JSSI

FUTURE HAZARDS WORKING GROUP

REPORT

15 September 2000

JSSI FUTURE HAZARDS WORKING GROUP REPORT

EXECUTIVE SUMMARY – 15 SEPTEMBER 2000

I BACKGROUND

In early 1998, the JAA agreed to launch the JAA Safety Strategy Initiative (JSSI). The purpose of JSSI is to develop a focused safety agenda to achieve continuous improvement of the JAA safety system.

Two complementary approaches are being used to develop the focused agenda:

- One approach based on past accident analysis ("historic approach").
- The future hazards approach ("predictive approach") based on an analysis of ongoing or future changes affecting the aviation system, is aimed at revealing unidentified hazards.

II THE FUTURE HAZARDS WORKING GROUP

The JSSI Steering Group (JSSI SG) established a working group (comprising JAA, FAA, NASA, IFA, Eurocontrol, European and American industry representatives) to review and finalise the procedure proposed to cope with the future hazards issues. The Future Hazards Working Group (FHWG) held its first meeting in October 1999 and was given eight month to fulfil its first tasks. This executive summary presents briefly the results of that work.

III ACHIEVEMENTS

The FHWG held six meetings of three days each in Europe and USA.

The FHWG reviewed and finalised the generic methodology aimed at revealing unidentified hazards which are the results of changes in the aviation system.

The FHWG finalised a "list of areas of changes", presenting nearly 150 specific changes (organised into 11 categories), that are considered to be potentially leading to future hazards.

The FHWG also provided recommendations on how to continue the work.

IV FUTURE WORK

The work done so far corresponds to tasks 1 & 2 as specified in the FH WG Terms of Reference (Annex D of the report). The FH WG was requested to present a status report - here joint - at that stage, in order for the JSSI SG to decide to launch following tasks.

The work done so far appears as a solid and promising basis for future work. The Future Hazards Working Group therefore recommends that tasks 3 & 4 of its Terms of Reference be launched. They will mainly consist in the formation of an experts group, under the control of the FHWG, tasked to prioritise and select areas of change and to propose specific methodologies aiming at identifying future hazards in each selected area.

That work having to be achieved within six months after initial meeting of the experts group.

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<u>FUTURE HAZARDS WORKING GROUP REPORT</u>

<u>TO THE JSSI STEERING GROUP</u>

1. BACKGROUND:

1.1 JAA Safety Strategy Initiative:

In early 1998 the JAA agreed to launch the JAA Safety Strategy Initiative (JSSI).
The purpose of JSSI is to develop a focused safety agenda to achieve the JAA aim for safety which reads:

The JAA aims at continuous improvement of its effective safety system leading to further reductions of the annual number of accidents and the annual number of fatalities irrespective of the growth of air traffic.

JSSI involves Authorities and interested parties and other bodies such as ICAO, EUROCONTROL, US Commercial Aviation Safety Team (CAST). This co-operation is fundamental to achieve a worldwide safety agenda and to avoid duplication of efforts. For instance, up to now CAST has taken the lead for the "historical approach" and JSSI has taken the lead for the "Future Hazards".

Two approaches are being used to develop the focused agenda:

- One approach based on past accident analysis ("historic approach") which has led to the identification of an initial list of 7 focus areas: Controlled Flight Into Terrain; Approach and Landing; Loss of Control; Design Related; Weather; Occupant Safety and Survivability and Runways Incursions.
- The Future Hazard approach ("predictive approach") based on an analysis of ongoing and future changes affecting the aviation system, is aimed at revealing unidentified hazards.

The two approaches are complementary.

JSSI is also developing a communication policy to address public perception of aviation safety.

1.2 Terms of Reference:

In May 1999 the JAA Committee established a Working Group to study Future Hazards, and the JSSI assembly provided the Future Hazards Working Group (FHWG) with Terms of Reference (Annex D) including its initial recommendations on how to proceed. Those recommendations took the form of:

- Proposed principles
- A draft methodology and
- An initial list of areas of change (as the methodology was founded on that concept).

The FH WG reviewed the materials provided by the JSSI Assembly, in accordance with its Terms of Reference, and came to several modifications and recommendations described in paragraphs 3 to 6.

2. <u>FUTURE HAZARDS WORKING GROUP (FHWG)</u>:

2.1 <u>WG composition</u>:

The Working Group was composed as follows:

- 4 JAA National Authorities (DGAC-F, ENAC-Italy, GICA-Poland, CAA-UK). It should be noted that the CAA-UK representative also acted as representative from the Research Committee.
- AECMA, Airbus, AEA
- EUROCONTROL SRU (Safety Regulation Unit)
- FAA, NASA, Boeing
- International Federation of Airworthiness (IFA)
- JAA HQ

The group also benefited from inputs and/or participation from outside experts.
The list of group members and outside experts is detailed in Annex E.

2.2 <u>WG meetings:</u>

The Group has held 6 meetings of two to three days between October 1999 and August 2000. During two of these meetings presentation sessions were organised to receive input from outside experts, in particular relative to methodologies.
As the US representation was important, one of these meetings was organised in Washington DC.
In addition to meetings, e-mail was extensively used.

2.3 <u>Consultation</u>

The group conducted two types of consultation work: 1. Towards identified missing expertise in the group, and 2. Towards US interested parties involved in CAST group of safer skies:

2.3.1 Missing expertise:

After two meetings of the group it was recognised that the group could benefit from outside expertise. Three main domains of expertise were identified as beneficial but missing: Insurance, University and related areas.

A letter was sent to identified individuals falling under the above criteria (“Ecole nationale supérieure de l’enseignement technique” in France, Lloyds Aviation in United-Kingdom, European Rail Research Institute, Nuclear Operator in France, State University of New Jersey, European Space Agency and Assicurazioni Generali in Italy).
The intent of the letter was twofold: first, to inform them of the working group and its progress so far and, second, to request that they share with the group their expertise on the identification and evaluation of future hazards and related subjects. It was highlighted that the FHWG would appreciate learning about experience in the identification and evaluation of future hazards.

The results of that consultation led to newcomers in the group whose contribution was found very beneficial (see paragraph 2.1) and to valuable contributions on the methodology from specialists involved in related work. These inputs enhanced the FHWG in its approach.

2.3.2 Commercial Aviation Safety Team (CAST):

The Federal Aviation Administration (FAA) announced the Safer Skies initiative in April 1998, with the broad initial goal of reducing the number of fatal accidents per million flights by 80 percent by 2007. Aviation experts from the FAA, the aviation industry, and other government agencies formed steering committees to oversee the initiative's work in three broad areas: commercial aviation, general aviation, and cabin safety. The commercial aviation committee, known as the Commercial Aviation Safety Team (CAST) chartered teams to review accidents in major categories, (i.e., controlled flight into terrain (CFIT), approach and landing, loss of control, etc.). A modified event sequence process was used to develop problem statements and interventions from a selected set of accidents and incidents. The interventions were prioritised by effectiveness and feasibility, and synergistic groups of effective and feasible interventions were developed and presented to CAST for implementation. CAST includes representatives from the airlines, pilot associations, U.S. government (FAA, NASA, and military), the Joint Aviation Authorities (JAA), engine and airplane manufacturers, including European manufacturers, etc. The activity of the FHWG was presented to CAST at their monthly meetings and a copy of the letter described in 2.3.4.3. was sent to all CAST members and observers. A number of suggestions and comments were received and incorporated.

2.3.3 Consultation on List of Areas of Change:

The consultation is described in paragraph 5.3

3. PRINCIPLES AND CATEGORISATION OF FUTURE HAZARDS:

The FHWG reviewed the proposed principles and definitions contained in the draft Terms of Reference. Strategic management of aviation safety requires a distinction between “historic” and “predictive” approaches to aviation safety. "Future Hazards" belongs to the latter category as it is based on an analysis of ongoing and future changes affecting the aviation system, aimed at revealing unidentified hazards.
On the basis of the initial principles, it was felt necessary to provide definitions of the terms used.
Hazard: "Condition, event, or circumstance that could lead to or contribute to an unplanned or undesired event" (ref. FAA Order "Safety Risk Management" 8040.4 date June 26, 1998).
Future Hazard: Hazard that has not yet been identified.

As a consequence, Future Hazards are summarised as follows:
Future Hazards are the undesirable consequences of past and future changes that have to be prioritised on the basis of their significance.

A categorisation of Future Hazards was agreed, based on a distinction between:
past Future Hazards (existing though unidentified) and
Future Future Hazards (not existing yet).
The above definitions, principles and categorisation are in Annex A to this report.

4. METHODOLOGY:

The FHWG reviewed two approaches during the examination and methodology selection process. Together these processes could be used to identify, assess and prioritise the future hazards facing aviation.

4.1 The two approaches are:

1. History based:
   Its foundation based on past events and data collected during those occurrences.
2. Predictive:
   Based on analysis of changes in the aviation system.

Influenced by “expert” opinion and engineering judgement – the predictive approach is applicable where any of the following conditions exist: new systems are introduced; the risks in the current system are underrepresented; operating conditions are expected to change significantly; and/or new regulations are introducing risk transfer changes.

Both the history based and predictive approaches share the ultimate objective of reducing future risks. "History based" identifies current problems and possible future transition issues; while "predictive" identifies future hazards where possibly no historical data exists. Both approaches may employ expert panels or teams and each use a step-by-step process that respects safety management principles (e.g. identify, analyse, design solutions, implement solutions and monitor results).

On that basis, both approaches can be considered data driven. In the context of Future Hazards, data ["Factual information…used as a basis for reasoning, discussion or calculation" (Merriam – Webster)] may not be used, as there may be no history. Therefore, in order to maintain the Future Hazards exercise as a data driven exercise, expert opinion achieved using structured methodology is considered as data. This is consistent with the definition of data driven used by CAST.

4.2 The Future Hazards WG developed the approach below that is fully described in Annex B:

Step 1 Identify areas of change
Step 2 Prioritise and select of areas of change
Step 3 Define methodology, determine future hazards and prioritise future hazards for each selected area of change
Step 4 Global review and synthesis of future hazards from each area
Step 5 Validate, prioritise and select synthesised future hazards
Step 6 Develop, validate, prioritise and select interventions
Step 7 Propose action to JSSI Steering Group
Step 8 Monitor the effect of intervention and iterate the process from the beginning

4.3 Recommendations on prioritisation of areas of changes and hazards:

4.3.1 Prioritisation of Areas of Change:

- The evaluation of the interactions between areas of changes should be performed rigorously using an appropriate method (e.g. scale used by the FHWG or other method).
- The criteria described in Step 2 for prioritisation of Areas of Changes should be refined (selection of sub-factors and weighting of the factors).
- Analytical hierarchy process (AHP) should be used to prioritise areas of changes using the above refined criteria.

These three recommendations should be actioned by a single ad-hoc group which should be briefed on the FHWG methodology and should receive appropriate training on AHP.

4.3.2 Prioritisation of Hazards

Each ad-hoc group analysing areas of changes using AHP and the criteria described in Sub Step 3b should prioritise the hazards.

5. AREAS OF CHANGE:

5.1 From a list to a matrix:

During the first few meetings of the Future Hazards Working Group it became clear that the original list of areas of change supplied to the Working Group did not encompass all relevant internal and external changes which may affect the aviation system. As a result of consultation with aviation experts, the original list expanded to include the following final categories:

Aircraft (AC)
Maintenance, Repair & Overhaul (MRO)
Operations (OP)
Crew (C)
Passenger (P)
Organisation (O)
Authority (AUTH)
Air Navigation System (ANS)
Airport (AP)
Environment (E)
Space (S)

As the list of individual areas of change grew in each major category, the Working Group realised that changes occurring in one category could not only induce changes in another category but also produce unforeseen hazards as a result of this synergism. In order to capture the potential influences of a particular ongoing or future change on related categories, the Working Group adopted a matrix format in which individual change areas (by category) were arranged in rows and the potentially affected categories were listed vertically in adjacent columns. By means of this arrangement, a systematic estimate of the interrelationships among the categories and individual areas of change could be made. For instance, certain kinds of changes in the Aircraft category (AC) could have very real spin-off effects on other categories such as Maintenance, Repair & Overhaul (MRO), Operations (OP), Crew (C), etc.
(See Annex C for the definition of the categories and the matrix of areas of changes).

5.2 Interactions between Areas of Change:

Serving as its own "expert panel," the members of the Working Group were asked to identify all potential major categories of change that could be affected by a change in a particular individual area. Working Group members indicated the dependence of all major change categories upon a particular area of change by placing an "x" in the corresponding intersection of the independent row elements of the matrix and the dependent change category columns. At the time this exercise was initially undertaken, the matrix contained approximately 115 rows and 11 columns (for a total of over 1200 elements).

A line-by-line review of the full matrix was carried out by the full Working Group at several meetings during which both the identified dependencies as well as onset timeframe, validation tools, and comments columns were discussed. As a result of this effort, the team felt that there was significant value in representing the dependencies in binary fashion; an "x" in a particular cell indicating dependency and blank for independent. The matrix of areas of change in Annex F shows all cells in the matrix in which at least one member of the Working Group identified dependence of a particular category upon a particular area of change. It was felt that this preliminary dependency identification would be a useful starting point for implementation of the suggested methodology for extracting possible future hazards from not only the individual change areas themselves, but also from the unique interdependencies of the categories of change affecting the aviation system.

5.3 Consultation on the Areas of Change:

The list of areas of changes established by the WG was sent in a matrix format together with some background information on Future Hazards WG and JSSI to the following bodies:

- JAA National Authorities

- Organisations represented in the Joint Steering Assembly (JSA) (i.e. manufacturers, operators, crew associations, etc…)
- Chairmen of the JAA Main Committees and Panels.
- JAA Directors
- Chairmen of Working/Study/Steering Groups
- Chairperson of the JAA Human Factors Steering Group
- CAST Members and Observers

Consultation period was around 45 days. A limited amount of comments were received:

- JAA Engine Study Group
- JAA Maintenance Committee
- JAA Large Aeroplane Systems Study Group
- US Regional Aircraft Association
- European Cockpit Association
- C. Frantzen from EDF, (French Nuclear Energy Operator).
- JAA Human Factors Steering Group

A Comment Response Document is included in Annex G.

6. FUTURE WORK:

We have completed tasks 1 & 2 of the FHWG Terms of Reference (Annex D), and as it was requested that the WG present a status report, within eight month, this report summarises our achievements.

The group considers that the updated principles, methodology and matrix of areas of changes constitute a solid and promising basis for future work on the issue of future hazards.

We therefore respectfully request the JSSI Steering Group to suggest to the JAA Committee that tasks 3 & 4 of its Terms of Reference be launched.

These tasks consist mainly in the prioritisation and selection of areas of change and in proposals for specific methodologies aimed at identifying the future hazards. The following paragraphs are the initial thoughts of the group on how these two tasks could be achieved:

6.1 Prioritisation and selection of the areas of change:

The updated methodology of the group suggests that this exercise be conducted on the basis of criteria (-nature, scope and source of the change, -trend, profile, -timing of the considered change, -interactions with other areas, -consideration under other initiative?). It is the opinion of the group that a group of experts, selected on the basis of their expertise and open mindedness, could achieve the task as described in 2.4.1

6.2 Specific methodologies for each selected areas

The specific methodology to be used in each selected area of change of course depends on the nature of that area. The group considers that as soon as the exercise of prioritising and selecting the area of change be achieved, the same group of experts proposes the specific methodology to be applied in each area and suggest the composition of the sub-groups on the basis of the recommendation of the FH WG in its updated methodology – step 3.

Note: Completion of task 4 does not mean completion of the work on Future Hazards. It will mean completion of step 2 of the methodology, steps 3 to 7 will remain to be done.

7. CONCLUSION:

The Future Hazards Working Group held six meeting of three days each in Europe and the USA.
The FHWG reviewed and finalised the generic methodology aimed at revealing unidentified hazards that are the results of changes in the aviation system.
The FHWG finalised a list of areas of changes presenting nearly 150 specific changes (organised in 11 categories) that are considered to be potentially leading to future hazards.

The Future Hazards Working Group recommends that tasks 3 & 4 of its Terms of Reference be launched. They will mainly consist in the formation of an experts group (operating through workshops), under the control of the FHWG, tasked to prioritise and select areas of change and to propose specific methodologies to be used in each selected area.

Tasks 3 and 4 should be achieved 6 months after initial meeting of the Expert Group.

ANNEX A

UPDATED PRINCIPLES AND CATEGORISATION

I BACKGROUND:

Strategic Safety management initiatives (JSSI, CAST, Safer Skies) aim at directing efforts of all interested parties towards directions where most safety benefit can be expected, in terms of accident prevention. Being an attempt to prevent occurrence of future accidents, accident prevention is, by definition, always orientated towards future. However, prevention activities can be categorised, at least in two categories: **"reactive"** and **"pro-active"**.

"Reactive" prevention:

The activity is data driven and consists of identifying and analysing the factors that have caused (or contributed to the cause of) past accidents, in order to define feasible and effective measures that will eliminate the most dangerous of these factors in the future.
It is "reactive" in that it is based on data related to past (although recent) events or situations.
"Reactive" prevention corresponds to activities conducted by JSSI and CAST groups dealing with CFIT, Approach & Landing, Loss of Control, etc...

"Pro-active" prevention:

The activity consists of trying to identify hazards that have not been (and/or could not be) identified so far, but could be causal or contributing factors of future accidents, in order to define feasible and effective measures that will eliminate (or prevent) these hazards or their consequences in the future.
It is "pro-active" in that it is an attempt to anticipate on potential causes (not identified so far) of future accident (the "future hazards" (FH)) with no available data or experience.

II PRINCIPLES:

As the pro-active prevention activity has not been experienced, it has been felt necessary to specify several principles in order to determine more specifically the scope of the exercise.

It has been said that FH have not been identified yet. That statement must not be misunderstood. Does it mean that future hazards have not led to any accidents yet?

Obviously, FH should include hazards that have not led to anything yet, but are they the only hazards? As the JSSI work is organised under the principle of identifying «groups» of errors, the so-called «focus areas», it may well be that some particular accidents were caused by hazards that will, in the future, fall under a new group of errors, a new focus area, or a new «concept»...Not yet identified. FH may have been there but unknown or unseen in the present state.

First principle:
Future hazards may include not yet identified existing hazards

Additionally, it would be, maybe not useless, but definitely costly, to identify potential future hazards without being able to prioritise them in terms of significance. This would be the metaphysical exercise that has to be prevented. Therefore, the concept of FH makes sense only if we are able to identify hazard(s), at least one, potentially leading to a significant number of fatalities and that we are able to prioritise them.

Second principle: Future hazards are to be prioritised on the basis of their significance.

Note: It will be necessary to elaborate on the term «significant».

Finally, on the basis of the fact that a data driven approach may only be efficient where there are data available, it is clear that such an approach will never reveal any hazards at the time a change occurs: **No data are available at the moment a change occurs**. On the other hand, there seems to be no reason why no data would have been identified and examined in an area where nothing would have changed.

Future hazards are likely to appear following something that has changed. Therefore, an orientation for the JSSI work with respect to FH could be given along the lines of the following third principle.

Third principle: Future hazards are undesirable consequences of changes.

Note: «change» must here be understood as widely as possible (change in techniques, organisations, environment, etc.). As an example of the wideness of the term change, approximately 70% of design related accidents are consequences of a «change» in the assumptions on which the concerned design was made. Another example of that wideness is the safety analysis relative to the obligation for aircraft to carry 8.33 kHz radio equipment in the European airspace

III DEFINITION AND CATEGORISATION OF FUTURE HAZARDS:

After the approach has been specified and the principles were set, it has been felt necessary to give a definition to the terms used, and to categorise them according to the principles.

a) Definitions:

Hazard: "Condition, event, or circumstance that could lead to or contribute to an unplanned or undesired event" (ref. FAA Order "Safety Risk Management" n°8040.4 date June 26, 1998).
Future Hazard: Hazard that has not yet been identified.

On the basis of the three principles and the two definitions above, it may be elaborated that:

«Future Hazards are the undesirable consequences of past or future changes that have to be prioritised on the basis of their significance».

It should be understood that the essence of FH is to be unknown rather than to be not existent. They might exist already, or not, but they are not revealed as such. Therefore, the pro-active methodology must be developed in order to «find» them. That methodology must be accurate enough not to create «virtual» hazards, but to «reveal» real ones, falling under the above principles, and the following categories.

b) Categorisation of Future Hazards:

"Past" Future Hazards: Future Hazard which, although not yet identified, is already existing.

"Past" Future Hazards may be further classified into **two sub-categories** as follows:

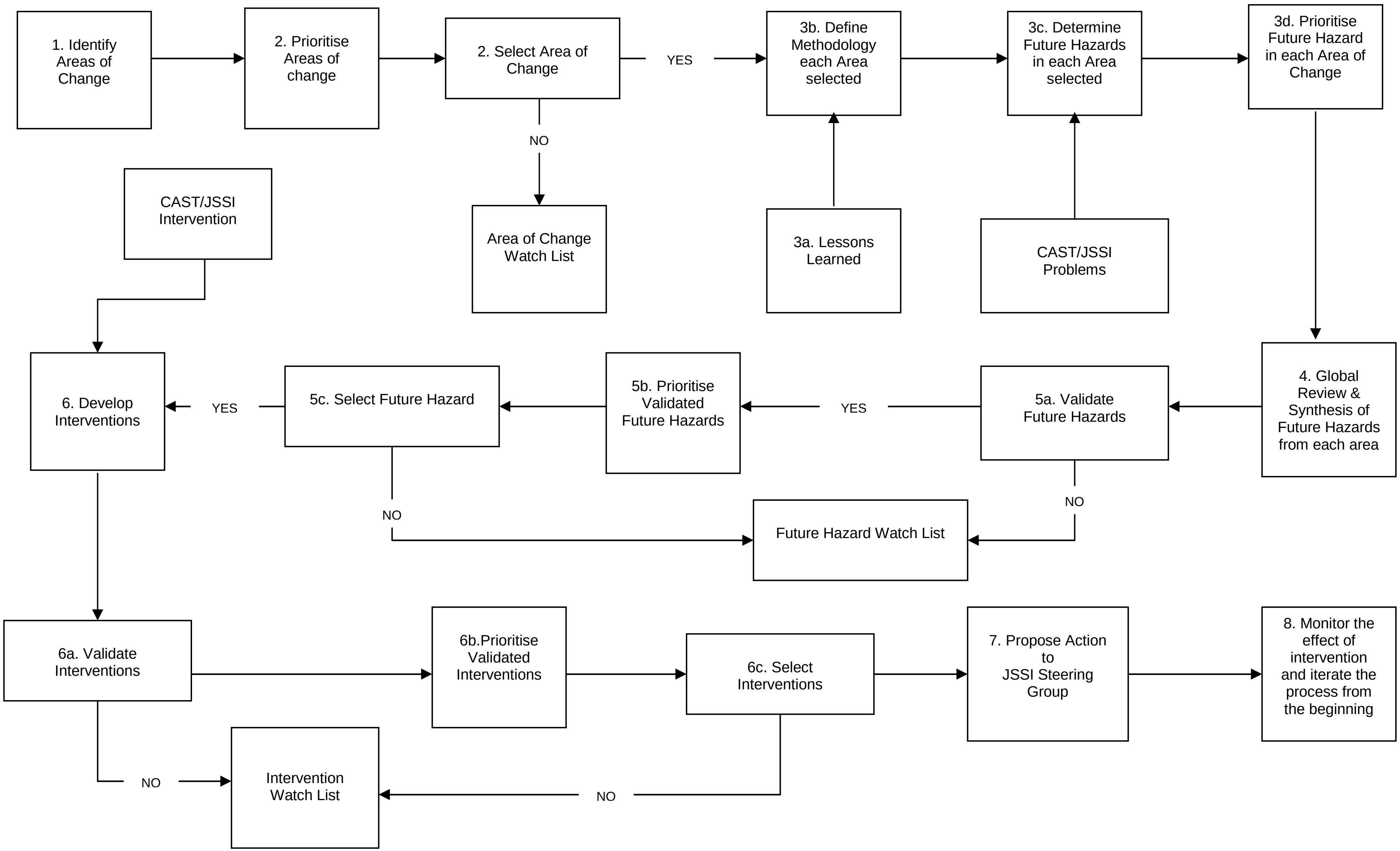
Sub-category 1.1: "Past" Future Hazards that have not been identified because they have not yet caused (or contributed to cause) an accident or incident.

Sub-category 1.2: "Past" Future Hazards that have caused (or contributed to cause) an accident or incident but have not been identified as such (not shown by accident/incident investigation or analysis).

"Future" Future Hazards: Future Hazard that does not exist yet and will appear in future (as a result of change in civil aviation operation conditions, context or environment).

Appendix 5

FUTURE HAZARDS WORKING GROUP METHODOLOGY



ANNEX B

FUTURE HAZARDS WORKING GROUP METHODOLOGY

1. DEFINITIONS

Before describing the various steps of the developed methodology it seems useful to define data and risks.

Data:
“Factual information…used as a basis for reasoning, discussion or calculation” (Merriam – Webster).

Discussion
Key words are “facts”, “information”, and “basis for”.
Other definitions of data are quite comparable to this one.

Risk:
“The combination of the probability, or frequency of occurrence of a defined hazard, and the magnitude of the consequence of the occurrence.”

Discussion
Ref. UK Civil Aviation Publication CAP 670. This definition has been chosen as it relates hazards to risk.

Hazard can be summarised as a potentially unsafe condition due to various causes. The risk is then the product of likelihood multiplied by the severity of a hazard.

2. THE 8 STEPS OF THE METHODOLOGY

Step 1: Identify areas of change

Members of the FHWG, in concert with regulation authorities, expert advice and input from interested parties, first developed a list of “Areas of Change.” Areas of Change can also be identified through engineering analysis. This list would include a description of the change area, how one change area related to others, and a validation process. In this context, changes must be understood as broadly as possible. To bring consistency and coherence to the process, “Areas of Change” are grouped by categories.

The listing is not meant to be all-inclusive; but a thorough, representative listing within each category is the initial goal. The categorical listing led to the creation of a matrix. The matrix (Annex C) listed area of changes grouped by categories, onset timeframes and validation tools. It also includes a comment column that provides more details for each change.

It is important to realise that this stage is an identification of the change, not an identification of the hazards that result from the change.

Identification of the changes should be as factual and complete as possible.

Each area of change within the matrix should be examined to determine its effect on the other categories of change. This exercise assists in the identification of crosscutting issues. Subjective judgements by the FHWG members on the cause for the change and effect relationships would act as supplemental input when attempting to prioritise the categories and their respective areas of change.

Step 2: Prioritisation and selection of areas of change

The objective of this step is to reduce the scope of the task. To determine which areas of change would be focused upon. The prioritisation of the areas of changes would depend on numerous criteria, i.e., nature and scope of the change, any trends or profiles present or anticipated, timing of the considered change, interactions with other areas, and sensitivity. ***The criteria would need to be refined (sub-criteria) and be weighted. As a consequence of this prioritisation and selection step, those areas not being actively worked would be placed on an "Areas of Changes Watch List" and be actively monitored.***

It was decided that an expert panel using the analytic hierarchy process (AHP) could accomplish this step. The rationale for this decision was based upon the following inputs:

- The expert panel would use both individual judgement (Delphi) and open panel discussions.
- It allowed dynamic discussion providing judgements by mutual agreement and revision of views.
- The panel would decide the variables, and
- Qualitative judgements could be scaled from 1 to 9 allowing varying degrees of choice on an issue.

Step 3:
Define methodology, determine future hazards and prioritise future hazards for each selected area of change

The output of step 2 would give you a level of prioritisation and selection of the areas of change.

At this point in the process, a sub methodology must be used to determine specific future hazards within each selected "area of change." It offers the opportunity to employ both the historic and predictive methodologies.

Sub Step 3a

Examine each selected area of change and determine if any "lessons learned" data are available. If not, can analogies to existing systems be made.

Sub Step 3b

Identify a methodology to "reveal" future hazards. This methodology could employ or adopt an existing process, if applicable, or develop a new process that would consider the following criteria: 1. Do the hazards impact former assumptions? 2. Do the hazards impact multiple areas of change? 3. Who is unaware of the change or its significance?

Some examples of methodologies that may be employed in steps 3b & 3c include: functional hazard analysis, brainstorming, engineering judgements, experiential knowledge, using "what-if" statements, etc. Whatever the methodology chosen, all inputs should be accepted non-judgementally, the inputs should be definable, clear and distinct.

Sub Step 3c

Determine the future hazards by the above-identified methodology.

Sub Step 3d

Prioritise the future hazards using the following criteria:

- Number of potential fatalities and/or accidents
  - Trend, future existence of the identified hazard
  - Geographical area & type of the operation
  - Size of A/C
- Public perception and understanding
- Any effective intervention?
- Stake holders of the area of change

Using the above criteria, one could think of establishing a risk assessment matrix identifying the consequences of the hazards (e.g. impact on people, environment assets, reputation) and the probability of occurrence.

AHP is the most logical method to employ at this sub step.

Step 4: Global review and synthesis of future hazards from each area

Examine the results from each of the selected areas of change both to determine if synergies exist between and among the identified hazards and to avoid redundancy. Either group consensus or expert panel input would accomplish this. The results would then be synthesized into a list of hazards.

Step 5: Validate, prioritise and select synthesized future hazards.

Sub Step 5a
Validate synthesized hazards, i.e., do the resultant hazards after synthesis still capture the nature and meaning of the hazard that existed before synthesis.

Sub Step 5b
Prioritise the resultant list of Future Hazards using the methodology and criteria outlined in step 3d, i.e., AHP using both the Delphi and group inputs.

Sub Step 5c
Select the Future Hazards to be worked. All other hazards would be placed on a "watch list" to be monitored and examined at some period in the future. Initial selection may be based upon resources; however, additional selection considerations may be developed and employed.

Step 6: Develop, validate, prioritise and select interventions

Sub Step 6a – 6b

Develop and prioritise interventions. The CAST ratings for effectiveness and feasibility can be used once the interventions are developed.

Sub Step 6c

Select proposed interventions that may require action by the Authorities, Industry or other Interested Parties.

Step 7: Propose action to JSSI Steering Group

The JSSI Steering Group will need to integrate interventions coming from the Future Hazards and Historic approaches**.** The concept of an Action Plan Team could be used, as it is generic enough to be applied to any kind of intervention.

Step 8: Monitor the effect of intervention and iterate the process from the beginning

Each member state or party could develop their own methodology to monitor selected interventions and their effect on the identified hazards. A recommended methodology is yet to be determined by the FHWG.

This process should be repeated on a recurring basis. As of yet, the FHWG has not determined how often this should be done.

3. BRIEF DESCRIPTION OF THE METHODS PROPOSED FOR STEPS 2, 3 AND 5:

Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP), developed by Dr. Thomas L. Saaty, can be described as a multi-criteria decision-making methodology that considers both subjective and objective factors. It gives a rational and defendable basis for decision-making. The decision maker often faces complex problems. AHP decomposes and synthesizes a problem into a hierarchy of top down (from a general goal or focus to its components, subcomponents and choices) and/or bottom up (from alternatives or choices to their primary factors or functions). This allows the most complex decisions and judgments to be broken down into multiple "bite size" pairwise comparisons. This also permits each person's preferences to influence the decision in a fair and equitable way, i.e., each vote (within the defined structure) counts and can influence the final decision. AHP has been successfully employed in planning, prediction, setting priorities and conflict resolution. Among its many applications, AHP was used in an analysis of terrorism for the U.S. Arms Control and Disarmament Agency and resource allocation decisions for large private, governmental and international concerns. It is based on sound mathematical methods (Matrix Algebra) and enables the decision maker to incorporate subjective experience and knowledge into their judgments.

Note: Caution should be exercised when using AHP to minimise the effects of the following issues:

1. Bias towards first examined issue (primary effect)
2. Influence of the latest information over what went on before (recency effect)
3. Panel members assume knowledge of others (out of role behaviour)
4. One member influences the group decision making (personal bias)

Formal Brainstorming

Formal brainstorming is applicable at the hazard and risk identification stages. The method is used as an explicit technique, with the aim to list a range of potential issues. It is essential for a formal brainstorming meeting to have a time-schedule, and a set of well-defined rules.

The main stages of the procedure are:

- Appointment of a co-ordinator
- Definition of the system to be analysed
- Creative session: the members present one potential hazard or risk at a time. There is no restriction that the team members must keep to their own domain of knowledge. A list of suggestions is constructed. The list contains no names, so as not to reveal the connection between a particular idea and the corresponding team member.
- Evaluation of all the ideas and construction of a final list.

Formal brainstorming (also known as focus groups) is an acknowledged way to organize expert discussion. Further guidance can be found in various Publications (e.g. SAE JA 1000-1 Reliability programme standard implementation guide). Formal brainstorming is best used when only a broad description of the change is available.

Functional Hazard Assessment (FHA)

"…The objective of a Functional Hazard Assessment (FHA) is to consider functions at the most appropriate level and to identify failure conditions and the associated classifications while considering both loss of functions and malfunctions. The FHA should identify the failure conditions [for each phase of flight] when the failure effects and classifications vary from one flight phase to another. The FHA also establishes derived safety requirements needed to limit the function failure effects which affect the failure condition classification. These requirements may include such things as design constraints, annunciation of failure conditions, recommended flight crew or maintenance action, etc. Furthermore, these requirements may involve single or multiple systems. All safety requirements should be traceable and validated at each level of derivation. A good way accomplish this is to create a table of derived requirements based on design decisions. Once the high level requirements have been identified, they may be used to generate lower level requirements as part of the preliminary system safety assessment (PSSA) process for the systems or items. This process is continued, with reiteration, until the design process is complete…."

This technique is most applicable when the basic elements of change are identified.

FHA can be broadly defined as follows:

A top down iterative process initiated at the beginning of the development or modification of a system. The objective is to determine how safe does the system need to be. System is used here with a broad meaning. Its essential prerequisite is a description of the high level function of a system.
In addition to SAE ARP4761 – Appendix A, a useful reference document is EUROCONTROL SAF ET1. STO 3. 1000. MAN-01.03 Functional Hazard Assessment.

Summary of discussion on sample use of AHP technique on 11x11 matrix

I received 12 responses plus my own for a total of 13 inputs. The matrices were solved for their "priority vector" and "consistency ratio." In addition, each response was examined and a rank order of the areas of change was provided based upon the priority vector.

A resultant ranking and "normalized" ranking of the areas of change was produced. Specifically, this enabled me to enumerate the top five areas of change (independent of the consistency ratio) and the bottom three areas.

A number of lessons learned were gained from this exercise.

1. A simple 11x11 matrix takes a great deal of thought to complete.
2. It is vital to create a hierarchy with specific goals, components and criteria to enable all respondents to understand and complete the matrix from the <u>same</u> viewpoint.
3. It would be better, from a consistency and capability standpoint, to divide larger matrices into smaller matrices less than or equal to a 7x7 matrix. The scale of 1-9 works very well and enables freedom of judgement over a large area.
4. It is much better to complete the matrix in a pairwise manner versus attempting to "outfox", "second guess" or "figure out" the response as you complete it.
5. Results can oftentimes be different from what you expect.
6. Subject matter experts should accomplish further breakdown of the areas and their hazards.

All present agreed that the method has merit and the ranking and/or priority of the areas of change would have taken much longer to accomplish and agreement much more difficult to reach without the use of AHP.

ANNEX C

UPDATED LIST OF AREAS OF CHANGES/MATRIX

A key output of the JAA Future Hazards Working Group is the matrix containing a comprehensive list of ongoing and future changes that may affect the international aviation system. The FHWG generated this matrix using expert opinion from various major international corporate and governmental representatives. The governmental experts were drawn from both aviation regulatory and research organisations. The following matrix attempts to capture and consolidate the significant categories of change that policy makers will need to consider as the international aviation system evolves to meet future commercial demand and safety requirements. 145 individual areas of change were identified by the FHWG. The change areas have been assigned to the following 11 major categories:

Category (abbreviation)	**Count**
Aircraft (AC)	27
Maintenance, Repair & Overhaul (MRO)	6
Operations (OP)	12
Crew (C)	18
Passenger (P)	7
Organisation (O)	6
Authority (AUTH)	4
Air Navigation System (ANS)	23
Airport (AP)	7
Environment (E)	31
Space Operations (S)	4

Definitions of each of these change categories follow.

FUTURE HAZARDS

CATEGORIES OF AREAS OF CHANGES

The JSSI Future Hazards ad hoc working group is focusing on changes in the Aviation system as explained in the Terms of Reference and working Principles. The following definitions provide the general scope of each of the eleven (11) categories of areas of changes. There is an amount of overlap between the categories but this was found acceptable.

1. AIRCRAFT

This category will include changes that affect the physical aircraft platform. Aircraft can include fixed-wing airplanes, rotorcraft, lighter-than-air, vertical-lift, and other air vehicles. It could include introductions of new aircraft types, or changes to aircraft systems and structures. System changes can relate to mechanical systems, hydraulics, electrical, propulsion, avionics, etc. This also includes any human-vehicle interface changes such as related to automation, expert systems, active controls, cockpit design, etc. (the main focus here is on systems interfaces related to pilots, cabin crew, maintenance, and service personnel). Aircraft structures changes could include introduction of composites, monolithic structure, non-rigid surfaces, smart structures, etc.

2. MAINTENANCE, REPAIRS, OVERHAUL

This category will include changes related to maintenance requirements, procedures, tools (hardware/software) and test equipment, processes, facilities, personnel (in particular in relation with Maintenance Resources Management) and training. This could include maintenance as performed by an airline or other party.

3. OPERATIONS

This category will include changes related to two different types of "operations:" 1) overall airline operations, and 2) single aircraft operations within the aviation infrastructure.

Under overall airline operations, we consider changes related to; route architectures (including network, direct city pairs, long-range routes, etc.), fleet mix, management of daily operations (i.e. dispatch, scheduling, etc.), quality control and vehicle health management processes (including data handling), freight operations, etc. This could also include operational integration issues for diverse vehicles such as airships, VTOL, supersonic, and uninhabited platforms.

Single aircraft operations changes may include; new flight routes (i.e. lower/higher altitudes, lower/higher speeds, etc), adverse weather operations, autonomous operations, etc.

4. CREW

This category will include changes related to the aircraft crew, both cockpit and cabin. This will include crew demographics (i.e. backgrounds, diversity, culture, education, experience, Crew Resources Management, etc.), training, crew-mix, human factors, and human-vehicle interfaces. Also includes role changes due to changes in the Aviation System.

5. PASSENGER

This category will include changes related to the passengers. This could include changes associated with changing passenger demographic and behaviour. Also changing passenger health and safety needs such as child seats, g-seats, escape systems, cabin air, etc.

6. ORGANISATION

Organisations means non governmental bodies involved in aviation activities such as design and manufacture, operations and maintenance of aircraft. This category area deals with changes related to organisational principles for example employment conditions, management and business processes. Includes alliance/partnership changes, union issues, virtual airlines, airworthiness responsibilities, subcontracting, mergers, etc.

7. AUTHORITY

Authority means the competent body legally responsible for the Safety Regulation of Civil Aviation.
In that context regulation means not only the drafting of requirements, but also, though not limited to, such activity as implementation, interpretation and application of the statutory civil aviation requirements.
Changes relative to THE AUTHORITY may include transfer of responsibilities, delegation of checking of compliance to third parties and/or approved organisations, development of new regulatory philosophies, privatisation, etc

8. AIR NAVIGATION SYSTEM

ANS is a generic team describing the totality of services provided to ensure the safety regularity and efficiency of air navigation and the appropriate functioning of air navigation systems.
ATM is one of the five elements of an Air Navigation System (ANS). Definition concentrates on ATM because it integrates the other four elements.
ATM is composed of a ground-based element and an airborne component. It should provide a safe, expeditious and orderly flow of air traffic.
The ground component can be subdivided: Air Traffic Services (ATS), Air Space Management (ASM) and Air Traffic Flow Management (ATFM).
ATS is a generic term meaning flight information services, alerting services, air traffic advisory services, and air traffic control services.
ASM is a generic term covering any management activity provided for the purpose of achieving the most efficient use of airspace based on actual needs.
ATFM is a generic term covering any management activity provided for the purpose of ensuring an optimum flow of traffic to or through areas during times when demand exceed available capacity of Air Traffic Control.

Note: For the sake of completeness the 4 other elements of the Air Navigation Service (in addition to ATM) are: CNS (Communication/Navigation/Surveillance); SAR (Search and Rescue); AIS (Aeronautical Information Service) and MET (Meteorology Service).

Changes affecting ANS include: decreased separation standard, increasingly complex interactions between ground systems and aircraft systems, etc….

9. AIRPORT

Airport means a defined area on land or water (including any building, installation and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.
Changes can include new surface traffic flow management technologies; changing characteristics of airport surfaces, airport capacity and terminal congestion, closure of airports, etc….

10. ENVIRONMENT

Environment means the general context in which the aviation system operates.
Among the factors influencing the aviation systems are: economical, social, political, ecological, scientific, judicial factors etc..
Changes in the ENVIRONMENT include: political instability, pressure towards Authorities, increased noise and emission constraints, climate changes, etc...

11. SPACE OPERATION

Space Operations include launch, cruise at an altitude beyond 100 km above the earth surface, re-entry (when applicable) and landing.
100 km (62 statute miles) is the NASA discriminant for classifying a flight as a space flight.
Changes to SPACE OPERATIONS include the development of commercial space operations, introduction of new space vehicles, etc…

DESCRIPTION OF THE AREAS OF CHANGE MATRIX

The first column of the matrix contains a code for each item in the list. An example entry is as follows. "AC1" stands for item 1 in the Aircraft (AC) category. The code is simply a convenient means for identifying the individual items in the matrix.

In the second column is the list of the areas of change. Ongoing and future changes that may affect the aviation system are described in short phrases. For certain categories, such as Crew and Air Navigation System, human factors considerations are quite similar, and for this reason analogous areas of change related to human/machine interaction phenomena appear in both categories. To avoid possible omission of different but related perspectives on a similar issue, the FHWG opted to err on the side of including apparently duplicative entries in one or more categories.

The FHWG felt it was important to estimate the onset time frame for each of the areas of change. The projected year or estimated time span for the various areas of change is listed in next column. In some cases, the change is already in progress and will continue for the foreseeable future. This characteristic is identified as "ongoing."

In order to determine whether a postulated change is in fact occurring, concrete indicator(s) should be used by safety analysts and policy makers. Potential indicators are listed in the column entitled "Validation Tool." The various indicators must permit experts to determine the nature and extent of the change if it is actually taking place.

The last column contains comments that serve to clarify and expand upon the description of the change area. Some comments also contain illustrative examples of the significance of a particular area of change. References are listed as appropriate. The FHWG felt that is was important to indicate where possible that the identified area of change is significant and worthy of active monitoring by appropriate government and industry leaders.

For the Matrix see: “Annex_C.xls”

ANNEX D

TERMS OF REFERENCE - FUTURE HAZARDS AD HOC GROUP

I BACKGROUND:

The safety management principles described in the JAA Safety Strategy Initiative initial proposal document include the two fundamental steps of aviation hazards identification and control.

The JSSI assembly recommended that the hazards be divided in two categories, current and future, or existing and potential, in order to ensure proper identification and control. Indeed, it has been acknowledged that current hazards will more likely be identified following a «data driven» methodology, based on past experience and therefore «reactive» in essence; but that future ones may remain unidentified if no other methodology is developed. It therefore was recommended that the JSSI exercise encompass compatible reactive and proactive methodologies to ensure adequate identification and control of the two types of hazards.

The JAA committee having validated that approach, the JSSI assembly proposed a definition for future hazards-FH- (on the basis of principles ensuring that the whole exercise remains pragmatic) together with a methodology aiming at «revealing» FH. Additionally, the JSSI assembly performed step one of the proposed methodology.

After final review and agreement from the JAA Committee, the process is now at a stage where it was felt necessary to set up an FH ad hoc group to develop further work.

II OBJECTIVES AND TASKS:

1. The FH ad hoc group must review and finalise the here joint principles and definition (annex I) and the methodology (annex II) proposed by the JSSI assembly (the ad hoc group should be free to suggest any adaptation considered as a clarification or an improvement).

2. After completion of task 1, and in the case where the final methodology proposed by the FH ad hoc group will not consist in fundamental changes, the FH ad hoc group must review and then finalise the list of areas of change proposed by the JSSI assembly (annex III). In that respect, the group should consider all means (ad hoc participation to the group, workshop, etc.), and notably those which would permit the widest scope of expertise.

3. After finalisation of the above list, the FH ad hoc group must prioritise and select areas of change.

4. After selection of the areas of change, the FH ad hoc group must propose sub methodologies aiming at revealing FH in each of the selected areas (it must be understood that the areas of change being of different natures, the sub methodologies to be applied in each area might also be of different natures), together with a proposal for bodies and people to be involved in each case.

5. The FH ad hoc group must inform of its work on a regular basis, and formally provide status report after completion of tasks 2 & 4 above, for guidelines from the JSSI SG.

III **MEMBERSHIP:**

The FH ad hoc group is open to all JAA authorities in principle, but the JSSI Assembly recommends that the proposals for nominations from NAA's be based on both «expertise» in the domains foreseen in the list of areas of change, and people's «interest» in this rather new approach in the JAA system.

The FH ad hoc group can only be efficient and pragmatic if the industry, in its widest understanding, agrees with the approach and accepts to commit resources. It is therefore needed to find expertise in most of the domains related to aviation safety, notably those which particularly evolved in recent past (systems technology, organisational approaches, aviation environment...).

The FH ad hoc group is also in principle open to observers, and notably from organisations having interests in aviation safety, such as foreign airworthiness authorities or research bodies having competence in risks analysis.

IV **REPORTING AND TIME SCALE:**

The FH ad hoc group reports to the JSSI steering group, and must complete tasks 1 & 2 within eight months.

V **WORKING METHODS:**

The whole exercise is new and therefore the risk of a metaphysical theory leading to costly and unfounded decisions must strictly be controlled. That leads to both the most accurate utilisation of available resources, and to the recommendation of the widest use of mail, E-mail and telephone work.

Annex D-I : FH AD HOC GROUP PRINCIPLES AND DEFINITION :

Have future hazards never led to any accidents yet? Obviously, FH should include hazards that never led to anything yet, but are they only those? As the JSSI work is organised under the principle of identifying « groups » of errors, the so-called « focus areas », it may well be that some particular accidents were caused by hazards that will, in the future, fall under a new group of errors, a new focus area, or a new « concept »...Not yet identified. FH may have been there but unknown or unseen as themselves.

First principle : Future hazards may include not yet identified existing hazards

It would be, maybe not useless, but definitely costly, to identify potential future hazards without being able to prioritise them in terms of significance. This would be the metaphysical exercise that has to be prevented

Therefore, the concept of FH makes only sense if we are able to identify hazards, at least one, potentially leading to a significant number of fatalities and that we are able to prioritise them.

Second principle : Future hazards are to be considered only when potentially leading to a significant number of accidents or fatalities.

Note : It will be necessary to elaborate on the term « significant ».

On the basis of the fact that a data driven principle may only be efficient where there are data available, it appears that such a principle will never reveal any hazards where there are changes. No data are available at the moment a change occurs.

On the other hand, there seems to be no reason why no data would have been identified and examined in an area where nothing would have changed.

Future hazards are likely to appear where something is changing. Therefore, an orientation for the JSSI work with respect to FH could be given along the lines of the following third principle.

Third principle : Future hazards are undesirable consequences of changes.

Note : « change » must here be understood as widely as possible (change in technics, organisations, environment, etc.). As an example of the wideness of the term change, the Boeing representative in the group specifies that approximately 70% of design related accidents are consequences of a « change » in the assumptions on which the concerned design was made. Another example of that wideness is the safety analysis relative to the obligation for aircraft to carry 8.33 KHZ radio equipment in the European airspace

On the basis of these three principles, future hazards may be defined as follows :

« Future hazards are the undesirable consequences of past or future changes that might lead to a significant number of accidents or fatalities ».

It should be understood that the essence of FH is to be unknown rather than to be not existing. They might exist already, or not, but they are not revealed as such. Therefore, the proactive methodology we are looking for must be developed in order to « find » them. That methodology must be accurate enough not to create « virtual » hazards, but to « reveal » real ones, falling under the above definition.

ANNEX D-II : PROPOSED METHODOLOGY

❶ Identification of areas of changes

Develop a list of areas of changes together with a description of these changes and an Identification of connected and interrelated areas.

❷ Prioritisation and selection of the areas

- nature, density and desirability of change
- trend (back to before, stable, continuing to change)
- moment of the considered change
- around : first priority!
- old : data available somewhere!
- future : can wait!
- regulator of the area
- number of connex areas and degree of influence on them

❸ Sub-methodology for each area selected :

a) Lessons learned if any can the data be made available? how?

b) Brainstorming to develop a method to « reveal » FH in the concerned area of changes
- area of change impacts former assumptions?
- area of change impacts aircraft, ops, crew...
- who is unaware of the change?

c) Determination of the FH by applying the ad hoc method.

d) Prioritisation
- number of potential fatalities
- trend, future existence of the identified hazard?
- geographical area & type of the operation
- size of A/C...
- public perception and understanding
- any effective proposed action?

❹ Synthesis of FH

Combination of results from different areas to avoid redundancy.

❺ Prioritisation of FH

Same as ❸ d) plus effectiveness & feasibility of the proposed action.

❻ Proposed actions
- to the authorities
- to the industry
- to the others

Note : That methodology is not intended to be implemented as such by each of the actors of the aeronautical field. It is known that some of these actors already developed their own system relevant to their scope of activity. This method should be considered as a « provider of FH » to them.

ANNEX D-III : PROPOSED LIST OF AREAS OF CHANGES

The « technology » :

- Increased reliance on systems; greater integration; expert systems; active controls...
- New structural concepts : composites, smart structures...
- New propulsion concepts : propfan, hydrogen fuel...
- Improved general aviation aircraft such as NASA AGATE proof of concept.
- *Ageing aircraft.*
- *Software integrity (number of lines of code increasing exponentially with every new generation).*

The « operations » :

- New operations or development of existing ones : Supersonic, hypersonic, vertical take off and landing, very large transport aircraft, unmanned aircraft, airships...
- *System monitoring and modelling (applying information technology tools to world-wide aviation operations for establishing normal baselines/trends/deviations in operational performances).*

The « crew » :

They are changing (cultures...) and we may want them to change (for instance, anticollision may become flight crew responsibility).

The « passenger » :

He is changing...Can he cause an accident? (crowd control during emergencies, unruly passenger).

The « organisation » :

Is that concept still existing? (virtual airline). Airworthiness responsibilities (OPS/145/21)

The « authority » :

Who is it? ICAO, JAA, EASA, NAA? What should it be doing? (degree of detail of the regulations, working methods, safety management methodologies, priorities...).

The « ATC » :

- air/ground communications.
- IFR/VFR collisions.
- Integration of ground, on board and space systems, compatibility of the various approaches of safety...
- *Capacity (congestion of airspace).*
- ATM 2000 +

The « airport » : Security, handling, passengers...

The « environment » : Atmosphere, economy, public perception, nuisances, terrorism.

Note 1 : Attention should given to the exhaustivity and homogeneity of this list.
Note 2 : « Connex areas » should be identified. For instance, « pilot » leads to « training school » which leads to « instructor », etc.
Note 3 : Items appearing in italics are examples quoted by NASA specialist Michael S. Lewis in an email to John Colomy dated 1/20/99.

ANNEX E

LIST OF WORKING GROUP MEMBERS AND OUTSIDE EXPERTS

WG Members

Mr F	Coudon	DGAC/SFACT/R	France ***(Chairman)***
Mr Y	Morier	JAA Headquarters	The Netherlands **(Secretary)**
Mr R	Ablett	CAA (Research Committee)	United Kingdom
Mr J R	Colomy	Federal Aviation Administration	Belgium
Mr C	Hedges	FAA	USA
Mr R den	Hertog	Fokker Services (AECMA)	The Netherlands
Mr J	Jedrzejewski	General Inspectorate of Civil Aviation	Poland
Mr S	Mineo	ENAC	Italy
Mr K L	Olsen	Federal Aviation Administration	USA
Mr G	Rebender	JAA Headquarters	The Netherlands
Capt J	Schmid	Swissair (AEA)	Switzerland
Mr C	Schmitt	Airbus Industries HQ, AI/EA-R	France
Mr V P	Schultz	NASA Langly	USA
Mr E	Schwartz	Boeing Commercial Airplane Group	USA
Mr B	Smith	NASA Ames Research Centre	USA
Mr S	Smith	FAA	USA
Mr A J	Troughton	IFA	United Kingdom
Mr J	Vazquez	EUROCONTROL	Belgium
Mr R	Visser	Fokker Services (AECMA)	The Netherlands
Mr J-P	Weitz	Luxair (AEA)	Luxembourg

Outside Experts:

Mr J	Caraballo	NASA	USA
Mr J	Dalton	Boeing	USA
Mr C	Frantzen	EDF (French Nuclear Electricity Operator)	France
Mr	Gicquel	CEA (Comité Européen des Assurances)	France
Mr J	Magny	European Space Agency – *(retired)*	The Netherlands
Mr B	Munier	Cachan University	France
Mr G	Won	FAA	USA

ANNEX F

INTERACTIONS BETWEEN AREAS OF CHANGE (PRELIMINARY)

See other file: "Annex_F.xls"

ANNEX G

COMMENT RESPONSE DOCUMENT
ESTABLISHED FOLLOWING CONSULTATION ON THE MATRIX

1. INTRODUCTION

A gist of the comments received from each commentator is provided, together with the response from the Future Hazards Working Group.

2. JAA ENGINE STUDY GROUP

The JAA Engine Study Group (ESG) identified large flocking birds as a growing. This is more a hazard than a change, and has been quoted in the comment column of AP4 (trend towards siting of runways adjacent to bodies of water). Another item identified by ESG is Electromagnetic interference from High Intensity Radiated Field. This item has been added in the comment column of item E21.

3. JAA MAINTENANCE COMMITTEE

The JAA Maintenance Committee stated that modification by non-TC holders is already well regulated. This was added to the Comment column relative to AC23.
They also stated un-approved parts being a well documented hazard it should not be part of a Future Hazards list as there is currently no evidence that the problem will increase. The comment column relative to item AC25 was modified to reflect this. (may become).

In the same manner they suggested that action is being taken in relation with ageing systems. This should be added to the comment column for the corresponding item (AC26) by referring to the US ASTRAC body.

They questioned the rationale relative to the decreasing cultural awareness. This item was made more general (Changes instead of decrease) and introduced in the Environment category as item E31.
They identified two further items:
- reduction of turn around at airports
- noise constraints

The first one has also been identified by the JAA D and F Study Group and was added to the Comment column of E1 (Increased pressure to improve aviation system throughput and flight safety). The second one is covered by the item "increasing stringent noise constraints" and their comment would be added to the Comment column (see item E11).

4. JAA D & F STUDY GROUP

The JAA D and F SG proposed to add a new item relative to very large engines. This was added to the comment column of AC19 (new higher energy propulsion and control systems).They also proposed to add a new item for large aeroplanes (e.g. JAR-25 aeroplanes): new design concept. This is covered by the very large aircraft item.

They also proposed to add two new items in the Aircraft category:
- increased number of electrical systems within the cabin
- increased use and reliance on analytical technique.

The first item is covered by item P7 “increasing use of personal electronic devices” in the Passenger category.

The second one lead to a revision of the item “Decreasing aircraft design expertise” which made it more general (operations were added). As a consequence the item was introduced in the Environment category as item E29. The specific point raised by the JAA D and F Study Group was introduced in the Comment column for the item E29.

They proposed also two more general items: "Risk sharing/increased use of subcontractors" and “very hard competition”.
The first item is covered by item “increased incentive to outsource airline activities” in the Organisation category (OR1).
The second one is covered” by item “increased pressure to improve aviation system throughput and flight safety” in the category Environment/Aviation Context.

They proposed to add two items in the Operation category:

- pressure for faster ground handling
- faster turn around time

These two items seem related and have also been proposed by the JAA Maintenance Committee.
Finally they suggested adding in the Authority category a new item: “Availability of specialist resources”.
This item lead to a long debate relative to the opportunity of creating a new item or including their proposal into the comment column of an already existing item. It was agreed that the issues was a consequence of increasingly higher products life cycle which issue is already reflected in the Comment column for item E29 (Decreasing aircraft design and operational expertise).

5. <u>US REGIONAL AIRLINE ASSOCIATION</u>

The US Regional Airline Association found items in relation to regional jets confusing at least and misleading at worst.
The Future Hazards Working Group has provided the following response:

- Modify the comment column in AC3 (rapid growth in use of advanced regional jets) to better reflect the issues.
- Answers to the Regional Airline Association specific comments:

  Of the four mentioned manufacturers, only BAe has manufactured these hull type airplanes for years. Bombardier has made corporate jet aircraft, while their Regional Jet experience is fairly recent. While the CRJ-700 and –900 versions will be derivatives, the BRJ-X is all new in the same style as the Embraer ERJ-170 and Fairchild Dornier 728 families. We have tried to illustrate the risks associated with these all new designs and this is reflected in the modified wording of the Area of change, see above.

6. EUROPEAN COCKPIT ASSOCIATION

The European Cockpit Association urged for caution in the exercise. This is agreed: the JAAC asked for a prudent approach. They also make comments in relation with several items in the crew category that were taken into account to improve the Comment column.

7. MR. FRANTZEN

Mr. Frantzen offered to following comments:

- Progress on modelling and testing : Together with the above comment from the JAA D and F Study Group, this lead to a considerable revision of the item “Decreasing aircraft design expertise” and its generalisation as item E29.
- Incorrect assumptions: This was introduced in the Comment column for item E29.
- Impact of the software industry: This comment was used to improve item E8 (COTS) and E9 (rapid pace of software and technology improvement) of Environment category.
- Unification of Computer Aided Design (CAD) and Loss of Influence of rules of the art not incorporated in CAD. This item was added in the Aircraft Category as item AC16.
- Lack of capability for crew to develop synthetic view on the actual operation.
- Too many modes of operators leading to loss of awareness of the system states: These two comments were introduced into the Comment column of item C3 (Increasing Amount of information available to Flight Crew) of the Crew category.
- Increased criminal liability: This comment is covered by item E3 (Change in public perception of Aviation Safety/liability and changes in judicial and legislative attitudes) of Environment category.
- Wrong devolution of priorities under pressure of public opinion: This comment has been introduced into the Comment column of item E3.

8. JAA HUMAN FACTORS STEERING GROUP

The JAA Human Factors Steering Group proposed a comprehensive set of comments that were taken into account to improve the matrix.