	2	3	0.8
161	Airlines/operators should implement procedures that call for an immediate recovery maneuver following a flight control warning (e.g. stall warning) (see 61)	5	2	3	0.8
233	Regulators should require operators to incorporate OEM strut servicing recommendations in mandatory maintenance procedure and surveill compliance.	6	5	1	0.8
312	Airline/operators should ensure 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. (re	3	2	5	0.8
105	Airlines/operators should train flight crews on how flight delays upon departure or enroute (weather, maintenance, ATC, etc.) can affect their subsequent decision making relative to the safe conduct of the flight.	3	2	4	0.7
113	Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.	3	2	4	0.7
203	Airlines/operators should provide crews with inflight rest periods and adequate facilities. (see 31, 130, 315)	3	2	4	0.7
218	Airlines/operators should properly surveill contractor training programs for adequacy of training.(see 110, 202)	3	2	4	0.7
245	To recover aircraft in unusual attitude, manufacturers should develop systems to return aircraft to normal attitude with one pilot button push (pilot initiated auto-recovery systems).	6	1	4	0.7
317	Regulators should ensure one level of safety exists for all commercial transport operations (whether passenger or freighter operations).	4	2	3	0.7
340	Airlines/operators should implement procedures to ensure flight crews are aware of appropriate Airworthiness Directives, Certification and flight testing standards. (see 76, 46)	4	2	3	0.7
37	Regulators should discontinue on-time arrival tracking for airlines.	2	2	5	0.6
334	Regulators should require airports to comply with International standards for airport construction.	5	2	2	0.6
311	Airlines/operators should ensure their “reward system” does not penalize flight crews for executing missed approaches. (see 217)	3	2	3	0.5
12	Air Traffic service providers should emphasize in ATC training the controllers' potential in assisting the flight crew in improving their situation awareness.	2	2	4	0.4
22	Airlines/operators should encourage a culture that emphasizes safe arrivals over timely arrivals. (see 63, 143)	2	2	4	0.4
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. (see 75)	2	2	4	0.4
88	Airlines/operators should train and monitor flight crew compliance with established communication phraseology guidelines. (see 240)	2	2	4	0.4
95	Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.	4	1	4	0.4
114	Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency.	4	1	4	0.4
235	Manufacturers should provide a more positive means of external strut pre-flight inspections.	5	3	1	0.4

259	Regulators should set engineering standards requiring propeller manufacturers to provide positive prevention designs, to eliminate all flight critical failure modes (eg. flat pitch).	5	1	3	0.4
335	Airlines/operators should establish more effective pilot screening and Capt upgrade criteria to eliminate candidates with demonstrable aviation personality deficiencies. (see 151, 251, 337)	5	1	3	0.4
355	Non-precision approaches should be conducted as constant angle, stabilized approaches. (see 59)	1	4	4	0.4
48	Airlines/operators and regulators should strictly enforce flight/duty time limitations.	3	1	4	0.3
94	Implement real time (digital) transmission of airport and weather information to the aircraft.	4	1	3	0.3
106	Air Traffic service providers should train and monitor ATC adherence to established communications procedures including hearback problems. (see 240)	2	1	5	0.3
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.	1	3	4	0.3
141	Airlines/operators and regulators should require training/standardization programs include training regarding physiological effects on aircrew performance, (e.g. low blood sugar).	3	1	3	0.3
217	Airlines/operators should ensure their "reward system" is not related to the completion of a route segment. (see 311)	2	2	3	0.3
324	Air Traffic services should ensure proper/close supervision of controllers undergoing training so that all outages, construction, airport hazards, etc. are reported to flight crews in a timely and accurate manner. (see 11)	3	1	4	0.3
349	Airlines/operators should ensure training for instructors and check airmen include objective criteria to be used in evaluating crew CRM performance. (see 25,131)	3	1	4	0.3
352	Airlines/operators should equip aircraft with autopilots to reduce crew workload during critical phases of flight.	3	1	3	0.3
353	Airlines/operators should establish and enforce a clear MEL policy to aid flight crews in making maintenance related decisions.	2	2	3	0.3
75	Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position. (see 45)	2	1	4	0.2
347	Parent airlines/operators should adopt a program to ensure the same level of safety in regional partners including, but not limited, to recruitment, training, operations and maintenance.	2	1	4	0.2
354	Organizations responsible for developing approach/arrival/departure procedures should not report to the organization responsible for Air Traffic service (e.g. In the FAA AVN-100 not reporting to AAT)	3	1	2	0.2
21	Establish/enhance quality assurance checks/training to ensure that timely and accurate communication between controllers and flight crews is occurring.	1	1	4	0.1
42	Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology.	1	1	5	0.1
63	Airlines/operators should implement a culture which encourages flight crew voluntary removal from flight status due to illness and/or emotional distress (including the use of a self assessment tool). (see 70)	2	1	2	0.1
108	Air Traffic service providers should implement and/or review procedures to ensure ATC training does not create a hazard to flight operations.	1	1	3	0.1
137	Manufacturers should ensure cockpit design that does not interfere with or distract the flight crew from executing their duties (e.g. rain in the cockpit, location of switches in cockpits)	1	1	3	0.1

220	Regulators should ensure that all POIs are current and qualified in one model of the company's equipment.	2	1	2	0.1
222	Regulators should require PMI's to have expertise in the assigned carrier's equipment.	2	1	2	0.1
242	To prevent excessive fatigue, airlines/operators should consider circadian rhythm in crew scheduling to compensate for the effects of rhythm interruptions.	1	1	4	0.1
320	Air Traffic service providers should institute an ATC "Crew Resource Management Program" similar to those required of flight crews. (FAA AC 120-51b)	1	1	4	0.1
236	Airlines/operators should develop/publish appropriate procedures for radio communications restoration.	0	0	1	0.0
240	To reduce the possibility of error, confusion and workload increase related to ATC clearances, regulators should require and operators ensure that flight crews utilize proper phraseology and readbacks. (see 88)	0	0	5	0.0
241	To eliminate hearback errors, ATC should reexamine and implement improvements to address hearback problems. (see 240)	0	0	5	0.0
247	To ensure timely dissemination of navaid anomalies, airlines/operators and ATC should re-emphasize the requirement that flight crews report and ATC disseminate any navigation anomalies.	1	0	4	0.0
257	To eliminate loop holes in crew rest requirements and to ensure adequate crew rest, regulators should clarify crew rest regulations. (see 31, 130, 203, 315, 316)	0	0	4	0.0
258	To facilitate the FAA awareness of safety related problems; there should be improved dissemination of the FAA hotline numbers.	0	4	4	0.0
296	To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.	1	0	5	0.0
346	Airlines/operators should ensure better educated regulators by providing intern programs.	1	1	1	0.0
27	Airlines/operators should implement maintenance procedures to ensure proper functioning of the CVR at all times. (Note: this intervention was recorded as a potential intervention of future accidents, it would not have prevented the subject accidents.)	N	N	N	N
28	Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.	N	N	N	N
54	Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. (not rated)	N	N	N	N
55	Airlines/operators should implement a Flight Operations Quality Assurance (FOQA) program to identify flight crew failure to respond to GPWS warnings. (not rated)	N	N	N	N
56	Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55)	N	N	N	N
57	Airlines/operators, regulators, and manufacturers should implement a program designed for sharing of safety related information within the aviation community. (not rated)	N	N	N	N
128	Airlines/operators and regulators should implement a no blame safety reporting and data sharing system with appropriate protections from litigation and prosecution concerns.	N	N	N	N
204	Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance.	N	N	N	N
208	Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings)	N	N	N	N

209	To improve survivability, manufacturers should improve design, installation and inspection schedules of emergency equipment to increase reliability (e.g. escape slides). (see 45, 138, 201, 202)	N	N	N	N
237	Airlines/operators should provide guidance to crew concerning evaluation of all options prior to decision making as part of CRM training. (see 25, 26, 131, 132, 133, 308)	N	N	N	N
244	To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations.	N	N	N	N
260	To prevent uncommanded in-flight flat pitch, research should be conducted into prop brake designs.	N	N	N	N
261	To improve passenger and flightcrew survivability, research should be conducted to explore new methods to increase crash survivability.	N	N	N	N
262	To improve passenger and flightcrew survivability, regulators should require and operators should implement existing knowledge of crash survivability.	N	N	N	N
297	To prevent CFIT, operators should develop procedures to ensure that flight crews do not descend when confusion exists concerning aircraft position.	N	N	N	N
303	Regulators should implement the NTSB recommendations to increase DFDR parameters. (not rated)	N	N	N	N
318	Flight Safety Foundation should develop a cost analysis tool to educate CEO's about the high economic and psychological costs of accidents and serious incidents. (not rated)	N	N	N	N
337	Airlines/operators should establish a process (which includes an interdisciplinary team) to document and investigate high risk behavior and poor judgement as evidenced by on-the-job performance. (see 151, 152, 335)	N	N	N	N
348	Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and mitigate safety concerns. (see 318)	N	N	N	N
356	Research should be done to develop an effective tactical decision making model for flight crews in time critical situations.	N	N	N	N

Appendix D

Approach and Landing Interventions
Sorted by Number

Int #	INTERVENTIONS	P	C	A	Overall Effect.
6	Regulators should establish standardized approach plate depiction/information requirements for approach plate publishers.	4	3	4	1.3
7	Airlines/operators should ensure that their training/standardization programs emphasize review of approach and missed approach procedures. (see 329)	5	2	5	1.4
12	Air Traffic service providers should emphasize in ATC training the controllers' potential in assisting the flight crew in improving their situation awareness.	2	2	4	0.4
13	Air Traffic service providers should enhance ATC training to emphasize the dangers of rushed approaches and performance characteristics of modern jet transports. (see 115, 157)	5	2	5	1.4
14	Install aural warning devices on aircraft to alert flightcrew of arrival at MDA/DH.	5	4	5	2.8
15	Airlines/operators should ensure that their training/standardization programs instruct when to disengage automated systems and fly manually. (see 246)	4	2	4	0.9
17	Airlines/operators should ensure that their training/standardization programs emphasize the importance of all flight-related briefings. (see 342)	4	2	4	0.9
19	Airlines/operators should implement a procedure to climb to a minimum safe altitude when position uncertainty exists by at least one crew member. Flight crew must advise ATC of intentions.	4	2	5	1.1
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 are reviewed during recurrent training.	4	3	4	1.3
21	Establish/enhance quality assurance checks/training to ensure that timely and accurate communication between controllers and flight crews is occurring.	1	1	4	0.1
22	Airlines/operators should encourage a culture that emphasizes safe arrivals over timely arrivals. (see 63, 143)	2	2	4	0.4
23	Airlines/operators should ensure that regularly scheduled recurrent training (e.g. LOFT) emphasizes crew cooperation and working together to maximize safe operations. (see 308, 314)	5	2	5	1.4
24	Airlines/operators should implement procedures to ensure appropriate crew pairing. (reference FSF corporate crew scheduling and fatigue evaluation.)	5	5	5	3.5
25	Airlines/operators should establish a CRM training program and regulators should require and insure that the initial training is provided prior to line flying and require recurrent CRM training. (see 131, 132, 349)	4	2	5	1.1
27	Airlines/operators should implement maintenance procedures to ensure proper functioning of the CVR at all times. (Note: this intervention was recorded as a potential intervention of future accidents, it would not have prevented the subject accidents.)	N	N	N	N
28	Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.	N	N	N	N
30	Airlines/operators should adopt the "delegated" approach to standard operating procedures. (e.g. monitored approach procedures)	5	3	4	1.7
35	Manufacturers should install TAWS (EGPWS) in all new aircraft, airlines/operators should retrofit TAWS into the existing fleet and international regulators should require the installation of TAWS.	6	5	6	5.0
37	Regulators should discontinue on-time arrival tracking for airlines.	2	2	5	0.6

42	Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology.	1	1	5	0.1
45	Manufacturers should ensure that all impending 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. (see 103, 138)	5	5	5	3.5
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. (see 75)	2	2	4	0.4
48	Airlines/operators and regulators should strictly enforce flight/duty time limitations.	3	1	4	0.3
49	Regulators should establish criteria for, and manufacturers should evaluate and improve, the reliability and failure tolerance of flight systems. (see 332)	5	3	5	2.1
54	Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. (not rated)	N	N	N	N
55	Airlines/operators should implement a Flight Operations Quality Assurance (FOQA) program to identify flight crew failure to respond to GPWS warnings. (not rated)	N	N	N	N
56	Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55)	N	N	N	N
57	Airlines/operators, regulators, and manufacturers should implement a program designed for sharing of safety related information within the aviation community. (not rated)	N	N	N	N
59	Implement precision approach capability (glideslope guidance) for all runways without established precision approach procedures (e.g. ILS, DGPS, etc.). (see 77)	5	5	6	4.2
60	Avionics manufacturers should improve GPWS capability to reduce GPWS nuisance warnings. (See 243)	5	5	3	2.1
61	Airlines/operators (and manufacturers in the airplane flight manual) should implement procedures that call for an immediate execution of the escape maneuver following a GPWS warning unless there is visual confirmation of terrain.	3	4	5	1.7
63	Airlines/operators should implement a culture which encourages flight crew voluntary removal from flight status due to illness and/or emotional distress (including the use of a self assessment tool). (see 70)	2	1	2	0.1
64	Airlines/operators should ensure that their training/standardization programs direct the flight crews to regularly cross check all instrumentation.	5	2	5	1.4
72	Air Traffic service providers should install MSAW-like capabilities world-wide with emphasis on high-risk airports.	6	3	5	2.5
75	Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position. (see 45)	2	1	4	0.2
77	Eliminate non-precision approaches where possible. (see 59)	5	5	6	4.2
79	Airlines/operators should implement a reliable process to communicate information to the flight crew that may affect flight or aircraft operations.	5	3	4	1.7
80	Airlines/operators should ensure, and regulators should check, that operators who create their own AOM's include all procedures prescribed by original equipment manufacturers Airplane Flight Manual (AFM).	5	4	5	2.8
82	Airlines/operators should clearly define, train and check the specific PF/PNF duties. (see 135)	4	2	5	1.1
85	The aviation industry should develop and implement synthetic vision capability (e.g. Precision Approach Terrain Information (PATI)).	6	5	6	5.0
88	Airlines/operators should train and monitor flight crew compliance with established communication phraseology guidelines. (see 240)	2	2	4	0.4
89	Airlines/operators and regulators should ensure that the frequency and effectiveness of proficiency checks for non-precision approaches are adequate.	3	3	5	1.3

93	Air Traffic service should provide real time (most current) radio communication of critical airport and weather information.	5	3	5	2.1
94	Implement real time (digital) transmission of airport and weather information to the aircraft.	4	1	3	0.3
95	Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.	4	1	4	0.4
96	Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate approach preparation and contingency review prior to commencing an approach.	5	2	4	1.1
99	Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced. (see 110)	5	2	5	1.4
100	Airlines/operators should ensure that their training/standardization programs emphasize the importance of adhering to MDA/DH.	6	2	5	1.7
103	Manufacturers should develop and implement system failure annunciation capabilities to alert flight crews of pending failures (e.g. HUMS). (see 45, 138)	5	2	5	1.4
105	Airlines/operators should train flight crews on how flight delays upon departure or enroute (weather, maintenance, ATC, etc.) can affect their subsequent decision making relative to the safe conduct of the flight.	3	2	4	0.7
106	Air Traffic service providers should train and monitor ATC adherence to established communications procedures including hearback problems. (see 240)	2	1	5	0.3
108	Air Traffic service providers should implement and/or review procedures to ensure ATC training does not create a hazard to flight operations.	1	1	3	0.1
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. (see 99)	5	3	5	2.1
111	Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training.	5	3	5	2.1
112	Airlines/operators and regulators should ensure that the frequency and effectiveness of proficiency checks for simulated instrument failures (partial panel) are adequate.	4	3	4	1.3
113	Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.	3	2	4	0.7
114	Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency.	4	1	4	0.4
115	Airlines/operators should ensure that their training/standardization programs emphasize the dangers of rushed approaches. (see 13, 157)	4	3	5	1.7
116	Airlines/operators should ensure that their training/standardization programs emphasize the dangers of high rate of descent and unstable approaches. (see 142)	5	4	5	2.8
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.	1	3	4	0.3
123	Airlines/operators should implement a true no-fault go around policy (learning vs. blame).	5	3	5	2.1
124	Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.	3	2	5	0.8
125	Airlines/operators should encourage flight crews to use precision approaches (glideslope guidance) when available and appropriate.	5	3	5	2.1

126	Air Traffic service providers should prioritize the use of precision approaches (glideslope guidance) when available and appropriate.	5	4	5	2.8
128	Airlines/operators and regulators should implement a no blame safety reporting and data sharing system with appropriate protections from litigation and prosecution concerns.	N	N	N	N
129	Regulators should establish criteria to ensure operators overall quality assurance and compliance procedures are effective rather than reliance on spot checks of individual components	4	3	5	1.7
130	Regulators should account for realistic rest scenarios when developing and implementing crew rest requirements during travel segments. (see 31, 203, 257, 315, 316)	5	3	5	2.1
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) (see 237)	5	2	5	1.4
132	Airlines/operators and regulators should ensure that disciplinary and prosecution policies don't adversely affect or countermand safety gains of good CRM practices. (see 308)	5	3	4	1.7
133	Airlines/operators training of Captains and Chief Pilots should include Management practices that promote team building and effective human relations (leadership training beyond current CRM programs). (see 308)	4	2	5	1.1
134	Airlines/operators and regulators should ensure check list designs prioritize critical items as recommended by NASA study, and that items are arranged in a manner to enhance checklist implementation	6	5	6	5.0
135	Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PF and PNF tasks. (see 82)	5	3	5	2.1
136	Airlines/operators should ensure that their training/standardization programs emphasize the importance of the sterile cockpit environment	3	3	4	1.0
137	Manufacturers should ensure cockpit design that does not interfere with or distract the flight crew from executing their duties (e.g. rain in the cockpit, location of switches in cockpits)	1	1	3	0.1
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. (see 45, 243)	4	2	4	0.9
141	Airlines/operators and regulators should require training/standardization programs include training regarding physiological effects on aircrew performance, (e.g. low blood sugar).	3	1	3	0.3
142	Airlines/operators should establish policies, parameters, and training to recognize unstabilized approaches and other factors and implement a go-around gate system. (see FSF - "defined gates" p. 193) (see 116, 123)	6	4	6	4.0
143	Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture) (see 22, 63, 348)	5	3	6	2.5
144	Airlines/operators and regulators should ensure that their training/standardization programs clarify the differences between vertical and slant range visibility	3	2	5	0.8
145	Airlines/operators and regulators should establish appropriate operational restrictions when equipment is inoperative (MEL)	4	4	4	1.8
146	Regulators should establish/enforce reasonable limitations on dispatch with safety related equipment inop. (MEL)	4	2	4	0.9

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)	5	2	5	1.4
149	Manufacturers should install a HUD as standard equipment. (see 85)	4	4	4	1.8
150	Regulators or other governing authorities should establish policies that ensure that surrounding lights are distinguishable from airport lighting in order to avoid confusion (safety process, policy).	5	3	5	2.1
151	Regulators should establish policies that require additional monitoring of flight crew members that have repeatedly failed check rides. (see 152, 335, 337)	4	4	4	1.8
152	Airlines/operators and regulators should raise standards (e.g. crew pairing, approach minimums, etc.) for flight crewmembers that meet minimum qualifications but have demonstrated specific weaknesses. (see 151, 335, 337)	5	2	3	0.8
153	Ensure that flight crews are adequately trained in a level D simulator for dynamic characteristics before assignment to the line. (see 312)	5	4	5	2.8
154	Airlines/operators should improve/increase training to increase awareness of icing effects on airplane type including dynamic simulator training.	2	4	5	1.1
156	Require that autothrottles be used with all autopilot coupled approaches.	5	5	4	2.8
157	Airlines/operators, regulators, Air Traffic service providers should establish policies or programs to address rushed approaches, including elimination of rushed approaches, recognition and rejection of rushed approaches and training for those encountered	4	3	5	1.7
158	Develop technology to provide real time assistance to flight crews with onboard system failures and diagnostics (e.g. data link transmittal to ground support) (see 103)	5	4	4	2.2
159	Manufacturers should incorporate an "input rudder" indicator or automatic yaw compensation to ensure that adequate yaw control is provided.	5	3	4	1.7
161	Airlines/operators should implement procedures that call for an immediate recovery maneuver following a flight control warning (e.g. stall warning) (see 61)	5	2	3	0.8
162	Airline/operators should include in their training programs the awareness of potential safety risks due to the complacency when operating at a very familiar airport (e.g. home base).	4	2	4	0.9
163	Airlines/operators should ensure that their training/standardization programs address common misperceptions that could lead to unsafe practices (i.e. ATC always wants high energy approaches).	5	3	5	2.1
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)).	5	3	5	2.1
201	Regulators should develop adequate oversight as appropriate to ensure compliance with regulations.(see 145, 146, 202, 345)	4	2	4	0.9
202	Airlines/operators should develop a quality assurance program to ensure compliance with regulations.(see 145, 146, 201)	4	3	4	1.3
203	Airlines/operators should provide crews with inflight rest periods and adequate facilities. (see 31, 130, 315)	3	2	4	0.7
204	Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance.	N	N	N	N
207	Airlines/operators should develop procedures to specify how transfer of control is formally accomplished.	5	3	4	1.7
208	Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings)	N	N	N	N

209	To improve survivability, manufacturers should improve design, installation and inspection schedules of emergency equipment to increase reliability (e.g. escape slides). (see 45, 138, 201, 202)	N	N	N	N
211	Airlines/operators should retrofit equipment to provide automatic altitude callouts on final approach. If unable, other altitude alerting or reminder systems (such as altimeter bugs) should be installed.	5	4	5	2.8
213	Airlines/operators and regulators should provide additional inspectors/inspection of sub-contract activity. (see 201, 202)	3	3	5	1.3
214	Regulators should enforce timely incorporation of appropriate manufacturers recommendations. (see 98, 201)	4	2	4	0.9
217	Airlines/operators should ensure their "reward system" is not related to the completion of a route segment. (see 311)	2	2	3	0.3
218	Airlines/operators should properly surveill contractor training programs for adequacy of training.(see 110, 202)	3	2	4	0.7
219	Regulators should ensure a company's training program is in accordance with approved training programs.(see 110, 201)	4	2	4	0.9
220	Regulators should ensure that all POIs are current and qualified in one model of the company's equipment.	2	1	2	0.1
222	Regulators should require PMI's to have expertise in the assigned carrier's equipment.	2	1	2	0.1
223	Regulators should ensure POIs are properly qualified and trained to approve appropriate company operational procedures.	3	3	5	1.3
224	Airlines/operators should ensure that all airline operations include compliance with all/seasonal guidance from the OEM.	5	4	5	2.8
225	Airlines/operators and regulators should ensure necessary manuals (operational & maintenance) are complete, accurate, available and appropriately used.	5	3	5	2.1
227	Airlines/operators should ensure that their training/standardization program emphasizes the benefits of inter-crew/company communications. (see 131)	5	2	4	1.1
228	Regulators should require airlines/operators to modify their training to maximize benefits of inter-crew/company communications.	5	2	4	1.1
231	Regulators should require and airlines/operators should promptly close out all regulatory safety audit findings.	4	2	4	0.9
232	Airlines/operators should ensure all nose gear struts are serviced for cold weather operation are in accordance with OEM recommendations.	6	5	2	1.7
233	Regulators should require operators to incorporate OEM strut servicing recommendations in mandatory maintenance procedure and surveill compliance.	6	5	1	0.8
235	Manufacturers should provide a more positive means of external strut pre-flight inspections.	5	3	1	0.4
236	Airlines/operators should develop/publish appropriate procedures for radio communications restoration.	0	0	1	0.0
237	Airlines/operators should provide guidance to crew concerning evaluation of all options prior to decision making as part of CRM training. (see 25, 26, 131, 132, 133, 308)	N	N	N	N
238	To preclude conducting flight training during operational flights, when a need for training is identified, operators should conduct training in accordance with their approved training program.	5	3	5	2.1
240	To reduce the possibility of error, confusion and workload increase related to ATC clearances, regulators should require and operators ensure that flight crews utilize proper phraseology and readbacks. (see 88)	0	0	5	0.0
241	To eliminate hearback errors, ATC should reexamine and implement improvements to address hearback problems. (see 240)	0	0	5	0.0

242	To prevent excessive fatigue, airlines/operators should consider circadian rhythm in crew scheduling to compensate for the effects of rhythm interruptions.	1	1	4	0.1
243	To prevent alerting overload, flight deck designs should consider smart alerting systems such as those with prioritization schemes or cancelable nuisance alerts.	5	4	5	2.8
244	To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations.	N	N	N	N
245	To recover aircraft in unusual attitude, manufacturers should develop systems to return aircraft to normal attitude with one pilot button push (pilot initiated auto-recovery systems).	6	1	4	0.7
246	To reduce pilot overload, airlines/operators policies should stress using the appropriate level of automation.	4	3	5	1.7
247	To ensure timely dissemination of navaid anomalies, airlines/operators and ATC should re-emphasize the requirement that flight crews report and ATC disseminate any navigation anomalies.	1	0	4	0.0
248	To ensure adequate testing of equipment, manufacturers' testing should be conducted under worst case scenarios taking into account new technologies and testing under simulated flight realistic conditions.	5	3	5	2.1
249	To ensure the accuracy and safety of computer modeling used for design and failure analysis, the modeling must be adequately re-validated on a continuing basis to account for new technology.	5	3	5	2.1
250	To ensure test components are representative of the final product, manufacturers should test the final component and regulators should require this type testing.	5	4	5	2.8
251	To preserve the original intended level of airworthiness, there should be a better definition and classification of subsequent in-service major and minor critical component changes. The definition of critical component should be more specific.	5	2	5	1.4
252	To prevent loss of control in flight, all changes to flight critical components, such as primary propeller pitch controller components, should be considered major changes.	5	4	4	2.2
253	To prevent loss of control, there should be redundancy and failure tolerance features for all flight critical components, such as dual path design, fail operational redundant systems, with fault annunciation.	6	3	3	1.5
254	To avoid the isolated incident syndrome and to ensure on-going assessment of flight critical control system reliability, a focused safety or risk assessment of all in-service failures or problems should be conducted to determine the need for immediate res	5	3	5	2.1
255	To prevent catastrophic failures, the manufacturers should issue immediate telegraphic information to all operators, and regulators should require an immediate mandatory action (AD), following the initial failure report of any critical component malfunction.	5	2	5	1.4
256	To prevent loss of aircraft control in-flight, all propeller pitch control systems must be designed to positively feather in the event of pitch control loss. Propeller pitch control system malfunctions must be positively annunciated to the flight crew.	6	4	4	2.7
257	To eliminate loop holes in crew rest requirements and to ensure adequate crew rest, regulators should clarify crew rest regulations. (see 31, 130, 203, 315, 316)	0	0	4	0.0
258	To facilitate the FAA awareness of safety related problems; there should be improved dissemination of the FAA hotline numbers.	0	4	4	0.0
259	Regulators should set engineering standards requiring propeller manufacturers to provide positive prevention designs, to eliminate all flight critical failure modes (eg. flat pitch).	5	1	3	0.4
260	To prevent uncommanded in-flight flat pitch, research should be conducted into prop brake designs.	N	N	N	N

261	To improve passenger and flightcrew survivability, research should be conducted to explore new methods to increase crash survivability.	N	N	N	N
262	To improve passenger and flightcrew survivability, regulators should require and operators should implement existing knowledge of crash survivability.	N	N	N	N
295	To enhance flight crew performance in low visibility operations, the aviation industry should continue to develop and implement HUD capability. (see 149)	5	4	4	2.2
296	To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.	1	0	5	0.0
297	To prevent CFIT, operators should develop procedures to ensure that flight crews do not descend when confusion exists concerning aircraft position.	N	N	N	N
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).	5	3	5	2.1
303	Regulators should implement the NTSB recommendations to increase DFDR parameters. (not rated)	N	N	N	N
304	Manufacturers should improve the design for an error tolerant ground spoiler deployment system.	6	4	5	3.3
305	Regulators should require airlines/operators to outfit aircraft with electronic checklists. If unable to install electronic checklists, use mechanical checklists or, at a minimum, develop a process to reinforce challenge and response checklists.	5	4	5	2.8
306	Regulators should require manufacturers to equip all new aircraft with electronic checklists.	5	3	4	1.7
308	Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, and advocacy. (IAW AC120-51b). (See 133)	6	2	4	1.3
309	Airlines/operators should require flight crews to fly precision instrument approach procedures during periods of reduced visibility and night operations. (see 59, 355)	5	3	4	1.7
310	Regulators should not allow noise abatement procedures that reduce the level of safety that existed prior to their implementation.	3	3	4	1.0
311	Airlines/operators should ensure their “reward system” does not penalize flight crews for executing missed approaches. (see 217)	3	2	3	0.5
312	Airline/operators should ensure 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. (re	3	2	5	0.8
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).	4	2	5	1.1
315	Regulators should update flight time/duty time regulations to counteract present commercial aviation environmental stressors. (e.g. crew rest requirements) (see 31, 130, 203, 257, 316)	5	2	4	1.1
316	Regulators should require airline/operators to train flightcrews to recognize and counteract acute and chronic fatigue. (see 31, 130, 203, 257,315)	5	2	5	1.4
317	Regulators should ensure one level of safety exists for all commercial transport operations (whether passenger or freighter operations).	4	2	3	0.7
318	Flight Safety Foundation should develop a cost analysis tool to educate CEO's about the high economic and psychological costs of accidents and serious incidents. (not rated)	N	N	N	N

319	Regulators should require a Special Qualification Airport Briefing guide be incorporated with approach charts. (Subject matter must include aircraft specific local operational procedures)	4	4	4	1.8
320	Air Traffic service providers should institute an ATC "Crew Resource Management Program" similar to those required of flight crews. (FAA AC 120-51b)	1	1	4	0.1
321	Regulators and military agencies should ensure procedures are in place to share information pertaining to operations at joint use airports. (Special Use Airports)	4	2	4	0.9
322	Airlines/operators should develop and implement a ground school and simulator training program similar to the Advanced Aircraft Maneuvering Program.	5	3	4	1.7
324	Air Traffic services should ensure proper/close supervision of controllers undergoing training so that all outages, construction, airport hazards, etc. are reported to flight crews in a timely and accurate manner. (see 11)	3	1	4	0.3
325	Airline/operators should emphasize during initial and recurrent training the importance of maintaining systems status awareness during non-normal events and hazardous approaches (goal to avoid tunnel vision/narrowed attention)	4	2	4	0.9
327	Air Traffic service runway selection policies should be based on the most current wind available.	5	4	5	2.8
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. (see 142, 311)	5	3	5	2.1
329	Airlines/operators should incorporate in initial and recurrent training ways to recognize multiple cues that will require go-around. Including CFIT training aid 2.1.9, FSF definition of stabilized approach, risk assessment tool, and windshear training ai	5	4	5	2.8
331	Airlines/operators and manufacturers should train crews to understand the capabilities and limitations of systems, conditions which would cause systems to not function as the crew anticipates, and how to detect those conditions (e.g. lack of brakes, spoil	5	3	5	2.1
332	Manufacturers should design ground sensing systems that are tolerant to adverse conditions without degrading inflight safety features (e.g. which prevent deployment of ground spoilers and reverse in-flight). (see 16)	6	4	4	2.7
334	Regulators should require airports to comply with International standards for airport construction.	5	2	2	0.6
335	Airlines/operators should establish more effective pilot screening and Capt upgrade criteria to eliminate candidates with demonstrable aviation personality deficiencies. (see 151, 251, 337)	5	1	3	0.4
337	Airlines/operators should establish a process (which includes an interdisciplinary team) to document and investigate high risk behavior and poor judgement as evidenced by on-the-job performance. (see 151, 152, 335)	N	N	N	N
339	Regulators should require captains and first officers each have identical approach charts for reference.	4	3	3	1.0
340	Airlines/operators should implement procedures to ensure flight crews are aware of appropriate Airworthiness Directives, Certification and flight testing standards. (see 76, 46)	4	2	3	0.7
342	Airlines/operators should establish an SOP to ensure that flight crews should not begin the approach until adequate briefing is completed for the expected runway. (see 17)	4	3	5	1.7
343	Airlines/operators should install radio altimeters in all aircraft and develop procedures for their use on approach as recommended by FSF ALAR.	5	3	4	1.7
345	Ensure regulators have adequate funding, training and processes to accomplish their oversight responsibilities. (see 201)	4	3	4	1.3

346	Airlines/operators should ensure better educated regulators by providing intern programs.	1	1	1	0.0
347	Parent airlines/operators should adopt a program to ensure the same level of safety in regional partners including, but not limited, to recruitment, training, operations and maintenance.	2	1	4	0.2
348	Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and mitigate safety concerns. (see 318)	N	N	N	N
349	Airlines/operators should ensure training for instructors and check airmen include objective criteria to be used in evaluating crew CRM performance. (see 25,131)	3	1	4	0.3
350	Airlines/operators should ensure that adequate approach briefings are conducted that include descriptions of normal approach, non-normal conditions and the results of risk assessment analysis. (see 300)	5	3	5	2.1
352	Airlines/operators should equip aircraft with autopilots to reduce crew workload during critical phases of flight.	3	1	3	0.3
353	Airlines/operators should establish and enforce a clear MEL policy to aid flight crews in making maintenance related decisions.	2	2	3	0.3
354	Organizations responsible for developing approach/arrival/departure procedures should not report to the organization responsible for Air Traffic service (e.g. In the FAA AVN-100 not reporting to AAT)	3	1	2	0.2
355	Non-precision approaches should be conducted as constant angle, stabilized approaches. (see 59)	1	4	4	0.4
356	Research should be done to develop an effective tactical decision making model for flight crews in time critical situations.	N	N	N	N

Appendix E

Approach and Landing Interventions
Grouped by Category

Int #	INTERVENTIONS	P	C	A	Overall Effect.
	1. Design 1.1 Development 1.1.1 Aircraft 1.1.1 Alerting Systems				
103	Manufacturers should develop and implement system failure annunciation capabilities to alert flight crews of pending failures (e.g. HUMS). (see 45, 138)	5	2	5	1.4
45	Manufacturers should ensure that all impending 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. (see 103, 138)	5	5	5	3.5
60	Avionics manufacturers should improve GPWS capability to reduce GPWS nuisance warnings. (See 243)	5	5	3	2.1
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. (see 45, 243)	4	2	4	0.9
243	To prevent alerting overload, flight deck designs should consider smart alerting systems such as those with prioritization schemes or cancelable nuisance alerts.	5	4	5	2.8
	1.1.1.2 Checklists				
305	Regulators should require airlines/operators to outfit aircraft with electronic checklists. If unable to install electronic checklists, use mechanical checklists or, at a minimum, develop a process to reinforce challenge and response checklists.	5	4	5	2.8
	1.1.1.3 Fault tolerance				
332	Manufacturers should design ground sensing systems that are tolerant to adverse conditions without degrading inflight safety features (e.g. which prevent deployment of ground spoilers and reverse in-flight). (see 16)	6	4	4	2.7
49	Regulators should establish criteria for, and manufacturers should evaluate and improve, the reliability and failure tolerance of flight systems. (see 332)	5	3	5	2.1
259	Regulators should set engineering standards requiring propeller manufacturers to provide positive prevention designs, to eliminate all flight critical failure modes (eg. flat pitch).	5	1	3	0.4
304	Manufacturers should improve the design for an error tolerant ground spoiler deployment system.	6	4	5	3.3
253	To prevent loss of control, there should be redundancy and failure tolerance features for all flight critical components, such as dual path design, fail operational redundant systems, with fault annunciation.	6	3	3	1.5
256	To prevent loss of aircraft control in-flight, all propeller pitch control systems must be designed to positively feather in the event of pitch control loss. Propeller pitch control system malfunctions must be positively annunciated to the flight crew.	6	4	4	2.7
	1.1.1.4 Miscellaneous design issues				
85	The aviation industry should develop and implement synthetic vision capability (e.g. Precision Approach Terrain Information (PATI)).	6	5	6	5.0
137	Manufacturers should ensure cockpit design that does not interfere with or distract the flight crew from executing their duties (e.g. rain in the cockpit, location of switches in cockpits)	1	1	3	0.1

235	Manufacturers should provide a more positive means of external strut pre-flight inspections.	5	3	1	0.4
245	To recover aircraft in unusual attitude, manufacturers should develop systems to return aircraft to normal attitude with one pilot button push (pilot initiated auto-recovery systems).	6	1	4	0.7
209	To improve survivability manufacturers should improve design, installation and inspection schedules of emergency equipment to increase reliability (e.g. escape slides). (see 45, 138, 201, 202)	N	N	N	N
	1.1.2 Air/Ground 1.1.2.1 Stabilized approaches				
158	Develop technology to provide real time assistance to flight crews with onboard system failures and diagnostics (e.g. data link transmittal to ground support) (see 103)	5	4	4	2.2
59	Implement precision approach capability (glideslope guidance) for all runways without established precision approach procedures (e.g. ILS, DGPS, etc.). (see 77)	5	5	6	4.2
	1.1.2.1 Datalink				
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.	1	3	4	0.3
28	Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.	N	N	N	N
94	Implement real time (digital) transmission of airport and weather information to the aircraft.	4	1	3	0.3
	1.2 Equipage 1.2.1 Aircraft 1.2.1.1 Alerting systems				
14	Install aural warning devices on aircraft to alert flightcrew of arrival at MDA/DH.	5	4	5	2.8
35	Manufacturers should install TAWS (EGPWS) in all new aircraft, airlines/operators should retrofit TAWS into the existing fleet and international regulators should require the installation of TAWS.	6	5	6	5.0
211	Airlines/operators should retrofit equipment to provide automatic altitude callouts on final approach. If unable, other altitude alerting or reminder systems (such as altimeter bugs) should be installed.	5	4	5	2.8
	1.2.1.2 Checklists				
306	Regulators should require manufacturers to equip all new aircraft with electronic checklists.	5	3	4	1.7
	1.2.1.3 Head-Up Displays				
149	Manufacturers should install a HUD as standard equipment. (see 85)	4	4	4	1.8
295	To enhance flight crew performance in low visibility operations, the aviation industry should continue to develop and implement HUD capability. (see 149)	5	4	4	2.2
	1.2.1.4 Miscellaneous				
343	Airlines/operators should install radio altimeters in all aircraft and develop procedures for their use on approach as recommended by FSF ALAR.	5	3	4	1.7
159	Manufacturers should incorporate an "input rudder" indicator or automatic yaw compensation to ensure that adequate yaw control is provided.	5	3	4	1.7
156	Require that autothrottles be used with all autopilot coupled approaches.	5	5	4	2.8
352	Airlines/operators should equip aircraft with autopilots to reduce crew workload during critical phases of flight.	3	1	3	0.3
	1.2.2 Ground Systems				
72	Air Traffic service providers should install MSAW-like capabilities world-wide with emphasis on high-risk airports.	6	3	5	2.5

	1.3 Design/test Processes				
248	To ensure adequate testing of equipment, manufacturers' testing should be conducted under worst case scenarios taking into account new technologies and testing under simulated flight realistic conditions.	5	3	5	2.1
249	To ensure the accuracy and safety of computer modeling used for design and failure analysis, the modeling must be adequately re-validated on a continuing basis to account for new technology.	5	3	5	2.1
250	To ensure test components are representative of the final product, manufacturers should test the final component and regulators should require this type testing.	5	4	5	2.8
251	To preserve the original intended level of airworthiness, there should be a better definition and classification of subsequent in-service major and minor critical component changes. The definition of critical component should be more specific.	5	2	5	1.4
252	To prevent loss of control in flight, all changes to flight critical components, such as primary propeller pitch controller components, should be considered major changes.	5	4	4	2.2
	2. Operational practices 2.1 Aircrew 2.1.1 Approach briefings				
342	Airlines/operators should establish an SOP to ensure that flight crews should not begin the approach until adequate briefing is completed for the expected runway. (see 17)	4	3	5	1.7
350	Airlines/operators should ensure that adequate approach briefings are conducted that include descriptions of normal approach, non-normal conditions and the results of risk assessment analysis. (see 300)	5	3	5	2.1
	2.1.2 Checklists				
135	Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PF and PNF tasks. (see 82)	5	3	5	2.1
	2.1.3 Go-Arounds				
30	Airlines/operators should adopt the "delegated" approach to standard operating procedures. (e.g. monitored approach procedures)	5	3	4	1.7
61	Airlines/operators (and manufacturers in the airplane flight manual) should implement procedures that call for an immediate execution of the escape maneuver following a GPWS warning unless there is visual confirmation of terrain.	3	4	5	1.7
297	To prevent CFIT, operators should develop procedures to ensure that flight crews do not descend when confusion exists concerning aircraft position.	N	N	N	N
	2.1.4 Standard Operating Procedures (SOP)				
99	Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced. (see 110)	5	2	5	1.4
207	Airlines/operators should develop procedures to specify how transfer of control is formally accomplished.	5	3	4	1.7
339	Regulators should require captains and first officers each have identical approach charts for reference.	4	3	3	1.0
236	Airlines/operators should develop/publish appropriate procedures for radio communications restoration.	0	0	1	0.0
296	To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.	1	0	5	0.0
	2.1.5 Stabilized Approaches				
125	Airlines/operators should encourage flight crews to use precision approaches (glideslope guidance) when available and appropriate.	5	3	5	2.1

	2.1.6 Miscellaneous				
95	Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices.	4	1	4	0.4
19	Airlines/operators should implement a procedure to climb to a minimum safe altitude when position uncertainty exists by at least one crew member. Flight crew must advise ATC of intentions.	4	2	5	1.1
161	Airlines/operators should implement procedures that call for an immediate recovery maneuver following a flight control warning (e.g. stall warning) (see 61)	5	2	3	0.8
	2.2 ATC				
93	Air Traffic service should provide real time (most current) radio communication of critical airport and weather information.	5	3	5	2.1
327	Air Traffic service runway selection policies should be based on the most current wind available.	5	4	5	2.8
126	Air Traffic service providers should prioritize the use of precision approaches (glideslope guidance) when available and appropriate.	5	4	5	2.8
	2.3 Aircrew/ATC/Airspace 2.3.1 Stabilized Approaches				
157	Airlines/operators, regulators, Air Traffic service providers should establish policies or programs to address rushed approaches, including elimination of rushed approaches, recognition and rejection of rushed approaches and training for those encountered	4	3	5	1.7
355	Non-precision approaches should be conducted as constant angle, stabilized approaches. (see 59)	1	4	4	0.4
77	Eliminate non-precision approaches where possible. (see 59)	5	5	6	4.2
309	Airlines/operators should require flight crews to fly precision instrument approach procedures during periods of reduced visibility and night operations. (see 59, 355)	5	3	4	1.7
	2.3 Documentation 2.3.1 Approach Charts				
319	Regulators should require a Special Qualification Airport Briefing guide be incorporated with approach charts. (Subject matter must include aircraft specific local operational procedures)	4	4	4	1.8
6	Regulators should establish standardized approach plate depiction/information requirements for approach plate publishers.	4	3	4	1.3
	2.3.2 Manuals				
80	Airlines/operators should ensure, and regulators should check, that operators who create their own AOM's include all procedures prescribed by original equipment manufacturers Airplane Flight Manual (AFM).	5	4	5	2.8
134	Airlines/operators and regulators should ensure check list designs prioritize critical items as recommended by NASA study, and that items are arranged in a manner to enhance checklist implementation	6	5	6	5.0
225	Airlines/operators and regulators should ensure necessary manuals (operational & maintenance) are complete, accurate, available and appropriately used.	5	3	5	2.1
	2.4 Maintenance 2.4.1 Minimum Equipment Lists				
145	Airlines/operators and regulators should establish appropriate operational restrictions when equipment is inoperative (MEL)	4	4	4	1.8
146	Regulators should establish/enforce reasonable limitations on dispatch with safety related equipment inop. (MEL)	4	2	4	0.9
353	Airlines/operators should establish and enforce a clear MEL policy to aid flight crews in making maintenance related decisions.	2	2	3	0.3

	2.4.2 Miscellaneous				
224	Airlines/operators should ensure that all airline operations include compliance with all/seasonal guidance from the OEM.	5	4	5	2.8
232	Airlines/operators should ensure all nose gear struts are serviced for cold weather operation are in accordance with OEM recommendations.	6	5	2	1.7
233	Regulators should require operators to incorporate OEM strut servicing recommendations in mandatory maintenance procedure and surveill compliance.	6	5	1	0.8
27	Airlines/operators should implement maintenance procedures to ensure proper functioning of the CVR at all times. (Note: this intervention was recorded as a potential intervention of future accidents, it would not have prevented the subject accidents.)	N	N	N	N
	2.5 Personnel 2.5.1 Crew Fatigue				
48	Airlines/operators and regulators should strictly enforce flight/duty time limitations.	3	1	4	0.3
203	Airlines/operators should provide crews with inflight rest periods and adequate facilities. (see 31, 130, 315)	3	2	4	0.7
242	To prevent excessive fatigue, airlines/operators should consider circadian rhythm in crew scheduling to compensate for the effects of rhythm interruptions.	1	1	4	0.1
315	Regulators should update flight time/duty time regulations to counteract present commercial aviation environmental stressors. (e.g. crew rest requirements) (see 31, 130, 203, 257, 316)	5	2	4	1.1
130	Regulators should account for realistic rest scenarios when developing and implementing crew rest requirements during travel segments (see 31, 203, 257, 315, 316)	5	3	5	2.1
	2.5.2 Standards				
24	Airlines/operators should implement procedures to ensure appropriate crew pairing. (reference FSF corporate crew scheduling and fatigue evaluation.)	5	5	5	3.5
152	Airlines/operators and regulators should raise standards (e.g. crew pairing, approach minimums, etc.) for flight crewmembers that meet minimum qualifications but have demonstrated specific weaknesses. (see 151, 335, 337)	5	2	3	0.8
335	Airlines/operators should establish more effective pilot screening and Capt upgrade criteria to eliminate candidates with demonstrable aviation personality deficiencies. (see 151, 251, 337)	5	1	3	0.4
	2.5.Miscellaneous				
354	Organizations responsible for developing approach/arrival/departure procedures should not report to the organization responsible for Air Traffic service (e.g. In the FAA AVN-100 not reporting to AAT)	3	1	2	0.2
	3. Safety Processes 3.1 Communication				
255	To prevent catastrophic failures, the manufacturers should issue immediate telegraphic information to all operators, and regulators should require an immediate mandatory action (AD), following the initial failure report of any critical component malfunction.	5	2	5	1.4
79	Airlines/operators should implement a reliable process to communicate information to the flight crew that may affect flight or aircraft operations.	5	3	4	1.7
321	Regulators and Military agencies should ensure procedures are in place to share information pertaining to operations at joint use airports. (Special Use Airports)	4	2	4	0.9
340	Airlines/operators should implement procedures to ensure flight crews are aware of appropriate Airworthiness Directives, Certification and flight testing standards. (see 76, 46)	4	2	3	0.7
57	Airlines/operators, regulators, and manufacturers should implement a program designed for sharing of safety related information within the aviation community.	N	N	N	N

247	To ensure timely dissemination of navaid anomalies, airlines/operators and ATC should re-emphasize the requirement that flight crews report and ATC disseminate any navigation anomalies.	1	0	4	0.0
258	To facilitate the FAA awareness of safety related problems, there should be improved dissemination of the FAA hotline numbers.	0	4	4	0.0
318	Flight Safety Foundation should develop a cost analysis tool to educate CEO's about the high economic and psychological costs of accidents and serious incidents. (not rated)	N	N	N	N
	3.2 Enforcement				
311	Airlines/operators should ensure their “reward system” does not penalize flight crews for executing missed approaches. (see 217)	3	2	3	0.5
132	Airlines/operators and regulators should ensure that disciplinary and prosecution policies don't adversely affect or countermand safety gains of good CRM practices. (see 308)	5	3	4	1.7
334	Regulators should require airports to comply with International standards for airport construction.	5	2	2	0.6
	3.3 Implementation of safety recommendations				
214	Regulators should enforce timely incorporation of appropriate manufacturers recommendations. (see 98, 201)	4	2	4	0.9
231	Regulators should require and airlines/operators should promptly close out all regulatory safety audit findings.	4	2	4	0.9
303	Regulators should implement the NTSB recommendations to increase DFDR parameters. (not rated)	N	N	N	N
	3.4 Monitoring 3.4.1 Aircrew proficiency				
89	Airlines/operators and regulators should ensure that the frequency and effectiveness of proficiency checks for non-precision approaches are adequate.	3	3	5	1.3
112	Airlines/operators and regulators should ensure that the frequency and effectiveness of proficiency checks for simulated instrument failures (partial panel) are adequate.	4	3	4	1.3
151	Regulators should establish policies that require additional monitoring of flight crew members that have repeatedly failed check rides. (see 152, 335, 337)	4	4	4	1.8
	3.4.1 ATC				
21	Establish/enhance quality assurance checks/training to ensure that timely and accurate communication between controllers and flight crews is occurring.	1	1	4	0.1
124	Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures.	3	2	5	0.8
324	Air Traffic services should ensure proper/close supervision of controllers undergoing training so that all outages, construction, airport hazards, etc. are reported to flight crews in a timely and accurate manner. (see 11)	3	1	4	0.3
	3.4.2 Compliance with existing requirements				
129	Regulators should establish criteria to ensure operators overall quality assurance and compliance procedures are effective rather than reliance on spot checks of individual components	4	3	5	1.7
201	Regulators should develop adequate oversight as appropriate to ensure compliance with regulations.(see 145, 146, 202, 345)	4	2	4	0.9
202	Airlines/operators should develop a quality assurance program to ensure compliance with regulations.(see 145, 146, 201)	4	3	4	1.3
	3.4.3 Flight Operations Quality Assurance (FOQA)				
54	Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs.	N	N	N	N
55	Airlines/operators should implement a Flight Operations Quality Assurance (FOQA) program to identify flight crew failure to respond to GPWS warnings.	N	N	N	N

56	Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55)	N	N	N	N
	3.4.4 Communication phraseology				
42	Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology.	1	1	5	0.1
88	Airlines/operators should train and monitor flight crew compliance with established communication phraseology guidelines. (see 240)	2	2	4	0.4
	3.4.5 Training programs				
218	Airlines/operators should properly surveill contractor training programs for adequacy of training.(see 110, 202)	3	2	4	0.7
219	Regulators should ensure company training program is in accordance with approved training program.(see 110, 201)	4	2	4	0.9
	3.4.6 Miscellaneous				
254	To avoid the isolated incident syndrome and to ensure on-going assessment of flight critical control system reliability, a focused safety or risk assessment of all in-service failures or problems should be conducted to determine the need for immediate res	5	3	5	2.1
37	Regulators should discontinue on-time arrival tracking for airlines.	2	2	5	0.6
213	Airlines/operators and regulators should provide additional inspectors/inspection of sub-contract activity. (see 201, 202)	3	3	5	1.3
345	Ensure regulators have adequate funding, training and processes to accomplish their oversight responsibilities. (see 201)	4	3	4	1.3
348	Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and mitigate safety concerns. (see 318)	N	N	N	N
	3.5 Policies 3.5.1 Phraseology				
240	To reduce the possibility of error, confusion and workload increase related to ATC clearances, regulators should require and operators ensure that flight crews utilize proper phraseology and readbacks. (see 88)	0	0	5	0.0
	3.5.2 Crew fatigue				
257	To eliminate loop holes in crew rest requirements and to ensure adequate crew rest, regulators should clarify crew rest regulations. (see 31, 130, 203, 315, 316)	0	0	4	0.0
	3.5.3 Safety culture				
22	Airlines/operators should encourage a culture that emphasizes safe arrivals over timely arrivals. (see 63, 143)	2	2	4	0.4
123	Airlines/operators should implement a true no-fault go around policy (learning vs. blame).	5	3	5	2.1
217	Airlines/operators should ensure their "reward system" is not related to the completion of a route segment. (see 311)	2	2	3	0.3
63	Airlines/operators should implement a culture which encourages flight crew voluntary removal from flight status due to illness and/or emotional distress (including the use of a self assessment tool). (see 70)	2	1	2	0.1
143	Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture) (see 22, 63, 348)	5	3	6	2.5
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. (see 142, 311)	5	3	5	2.1
128	Airlines/operators and regulators should implement a no blame safety reporting and data sharing system with appropriate protections from litigation and prosecution concerns.	N	N	N	N

	3.5.4 Uniform standards				
317	Regulators should ensure one level of safety exists for all commercial transport operations (whether passenger or freighter operations).	4	2	3	0.7
347	Parent airlines/operators should adopt a program to ensure the same level of safety in regional partners including, but not limited, to recruitment, training, operations and maintenance.	2	1	4	0.2
	3.5.5 Miscellaneous				
310	Regulators should not allow noise abatement procedures that reduce the level of safety that existed prior to their implementation.	3	3	4	1.0
	3.6 Research				
204	Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance.	N	N	N	N
208	Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings)	N	N	N	N
244	To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations.	N	N	N	N
260	To prevent uncommanded in-flight flat pitch, research should be conducted into prop brake designs.	N	N	N	N
261	To improve passenger and flightcrew survivability, research should be conducted to explore new methods to increase crash survivability.	N	N	N	N
337	Airlines/operators should establish a process (which includes an interdisciplinary team) to document and investigate high risk behavior and poor judgement as evidenced by on-the-job performance. (see 151, 152, 335)	N	N	N	N
356	Research should be done to develop an effective tactical decision making model for flight crews in time critical situations.	N	N	N	N
	3.7 Miscellaneous				
108	Air Traffic service providers should implement and/or review procedures to ensure ATC training does not create a hazard to flight operations.	1	1	3	0.1
150	Regulators or other governing authorities should establish policies that ensure that surrounding lights are distinguishable from airport lighting in order to avoid confusion (safety process, policy).	5	3	5	2.1
	4. Training 4.1 Crew Resource Management (CRM) 4.1.1 Aircrew 4.1.1.1 Content				
82	Airlines/operators should clearly define, train and check the specific PF/PNF duties. (see 135)	4	2	5	1.1
23	Airlines/operators should ensure that regularly scheduled recurrent training (e.g. LOFT) emphasizes crew cooperation and working together to maximize safe operations. (see 308, 314)	5	2	5	1.4
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. (see 75)	2	2	4	0.4
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) (see 237)	5	2	5	1.4
133	Airlines/operators training of Captains and Chief Pilots should include Management practices that promote team building and effective human relations (leadership training beyond current CRM programs). (see 308)	4	2	5	1.1

308	Airlines/operators should ensure their formal CRM training emphasizes the following management skills: decision making, workload management, crew coordination, planning, communication, situational awareness, and advocacy. (IAW AC120-51b). (See 133)	6	2	4	1.3
237	Airlines/operators should provide guidance to crew concerning evaluation of all options prior to decision making as part of CRM training. (see 25, 26, 131, 132, 133, 308)	N	N	N	N
349	Airlines/operators should ensure training for instructors and check airmen include objective criteria to be used in evaluating crew CRM performance. (see 25,131)	3	1	4	0.3
	4.1.1.2 Scheduling				
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 are reviewed during recurrent training.	4	3	4	1.3
25	Airlines/operators should establish a CRM training program and regulators should require and insure that the initial training is provided prior to line flying and require recurrent CRM training. (see 131, 132, 349)	4	2	5	1.1
	4.1.2 ATC				
320	Air Traffic service providers should institute an ATC "Crew Resource Management Program" similar to those required of flight crews. (FAA AC 120-51b)	1	1	4	0.1
	4.2 Situation Awareness 4.2.1 Aircrew				
325	Airline/operators should emphasize during initial and recurrent training the importance of maintaining systems status awareness during non-normal events and hazardous approaches (goal to avoid tunnel vision/narrowed attention)	4	2	4	0.9
329	Airlines/operators should incorporate in initial & recurrent training ways to recognize multiple cues that will require go-around. Including CFIT training aid 2.1.9, FSF definition of stabilized approach, risk assessment tool, and windshear training aid	5	4	5	2.8
142	Airlines/operators should establish policies, parameters, and training to recognize unstabilized approaches and other factors and implement a go-around gate system. (see FSF - "defined gates" p. 193) (see 116, 123)	6	4	6	4.0
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)	5	2	5	1.4
144	Airlines/operators and regulators should ensure that their training/standardization programs clarify the differences between vertical and slant range visibility	3	2	5	0.8
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).	5	3	5	2.1
75	Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position. (see 45)	2	1	4	0.2
105	Airlines/operators should train flight crews on how flight delays upon departure or enroute (weather, maintenance, ATC, etc.) can affect their subsequent decision making relative to the safe conduct of the flight.	3	2	4	0.7
141	Airlines/operators and regulators should require training/standardization programs include training regarding physiological effects on aircrew performance, (e.g. low blood sugar).	3	1	3	0.3
162	Airline/operators should include in their training programs the awareness of potential safety risks due to the complacency when operating at a very familiar airport (e.g. home base).	4	2	4	0.9
316	Regulators should require airline/operators to train flightcrews to recognize and counteract acute and chronic fatigue. (see 31, 130, 203, 257,315)	5	2	5	1.4
12	Air Traffic service providers should emphasize in ATC training the controllers' potential in assisting the flight crew in improving their situation awareness.	2	2	4	0.4

	4.3 Basic skills 4.3.1 Aircrew				
115	Airlines/operators should ensure that their training/standardization programs emphasize the dangers of rushed approaches. (see 13, 157)	4	3	5	1.7
312	Airline/operators should ensure 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.	3	2	5	0.8
116	Airlines/operators should ensure that their training/standardization programs emphasize the dangers of high rate of descent and unstable approaches. (see 142)	5	4	5	2.8
322	Airlines/operators should develop and implement a ground school and simulator training program similar to the Advanced Aircraft Maneuvering Program.	5	3	4	1.7
7	Airlines/operators should ensure that their training/standardization programs emphasize review of approach and missed approach procedures. (see 329)	5	2	5	1.4
15	Airlines/operators should ensure that their training/standardization programs instruct when to disengage automated systems and fly manually. (see 246)	4	2	4	0.9
17	Airlines/operators should ensure that their training/standardization programs emphasize the importance of all flight-related briefings. (see 342)	4	2	4	0.9
100	Airlines/operators should ensure that their training/standardization programs emphasize the importance of adhering to MDA/DH.	6	2	5	1.7
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. (see 99)	5	3	5	2.1
113	Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.	3	2	4	0.7
136	Airlines/operators should ensure that their training/standardization programs emphasize the importance of the sterile cockpit environment.	3	3	4	1.0
96	Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate approach preparation and contingency review prior to commencing an approach.	5	2	4	1.1
114	Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency.	4	1	4	0.4
153	Ensure that flight crews are adequately trained in a level D simulator for dynamic characteristics before assignment to the line. (see 312)	5	4	5	2.8
64	Airlines/operators should ensure that their training/standardization programs direct the flight crews to regularly cross check all instrumentation.	5	2	5	1.4
111	Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training.	5	3	5	2.1
238	To preclude conducting flight training during operational flights, when a need for training is identified, operators should conduct training in accordance with their approved training program.	5	3	5	2.1
154	Airlines/operators should improve/increase training to increase awareness of icing effects on airplane type including dynamic simulator training.	2	4	5	1.1
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)).	5	3	5	2.1
246	To reduce pilot overload, airlines/operators policies should stress using the appropriate level of automation.	4	3	5	1.7
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).	4	2	5	1.1

331	Airlines/operators and manufacturers should train crews to understand the capabilities and limitations of systems, conditions which would cause systems to not function as the crew anticipates, and how to detect those conditions (e.g. lack of brakes, spoil	5	3	5	2.1
	4.3.2 ATC				
13	Air Traffic service providers should enhance ATC training to emphasize the dangers of rushed approaches and performance characteristics of modern jet transports. (see 115, 157)	5	2	5	1.4
106	Air Traffic service providers should train and monitor ATC adherence to established communications procedures including hearback problems. (see 240)	2	1	5	0.3
	4.3.2 Regulators				
223	Regulators should ensure POIs are properly qualified and trained to approve appropriate company operational procedures.	3	3	5	1.3
220	Regulators should ensure that all POIs are current and qualified in one model of the company's equipment.	2	1	2	0.1
222	Regulators should require PMI's to have expertise in the assigned carrier's equipment.	2	1	2	0.1
346	Airlines/operators should ensure better educated regulators by providing intern programs.	1	1	1	0.0
	4.4 Miscellaneous				
227	Airlines/operators should ensure that their training/standardization program emphasizes the benefits of inter-crew/company communications. (see 131)	5	2	4	1.1
228	Regulators should require airlines/operators to modify their training to maximize benefits of inter-crew/company communications.	5	2	4	1.1
163	Airlines/operators should ensure that their training/standardization programs address common misperceptions that could lead to unsafe practices (i.e. ATC always wants high energy approaches).	5	3	5	2.1
	5. Miscellaneous				
262	To improve passenger and flightcrew survivability, regulators should require and operators should implement existing knowledge of crash survivability.	N	N	N	N
241	To eliminate hearback errors, ATC should reexamine and implement improvements to address hearback problems. (see 240)	0	0	5	0.0

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Appendix F

Approach and Landing Intervention Summaries

Approaches

Airlines/operators should encourage flight crews to fly precision approach procedures any time they are available and require them at night or during periods of reduced visibility (125 & 309). Air Traffic service providers should give priority to the use of precision approaches when available and appropriate (126).

- Implement precision approach capability (vertical guidance) for all runways without established precision approach procedures (59 & 77).
- Airline /operators and regulators should ensure that the frequency and effectiveness of proficiency checks for non-precision approaches are adequate (89).
- Non-precision approaches should be flown as constant angle, stabilized approaches (355).

Regulators should develop world-wide standard procedures for category II approaches (200).

Organizations responsible for developing approach/arrival/departure procedures should not report to the organization responsible for Air Traffic Service (354).

Approaches

59	Implement precision approach capability (glideslope guidance) for all runways without established precision approach procedures (e.g. ILS, DGPS, etc.). (see 77)
77	Eliminate non-precision approaches where possible. (see 59)
89	Airlines/operators and regulators should ensure that the frequency and effectiveness of proficiency checks for nonprecision approaches are adequate.

Approaches cont.

125	Airlines/operators should encourage flight crews to use precision approaches (glideslope guidance) when available and appropriate.
126	Air Traffic service providers should prioritize the use of precision approaches (glideslope guidance) when available and appropriate.
200	Regulators should develop world-wide standard procedures for category II approaches.
309	Airlines/operators should require flight crews to fly precision instrument approach procedures during periods of reduced visibility and night operations. (see 59, 355)
354	Organizations responsible for developing approach/arrival/departure procedures should not report to the organization responsible for Air Traffic service (e.g. In the FAA AVN-100 not reporting to AAT)
355	Non-precision approaches should be conducted as constant angle, stabilized approaches. (see 59)

ATC/Crew Communication

Airline/Operators and Air Traffic Service Providers should work together to improve communications between flight crews and controllers. Areas of concentration should include: data link of ATC information directly to the flight deck (28, 29, 122), improved cross check of information by flight crew (95), procedures to address hearback problems (106, 241), establishment of communication quality assurance programs (21)

To mitigate confusion and enhance efficiency, Air Traffic Service Providers should implement a system to automatically transmit ATC instructions, clearances and information (weather, notams, etc) via computer link to the aircraft (which would allow down loading to the FMS) as opposed to voice communications to the flight crew (28, 29, 122).

To mitigate confusion between ATC and flight crews, airlines/operators should establish procedures for flight crews to cross check instructions, clearances and information to ensure consistency with expected procedures and practices and to query ATC if uncertainty exists (296, 95).

Establish/enhance quality assurance checks/training to ensure that timely and accurate communication between controllers and flight crews is occurring (21).

To ensure timely dissemination of navaid anomalies, airlines/operators and ATC should re-emphasize the requirement that flight crews report and ATC disseminate any navigation anomalies (247).

Air Traffic Service Providers should implement improvements in training and monitoring of adherence to established communications procedures including ways to address hearback problems (106, 240).

Air Traffic Service Providers should implement an ATC CRM Program similar to that required of flight crews (320).

ATC/crew communication

21	Establish/enhance quality assurance checks/training to ensure that timely and accurate communication between controllers and flight crews is occurring.
28	Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft.
29	Implement transmission of ATC instructions (between the ground and aircraft) via a computer link which would allow downloading to the FMS.
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. (see 240)
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.

ATC/crew communication cont.

241	To eliminate hearback errors, ATC should re-examine and implement improvements to address hearback problems. (see 240)
247	To ensure timely dissemination of navaid anomalies, airlines/operators and ATC should re-emphasize the requirement that flight crews report and ATC disseminate any navigation anomalies.
296	To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.
320	Air Traffic service providers should institute an ATC "Crew Resource Management Program" similar to those required of flight crews. (FAA AC 120-51b)

ATC Phraseology

Airline/operators and Air Traffic Service Providers should train and monitor flight crews and controllers to ensure proficiency in basic English language and ICAO phraseology (40, 41, 42).

Develop additional ICAO phraseology for flight crew/air traffic service to address communication regarding aircraft position, equipment status and communication which is not consistent with the situation or with expected responses (83).

ATC phraseology

40	Airlines/operators and air traffic service providers should ensure fluency/proficiency in the use of basic English language.
41	Air Traffic service providers should train flight crews and controllers to ICAO standards to ensure fluency/proficiency in the use of the ICAO phraseology.

ATC phraseology cont.

42	Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology.
83	Develop additional ICAO phraseology for flight crew/air traffic service to address communication regarding aircraft position, equipment status, and communication which is not consistent with the situation or with expected responses.

ATC Procedures

Air traffic Service Providers should implement a Quality Assurance program to ensure adherence to established procedures (124).

ATC procedures

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

ATC Trainees/Supervision

Air traffic Service Providers should implement procedures that ensure ATC trainees are always supervised and that this training does not create a hazard to flight operations (108, 11).

Air Traffic Services should ensure proper/close supervision of controllers undergoing training so that all outages, construction, airport hazards, etc. are reported to flight crews in a timely and accurate manner (324).

ATC trainees/supervision

11	Air Traffic service providers should implement procedures that ensure that ATC trainees are always supervised. (see 324)
108	Air Traffic service providers should implement and/or review procedures to ensure ATC training does not create a hazard to flight operations.
324	Air Traffic services should ensure proper/close supervision of controllers undergoing training so that all outages, construction, airport hazards, etc. are reported to flight crews in a timely and accurate manner. (see 11)

Awareness

Airlines/operators should require training/standardization programs that teach situation awareness (147).

Awareness

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).

Awareness (position)

Uncertainty of the aircraft's position by flight crew and/or ATC is a common factor in CFIT and Approach and Landing accidents. Interventions targeting several areas such as, Procedures, Equipment, and Air Traffic Control can reduce the risk of this type of accident.

Procedures:

- Airline/operators should implement a procedure requiring aircraft to climb to a minimum safe altitude when position uncertainty exists (19).
- Airline/operators should develop procedures to ensure that flight crews do not descend when confusion exists concerning aircraft position (297).
- Airline/operators should implement procedures that call for an immediate execution of the escape maneuver following a GPWS warning unless there is visual confirmation of terrain (61).

- Airline/operators should ensure that their training/standardization programs direct flight crews to use all available tools/resources to establish aircraft position (47, 75).
- Airline/operators and regulators should emphasize only published route segments should be flown in non-radar environments. (50)
- Airlines/operators and regulators should standardize on usage of QNH altimeter settings (91).
- Airlines/operators should ensure that their training/standardization programs emphasize the importance of adhering to MDA/DH (100).

Equipment:

- Manufacturers should install TAWS (EGPWS) in all new aircraft, airlines/operators should retrofit TAWS into the existing fleet and international regulators should require the installation of TAWS (35).
- Airline/operators should install radio altimeters in all aircraft and develop procedures for their use on approach as recommended by FSF ALAR (343).
- Airline/operators should install/retrofit equipment to provide automatic altitude callouts on final approach and alert flight crew of arrival at MDA/DH (14, 211).
- Air Traffic Service providers should install DME at all appropriate airports and implement worldwide surveillance radar (32, 121).
- Airline/operators should ensure currency of FMS data bases (51); FMS equipment (logic) should have the capability to depict previously entered waypoints between present position and current “to” waypoint, and to depict previously entered waypoints behind the aircraft’s fight path (53, 127).
- Datalink of GPS aircraft position to ATC (58).

ATC:

- Air Traffic Service providers should emphasize controller’s potential effectiveness in assisting the flight crew to improve their situation awareness and to use all available tools to establish aircraft position (10, 12).
- Air Traffic service providers should review the engineering standards for the siting of future Terminal Radar Systems to ensure the maximum effectiveness of MSAW is available (71).
- Air Traffic service providers should install MSAW-like capabilities world-wide with emphasis on high-risk airports (72).

Awareness (position)

10	Air Traffic service providers should train Air Traffic Controllers to use all available tools to establish aircraft position (example: don't fixate on just DME).

12	Air Traffic service providers should emphasize in ATC training the controllers' potential in assisting the flight crew in improving their situation awareness.
14	Install aural warning devices on aircraft to alert flightcrew of arrival at MDA/DH.
19	Airlines/operators should implement a procedure to climb to a minimum safe altitude when position uncertainty exists by at least one crew member. Flight crew must advise ATC of intentions.
32	In the absence of GPS, Air Traffic service providers should install DME equipment at all appropriate airports.
35	Manufacturers should install TAWS (EGPWS) in all new aircraft, airlines/operators should retrofit TAWS into the existing fleet and international regulators should require the installation of TAWS.
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. (see 75)
50	Airlines/operators and regulators should emphasize that only published route segments should be flown in non-radar environments.
51	Airlines/operators should ensure the currency of the FMS database and update as appropriate.
53	Airlines/operators should install FMS equipment (logic) which has the capability to depict previously entered waypoints that are between the current present position and the current "to" waypoint.
58	Establish datalink of the aircraft GPS position to relay aircraft position to ATC.

Awareness (position) cont.

61	Airlines/operators (and manufacturers in the airplane flight manual) should implement procedures that call for an immediate execution of the escape maneuver following a GPWS warning unless there is visual confirmation of terrain.
71	Air Traffic service providers review the engineering standards for the siting of future Terminal Radar Systems to ensure the maximum effectiveness of MSAW is available.
72	Air Traffic service providers should install MSAW-like capabilities world-wide with emphasis on high-risk airports.
75	Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position. (see 45)
91	Airlines/operators and regulators should standardize on usage of QNH altimeter settings.
100	Airlines/operators should ensure that their training/standardization programs emphasize the importance of adhering to MDA/DH.
121	Air Traffic service providers should implement worldwide surveillance radar (example: ADS/B)
127	Airlines/operators should install FMS equipment (logic) which has the capability to depict previously entered way-points behind the aircraft's flightpath.
211	Airlines/operators should retrofit equipment to provide automatic altitude callouts on final approach. If unable, other altitude alerting or reminder systems (such as altimeter bugs) should be installed.
297	To prevent CFIT, operators should develop procedures to ensure that flight crews do not descend when confusion exists concerning aircraft position.
343	Airlines/operators should install radio altimeters in all aircraft and develop procedures for their use on approach as recommended by FSF ALAR.

Basic skills (poor visibility)

Airline/operators and regulators should ensure that their training/standardization programs clarify the differences between vertical and slant range visibility (144).

Airline/operators should ensure 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 (312).

Basic skills (poor visibility)

144	Airlines/operators and regulators should ensure that their training/standardization programs clarify the differences between vertical and slant range visibility.
312	Airline/operators should ensure 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.

Checklist design

Airlines/operators and regulators should ensure checklist designs prioritize critical items (134) and promote effective crew coordination and distribution of PF and PNF tasks (135).

Checklist design

134	Airlines/operators and regulators should ensure check list designs prioritize critical items as recommended by the NASA study, and that items are arranged in a manner to enhance checklist implementation
135	Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PF and PNF tasks. (see 82)

Communication (company to crew)

Airlines/operators should ensure, and regulators should require, that their training/standardization programs emphasize the benefits of inter-crew/company communications (227, 228).

Airlines/operators should implement a process to communicate information to the flight crew that may affect flight or aircraft operations (79) (e.g. recent aircraft maintenance actions (46), AD's, certification and flight test standards, etc.) (340).

Develop technology to provide real time assistance to flight crews with onboard system failures and diagnostics (158).

Airlines/operators and regulators should improve the availability, clarity, and prioritization of NOTAM information (78).

Communication (company to crew)

46	Airlines/operators should implement procedures to increase flightcrew awareness of recent aircraft maintenance actions.
78	Airlines/operators and regulators should improve the availability, clarity, and prioritization of NOTAM information.
79	Airlines/operators should implement a reliable process to communicate information to the flight crew that may affect flight or aircraft operations.
158	Develop technology to provide real time assistance to flight crews with onboard system failures and diagnostics (e.g. data link transmittal to ground support) (see 103)
227	Airlines/operators should ensure that their training/standardization program emphasizes the benefits of inter-crew/company communications. (see 131)
228	Regulators should require airlines/operators to modify their training to maximize benefits of inter-crew/company communications.
340	Airlines/operators should implement procedures to ensure flight crews are aware of appropriate Airworthiness Directives, Certification and flight testing standards. (see 76, 46)

CRM

Airlines/operators and regulators should ensure that CRM training is implemented and provided prior to line flying to maximize safe operations (25); that disciplinary policies don't adversely effect the safety gains from good CRM practices (132); that checklist design and implementation of procedures promote effective crew coordination (135); and that training for instructors and check airmen include objective criteria to evaluate crew CRM performance (349). CRM programs should emphasize (23, 131, 308, 237):

- the team concept with crew cooperation and coordination, working together, and cross cultural issues
- communication
- workload management, planning, and evaluation of all options prior to decision making

Airlines/operators should develop simulator training scenarios that require flight crews to learn multi-tasking abilities and appropriate prioritization abilities (314).

Research should be done to develop an effective tactical decision making model for flight crews in time critical situations (356).

CRM

23	Airlines/operators should ensure that regularly scheduled recurrent training (e.g. LOFT) emphasizes crew cooperation and working together to maximize safe operations. (see 308, 314)
25	Airlines/operators should establish a CRM training program and regulators should require and insure that the initial training is provided prior to line flying and require recurrent CRM training. (see 131, 132, 349)
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) (see 237)
132	Airlines/operators and regulators should ensure that disciplinary and prosecution policies don't adversely affect or countermand safety gains of good CRM practices. (see 308)

135	Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PF and PNF tasks. (see 82)
237	Airlines/operators should provide guidance to crew concerning evaluation of all options prior to decision making as part of CRM training. (see 25, 26, 131, 132, 133, 308)
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. (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 attached LOFT scenarios).
349	Airlines/operators should ensure training for instructors and check airmen include objective criteria to be used in evaluating crew CRM performance. (see 25,131)
356	Research should be done to develop an effective tactical decision making model for flight crews in time critical situations.

Crew Rest

To ensure flight crews receive adequate opportunities for rest regulators should accomplish the following actions:

- account for realistic rest scenarios when developing and implementing crew rest requirements during travel segments (130)
- clarify and update flight/duty time regulations to counteract present commercial aviation environmental stressors (315, 257)
- require airline/operators to train flight crews to recognize and counteract acute and chronic fatigue (316)
- strictly enforce flight/duty time limitations (48)

To ensure flight crews receive adequate opportunities for rest, airline/operators should accomplish the following actions:

- strictly enforce flight/duty time limitations (48)
- consider circadian rhythm in crew scheduling (242)
- provide crews with in-flight rest periods and adequate facilities (203)

Crew Rest

48	Airlines/operators and regulators should strictly enforce flight/duty time limitations.
130	Regulators should account for realistic rest scenarios when developing and implementing crew rest requirements during travel segments, (see 31, 203, 257, 315, 316)
203	Airlines/operators should provide crews with inflight rest periods and adequate facilities. (see 31, 130, 315)
242	To prevent excessive fatigue, airlines/operators should consider circadian rhythm in crew scheduling to compensate for the effects of rhythm interruptions.
257	To eliminate loop holes in crew rest requirements and to ensure adequate crew rest, regulators should clarify crew rest regulations. (see 31, 130, 203, 315, 316)
315	Regulators should update flight time/duty time regulations to counteract present commercial aviation environmental stressors. (e.g. crew rest requirements) (see 31, 130, 203, 257, 316)
316	Regulators should require airline/operators to train flightcrews to recognize and counteract acute and chronic fatigue. (see 31, 130, 203, 257,315)

Crew Team Training

Airlines/operators should ensure command oversight and team building/effective human relations training is provided during the captain upgrade process and also in recurrent training (133). First officer responsibility for monitoring should be reinforced during recurrent training (20).

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 are reviewed during recurrent training.
133	Airlines/operators training of Captains and Chief Pilots should include management practices that promote team building and effective human relations (leadership training beyond current CRM programs). (see 308)

Current but not competent aircrew

Regulators and airlines/operators should establish policies that require additional monitoring of crewmembers who have repeatedly failed checkrides (151) and should have special scheduling standards, approach minimums, etc., for those who meet minimum qualifications but have demonstrated specific weaknesses (152).

- Airlines/operators should establish more effective pilot screening and captain upgrade criteria to eliminate candidates with demonstrable aviation personality deficiencies (335).
- Airlines/operators should establish a process (which includes an interdisciplinary team) to document and investigate high risk behavior and poor judgement triggered by on-the-job performance (337).

Current but not competent aircrew

151	Regulators should establish policies that require additional monitoring of flight crew members that have repeatedly failed check rides. (see 152, 335, 337)
152	Airlines/operators and regulators should raise standards (e.g. crew pairing, approach minimums, etc.) for flight crewmembers that meet minimum qualifications but have demonstrated specific weaknesses. (see 151, 335, 337)
335	Airlines/operators should establish more effective pilot screening and upgrade criteria to eliminate candidates with demonstrable aviation personality deficiencies. (see 151, 251, 337)
337	Airlines/operators should establish a process (which includes an interdisciplinary team) to document and investigate high risk behavior and poor judgement triggered by on-the-job performance. (see 151, 152, 335)

Electronic checklists

Regulators should require manufacturers to equip new aircraft with electronic checklists (306); and airlines/operators to outfit aircraft with electronic checklists, or at a minimum, mechanical checklists containing a process to reinforce challenge and response (305).

Electronic checklists

305	Regulators should require airlines/operators to outfit aircraft with electronic checklists. If unable to install electronic checklists, use of mechanical checklists or, at a minimum, development of a process to reinforce challenge and response checklists.
306	Regulators should require manufacturers to equip all new aircraft with electronic checklists.

Equipment (automation)

Airlines/operators should ensure that:

- the aircraft is equipped with all expected NAVAID frequencies (73)
- the aircraft is equipped with autopilots to reduce crew workload during critical phases of flight (352)
- training/standardization programs instruct when to disengage automated systems and fly manually (15)

Manufacturers should ensure that:

- automated systems provide the flight crew with sufficient information (automation feedback) to prevent mode confusion (16)
- the FMS logic displays NAVAID's with the same identifier in a progressive distance manner (76)
- failure of the aircraft system to capture glideslope (or VNAV) is adequately annunciated to the flight crew (3)

Manufacturers should develop systems to return aircraft to normal altitude with one pilot button push to recover aircraft in unusual altitude (pilot initiated auto-recovery systems) (245).

Require that autothrottles be used with all autopilot coupled approaches (156).

Manufacturers should incorporate an "input rudder" indicator or automatic yaw compensation to ensure that adequate yaw control is provided (159).

Equipment (automation)

3	Ensure that failure of the aircraft system to capture glideslope (or VNAV) is adequately annunciated to the flight crew.
15	Airlines/operators should ensure that their training/standardization programs instruct when to disengage automated systems and fly manually. (see 246)
16	Manufacturers should ensure that automated systems provide the flight crew with sufficient information (automation feedback) to prevent mode confusion.
73	Airlines/operators should ensure that the aircraft is equipped with all expected NAVAID frequencies.

Equipment (automation) cont.

76	The manufacturer of the FMS should ensure that the FMS logic displays NAVAID's with the same identifier in a progressive distance manner.
156	Require autothrottles with autopilot coupled approaches.
159	Manufacturers should incorporate an "input rudder" indicator or automatic yaw compensation to ensure that adequate yaw control is provided.
245	To recover aircraft in unusual altitude, manufacturers should develop systems to return aircraft to normal altitude with one pilot button push (pilot initiated auto-recovery systems).
352	Airlines/operators should equip aircraft with autopilots to reduce crew workload during critical phases of flight.

Equipment (failure)

To ensure adequate testing of equipment, manufacturers' testing should:

- be conducted on the final component to ensure test components are representative of the final product (250)
- be conducted under the worst case scenarios taking into account new technologies and testing under simulated flight realistic conditions (248)

With flight critical components and/or systems, airlines/operators, regulators, and manufacturers should:

- avoid simultaneous maintenance on redundant systems (66)
- consider any changes as major changes (252)
- develop better (more specific) definitions and classifications of subsequent in-service major and minor critical component changes (251)
- utilize redundancy and failure tolerance features with fault annunciation (253)
- conduct a focused safety or risk assessment of all in-service failures or problems (254)
- ensure that design changes (service bulletins) to flight critical systems are incorporated in a timely manner (98)
- require immediate mandatory action following an initial failure report (255)

- prohibit engineering flight tests during revenue flights following maintenance of critical systems (90)

Manufacturers should ensure that propeller systems:

- provide positive prevention designs to eliminate all flight critical failure modes (259)
- be designed to feather in the event of pitch control loss and provide positive annunciation of malfunctions to the flight crew (256)

To prevent uncommanded in-flight flat pitch, research should be conducted into prop brake designs (260).

Regulators should develop more stringent Failure Mode Effects Analysis (FMEA) requirements to ensue complete evaluation of failure modes (298).

Manufacturers should improve the design for an error-tolerant ground spoiler deployment system (304) including ground sensing systems that are tolerant to adverse conditions (332).

Manufacturers should ensure that all impending 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 develop and implement system failure annunciation capabilities to alert flight crews of pending failures (e.g. HUMS) (103).

Regulators should establish criteria for, and manufacturers should evaluate and improve, the reliability and failure tolerance of flight systems (49).

To ensure the accuracy and safety of computer modeling used for design and failure analysis, the modeling must be adequately re-validated on a continuing basis to account for new technology (249).

To facilitate the FAA awareness of safety related problems; there should be improved dissemination of the FAA hotline numbers (258).

Manufacturers should provide a more positive means of external strut pre-flight inspections (235).

Equipment (failure)

45	Manufacturers should ensure that all impending 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. (see 103, 138)
49	Regulators should establish criteria for, and manufacturers should evaluate and improve, the reliability and failure tolerance of flight systems. (see 332)
66	Airlines/operators should implement procedures to avoid simultaneous maintenance on redundant flight critical systems.
90	Airlines/operators and regulators should prohibit engineering flight tests during revenue flights following maintenance of critical systems.
98	Airlines/operators and regulators should review procedures to ensure that design changes (service bulletins) to flight critical systems are incorporated in a timely manner.
103	Manufacturers should develop and implement system failure annunciation capabilities to alert flight crews of pending failures (e.g. HUMS). (see 45, 138)
235	Manufacturers should provide a more positive means of external strut pre-flight inspections.
248	To ensure adequate testing of equipment, manufacturers' testing should be conducted under worst case scenarios taking into account new technologies and testing under simulated flight realistic conditions.
249	To ensure the accuracy and safety of computer modeling used for design and failure analysis, the modeling must be adequately re-validated on a continuing basis to account for new technology.
250	To ensure test components are representative of the final product, manufacturers should test the final component and regulators should require this type testing.

Equipment (failure) cont.

251	To preserve the original intended level of airworthiness, there should be a better definition and classification of subsequent in-service major and minor critical component changes. The definition of critical component should be more specific.
252	To prevent loss of control in flight, all changes to flight critical components, such as primary propeller pitch controller components, should be considered major changes.
253	To prevent loss of control, there should be redundancy and failure tolerance features for all flight critical components, such as dual path design, fail operational redundant systems, with fault annunciation.
254	To avoid the isolated incident syndrome and to ensure on-going assessment of flight critical control system reliability, a focused safety or risk assessment of all in-service failures or problems should be conducted to determine the need for immediate resolution.
255	To prevent catastrophic failures, the manufacturers should issue immediate telegraphic information to all operators, and regulators should require an immediate mandatory action (AD), following the initial failure report of any critical component malfunction.
256	To prevent loss of aircraft control in-flight, all propeller pitch control systems must be designed to positively feather in the event of pitch control loss. Propeller pitch control system malfunctions must be positively annunciated to the flight crew.
258	To facilitate the FAA awareness of safety related problems, there should be improved dissemination of the FAA hotline numbers.
259	Regulators should set engineering standards requiring propeller manufacturers to provide positive prevention designs, to eliminate all flight critical failure modes (e.g. flat pitch).
260	To prevent uncommanded in-flight flat pitch, research should be conducted into prop brake designs.
298	To ensure complete evaluation of failure modes, regulators should develop more stringent Failure Mode Effects Analysis (FMEA) requirements.
304	Manufacturers should improve the design for an error tolerant ground spoiler deployment system.

Equipment (failure) cont.

332	Manufacturers should design ground sensing systems that are tolerant to adverse conditions without degrading inflight safety features (e.g. which prevent deployment of ground spoilers and reverse in-flight). (see 16)

Flight crew and ATC phraseology

Airlines/operators and air traffic service providers should train and monitor flight crew and ATC compliance with established communication phraseology (42) and readback guidelines (88, 240) including ICAO standards (41) and fluency/proficiency English language (40).

Develop additional ICAO phraseology to address communication regarding aircraft position, equipment status etc. (83).

Flight crew and ATC phraseology

40	Airlines/operators and air traffic service providers should ensure fluency/proficiency in the use of basic English language.
41	Air Traffic service providers should train flight crews and controllers to ICAO standards to ensure fluency/proficiency in the use of the ICAO phraseology.
42	Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology.
83	Develop additional ICAO phraseology for flight crew/air traffic service to address communication regarding aircraft position, equipment status, and communication which is not consistent with the situation or with expected responses.
88	Airlines/operators should train and monitor flight crew compliance with established communication phraseology guidelines. (see 240)
240	To reduce the possibility of error, confusion and workload increase related to ATC clearances, regulators should require and operators ensure that flight crews utilize proper phraseology and readbacks. (see 88)

Flight Crew Proficiency/Basic Skills

Airlines/operators should ensure that their training/standardization programs provide sufficient training, in terms of content, frequency and

effectiveness, to ensure flight crew proficiency (114). Areas of concentration should include: use of FMS (52), use of HSI display (62), Non--FMS/raw data approaches (67), non-precision approaches (89), low light/poor visibility optical and physiological illusions (312), importance of adhering to MDA/DA (100), potential safety risks due to complacency when operating at familiar airports (162), simulated instrument failures (partial panel) flight (112), regular cross check of all instrumentation (64), and common misperceptions that could lead to unsafe practices (163).

Airline/operators should ensure that flight crews are adequately trained in a level D simulator for dynamic characteristics (153) and receive exposure to an Advanced Aircraft Maneuvering Program (322) before assignment to the line.

Airline/operators should properly monitor contractor training programs for adequacy of training (218).

Airline/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training (111).

Airline/operators and manufactures should train crews to understand the capabilities and limitations of systems, conditions which would cause systems to not function as the crew anticipates, and how to detect those conditions. (e.g. lack of brakes, spoilers, reversers) (331).

Flight Crew Proficiency and Basic Skills

52	Airlines/operators should ensure that their training/standardization programs establish flight crew proficiency in the use of the FMS system.
62	Airlines/operators should ensure that their training/standardization programs establish flight crew proficiency in all uses of the HSI display, when equipped.
64	Airlines/operators should ensure that their training/standardization programs direct the flight crews to regularly cross check all instrumentation.
67	Airlines/operators should require flight crews to perform non-FMS (raw data) approaches during proficiency/recurrent check rides.

Flight Crew Proficiency and Basic Skills cont.

89	Airlines/operators and regulators should ensure that the frequency and effectiveness of proficiency checks for non-precision approaches are adequate.
100	Airlines/operators should ensure that their training/standardization programs emphasize the importance of adhering to MDA/DH.
111	Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training.
112	Airlines/operators and regulators should ensure that the frequency and effectiveness of proficiency checks for simulated instrument failures (partial panel) are adequate.
114	Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency.
153	Ensure that flight crews are adequately trained in a level D simulator for dynamic characteristics before assignment to the line. (see 312)
162	Airline/operators should include in their training programs the awareness of potential safety risks due complacency when operating at a very familiar airport (e.g. home base).
163	Airlines/operators should ensure that their training/standardization programs address common misperceptions that could lead to unsafe practices (i.e. ATC always wants high energy approaches).
218	Airlines/operators should properly monitor contractor training programs for adequacy of training.(see 110, 202)
312	Airline/operators should ensure 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.
322	Airlines/operators should develop and implement a ground school and simulator training program similar to the Advanced Aircraft Maneuvering Program.
331	Airlines/operators and manufacturers should train crews to understand the capabilities and limitations of systems, conditions which would cause systems to not function as the crew anticipates, and how to detect those conditions (e.g. lack of brakes, spoilers, etc.)

Flight Crew – Standard Operating Procedures (SOP's)

Airlines/operators and regulators should ensure:

- that clear, concise, accurate, appropriate standard operating procedures are published and enforced (99)
- that their training/standardization and monitoring programs emphasize the importance of adherence to SOP's and identify the rationale behind those procedures (110)
- that their training/standardization programs emphasize the importance of adequate preflight planning (113), and a sterile cockpit environment (136)

Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance (204).

Flight crew – SOP

99	Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced. (see 110)
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. (see 99)
113	Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning.
136	Airlines/operators should ensure that their training/standardization programs emphasize the importance of the sterile cockpit environment
204	Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. (not rated)

Flight related briefings

Airlines/operators should ensure that their training/standardization programs and SOP's emphasize the importance of all flight-related briefings (17), specifically approach and missed approach preparation (7) including:

- review of procedures
- contingency review (96)
- risk assessment (350)

- conducting adequate briefings for the expected runway that include descriptions of normal approach and non-normal conditions prior to commencing the approach(342, 350)

Airlines/operators should utilize a risk assessment tool to enhance flight crew awareness of hazards associated with all approaches and airports (300).

Regulators should require a Special Airport Briefing guide be incorporated with approach charts (319).

Flight related briefings

7	Airlines/operators should ensure that their training/standardization programs emphasize review of approach and missed approach procedures. (see 329)
17	Airlines/operators should ensure that their training/standardization programs emphasize the importance of all flight-related briefings. (see 342)
96	Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate approach preparation and contingency review prior to commencing an approach.
300	Airlines/operators will 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).
319	Regulators should require a Special Airport Briefing Guide be incorporated with approach charts. (Subject matter must include aircraft specific local operational procedures)
342	Airlines/operators should establish a SOP to ensure that flight crews should not begin the approach until an adequate briefing is completed for the expected runway. (see 17)
350	Airlines/operators should ensure that adequate approach briefings are conducted that include descriptions of normal approach, non-normal conditions and the results of the risk assessment tool analysis. (see 300)

FOQA

Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs (54) to identify systemic procedural deviations and unsafe trends (56), as well as flight crew failure to respond to GPWS warnings (55).

FOQA

54	Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. (not rated)
55	Airlines/operators should implement a Flight Operations Quality Assurance (FOQA) program to identify flight crew failure to respond to GPWS warnings.
56	Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) (not rated)

GPWS Warnings

Airlines/operators (and manufacturers in the airplane operations manual) should implement procedures and training/standards programs that require immediate execution of the escape maneuver, with emphasis on proper aircraft configuration (117) following a GPWS warning unless there is visual confirmation of the terrain (61).

GPWS Warnings

61	Airlines/operators (and manufacturers in the airplane flight manual) should implement procedures that call for an immediate execution of the escape maneuver following a GPWS warning unless there is visual confirmation of terrain.
117	Airlines/operators should ensure that their training/standardization programs instruct that ground proximity escape maneuvers are to be conducted with the aircraft properly configured (e.g. speedbrakes retracted).

HUD/synthetic vision

The aviation industry should continue to develop and implement HUD capability (295), and manufacturers should install HUD as standard equipment (149), to enhance flight crew performance in low visibility operations.

The aviation industry should develop and implement synthetic vision capability (85).

HUD/synthetic vision

85	The aviation industry should develop and implement synthetic vision capability (e.g. Precision Approach Terrain Information (PATI)).
149	Manufacturers should install a HUD as standard equipment. (see 85)
295	To enhance flight crew performance in low visibility operations, the aviation industry should continue to develop and implement HUD capability. (see 149)

Information sharing

Airlines/operators, regulators, and manufacturers (and military agencies involved with joint use airports (321)) should share safety related information (57) for the benefit of all involved with protection from litigation and prosecution (128).

Information sharing

57	Airlines/operators, regulators, and manufacturers should implement a program designed for sharing of safety related information within the aviation community. (not rated)
128	Airlines/operators and regulators should implement a no blame safety reporting and data sharing system with appropriate protections from litigation and prosecution concerns.
321	Regulators and Military agencies should ensure procedures are in place to share information pertaining to operations at joint use airports. (Special Use Airports)

LOFT/Simulator Training

Airline/operators should ensure that initial and recurrent simulator training be conducted in Level D simulators (153) and include:

- scenarios where flight crews learn multi-tasking and prioritization abilities in concert with CRM skills (e.g. LOFT scenarios) (314, 23)
- scenarios that match realistic situations (e.g. stall recoveries during approach, landing configuration at flight idle with the autopilot on) (165)
- an Advanced Aircraft Maneuvering Program (322)

LOFT/simulator training

23	Airlines/operators should ensure that regularly scheduled recurrent training (e.g. LOFT) emphasizes crew cooperation and working together to maximize safe operations. (see 308, 314)
153	Ensure that flight crews are adequately trained in a level D simulator for dynamic characteristics before assignment to the line. (see 312)
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)).
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 attached LOFT scenarios).
322	Airlines/operators should develop and implement a ground school and simulator training program similar to the Advanced Aircraft Maneuvering Program.

Manuals

Airlines/operators and regulators should ensure necessary manuals (operational & maintenance) are complete, accurate, available and appropriately used (225).

Regulators should require and airline/operators ensure OEM seasonal guidance and specifically, strut cold weather servicing recommendations are incorporated in their mandatory maintenance/operational procedures (224,232,233).

Airlines/operators should ensure, and regulators should check, that operators who create their own AOM's include all procedures prescribed by original equipment manufacturers Airplane Flight Manual (AFM) (80).

Manuals

80	Airlines/operators should ensure, and regulators should check, that operators who create their own AOM's include all procedures prescribed by original equipment manufacturers Airplane Flight Manual (AFM).
224	Airlines/operators should ensure that all airline operations include compliance with all/seasonal guidance from the OEM.
225	Airlines/operators and regulators should ensure necessary manuals (operational & maintenance) are complete, accurate, available and appropriately used.
232	Airlines/operators should ensure all nose gear struts are serviced for cold weather operation are in accordance with OEM recommendations.
233	Regulators should require operators to incorporate OEM strut servicing recommendations in mandatory maintenance procedure and monitor compliance.

MEL

Airlines/operators and regulators should establish and enforce a clear MEL policy to aid flight crews in making maintenance related decisions (353), and establish appropriate operational restrictions (145) and reasonable limitations on dispatch with safety related equipment inoperative (146).

MEL

145	Airlines/operators and regulators should establish appropriate operational restrictions when equipment is inoperative (MEL)
146	Regulators should establish/enforce reasonable limitations on dispatch with safety related equipment (MEL)
353	Airlines/operators should establish and enforce a clear MEL policy to aid flight crews in making maintenance related decisions.

NAV charts/approach plates

Aviation industry regulators should establish standardized approach plate depiction/information requirements (6) including color contours for terrain (5), and inclusion of a Special Airport Briefing guide (319), and a standard presentation format of instrument approach procedures (8); and require that captains and first officers each have identical approach charts for reference (339).

Regulators should eliminate duplicate NAVAID identifiers within the same geographic area (74).

Manufacturers should ensure that FMS depiction is consistent with approach plate presentation (4).

NAV charts/approach plates

4	Ensure FMS depiction is consistent with approach plate presentation.
5	Regulators should mandate that approach plates show color contours for terrain
6	Regulators should establish standardized approach plate depiction/information requirements for approach plate publishers.
8	The aviation industry should establish worldwide standards for the presentation format of instrument approach procedures.
74	Regulators should review and where appropriate eliminate duplicate NAVAID identifiers within the same geographic area.

NAV charts/approach plates cont.

319	Regulators should require a Special Airport Briefing guide be incorporated with approach charts. (Subject matter must include aircraft specific local operational procedures)
339	Regulators should require captains and first officers each have identical approach charts for reference.

PF/PNF duties

Airlines/operators should clearly define, train and check the specific PF/PNF duties (82) and how transfer of control is formally accomplished (207). Checklist design and implementation of procedures should promote effective crew coordination and distribution of PF and PNF tasks (135). Consideration should also be given to use of the “delegated” approach technique (30).

PF/PNF duties

30	Airlines/operators should adopt the "delegated" approach to standard operating procedures. (e.g. monitored approach procedures)
82	Airlines/operators should clearly define, train and check the specific PF/PNF duties. (see 135)
135	Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PF and PNF tasks. (see 82)
207	Airlines/operators should develop procedures to specify how transfer of control is formally accomplished.

Press-on-itis

Airlines/operators should train flight crews on how flight delays upon departure or enroute (weather, maintenance, ATC, etc.) can affect their subsequent decision making relative to the safe conduct of the flight (105).

Airlines/operators should ensure their "reward system" is not related to the completion of a route segment (217).

To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations (244).

Press-on-itis

105	Airlines/operators should train flight crews on how departure or enroute flight delays (weather, maintenance, ATC, etc.) can affect their subsequent decision making relative to the safe conduct of the flight.
217	Airlines/operators should ensure their "reward system" is not related to the completion of a route segment. (see 311)
244	To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations.

Quality Assurance

Regulators should establish criteria to ensure that operators' overall quality assurance and compliance procedures are effective, rather than rely on spot checks of individual components (129).

Airlines/operators should develop a quality assurance program to ensure compliance with regulations (202).

Airlines/operators and regulators should provide additional inspectors/inspection of sub-contract activity (213).

Quality Assurance

129	Regulators should establish criteria to ensure operators overall quality assurance and compliance procedures are effective rather than reliance on spot checks of individual components
202	Airlines/operators should develop a quality assurance program to ensure compliance with regulations.(see 145, 146, 201)
213	Airlines/operators and regulators should provide additional inspectors/inspection of sub-contract activity. (see 201, 202)

Regulators

Regulators should ensure one level of safety exists for all commercial transport operations (whether passenger of freighter operations) (317).

Regulators should ensure POIs and PMIs are qualified on their assigned carrier's equipment (220, 222) and trained to approve company operational and training programs/procedures (223, 219).

Regulators should have necessary funding, training and processes to accomplish their oversight responsibilities in order to ensure operators and sub contractors are in compliance with regulations (129, 201, 213, 345).

Regulators should enforce timely incorporation of appropriate manufacturers' recommendations (214), and prompt close out of safety audit findings (231).

Regulators should require a Special Airport Briefing guide be incorporated with approach charts (319).

Regulators will not allow noise abatement procedures that would reduce the level of safety that existed prior to their implementation (310).

Airline/operators should provide intern programs to better-educated regulators (346).

Regulators should establish criteria to ensure operators overall quality assurance and compliance procedures are effective rather than reliance on spot checks of individual components (150).

Regulators should implement the NTSB recommendations to increase DFDR parameters (303).

Regulators should require airports to comply with International standards for airport construction (334).

Regulators

129	Regulators should establish criteria to ensure operators overall quality assurance and compliance procedures are effective rather than rely on spot checks of individual components
150	Regulators or other governing authorities should establish policies that ensure that surrounding lights are distinguishable from airport lighting in order to avoid confusion (safety process, policy).

Regulators

201	Regulators should develop adequate oversight as appropriate to ensure compliance with regulations.(see 145, 146, 202, 345)
213	Airlines/operators and regulators should provide additional inspectors/inspection of sub-contract activity. (see 201, 202)
214	Regulators should enforce timely incorporation of appropriate manufacturers recommendations. (see 98, 201)
219	Regulators should ensure company training program is in accordance with approved training program.(see 110, 201)
220	Regulators should ensure that all POIs are current and qualified in one model of the companies equipment.
222	Regulators should require PMI's to have expertise in the assigned carrier's equipment.
223	Regulators should ensure POIs are properly qualified and trained to approve appropriate company operational procedures.
231	Regulators should require and airlines/operators should promptly close out all regulatory safety audit findings.
303	Regulators should implement the NTSB recommendations to increase DFDR parameters. (not rated)
310	Regulators will not allow noise abatement procedures that reduce the level of safety that existed prior to their implementation.
317	Regulators should ensure one level of safety exists for all commercial transport operations (whether passenger or freighter operations). (see 338)
319	Regulators should require a Special Airport Briefing guide be incorporated with approach charts. (Subject matter must include aircraft specific local operational procedures)
334	Regulators should require airports to comply with International standards for airport construction.
345	Ensure regulators have adequate funding, training and processes to accomplish their oversight responsibilities. (see 201)
346	Airlines/operators should ensure better-educated regulators by providing intern programs.

Safety culture

Airlines/operators should, and regulatory agencies must, encourage a culture that enhances safety (143) by:

- emphasizing safe arrivals over timely arrivals (22) (a "reward system" that does not penalize executing missed approaches) (311), (a true no-fault go around policy (123)), and that is not

based on completion of a route segment (217), and regulators discontinuing on-time arrival tracking for airlines (37)
- implementing policies regarding flight crew medical viability including voluntary removal from flight status due to illness and/or emotional distress (63), enforcement pertaining to use of prescription and non-prescription medication (2, 70), enforcement and reporting of substance abuse (101), and training/standardization programs regarding physiological effects on aircrew performance (e.g. low blood sugar) (141)
- incorporating a company self-audit process (348), and development of a cost analysis tool regarding the high economic and psychological costs of accidents and serious incidents (318)
- implementing policies regarding crew pairing (24)

Parent airlines/operators should adopt a program to ensure the same level of safety in regional partners (347).

Operators should conduct training in accordance with their approved training program to preclude conducting flight training during operational flights (238).

Safety culture

2	Airlines/operators and regulators should strictly enforce the regulations pertaining to alcohol use/substance abuse.
22	Airlines/operators should encourage a culture that emphasizes safe arrivals over timely arrivals. (see 63, 143)
24	Airlines/operators should implement procedures to ensure appropriate crew pairing. (reference FSF corporate crew scheduling and fatigue evaluation.)
37	Regulators should discontinue on-time arrival tracking for airlines.
63	Airlines/operators should implement a culture which encourages flight crew voluntary removal from flight status due to illness and/or emotional distress (including the use of a self assessment tool). (see 70)
70	Airlines/operators and regulators should strictly enforce the regulations pertaining to flight crew use of prescription and non-prescription medication. (see 63)
101	Airlines/operators should establish a policy which supports the reporting of substance abuse.

123	Airlines/operators should implement a true no-fault go around policy (learning vs. blame). (Will delete)+B256
141	Airlines/operators and regulators should require training/standardization programs include training regarding physiological effects on aircrew performance, (e.g. low blood sugar).
143	Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture) (see 22, 63, 348)
217	Airlines/operators should ensure their "reward system" is not related to the completion of a route segment. (see 311)
238	To preclude conducting flight training during operational flights, when a need for training is identified, operators should conduct training in accordance with their approved training program.
311	Airlines/operators should ensure their “reward system” does not penalize flight crews for executing missed approaches. (see 217) (Will not use)
318	Flight Safety Foundation should develop a cost analysis tool to educate CEO's about the high economic and psychological costs of accidents and serous incidents. (not rated)
347	Parent airlines/operators should adopt a program to ensure the same level of safety in regional partners including, but not limited, to recruitment, training, operations and maintenance
348	Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318)

Stabilized Approach/Go-around Decision

Airlines/operators should establish policies, parameters and training to help crews recognize the dangers of rushed, high rate of descent, unstabilized approaches (115, 116, 142 & 157), and should also implement a go-around gate system. The training should emphasize:

- Developing an operational culture where crews think “I will go-around unless” rather than “I will land unless” (328), coupled with a true no-fault go-around policy (123).
- Recognizing multiple cues that will require a go-around (329), and particularly understanding the exact parameters that have to be met at each “gate (142).”

Airline/operators should ensure their reward system does not penalize crews for executing missed approaches (311).

Air Traffic service providers should enhance ATC controllers training to emphasize the dangers of rushed approaches, to understand the

performance characteristics of modern jet transports (13 & 157), and to utilize the most current wind information available (327).

Stabilized approach/go-around decision

13	Air Traffic service providers should enhance ATC training to emphasize the dangers of rushed approaches and performance characteristics of modern jet transports. (see 115, 157)
115	Airlines/operators should ensure that their training/standardization programs emphasize the dangers of rushed approaches. (see 13, 157)
116	Airlines/operators should ensure that their training/standardization programs emphasize the dangers of high rate of decent and unstable approaches. (see 142)
123	Airlines/operators should implement a true no-fault go around policy (learning vs. blame). (Will delete)+B256
142	Airlines/operators should establish policies, parameters, and training to recognize unstabilized approaches and other factors and implement a go-around gate system. (see FSF - "defined gates" p. 193) (see 116, 123)

Stabilized approach/go-around decision cont.

157	Airlines/operators, regulators, Air Traffic service providers should establish policies or programs to address rushed approaches, including elimination of rushed approaches, recognition and rejection of rushed approaches and training for those encountered
311	Airlines/operators should ensure their “reward system” does not penalize flight crews for executing missed approaches. (see 217) (Will not use)
327	Air Traffic service runway selection policies should be based on the most current wind available.
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. (see 142, 311)
329	Airlines/operators should incorporate in initial and recurrent training ways to recognize multiple cues that will require go-around. Including CFIT training aid 2.1.9, FSF definition of stabilized approach, risk assessment tool, and windshear training aid.

Survivability

To improve survivability, manufacturers should improve the design and installation of emergency equipment and airlines/operators should improve inspection schedules (209); existing knowledge of crash survivability should be implemented (262); and research should be conducted on new methods to increase survivability (261).

Survivability

209	To improve survivability, manufacturers should improve design, installation and inspection schedules of emergency equipment to increase reliability (e.g. escape slides). (see 45, 138, 201, 202)
261	To improve passenger and flightcrew survivability, research should be conducted to explore new methods to increase crash survivability.
262	To improve passenger and flightcrew survivability, regulators should require and operators should implement existing knowledge of crash survivability.

Systems status awareness

Airlines/operators should train crews on the importance of maintaining systems status awareness:

- during non-normal events and hazardous approaches (325)
- regarding the capabilities and limitations of systems, and the conditions (and how to detect them) that could cause the systems to not function as the crew anticipates (331)

Systems status awareness

325	Airline/operators should emphasize during initial and recurrent training the importance of maintaining systems status awareness during non-normal events and hazardous approaches (goal to avoid tunnel vision/narrowed attention)
331	Airlines/operators and manufacturers should train crews to understand the capabilities and limitations of systems, conditions which would cause systems to not function as the crew anticipates, and how to detect those conditions (e.g. lack of brakes, spoil

Warnings

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)
- flight deck designs consider smart alerting systems such as those with prioritization schemes or cancelable nuisance alerts to prevent alerting overload (243)

Avionics manufacturers should improve GPWS capability to reduce GPWS nuisance warnings (60).

Airlines/operators should implement procedures that call for an immediate recovery maneuver following a flight control warning (e.g. stall warning) (161).

Manufacturers should install TAWS (EGPWS) in all new aircraft, airlines/operators should retrofit TAWS into the existing fleet and international regulators should require the installation of TAWS.

Warnings

35	Manufacturers should install TAWS (EGPWS) in all new aircraft; airlines/operators should retrofit TAWS into the existing fleet and international regulators should require the installation of TAWS.
60	Avionics manufacturers should improve GPWS capability to reduce GPWS nuisance warnings.
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. (see 45)
161	Airlines/operators should implement procedures that call for an immediate recovery maneuver following a flight control warning (e.g. stall warning) (see 61)
243	Flight deck designs should consider smart alerting such as those with prioritization schemes or cancelable nuisance alerts systems to prevent alerting overload.

Weather

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

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

Airlines/operators should improve/increase training to increase awareness of icing effects on airplane type including dynamic simulator training (154).

The aviation industry should continue to develop and implement HUD capability to enhance flight crew performance in low visibility operations (295).

Airline/operators should ensure 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 (312).

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.
154	Airlines/operators should improve/increase training to increase awareness of icing effects on airplane type including dynamic simulator training.
295	To enhance flight crew performance in low visibility operations, the aviation industry should continue to develop and implement HUD capability. (see 149)
312	Airline/operators should ensure 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.

Workload

To reduce flight crew workload and prevent overload during critical phases of flight, the following actions should be taken:

- airline/operators should ensure procedures do not increase pilot workload during critical phases of flight (120)
- airlines/operators should ensure policies stress using the appropriate level of automation (246)
- airline/operators should equip aircraft with autopilots (352)
- airline/operators should ensure that crew rest considerations (cabin crew and flight crew) are calculated and administered by dispatch/scheduling rather than burdening flight crews with these considerations (31)
- research should be conducted to understand the phenomenon of flight crew overload (208)

Workload

31	Airlines/operators should ensure that crew rest considerations (cabin crew and flight crew) are calculated and administered by dispatch/crew scheduling rather than burdening crews with these considerations. (see 130, 203, 257, 315, 316)
120	Airlines/operators should ensure procedures do not increase pilot workload during critical phases of flight.
208	Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) (not rated)
246	To reduce pilot overload, airlines/operators policies should stress using the appropriate level of automation.
352	Airlines/operators should equip aircraft with autopilots to reduce crew workload during critical phases of flight.

Interventions not included in any summary

27	Airlines/operators should implement maintenance procedures to ensure proper functioning of the CVR at all times. (Note: this intervention was recorded as a potential intervention of future accidents; it would not have prevented the subject accidents.)
68	Manufacturers should implement a system to identify the recommended implementation schedule and priority of aircraft and operational changes.
137	Manufacturers should ensure cockpit design that does not interfere with or distract the flight crew from executing their duties (e.g. rain in the cockpit, location of switches in cockpits)
164	Airlines/operators and manufacturers should provide angle of attack information to crews so they can determine their current angle of attack, relative to critical angle of attack.
236	Airlines/operators should develop/publish appropriate procedures for radio communications restoration.

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Appendix G

Master Problem Statement Intervention Matrix

1	Not applicable						
2	FLIGHTCREW - FAILURE TO FOLLOW PROCEDURES (COMMUNICATIONS)	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 are reviewed during recurrent training. [4/3/4] [1.3]	42 Airlines/operators and air traffic service providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology. [1/1/5] [0.1]	88 Airlines/operators should train and monitor flight crew compliance with established communication phraseology guidelines. (see 240) [2/2/4] [0.4]	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. (see 99) [5/3/5] [2.1]	204 Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. [not rated]	240 To reduce the possibility of error, confusion and workload increase related to ATC clearances, regulators should require and operators ensure that flight crews utilize proper phraseology and readbacks. (see 88) [0/0/5] [0.0]
	2 continued	350 Airlines/operators should ensure that adequate approach briefings are conducted that include descriptions of normal approach, non-normal conditions and the results of the risk assessment tool analysis. (see 300) [5/3/5] [2.1]					
3	AIR TRAFFIC SYSTEM - LACK OF STANDARDIZATION (APPROACH/ DEPARTURE PLATES)	6 Regulators should establish standardized approach plate depiction/information requirements for approach plate publishers [4/3/4] [1.3]	57 Airlines/operators, regulators, and manufacturers should implement a program designed for sharing of safety related information within the aviation community. [not rated]				
4	Not applicable						

NOTE: Interventions 128 and 143 have been applied to some problems, however they could be applied to every problem.

- Intervention 128: Airlines/operators and regulators should implement a no blame safety reporting and data sharing system with appropriate protections from litigation and prosecution concerns.
- Intervention 143: Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture) (see 22, 63, 348) [5/3/6] [2.5]
- P/C/A values shown in [P/C/A]. Overall Effectiveness shown in [O.E]

5	ATC / FLIGHTCREW INADEQUATE COMMUNICATIONS	28 Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft. [not rated]	75 Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position. (see 45) [2/1/4] [0.2]	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. [1/3/4] [0.3]			
6	ATC – FAILURE TO FOLLOW PROCEDURES (COMMUNICATIONS)	21 Establish/enhance quality assurance checks/training to ensure that timely and accurate communication between controllers and flight crews is occurring. [1/1/4] [0.1]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	93 Air Traffic service should provide real time (most current) radio communication of critical airport and weather information. [5/3/5] [2.1]	124 Air Traffic service providers should implement a Quality Assurance program to ensure adherence to established procedures. [3/2/5] [0.8]	204 Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. [not rated]	241 To eliminate hearback errors, ATC should reexamine and implement improvements to address hearback problems. (see 240) [0/0/5] [0.0]
	6 continued	320 Air Traffic service providers should institute an ATC "Crew Resource Management Program" similar to those required of flight crews. (FAA AC 120-51b) [1/1/4] [0.1]					
7	Not applicable						
8	ATC – FAILURE TO FOLLOW PROCEDURES (SOP)	13 Air Traffic service providers should enhance ATC training to emphasize the dangers of rushed approaches and performance characteristics of modern jet transports. (see 115, 157) [4/1/4] [0.4]	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	93 Air Traffic service should provide real time (most current) radio communication of critical airport and weather information. [5/3/5] [2.1]	106 Air Traffic service providers should train and monitor ATC adherence to established communications procedures including hearback problems. (see 240) [2/1/5] [0.3]	204 Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. [not rated]
9	AIRLINE OPERATIONS - PF/PNF FLYING PROCEDURES (INCREASED WORKLOAD AT A CRITICAL PHASE)	99 Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced. (see 110) [4/1/4] [0.4]					

10	FLIGHTCREW - FAILURE TO FOLLOW PROCEDURES (SOP)	7 Airlines/operators should ensure that their training/standardization programs emphasize review of approach and missed approach procedures. (see 329) [4/1/4] [0.4]	15 Airlines/operators should ensure that their training/standardization programs instruct when to disengage automated systems and fly manually. (see 246) [4/2/4] [0.9]	17 Airlines/operators should ensure that their training/standardization programs emphasize the importance of all flight-related briefings. (see 342) [4/2/4] [0.9]	19 Airlines/operators should implement a procedure to climb to a minimum safe altitude when position uncertainty exists by at least one crew member. Flight crew must advise ATC of intentions. [4/2/5] [1.1]	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 are reviewed during recurrent training. [4/3/4] [1.3]	23 Airlines/operators should ensure that regularly scheduled recurrent training (e.g. LOFT) emphasizes crew cooperation and working together to maximize safe operations. (see 308, 314) [4/1/4] [0.4]
	10 continued	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	72 Air Traffic service providers should install MSAW-like capabilities world-wide with emphasis on high-risk airports. [6/3/5] [2.5]	82 Airlines/operators should clearly define, train and check the specific PF/PNF duties. (see 135) [4/2/5] [1.1]	85 The aviation industry should develop and implement synthetic vision capability (e.g. Precision Approach Terrain Information (PATI)). [6/5/6] [5.0]	96 Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate approach preparation and contingency review prior to commencing an approach. [5/2/4] [1.1]
	10 continued	99 Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced. (see 110) [4/1/4] [0.4]	100 Airlines/operators should ensure that their training/standardization programs emphasize the importance of adhering to MDA/DH. [6/2/5] [1.7]	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. (see 99) [5/3/5] [2.1]	111 Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training. [5/3/5] [2.1]	114 Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency. [4/1/4] [0.4]	128 Airlines/operators and regulators should implement a no blame safety reporting and data sharing system with appropriate protections from litigation and prosecution concerns. [not rated]
	10 continued	131 Airlines/operators should ensure that their training/standardization programs emphasizes the importance of the team concept, cross cultural issues, eval. of options and the obligation of the FO to effectively comm. any concerns (CRM) (see 237) [4/1/4] [0.4]	136 Airlines/operators should ensure that their training/standardization programs emphasize the importance of the sterile cockpit environment [3/3/4] [1.0]	142 Airlines/operators should establish policies, parameters, and training to recognize unstabilized approaches and other factors and implement a go-around gate system. (see FSF - "defined gates" p. 193) (see 116, 123) [6/4/6] [4.0]	204 Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. [not rated]	207 Airlines/operators should develop procedures to specify how transfer of control is formally accomplished. [4/2/3] [0.7]	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]

	10 continued	211 Airlines/operators should retrofit equipment to provide automatic altitude callouts on final approach. If unable, other altitude alerting or reminder systems (such as altimeter bugs) should be installed. [5/4/5] [2.8]	305 Regulators should require airlines/operators to outfit aircraft with electronic checklists. If unable to install electronic checklists, use mechanical checklists or, at a minimum, develop a process to reinforce challenge and response checklists. [5/4/5] [2.8]	309 Airlines/operators should require flight crews to fly precision instrument approach procedures during periods of reduced visibility and night operations. (see 59, 355) [4/2/3] [0.7]	325 Airline/operators should emphasize during initial and recurrent training the importance of maintaining systems status awareness during non-normal events and hazardous approaches (goal to avoid tunnel vision/narrowed attention) [4/2/4] [0.9]	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. (see 142, 311) [5/3/5] [2.1]	329 Airlines/operators should incorporate in initial and recurrent training ways to recognize multiple cues that will require go-around. Including CFIT training aid 2.1.9, FSF definition of stable approach, risk assessment tool, and windshear training aid [5/4/5] [2.8]
	10 continued	337 Airlines/operators should establish a process (which includes an interdisciplinary team) to document and investigate high risk behavior and poor judgement triggered by on-the-job performance. (see 151, 152, 335) [not rated]	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]	350 Airlines/operators should ensure that adequate approach briefings are conducted that include descriptions of normal approach, non-normal conditions and the results of the risk assessment tool analysis. (see 300) [5/3/5] [2.1]	356 Research should be done to develop an effective tactical decision making model for flight crews in time critical situations. [not rated]		
11	FLIGHTCREW - INADEQUATE SITUATION AWARENESS (VERTICAL)	14 Install aural warning devices on aircraft to alert flightcrew of arrival at MDA/DH. [5/4/5] [2.8]	19 Airlines/operators should implement a procedure to climb to a minimum safe altitude when position uncertainty exists by at least one crew member. Flight crew must advise ATC of intentions. [4/2/5] [1.1]	21 Establish/enhance quality assurance checks/training to ensure that timely and accurate communication between controllers and flight crews is occurring. [1/1/4] [0.1]	35 Manufacturers should install TAWS (EGPWS) in all new aircraft, airlines/operators should retrofit TAWS into the existing fleet and international regulators should require the installation of TAWS. [6/5/6] [5.0]	61 Airlines/operators (and manufacturers in the airplane flight manual) should implement procedures that call for an immediate execution of the escape maneuver following a GPWS warning unless there is visual confirmation of terrain. [3/4/5] [1.7]	64 Airlines/operators should ensure that their training/standardization programs direct the flight crews to regularly cross check all instrumentation. [4/1/4] [0.4]
	11 continued	82 Airlines/operators should clearly define, train and check the specific PF/PNF duties. (see 135) [4/2/5] [1.1]	100 Airlines/operators should ensure that their training/standardization programs emphasize the importance of adhering to MDA/DH. [6/2/5] [1.7]	116 Airlines/operators should ensure that their training/standardization programs emphasize the dangers of high rate of descent and unstable approaches. (see 142) [5/4/5] [2.8]	131 Airlines/operators should ensure that their training/standardization program emphasizes the importance of the team concept, cross cultural issues, eval. of options and the obligation of the FO to effectively comm. any concerns (CRM) (see 237) [4/1/4] [0.4]	142 Airlines/operators should establish policies, parameters, and training to recognize unstabilized approaches and other factors and implement a go-around gate system. (see FSF - "defined gates" p. 193) (see 116, 123) [6/4/6] [4.0]	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) [4/1/4] [0.4]
	11 continued	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]	211 Airlines/operators should retrofit equipment to provide automatic altitude callouts on final approach. If unable, other altitude alerting or reminder systems (such as altimeter bugs) should	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations. [not rated]	297 To prevent CFIT, operators should develop procedures to ensure that flight crews do not descend when confusion exists concerning aircraft position. [not rated]	329 Airlines/operators should incorporate in initial and recurrent training ways to recognize multiple cues that will require go-around. Including CFIT trng aid 2.1.9, FSF defn. of stab.	342 Airlines/operators should establish a SOP to ensure that flight crews should not begin the approach until an adequate briefing is completed for the expected runway. (see

			be installed. [5/4/5] [2.8]			approach, risk assessment tool, and windshear training aid [5/4/5] [2.8]	17) [3/2/4] [0.7]
	11 continued	343 Airlines/operators should install radio altimeters in all aircraft and develop procedures for their use on approach as recommended by FSF ALAR. [4/2/3] [0.7]					
12	FLIGHTCREW - INADEQUATE SITUATION AWARENESS (HORIZONTAL)	82 Airlines/operators should clearly define, train and check the specific PF/PNF duties. (see 135) [4/2/5] [1.1]	114 Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency. [4/1/4] [0.4]	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations. [not rated]	297 To prevent CFIT, operators should develop procedures to ensure that flight crews do not descend when confusion exists concerning aircraft position. [not rated]	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. (IAW AC120-51b). [6/3/4] [1.3]	
13	FLIGHTCREW - MISINTERPRETED PRESENTATION	57 Airlines/operators, regulators, and manufacturers should implement a program designed for sharing of safety related information within the aviation community. [not rated]	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations. [not rated]				
14	AIRCRAFT EQUIPMENT - EQUIPMENT FAILURE	45 Manufacturers should ensure that all impending 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. (see 103, 138) [5/5/5] [3.5]	49 Regulators should establish criteria for, and manufacturers should evaluate and improve, the reliability and failure tolerance of flight systems. (see 332) [5/3/5] [2.1]	64 Airlines/operators should ensure that their training/standardization programs direct the flight crews to regularly cross check all instrumentation. [4/1/4] [0.4]	112 Airlines/operators and regulators should ensure that the frequency and effectiveness of proficiency checks for simulated instrument failures (partial panel) are adequate. [4/3/4] [1.3]	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. (see 45, 243) [4/2/4] [0.9]	209 To improve survivability manufacturers should improve design, installation and inspection schedules of emergency equipment to increase reliability (e.g. escape slides). (see 45, 138, 201, 202) [not rated]
	14 continued	245 To recover aircraft in unusual attitude, manufacturers should develop systems to return aircraft to normal attitude with one pilot button push (pilot initiated auto-recovery systems). [6/1/4] [0.7]	252 To prevent loss of control in flight, all changes to flight critical components, such as primary propeller pitch controller components, should be considered major changes. [5/4/4] [2.2]	255 To prevent catastrophic failures, the manuf should issue immediate telegraphic information to all operators, and regulators should require an immediate mandatory action (AD), following the initial failure report of any critical comp malf [4/1/4] [0.4]	303 Regulators should implement the NTSB recommendations to increase DFDR parameters. [not rated]	304 Manufacturers should improve the design for an error tolerant ground spoiler deployment system. [6/4/6] [3.3]	322 Airlines/operators should develop and implement a ground school and simulator training program similar to the Advanced Aircraft Maneuvering Program. [4/2/3] [0.7]

15	AIRLINE OPERATIONS - CORPORATE "ON-TIME" CULTURE	143 Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture) (see 22, 63, 348) [5/3/6] [2.5]	204 Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. [not rated]	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]			
16	FLIGHTCREW - CRM FAILURE	17 Airlines/operators should ensure that their training/standardization programs emphasize the importance of all flight-related briefings. (see 342) [4/2/4] [0.9]	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 are reviewed during recurrent training. [4/3/4] [1.3]	23 Airlines/operators should ensure that regularly scheduled recurrent training (e.g. LOFT) emphasizes crew cooperation and working together to maximize safe operations. (see 308, 314) [4/1/4] [0.4]	25 Airlines/operators should establish a CRM training program and regulators should require and insure that the initial training is provided prior to line flying and require recurrent CRM training. (see 131, 132, 349) [4/2/5] [1.1]	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. (see 75) [2/2/4] [0.4]	64 Airlines/operators should ensure that their training/standardization programs direct the flight crews to regularly cross check all instrumentation. [4/1/4] [0.4]
	16 continued	82 Airlines/operators should clearly define, train and check the specific PF/PNF duties. (see 135) [4/2/5] [1.1]	95 Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices. [4/1/4] [0.4]	99 Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced. (see 110) [4/1/4] [0.4]	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. (see 99) [5/3/5] [2.1]	111 Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training. [5/3/5] [2.1]	123 Airlines/operators should implement a true no-fault go around policy (learning vs. blame). [5/3/5] [2.1]
	16 continued	131 Airlines/operators should ensure that their training/standardization prog. emphasizes the importance of the team concept, cross cultural issues, eval. of options and the obligation of the FO to effectively comm. any concerns (CRM) (see 237) [4/1/4] [0.4]	133 Airlines/operators training of Captains and Chief Pilots should include Management practices that promote team building and effective human relations (leadership training beyond current CRM programs). (see 308) [4/2/5] [1.1]	135 Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PF and PNF tasks. (see 82) [5/3/5] [2.1]	136 Airlines/operators should ensure that their training/standardization programs emphasize the importance of the sterile cockpit environment [3/3/4] [1.0]	142 Airlines/operators should establish policies, parameters, and training to recognize unstabilized approaches and other factors and implement a go-around gate system. (see FSF - "defined gates" p. 193) (see 116, 123) [6/4/6] [4.0]	151Regulators should establish policies that require additional monitoring of flight crew members that have repeatedly failed check rides. (see 152, 335, 337) [4/4/4] [1.8]
	16 continued	204 Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. [not rated]	207 Airlines/operators should develop procedures to specify how transfer of control is formally accomplished. [4/2/3] [0.7]	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]	227 Airlines/operators should ensure that their training/standardization program emphasizes the benefits of inter-crew/company communications. (see 131) [5/2/4] [1.1]	228 Regulators should require airlines/operators to modify their training to maximize benefits of inter-crew/company communications. [5/2/4] [1.1]	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations. [not rated]

	16 continued	296 To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists. [1/0/5] [0.0]	297 To prevent CFIT, operators should develop procedures to ensure that flight crews do not descend when confusion exists concerning aircraft position. [not rated]	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. (IAW AC120-51b). [6/3/4] [1.3]	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). [4/2/5] [1.1]	337 Airlines/operators should establish a process (which includes an interdisciplinary team) to document and investigate high risk behavior and poor judgement triggered by on-the-job performance. (see 151, 152, 335) [not rated]	342 Airlines/operators should establish a SOP to ensure that flight crews should not begin the approach until an adequate briefing is completed for the expected runway. (see 17) [3/2/4] [0.7]
	16 continued	349 Airlines/operators should ensure training for instructors and check airmen include objective criteria to be used in evaluating crew CRM performance. (see 25,131) [3/1/4] [0.3]	356 Research should be done to develop an effective tactical decision making model for flight crews in time critical situations. [not rated]				
17	AIRLINE OPERATIONS - LACK OF STANDARDIZED PROCEDURES	15 Airlines/operators should ensure that their training/standardization programs instruct when to disengage automated systems and fly manually. (see 246) [4/2/4] [0.9]	30 Airlines/operators should adopt the "delegated" approach to standard operating procedures. (e.g. monitored approach procedures) [4/2/3] [0.7]	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	80 Airlines/operators should ensure, and regulators should check, that operators who create their own AOM's include all procedures prescribed by original equipment manufacturers Airplane Flight Manual (AFM). [5/4/5] [2.8]	82 Airlines/operators should clearly define, train and check the specific PF/PNF duties. (see 135) [4/2/5] [1.1]
	17 continued	99 Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced. (see 110) [4/1/4] [0.4]	105 Airlines/operators should train flight crews on how flight delays upon departure or enroute (weather, maintenance, ATC, etc.) can affect their subsequent decision making relative to the safe conduct of the flight. [3/2/4] [0.7]	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. (see 99) [5/3/5] [2.1]	123 Airlines/operators should implement a true no-fault go around policy (learning vs. blame). [5/3/5] [2.1]	129 Regulators should establish criteria to ensure operators overall quality assurance and compliance procedures are effective rather than reliance on spot checks of individual components [3/2/4] [0.7]	134 Airlines/operators and regulators should ensure check list designs prioritize critical items as recommended by NASA study, and that items are arranged in a manner to enhance checklist implementation [6/5/6] [5.0]
	17 continued	135 Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PF and PNF tasks. (see 82) [5/3/5] [2.1]	142 Airlines/operators should establish policies, parameters, and training to recognize unstabilized approaches and other factors and implement a go-around gate system. (see FSF - "defined gates" p. 193) (see 116, 123) [6/4/6] [4.0]	201 Regulators should develop adequate oversight as appropriate to ensure compliance with regulations.(see 145, 146, 202, 345) [4/2/4] [0.9]	202 Airlines/operators should develop a quality assurance program to ensure compliance with regulations.(see 145, 146, 201) [4/3/4] [1.3]	204 Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. [not rated]	236 Airlines/operators should develop/publish appropriate procedures for radio communications restoration. [0/0/1] [0.0]
	17 continued	305 Regulators should require airlines/operators to outfit aircraft with electronic checklists. If unable to install electronic	328 Airlines/operators should ensure that flight crews are trained to think in terms of "I will go-around unless" rather	331 Airlines/operators and manufacturers should train crews to understand the capabilities and limitations of systems,	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation),		

		checklists, use mechanical checklists or, at a minimum, develop a process to reinforce challenge and response checklists. [5/4/5] [2.8]	than "I will land unless". Regulatory policy should support this approach. (see 142, 311) [5/3/5] [2.1]	conditions which would cause systems to not function as the crew anticipates, and how to detect those conditions (e.g. lack of brakes, spoilers) [5/3/5] [2.1]	operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]		
18	Not applicable						
19	FLIGHTCREW - LACK OF BASIC PILOTING SKILLS OR KNOWLEDGE	7 Airlines/operators should ensure that their training/standardization programs emphasize review of approach and missed approach procedures. (see 329) [4/1/4] [0.4]	30 Airlines/operators should adopt the "delegated" approach to standard operating procedures. (e.g. monitored approach procedures) [4/2/3] [0.7]	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	64 Airlines/operators should ensure that their training/standardization programs direct the flight crews to regularly cross check all instrumentation. [6/3/6] [2,4]	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. (see 99) [5/3/5] [2.1]
	19 continued	111 Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training. [5/3/5] [2.1]	114 Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency. [4/1/4] [0.4]	116 Airlines/operators should ensure that their training/standardization programs emphasize the dangers of high rate of descent and unstable approaches. (see 142) [5/4/5] [2.8]	144 Airlines/operators and regulators should ensure that their training/standardization programs clarify the differences between vertical and slant range visibility [3/2/5] [0.8]	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) [4/1/4] [0.4]	153 Ensure that flight crews are adequately trained in a level D simulator for dynamic characteristics before assignment to the line. (see 312) [5/4/5] [2.8]
	19 continued	159 Manufacturers should incorporate an "input rudder" indicator or automatic yaw compensation to ensure that adequate yaw control is provided. [4/2/3] [0.7]	312 Airline/operators should ensure 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. [3/2/5] [0.8]	331 Airlines/operators and manufacturers should train crews to understand the capabilities and limitations of systems, conditions which would cause systems to not function as the crew anticipates, and how to detect those conditions (e.g. lack of brakes, spoilers) [5/3/5] [2.1]			
20	AIRLINE OPERATIONS - LACK OF TRAINING (FLIGHTCREW)	15 Airlines/operators should ensure that their training/ standardization programs instruct when to disengage automated systems and fly manually. (see 246) [4/2/4] [0.9]	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	57 Airlines/operators, regulators, and manufacturers should implement a program designed for sharing of safety related information within the aviation community. [not rated]	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	111 Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training. [5/3/5] [2.1]

						the rationale behind those procedures. (see 99) [5/3/5] [2.1]	
	20 continued	114 Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency. [4/1/4] [0.4]	131 Airlines/operators should ensure that their training/standardization prog. emphasizes the importance of the team concept, cross cultural issues, eval. of options and the obligation of the FO to effectively comm. any concerns (CRM) (see 237) [4/1/4] [0.4]	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) [4/1/4] [0.4]	150 Regulators or other governing authorities should establish policies that ensure that surrounding lights are distinguishable from airport lighting in order to avoid confusion (safety process, policy). [5/3/5] [2.1]	151 Regulators should establish policies that require additional monitoring of flight crew members that have repeatedly failed check rides. (see 152, 335, 337) [4/4/4] [1.8]	153 Ensure that flight crews are adequately trained in a level D simulator for dynamic characteristics before assignment to the line. (see 312) [5/4/5] [2.8]
	20 continued	154 Airlines/operators should improve/increase training to increase awareness of icing effects on airplane type including dynamic simulator training. [2/4/5] [1.1]	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)). [5/3/5] [2.1]	201 Regulators should develop adequate oversight as appropriate to ensure compliance with regulations.(see 145, 146, 202, 345) [4/2/4] [0.9]	202 Airlines/operators should develop a quality assurance program to ensure compliance with regulations.(see 145, 146, 201) [4/3/4] [1.3]	218 Airlines/operators should properly surveill contractor training programs for adequacy of training.(see 110, 202) [3/2/4] [0.7]	227 Airlines/operators should ensure that their training/standardization program emphasizes the benefits of inter-crew/company communications. (see 131) [5/2/4] [1.1]
	20 continued	228 Regulators should require airlines/operators to modify their training to maximize benefits of inter-crew/company communications. [5/2/4] [1.1]	243 To prevent alerting overload, flight deck designs should consider smart alerting systems such as those with prioritization schemes or cancelable nuisance alerts. [5/4/5] [2.8]	312 Airline/operators should ensure 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. [3/2/5] [0.8]	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). [4/2/5] [1.1]	322 Airlines/operators should develop and implement a ground school and simulator training program similar to the Advanced Aircraft Maneuvering Program. [4/2/3] [0.7]	331 Airlines/ops and manufacturers should train crews to understand the capabilities and limitations of sys., conditions which would cause sys. to not function as the crew anticipates, and how to detect those conditions (e.g. lack of brakes, spoilers) [5/3/5] [2.1]
	20 continued	340 Airlines/operators should implement procedures to ensure flight crews are aware of appropriate Airworthiness Directives, Certification and flight testing standards. (see 76, 46) [4/2/3] [0.7]	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]	350 Airlines/operators should ensure that adequate approach briefings are conducted that include descriptions of normal approach, non-normal conditions and the results of the risk assessment tool analysis. (see 300) [5/3/5] [2.1]	356 Research should be done to develop an effective tactical decision making model for flight crews in time critical situations. [not rated]		
21	FLIGHTCREW - "PRESS-ON-ITUS"	7 Airlines/operators should ensure that their training/standardization programs emphasize review of approach and missed approach procedures. (see 329)	22 Airlines/operators should encourage a culture that emphasizes safe arrivals over timely arrivals. (see 63, 143) [2/2/4] [0.4]	35 Manufacturers should install TAWS (EGPWS) in all new aircraft, airlines/operators should retrofit TAWS into the existing fleet and international regulators	37 Regulators should discontinue on-time arrival tracking for airlines. [2/2/5] [0.6]	57 Airlines/operators, regulators, and manufacturers should implement a program designed for sharing of safety related information within the aviation	59 Implement precision approach capability (glideslope guidance) for all runways without established precision approach procedures (e.g. ILS, DGPS, etc.).

		[4/1/4] [0.4]		should require the installation of TAWS. [6/5/6] [5.0]		community. [not rated]	(see 77) [5/5/6] [4.2]

	21 continued	61 Airlines/operators (and manufacturers in the airplane flight manual) should implement procedures that call for an immediate execution of the escape maneuver following a GPWS warning unless there is visual confirmation of terrain. [3/4/5] [1.7]	77 Eliminate non-precision approaches where possible. (see 59) [5/5/6] [4.2]	96 Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate approach preparation and contingency review prior to commencing an approach. [5/2/4] [1.1]	105 Airlines/operators should train flight crews on how flight delays upon departure or enroute (weather, maintenance, ATC, etc.) can affect their subsequent decision making relative to the safe conduct of the flight. [3/2/4] [0.7]	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. (see 99) [5/3/5] [2.1]	111 Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training. [5/3/5] [2.1]
	21 continued	115 Airlines/operators should ensure that their training/standardization programs emphasize the dangers of rushed approaches. (see 13, 157) [3/2/4] [0.7]	125 Airlines/operators should encourage flight crews to use precision approaches (glideslope guidance) when available and appropriate. [5/3/5] [2.1]	131 Airlines/operators should ensure that their training/standardization prog. emphasizes the importance of the team concept, cross cultural issues, eval. of options and the obligation of the FO to effectively comm. any concerns (CRM) (see 237) [4/1/4] [0.4]	141 Airlines/operators and regulators should require training/standardization programs include training regarding physiological effects on aircrew performance, (e.g. low blood sugar). [[3/1/3] [0.3]	162 Airline/operators should include in their training programs the awareness of potential safety risks due to the complacency when operating at a very familiar airport (e.g. home base). [4/2/4] [0.9]	204 Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. [not rated]
	21 continued	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations. [not rated]	300 Airlines/operators will 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). [5/3/5] [2.1]	311 Airlines/operators should ensure their “reward system” does not penalize flight crews for executing missed approaches. (see 217) [3/2/3] [0.5]	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. (see 142, 311) [5/3/5] [2.1]	329 Airlines/operators should incorporate in initial and recurrent training ways to recognize multiple cues that will require go-around. Including CFIT trng aid 2.1.9, FSF defn. of stab. approach, risk assessment tool, and windshear training aid [5/4/5] [2.8]	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]
	21 continued	356 Research should be done to develop an effective tactical decision making model for flight crews in time critical situations. [not rated]					

22	FLIGHTCREW - PNF DUTIES NOT PERFORMED	64 Airlines/operators should ensure that their training/standardization programs direct the flight crews to regularly cross check all instrumentation. [4/1/4] [0.4]	72 Air Traffic service providers should install MSAW-like capabilities world-wide with emphasis on high-risk airports. [6/3/5] [2.5]	82 Airlines/operators should clearly define, train and check the specific PF/PNF duties. (see 135) [4/2/5] [1.1]	135 Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PF and PNF tasks. (see 82) [5/3/5] [2.1]	204 Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. [not rated]	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]
	22 continued	306 Regulators should require manufacturers to equip all new aircraft with electronic checklists. [4/2/3] [0.7]	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). [4/2/5] [1.1]	325 Airline/operators should emphasize during initial and recurrent training the importance of maintaining systems status awareness during non-normal events and hazardous approaches (goal to avoid tunnel vision/narrowed attention) [4/2/4] [0.9]	331 Airlines/ops and manufacturers should train crews to understand the capabilities and limitations of sys., conditions which would cause sys. to not function as the crew anticipates, and how to detect those conditions . (e.g. lack of brakes, spoilers) [5/3/5] [2.1]	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]	
23	FLIGHTCREW - DISREGARD FLIGHTDECK WARNING	35 Manufacturers should install TAWS (EGPWS) in all new aircraft, airlines/operators should retrofit TAWS into the existing fleet and international regulators should require the installation of TAWS. [6/5/6] [5.0]	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	55 Airlines/operators should implement a Flight Operations Quality Assurance (FOQA) program to identify flight crew failure to respond to GPWS warnings. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	60 Avionics manufacturers should improve GPWS capability to reduce GPWS nuisance warnings. [5/5/3] [2.1]	99 Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced. (see 110) [4/1/4] [0.4]
	23 continued	105 Airlines/operators should train flight crews on how flight delays upon departure or enroute (weather, maintenance, ATC, etc.) can affect their subsequent decision making relative to the safe conduct of the flight. [3/2/4] [0.7]	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. (see 99) [5/3/5] [2.1]	111 Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training. [5/3/5] [2.1]	128 Airlines/operators and regulators should implement a no blame safety reporting and data sharing system with appropriate protections from litigation and prosecution concerns. [not rated]	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. (see 45, 243) [4/2/4] [0.9]	145 Airlines/operators and regulators should establish appropriate operational restrictions when equipment is inoperative (MEL) [4/4/4] [1.8]

	23 continued	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) [4/1/4] [0.4]	161 Airlines/operators should implement procedures that call for an immediate recovery maneuver following a flight control warning (e.g. stall warning) (see 61) [5/2/3] [0.8]	204 Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. [not rated]	208 Research should be conducted to understand the phenomenon of flight crew overload (e.g. why do flight crews ignore GPWS warnings) [not rated]	243 To prevent alerting overload, flight deck designs should consider smart alerting systems such as those with prioritization schemes or cancelable nuisance alerts. [5/4/5] [2.8]	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations. [not rated]
	23 continued	245 To recover aircraft in unusual attitude, manufacturers should develop systems to return aircraft to normal attitude with one pilot button push (pilot initiated auto-recovery systems). [6/1/4] [0.7]	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. (IAW AC120-51b). [6/3/4] [1.3]	315 Regulators should update flight time/duty time regulations to counteract present commercial aviation environmental stressors. (e.g. crew rest requirements) (see 31, 130, 203, 257, 316) [5/2/4] [1.1]	316 Regulators should require airline/operators to train flightcrews to recognize and counteract acute and chronic fatigue. (see 31, 130, 203, 257,315) [4/1/4] [0.4]	322 Airlines/operators should develop and implement a ground school and simulator training program similar to the Advanced Aircraft Maneuvering Program. [4/2/3] [0.7]	329 Airlines/operators should incorporate in initial and recurrent training ways to recognize multiple cues that will require go-around. Including CFIT trng aid 2.1.9, FSF defn. of stab. approach, risk assessment tool, and windshear training aid [5/4/5] [2.8]
	23 continued	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]					
24	FLIGHTCREW/ AIRLINE OPERATIONS – AEROMEDICAL, CREW MEDICAL / FATIGUE CONCERNS	48 Airlines/operators and regulators should strictly enforce flight/duty time limitations. [3/1/4] [0.3]	130 Regulators should account for realistic rest scenarios when developing and implementing crew rest requirements during travel segments (see 31, 203, 257, 315, 316) [5/3/5] [2.1]	141 Airlines/operators and regulators should require training/standardization programs include training regarding physiological effects on aircrew performance, (e.g. low blood sugar). [[3/1/3] [0.3]	142 Airlines/operators should establish policies, parameters, and training to recognize unstabilized approaches and other factors and implement a go-around gate system. (see FSF - "defined gates" p. 193) (see 116, 123) [6/4/6] [4.0]	203 Airlines/operators should provide crews with inflight rest periods and adequate facilities. (see 31, 130, 315) [3/2/4] [0.7]	242 To prevent excessive fatigue, airlines/operators should consider circadian rhythm in crew scheduling to compensate for the effects of rhythm interruptions. [1/1/4] [0.1]
	24 continued	257 To eliminate loop holes in crew rest requirements and to ensure adequate crew rest, regulators should clarify crew rest regulations. (see 31, 130, 203, 315, 316) [0/0/4] [0.0]	258 To facilitate the FAA awareness of safety related problems; there should be improved dissemination of the FAA hotline numbers. [0/4/4] [0.0]	315 Regulators should update flight time/duty time regulations to counteract present commercial aviation environmental stressors. (e.g. crew rest requirements) (see 31, 130, 203, 257, 316)	316 Regulators should require airline/operators to train flightcrews to recognize and counteract acute and chronic fatigue. (see 31, 130, 203, 257,315) [4/1/4] [0.4]	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively	

				[5/2/4] [1.1]		identify and correct/accept safety concerns. (see 318) [not rated]	
25	Not applicable						
26	AIRCRAFT EQUIPMENT - CVR INOPERATIVE (for future accident prevention)	27 Airlines/operators should implement maintenance procedures to ensure proper functioning of the CVR at all times. (Note: this intervention was recorded as a potential intervention of future accidents, it would not have prevented the subject accidents.) [not rated]					
27	AIR TRAFFIC SYSTEM - INADEQUATE TRAINING/ SUPERVISION	108 Air Traffic service providers should implement and/or review procedures to ensure ATC training does not create a hazard to flight operations. [1/1/3] [0.1]	324 Air Traffic services should ensure proper/close supervision of controllers undergoing training so that all outages, construction, airport hazards, etc. are reported to flight crews in a timely and accurate manner. (see 11) [3/1/4] [0.3]				
28	Not applicable						

29	AIRLINE OPERATIONS - NO-FAULT GO-AROUND POLICY	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	123 Airlines/operators should implement a true no-fault go around policy (learning vs. blame). [5/3/5] [2.1]	142 Airlines/operators should establish policies, parameters, and training to recognize unstabilized approaches and other factors and implement a go-around gate system. (see FSF - "defined gates" p. 193) (see 116, 123) [6/4/6] [4.0]	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. (see 142, 311) [5/3/5] [2.1]	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]
30	Not applicable						
31	FLIGHTCREW - PREOCCUPATION WITH AUTOMATED NAVIGATION (FMS)	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations. [not rated]					
32	AIRLINE OPERATIONS - INADEQUATE INFORMATION DISSEMINATION	79 Airlines/operators should implement a reliable process to communicate information to the flight crew that may affect flight or aircraft operations. [4/2/3] [0.7]	80 Airlines/operators should ensure, and regulators should check, that operators who create their own AOM's include all procedures prescribed by original equipment manufacturers Airplane Flight Manual (AFM). [5/4/5] [2.8]	99 Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced. (see 110) [4/1/4] [0.4]	214 Regulators should enforce timely incorporation of appropriate manufacturers recommendations. (see 98, 201) [4/2/4] [0.9]	224 Airlines/operators should ensure that all airline operations include compliance with all/seasonal guidance from the OEM. [5/4/5] [2.8]	225 Airlines/operators and regulators should ensure necessary manuals (operational & maintenance) are complete, accurate, available and appropriately used. [5/3/5] [2.1]
	32 continued	319 Regulators should require a Special Qualification Airport Briefing guide be incorporated with approach charts. (Subject matter must include aircraft specific local operational procedures) [4/4/4] [1.8]	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]				
33	AIR TRAFFIC SYSTEM - INADEQUATE INFORMATION DISSEMINATION	12 Air Traffic service providers should emphasize in ATC training the controllers' potential in assisting the flight crew in improving their situation awareness. [2/2/4] [0.4]	21 Establish/enhance quality assurance checks/training to ensure that timely and accurate communication between controllers and flight crews is occurring. [1/1/4] [0.1]	28 Implement a system to automatically transmit ATC instructions/information between the ground controller and the aircraft. [not rated]	57 Airlines/operators, regulators, and manufacturers should implement a program designed for sharing of safety related information within the aviation community. [not rated]	93 Air Traffic service should provide real time (most current) radio communication of critical airport and weather information. [64/6] [3.1]	94 Implement real time (digital) transmission of airport and weather information to the aircraft. [4/1/3] [0.3]

	33 continued	106 Air Traffic service providers should train and monitor ATC adherence to established communications procedures including hearback problems. (see 240) [2/1/5] [0.3]	247 To ensure timely dissemination of navaid anomalies, airlines/operators and ATC should re-emphasize the requirement that flight crews report and ATC disseminate any navigation anomalies. [1/0/4] [0.0]	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. (IAW AC120-51b). [6/3/4] [1.3]	324 Air Traffic services should ensure proper/close supervision of controllers undergoing training so that all outages, construction, airport hazards, etc. are reported to flight crews in a timely and accurate manner. (see 11) [3/1/4] [0.3]	327 Air Traffic service runway selection policies should be based on the most current wind available. [5/4/5] [2.8]	
34	FLIGHTCREW – FAILURE TO EXERCISE COMMAND (CAPTAIN) RESPONSIBILITY	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 are reviewed during recurrent training. [4/3/4] [1.3]	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. (see 142, 311) [5/3/5] [2.1]	329 Airlines/operators should incorporate in initial and recurrent training ways to recognize multiple cues that will require go-around. Including CFIT trng aid 2.1.9, FSF defn. of stab. approach, risk assessment tool, and windshear training aid [5/4/5] [2.8]	356 Research should be done to develop an effective tactical decision making model for flight crews in time critical situations. [not rated]		
35	AIRLINE OPERATIONS - INADEQUATE SAFETY DATA SHARING	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	57 Airlines/operators, regulators, and manufacturers should implement a program designed for sharing of safety related information within the aviation community. [not rated]	321 Regulators and Military agencies should ensure procedures are in place to share information pertaining to operations at joint use airports. (Special Use Airports) [4/2/4] [0.9]		

36	AIRLINE OPERATIONS - IMPROPER MAINTENANCE OF CRITICAL SYSTEMS (AVIONICS)	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]			
37	Number not used						
38	FLIGHT CREW INAPPROPRIATE TASK PRIORITIZATION UNDER TIME CONSTRAINTS	82 Airlines/operators should clearly define, train and check the specific PF/PNF duties. (see 135) [4/2/5] [1.1]	96 Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate approach preparation and contingency review prior to commencing an approach. [5/2/4] [1.1]	100 Airlines/operators should ensure that their training/standardization programs emphasize the importance of adhering to MDA/DH. [6/2/5] [1.7]	111 Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training. [5/3/5] [2.1]	114 Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency. [5/2/5] 1.4]	115 Airlines/operators should ensure that their training/standardization programs emphasize the dangers of rushed approaches. (see 13, 157) [3/2/4] [0.7]
	38 continued	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations. [not rated]	305 Regulators should require airlines/operators to outfit aircraft with electronic checklists. If unable to install electronic checklists, use mechanical checklists or, at a minimum, develop a process to reinforce challenge and response checklists. [5/4/5] [2.8]	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. (IAW AC120-51b). [6/3/4] [1.3]	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). [4/2/5] [1.1]	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. (see 142, 311) [5/3/5] [2.1]

	38 continued	329 Airlines/operators should incorporate in initial and recurrent training ways to recognize multiple cues that will require go-around. Including CFIT trng aid 2.1.9, FSF defn. of stab. approach, risk assessment tool, and windshear training aid {6/5/6} [3.8]	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]	356 Research should be done to develop an effective tactical decision making model for flight crews in time critical situations. [not rated]			
39	AIRCRAFT EQUIPMENT - DESIGN NOT ERROR TOLERANT	45 Manufacturers should ensure that all impending 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. (see 103, 138) [5/5/5] [3.5]	49 Regulators should establish criteria for, and manufacturers should evaluate and improve, the reliability and failure tolerance of flight systems. (see 332) [5/3/5] [2.1]	103 Manufacturers should develop and implement system failure annunciation capabilities to alert flight crews of pending failures (e.g. HUMS). (see 45, 138) [4/1/4] [0.4]	111 Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training. [5/3/5] [2.1]	235 Manufacturers should provide a more positive means of external strut pre-flight inspections. [5/3/1] [0.4]	248 To ensure adequate testing of equipment, manufacturers' testing should be conducted under worst case scenarios taking into account new technologies and testing under simulated flight realistic conditions. [5/3/5] [2.1]
	39 continued	253 To prevent loss of control, there should be redundancy and failure tolerance features for all flight critical components, such as dual path design, fail operational redundant systems, with fault annunciation. [6/3/3] [1.5]	256 To prevent loss of aircraft control in-flight, all propeller pitch control systems must be designed to positively feather in the event of pitch control loss. Propeller pitch control system malf must be positively annunciated to the flt crew. [6/4/4] [2.7]	260 To prevent uncommanded in-flight flat pitch, research should be conducted into prop brake designs. [not rated]	304 Manufacturers should improve the design for an error tolerant ground spoiler deployment system. [6/4/6] [3.3]	332 Manufacturers should design ground sensing systems that are tolerant to adverse conditions without degrading inflight safety features (e.g. which prevent deployment of ground spoilers and reverse in-flight). (see 16) [6/4/4] [2.7]	
40	AIRLINE OPERATIONS - FAILURE TO COMPLY WITH EXISTING REGULATIONS	129 Regulators should establish criteria to ensure operators overall quality assurance and compliance procedures are effective rather than reliance on spot checks of individual components [3/2/4] [0.7]	201 Regulators should develop adequate oversight as appropriate to ensure compliance with regulations.(see 145, 146, 202, 345) [4/2/4] [0.9]	231 Regulators should require and airlines/operators should promptly close out all regulatory safety audit findings. [4/2/4] [0.9]	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]		
41	FLIGHT CREW – FAILURE TO USE AVAILABLE APPROACH AIDS	89 Airlines/operators and regulators should ensure that the frequency and effectiveness of proficiency checks for non-precision approaches are adequate. [3/3/5] [1.3]	125 Airlines/operators should encourage flight crews to use precision approaches (glideslope guidance) when available and appropriate. [5/3/5] [2.1]	309 Airlines/operators should require flight crews to fly precision instrument approach procedures during periods of reduced visibility and night operations. (see 59, 355)	325 Airline/operators should emphasize during initial and recurrent training the importance of maintaining systems status awareness during non-normal events and hazardous approaches		

				[4/2/3] [0.7]	(goal to avoid tunnel vision/narrowed attention) [4/2/4] [0.9]		
42	FLIGHT CREW – FAILURE TO ADDRESS COMBINED HAZARDS ASSOCIATED WITH THE SITUATION	23 Airlines/operators should ensure that regularly scheduled recurrent training (e.g. LOFT) emphasizes crew cooperation and working together to maximize safe operations. (see 308, 314) [4/1/4] [0.4]	25 Airlines/operators should establish a CRM training program and regulators should require and insure that the initial training is provided prior to line flying and require recurrent CRM training. (see 131, 132, 349) [4/2/5] [1.1]	64 Airlines/operators should ensure that their training/standardization programs direct the flight crews to regularly cross check all instrumentation. [4/1/4] [0.4]	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. (see 99) [5/3/5] [2.1]	111 Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training. [5/3/5] [2.1]	114 Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency. [4/1/4] [0.4]
	42 continued	142 Airlines/operators should establish policies, parameters, and training to recognize unstabilized approaches and other factors and implement a go-around gate system. (see FSF - "defined gates" p. 193) (see 116, 123) [6/4/6] [4.0]	154 Airlines/operators should improve/increase training to increase awareness of icing effects on airplane type including dynamic simulator training. [2/4/5] [1.1]	204 Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. [not rated]	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations. [not rated]	300 Airlines/operators will 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). [5/3/5] [2.1]
	42 continued	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. (IAW AC120-51b). [6/3/4] [1.3]	312 Airline/operators should ensure 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. [3/2/5] [0.8]	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). [5/3/6] [21]	319 Regulators should require a Special Qualification Airport Briefing guide be incorporated with approach charts. (Subject matter must include aircraft specific local operational procedures) [4/4/4] [1.8]	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. (see 142, 311) [5/3/5] [2.1]	329 Airlines/operators should incorporate in initial and recurrent training ways to recognize multiple cues that will require go-around. Including CFIT trng aid 2.1.9, FSF defn. of stab. approach, risk assessment tool, and windshear training aid [5/4/5] [2.8]

	42 continued	331 Airlines/ops and manufacturers should train crews to understand the capabilities and limitations of sys., conditions which would cause sys. to not function as the crew anticipates, and how to detect those conditions (e.g. lack of brakes, spoilers) [5/3/5] [2.1]	349 Airlines/operators should ensure training for instructors and check airmen include objective criteria to be used in evaluating crew CRM performance. (see 25,131) [4/2/5]	350 Airlines/operators should ensure that adequate approach briefings are conducted that include descriptions of normal approach, non-normal conditions and the results of the risk assessment tool analysis. (see 300) [5/3/5] [2.1]	356 Research should be done to develop an effective tactical decision making model for flight crews in time critical situations. [not rated]		[1.3]
43	FLIGHT CREW – HOME AERODROME COMPLACENCY	17 Airlines/operators should ensure that their training/standardization programs emphasize the importance of all flight-related briefings. (see 342) [4/2/4] [0.9]	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	162 Airline/operators should include in their training programs the awareness of potential safety risks due to the complacency when operating at a very familiar airport (e.g. home base). [4/2/4] [0.9]	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations. [not rated]	342 Airlines/operators should establish a SOP to ensure that flight crews should not begin the approach until an adequate briefing is completed for the expected runway. (see 17) [3/2/4] [0.7]
44	FLIGHT CREW –FAILURE TO RECOGNIZE AND CORRECT UNSTABLE APPROACH	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	59 Implement precision approach capability (glideslope guidance) for all runways without established precision approach procedures (e.g. ILS, DGPS, etc.). (see 77) [5/5/6] [4.2]	85 The aviation industry should develop and implement synthetic vision capability (e.g. Precision Approach Terrain Information (PATI)). [6/5/6] [5.0]	115 Airlines/operators should ensure that their training/standardization programs emphasize the dangers of rushed approaches. (see 13, 157) [3/2/4] [0.7]	116 Airlines/operators should ensure that their training/standardization programs emphasize the dangers of high rate of descent and unstable approaches. (see 142) [5/4/5] [2.8]
	44 continued	142 Airlines/operators should establish policies, parameters, and training to recognize unstabilized approaches and other factors and implement a go-around gate system. (see FSF - “defined gates” p. 193) (see 116, 123) [6/4/6] [4.0]	157 Airlines/operators, regulators, Air Traffic service providers should establish policies or programs to address rushed appr., incl. elim. Of rushed appr., recognition and rejection of rushed appr. and trng for those encountered [3/2/4] [0.7]	163 Airlines/operators should ensure that their training/standardization programs address common misperceptions that could lead to unsafe practices (i.e. ATC always wants high energy approaches). [5/3/5] [2.1]	204 Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. [not rated]	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations. [not rated]

	44 continued	295 To enhance flight crew performance in low visibility operations, the aviation industry should continue to develop and implement HUD capability. (see 149) [6/5/5] 3.2]	309 Airlines/operators should require flight crews to fly precision instrument approach procedures during periods of reduced visibility and night operations. (see 59, 355) [4/2/3] [0.7]	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. (see 142, 311) [5/3/5] [2.1]	342 Airlines/operators should establish a SOP to ensure that flight crews should not begin the approach until an adequate briefing is completed for the expected runway. (see 17) [3/2/4] [0.7]	352 Airlines/operators should equip aircraft with autopilots to reduce crew workload during critical phases of flight. [[3/1/3] [0.3]	355 Non-precision approaches should be conducted as constant angle, stabilized approaches. (see 59) [1/1/4] [0.4]
45	FLIGHT CREW- FAILURE TO UNDERSTAND THE IMPLICATIONS OF INOPERATIVE OR DEGRADED SYSTEMS	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. (see 99) [5/3/5] [2.1]	111 Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training. [5/3/5] [2.1]	114 Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency. [4/1/4] [0.4]	145 Airlines/operators and regulators should establish appropriate operational restrictions when equipment is inoperative (MEL) [4/4/4] [1.8]	146 Regulators should establish/enforce reasonable limitations on dispatch with safety related equipment inop. (MEL) [4/2/4] [0.9]	225 Airlines/operators and regulators should ensure necessary manuals (operational & maintenance) are complete, accurate, available and appropriately used. [5/3/5] [2.1]
	45 continued	331 Airlines/ops and manufacturers should train crews to understand the capabilities and limitations of sys., conditions which would cause sys. to not function as the crew anticipates, and how to detect those conditions (e.g. lack of brakes, spoilers) [5/3/5] [2.1]	353 Airlines/operators should establish and enforce a clear MEL policy to aid flight crews in making maintenance related decisions. [2/2/3] [0.3]				
46	AIR TRAFFIC SYSTEM-PROCEDURES THAT COMPROMISE SAFETY	21 Establish/enhance quality assurance checks/training to ensure that timely and accurate communication between controllers and flight crews is occurring. [1/1/4] [0.1]	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	57 Airlines/operators, regulators, and manufacturers should implement a program designed for sharing of safety related information within the aviation community. [not rated]	310 Regulators will not allow noise abatement procedures that reduce the level of safety that existed prior to their implementation. [3/3/4] [1.0]	324 Air Traffic services should ensure proper/close supervision of controllers undergoing training so that all outages, construction, airport hazards, etc. are reported to flight crews in a timely and accurate manner. (see 11) [3/1/4] [0.3]

	46 continued	354 Organizations responsible for developing approach/arrival/departure procedures should not report to the organization responsible for Air Traffic service (e.g. In the FAA AVN-100 not reporting to AAT) [3/1/2] [0.2]					
47	FLIGHT CREW – FAILURE TO MAINTAIN AIRCRAFT SYSTEMS STATUS AWARENESS	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations. [not rated]	325 Airline/operators should emphasize during initial and recurrent training the importance of maintaining systems status awareness during non-normal events and hazardous approaches (goal to avoid tunnel vision/narrowed attention) [4/2/4] [0.9]	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. (see 142, 311) [5/3/5] [2.1]	329 Airlines/operators should incorporate in initial and recurrent training ways to recognize multiple cues that will require go-around. Including CFIT trng aid 2.1.9, FSF defn. of stab. approach, risk assessment tool, and windshear training aid [5/4/5] [2.8]	331 Airlines/operators and manufacturers should train crews to understand the capabilities and limitations of systems, conditions which would cause systems to not function as the crew anticipates, and how to detect those conditions (e.g. lack of brakes, spoilers) [5/3/5] [2.1]
48	AIRLINE OPERATIONS - LACK OF STABILIZED APPROACH CRITERIA, MANDATORY GO-AROUND POLICY	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	115 Airlines/operators should ensure that their training/standardization programs emphasize the dangers of rushed approaches. (see 13, 157) [3/2/4] [0.7]	116 Airlines/operators should ensure that their training/standardization programs emphasize the dangers of high rate of descent and unstable approaches. (see 142) [5/4/5] [2.8]	123 Airlines/operators should implement a true no-fault go around policy (learning vs. blame). [5/3/5] [2.1]	142 Airlines/operators should establish policies, parameters, and training to recognize unstabilized approaches and other factors and implement a go-around gate system. (see FSF - "defined gates" p. 193) (see 116, 123) [6/4/6] [4.0]
	48 continued	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. (see 142, 311) [5/3/5] [2.1]	329 Airlines/operators should incorporate in initial and recurrent training ways to recognize multiple cues that will require go-around. Including CFIT trng aid 2.1.9, FSF defn. of stab. approach, risk assessment tool, and windshear training aid [5/4/5] [2.8]	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]			
49	Number not used						
50	AIRLINE OPERATIONS - INEFFECTIVE CORRECTION OF PROCEDURAL NON-COMPLIANCE	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe	57 Airlines/operators, regulators, and manufacturers should implement a program designed for sharing of safety related information within the aviation	79 Airlines/operators should implement a reliable process to communicate information to the flight crew that may affect flight or aircraft operations. [4/2/3] [0.7]	82 Airlines/operators should clearly define, train and check the specific PF/PNF duties. (see 135) [4/2/5] [1.1]	99 Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced. (see 110) [4/1/4] [0.4]

			trends. (see 54, 55) [not rated]	community. [not rated]			
	50 continued	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. (see 99) [5/3/5] [2.1]	116 Airlines/operators should ensure that their training/standardization programs emphasize the dangers of high rate of descent and unstable approaches. (see 142) [5/4/5] [2.8]	128 Airlines/operators and regulators should implement a no blame safety reporting and data sharing system with appropriate protections from litigation and prosecution concerns. [not rated]	204 Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. [not rated]	337 Airlines/operators should establish a process (which includes an interdisciplinary team) to document and investigate high risk behavior and poor judgement triggered by on-the-job performance. (see 151, 152, 335) [not rated]	340 Airlines/operators should implement procedures to ensure flight crews are aware of appropriate Airworthiness Directives, Certification and flight testing standards. (see 76, 46) [4/2/3] [0.7]
	50 continued	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]					
51	AIRLINE OPERATIONS – SYSTEMIC COMPLACENCY AND NON-STANDARD CONDUCT	13 Air Traffic service providers should enhance ATC training to emphasize the dangers of rushed approaches and performance characteristics of modern jet transports. (see 115, 157) [4/1/4] [0.4]	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 are reviewed during recurrent training. [4/3/4] [1.3]	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	99 Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced. (see 110) [4/1/4] [0.4]	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. (see 99) [5/3/5] [2.1]	128 Airlines/operators and regulators should implement a no blame safety reporting and data sharing system with appropriate protections from litigation and prosecution concerns. [not rated]
	51 continued	129 Regulators should establish criteria to ensure operators overall quality assurance and compliance procedures are effective rather than reliance on spot checks of individual components [3/2/4] [0.7]	136 Airlines/operators should ensure that their training/standardization programs emphasize the importance of the sterile cockpit environment [3/3/4] [1.0]	143 Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture) (see 22, 63, 348) [5/3/6] [2.5]	157 Airlines/operators, regulators, Air Traffic service providers should establish policies or programs to address rushed appr., incl. elim. Of rushed appr., recognition and rejection of rushed appr. and trng for those encountered [3/2/4] [0.7]	163 Airlines/operators should ensure that their training/standardization programs address common misperceptions that could lead to unsafe practices (i.e. ATC always wants high energy approaches). [5/3/5] [2.1]	202 Airlines/operators should develop a quality assurance program to ensure compliance with regulations.(see 145, 146, 201) [4/3/4] [1.3]
	51 continued	204 Research should be conducted to better understand the underlying reasons/causes for procedural	318 Flight Safety Foundation should develop a cost analysis tool to educate CEO's about the high economic	337 Airlines/operators should establish a process (which includes an interdisciplinary team) to document and	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation),	350 Airlines/operators should ensure that adequate approach briefings are conducted that include descriptions	

		noncompliance. [not rated]	and psychological costs of accidents and serous incidents. [not rated]	investigate high risk behavior and poor judgement triggered by on-the-job performance. (see 151, 152, 335) [not rated]	operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]	of normal approach, non-normal conditions and the results of the risk assessment tool analysis. (see 300) [5/3/5] [2.1]	
52	REGULATORS - INEFFECTIVE OVERSIGHT OF KNOWN PROCEDURAL NON-COMPLIANCE	129 Regulators should establish criteria to ensure operators overall quality assurance and compliance procedures are effective rather than reliance on spot checks of individual components [3/2/4] [0.7]	201 Regulators should develop adequate oversight as appropriate to ensure compliance with regulations.(see 145, 146, 202, 345) [4/2/4] [0.9]	204 Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. [not rated]	219 Regulators should ensure company training program is in accordance with approved training program.(see 110, 201) [4/2/4] [0.9]	231 Regulators should require and airlines/operators should promptly close out all regulatory safety audit findings. [4/2/4] [0.9]	345 Ensure regulators have adequate funding, training and processes to accomplish their oversight responsibilities. (see 201) [4/3/4] [1.3]
	52 continued	346 Airlines/operators should ensure better educated regulators by providing intern programs. [1/1/1] [0.0]					
53	AIRLINE OPERATIONS - INEFFECTIVE/ INAPPROPRIATE DISCIPLINARY POLICIES	23 Airlines/operators should ensure that regularly scheduled recurrent training (e.g. LOFT) emphasizes crew cooperation and working together to maximize safe operations. (see 308, 314) [4/1/4] [0.4]	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	131 Airlines/operators should ensure that their training/standardization prog. emphasizes the importance of the team concept, cross cultural issues, eval. of options and the obligation of the FO to effectively comm. any concerns (CRM) (see 237) [4/1/4] [0.4]	132 Airlines/operators and regulators should ensure that disciplinary and prosecution policies don't adversely affect or countermand safety gains of good CRM practices. (see 308) [4/2/3] [0.7]	133 Airlines/operators training of Captains and Chief Pilots should include Management practices that promote team building and effective human relations (leadership training beyond current CRM programs). (see 308) [4/2/5] [1.1]
	53 continued	337 Airlines/operators should establish a process (which includes an interdisciplinary team) to document and investigate high risk behavior and poor judgement triggered by on-the-job performance. (see 151, 152, 335) [not rated]					
54	ATC/FLIGHTCREW - ACTIONS /INACTION'S CONTRIBUTED TO INCREASED WORKLOAD	13 Air Traffic service providers should enhance ATC training to emphasize the dangers of rushed approaches and performance characteristics of modern jet transports. (see 115, 157) [4/1/4] [0.4]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	114 Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency. [4/1/4] [0.4]	115 Airlines/operators should ensure that their training/standardization programs emphasize the dangers of rushed approaches. (see 13, 157) [3/2/4] [0.7]	126 Air Traffic service providers should prioritize the use of precision approaches (glideslope guidance) when available and appropriate. [5/4/5] [2.8]	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]
	54 continued	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to	314 Airlines/operators should develop simulator training scenarios that require flight crews to	356 Research should be done to develop an effective tactical decision making model for flight			

		develop directive information systems for go-around situations. [not rated]	learn multi-tasking abilities and appropriate prioritization abilities in concert with CRM skills (see Red Flag LOFT scenarios). [4/2/5] [1.1]	crews in time critical situations. [not rated]			
55	AIRLINE OPERATIONS - BURDENED FLIGHT CREW WITH NON-FLIGHT RELATED TASKS	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]					

56	MANUFACTURERS/ AIRLINE OPERATIONS- INAPPROPRIATE CHECKLIST ITEM PRIORITY	80 Airlines/operators should ensure, and regulators should check, that operators who create their own AOM's include all procedures prescribed by original equipment manufacturers Airplane Flight Manual (AFM). [5/4/5] [2.8]	99 Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced. (see 110) [4/1/4] [0.4]	134 Airlines/operators and regulators should ensure check list designs prioritize critical items as recommended by NASA study, and that items are arranged in a manner to enhance checklist implementation [6/5/6] [5.0]	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]		
57	AIRCRAFT EQUIPMENT - DESIGN SHORTCOMINGS	35 Manufacturers should install TAWS (EGPWS) in all new aircraft, airlines/operators should retrofit TAWS into the existing fleet and international regulators should require the installation of TAWS. [6/5/6] [5.0]	45 Manufacturers should ensure that all impending 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. (see 103, 138) [5/5/5] [3.5]	61 Airlines/operators (and manufacturers in the airplane flight manual) should implement procedures that call for an immediate execution of the escape maneuver following a GPWS warning unless there is visual confirmation of terrain. [3/4/5] [1.7]	103 Manufacturers should develop and implement system failure annunciation capabilities to alert flight crews of pending failures (e.g. HUMS). (see 45, 138) [6/3/6] [2.4]	137 Manufacturers should ensure cockpit design that does not interfere with or distract the flight crew from executing their duties (e.g. rain in the cockpit, location of switches in cockpits) [1/1/3] [0.1]	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. (see 45, 243) [4/2/4] [0.9]
	57 continued	156 Require that autothrottles be used with all autopilot coupled approaches. [6/6/5] [3/8]	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]	243 To prevent alerting overload, flight deck designs should consider smart alerting systems such as those with prioritization schemes or cancelable nuisance alerts. [5/4/5] [2.8]	249 To ensure the accuracy and safety of computer modeling used for design and failure analysis, the modeling must be adequately re-validated on a continuing basis to account for new technology. [5/3/5] [2.1]	250 To ensure test components are representative of the final product, manufacturers should test the final component and regulators should require this type testing. [5/4/5] [2.8]	251 To preserve the original intended level of airworthiness, there should be a better definition and classification of subsequent in-service major and minor critical component changes. The definition of critical component should be more specific. [4/1/4] [0.4]
	57 continued	252 To prevent loss of control in flight, all changes to flight critical components, such as primary propeller pitch controller components, should be considered major changes. [5/4/4] [2.2]	253 To prevent loss of control, there should be redundancy and failure tolerance features for all flight critical components, such as dual path design, fail operational redundant systems, with fault annunciation. [6/3/3] [1.5]	254 To avoid the isolated incident syndrome and to ensure on-going assessment of flt critical control sys. reliability, a focused safety or risk assessment of all in-service failures or problems should be cond. to determine the need for immediate res [5/3/5] [2.1]	255 To prevent catastrophic failures, the manuf should issue immediate telegraphic information to all operators, and regulators should require an immediate mandatory action (AD), following the initial failure report of any critical comp malf [4/1/4] [0.4]	259 Regulators should set engineering standards requiring propeller manufacturers to provide positive prevention designs, to eliminate all flight critical failure modes (e.g. flat pitch). [5/1/3] [0.4]	260 To prevent uncommanded in-flight flat pitch, research should be conducted into prop brake designs. [not rated]

	57 continued	332 Manufacturers should design ground sensing systems that are tolerant to adverse conditions without degrading inflight safety features (e.g. which prevent deployment of ground spoilers and reverse in-flight). (see 16) [6/4/4] [2.7]					
100	REGULATORS - INSUFFICIENT AIR CARRIER OVERSIGHT .	143 Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture) (see 22, 63, 348) [5/3/6] [2.5]	151Regulators should establish policies that require additional monitoring of flight crew members that have repeatedly failed check rides. (see 152, 335, 337) [4/4/4] [1.8]	152 Airlines/operators and regulators should raise standards (e.g. crew pairing, approach minimums, etc.) for flight crewmembers that meet minimum qualifications but have demonstrated specific weaknesses. (see 151, 335, 337) [5/2/3] [0.8]	201 Regulators should develop adequate oversight as appropriate to ensure compliance with regulations.(see 145, 146, 202, 345) [4/2/4] [0.9]	202 Airlines/operators should develop a quality assurance program to ensure compliance with regulations.(see 145, 146, 201) [4/3/4] [1.3]	214 Regulators should enforce timely incorporation of appropriate manufacturers recommendations. (see 98, 201) [4/2/4] [0.9]
	100 continued	220 Regulators should ensure that all POIs are current and qualified in one model of the companies equipment. [2/1/2] [0.1]	222 Regulators should require PMI's to have expertise in the assigned carrier's equipment. [2/1/2] [0.1]	223 Regulators should ensure POIs are properly qualified and trained to approve appropriate company operational procedures. [3/3/5] [1.3]	345 Ensure regulators have adequate funding, training and processes to accomplish their oversight responsibilities. (see 201) [4/3/4] [1.3]	346 Airlines/operators should ensure better educated regulators by providing intern programs. [1/1/1] [0.0]	347 Parent airlines/operators should adopt a program to ensure the same level of safety in regional partners including, but not limited, to recruitment, training, operations and maintenance. [2/1/4] [0.2]
101	AIRLINE OPERATIONS - FAILURE TO MAINTAIN AIRCRAFT SYSTEMS	14 Install aural warning devices on aircraft to alert flightcrew of arrival at MDA/DH. [5/4/5] [2.8]	45 Manufacturers should ensure that all impending 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. (see 103, 138) [5/5/5] [3.5]	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	143 Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture) (see 22, 63, 348) [5/3/6] [2.5]	145 Airlines/operators and regulators should establish appropriate operational restrictions when equipment is inoperative (MEL) [4/4/4] [1.8]

	101 continued	146 Regulators should establish/enforce reasonable limitations on dispatch with safety related equipment inop. (MEL) [4/2/4] [0.9]	202 Airlines/operators should develop a quality assurance program to ensure compliance with regulations.(see 145, 146, 201) [4/3/4] [1.3]	211 Airlines/operators should retrofit equipment to provide automatic altitude callouts on final approach. If unable, other altitude alerting or reminder systems (such as altimeter bugs) should be installed. [5/4/5] [2.8]	232 Airlines/operators should ensure all nose gear struts are serviced for cold weather operation are in accordance with OEM recommendations. [6/5/2] [1.7]	233 Regulators should require operators incorporate OEM strut servicing recommendations in mandatory maintenance procedure and surveill compliance. [6/5/1] [0.8]	343 Airlines/operators should install radio altimeters in all aircraft and develop procedures for their use on approach as recommended by FSF ALAR. [4/2/3] [0.7]
	101 continued	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]					
102	FLIGHT CREW - INADEQUATE PLANNING/BRIEFING	7 Airlines/operators should ensure that their training/standardization programs emphasize review of approach and missed approach procedures. (see 329) [4/1/4] [0.4]	17 Airlines/operators should ensure that their training/standardization programs emphasize the importance of all flight-related briefings. (see 342) [4/2/4] [0.9]	95 Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices. [4/1/4] [0.4]	96 Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate approach preparation and contingency review prior to commencing an approach. [5/2/4] [1.1]	113 Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate preflight planning. [3/2/4] [0.7]	114 Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency. [4/1/4] [0.4]
	102 continued	204 Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. [not rated]	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]	300 Airlines/operators will 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). [5/3/5] [2.1]	342 Airlines/operators should establish a SOP to ensure that flight crews should not begin the approach until an adequate briefing is completed for the expected runway. (see 17) [3/2/4] [0.7]	350 Airlines/operators should ensure that adequate approach briefings are conducted that include descriptions of normal approach, non-normal conditions and the results of the risk assessment tool analysis. (see 300) [5/3/5] [2.1]	
103	AIR TRAFFIC SYSTEM - INADEQUATE WEATHER INFORMATION PROVIDED TO THE FLIGHT CREW	93 Air Traffic service should provide real time (most current) radio communication of critical airport and weather information. [5/3/5] [2.1]	94 Implement real time (digital) transmission of airport and weather information to the aircraft. [4/1/3] [0.3]				
104	AIRLINE OPERATIONS/ REGULATORS – LACK OF PROCEDURES AND REGULATIONS TO IDENTIFY FLIGHT CREW WITH DEMONSTRATED WEAKNESSES	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 are reviewed	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	63 Airlines/operators should implement a culture which encourages flight crew voluntary removal from flight status due to illness and/or emotional distress (including the use of a self assessment tool).	151Regulators should establish policies that require additional monitoring of flight crew members that have repeatedly failed check rides. (see 152, 335, 337) [4/4/4] [1.8]	152 Airlines/operators and regulators should raise standards (e.g. crew pairing, approach minimums, etc.) for flight crewmembers that meet minimum qualifications but have demonstrated specific weaknesses.

		during recurrent training. [4/3/4] [1.3]			(see 70) [2/1/2] [0.1]		(see 151, 335, 337) [5/2/3] [0.8]
	104 continued	219 Regulators should ensure company training program is in accordance with approved training program.(see 110, 201) [4/2/4] [0.9]	238 To preclude conducting flight training during operational flights, when a need for training is identified, operators should conduct training in accordance with their approved training program. [5/3/5] [2.1]	335 Airlines/operators should establish more effective pilot screening and Capt. upgrade criteria to eliminate candidates with demonstrable aviation personality deficiencies. (see 151, 251, 337) [5/1/3] [0.4]	337 Airlines/operators should establish a process (which includes an interdisciplinary team) to document and investigate high risk behavior and poor judgement triggered by on-the-job performance. (see 151, 152, 335) [not rated]	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]	
105	AIRLINE OPERATIONS - PAIRING INEXPERIENCED PILOTS	24 Airlines/operators should implement procedures to ensure appropriate crew pairing. (reference FSF corporate crew scheduling and fatigue evaluation.) [5/5/5] [3.5]	143 Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture) (see 22, 63, 348) [5/3/6] [2.5]	152 Airlines/operators and regulators should raise standards (e.g. crew pairing, approach minimums, etc.) for flight crewmembers that meet minimum qualifications but have demonstrated specific weaknesses. (see 151, 335, 337) [5/2/3] [0.8]	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]		
106	FLIGHT CREW – FAILURE TO RECOGNIZE THE STATE OF THE AIRPLANE	149 Manufacturers should install a HUD as standard equipment. (see 85) [4/4/4] [1.8]	243 To prevent alerting overload, flight deck designs should consider smart alerting systems such as those with prioritization schemes or cancelable nuisance alerts. [5/4/5] [2.8]	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations. [not rated]		

107	FLIGHT CREW – FAILURE TO USE ALL AVAILABLE INFORMATION RESOURCES	45 Manufacturers should ensure that all impending 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. (see 103, 138) [5/5/5] [3.5]	79 Airlines/operators should implement a reliable process to communicate information to the flight crew that may affect flight or aircraft operations. [4/2/3] [0.7]	158 Develop technology to provide real time assistance to flight crews with onboard system failures and diagnostics (e.g. data link transmittal to ground support) (see 103) [5/4/4] [2.2]	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]	227 Airlines/operators should ensure that their training/standardization program emphasizes the benefits of inter-crew/company communications. (see 131) [5/2/4] [1.1]	228 Regulators should require airlines/operators to modify their training to maximize benefits of inter-crew/company communications. [5/2/4] [1.1]
	107 continued	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations. [not rated]	356 Research should be done to develop an effective tactical decision making model for flight crews in time critical situations. [not rated]				
201	(Deleted or combined with another problem statement) (see 5)						
202	(Deleted or combined with another problem statement) (see 38)						
203	(Deleted or combined with another problem statement) (see 24)						
204	FLIGHT CREW – NOT ADEQUATELY PREPARED FOR THE TASK	17 Airlines/operators should ensure that their training/standardization programs emphasize the importance of all flight-related briefings. (see 342) [4/2/4] [0.9]	95 Airlines/operators should establish procedures for flight crews to review/cross check instructions, clearances, etc. to ensure consistency with expected procedures or practices. [4/1/4] [0.4]	96 Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate approach preparation and contingency review prior to commencing an approach. [5/2/4] [1.1]	114 Airlines/operators should ensure that their training/standardization programs provide sufficient training to ensure aircrew proficiency. [4/1/4] [0.4]	342 Airlines/operators should establish a SOP to ensure that flight crews should not begin the approach until an adequate briefing is completed for the expected runway. (see 17) [3/2/4] [0.7]	350 Airlines/operators should ensure that adequate approach briefings are conducted that include descriptions of normal approach, non-normal conditions and the results of the risk assessment tool analysis. (see 300) [5/3/5] [2.1]
205	(Deleted or combined with another problem statement) (see 22)						

206	FLIGHT CREW – FAILURE TO RESPOND TO OR PROCESS FLIGHT DECK WARNING	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	204 Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. [not rated]	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]	243 To prevent alerting overload, flight deck designs should consider smart alerting systems such as those with prioritization schemes or cancelable nuisance alerts. [5/4/5] [2.8]	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations. [not rated]
	206 continued	356 Research should be done to develop an effective tactical decision making model for flight crews in time critical situations. [not rated]					
207	FLIGHT CREW – FAILURE TO USE THE APPROPRIATE LEVEL OF AUTOMATION	15 Airlines/operators should ensure that their training/standardization programs instruct when to disengage automated systems and fly manually. (see 246) [4/2/4] [0.9]	204 Research should be conducted to better understand the underlying reasons/causes for procedural noncompliance. [not rated]	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]	246 To reduce pilot overload, airlines/operators policies should stress using the appropriate level of automation. [3/2/4] [0.7]		
208	AIRCRAFT EQUIPMENT - FLIGHT DECK WARNINGS OVERLOAD CREW	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]	243 To prevent alerting overload, flight deck designs should consider smart alerting systems such as those with prioritization schemes or cancelable nuisance alerts. [5/4/5] [2.8]	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations. [not rated]	356 Research should be done to develop an effective tactical decision making model for flight crews in time critical situations. [not rated]
301	AIRLINE OPERATIONS/ MANUFACTURERS - PROCEDURES NOT RECONCILED	80 Airlines/operators should ensure, and regulators should check, that operators who create their own AOM's include all procedures prescribed by original equipment manufacturers Airplane Flight Manual (AFM). [5/4/5] [2.8]	224 Airlines/operators should ensure that all airline operations include compliance with all/seasonal guidance from the OEM. [5/4/5] [2.8]	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]			
302	(Deleted or combined with another problem statement) (see 48)						
303	FLIGHT CREW – FAILURE TO PROCESS AND INTERPRET AVAILABLE RELEVANT DATA	208 Research should be conducted to understand the phenomenon of flight crew overload. (e.g. why do flight crews ignore GPWS warnings) [not rated]	244 To prevent plan continuation errors (e.g. press-on-itis), research should be conducted to develop directive information systems for go-around situations. [not rated]	297 To prevent CFIT, operators should develop procedures to ensure that flight crews do not descend when confusion exists concerning aircraft position. [not rated]	329 Airlines/operators should incorporate in initial and recurrent training ways to recognize multiple cues that will require go-around. Including CFIT trng aid 2.1.9, FSF defn. of stab.	356 Research should be done to develop an effective tactical decision making model for flight crews in time critical situations. [not rated]	

					approach, risk assessment tool, and windshear training aid [5/4/5] [2.8]		
304	AIRPORT AUTHORITY - FAILURE TO ENSURE RUNWAY CLEARWAY IS FREE OF HAZARDS	334 Regulators should require airports to comply with International standards for airport construction. [5/2/2] [0.6]					
305	AIRLINE OPERATIONS - LACK OF A PROACTIVE SAFETY CULTURE/PROGRAM	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	55 Airlines/operators should implement a Flight Operations Quality Assurance (FOQA) program to identify flight crew failure to respond to GPWS warnings. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	57 Airlines/operators, regulators, and manufacturers should implement a program designed for sharing of safety related information within the aviation community. [not rated]	105 Airlines/operators should train flight crews on how flight delays upon departure or enroute (weather, maintenance, ATC, etc.) can affect their subsequent decision making relative to the safe conduct of the flight. [3/2/4] [0.7]	128 Airlines/operators and regulators should implement a no blame safety reporting and data sharing system with appropriate protections from litigation and prosecution concerns. [not rated]
	305 continued	143 Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture) (see 22, 63, 348) [5/3/6] [2.5]	201 Regulators should develop adequate oversight as appropriate to ensure compliance with regulations.(see 145, 146, 202, 345) [4/2/4] [0.9]	202 Airlines/operators should develop a quality assurance program to ensure compliance with regulations.(see 145, 146, 201) [4/3/4] [1.3]	213 Airlines/operators and regulators should provide additional inspectors/inspection of sub-contract activity. (see 201, 202) [3/3/5] [1.3]	214 Regulators should enforce timely incorporation of appropriate manufacturers recommendations. (see 98, 201) [4/2/4] [0.9]	217 Airlines/operators should ensure their "reward system" is not related to the completion of a route segment. (see 311) [2/2/3] [0.3]
	305 continued	317 Regulators should ensure one level of safety exists for all commercial transport operations (whether passenger or freighter operations). (see 338) [4/2/3] [0.7]	318 Flight Safety Foundation should develop a cost analysis tool to educate CEO's about the high economic and psychological costs of accidents and serous incidents. [not rated]	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. (see 142, 311) [5/3/5] [2.1]	329 Airlines/operators should incorporate in initial and recurrent training ways to recognize multiple cues that will require go-around. Incl CFIT training aid 2.1.9, FSF defn of stabilized approach, risk assessment tool, and windshear training aid [5/4/5] [2.8]	337 Airlines/operators should establish a process (which includes an interdisciplinary team) to document and investigate high risk behavior and poor judgement triggered by on-the-job performance. (see 151, 152, 335) [not rated]	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]
306	(Deleted or combined with another problem statement) (see 100)						
307	REGULATORS - FAILURE TO ENFORCE "ONE LEVEL OF SAFETY"	54 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs. [not rated]	56 Airlines/operators should implement Flight Operations Quality Assurance (FOQA) programs to identify systemic procedural deviations and unsafe trends. (see 54, 55) [not rated]	57 Airlines/operators, regulators, and manufacturers should implement a program designed for sharing of safety related information within the aviation community. [not rated]	317 Regulators should ensure one level of safety exists for all commercial transport operations (whether passenger or freighter operations). (see 338) [4/2/3] [0.7]	339 Regulators should require captains and first officers each have identical approach charts for reference. [4/3/3] [1.0]	
308	AIRLINE OPERATIONS - SEVERE CORPORATE PRESSURE TO ACCOMPLISH MISSION	143 Airlines/operators should and regulatory agencies must encourage a culture that enhances	317 Regulators should ensure one level of safety exists for all commercial transport operations	337 Airlines/operators should establish a process (which includes an interdisciplinary team)	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS		

		safety in their daily operations (safety culture) (see 22, 63, 348) [5/3/6] [2.5]	(whether passenger or freighter operations). (see 338) [4/2/3] [0.7]	to document and investigate high risk behavior and poor judgement triggered by on-the-job performance. (see 151, 152, 335) [not rated]	recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]		
309	AIRLINE OPERATIONS-INADEQUATE "SPECIAL QUALIFICATION AIRPORT" TRAINING	143 Airlines/operators should and regulatory agencies must encourage a culture that enhances safety in their daily operations (safety culture) (see 22, 63, 348) [5/3/6] [2.5]	317 Regulators should ensure one level of safety exists for all commercial transport operations (whether passenger or freighter operations). (see 338) [4/2/3] [0.7]	319 Regulators should require a Special Qualification Airport Briefing guide be incorporated with approach charts. (Subject matter must include aircraft specific local operational procedures) [4/4/4] [1.8]	348 Airlines/operators should utilize a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns. (see 318) [not rated]		

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Appendix H

Problem Frequency Matrix

		# 1 Uganda Rome	# 3 Grand Cayman Cayman Air	# 4 Swanton Air Transport	# 5 Luxembor g Cargolux	# 6 Guantan- amo American Intl.	# 7 Warsaw Lufthansa	# 8 Nashville Valujet	# 9 Houston Continenta l	# 11 Brunswick Atlantic Southeast	# 12 Hibbing Northwest Airlink	# 13 Columbus Jetstream	# 16 Amsterda m KLM Cityhopper	Total Accident s in Which Found
1	FLIGHTCREW – INSUFFICIENT ENGLISH LANGUAGE SKILLS													0
2	FLIGHTCREW - FAILURE TO FOLLOW PROCEDURES (COMMUNICATION S)			1					1					2
3	AIR TRAFFIC SYSTEM - LACK OF STANDARDIZATIO N (APPROACH/ DEPARTURE PLATES)	1												1
4	ATC - INSUFFICIENT ENGLISH LANGUAGE SKILLS													0
5	ATC / FLIGHTCREW INADEQUATE COMMUNICATION S			1					1					2
6	ATC - FAILURE TO FOLLOW PROCEDURES (COMMUNICATION S)	1		1		1			1					4

7	ATC - INADEQUATE SITUATION AWARENESS (HORIZONTAL)													0
8	ATC - FAILURE TO FOLLOW PROCEDURES (SOP)	1		1										2
9	AIRLINE OPERATIONS - PF/PNF FLYING PROCEDURES (INCREASED WORKLOAD AT A CRITICAL PHASE)				1									1
10	FLIGHTCREW - FAILURE TO FOLLOW PROCEDURES (SOP)	1	1	1	1			1	1		1		1	8
11	FLIGHTCREW - INADEQUATE SITUATION AWARENESS (VERTICAL)	1			1						1			3
12	FLIGHTCREW - INADEQUATE SITUATION AWARENESS (HORIZONTAL)	1												1
13	FLIGHTCREW - MISINTERPRETED PRESENTATION													0
14	AIRCRAFT EQUIPMENT - EQUIPMENT FAILURE		1	1	1					1				4

15	AIRLINE OPERATIONS - CORPORATE "ON-TIME" CULTURE	1												1
16	FLIGHTCREW - CRM FAILURE	1		1	1	1		1	1		1	1	1	9
17	AIRLINE OPERATIONS - LACK OF STANDARDIZED PROCEDURES	1	1		1			1	1		1	1	1	8
18	AIR TRAFFIC SYSTEM - LIMITED NAVAID AVAILABILITY													0
19	FLIGHTCREW - LACK OF BASIC PILOTING SKILLS OR KNOWLEDGE	1	1		1		1		1			1	1	7
20	AIRLINE OPERATIONS - LACK OF TRAINING (FLIGHTCREW)	1			1			1	1		1	1	1	7
21	FLIGHTCREW - "PRESS-ON-ITUS"	1	1		1				1					4
22	FLIGHTCREW - PNF DUTIES NOT PERFORMED	1	1		1				1		1	1		6
23	FLIGHTCREW - DISREGARD FLIGHTDECK WARNING	1		1	1	1			1			1		6
24	FLIGHTCREW/ AIRLINE OPERATIONS – AEROMEDICAL, CREW MEDICAL / FATIGUE CONCERNS		1	1	1	1			1	1				6

25	AIRCRAFT EQUIPMENT - DESIGN SHORTCOMINGS (AVIONICS)													0
26	AIRCRAFT EQUIPMENT - CVR INOPERATIVE (for future accident prevention)													0
27	AIR TRAFFIC SYSTEM - INADEQUATE TRAINING/ SUPERVISION					1								1
28	AIR TRAFFIC SYSTEM - INADEQUATE INFRASTRUCTUR E (EQUIPMENT/ DESIGN)													0
29	AIRLINE OPERATIONS - NO-FAULT GO-AROUND POLICY		1						1					2
30	ATC - INADEQUATE SITUATION AWARENESS (VERTICAL)													0
31	FLIGHTCREW - PREOCCUPATION WITH AUTOMATED NAVIGATION (FMS)													0
32	AIRLINE OPERATIONS - INADEQUATE INFORMATION DISSEMINATION			1		1		1						3

33	AIR TRAFFIC SYSTEM - INADEQUATE INFORMATION DISSEMINATION	1		1		1	1							4
34	FLIGHTCREW - FAILURE TO EXERCISE COMMAND (CAPTAIN) RESPONSIBILITY	1	1						1			1		4
35	AIRLINE OPERATIONS - INADEQUATE SAFETY DATA SHARING					1								1
36	AIRLINE OPERATIONS - IMPROPER MAINTENANCE OF CRITICAL SYSTEMS (AVIONICS)													0
37	Number not used													
38	FLIGHT CREW INAPPROPRIATE TASK PRIORITIZATION UNDER TIME CONSTRAINTS	1	1	1				1			1	1		6
39	AIRCRAFT EQUIPMENT - DESIGN NOT ERROR TOLERANT		1					1	1	1			1	5
40	AIRLINE OPERATIONS - FAILURE TO COMPLY WITH EXISTING REGULATIONS					1		1						2

41	FLIGHT CREW - FAILURE TO USE AVAILABLE APPROACH AIDS	1	1											2
42	FLIGHT CREW - FAILURE TO ADDRESS COMBINED HAZARDS ASSOCIATED WITH THE SITUATION	1	1			1	1		1		1	1	1	8
43	FLIGHT CREW - HOME AERODROME COMPLACENCY		1	1	1				1				1	5
44	FLIGHT CREW - FAILURE TO RECOGNIZE AND CORRECT UNSTABLE APPROACH	1	1	1	1	1					1	1	1	8
45	FLIGHT CREW- FAILURE TO UNDERSTAND THE IMPLICATIONS OF INOPERATIVE OR DEGRADED SYSTEMS		1										1	2
46	AIR TRAFFIC SYSTEM- PROCEDURES THAT COMPROMISE SAFETY		1			1								2
47	FLIGHT CREW - FAILURE TO MAINTAIN AIRCRAFT SYSTEMS STATUS AWARENESS		1											1

48	AIRLINE OPERATIONS - LACK OF STABILIZED APPROACH CRITERIA, MANDATORY GO-AROUND POLICY		1				1					1		3
49	Number not used													
50	AIRLINE OPERATIONS - INEFFECTIVE CORRECTION OF PROCEDURAL NON-COMPLIANCE							1	1		1			3
51	AIRLINE OPERATIONS – SYSTEMIC COMPLACENCY AND NON-STANDARD CONDUCT								1			1		2
52	REGULATORS - INEFFECTIVE OVERSIGHT OF KNOWN PROCEDURAL NON-COMPLIANCE					1		1	1		1			4
53	AIRLINE OPERATIONS - INEFFECTIVE/ INAPPROPRIATE DISCIPLINARY POLICIES								1					1
54	ATC/FLIGHTCREW - ACTIONS /INACTION'S CONTRIBUTED TO INCREASED WORKLOAD	1							1			1		3

55	AIRLINE OPERATIONS - BURDENED FLIGHT CREW WITH NON-FLIGHT RELATED TASKS								1					1
56	MANUFACTURERS/ AIRLINE OPERATIONS-INAPPROPRIATE CHECKLIST ITEM PRIORITY							1	1					2
57	AIRCRAFT EQUIPMENT - DESIGN SHORTCOMINGS	1		1			1		1	1		1		6
100	REGULATORS - INSUFFICIENT AIR CARRIER OVERSIGHT .	1				1		1			1			4
101	AIRLINE OPERATIONS - FAILURE TO MAINTAIN AIRCRAFT SYSTEMS	1						1						2
102	FLIGHT CREW - INADEQUATE PLANNING/BRIEFING	1												1
103	AIR TRAFFIC SYSTEM - INADEQUATE WEATHER INFORMATION PROVIDED TO THE FLIGHT CREW	1		1										2

104	AIRLINE OPERATIONS/ REGULATORS - LACK OF PROCEDURES AND REGULATIONS TO IDENTIFY FLIGHT CREW WITH DEMONSTRATED WEAKNESSES			1							1	1		3
105	AIRLINE OPERATIONS - PAIRING INEXPERIENCED PILOTS										1	1		2
106	FLIGHT CREW - FAILURE TO RECOGNIZE THE STATE OF THE AIRPLANE													0
107	FLIGHT CREW - FAILURE TO USE ALL AVAILABLE INFORMATION RESOURCES							1					1	2
201	(Deleted or combined with another problem statement) (see 5)													0
202	(Deleted or combined with another problem statement) (see 38)													
203	(Deleted or combined with another problem statement) (see 24)													
204	FLIGHT CREW - NOT ADEQUATELY PREPARED FOR	1		1									1	3

	THE TASK													
205	(Deleted or combined with another problem statement) (see 22)													
206	FLIGHT CREW - FAILURE TO RESPOND TO OR PROCESS FLIGHT DECK WARNING			1										1
207	FLIGHT CREW - FAILURE TO USE THE APPROPRIATE LEVEL OF AUTOMATION			1	1									2
208	AIRCRAFT EQUIPMENT - FLIGHT DECK WARNINGS OVERLOAD CREW			1										1
301	AIRLINE OPERATIONS/ MANUFACTURERS - PROCEDURES NOT RECONCILED						1	1						2
302	(Deleted or combined with another problem statement) (see 48)													
303	FLIGHT CREW - FAILURE TO PROCESS AND INTERPRET AVAILABLE RELEVANT DATA						1							1

304	AIRPORT AUTHORITY - FAILURE TO ENSURE RUNWAY CLEARWAY IS FREE OF HAZARDS						1							1
305	AIRLINE OPERATIONS - LACK OF A PROACTIVE SAFETY CULTURE/PROGRAM	1			1	1		1			1			5
306	(Deleted or combined with another problem statement) (see 100)													
307	REGULATORS - FAILURE TO ENFORCE "ONE LEVEL OF SAFETY"					1					1			2
308	AIRLINE OPERATIONS - SEVERE CORPORATE PRESSURE TO ACCOMPLISH MISSION					1								1
309	AIRLINE OPERATIONS - INADEQUATE "SPECIAL QUALIFICATION AIRPORT" TRAINING					1								1

APPENDIX I

OTHER STUDIES AND DATA BASES: ALAR; FOQA; AND ASRS

COMPARISON OF PROBLEMS AND INTERVENTIONS FROM ALAR & JSAT

The JSAT methodology analyzes a limited number of accidents in great depth in order to document and gain a rich understanding of complex causal chains that cannot be obtained when working with automated data bases and discrete data fields. However, to achieve this rich understanding, the methodology sacrifices the statistical significance that can be gained from analyzing a much more broadly based but somewhat static data set. Conscious of this tradeoff, CAST directed the JSAT to compared its work to the conclusions and supporting data in the "Approach and Landing Accident Reduction Report" (ALAR), a 1998 study managed by the Flight Safety Foundation. The ALAR Task Force worked three years and involved 125 aviation safety professionals from around the globe.

The ALAR study was based on a high-level data analysis of 287 fatal accidents and an event sequence analyses of 76 accidents and incidents. Some of the 76 accidents and incidents were taken from the 287-accident-sample. The ALAR team also used data from a Flight Safety Foundation study of controlled flight into terrain, a FSF/Dutch NLR study of 156 CFIT accidents, an NLR study of factors influencing airport safety, and 3300 line audits for validation by non-accident data. CFIT, landing overruns, loss of control, runway incursions and non-stabilized approaches accounted for 76 percent of all the occurrences in a study of 76 approach and landing accidents by FSF ALAR.

The FSF found that the highest risks are associated with flight in poor visibility, landing on contaminated runways with adverse winds, freight or ferry flights, non-precision approaches and failure to equip an aircraft with terrain awareness tools such as EGPWS or a radio altimeter. Most

frequently identified causal factors were flight crew decision-making, failure to follow SOPs, failure in CRM and a lack of positional awareness. The FSF also found that human error is the prominent factor in all accidents with most errors attributed to the crews. Airline management failure was indicated in a large number of cases where poor SOPs, poor safety culture, lack of training and poor oversight were identified. The findings and data from all these studies were highly correlated. This resulted in eight primary conclusions that defined the most significant safety problems.

The purpose of the comparison was to identify the degree to which the problems identified by the JSAT and the proposed interventions were consistent with, or different from, a more traditional methodology that used a large data set. Any two studies based on very different methodologies could be expected to produce somewhat different outcomes, but extreme differences between JSAT and ALAR would suggest that one or both studies had failed to address an adequate range of issues. Conversely, a complete absence of differences between the two studies would indicate that the JSAT added almost no value, except perhaps to confirm the ALAR findings. However, moderate differences between the two reports could identify issues addressed by ALAR that the JSAT team might choose to incorporate in its work. Moderate differences also could identify issues that the JSAT methodology addressed but which could not be addressed in a more traditional methodology.

A team of four JSAT members conducted the comparison, including one member who also had been part of the ALAR study. To make the comparison manageable, the team first edited the JSAT problem statements and interventions to consolidate those that were very similar. The team then identified all statements from the ALAR report that, in the JSAT terminology, would qualify as "interventions." Those interventions were categorized by broad subject areas, then were edited to eliminate duplications or to combine those that spoke to the same issue and had only minor differences. The result was a

list of 62 JSAT problem statements, 135 JSAT interventions and 84 ALAR interventions.

Findings: Problem Statements.

Table 1 shows 17 causal factors and 13 circumstantial factors that data from the ALAR report identified as occurring most often in approach and landing accidents around the world, including CFIT accidents. That data was based on official accident data, as recorded and presented in discrete fields by national authorities. Table 2 lists 62 problem statements addressed by the JSAT.

The team first estimated the frequency with which the JSAT problem statements applied to approach and landing accidents in general. Of the 62 JSAT problem statements, ALAR data shows that 12 are cited by national authorities as causal or circumstantial factors in 63 to 76 percent of all approach and landing accidents. Of those top 12 problems, 8 directly address flight crew failures and flight crew performance. The other four problems address factors external to the cockpit that can lead to deficiencies in flight crew performance or which may tolerate deficiencies that are known to exist.

The eight JSAT problems that are cited by ALAR in 63 to 76 percent of all approach and landing accidents are:

flight crew - failure to recognize and correct unstable approach;
flight crew - failure to use all available information resources;
flight crew - failure to respond to or process flight deck warning;
flight crew - failure to follow standard operating procedures;
flight crew - failure to follow standard procedure in communications;
flight crew - failure to prioritize tasks appropriately under time constraints;
flight crew - failure to perform pilot-not-flying duties; and
flight crew - failure in CRM.

The remaining four of the top 12 JSAT problems, according to ALAR data, address operators/airlines and weather information from ATS, where problems

can influence crew performance. Those problems also occur in 63 to 76 percent of all approach and landing accidents. they are:

airlines - pf/pnf flying procedures increase workload at a critical phase;

air traffic services - inadequate weather information provided to the flight crew;

airlines - ineffective correction of procedural non-compliance; and

airlines and regulators -- lack of procedures and regulations to identify flight crew embers with demonstrated weaknesses.

ALAR data shows that an additional 27 problems addressed by the JSAT appear in 30 percent to 50 percent of all landing and approach accidents around the world. Of those 27 problem statements, the ALAR data identify several variations on the themes of situational awareness by flight crews, basic flying skills, and flight crews' failure to use, understand or respond to information or risk factors. Other flight crew issues in this 30- to 50-percent range involve interaction with ATC: inadequate crew-ATC communications; and failure to act or inappropriate actions that increase workload. This 30- to 50-percent range also includes issues related to corporate and system safety cultures:

airlines - ineffective/ inappropriate disciplinary policies;

airlines - failure to comply with existing regulations;

airlines - systemic complacency and non-standard conduct;

airlines - corporate "on-time" culture;

airlines - severe corporate pressure to accomplish mission;

airlines - lack of a proactive safety culture/program;

airlines - no-fault go-around policy;

airlines - burdened flight crew with non-flight related tasks;

airlines - inadequate information dissemination;

airlines - lack of standardized procedures;

airlines - lack of stabilized approach criteria, mandatory go-around policy;

airlines - lack of flight crew training;

airlines - inadequate training of flight crews operating into special qualification airports;

airlines - procedures that are not reconciled with the aircraft operating manual;
inappropriate priority of items on operators' and manufacturers' checklists;
insufficient oversight of air carriers by regulators; and
regulators' failure to apply one level of safety to all classes of air carriers.

The JSAT addressed several problems that the ALAR data identified as affecting only 12 percent to 25 percent of all approach and landing accidents. However, these relatively low ALAR ratings may reflect the limitations of an automated data base with discrete fields, as issues simply may not fit the identified fields, or they may be present in an accident but not identified at the time of data entry. The handful of JSAT problem statements that fall into this category address the following areas:

flight crew – failure to use the appropriate level of automation;
flight crew – not adequately prepared for the task;
airlines – failure to maintain aircraft systems;
airlines – inappropriate crew pairing;
manufacturers – flight deck warnings overloading crews; and
air traffic systems – inadequate dissemination of information.
.

Fifteen of the 62 JSAT problems were not addressed in the ALAR data. Again, the absence of these problems in the ALAR report most likely reflects differences in methodology. The 15 problems include aircraft equipment failures, maintenance, and design shortcomings, such as a need for more error-tolerant designs and displays that are easier to interpret.

Other problems not addressed in the ALAR report reflect a slight difference in the range of topics addressed by the respective methodologies, as the JSAT addressed air traffic service (ATS) providers and the role of airport authorities more directly than did the ALAR report. For example, the JSAT addressed five issues that apply to ATS providers:

ATS - failure to follow standard operating procedures;
ATS - failure to use standard communication phraseology;

ATS - lack of standardized approach and departure plates;
ATS - inadequate supervision of trainee controllers; and
ATS - practices that compromise safety (clearances that preclude a stabilized approach).

The remaining problems not directly addressed by ALAR apply to flight crew performance, including one item that addresses both flight crews and their operators:

flight crew – home aerodrome complacency;
flight crew – failure to process and interpret available relevant data ;
flight crew – inadequate planning/briefing;
flight crew – failure to exercise command (captain) responsibility; and
flight crew and airlines – aeromedical, crew medical/fatigue concerns.

ALAR Interventions Not Significantly Addressed by JSAT.

A comparison of JSAT and ALAR interventions produces results similar to those from comparing the problems addressed in each report. Table 3 offers a list of statements in the ALAR report that correspond to "interventions" in the JSAT report.

A comparison based on a simple count shows about two-thirds of the proposed interventions from each report correlate closely. Most differences were related to interventions that had relatively low priority in the study that addressed them, or were stated in detailed terms to address a specific problem, and, therefore, do not match well with interventions from the other report. For example, the JSAT recommended that pilots, regulators, manufacturers, operators, meteorological agencies and ATS providers use four digits to express altimeter settings. This recommendation would help to alleviate the broad problems of position awareness and standard communications, which both reports addressed. However, due largely to the specific nature of the recommendation, no comparable intervention could be identified in the FSF ALAR report.

As with the problem statements, JSAT interventions that addressed aircraft equipment, ATS performance and ATS procedures constituted the largest group of JSAT interventions not addressed in the ALAR report. The issue of equipment failures and related maintenance may illustrate the benefits of the JSAT methodology. Maintenance is only infrequently cited by national authorities as a cause or factor in all types of accidents, including approach and landing accidents. However, the role of proper maintenance often is subtle but real. For example, relatively minor deficiencies may be deferred and lead to problems that can distract a flight crew during a complex phase of flight. The JSAT team identified equipment/maintenance as a problem or intervention in five of the 12 accidents. Similarly, the JSAT included several recommendations that addressed the need to develop aircraft systems and equipment that is more error-tolerant, such as ground-sensing and speed brake deployment.

The JSAT also placed more emphasis on the role of ATS in safe approach and landing operations. For example, the JSAT included several recommendations on standard ATC communications procedures and for specific types of navaids where precision approaches are unavailable. These issues were seldom identified by national authorities as having "caused" accidents, but the JSAT often found ATS issues constituted missed opportunities to break the causal chain in an accident. Again, this illustrates the benefits of the JSAT methodology and its capacity to understand how complex causal chains line up before resulting in an accident. The JSAT also recommended new training for air traffic controllers to educate controllers on the following topics :

capabilities of selected aircraft;
the relative importance of stabilized approaches;
vectoring techniques over high terrain (complete with GPWS logic); and
how some common ATC practices ensure unstabilized approaches (such as "maintain 220 to the outer marker).

Conclusion: The problems addressed and interventions proposed by the JSAT correlated strongly to those in the FSF ALAR. Nevertheless, some differences were identified. Generally, the JSAT placed more emphasis on the roles of equipment and air traffic services in safe approach and landing operations and relied somewhat more on engineering interventions than did the ALAR. In contrast, ALAR relied a bit more on non-engineering interventions, though each report addressed both broad types of approaches at some length.

TABLE 1: Summary of
ALAR Causal and Circumstantial Factors

Causal Factors	Percent Of Accidents
Judgement/ Airmanship	74%
Press-on Itis	42%
SOP	72%
CRM (Cross Check/ Coordinate	63%
Incorrect/ Inadequate ATC instructions	33%
Lack of Qualification (Pilot Training)	22%
Disorientation/ Illusions	21%
Automation Interaction	20%

Circumstantial Factors	Percent Of Accidents
Poor Visibility	59%
Contaminated Runway	18%
CRM (Cross Check/ Coordinate	58%
Incorrect/ Inadequate Crew Procedures	47%
Company Management Failure	46%
Inadequate/ Inappropriate (Pilot Training)	37%
Inadequate Regulation	30%
Lack of/ Inadequate ATC & Equipment	21%

TABLE 2: SUMMARY OF 62 JSAT PROBLEMS

AIR TRAFFIC SYSTEM - INADEQUATE WEATHER INFORMATION PROVIDED TO THE FLIGHT CREW
AIRLINES - INEFFECTIVE CORRECTION OF PROCEDURAL NON-COMPLIANCE
FLIGHT CREW -FAILURE TO RECOGNIZE AND CORRECT UNSTABLE APPROACH
FLIGHT CREW - FAILURE TO USE ALL AVAILABLE INFORMATION RESOURCES
FLIGHT CREW - FAILURE TO RESPOND TO OR PROCESS FLIGHT DECK WARNING
FLIGHT CREW INAPPROPRIATE TASK PRIORITIZATION UNDER TIME CONSTRAINTS
FLIGHTCREW - FAILURE TO FOLLOW PROCEDURES (SOP)
FLIGHTCREW - CRM FAILURE
AIRLINES - PF/PNF FLYING PROCEDURES (INCREASED WORKLOAD AT A CRITICAL PHASE)
FLIGHTCREW - FAILURE TO FOLLOW PROCEDURES (COMMUNICATIONS)
AIRLINES/ REGULATORS - LACK OF PROCEDURES AND REGULATIONS TO IDENTIFY FLIGHT CREW WITH DEMONSTRATED WEAKNESSES
FLIGHTCREW - PNF DUTIES NOT PERFORMED
FLIGHTCREW - INADEQUATE SITUATION AWARENESS (HORIZONTAL)
FLIGHTCREW - INADEQUATE SITUATION AWARENESS (VERTICAL)
FLIGHT CREW- FAILURE TO UNDERSTAND THE IMPLICATIONS OF INOPERATIVE OR DEGRADED SYSTEMS
FLIGHT CREW - FAILURE TO ADDRESS COMBINED HAZARDS ASSOCIATED WITH THE SITUATION
FLIGHT CREW - FAILURE TO MAINTAIN AIRCRAFT SYSTEMS STATUS AWARENESS
FLIGHT CREW - FAILURE TO USE AVAILABLE APPROACH AIDS
AIRLINES - INEFFECTIVE/ INAPPROPRIATE DISCIPLINARY POLICIES
AIRLINES - FAILURE TO COMPLY WITH EXISTING REGULATIONS
AIRLINES – SYSTEMIC COMPLACENCY AND NON-STANDARD CONDUCT
AIRLINES - CORPORATE "ON-TIME" CULTURE
AIRLINES - SEVERE CORPORATE PRESSURE TO ACCOMPLISH MISSION

AIRLINES - LACK OF A PROACTIVE SAFETY CULTURE/PROGRAM
AIRLINES - NO-FAULT GO-AROUND POLICY
AIRLINES - BURDENED FLIGHT CREW WITH NON-FLIGHT RELATED TASKS
AIRLINES - INADEQUATE INFORMATION DISSEMINATION
AIRLINES - LACK OF STANDARDIZED PROCEDURES
AIRLINES - LACK OF STABILIZED APPROACH CRITERIA, MANDATORY GO-AROUND POLICY
REGULATORS - INSUFFICIENT AIR CARRIER OVERSIGHT
AIRLINES/ MANUFACTURERS - PROCEDURES NOT RECONCILED
MANUFACTURERS/ AIRLINES- INAPPROPRIATE CHECKLIST ITEM PRIORITY
FLIGHTCREW - "PRESS-ON-ITUS"
FLIGHTCREW - LACK OF BASIC PILOTING SKILLS OR KNOWLEDGE
AIRLINES - INADEQUATE "SPECIAL QUALIFICATION AIRPORT" TRAINING
ATC / FLIGHTCREW INADEQUATE COMMUNICATIONS
ATC/FLIGHTCREW - ACTIONS /INACTION'S CONTRIBUTED TO INCREASED WORKLOAD
AIRLINES - LACK OF TRAINING (FLIGHTCREW)
REGULATORS - FAILURE TO ENFORCE "ONE LEVEL OF SAFETY"
AIRLINES - FAILURE TO MAINTAIN AIRCRAFT SYSTEMS
AIRLINES - PAIRING INEXPERIENCED PILOTS
REGULATORS - INEFFECTIVE OVERSIGHT OF KNOWN PROCEDURAL NON-COMPLIANCE
FLIGHT CREW - NOT ADEQUATELY PREPARED FOR THE TASK
AIRCRAFT EQUIPMENT -FLIGHT DECK WARNINGS OVERLOAD CREW
FLIGHT CREW - FAILURE TO USE THE APPROPRIATE LEVEL OF AUTOMATION
AIR TRAFFIC SYSTEM - INADEQUATE INFORMATION DISSEMINATION
FLIGHTCREW - DISREGARD FLIGHTDECK WARNING
AIRCRAFT EQUIPMENT - EQUIPMENT FAILURE
AIRCRAFT EQUIPMENT - DESIGN SHORTCOMINGS
AIRPORTS - FAILURE TO ENSURE RUNWAY CLEARWAY IS FREE OF HAZARDS

AIR TRAFFIC SYSTEM - LACK OF STANDARDIZED APPROACH/DEPARTURE PLATES
ATC - FAILURE TO FOLLOW PROCEDURES (SOP)
ATC - FAILURE TO FOLLOW PROCEDURES (COMMUNICATIONS)
AIR TRAFFIC SYSTEM- PROCEDURES THAT COMPROMISE SAFETY
AIR TRAFFIC SYSTEM - INADEQUATE TRAINING/ SUPERVISION
FLIGHT CREW - HOME AERODROME COMPLACENCY
FLIGHT CREW - FAILURE TO PROCESS AND INTERPRET AVAILABLE RELEVANT DATA
FLIGHT CREW - INADEQUATE PLANNING/BRIEFING
AIRCRAFT EQUIPMENT - DESIGN NOT ERROR TOLERANT
FLIGHTCREW/ AIRLINES – AEROMEDICAL, CREW MEDICAL / FATIGUE CONCERNS
AIRLINES - INADEQUATE SAFETY DATA SHARING
FLIGHTCREW - FAILURE TO EXERCISE COMMAND (CAPTAIN) RESPONSIBILITY

TABLE 3: SUMMARY OF ALAR INTERVENTIONS

ATS providers should emphasize in ATC training the controllers' potential in assisting the flight crew in improving their situation awareness.
Airlines/operators should ensure that their training/standardization programs instruct when to disengage automated systems and fly manually.
Airlines/operators should implement a procedure to climb to a minimum safe altitude when position uncertainty exists by at least one crew member. Flight crew must advise ATC of intentions.
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 are reviewed during recurrent training.
Establish/enhance quality assurance checks/training to ensure that timely and accurate communication between controllers and flight crews is occurring.
Airlines/operators should adopt the "delegated" approach to SOPs, e.g., monitored approach procedures.
Manufacturers should install TAWS (EGPWS) in all new aircraft, airlines/operators should retrofit TAWS into the existing fleet and international regulators should require the installation of TAWS.
English language--pilots.
English language--controllers.
Airlines/operators and ATS providers should implement a monitoring program to ensure the consistent use of the ICAO phraseology.
Manufacturers should ensure that all impending 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.
Implement precision approach capability (glideslope guidance) for all runways without established precision approach procedures (e.g. ILS, DGPS, etc.).
Avionics manufacturers should improve GPWS capability to reduce GPWS nuisance warnings.
Airlines/operators should ensure that their training/standardization programs direct the flight crews to regularly cross check all instrumentation.
ATS providers should install MSAW-like capabilities world-wide with emphasis on high-risk airports.
Airlines/operators should ensure that their training/standardization programs direct that flight crews use all available tools to establish aircraft position.
Airlines/operators should ensure, and regulators should check, that operators who create their own AOM's include all procedures prescribed by original equipment manufacturers Airplane Flight Manual (AFM).
The aviation industry should develop and implement synthetic vision capability (e.g. Precision Approach Terrain Information (PATI)).
Airlines/operators should train and monitor flight crew compliance with established communication phraseology guidelines.
Airlines/operators and regulators should ensure that the frequency and effectiveness of proficiency checks for non-precision approaches are adequate.

Airlines/operators should ensure that their training/standardization programs emphasize the importance of adequate approach preparation and contingency review prior to commencing an approach.
Airlines/operators should ensure that clear, concise, accurate, appropriate SOPs are published and enforced.
Airlines/operators should ensure that their training/standardization programs emphasize the importance of adhering to MDA/DH.
Airlines/operators should train flight crews on how flight delays upon departure or enroute (weather, maintenance, ATC, etc.) can affect their subsequent decision making relative to the safe conduct of the flight.
ATS providers should train and monitor ATC adherence to established communications procedures including hearback problems.
ATS providers should implement and/or review procedures to ensure ATC training does not create a hazard to flight operations.
Airlines/operators and regulators should ensure that their training/standardization and monitoring programs emphasize the importance of adherence to SOPs and identify the rationale behind those procedures.
Airlines/operators should ensure that their training/standardization programs emphasize basic airmanship skills and knowledge during initial and recurrent training.
Airlines/operators and regulators should ensure that the frequency and effectiveness of proficiency checks for simulated instrument failures (partial panel) are adequate.
Airlines/operators should ensure their training/standardization programs emphasize the importance of adequate preflight planning.
ATS providers should implement transmission of ATC instructions/information (between the ground and aircraft) via a computer link as opposed to voice communications.
Airlines/operators should implement a true no fault go around policy (learning vs. blame).
ATS providers should implement a Quality Assurance program to ensure adherence to established procedures.
Airlines/operators should encourage flight crews to use precision approaches (glideslope guidance) if available & appropriate.
ATS providers should prioritize the use of precision approaches (glideslope guidance) when available and appropriate.
Airlines/operators and regulators should implement a no blame safety reporting and data sharing system with appropriate protections from litigation and prosecution concerns.
Airlines/operators and regulators should ensure check list designs prioritize critical items as recommended by NASA study, and that items are arranged in a manner to enhance checklist implementation.
Airlines/operators and regulators should ensure checklist design and implementation of procedures to promote effective crew coordination and distribution of PF and PNF tasks.
Airlines/operators should ensure that their training/standardization programs emphasize the importance of the sterile cockpit environment.

Manufacturers should ensure cockpit design that does not interfere with or distract the flight crew from executing their duties (e.g. rain in the cockpit, location of switches in cockpits).
Airlines/operators and regulators should require training/standardization programs include training regarding physiological effects on aircrew performance, (e.g. low blood sugar).
Airlines/operators should establish policies, parameters, and training to recognize unstabilized approaches and other factors and implement a go-around gate system.
Airlines/operators and regulators should ensure that their training/standardization programs clarify the differences between vertical and slant range visibility
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).
Regulators or other governing authorities should establish policies that ensure that surrounding lights are distinguishable from airport lighting in order to avoid confusion (safety process, policy).
Airlines/operators should improve/increase training to increase awareness of icing effects on airplane type including dynamic simulator training.
Airlines/operators, regulators, ATS providers should establish policies or programs to address rushed approaches, including elimination of rushed approaches, recognition and rejection of rushed approaches and training for those encountered.
Develop technology to provide real time assistance to flight crews with onboard system failures and diagnostics (e.g. data link transmittal to ground support).
Manufacturers should incorporate an "input rudder" indicator or automatic yaw compensation to ensure that adequate yaw control is provided.
Airline/operators should include in their training programs the awareness of potential safety risks due to the complacency when operating at a very familiar airport (e.g. home base).
Airlines/operators should ensure that their training/standardization programs address common misperceptions that could lead to unsafe practices (i.e. ATC always wants high-energy approaches).
Airlines/operators should develop procedures to specify how transfer of control is formally accomplished.
Airlines/operators should retrofit equipment to provide automatic altitude callouts on final approach. If unable, other altitude alerting or reminder systems (such as altimeter bugs) should be installed.
Airlines/operators and regulators should provide additional inspectors/inspection of sub-contract activity.
Regulators should enforce timely incorporation of appropriate manufacturers recommendations.
Regulators should require PMI's to have expertise in the assigned carrier’s equipment.
Airlines/operators should ensure that all AIRLINES include compliance with all/seasonal guidance from the OEM.
Airlines/operators and regulators should ensure necessary manuals (operational & maintenance) are complete, accurate, available and appropriately used.
Airlines/operators should ensure that their training/standardization program emphasizes the benefits of inter-crew/company communications.

Regulators should require airlines/operators to modify their training to maximize benefits of inter-crew/company communications.
Regulators should require and airlines/operators should promptly close out all regulatory safety audit findings.
Airlines/operators should ensure all nose gear struts are serviced for cold weather operation are in accordance with OEM recommendations.
Regulators should require operators to incorporate OEM strut servicing recommendations in mandatory maintenance procedure and monitor compliance.
Manufacturers should provide a more positive means of external strut pre-flight inspections.
Airlines/operators should develop/publish appropriate procedures for radio communications restoration.
To preclude conducting flight training during operational flights, when a need for training is identified, operators should conduct training in accordance with their approved training program.
To reduce the possibility of error, confusion and workload increase related to ATC clearances, regulators should require and operators ensure that flight crews utilize proper phraseology and readbacks.
To prevent excessive fatigue, airlines/operators should consider circadian rhythm in crew scheduling to compensate for the effects of rhythm interruptions.
To prevent alerting overload, flight deck designs should consider smart alerting systems such as those with prioritization schemes or cancelable nuisance alerts.
To recover aircraft in unusual attitude, manufacturers should develop systems to return aircraft to normal attitude with one pilot button push (pilot initiated auto-recovery systems).
To reduce pilot overload, airlines/operators policies should stress using the appropriate level of automation.
To ensure timely dissemination of navaid anomalies, airlines/operators and ATC should re-emphasize the requirement that flight crews report and ATC disseminate any navigation anomalies.
To ensure adequate testing of equipment, manufacturers' testing should be conducted under worst case scenarios taking into account new technologies and testing under simulated flight realistic conditions.
To ensure the accuracy and safety of computer modeling used for design and failure analysis, the modeling must be adequately re-validated on a continuing basis to account for new technology.
To ensure test components are representative of the final product, manufacturers should test the final component and regulators should require this type testing.
To preserve the original intended level of airworthiness, there should be a better definition and classification of subsequent in-service major and minor critical component changes. The definition of critical component should be more specific.
To prevent loss of control in flight, all changes to flight critical components, such as primary propeller pitch controller components, should be considered major changes.
To prevent loss of control, there should be redundancy and failure tolerance features for all flight critical components, such as dual path design, fail operational redundant systems, with fault annunciation.
To avoid the isolated incident syndrome and to ensure on-going assessment of flight critical control system reliability, a focused safety or risk assessment of all in-service failures or problems should be conducted to determine the need for immediate rest.

To prevent catastrophic failures, the manufacturers should issue immediate telegraphic information to all operators, and regulators should require an immediate mandatory action (AD), following the initial failure report of any critical component malfunction.
To prevent loss of aircraft control in-flight, all propeller pitch control systems must be designed to positively feather in the event of pitch control loss. Propeller pitch control system malfunctions must be positively annunciated to the flight crew.
To facilitate FAA awareness of safety related problems, improve the dissemination of FAA hotline numbers.
Regulators should set engineering standards requiring propeller manufacturers to provide positive prevention designs, to eliminate all flight critical failure modes (eg. flat pitch).
To improve passenger and flightcrew survivability, regulators should require and operators should implement existing knowledge of crash survivability.
To enhance flight crew performance in low visibility operations, the aviation industry should continue to develop and implement HUD capability.
To mitigate confusion regarding ATC clearances, operators should develop procedures to ensure flight crews query ATC whenever uncertainty exists.
Airlines/operators will adopt, implement and train a risk assessment tool to enhance flight crew awareness of hazards associated with all approaches and airports.
Manufacturers should improve the design for an error tolerant ground spoiler deployment system.
Regulators should require airlines/operators to outfit aircraft with electronic checklists. If unable to install electronic checklists, use mechanical checklists or, at a minimum, develop a process to reinforce challenge and response checklists.
Regulators should require manufacturers to equip all new aircraft with electronic checklists.
Airlines/operators should require flight crews to fly instrument approach procedures during periods of reduced visibility and night operations.
Regulators will not allow noise abatement procedures that reduce the level of safety that existed prior to their implementation.
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 attached LOFT scenarios).
Regulators should update flight time/duty time regulations to counteract present commercial aviation environmental stressors. (e.g. crew rest requirements).
Regulators should ensure one level of safety exists for all commercial transport operations (whether passenger or freighter operations).
Regulators should require a Special Airport Briefing guide be incorporated with approach charts. (Subject matter must include aircraft specific local operational procedures).
ATS providers should institute an ATC "Crew Resource Management Program" similar to those required of flight crews. (FAA AC 120-51b)
Regulators and Military agencies should ensure procedures are in place to share information pertaining to operations at Joint Use and Special Use Airports.

Airlines/operators should develop and implement a ground school and simulator training program similar to the American Airlines Advanced Aircraft Maneuvering Program.
ATS should ensure proper/close supervision of controllers undergoing training so that all outages, construction, airport hazards, etc. are reported to flight crews in a timely and accurate manner.
Airline/operators should emphasize during initial and recurrent training the importance of maintaining systems status awareness during non-normal events and hazardous approaches (goal to avoid tunnel vision/narrowed attention).
Air Traffic service runway selection policies should be based on the most current wind available.
Airlines/operators should incorporate in initial and recurrent training ways to recognize multiple cues that will require go-around. Including CFIT training aid 2.1.9, FSF definition of stabilized approach, risk assessment tool, and windshear training aid.
Airlines/operators and manufacturers should train crews to understand the capabilities and limitations of systems, conditions which would cause systems to not function as the crew anticipates, and how to detect those conditions (e.g. lack of brakes, spoil deployment, etc.).
Manufacturers should design ground sensing systems that are tolerant to adverse conditions without degrading inflight safety features (e.g. which prevent deployment of ground spoilers and reverse in-flight).
Airlines/operators should establish a process (which includes an interdisciplinary team) to document and investigate high risk behavior and poor judgement triggered by on-the-job performance.
Regulators should require captains and first officers each have identical approach charts for reference.
Airlines/operators should implement procedures to ensure flight crews are aware of appropriate Airworthiness Directives, Certification and flight testing standards.
Airlines/operators should install radio altimeters in all aircraft and develop procedures for their use on approach as recommended by FSF ALAR.
Ensure regulators have adequate funding, training and processes to accomplish their oversight responsibilities.
Airlines/operators should ensure better educated regulators by providing intern programs.
Parent code share airlines/operators should adopt a program to ensure the same level of safety in code share partners including, but not limited, to recruitment, training, operations and maintenance.

Airlines/operators should ensure training for instructors and check airmen include objective criteria to be used in evaluating crew CRM performance.
Airlines/operators should ensure that adequate approach briefings are conducted that include descriptions of normal approach, non-normal conditions and the results of the risk assessment tool analysis.
Airlines/operators should equip aircraft with autopilots to reduce crew workload during critical phases of flight.
Airlines/operators should establish and enforce a clear MEL policy to aid flight crews in making maintenance related decisions.
Organizations responsible for developing approach/arrival/departure procedures should not report to the organization responsible for Air Traffic service (e.g. In the FAA AVN-100 reports to AAT).
Non-precision approaches should be conducted as constant angle, stabilized approaches.
Ensure transmission of most current airport and weather information, either by real-time digital transmission or, where that is not feasible, by voice communication and updates.*
Airlines/operators should encourage a culture that emphasizes safe arrivals over timely arrivals. This, in turn, requires that regulators discontinue tracking on-time arrivals.*
Airlines/operators and regulatory agencies must encourage a culture that enhances safety in daily operations, including a self-audit process (such as FSF ICARUS recommendation), operational risk management programs and accident cost analysis to proactively identify and correct/accept safety concerns, and encouraging flight crews to voluntary remove themselves from flight status due to illness and/or emotional distress (with the use of a self assessment tool).*
Airlines/operators should establish and train to the principal that all flight-related briefings are essential to safe flight and that the approach should not be initiated until briefing is completed for the expected runway.*
Regulators should establish policies that require additional monitoring of flight crew members that have repeatedly failed check rides and those who meet minimum qualifications but have demonstrated specific weaknesses.*
Regulators should update flight time/duty time regulations to account for realistic off-duty rest scenarios and adequate facilities for rest periods between flights and in-flight.*
Airlines/operators and regulators should establish appropriate operational restrictions when equipment is inoperative (MEL), including limitations on flights crews and dispatch.*
Ensure that flight crews are adequately trained in a level D simulator for dynamic characteristics before assignment to the line, including 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. *
Regulators should develop adequate oversight, including QA programs, to ensure compliance with regulations.*
Airlines/operators (and manufacturers in the airplane flight manual) should implement procedures that call for an immediate execution of a recovery or escape maneuver following a GPWS or other flight-control warning unless there is visual confirmation of terrain.*
Regulators should ensure company training programs, including those delivered by contractors, are in accordance with approved training program.*

Regulators should ensure that all POIs are current and qualified in one model of the company's equipment and that POIs have all other qualifications and training necessary to approve company operational procedures.*

Use of Flight Operational Quality Assurance (FOQA) Data

Flight Operational Quality Assurance (FOQA) data is electronically recorded during flight and, depending upon the sophistication of the recording equipment and sensors, can measure hundreds of flight parameters several times per second, including air speed, altitude, pitch, application of power, flight control inputs, etc. The CAST directed the Approach and Landing JSAT to examine FOQA data to determine whether it could contribute to the analysis and understanding of approach and landing events.

In December 1998, FOQA experts from the airline industry and NASA briefed the JSAT on the acquisition and organization of FOQA data, how airlines currently use that data, and the types of questions that FOQA data could answer. The JSAT then formulated a limited set of questions (see below) to determine the frequency of certain conditions that the team's analysis and problem statements had identified as common precursors to approach and landing accidents.

Responses to the Team's questions were mixed. FOQA data could not answer some questions because they were not posed in a manner that fit recorded parameters. In some other cases, FOQA Flight Operating Analysis software required modifications to answer the questions as posed, but not enough time was available to make the necessary modifications.

The most useful results addressed rushed or unstable approaches. Though FOQA data cannot record a "rushed approach" as a discrete data field, FOQA can identify several factors that define unstable approaches. For example, one set of FOQA data showed that a surprisingly high 11% of all approaches are unstable in airspeed or sink rates at 500 feet, but just 0.5% of those unstable approaches resulted in go-arounds.

However, the JSAT recognized that more parameters were needed to define unstable approaches, such as position on the glide slope or glide path, the position of various aircraft controls, and the state of those parameters at 250 feet. Similarly, the fact that 11% of approaches may be considered unstable, while only 0.5% of those fast approaches leads to a go-around may indicate several problem areas. For example, the data suggest that the air traffic control system often encourages speeds higher than operationally prudent (with directions such as "maintain 210 to the marker"). However, the data might also indicate that pilots at 500 feet are comfortable with speeds higher than prescribed.

The FOQA analysis effort provided some valuable lessons for future JSATs. First, if FOQA data is to support the JSAT's analysis, FOQA questions must be posed relatively early in the process. Second, questions must be carefully framed to address all parameters that define the issue that the JSAT is trying to understand. Furthermore, the JSAT must use parameters that are either currently recorded or are easily traced in existing FOQA programs.

FOQA Questions

1. Can you give us an example of a problem discovered through FOQA data, in which an intervention was subsequently introduced, and then the success of that intervention was measured through FOQA data?

2. Based on the FOQA data you have collected and analyzed to date, what interventions would you recommend be put in place to prevent approach and landing accidents

3. Given the ALAR definition of a stabilized approach, can you determine the frequency of unstabilized approaches (i.e. percent of unstabilized approaches to norm)?

4. Can FOQA data provide the frequency of GPWS (pull up) activation and the percentage of times the crew responded to the activation?

5. Same as above, but for GPWS glide path activation.

6. What is the percentage of go-arounds during unstabilized approaches?

7. How often do pilots tune to the ILS approaches when one is available?

8. Is it possible to assess basic pilot skill by measuring flight attitude deviations during manual approaches? If so, what is the percentage of approaches that indicate lack of basic skills?

9. Can FOQA measure the Airline/Operators effectiveness of corrections of known procedure non-compliance?

10. Can FOQA identify pilots with a history of recurring deviations from standard operating procedures such as altitude deviations and unstable approaches with no go-around?

11. How frequently is the airplane flown in the wrong autopilot mode (i.e. VNAV/LNAV vs. coupled ILS, or VNAV on a nonprecision approach)?

12. What is the frequency of failure to use the prescribed level of automation in accordance with company policy?

13. If FOQA data can determine when a go-around or missed approach is warranted, can FOQA data tell us to what extent the go-around or missed approach is not executed?

14. Within 30 miles of a landing runway how often, in percentage, are flight crews descending below a prescribed altitude by more than 200 feet?

15. During approach, can FOQA data tell us if flight crews have lost situational awareness (crews are “behind the aircraft”), have omitted checklist items or failed to conduct a checklist, missed radio calls, or otherwise appear rushed?

16. To what extent are flight crews late to configure their airplane during the approach phase of flight?

17. In IMC, how many non-precision approaches are flown vs. precision approaches?

18. During approach, to what extent are pilots late in programming their FMS?

19. During the approach phase, to what extent do pilots mismanage their auto flight (pilot) system modes?

20. To what extent pilots have checklist errors during the approach phase?

21. During the approach phase, to what extent are altimeter settings miss set?

22. To what extent do pilots disregard GPWS warnings in the approach phase?

Comparing the JSAT results with the ASRS database

The JSAT charter specifically calls for the inclusion of incidents 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. To test this assumption and to follow the JSAT charter, the Team decided to compare its results with NASA's Aviation Safety Reporting System (ASRS) database.

Since its establishment in 1975, NASA's ASRS has been receiving incident reports from pilots, air traffic controllers, air carrier inspectors, cabin crews, maintenance personnel, military personnel, and other individuals concerned with aviation safety. The current monthly report intake average stands at more than 2,600, with a database total of well over 300,000 reports. This database has been an extremely valuable resource for safety recommendations and safety-related research. In spite of the data biases and limitations (such as the facts that the reports are subjective and retrospective), the Team felt these data could support its process and selected four major inquiries for the ASRS database:

- are the problems identified by the JSAT present in the ASRS data?
- what problems can be identified in the ASRS data that were not identified by the JSAT?
- how effective would the JSAT intervention strategies have been in preventing the events reported to ASRS?
- what intervention strategies were used by reporters that prevented the reported incidents from becoming accidents?

Unfortunately, it became clear that such an inquiry would require much more time than was available, as well as additional funding. These resources were necessary because reports submitted to ASRS do not necessarily use the same phraseology as used by the JSAT. Moreover, the terminology used by ASRS analysts to code the reports does not match well with the terminology used by

the Team in defining Standard Problem Statements or Standard Interventions. Thus, to provide informative responses to the JSAT inquiries, complete analyses of relevant reports was necessary. These relevant reports are easily retrievable using basic keywords and coded terms (such as aircraft weight and phase of flight). However, the level of detail required to support the JSAT analysis cannot be achieved by keyword search.

To enable future JSATs to take full advantage of the ASRS rich database, we recommend that ASRS be requested to screen all incoming reports according to a given set of criteria. That is, the JSAT organizers can set up in advance basic criteria (say, aircraft heavier than 12,500 lb., and anything having to do with loss of control, or almost loss of control), and ask that all incoming ASRS reports be screened. All arriving reports that meet the set criteria will be set aside for the JSAT to study. That will give the Team the most recent and most relevant reports. Following an initial analysis of a few reports, an extended set of criteria, and/or a set of questions to include in a structured interview with the reporter can be developed (Once a report is in the database, the reporter is no longer known and can not be interviewed. Therefore, it is critical that such a structured interview be done as soon as a report is received. To do that, ASRS analysts must be provided with key concepts to identify relevant reports and with specific questions to ask the person who submitted the report). This is the kind of data one can never get from an accident report, or from FOQA. This is also the kind of data that can truly support, extend and validate the JSAT process.

Appendix J

UNRATED INTERVENTIONS

The team found that the its rating system (based on power, confidence, and future global applicability) could not be easily used for certain types of interventions. Those interventions include: data collection, research, survivability, and some of the interventions related to safety culture. For example, research and data collection in and of themselves cannot prevent accidents. Instead, they produce knowledge that could lead to effective interventions. Therefore, these interventions were not rated.

For example, installing TAWS/EGPWS in all aircraft could clearly produce tangible, short-term benefits. Yet, in a number of accidents, GPWS was present and functioning, but flight crews ignored the GPWS warnings. This suggests that the full benefit from TAWS/EGPWS may not be realized without research designed to provide an understanding of why such warnings are ignored and how interventions could change that behavior. Consequently, the JSAT developed an intervention for research to understand the phenomena of procedural noncompliance. The results of such research should enable the industry to design better warning systems, but research without action does not produce tangible safety results. The unrated interventions appear at the end of Appendix C.

The unrated interventions that fall into the three broad categories: data collection, research, and safety culture are not always mutually exclusive. They may complement each other. These three categories, as well as a fourth category of survivability, are discussed briefly below.

Data Collection

The set of interventions which address data collection recognizes that many, if not all, causal and contributing factors identified in an accident may have occurred in earlier routine operations. Often, these factors are identified as "accidents waiting to happen" by the individuals noticing them, but all too often that knowledge remains with the individual.

The Team recognized the tremendous value of programs aimed at proactively soliciting, collecting and acting upon safety-related data (such as FOQA, ASRS, CHIRP, ASAP, and PRIORs), and developed recommendation 6 in further support of such programs.

Collecting safety and operationally related data is not enough. The data has to be processed so useful information can be provided to different participants in the air space system. Most, and often all, of the links in the chain of events of any accident represent known events, errors, and problems. When problems are reported and data are collected, proper action based on these data is often the best way to prevent future accidents.

Data collection and health monitoring are important first steps. Programs such as FOQA and ASAP, combined with self- and external-audits at different levels are all necessary to determine where possible safety breaches exist. Such breaches can be addressed in time only if data from routine operations and incidents are collected.

Collected data must be turned into information before it can be put to use. The data must be analyzed and understood before any recommendations can be made. Part of this process must include focused research to understand the underlying causes of the observed symptoms. For example, we know that some accidents could have been prevented had the people involved simply followed standard operating procedures (SOPs). However, adding another SOP stating

"thou shalt follow SOPs" will not help. We must first understand why people do not follow SOPs. That is the point of JSAT intervention strategy 208: “Research should be conducted to understand the phenomenon of flight crew overload, (e.g. why do flight crews ignore GPWS warnings).”

We also need to look at all the situations where people have "saved the day" by violating SOPs, before we can have a comprehensive understanding of the nature of the interaction between people and SOPs. Such a comprehensive understanding is the prerequisite basis for the development of better SOPs, as well as improved compliance (e.g., JSAT intervention strategy 99: “Airlines/operators should ensure that clear, concise, accurate, appropriate standard operating procedures are published and enforced”).

In addition to developing better SOPs, we must also develop other proactive interventions. Conclusions drawn from data and research can be implemented as new design features, new selection and training methods/requirements, new procedures for design, construction, maintenance, and operations, and what's more - a new philosophy underlying all these. Such intervention strategies need not be overly complex. An intervention might simply make people aware of the existence of a potential problem, as in JSAT intervention strategy 79: “Airlines/operators should implement a reliable process to communicate information to the flight crew that may affect flight or aircraft operations” and intervention 162: “Airline/operators should include in their training programs the awareness of potential safety risks due to the complacency when operating at a very familiar airport (e.g. home base).” The critical point here is the ability to intervene with small problems identified in the system before they become big problems. Most of the Team's intervention strategies are examples of such interventions, except that these were developed too late to prevent the accidents analyzed.

Finally, the effectiveness of implementing specific intervention strategies must be measured through a reliable feedback system. The data collection effort described above can serve as the main source of feedback. In addition, given

the system-wide emphasis, data and information must be shared between different organizations within the aviation system. Because any change in any part of the system may affect the rest of the system, the feedback measuring the effects of any such changes must be shared as well.

Research

To develop effective interventions, the Team had to understand the factors contributing to the accidents. However, questions like "why didn't the crew follow SOPs?" or "why did the crew ignore the GPWS?" remained unanswered. It became clear that effective interventions can only be developed once we understand the underlying factors, and that these factors are not well understood.

The Team identified four major areas of crew behavior for which insufficient knowledge exists to enable the development of effective intervention strategies. These areas are: procedural noncompliance, information overload, plan continuation, and tactical decision making.

Safety Culture

Accidents in domestic commercial aviation are so rare, that it is statistically possible for an organization to operate for years without an accident, regardless of the safety culture of that organization. Similarly, it is possible for a relatively safe organization to experience accidents.

Safe operations are the result of intentional, concentrated and dedicated efforts by all members of the organization. In aviation, because of the inter-connection and inter-dependence of so many different organizations, a true Safety Culture must be system wide, encompassing all levels within the regulators, the operators, and the manufacturers.

As the Team progressed in its data analysis and in the formulation of intervention strategies, the notion of "safety culture" emerged in various discussions and under different guises. In grouping intervention strategies that would support each other, interventions directly related to safety culture formed a large group.

It is easy to isolate specific examples of safe behaviors within an organization, but in isolation they are likely to appear trite (“pilots should not fly with low blood sugar”). The important point is to recognize the extent to which an organization will go to ensure sure operations.

Defining Safety Culture is not a trivial issue. The behavior of an organization starts at the top; safety culture is no exception. A proactive safety culture can only be achieved when senior management demonstrates a complete and sincere commitment to safety.

Once all members of the organization trust upper management's commitment to safety, and its unequivocal support of safe choices as top priority, a safety culture can flourish. The intervention strategies developed by the Approach and Landing JSAT suggest that a system-wide aviation safety culture needs to stand on four legs: data collection, data analysis, proactive interventions, and feedback/information sharing.

Implementing selected JSAT interventions would not constitute a safety culture. Rather, it is necessary for an organization to have a demonstrable commitment to the *spirit* of the interventions. In the judgement of the members of the Approach and Landing JSAT, a long-term investment in developing, establishing and enhancing a system-wide Safety Culture is a significant intervention to prevent future accidents.

Survivability

A fourth category of interventions that could not be rated for effectiveness in preventing accidents addresses post-crash survivability. Even though such interventions can not prevent accidents, their implementation may prevent fatalities, or otherwise mitigate the consequences of the accident. Although not specifically stated in the Approach and Landing JSAT Charter, the Team developed some interventions pertaining to survivability based on the data reviewed.

Appendix K

TEAM MEMBERS

The Approach and Landing JSAT, as part of the commercial aviation portion of the FAA Administrators "Safer Skies" Program, attempted to obtain representation from all aspects of that sector. In addition, since the "Safer Skies" agenda has a world-wide goal to reduce accidents by 80% in 10 years, the JSAT leadership pursued international involvement. Individuals who had participated in studies previously conducted in the area of Approach and Landing Accident Reduction were recruited for the JSAT

Below is a list of the Approach and Landing JSAT leadership, followed by an alphabetical listing of the Team members.

Team Co-Chairpersons

Ronald T. Wojnar
Manager, Transport Airplane Directorate
FAA

Jay J. Pardee
Manager, Engine and Propeller Directorate
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Paul Russell
Chief Engineer, Airplane Safety Engineering
Boeing Commercial Airplanes Company

Quentin J. Smith, Jr.
Manager, Air Transportation Division.
FAA

Team Leader

Thomas Toula
Manager, Air Carrier Training
FAA

JSAT Coordinator

Kyle L. Olsen
Transport Airplane Directorate
FAA

Secretary and Team Member

Jorge Fernandez
ANE-102
FAA

Facilitators

Michele A. Preble
ANE-40
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Lirio L. Liu
International Branch ANM-116
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Team Members

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Paul Best

AFS-420
FAA

Steve Boyd
ANM-111
FAA

John F. Brooks
Airplane Safety Engineering
Boeing Commercial Airplanes Company

Kevin Comstock
Staff Engineer
Air Line Pilots Association

Captain Garry Chesnutt
APA Representative
American Airlines

Captain Howard Crisp
ATA Representative
United Parcel Service Airlines

Jerry Davis
Airbus Industrie,

Captain Richard Fariello
ATA Representative
TWA

Edward Garlick
ANE-505.4
FAA

Captain Gerard Guyot
Airbus Industrie

Stephen Gibbs
AFS-330
FAA

Sharon Hecht
ANM-111
FAA

Sally Hickman
Airplane Safety Engineering
Boeing Commercial Airplanes Company

Win Karish
AFS, ANE-200
FAA

Captain David Keeling
ATA Representative
Southwest Airlines

Major Ray King
USAF Representative
HQ AFSC/SEPR

Captain Mike McFarland
ATA Representative
TWA

Captain Dick McKinney (AA-Ret.)
Flight Safety Foundation Representative

Jim Mast
SEA-FPO
FAA

Dr. Bob Matthews
Office of Accident Investigation
FAA

Captain Erik Reed Mohn
Flight Safety Foundation Representative
SAS Flight Academy

Ton Nieuwpoort
National Aerospace Lab (NLR)
Netherlands

Hank Reed
Airplane Safety Engineering
Boeing Commercial Airplanes Company

Captain Corkey Romeo
ATA Representative
U S Airways

Chris Schaap
JAA/JSSI Representative-Netherlands
Civil Aviation Authority
Captain John Sciera
ALPA Representative
Delta Airlines

Dr. William Shontz
Human Factors
Boeing Commercial Airplanes Company

Captain Doug Smith
RAA Representative
Gulfstream International

Ron Stefanik
APA Representative
American Airlines

Dick Weaver
NY FPO
FAA

John White II
Aviation Safety Program Office
NASA

Captain Dave Williams
Airplane Safety Engineering
Boeing Commercial Airplanes Company

Rick Williams
ALPA Representative
Delta Airlines

Captain Bill "Deacon"Yantiss
ATA Representative
United Airlines

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