

**BY ORDER OF THE COMMANDER
AIR FORCE RESERVE COMMAND**

**AIR FORCE RESERVE COMMAND
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Safety

**CAUSAL FINDINGS ANALYSIS
METHODOLOGY-AVIATION**

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

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This pamphlet explains procedures for determining causal factors for US Air Force aviation mishaps. It supports Air Force Policy Directive (AFPD) 91-2, *Safety Programs*, and Air Force Instruction (AFI) 91-204, *Safety Investigations and Reports*. It is intended for use by individuals who investigate and report Air Force mishaps, and is particularly tailored to the needs of persons assigned to formal Safety Investigation Boards (SIB) following all classes of flight mishaps (see AFI 91-204 for definitions). Ensure that all records created as a result of processes, prescribed in this publication are maintained in accordance with Air Force Manual 33-363, *Management of Records*, and disposed of in accordance with the Air Force Records Disposition Schedule (RDS) located in Air Force Records Information Management System (AFRIMS) at Air Force (AF) Portal: <https://www.my.af.mil/gcss-af61a/afrims/afrims/rims.cfm>

SUMMARY OF CHANGES

This interim change removes all references and attachments related to the Machine, Media, Man, Management and Method (5M) checklist, references to AFPAM91-211 which has been rescinded and updates links to AFSAS and AFSEC Portal resources. A margin bar (|) indicates newly revised material.

Chapter 1

GENERAL INFORMATION

1.1. Introduction. This document describes Air Force Reserve Command's approach to determining causal findings and other findings of significance to assist safety investigation board (SIB) members in developing formal recommendations for mishap reports. Its origin stems from the desire to help investigating officers (IO) maximize the mishap prevention value of their mishap reports. A good report results in a recommendation(s) that tackles the root cause or causes of a mishap. Far too often SIBs stop investigating once the board discovers what or what or who appears to be the cause of the mishap. Unfortunately, it is human nature to stop there and not to continue further and ask why the cause occurred or why the individual might have made a mistake--in effect, identify a root cause. Without a root cause identified, the SIB developed recommendations will prove ineffective in mishap prevention.

1.2. What is Causal Finding Analysis Methodology (CFAM)? CFAM is a six-step methodology used to determine: (1) What happened; (2) Why it happened; and (3) What to do to prevent it from happening again. CFAM consists of a simple diagram of events that become a draft set of findings for input into AFSAS. Keep in mind that CFAM is a methodology. It is not meant to be a replacement for USAF mishap investigation principles, but a supplement to the Air Force investigative process.

1.3. Reasons to use CFAM. There are six reasons to utilize CFAM:

- 1.3.1. Contributes to better organized investigation and report.
- 1.3.2. Provides a ready-made plan for conducting an investigation.
- 1.3.3. Simplifies a complex process.
- 1.3.4. Can be used as a time/effort management tool for SIB Presidents.
- 1.3.5. Makes investigation and report writing easier by providing a more structured and standard method to accomplish both.
- 1.3.6. *Bottom line* - Develop better recommendations for mishap prevention.

1.4. Required Tools.

- 1.4.1. A large wall or desk for a work space.
- 1.4.2. A roll of butcher paper or large easel pad.
 - 1.4.2.1. Note: The butcher paper makes it possible to save your work or to take it with you when you change locations. For example, simply roll it up and set it aside while you wait for your engine analysis from depot. You'll be able to unroll it months later and pick up where you left off. It will also provide a historical and visual record of your work.
- 1.4.3. Masking tape.
- 1.4.4. Two different colored adhesive notes.
- 1.4.5. A fine point permanent marker.

1.4.6. DELETED

1.4.7. The Safety Training Decision Tree ([Attachment 2](#)).

1.4.8. CFAM Cheat Sheet ([Attachment 3](#)).

1.4.8.1. Note: The Cheat Sheet is intended to be removed from this pamphlet and taped to the wall near your work area for use as a guide.

Chapter 2

SIX STEPS TO THE ROOT CAUSE – STEP 1

2.1. Determine the mishap sequence of events.

2.1.1. The objective of this step is to create a draft set of findings. Using one color of your adhesive notes, start on the far right of your work space and post the mishap sequence of events in reverse chronological order. Each event must be a singular statement. Avoid using “and” to prevent having two events on one Adhesive note. Each event must have a logical connection to a preceding event. If no logical relationship exists, then you have not yet correctly described the mishap sequence.

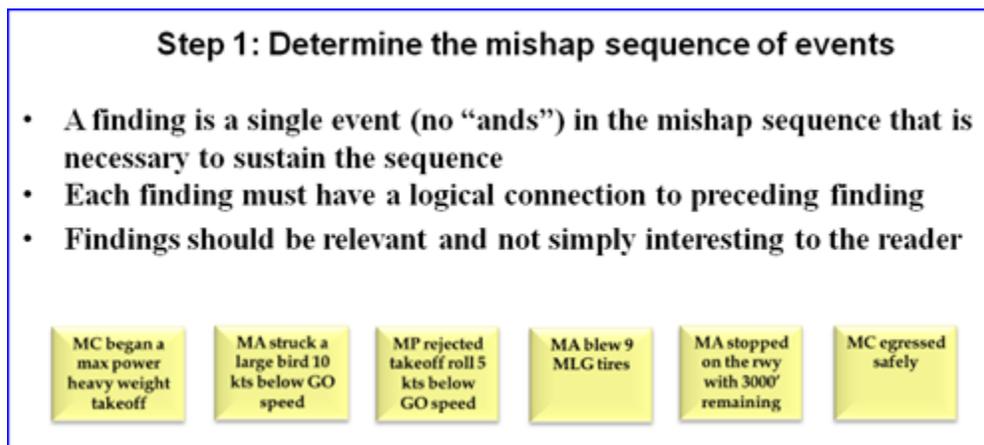
2.1.1.1. The sequence will read left to right when complete. It must continue to the point where all damage or rescue efforts are complete. In some cases the chain of events may begin with design deficiencies or improperly written directives prepared long before the actual mishap sequence. The key sequence is Design/TCTO/Regulations/Training/Mishap. That is the order aircraft are designed and fielded. Many times SIBS have a tendency to put guidance or training first and then design. The correct order is; first the design, then the TO’s, then regulatory guidance, which results in the training plan and then the mishap.

2.1.1.2. You will start on the far right because you know where the mishap ended, but you don’t yet know where it began.

2.1.2. For the purpose of example, we will diagram a hypothetical mishap involving an aircraft that blew nine main landing gear (MLG) tires while performing a rejected takeoff after striking a large bird 10 knots below “GO speed”. See [figure 2.1](#) for help in visualizing Step 1.

2.1.3. Step 1 is complete once the sequence of events is firmly established.

Figure 2.1. Step 1 Determine the mishap sequence of events.



Chapter 3

SIX STEPS TO THE ROOT CAUSE – STEP 2

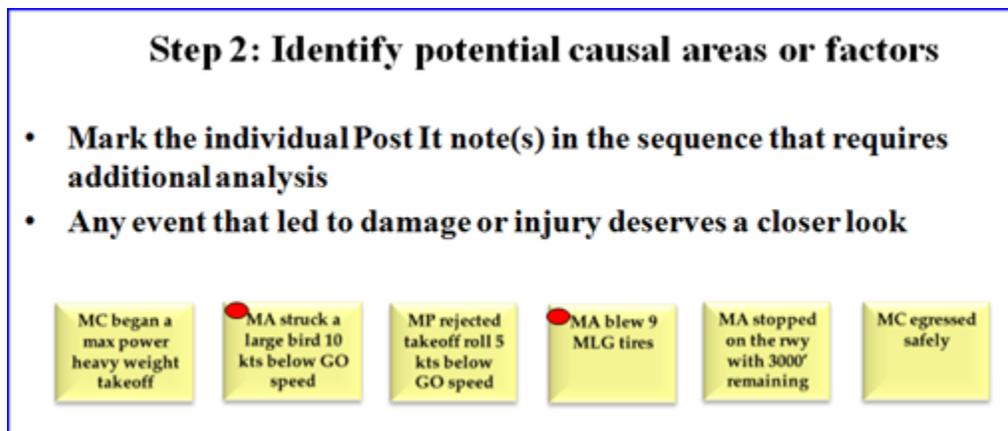
3.1. Identify potential causal areas or factors.

3.1.1. The objective of this step is to determine areas requiring further investigation. All events that led to damage or injury deserve a closer look and will be identified by placing a mark on the Adhesive note.

3.1.2. In our example, we have two events in which damaged occurred: “Mishap Aircraft (MA) blew 9 MLG tires”, and “MA struck large bird 10 KTS below GO speed”. We’ll mark those events by placing a red dot in the left hand corner of each Adhesive note. Note: If a crew member had been injured during the egress we would need to mark it also to determine why it happened to prevent it from happening again. Refer to [Figure 3.1](#) below.

3.1.3. Step 2 is complete once all areas requiring further investigation are identified.

Figure 3.1. Step 2 Identify potential causal areas or factors.



Chapter 4

SIX STEPS TO THE ROOT CAUSE – STEP 3

4.1. Ask “Why” of the potential causal areas.

4.1.1. The objective of this step is to drill into the areas identified in Step 2.

4.1.2. So how do you drill into those areas? First, use your intuition and experience as an aviator to ask what may have caused each of these events.

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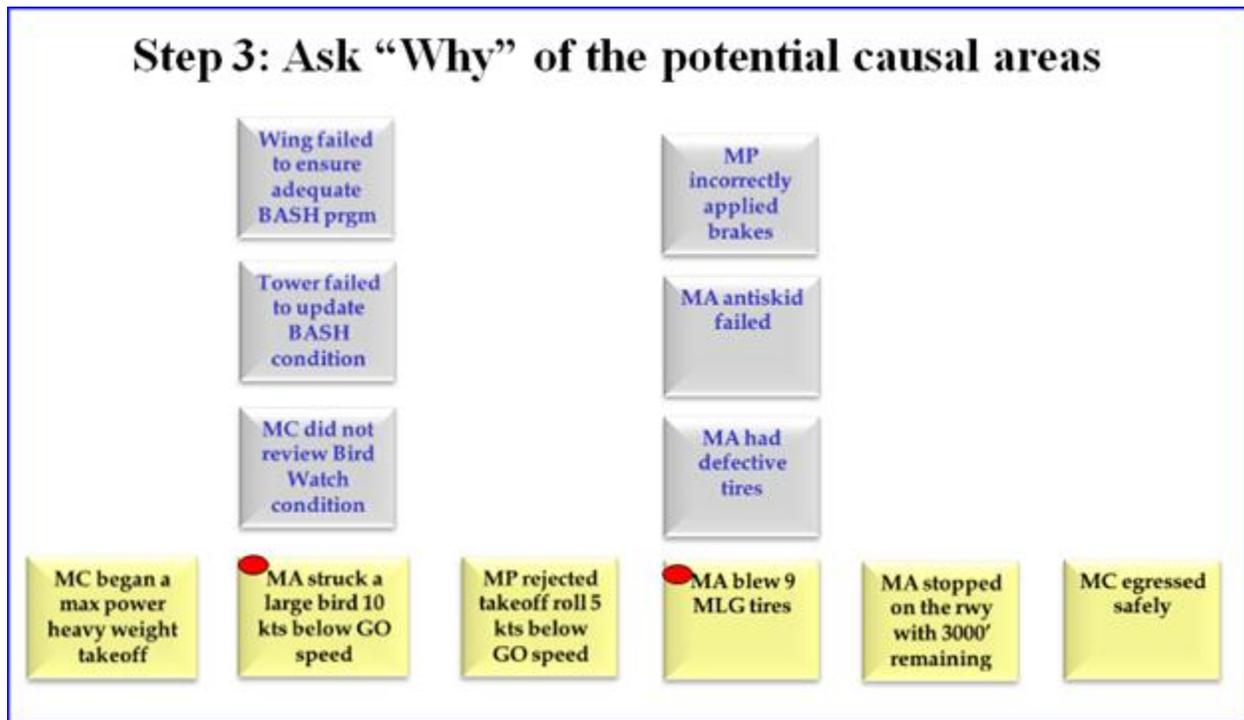
4.1.3. Place a new color adhesive note above the highlighted finding with the factor or condition that you want to explore further. State each factor in the form of a statement, not as a question (the reason for this will become apparent later).

4.1.3.1. Try to avoid the tendency to use single words in place of complete statements. Incomplete statements may make sense at the time, but if you have to put your investigation on hold for long period of time, you may have a tough time trying to figure out exactly what you meant.

4.1.4. For our example, you would place a new color adhesive note above “MA blew 9 MLG tires” that might read “MA had defective tires” and another above that note stating “MA antiskid failed” and another one above that with “MP incorrectly applied brakes” and so on. These will be the areas that you or the SIB will need to examine. See [Figure 4.1](#) below.

4.1.5. Step 3 is complete once you have exhausted all the possibilities of why the event occurred.

Figure 4.1. Step 4 Ask why of the potential causal areas.



Chapter 5

SIX STEPS TO THE ROOT CAUSE – STEP 4

5.1. Determine Causal Factors.

5.1.1. The objective of this step is to identify your Causal Factors and/or Other Findings of Significance. Investigate the mishap or event based on your intuition/experience. Dig deeply into each factor or condition from Step 3 to discover the actual root cause(s) that can be corrected to prevent future mishaps. As you do this you will eliminate several adhesive notes.

5.1.1.1. Once a condition is eliminated (disproved), such as “MA had defective tires”, you will place a large “X” over the text and move the adhesive underneath that event. The intent is to keep digging into each condition until all of the adhesive notes are moved below the event sequence line. Any condition not X’d out (proven correct) will likely be a Causal Factor or Other Findings of Significance for that event.

5.1.1.1.1. Note: Conditions that are eliminated may later be addressed as “Non-Factors Worthy of Discussion” when writing the final report.

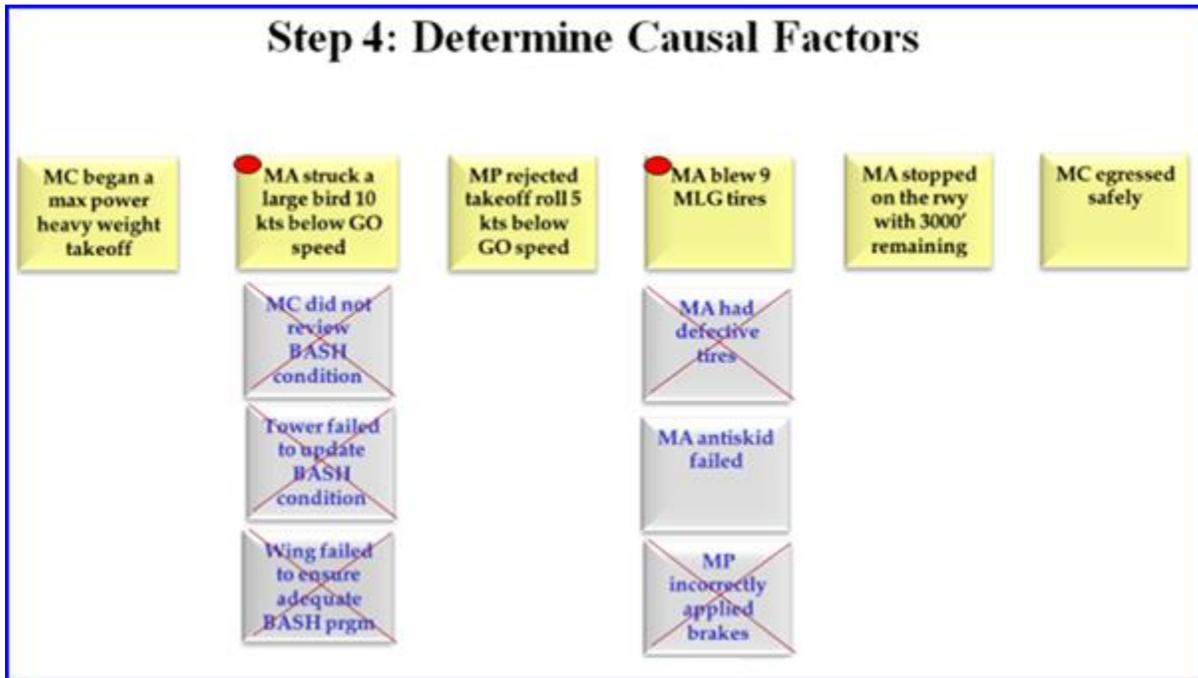
5.1.2. In our example in Figure 5.1, you determine that the MP correctly applied brakes and that the antiskid had, in fact, failed. Place a large “X” over “MP incorrectly applied brakes” and move it “below the line.” Since “MA antiskid failed” was proven to be correct it is moved below the line without an “X” to complete this step. You also determined all BASH requirements were met and ruled out all three potential factors. This is illustrated by X-ing out all of these three factors in figure 5.1.

5.1.2.1. Note: As you interview mishap personnel and review the technical data, you may generate additional adhesive notes (conditions) to stick above an event. You may even expand your sequence of events as details come to light.

5.1.2.2. You may also have additional adhesive notes that are not Causal Factors or Other Findings of Significance such as “waiting on an answer from a depot teardown request” or results from a “potentially contaminated fluid sample” that you can put in a “holding area” in the bottom right of your work area as a reminder for the SIB.

5.1.3. This step is complete once all of your adhesive notes are below “the line” as shown in **figure 5.1**.

Figure 5.1. Determine the Causal Factors.



Chapter 6

SIX STEPS TO THE ROOT CAUSE – STEP 5

6.1. Reconstruct the sequence of events and repeat Step 3.

6.1.1. The objective of this step is to complete your draft findings by inserting the non-X'd out factors into the sequence of events. We'll repeat the methodology used in steps 3 and 4 until we reach a logical conclusion. Once the non-X'd out factors are inserted into the sequence and you can go no further, this step is complete.

6.1.2. In our example, we determined the antiskid system failed. This appears to be a Causal Factor, but we still don't know *why* this happened. Before we start with step 3, we'll insert the "MA antiskid failed" adhesive into the proper point in the sequence of events. In our case it was just prior to "MA blew 9 MLG tires". Next, we treat this factor as another event to research and start putting Adhesive notes above the line just as we did earlier. See figure 6.1 and 6.2 for a visual illustration.

6.1.2.1. Previously, in Step 2 you were told not to use questions or single word statements. It should now be apparent that neither of these would smoothly fit into our sequence of events and would need to be rewritten.

6.1.2.2. Note: Causes (or "causal findings") are those findings that singularly or in combination with other causes resulted in the damage or injury that occurred. They may be:

6.1.2.2.1. Deficiencies or decisions, which if corrected, eliminated, or avoided would likely have prevented or mitigated the mishap damage or significant injuries.

6.1.2.2.2. Acts, omissions, conditions, or circumstances that either start or sustain the mishap sequence.

6.1.2.2.3. An element of human or mechanical performance.

6.1.2.2.4. An environmental condition (if it was not reasonably avoidable).

6.1.3. Not all of your non-X'd out Adhesive notes will be causal or Other Findings of Significance (OFS). If your original sequence had holes, the methodology will fill those holes. To determine if a factor is causal review **paragraph 7.14.3.2**.

Figure 6.1. Reconstruct the sequence of events.

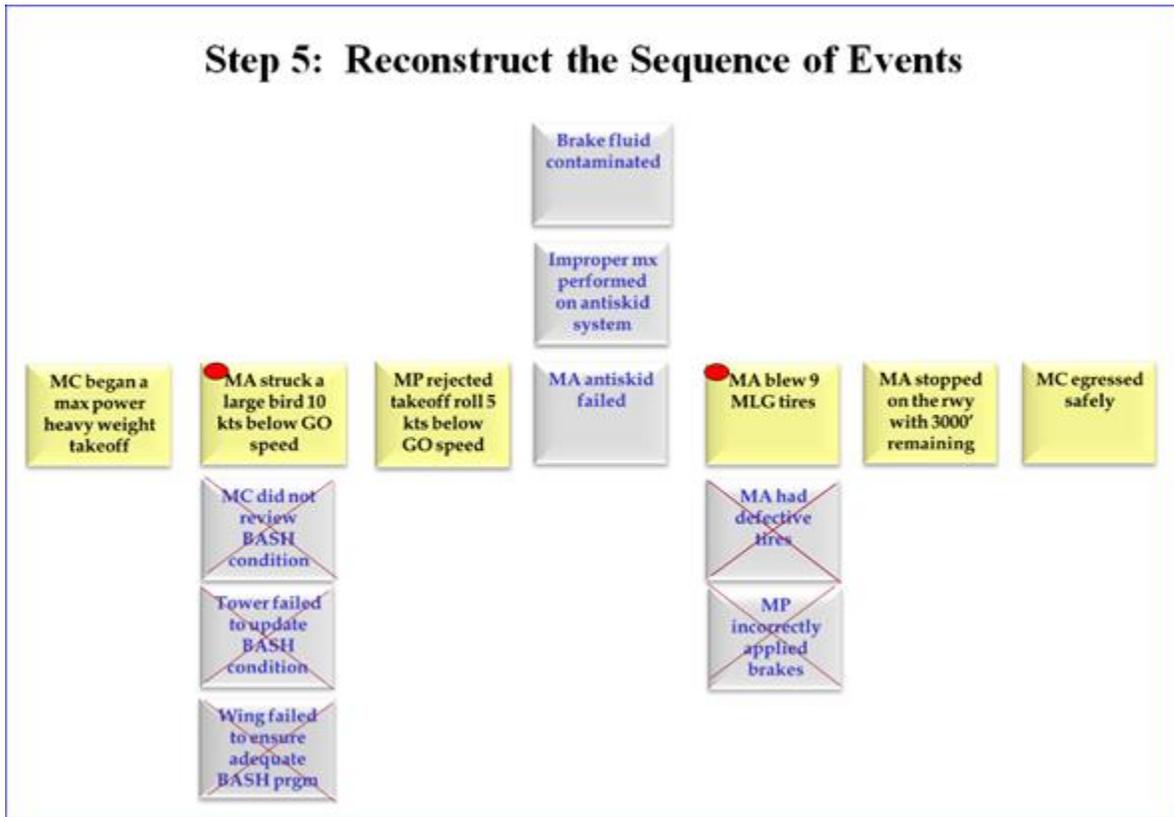
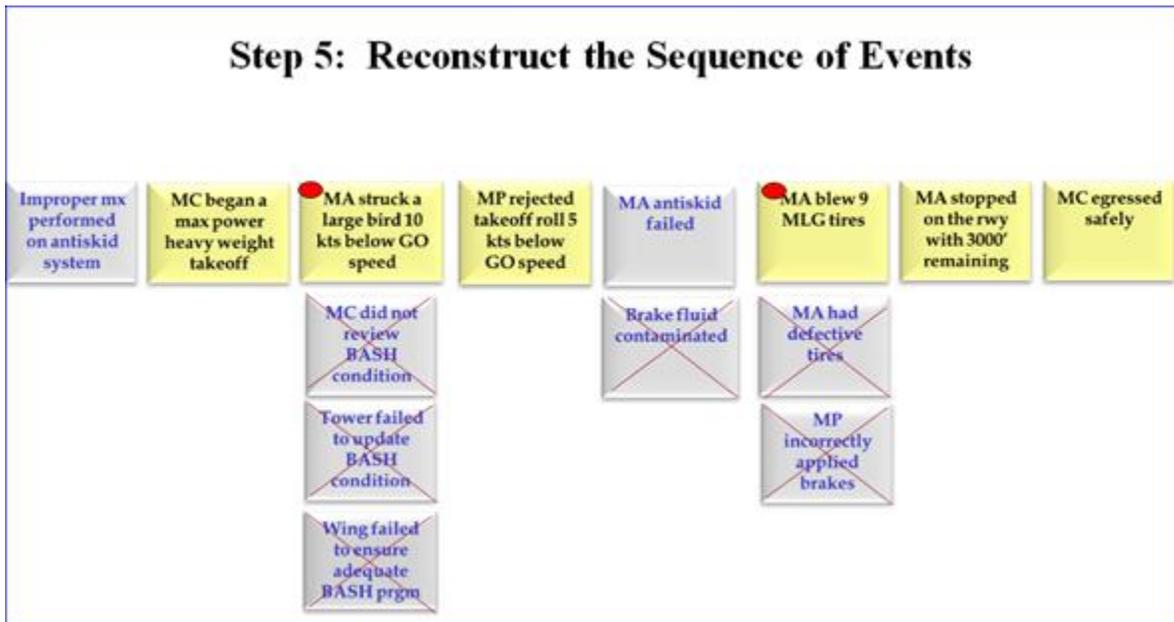


Figure 6.2. Reconstruct the Sequence of events 2.



6.1.4. In the case of our example, we've determined that the antiskid failed due to improper maintenance. We still have not reached a logical conclusion because we don't know why the maintenance was performed improperly. A SIB would need to keep repeating the cycle until

it could no longer ask “why”. For the purposes of this pamphlet we’ll stop here. If it were an actual investigation, the SIB may have determined that the improper maintenance was due to an inadequate training program, improper supervision, etc. The point here is to not stop the investigation and assign cause to the crew chief that performed the procedure. Unfortunately, too many SIBs will stop at this point.

6.1.5. Your causal findings will now stand out in the event sequence since they are a different color. Since you wrote each condition as a factual statement, it easily fits into the sequence of events without any rewording. Now you have a solid draft of the Findings, Causes, and Analysis to enter into AFSAS. Your recommendations can easily be formulated by referring to the respective condition number and its corresponding potential recommendations found in the 5M checklist (see attachment 1). See **Figure 6.3**

6.1.5.1. Final note: All too often investigators assign training as a recommendation without fully exploring whether training is the real fix. If your causal findings and recommendations include training as a recommendation, run attachment 2 as a test before you make your final report. **Attachment 2** will take the investigator through a quick decision tree analysis of when to recommend, but more importantly, when not to recommend training as the answer. If a worker has the skills and knowledge to do the job safely then training will not address the unsafe job performance. Problems that can be addressed effectively by training include those that arise from a lack of knowledge of a work process, unfamiliarity with equipment, or incorrect execution of a task. This is not to say that safety and health training is not an important part of a mishap prevention program. Safety training and education are a vital element of any effective safety program. Some of the appropriate times when safety and health training should be provided are:

6.1.5.1.1. A worker lacks the safety skills.

6.1.5.1.2. A new employee is hired.

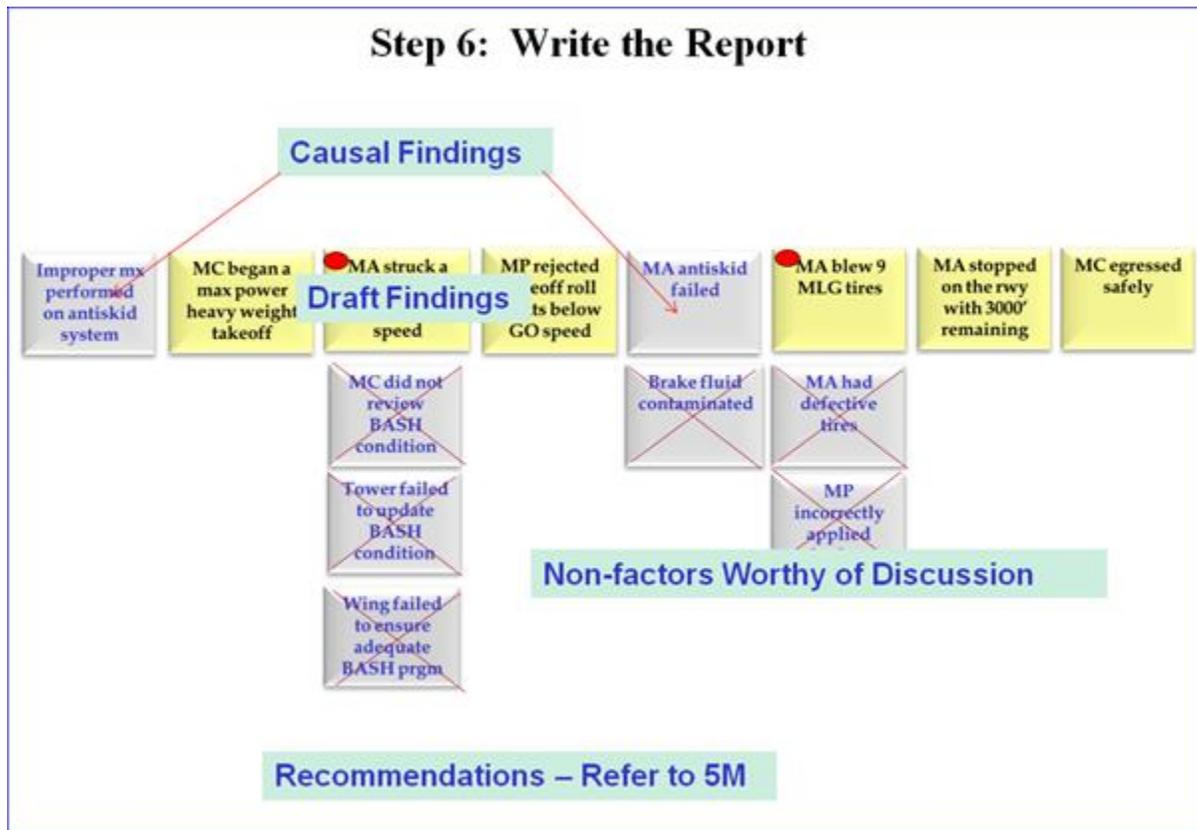
6.1.5.1.3. An employee is transferred to another job or task.

6.1.5.1.4. Changes are made to operating procedures.

6.1.5.1.5. A worker has not performed a task for some period of time.

6.1.6. At this point you can review/edit the complete sequence of events and input into AFSAS. This will also help you draft the narrative correctly and efficiently. Remember, conditions or factors that were X'd out may be discussed in the narrative as areas investigated and found to be non-factors, i.e., Non-Factors Worthy of Discussion. Don't forget to include Other Findings of Significance (OFS).

Figure 6.3. Write the Report.



Chapter 7

SIX STEPS TO THE ROOT CAUSE – STEP 6

7.1. Write the AFSAS final report.

7.1.1. The objective of this step is to assist the investigator in organizing the AFSAS final message from the data gathered during steps one through five. Log on to AFSAS at <https://afsas.af.mil/Home.do>. Reference AFI 91-204, AFMAN 91-223 and AFSEC Formal Report tips on the AFSEC Portal website. <https://www.my.af.mil/gcss-af/USAF/ep/browse.do?categoryId=p6925EC1424C50FB5E044080020E329A9&channelPageId=s6925EC1333780FB5E044080020E329A9> for further guidance on drafting the report.

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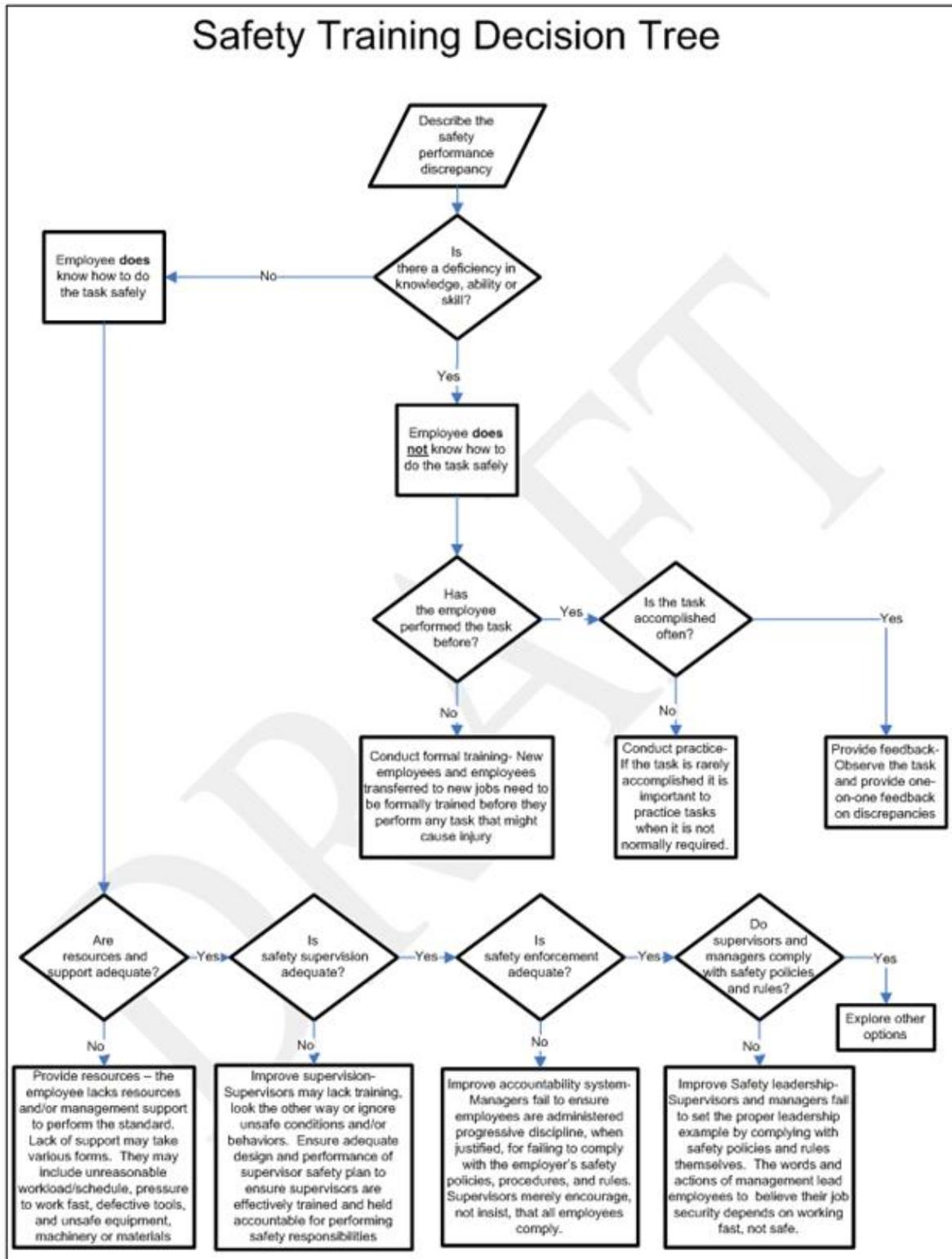
BEGIN SIGNATURE
MARYANNE MILLER, Lt Gen, USAF
Commander

Attachment 1

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Attachment 2

SAFETY TRAINING DECISION TREE



Attachment 3

CFAM CHEAT SHEET (INTENDED TO BE REMOVED FOR USE AS A GUIDE)

