MINISTRY OF TRANSPORT AND COMMUNICATIONS

REPUBLIC OF THE UNION OF MYANMAR

AIRCRAFT ACCIDENT INVESTIGATION BUREAU

GUIDELINES FOR SAFETY RECOMMENDATIONS

Effective Date- 22nd September 2020 First Edition

SECTION 0	**: MANUAL ADMINISTRATION**
CHAPTER 1	**: FOREWORD**

1. These guidelines for safety recommendations are an internal document of the Aircraft Accident Investigation Bureau (AAIB) of Myanmar. These contain guidance material relating to validation of a safety issue/deficiency, safety recommendation addressees, writing safety recommendations, measuring the success of the recommendations ,and examples of safety recommendation of global concern.

2. Except for material which has been approved for public distribution, the contents of these guidelines are not intended to be communicated to persons outside the AAIB without the consent of the AAIB.

3. These guidelines are not regulatory in nature and are not a binding statement of policy, and are not all inclusive. Deviation from the guidance offered in these guidelines may at times be necessary to meet the specific needs of an investigation.

4. These guidelines will be revised when necessary. The Investigators of Accidents and AAIB officers are encouraged to contribute ideas for improving the contents of these guidelines.

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SECTION 0 : MANUAL ADMINISTRATION
CHAPTER 4 : AMENDMENT RECORD

Amendment No.	Date of issue	Date entered	Entered by

SECTION 1	**: PRINCIPLES OF SAFETY COMMUNICATION**
CHAPTER 1	**: GENERAL**

1. The purpose of accident and incident investigations is to advance safety by identifying safety issues, deficiencies and underlying/contributing factors that pose a risk to future operations. The State conducting the investigation, at any stage of the investigation of an accident or incident, shall recommend any preventive action that it considers necessary to be taken promptly to enhance aviation safety.

2. The purpose of safety communication is to ensure that identified risks are communicated to those entities or organizations best able to effect change and to convince them to take remedial safety action. Safety communication can be formal, semi-formal or informal and may take many forms, such as investigation team discussions, briefings, written interim statements and safety advisories, and formal safety recommendations. The form and timing of safety communication is influenced by the degree of risk associated with the underlying safety issue.

3. The openness of Annex 13 investigations and the involvement of stakeholders in the investigation process should encourage the involved organizations/stakeholders to take action before a recommendation is made. In fact, some investigation authorities view having to resort to formal recommendations as being a failure of less formal communications to produce change.

4. The failure to take immediate actions may be an indicator that the involved organizations/stakeholders are not convinced that action is required or that the changes required are, or are viewed to be, very difficult to achieve. Therefore, the investigation authority’s recommendations must be close to perfect to achieve positive results.

5. A formal safety recommendation would be the appropriate type of safety communication for safety issues/ deficiencies assessed as posing a high risk to the conduct of air operations.

6. The remainder of this document will concentrate on guidelines on the identification, drafting and follow-up of safety recommendations.

SECTION 1	**: PRINCIPLES OF SAFETY COMMUNICATION**
CHAPTER 2	**: DEFINITIONS**

Accident investigation authority. The authority designated by a State as responsible for aircraft accident and incident investigations within the context of this Annex 13.

Aircraft. Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface.

Causes. Actions, omissions, events, conditions, or a combination thereof, which led to the accident or incident. The identification of causes does not imply the assignment of fault or the determination of administrative, civil or criminal liability.

Contributing factors. Actions, omissions, events, conditions, or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the accident or incident occurring, or mitigated the severity of the consequences of the accident or incident. The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil or criminal liability.

Safety recommendation. A proposal of an accident investigation authority based on information derived from an investigation, made with the intention of preventing accidents or incidents and which in no case has the purpose of creating a presumption of blame or liability for an accident or incident. In addition to safety recommendations arising from accident and incident investigations, safety recommendations may result from diverse sources, including safety studies.

Safety Recommendation of global concern (SRGC). A safety recommendation regarding a systemic deficiency having a probability of recurrence, with significant consequences at a global level, and requiring timely action to improve safety.

SECTION 2	**: VALIDATION OF A SAFETY ISSUE/DEFICIENCY**
CHAPTER 1	**: GENERAL**

1. The following are steps that would assist in determining the requirement and bases for a safety recommendation:

a) Using the information determined by the investigation, determine the history of the flight of the aircraft and the pre-flight, in-flight and post-flight events that contributed to the adverse consequences related to the occurrence;
Note: An event describes a happening or an action step in a sequence of actions that lead to or could lead to an occurrence.

b) From the list of events, determine the safety significant events. Safety significant events would include but not be limited to events:

- that are undesirable from a risk perspective;
- that are potentially linked as an antecedent to another undesirable event;
- that are non-standard or unusual; or
- where one or more alternative actions or options are available;

c) For the safety significant event of interest, determine the underlying factors that contributed to or facilitated the event;

d) For the underlying factor of interest, determine the level of risk. Risk can be defined in terms of two components: the probability that the underlying factor will lead to an adverse consequence and the severity of that adverse consequence;
Note: ICAO Safety Management Manual (Doc 9859) provides guidance on the risk assessment process

e) For the underlying factor of interest, determine the availability and the effectiveness of physical or administrative defences needed to limit, reduce or prevent unwanted consequences;

f) For the underlying factor of interest, validate the safety deficiency. This validation is based on the results of risk analysis and defence analysis above. A safety deficiency is an underlying factor with risks for which the defences are less than adequate;

g) For each safety deficiency, determine possible risk-control options that have the potential to mitigate the risk of the safety deficiency contributing to a future occurrence. Each risk-control option must be critically evaluated to determine the benefits that would result from the control option, the administrative and financial feasibility and the reasonableness of the control option; and

h) Based on the preceding analyses, determine the risk-control option that has the best potential for mitigating the risk associated with the validated safety deficiency.

2. In summary, a safety recommendation would be warranted if the analysis of the investigation information determines the existence of an underlying factor(s) with high risks and for which the defences are less than adequate. A safety recommendation would be issued at any time during the investigation whenever it is assessed that there is an immediate risk to the conduct of air operations and an urgent need for immediate formal communications with the action addressee responsible for the matter. A safety recommendation would be made in the Final Report of the investigation in situations wherein immediate action is not needed or wherein the deficiency is not clearly defined and justified until the Final Report stage. See Figure 1 for a flow diagram of the steps to determine the requirement and bases for a safety recommendation.

SECTION 3	**: SAFETY RECOMMENDATION ADDRESSEES**
CHAPTER 1	**: SAFETY RECOMMENDATION ACTION ADDRESSEES**

1. Safety recommendations must be communicated to the entity or organization that is best able to take action to mitigate the risks, has the authority and responsibility to take remedial action and has the mandate to take action that will have the broadest impact.

2. There should only be one principal action addressee for each recommendation. Having multiple addressees will result in a situation where there could be uncertainty as to what addressee is responsible for taking safety action. Having multiple principal action addressees also will make it difficult to track and evaluate action taken in response to the recommendation. In such situations, it would be preferable to send the recommendation independently to each addressee. Alternatively, one addressee could be designated as the lead action addressee and the other addressees designated as support action addressees.

3. For SRGCs, the action addressee normally would be the State civil aviation authority responsible for the certification and oversight, in part, of the design, manufacture, maintenance and/or operations of the aircraft or facilities involved in the occurrence. For other safety recommendations, the action addressee could be, but not be limited to, the air operator, manufacturer, maintenance organization, air traffic services provider and airport operator. ICAO would be the action addressee for recommendations related to the international Standards and Recommended Practices contained in the Annexes to the Convention on International Civil Aviation and perceived deficiencies in ICAO guidance material.

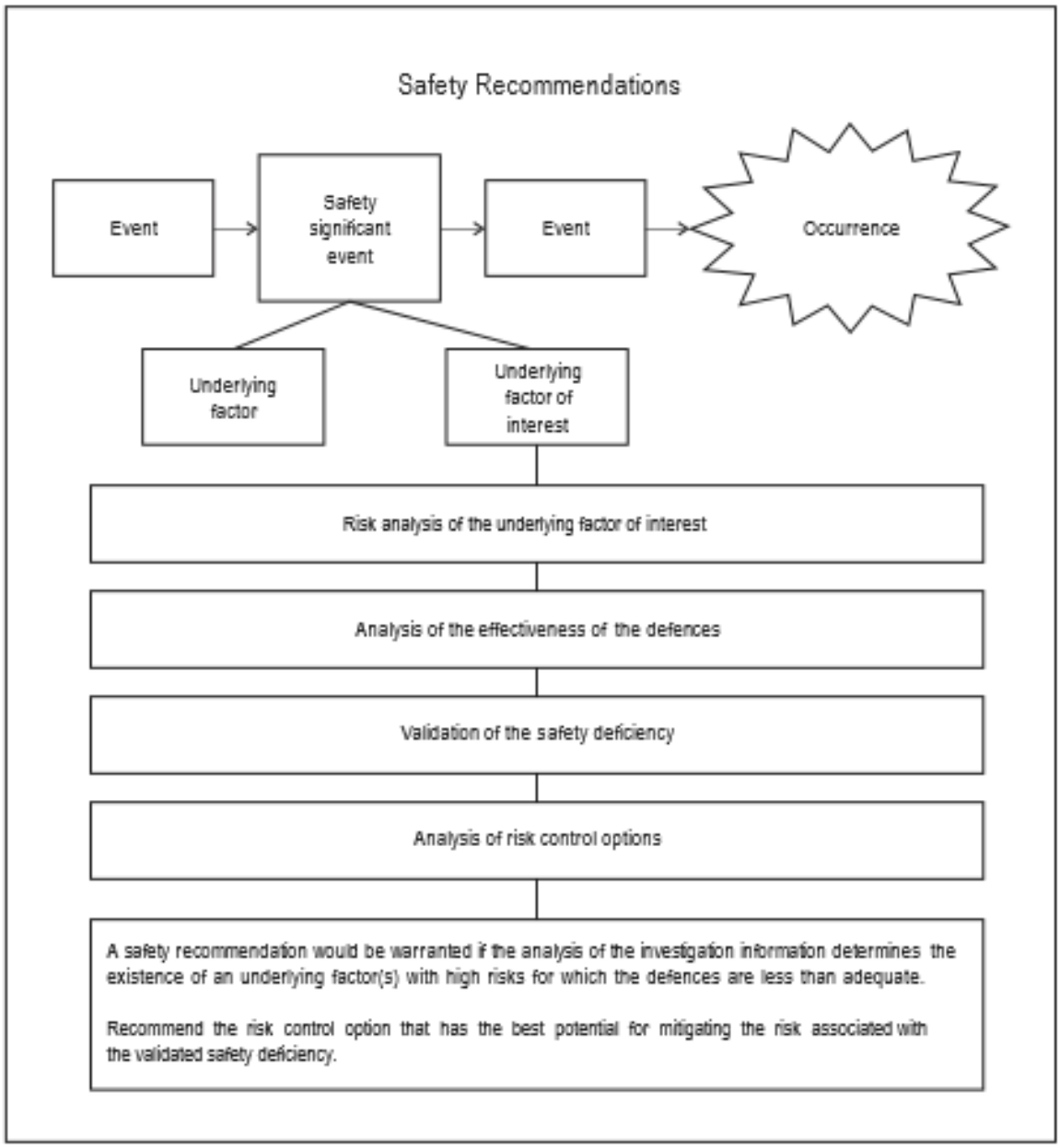

Figure 1. Steps to determine the requirement and bases for a safety recommendation

SECTION 3	**: SAFETY RECOMMENDATION ADDRESSEES**
CHAPTER 2	**: SAFETY RECOMMENDATION INFORMATION ADDRESSEES**

For the purpose of advancing the safety of operations, copies of the safety recommendation also should be sent to those persons or organizations of the aviation community that have a direct interest in the safety issue or who would benefit from the information that was the basis for the safety recommendation. Information addressees could be, but is not limited to, the following: involved government departments; involved States and accident investigation authorities; and involved stakeholders, such as the airline, maintenance organization, manufacturer, air traffic services provider, and airport operator.

SECTION 4	**: WRITING SAFETY RECOMMENDATIONS**
CHAPTER 1	**: FRAMEWORK OF A SAFETY RECOMMENDATION**

To be effective, a safety recommendation must present a compelling argument for safety action to mitigate the risks identified by the investigation. A clear, succinct and well-structured safety communication would facilitate this objective. The following is a suggested framework for a safety recommendation, including guidelines as to the type of information that should be included:

a) The background section should include the following:

- A summary of the occurrence, including the date, aircraft type and location of the occurrence. This summary should describe what happened, not why it happened. This section should also identify the investigation authority, the investigation number and the status of the investigation;
- The safety significant event associated with the safety issue, along with the adverse consequence(s) that resulted from the associated unsafe condition;
- The associated safety deficiency(ies), if any; and
- The immediate circumstances that led to the adverse consequence.

b) The supporting information section should include the following:

- Historical evidence of the risks and consequences, by referring to other occurrences where similar circumstances resulted in adverse consequences, to demonstrate that this was not just an isolated occurrence;
- Information as to how the number of such accidents has varied over time, by geographic area, by aircraft type and by type of operation. This section should also include a description of the adverse consequences associated with the occurrences. This information establishes the probability of adverse consequences, and the severity of the consequences in terms of historical evidence; and
- The risk control options currently in use and the effectiveness of these options, if applicable.

c) The deficiency analysis section should include the following:

- The unsafe condition/factor underlying the safety significant event;
- The shortcomings of prior actions taken, if any;
- The inadequacies of existing defences; and
- The residual risk.

d) The safety recommendation section should include the following:

- A summary of the safety deficiency statement, including the unsafe condition, inadequacies of defences, and the residual risk (of adverse consequences) if no action is taken; and
- The recommended safety action (risk-control options), including the performance expectations.

e) Attachments supporting the integrity of the factual information and argument for change could be appended to the recommendation document, such as, but not limited to, statistics, lists of similar previous occurrences, technical and scientific analyses, and flight data recorder printouts and analyses.

Note: For safety recommendations issued in Final Reports, the above information should be included in the factual information, analysis, conclusions, recommendations and attachments sections of the Final Report.

SECTION 4	**: WRITING SAFETY RECOMMENDATIONS**
CHAPTER 2	**: COVERING LETTER FOR SAFETY RECOMMENDATIONS**

The covering letter for the safety recommendation should include the following information:

a) The specific addressee, who should be the head official of the organization and who is best suited to implement the required safety action. This could be, but is not limited to, the following: the government minister, director general, secretary general or chief executive officer;

b) The date;

c) The occurrence summary (see framework section);

d) The purpose of the safety recommendation;

e) The safety deficiency statement;

f) The recommended safety action(s); and

g) The requirement to respond within 90 days regarding:

- actions taken; — actions planned, including alternative actions, if applicable; or
- reasons why no action will be taken.

Note: For safety recommendations issued in the Final Report, a separate cover letter should be sent to each head official deemed responsible for taking action on a safety recommendation.

SECTION 4	**: WRITING SAFETY RECOMMENDATIONS**
CHAPTER 3	**: DISTRIBUTION OF SAFETY RECOMMENDATIONS**

1. Copies of the safety recommendation should be sent to persons or organizations in the aviation community that have a direct interest in the safety issue which was the basis for the safety recommendation, as well as to other members of the aviation community who would benefit from the information, including but not limited to, the following:

   a) The safety recommendation action addressee;

   b) Involved government departments;

   c) Involved States and accident investigation authorities;

   d) Involved stakeholders, such as, but not limited to, the airline, maintenance organization, manufacturer, air traffic services provider and airport operator; and

   e) Others who may benefit from lessons learned.

2. The ICAO Accident Investigation Section must be provided with a copy of each SRGC.

3. Some accident investigation authorities post their safety recommendations on a website.

SECTION 5	**: MEASURING THE SUCCESS OF THE RECOMMENDATIONS**
CHAPTER 1	**: GENERAL**

The purpose of a safety recommendation is to ensure that identified risks are communicated to those entities or organizations best able to effect change and to convince them to take remedial safety action. In this regard, the issuance of safety recommendations by the investigation authority can be viewed as the most important output of the investigation. The full potential of recommendations to prevent future accidents and incidents cannot be realized until appropriate safety action to mitigate the risks underlying the recommendation is taken by the entity to which the recommendation was issued. Measuring the effectiveness of safety recommendations to achieve positive changes requires an evaluation of the actions taken against the performance expectations of the safety recommendation. Refer to Figure 2 for a flow diagram for tracking safety recommendations.

SECTION 5	**: MEASURING THE SUCCESS OF THE RECOMMENDATIONS**
CHAPTER 2	**: MANDATING RESPONSES TO SAFETY RECOMMENDATIONS**

1. ICAO Annex 13 requires that a State that receives safety recommendations shall inform the proposing State, within 90 days of the date of the dated transmittal correspondence, of the preventive action taken or under consideration, or the reasons why no action will be taken. In most States, the State civil aviation authority is responsible for ensuring compliance with this Standard; in other States the State accident investigation authority is the entity responsible.

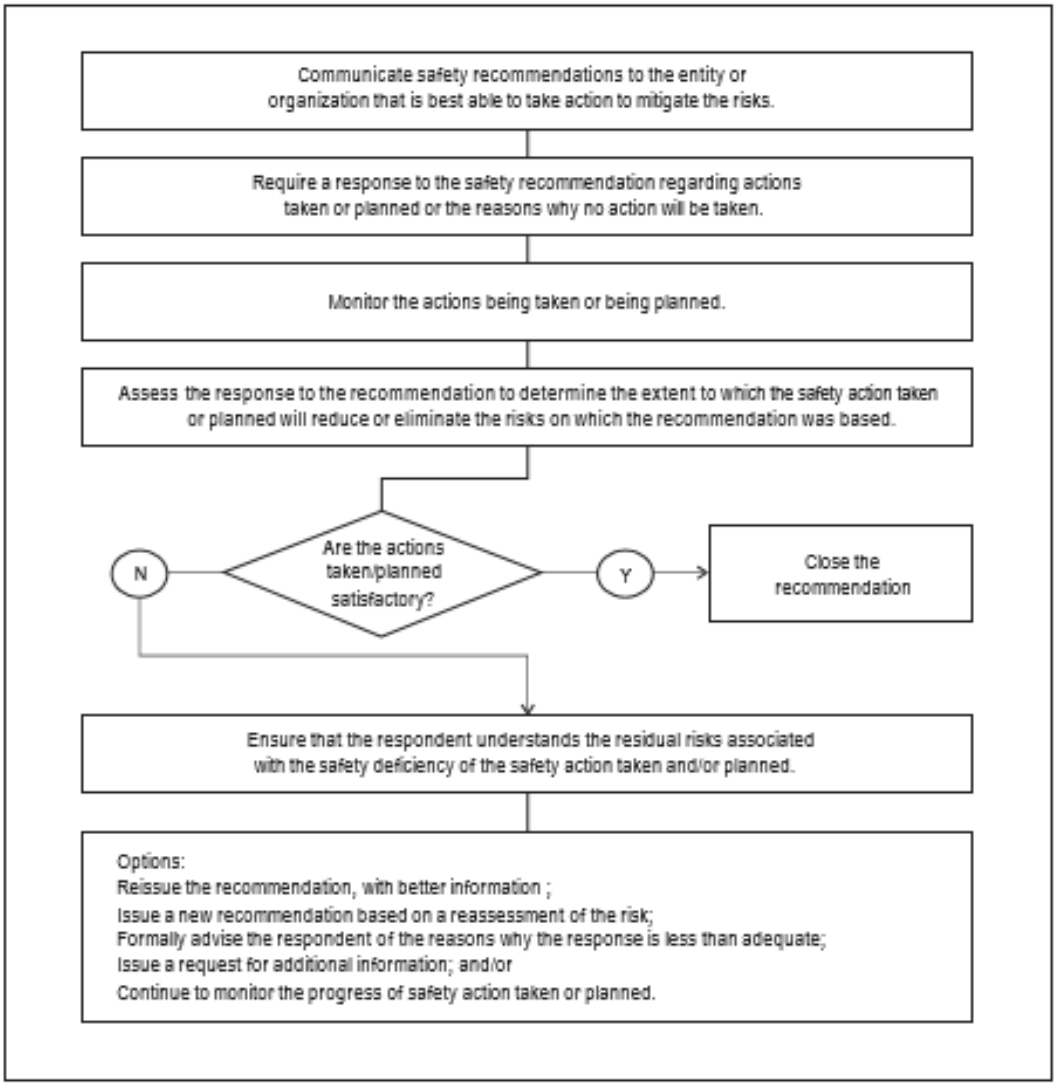

Figure 2. Flow diagram for tracking safety recommendations

2. Some accident investigation authorities post the responses to safety recommendations on a website.

SECTION 5	**: MEASURING THE SUCCESS OF THE RECOMMENDATIONS**
CHAPTER 3	**: MONITORING THE PROGRESS OF ACTION TAKEN**

1. Annex 13 states that a State that receives a safety recommendation shall implement procedures to monitor the progress of the action taken in response to that safety recommendation. Annex 13 also states that a State conducting the investigation, or any other State issuing a safety recommendation, shall implement procedures to record the responses to the safety recommendation issued. In some States, the State accident investigation authority is responsible for ensuring compliance with these Standards; in other States, the State civil aviation authority is the entity responsible.

2. Notwithstanding the Annex 13 provisions, it would be prudent for the accident investigation authority that issued the safety recommendation to establish a direct staff-level liaison with the accident investigation authority of the State responsible for responding to the recommendation in order to arrange for routine updates as to the status of the action taken and/or action planned.

3. For situations where a response is not received within the prescribed 90 days, it would be prudent for the State that issued the recommendation to formally request a status report from the action addressee to which the safety recommendation was made. If there is a significant change in the action taken or under consideration, the addressee of the recommendation should inform the authority making the recommendation of the changes, including reasons why the proposed action has changed.

4. Some accident investigation authorities post the responses to recommendations on a website.

SECTION 5	**: MEASURING THE SUCCESS OF THE RECOMMENDATIONS**
CHAPTER 4	**: ASSESSING RESPONSES AND ACTION TAKEN**

1. It would be prudent for the accident investigation authority that issued the recommendation to have a process and guidelines for assessing responses to recommendations. The purpose of evaluating the safety action taken and/or planned is simply to determine whether further safety action is required.

2. The following is a suggested process for assessing responses to recommendations:

a) Review the recommendation to confirm the performance expectations of the recommendation;

b) Review the response to the recommendation to determine the extent to which the addressee has accepted the existence of the safety deficiency underlying the recommendation;

c) Assess the extent to which the safety action taken, or planned, will reduce or eliminate the risks on which the recommendation is based;

d) Reassess the residual risks associated with the safety deficiency, taking into account the safety action taken and/or planned; and

e) Categorize the response in terms of risk mitigation.

3. Some accident investigation authorities assign category of risk mitigation to the responses to safety recommendations, such as “satisfactory”, “partly satisfactory” or “unsatisfactory”. Some accident investigation authorities post the category of risk mitigation on a website.

4. Some accident investigation authorities assign a status to each recommendation, such as “open” or “closed”. Some accident investigation authorities post the status of their recommendations on a website.

5. Some accident investigation authorities inform the State responding to a recommendation, in writing, of their assessment of the response. Some accident investigation authorities post the assessments of the responses to their recommendations on a website.

Note: Prior to making public its assessment of responses to its recommendations, it would be prudent for the accident investigation authority to provide advance notice to the State responding to the recommendation of its intent to do so. (Additional guidance can be found in the next section regarding the follow-up to situations wherein the action taken/planned in response to a recommendation is less than adequate.)

6. For each SRGC, the State that issued the recommendation should provide the ICAO Accident Investigation Section with a copy of the responses to its recommendation, the State's assigned category of risk mitigation of the action taken, and the status of the recommendation.

SECTION 5	**: MEASURING THE SUCCESS OF THE RECOMMENDATIONS**
CHAPTER 5	**: FOLLOW-UP TO LESS-THAN-ADEQUATE ACTION TAKEN/ PLANNED**

1. If it is assessed that a response to a safety recommendation is less than adequate, it would be prudent for the investigation authority to contact the authority responsible for taking action on the recommendation to ensure that:

a) the recipient of the recommendation understands the recommendation and the risk level associated with the safety deficiency;

b) the accident investigation authority that issued the recommendation understands the substance of the response to the recommendation, including the potential of the action taken and/or action planned to mitigate risk; and

c) the recipient of the recommendation understands the residual risks associated with the safety deficiency, taking into account the safety action taken and/or planned.

2. The follow-up options to a less-than-adequate response would vary based on the level of residual risk and the urgency for additional safety action. The following are some options that should be considered:

a) Reissue the recommendation, with changes, additional clarification and/or better information;

b) Issue a new recommendation based on a reassessment of the risk of the underlying deficiency;

c) Formally advise the action addressee of the recommendation as to the investigation authority's assessment of the response, including the reasons why the response is less than adequate;

d) If appropriate, inform ICAO and/or other States about a less-than-adequate response to a recommendation;

e) Issue a request for additional information from the safety recommendation action addressee; and/or

f) Continue to monitor the progress of the safety action taken or planned.

SECTION 6	**: ADDITIONAL GUIDANCE ON SAFETY RECOMMENDATIONS**
CHAPTER 1	**: QUALITIES OF A GOOD SAFETY RECOMMENDATION**

The following are some qualities of a good safety recommendation:

a) There is a clear and positive link to a safety significant event:

- The challenge is to convince the unconvinced;
- The potential for a safety recommendation to achieve change will be adversely affected if the underlying factor is not directly linked to the safety significant event; and
- The logic of the argument to achieve change must be concise and clear.

b) Data are accurate and indisputable:

- All data must be validated and carefully scrutinized.

c) The analysis is sound:

- Use of assumptions or stretching data weakens the safety recommendation and reduces the chances that appropriate action will be taken.

d) The safety recommendation is addressed to the entity best able to take the corrective action.

e) The recommendation is achievable:

- It will be a waste of effort to produce an unachievable recommendation;
- An unachievable recommendation will diminish the credibility of the accident investigation authority; and
- It is inadvisable to shy away from issuing recommendations on difficult issues.

f) There is a significant risk in being too prescriptive:

- The action addressee is likely in a better situation to determine the most appropriate method to mitigate the risk; and
- The credibility of the accident investigation authority may be at risk.

g) A performance-based recommendation will make the action taken in response to a recommendation more measurable by both the accident investigation authority and the safety recommendation action addressee.

h) A good recommendation is one that is written in a way that clearly states:

- The deficiency (underlying factor and residual risk);
- The action required to mitigate the risk (or to make the risk tolerable); and
- The expected result of action being taken.

SECTION 6	**: ADDITIONAL GUIDANCE ON SAFETY RECOMMENDATIONS**
CHAPTER 2	**: CHARACTERISTICS OF A WEAK RECOMMENDATION**

The following are some characteristics of a weak safety recommendation:

a) The action addressee is not identified:

- There will be uncertainty as to who is responsible for taking the recommended safety action; and
- There is a risk that no one will take on this responsibility and no action will be taken.

b) Too many action addressees:

- There will be uncertainty as to who is responsible for taking the recommended safety action and/or who will take the lead in coordinating the safety action to be taken.

c) The action addressee does not have the mandate to mitigate the identified deficiency:

- There is significant risk that safety action will not be taken.

d) The addressee is not the one that can correct the deficiency on a systemic level:

- There is significant risk that safety action will not be taken at the systemic level.

e) The factual information is incorrect or inappropriately skewed:

- The recommendation will lack credibility and no one will take action.

f) The logic linking facts, analysis and conclusions is flawed:

- The recommendation will lack credibility and no one will take action.

g) The risk or consequences are exaggerated:

- The recommendation will lack credibility and no one will take action.

h) The recommendation is not based on a finding or a cause/contributing factor:

- The recommendation will be interpreted as having a low priority; and
- The safety action will be delayed or not taken at all.

i) The recommendation is too specific:

- The recommended safety action might not be the best option available to correct a systemic deficiency.

j) The recommendation is too broad:

- It will be difficult to determine the best option to mitigate the risk; and
- Assessing the suitability of the safety action taken will be more difficult.

k) The recommended action is not achievable:

- The recommendation will lack credibility and no one will take action; and
- The credibility of future recommendations by the accident investigation authority could be at risk.

l) The performance expectations of the recommendation are unclear:

- It will be more difficult to determine the best option to mitigate the risk; and
- It will be more difficult to assess whether the safety action taken meets the expectations of the recommendation.

m) Too many recommendations in a report:

- Having too many recommendations will possibly dilute their overall importance.

n) Recommendations made on low-risk issues:

- The recommendations collectively will be deemed to be of low priority; and
- The credibility of future recommendations by the accident investigation authority could be at risk.

o) A recommendation based on a single, local event:

- The recommendation will be deemed as being low priority; and
- The safety action will be delayed or not taken at all.

p) The recommendation is not clearly identified as such:

- There is a risk that such recommendations will be overlooked; and
- There is a risk that no safety action will be taken.

SECTION 7	**:**	**EXAMPLES OF SAFETY RECOMMENDATIONS OF GLOBAL CONCERN**
CHAPTER 1	**:**	**UNITED KINGDOM AIR ACCIDENTS INVESTIGATION BRANCH (AAIB) SAFETY RECOMMENDATION 2009-029**

1. B 777-236ER, Engine rollback, Heathrow, 17 January 2008, 152 on board

1.1 While the aircraft was on final approach at 720 ft agl, the right engine suffered an uncommanded reduction in engine power to 1.03 EPR, and seven seconds later, the left engine suffered an uncommanded reduction in engine power to 1.02 EPR. The investigation identified that the following probable causal factors led to the fuel flow restrictions:

- Accreted ice from within the fuel system released, causing a restriction to the engine fuel flow at the face of the fuel oil heat exchanger, on both of the engines; and
- Certification requirements, with which the aircraft and engine fuel systems had to comply, did not take account of this phenomenon as the risk was unrecognized at that time.

1.2 Several recommendations were raised that are of global concern. The safety issues are related to systemic deficiencies in fuel system design and crashworthiness, which had already been evident in previous accidents on other types. The issue was wide ranging and affected all aircraft and engines; in addition, the crashworthiness was significant for all types as well. Timely action was needed to prevent recurrence. The safety recommendations were as follows:

- Safety Recommendation 2008-049: It is recommended that the Federal Aviation Administration and the European Aviation Safety Agency review the current certification requirements to ensure that aircraft and engine fuel systems are tolerant to the potential build up and sudden release of ice in the fuel feed systems.
- Safety Recommendation 2009-096: It is recommended that the Federal Aviation Administration, in conjunction with the European Aviation Safety Agency review the requirements for landing gear failures to include the effects of landing on different types of surface.

- Safety Recommendation 2009-098: It is recommended that the Federal Aviation Administration and the European Aviation Safety Agency, review the qualification testing requirements applied by manufacturers to cabin fittings, to allow for dynamic flexing of fuselage and cabin structure.
- Safety Recommendation 2009-031: It is recommended that the Federal Aviation Administration and the European Aviation Safety Agency jointly conduct research into ice formation in aviation turbine fuels.
- Safety Recommendation 2009-030: It is recommended that the Federal Aviation Administration and the European Aviation Safety Agency conduct a study into the feasibility of expanding the use of anti ice additives in aviation turbine fuel on civil aircraft.
- Safety Recommendation 2009-032: It is recommended that the Federal Aviation Administration and the European Aviation Safety Agency jointly conduct research into ice accumulation and subsequent release mechanisms within aircraft and engine fuel systems.

2. Boeing 737-86J, took off with insufficient thrust for the environmental conditions and struck an obstacle after lift-off, 21 July 2017.

2.1 The Boeing 737-800 took off with insufficient power to meet regulated performance requirements. The aircraft struck a supplementary runway approach light, which was 36 cm tall and 29 m beyond the end of the take-off runway.

2.2 The investigation found the following causal factors for this serious incident:

- An incorrect OAT was entered into the FMC, which caused the FMC to calculate an N1 setting for take-off which was significantly below that required for the aircraft weight and environmental conditions.
- The incorrect OAT was not identified subsequently by the operating crew.
- The abnormal acceleration during the take-off run was not identified until the aircraft was rapidly approaching the end of the runway, and no action was taken to either reject the take-off or increase engine thrust.

2.3 The investigation found the following contributory factors for this serious incident:

- The aircraft's FMC did not have the capability to alert the flight crew to the fact that they had entered the incorrect OAT into the FMC, although this capability existed in a later FMC software standard available at the time.

- The Electronic Flight Bags (EFB) did not display N1 on their performance application (some applications do), which meant that the crew could not verify the FMC-calculated N1 against an independently-calculated value.

2.4 The investigation identified other examples of accidents or serious incidents where there was a gross failure of an aircraft to achieve its expected take-off performance, and found that technical solutions to address this serious safety issue are now feasible.

2.5 Some recommendations were made that are of global concern as the issues were due to systemic deficiencies related to take-off performance which was endemic, it was also clear that other AIAs had raised similar issues with other investigations, so the need for timely action is evident. These recommendations focused on take-off acceleration monitoring.

2.6 Safety Recommendation 2018-014: It is recommended that the European Aviation Safety Agency, in conjunction with the Federal Aviation Administration, sponsor the development of technical specifications and, subsequently, develop certification standards for a Take-off Acceleration Monitoring System which will alert the crew of an aircraft to abnormally low acceleration during take-off.

2.7 Safety Recommendation 2018-015: It is recommended that the International Civil Aviation Organization note the conclusions of this report and introduce provisions addressing Take-off Acceleration Monitoring Systems.

SECTION 7	**: EXAMPLES OF SAFETY RECOMMENDATIONS OF GLOBAL CONCERN**
CHAPTER 2	**: AUSTRALIAN TRANSPORT SAFETY BUREAU (ATSB) SAFETY RECOMMENDATION**

1. B-747-438 Water leak, Bangkok, 7 January 2008, 346 passengers, 19 crew

1.1 Significant safety issue: The United States Federal Aviation Administration regulations and associated guidance material did not fully address the potential harm to flight safety posed by liquid contamination of electrical system units in transport category aircraft.

1.2 The ATSB considers that the risk of ongoing or emerging design, operation and maintenance issues with the potential to result in liquid contamination of electrical system units in transport category aircraft could be significantly reduced over time by improved regulatory guidance and oversight. For example, existing designs and processes should be monitored for continuing effectiveness while consideration of alternative design principles may be applied to new aircraft designs.

1.3 ATSB Recommendation issued to: U.S. Federal Aviation Administration.

1.4 The Australian Transport Safety Bureau recommends that the U.S. FAA take safety action to address this safety issue.

2. Runway excursion involving Boeing 737, Darwin Airport, Northern Territory, 6 December 2016.

2.1 Background: The flight crew established and maintained clear visual reference to the 60 m wide runway and surrounds until they encountered heavy rain shortly before reaching the runway threshold. Under the influence of a light but increasing crosswind, the aircraft drifted right without the flight crew being able to discern the extent of the drift. The aircraft landed 21 m to the right of the runway centre line and, shortly after touchdown, the right landing gear departed the sealed surface of the runway, destroying six runway lights before the aircraft returned to the runway. The aircraft incurred minor damage from ground debris and there were no injuries.

2.2 Significant safety issue: Category I runways that are wider than 50 m and without centre line lighting are over-represented in veer-off occurrences involving transport category aircraft landing in low visibility conditions. The installation of centre line lighting on wider Category I runways is recommended but not mandated by the International Civil Aviation Organization Annex 14.

2.3 Recommendation to ICAO: The Australian Transport Safety Bureau recommends that the International Civil Aviation Organization review the effectiveness of Annex 14, recommendation 5.3.12.2 (for the installation of runway centre line lighting on Category I runways that are wider than 50 m), given that Category I runways that are wider than 50 m and without centre line lighting are over-represented in veer-off occurrences involving transport category aircraft landing in low visibility conditions.

2.4 Reason why this is an SRGC: This recommendation affects all runways throughout the world greater than 50 m wide and Cat 1 without centre line lighting. There have been a number of accidents and serious incidents that have been a result of this safety issue in various countries, and there is a high risk of reoccurrence.

SECTION 7	**: EXAMPLES OF SAFETY RECOMMENDATIONS OF GLOBAL CONCERN**
CHAPTER 3	**: FRENCH BUREAU D'ENQUÊTES ET D' ANALYSES POUR LA SÉCURITÉ DE L' AVIATION CIVILE (BEA)**

1. Impact Assessment on the safety benefit of detection and warning systems of gross errors (SRGC Local reference FRAN-2018-0023)

1.1 Over the last 15 years, several safety investigations and safety studies have been conducted worldwide on the use of erroneous parameters at take-off. With reference to this subject, several safety recommendations were issued concerning On-Board Weight and Balance Systems (OBWBS), Take-Off Performance Monitoring Systems (TOPMS) or gross error detection/warning systems.

1.2 Consequently, the BEA recommends that: EASA, with relation to updating its impact assessment, assess the safety benefit of gross error detection/warning systems, in particular taking into account existing systems (Airbus TOS, Boeing FMS/EFB messages and protections, Lufthansa Systems LINTOP, etc.).

1.3 Reason why this is an SRGC: The BEA considered this safety recommendation a SRGC due to the systemic deficiency, having a probability of recurrence, with significant consequences on the safe conduct of the flight.

SECTION 7	**: EXAMPLES OF SAFETY RECOMMENDATIONS OF GLOBAL CONCERN**
CHAPTER 4	**: GERMAN FEDERAL BUREAU OF AIRCRAFT ACCIDENT INVESTIGATION (BFU)**

1. The following is an example of a recommendation that might be considered to be a Safety Recommendation of Global Concern. The following two examples of recommendations are issued as outcomes of different investigations by the BFU: Similarities of the safety recommendations are systemic deficiencies having a probability of recurrence with significant consequences at a global level.

1.1 BFU SRGC: 06/2010 BFU-Report: File 5X003-0/08

(a) An Airbus A320 landed at Hamburg Airport, during the course of which the left wingtip touched the ground. During the cruise phase of the flight the crew monitored the ATIS weather information, which reported the wind in Hamburg as 23 kt from 280°, gusting 37 kt, and decided to make an approach and landing on Runway 23 which was then in use. During the approach to land, the Air Traffic Controller gave several wind updates. Immediately prior to touchdown, the wind was reported as 300°/33 kt, gusting up to 47 kt.

(b) Investigation into this serious incident revealed that the Airbus A320 crew had a considerable problem with the values quoted for wind speed and direction and interpretation of the gust information. The crew did not interpret the value quoted for maximum crosswind demonstrated for landing in an Operating Manual B (OM/B) Chapter Limitations as a prescribed limitation or operational threshold. The crew was not aware that in general no direction is given for gusts. The existing definition of gusts and the measuring method described in ICAO Annex 3, did not allow stating the gust direction.

(c) A survey of more than 80 pilots revealed that about half regarded the numerical value of the maximum demonstrated crosswind stated OM/B as a limit, while the other half regarded the numerical value as a guide; this indicates to the BFU that there is a need for clarification. Likewise, the distribution of answers to question three, as to whether a landing should be allowed in the presence of a 40 kt gust report, highlights pilot uncertainty about the application and interpretation of the numerical value of the maximum demonstrated crosswind in conjunction with the value stated for wind vector and gusts.

(d) The BFU was of the opinion that the measuring and handling of gusts wind values in everyday operations was neither sufficiently clear, nor adequately processed for flight crews.

1.2 BFU Safety Recommendation 06/2010:

EASA should place a contract with a suitable research institute (DLR, University or similar) to determine what measuring systems are suitable to detect the presence of near-surface gusts on airports, and how the resulting gust data and wind direction information should be processed and communicated to pilots. The results should lead to a process through which the information so obtained can be standardized and incorporated into the regulations governing air operations.

1.3 BFU SRGC No. 07/2017 BFU-Report: File No. 16-0055-EX

(a) An Airbus A320 with 110 passengers on board collided with two de-icing vehicles as it began taxiing from the De-icing Area (DA) 14 in front of runway 26L of Munich Airport. The airplane's wings' transition zones with the sharklets had collided with the booms of the de-icing vehicles. The drivers' cabs of the de-icing vehicles stood abeam of the corresponding edge marking of the taxiway. The vehicles had tipped by about 20° and therefore they stood on their left or right wheels, respectively. At the time of the occurrence the operators of the two de-icing vehicles had been in their respective cubicles at the end of the vehicles' booms. The cubicles had been in approximately 6 m above ground. Initially the fire brigade secured the de-icing vehicles with steel cables. Then the two operators were rescued. Due to the tilted position of the de-icing vehicles, a great risk of a severe accident occurring had developed for the de-icing personnel.

(b) The BFU came to the conclusion that a misinterpretation in the communication regarding the finalization of the de-icing procedure occurred between the flight crew and the team leader of the de-icing crew. Neither of the two pilots checked for obstacle clearance before taxiing. The missing standardized phraseology for pilots and de-icing personnel contributed to the serious incident.

(c) Neither the phraseology of the de-icing plan nor the SAE document ARP6257TM contained precise stipulations for the communication if the de-icing procedure had to be aborted. This case shows that neither the pilots nor the team leader had used the

wrong wording. Still both did not fully understand the other's information; instead they understood what fit their mental image of the situation. De-icing companies and operators have recognized the importance of standardized communications and accepted their application, but there was no extensive ICAO standard phraseology in place for the de-icing process, which would apply for pilots and de-icing personnel. Therefore the possibility for miscommunication was increased.

1.4 BFU Safety Recommendation No. 07/2017:

The Society of Automotive Engineers (SAE International) should amend the document Aircraft Ground De/Anti-Icing Communication Phraseology for Flight and Ground Crews (ARP6257TM) to mitigate the risk of miscommunication. Section 3.2.2 Abnormal Operations should include recommendations for standardized phraseology for pilots and de-icing personnel in regard to biunique communication in case the de-icing procedure has to be aborted.

SECTION 7	**: EXAMPLES OF SAFETY RECOMMENDATIONS OF GLOBAL CONCERN**
CHAPTER 5	**: BRAZILIAN AERONAUTICAL ACCIDENTS INVESTIGATION AND PREVENTION CENTER (CENIPA)**

1. System/component failure or malfunction involving a helicopter model S-76A, Pampulha Airport, Belo Horizonte – MG, 20 September 2007.

1.1 Background: During the taxi, the pilots perceived an abnormal noise and interpreted it as characteristic of a compressor "stall". Number two engine parameters were abnormal, with the temperature rising rapidly, reaching the red belt, and the "fuel press low light" lit for engine one. The commander cut engine number two and simultaneously found that engine number one had been cut without command. One of the passengers reported the smell of smoke. Passenger disembarkation was carried out and then there was fire in the area between the main gear box and the engines. The pilots triggered the fire extinguishers of the engines, but they were not efficient. The firefighters of the airfield were immediately called and the fire was extinguished. The two crewmen and the five passengers were unharmed. The aircraft suffered serious damage.

1.2 Significant safety issue: To the Federal Aviation Administration it is recommended: RSO (A) 43/2009 - CENIPA Issued on 27 April 2009 To determine to the operators of the S-76A aircraft model, TCDS No. H1NE, manufactured by Sikorsky Aircraft Corporation, equipped with the electrical/hydraulic rotor brake system, the deactivation of such a system, in accordance with the Maintenance Manual SA 4047-76-2, ATA 66-50-00, page 206, revision date 15 FEB 1986, until the incorporation of the ASB 76-66-48 of Sikorsky Aircraft Corporation, dated 11 SEP 2007.

1.3 Reason why this is an SRGC: This recommendation affects all operators of model S-76A around the world. There was more occurrences involving the system. There is a risk of reoccurrence until the incorporation of the ASB 76-66-48 of Sikorsky Aircraft Corporation.

SECTION 7	**: EXAMPLES OF SAFETY RECOMMENDATIONS OF GLOBAL CONCERN**
CHAPTER 6	**: INDONESIA NATIONAL TRANSPORT SAFETY COMMITTEE (KNKT), SRGC RELATED TO BOEING 737-8 (MAX)**

1. On 29 October 2018, at about 06:32 Local Time, a Lion Air Boeing 737-8 (MAX) aircraft registered PK-LQP, was being operated as a scheduled passenger flight from Soekarno-Hatta International Airport (WIII), Jakarta to Depati Amir Airport (WIPK), Pangkal Pinang, when the aircraft disappeared from radar after informing flight control, altitude and airspeed issues. The multiple alerts, repetitive activations of the of the Maneuvering Characteristics Augmentation System (MCAS) and numerous ATC communications contributed to the flight crew difficulties to control the aircraft. The aircraft impacted the water in Tanjung Karawang, West Java. All persons on board perished and the aircraft was destroyed.

2. The MCAS was a new feature introduced on the Boeing 737-8 (MAX) to enhance pitch characteristics during manual flight in elevated angles of attack (AOA). The investigation considered that the design and certification of the MCAS was inadequate. The aircraft flight manual and flight crew training did not include information about MCAS. On 10 March 2019, a similar accident occurred in Ethiopia involving a Boeing 737-8 (MAX) experiencing erroneous AOA inputs.

3. The investigation concluded with a number of contributing factors, with the following being associated with the aircraft certification process:

- During the design and certification of the Boeing 737-8 (MAX), assumptions were made about flight crew response to malfunctions which, even though consistent with current industry guidelines, turned out to be incorrect.
- Reliance of MCAS on a single sensor was deemed appropriate and met all certification requirements.
- MCAS was designed to rely on a single AOA sensor, making it vulnerable to erroneous input from that sensor.
- The absence of guidance on MCAS or more detailed use of trim in the flight manuals and in crew training made it more difficult for flight crews to properly respond to un-commanded MCAS.

- The AOA DISAGREE alert was not correctly enabled during the Boeing 737-8 (MAX) development. As a result, it did not appear during flight with the miscalibrated AOA sensor; could not be documented by the flight crew; and was therefore not available to help maintenance personnel identify the miscalibrated AOA sensor.

4. KNKT of Indonesia issued safety recommendations to, among others, Boeing Company and the Federal Aviation Administration (FAA). Some of those recommendations were as follows:

5. To Boeing Company

5.1 Safety recommendation 04.M-2018-35.11

During the accident, multiple alerts and indications occurred which increased flight crew's workload. This obscured the problem and the flight crew could not arrive at a solution during the initial or subsequent automatic and stabilizer trim input, such as performing the runaway stabilizer procedure or continuing to use electric trim to reduce column forces and maintain level flight.

Therefore, KNKT recommends that the aircraft manufacturer consider the effect of all possible flight deck alerts and indications on flight crew recognition and response; and incorporate design, flight crew procedures, and/or training requirements where needed to minimize the potential for flight crew actions that are inconsistent with manufacturer assumptions.

5.2 Safety recommendation 04.M-2018-35.14

The flight crew should have been provided with information and alerts to help them understand the system and know how to resolve potential issues. Flight crew procedures and training should be appropriate. Therefore, KNKT recommends that Boeing develop guidance for the criteria of information which should be included in flight crew and engineer's manuals.

6. To the Federal Aviation Administration (FAA)

6.1 Safety recommendation 04.R-2018-35.21

In the accident flight, the system malfunction led to a series of aircraft and flight crew interactions which the flight crew did not understand or knew how to resolve them. It was the flight crew response assumptions in the initial design process which, coupled with the

repetitive MCAS activations, turned out to be incorrect and inconsistent with the Functional Hazard Assessment (FHA) classification of Major.

Therefore, the KNKT recommends that the FAA review the processes for determining the FAA's level of involvement (degree of delegation) and how changes in the design are communicated to the FAA to ensure an appropriate level of review.

6.2 Safety recommendation 04.R-2018-35.24

During the accident and previous flights, the flight crew initially responded in the same way by pulling back on the control column. However, they did not consistently trim out the resulting column forces as had been assumed. As a result, Boeing assumption was different from the flight crew behaviour and reaction time in responding to MCAS activation.

Therefore, the KNKT recommends that the FAA work with international regulatory authorities to review assumptions on flight crew behaviour used during design, and revise certification processes to ensure assumptions used during the design process are validated.

6.3 Safety recommendation 04.R-2018-35.25

The flight crew should have been provided with information and alerts to help them understand the system and know how to resolve potential issues. Flight crew procedures and training should be appropriate.

Therefore, KNKT recommends that the FAA work with international regulatory authorities to review the guidance for the criteria of information which should be included in flight crew and engineer's manuals.

6.4 Safety recommendation 04.R-2018-35.27

The aircraft was equipped with an airframe-mounted low frequency underwater locator beacon (ULB) which operated at a frequency of 8.8 kHz. The beacon is included in ICAO Standards. The purpose of the beacon is to aid in the location of submerged aircraft. During the search phase, multiple surveys were conducted to detect a signal at 8.8 kHz, however no such signals were detected in the area where the wreckage was recovered. The beacon was mounted on the forward side of the nose pressure bulkhead. Most of the preferred installation locations could not be used because they proved to be incompatible with EASA and FAA Non-Rechargeable Lithium Battery certification requirements, or they did not meet the ICAO empennage and wings exclusion.

Therefore, KNKT recommends that the FAA work with international regulatory authorities to review the requirements for installation of Non-Rechargeable Lithium Battery certification requirements.

7. Safety recommendations from the U.S. National Transportation Safety Board (NTSB)

7.1 The NTSB participated in the investigation and, on 19 September 2019, issued a Safety Recommendation Report titled: Assumptions Used in the Safety Assessment Process and the Effects of Multiple Alerts and Indications on Pilot Performance.

7.2 The NTSB recommendations to the FAA were as follows:

a) Require that Boeing:

1) Ensure that system safety assessments for the 737 MAX in which it assumed immediate and appropriate pilot corrective actions in response to un-commanded flight control inputs, from systems such as the Maneuvering Characteristics Augmentation System (MCAS), consider the effect of all possible flight deck alerts and indications on pilot recognition and response; and

2) Incorporate design enhancements (including flight deck alerts and indications), pilot procedures, and/or training requirements, where needed, to minimize the potential for and safety impact of pilot actions that are inconsistent with manufacturer assumptions. (A-19-10)

b) Require that for all other US type-certificated transport-category airplanes, manufacturers

1) Ensure that system safety assessments for which they assumed immediate and appropriate pilot corrective actions in response to un-commanded flight control inputs consider the effect of all possible flight deck alerts and indications on pilot recognition and response; and

2) Incorporate design enhancements (including flight deck alerts and indications), pilot procedures, and/or training requirements, where needed, to minimize the potential for and safety impact of pilot actions that are inconsistent with manufacturer assumptions. (A-19-11)

c) Notify other international regulators that certify transport-category airplane type designs (for example, the European Union Aviation Safety Agency, Transport Canada, the National Civil Aviation Agency-Brazil, the Civil Aviation Administration of China, and the Russian Federal Air Transport Agency) of Recommendation A-19-11 and encourage them to evaluate its relevance to their processes and address any changes, if applicable. (A-19-12)

d) Develop robust tools and methods, with the input of industry and human factors experts, for use in validating assumptions about pilot recognition and response to safety-significant failure conditions as part of the design certification process. (A-19-13)

e) Once the tools and methods have been developed as recommended in Recommendation A-19-13, revise existing Federal Aviation Administration (FAA) regulations and guidance to incorporate their use and documentation as part of the design certification process, including re-examining the validity of pilot recognition and response assumptions permitted in existing FAA guidance. (A-19-14)

f) Develop design standards, with the input of industry and human factors experts, for aircraft system diagnostic tools that improve the prioritization and clarity of failure indications (direct and indirect) presented to pilots to improve the timeliness and effectiveness of their response. (A-19-15)

g) Once the design standards have been developed as recommended in Recommendation A-19-15, require implementation of system diagnostic tools on transport-category aircraft to improve the timeliness and effectiveness of pilots' response when multiple flight deck alerts and indications are present. (A-19-16)

SECTION 8	**: EXAMPLE OF SAFETY RECOMMENDATIONS "NOT" OF GLOBAL CONCERN**
CHAPTER 1	**: TRANSPORTATION SAFETY BOARD OF CANADA (TSBC) SAFETY RECOMMENDATION**

1. The following is submitted as an example of a recommendation that might not be considered to be a Safety Recommendation of Global Concern. This recommendation comes from a recently released Safety Issues Investigation (A17O0038) into runway incursions at Toronto's Lester B. Pearson International Airport (CYYZ).

2. This particular recommendation (A18-07) is addressed to a specific airport operator, and focuses on the layout and characteristics of a particular part of the airport complex. The combination of several uncommon characteristics on these rapid exit taxiways, including direct-access, short distance, a curve, and the type and placement of the runway holding positions and the associated visual cues, make the incursion hazard at these locations unique. This combination is not known to occur elsewhere.

3. As the standards, both locally and internationally, were not found to be deficient, the TSB addressed the recommendation directly to the airport operator (the Greater Toronto Airports Authority) to recommend that they make physical changes to address this unique hazard.

4. Recommendation A18-07 – Taxiway layout and conspicuity

4.1 The taxiway layout between the closely spaced parallel runways at Toronto/Lester B. Pearson International Airport (CYYZ) has several characteristics that are uncommon when compared with those at other airports, both within North America and globally. The runways are spaced a relatively short distance apart, and the rapid exit taxiways provide direct access to the adjacent runway without first progressing to another transitional surface. The runway holding positions are located immediately following a 65° curve and are situated at greater distances from the protected inner runway than is seen elsewhere.

4.2 These uncommon characteristics, and the short distance between the runways, present significant challenges for flight crews. When exiting the landing runway, crews are normally occupied with other tasks and, because they are using a rapid exit taxiway, the aircraft is usually travelling at taxi speeds that are faster than typical. A flight crew's unfamiliarity with these uncommon characteristics, the short amount of time and distance available, and distraction due to other tasks reduces their ability to identify the runway holding positions. As demonstrated by the occurrences covered in this investigation, if

these positions are not identified, aircraft can incur on the other active runway and potentially collide with another aircraft.

4.3 International guidance recommends many strategies to address runway incursions. All but one of these has been implemented on the south complex at CYYZ; the remaining strategy is to make physical changes to the taxiway layout.

4.4 A change of this scale may be required to increase the distance and taxiing time between runway holding positions, to reduce the taxiing speeds of aircraft approaching the hold-short line, to prevent direct access to adjacent runways from rapid exit taxiways, and to re-situate visual cues in common locations. Among the possible reconfigurations that may address these factors is the inclusion of an intermediate parallel taxiway between the runways, as found at numerous other airports with parallel runways.

4.5 It is recognized, however, that a change this significant cannot be made overnight, and simpler incursion mitigation strategies may need to be implemented, or current strategies improved, in the meantime. Although much has been done over the past few years to improve the conspicuity of the runway holding positions, options still remain, such as altering the type, amount, or intensity of the runway holding position lighting, which may further improve the likelihood that flight crews identify the cues and stop before incurring on the runway.

4.6 Therefore, the Board recommends that the Greater Toronto Airports Authority make physical changes to the taxiway layout to address the risk of incursions between the parallel runways and, until these changes can be made, make further improvements to increase the conspicuity of the runway holding positions.