The Investigative Process

Session Time: Three, 50-minute sessions

DESIRED RESULTS

ESSENTIAL UNDERSTANDINGS

Develop interest in one or more aviation/aerospace career pathways and learn what is required to pursue future employment in the industry. (EU3)

Understand the importance of professionalism, ethics, and dedication as they relate to all aviation/aerospace operations. (EU4)

Develop an uncompromising safety mindset, understanding that growth and development in the aviation/aerospace industry must always be accompanied by responsive safety initiatives. (EU6)

ESSENTIAL QUESTIONS

1. Can we really know what went wrong in an aviation accident?
2. Why is the NTSB an independent government entity?

LEARNING GOALS

Students Will Know

- How aircraft accident investigations conducted by the NTSB improve aviation safety.
- The seven different elements of an NTSB "Go Team."
- Skills needed to become a successful aircraft accident investigator.

Students Will Be Able To

- *Define* an aircraft accident. (DOK-L1)
- *Summarize* the skills needed to be an effective aircraft accident investigator (DOK-L2)
- *Describe* the role of the NTSB during an aircraft accident investigation. (DOK-L2)
- *List and describe* the general elements related to the aircraft accident investigation process. (DOK-L2)

ASSESSMENT EVIDENCE

Warm-up
Students will write down and discuss what they think defines an "aircraft accident."

Formative Assessment
Students will list important skills and qualities needed of an effective NTSB investigator.

Summative Assessment

Students will develop a flowchart for the aircraft accident investigation process based on their "Go Team" assignment from the jigsaw activity.

LESSON PREPARATION

MATERIALS/RESOURCES

- The Investigative Process Presentation
- The Investigative Process Student Activity
- The Investigative Process Teacher Notes
- The Investigative Process Teaching Aid

LESSON SUMMARY

Lesson 1: The Investigative Process
Lesson 2: Accident Case Study

This lesson introduces students to the National Transportation Safety Board (NTSB) and the aircraft accident investigation process to understand how investigations improve aviation safety.

This three-session lesson will begin by having students dissect and discuss the definition of an aircraft accident. The teacher will present key elements related to the NTSB's mission and the aircraft accident investigation process.

Students will briefly look at career opportunities with the NTSB as an aircraft accident investigator with emphasis on establishing an interest in a specific part of the NTSB "Go Team." In a jigsaw activity, students will be presented with an event in which they will apply the concepts of an aircraft accident investigation both as individual investigators and as a group of investigators within the "Go Team." Students will present their findings.

Finally, students will develop a flowchart of the aircraft accident investigation process based on their "Go Team" assignment from the jigsaw activity.

BACKGROUND

See **The Investigative Process Teaching Aid** for an extensive explanation of the NTSB, the definition of an aviation accident, a description of a "Go Team," and the general investigative process.

DIFFERENTIATION

For learners who have difficulty staying on task, have them create graphic organizers to map the information they learn over the three sessions. Students who record and review their notes in graphic organizers are more easily able to recall and use the information.

To promote reflective thinking, circulate around the classroom and assist students who might have trouble coming up with ideas during the assessments. Ask questions that provoke their own ideas for possible answers.

LEARNING PLAN

ENGAGE

Teacher Materials: The Investigative Process Presentation, The Investigative Process Teacher Notes
Student Material: The Investigative Process Student Activity

Slides 1-3: Introduce the topic and learning objectives for this lesson.

Slide 4: Show a short video to capture the student's attention. Ask students: Was the event just an "accident"?

- "I Hate Mondays" (Length 00:18)
  http://video.link/w/6ILd

Slides 5: On a more serious and related note, ask students to consider whether the event shown in the picture on slide 5 should be classified as an aircraft accident. Allow for a brief discussion. Guide student thinking to consider features that determine an accident.

Slide 6: Continue the discussion about what defines an aircraft accident. Guide student thinking to consider features that determine an accident. Based on these images, students should be considering the severity of damage and injury while also asking whether the event resulted in fatalities. Record their answers in a visible location.

Conduct the **Warm-up.**

Collect student work and grade according to completeness and participation. When students are finished, ask volunteers share their answers with the class.

[DOK-L1; *define*, *state*]

Warm-Up

Ask students how they think the government defines an aircraft accident. Have them individually write their own definition of an aircraft accident.

Slide 7: Provide students with **The Investigative Process Student Activity.**

The following slides will lead students through the NTSB's definition of an aircraft accident. Provide the National Transportation Safety Board's (NTSB) definition of an aircraft accident. Emphasize three key factors – death, injury, and damage. Students should compare this definition to the explanations shared previously to support their growing understanding of what constitutes an aircraft accident.

Below are other definitions that may need to be provided for students to completely understand how an **aircraft accident** is defined:

Serious injury means any injury which: (1) Requires hospitalization for more than 48 hours, commencing within 7 days from the date of the injury was received; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, muscle, or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns, or any burns affecting more than 5 percent of the body surface.

Substantial damage means damage or failure which adversely affects the structural strength, performance, or flight characteristics of the aircraft, and which would normally require major repair or replacement of the affected component. Engine failure or damage limited to an engine if only one engine fails or is damaged, bent fairings or cowling, dented skin, small punctures in the aircraft's skin or fabric, ground damage to rotor or propeller blades, and damage to landing gear, wheels, tires, flaps, engine accessories, brakes, or wingtips are not considered "substantial damage."

Use **The Investigative Process Teacher Notes** to evaluate student work.

Questions

After providing the definition, ask students two questions:

What are the three key factors that define an aircraft accident?
Any person suffers death or serious injury or the aircraft receives substantial damage.

When must one or more of these three things occur?
Between the time any person boards the aircraft with the intention of flight and all such persons have disembarked.

EXPLORE

Teacher Materials: The Investigative Process Presentation, The Investigative Process Teacher Notes, The Investigative Process Teaching Aid
Student Material: The Investigative Process Student Activity

Slide 8: Provide students with an understanding of the NTSB, its independence from other government agencies, and its mission.

Slides 9-10: Lead a class discussion on why it is important for an agency like the NTSB to have independence.

Questions

Ask students the question, "Why is it important for the NTSB to be an independent government agency when conducting aircraft accident investigations?

The U.S. Department of Transportation (DOT) (of which the Federal Aviation Administration is a part) has broad operational and regulatory responsibilities that affect the safety, adequacy, and efficiency of the transportation system. Aviation accidents may suggest deficiencies in that system. Because of this, the NTSB's independence was deemed necessary for proper oversight. The NTSB has no authority to regulate, fund, or be directly involved in the operation of any mode of transportation. It conducts investigations and makes recommendations from an objective viewpoint.

Teachers may need to describe what is meant by "agency independence," which is that the agency is independent of presidential control. This means that unlike a normal government agency or department, it doesn't have a director, administrator, or secretary appointed by the President of the United States.

Independent agencies, such as the NTSB, almost always have a commission or board of five to seven members who share power over the agency. This is also why the NTSB has "Board" in its title.

Use the background information in **The Investigative Process Teaching Aid** to facilitate discussion.

Slide 11: Lead a class discussion about how accident investigations improve aviation safety.

Questions

Ask student how they think aircraft accident investigations conducted by the NTSB improve aviation safety.

The primary way in which NTSB accidents improve aviation safety is by determining the probable cause(s) of accidents and then issuing safety recommendations to prevent them from happening again.

Slide 12: Review the mission of the NTSB.

The NTSB:

- Conducts investigations related to
  - All civil domestic air carrier, commuter, and air taxi accidents
  - In-flight collisions
  - Fatal and nonfatal general aviation accidents
  - Certain public-use aircraft accidents
  - Safety issues that extend beyond a single accident to examine specific aviation safety problems from a broader perspective
- Supports investigations related to
  - Major airline crashes in foreign countries that involve U.S. carriers
  - U.S.-manufactured or -designed equipment
- Coordinates federal assistance to families following major aviation accidents (and other modes of transportation) as needed

Slide 13: Show a video of an NTSB aircraft accident investigator on the scene of an accident.

- "NTSB Interview at Iliamna Crash Site" (Length 1:59)
  https://video.link/w/8ILd

The video will provide students with a general overview what it's like to be an NTSB investigator. Prior to showing the video, advise the students to consider the unique nature of what appears to be an aircraft accident and its relationship to career opportunities with the NTSB. In addition, challenge the students to identify where the aircraft wreckage is based on the view from the airplane flying over the scene.

Slide 14: Conduct **Formative Assessment.**

Formative Assessment

Ask students to imagine they are a member of a committee responsible for hiring a new NTSB accident investigator. Students should write down a list of the qualities they would look for in an employee.

Grade based on completeness and participation. Allow up to 5 minutes for the Formative Assessment. Ask volunteers to share their responses with the class. Collect student work after the discussion.

[DOK-L2; *classify*, DOK-L1; *list*]

Slides 15-19: In a class discussion, students will discuss what they think are some unique opportunities available to NTSB accident investigators. They should also start thinking about the specific skills NTSB investigators need.

The following slides introduce students to careers in accident investigation and also serve as the transition into the second session of the lesson where the investigative process is explained to include focus on the NTSB "Go Team."

Analytical Skills

- Determining probable cause is one of the essential purposes for having NTSB accident investigators on-scene promptly after an aviation incident or accident. The image in the slide shows a significant amount of wreckage to be analyzed. The skills of NTSB investigators make it possible for the results of an investigation to lead to recommendations for improving civil aviation safety.

Knowledge of Aircraft Systems and Components

- In many cases, the NTSB investigator must inspect even the smallest parts of an aircraft and its systems to determine if any mechanical failures contributed to the cause of an aviation accident. Therefore, the NTSB investigator must have a diverse and deep knowledge of aircraft systems and components.

Good Communication Skills

- An NTSB investigator may also be designated as the spokesperson who will provide the public with a briefing of initial findings after an aviation accident. This NTSB investigator is likely to go from the on-scene investigation to such a briefing in order to provide the public with the most current and accurate information.

Risk Management Skills

- NTSB investigators must be willing to travel into odd places in order to complete the initial on-scene investigation. These NTSB investigators may have to hike and then rappel down a hillside in dense forest to get to the crash scene. If the aircraft is sitting on unstable ground, the investigation may be much more challenging and dangerous. Therefore, risk management and safety skills are required to become an NTSB investigator.

EXPLAIN

Teacher Materials: The Investigative Process Presentation, The Investigative Process Teacher Notes, The Investigative Process Teaching Aid
Student Material: The Investigative Process Student Activity

Slides 20-25: The "NTSB Go Team" slides explain the elements related to the NTSB "Go Team," the Party System, and the stages of an accident investigation. The explanation can be supported by the background information provided in **The Investigative Process Teaching Aid.**

EXTEND

Teacher Material: The Investigative Process Presentation

Slide 26: The jigsaw activity and group presentations will extend into the third session of this lesson.

First, divide students into groups of seven. Assign one student in every jigsaw group to each of the seven different "Go Team" functions: Operations, Structures, Powerplants, Systems, Air Traffic Control, Weather, and Human Performance.

Each student will become an expert in his or her assigned function.

Show students the AOPA Air Safety Institute Accident Case Study video.

- "Unintended Consequences" (Length 07:16)
  http://video.link/w/9ILd

Students may need/ want to watch the video twice.

Instruct students to pay close attention to the details presented in the video related to their function within the "Go Team" investigation. After the video, have students record up to three observations about the accident scenario that fall within their areas of "Go Team" expertise.

Have the students organize into "expert" groups in which all students assigned the same function work together to check for correctness and completeness. For example, all the students assigned to Air Traffic Control should compare notes. This function represents the "individual" nature of a "Go Team" investigation.

When the task is complete, students return to their original jigsaw groups to share their observations and determine how the seven individual areas of expertise may contribute to determining the cause of the accident. Each jigsaw group will present their "Go Team" observations to the class. This part of the activity simulates the collection, analysis, and reporting processes of the aircraft accident investigation.

Answers

Examples for each expert group:

Operations *- Determine what the pilot had completed recently. In the example video, it is stated the pilot had recently flown the exact route under very similar conditions. Some additional considerations could be determining when the pilot last attended training or if the pilot legally "current" to fly the airplane.*

Structures *- In the example, analyzing the structures of the aircraft could indicate whether or not the pilot tried to make an abrupt maneuver (climb) to avoid the terrain at the last minute.*

Powerplants *- Inspections would be made to determine whether or not the powerplants were functioning normally on this flight. This can be difficult to determine, but the aircraft reportedly performed as expected on the first flight, and there were no notifications of distress transmitted over the radio.*

Systems *- Even though it was required by law, there was no terrain awareness system installed in this aircraft.*

Air Traffic Control *- Common instructions within ATC operating guidance were given to the pilot on departure. Pilot did not request radar service ("flight following") for this flight. Perhaps an area of concern would be the previous experiences with this particular ATC facility and the habit of not providing VFR traffic radar services.*

Weather *- By all accounts it was a beautiful night to fly with calm winds and clear skies. The absence of a moon would have made for a very dark evening. On a clear night, a full moon allows pilots to see detail in the terrain and identify mountains and rivers. Without the light of the moon, the pilot would likely not be able to see the terrain rising in front of him.*

Human Performance *- The pilot was familiar with the terrain around the airport and elected to not follow recommended departure procedures. The pilot had likely completed this flight segment several times and was complacent about avoiding the Superstition Mountains.*

EVALUATE

Teacher Material: The Investigative Process Presentation

Slide 27: Conduct **Summative Assessment.**

Summative Assessment

Students will develop a flowchart for the aircraft accident investigation process emphasizing their own "Go Team" assignment from the jigsaw activity. Start the Summative Assessment about 10 minutes before the end of class.

Collect student work at the end of class and use the Scoring Rubric for grading.

[DOK-L2; *organize*]

Summative Assessment Scoring Rubric

- Follows assignment instructions
- Illustration shows evidence of one or more of the following:
  - Knowledge of the aircraft accident investigation process
  - Understanding of how aircraft accident investigations improve aviation safety
  - Knowledge of the different elements of an NTSB "Go Team"
  - Identification of skills needed to become a successful aircraft accident investigator
- Shows understanding of concepts covered in the lesson.

Points	Performance Levels
9-10	Consistently demonstrates criteria
7-8	Usually demonstrates criteria
5-6	Sometimes demonstrates criteria
0-4	Rarely to never demonstrates criteria

GOING FURTHER

Encourage students to explore other aircraft accidents and compare their own assessments of probable cause and safety recommendations to what is reported by the NTSB. Teachers can find more AOPA Air Safety Institute Accident Case Studies here: https://www.aopa.org/training-and-safety/online-learning/accident-case-studies.

STANDARDS ALIGNMENT

NGSS STANDARDS

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Three-dimensional Learning

- **HS-ETS1-1** - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
  - Science and Engineering Practices
    - Asking Questions and Defining Problems

        - Constructing Explanations and Designing Solutions
    - Disciplinary Core Ideas
        - ETS1.A: Defining and Delimiting Engineering Problems
    - Crosscutting Concepts
        - Systems and System Models
        - Influence of Science, Engineering, and Technology on Society and the Natural World
- **HS-ETS1-2** - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
    - Science and Engineering Practices
        - Constructing Explanations and Designing Solutions
    - Disciplinary Core Ideas
        - ETS1.A: Defining and Delimiting Engineering Problems
    - Crosscutting Concepts
        - None
- **HS-ETS1-2** - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
    - Science and Engineering Practices
        - Constructing Explanations and Designing Solutions
    - Disciplinary Core Ideas
        - ETS1.C: Optimizing the Design Solution
    - Crosscutting Concepts
        - none
- **HS-ETS1-3** - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
    - Science and Engineering Practices
        - Constructing Explanations and Designing Solutions
    - Disciplinary Core Ideas
        - ETS1.B: Developing Possible Solutions
    - Crosscutting Concepts
        - Influence of Science, Engineering, and Technology on Society and the Natural World

COMMON CORE STATE STANDARDS

- **RST.9-10.2** - Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

- **RST.9-10.4** - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

- **RST.9-10.**7 - Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
- **WHST.9-10.2** - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- **WHST.9-10.6** - Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
- **WHST.9-10.7** - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- **WHST.9-10.8** - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
- **WHST.9-10.9** - Draw evidence from informational texts to support analysis, reflection, and research.

REFERENCES

https://www.ntsb.gov/Pages/default.aspx
https://www.ntsb.gov/investigations/process/Documents/MajorInvestigationsManual.pdf
https://www.ntsb.gov/investigations/process/Documents/MajorInvestigationsManualApp.pdf
https://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title49/49cfr830_main_02.tpl
https://www.aopa.org/training-and-safety/air-safety-institute