SYST 460/560 FALL 2009
MID-TERM EXAM

TAKEHOME EXAM PART II – NTSB Report Analysis

INSTRUCTIONS

1. Initial: I have adhered to the University Honor Code ______
   Note: All violations of Honor Code will be reported
2. OPEN Book
3. Write and draw clearly. Provide explanations were required.
5. Turn in hard-copy (with answers) of this report.
6. Good luck and Have Fun!

Note on Learning:
The purpose of the takehome exam is to provide you an opportunity to increase your knowledge through reflection and reasoning about the material. This type of learning will not occur in a single sitting. This type of learning occurs over several iterations. You will need to read, reflect, research, and reason to answer the questions.

Suggested time line:
Week 1
1. Download and read the NTSB Safety Report. Understand how the report is organized and the outline of the sequence of events that resulted in the accident.
2. Review the exam and identify nature of the questions and the type of information required
3. Re-read the NTSB Safety Report and start to highlight the relevant sections.
4. Start to answer questions. Answer as many as you can on the first pass. Identify questions that need more research.

Week 2
5. Conduct research to answer specific questions. Complete these questions
6. Review previous answers. Expand on the answers. Be sure explanations are complete and consistent.
Read the **Executive Summary** and answer the following questions

1. Describe the outcome of the accident

   _____________________________________________________________
   _____________________________________________________________
   _____________________________________________________________
   _____________________________________________________________
   _____________________________________________________________

2. Describe the main probable cause of the accident

   _____________________________________________________________
   _____________________________________________________________
   _____________________________________________________________
   _____________________________________________________________
   _____________________________________________________________

3. Describe the factors that contributed to the accident
   
   a. ___________________________________________________________
   b. ___________________________________________________________

4. Identify the hazards that contributed to the accident
   
   a. ___________________________________________________________
   b. ___________________________________________________________
   c. ___________________________________________________________
   d. ___________________________________________________________
   e. ___________________________________________________________
   f. ___________________________________________________________
   g. ___________________________________________________________
   h. ___________________________________________________________
Section 1.1 History of Flight, Paragraph 3.

According to Delta dispatch records, the flight departed the gate at 1431 and took off about 1441, with the captain performing the pilot flying (PF) duties during the trip to LaGuardia. The pilots stated that the departure, climbout, and en route portions of the flight proceeded uneventfully, although they experienced turbulence at their cruising altitude of flight level (FL) 370.

5. What sensor is used to measure aircraft altitude?

6. Explain how this sensor works (be sure to explain the role of the “barometric setting”

7. What was the barometric setting for the altimeter when the aircraft was in cruise at FL370?

8. What would be the effect on the altitude of the aircraft if the barometric pressure is adjusted up or down (keep in mind the pilots have programmed the Autopilot to maintain 37,000’)?

9. Transition Altitude
   a. What is the “transition altitude”
   b. With regard to the Barometric Setting, what pilot action takes place at the Transition Altitude
c. Why is the system designed to include a Transition Altitude? Explain what would happen if the transition altitude did not exist.
Section 1.1 History of Flight, Paragraph 4.

The pilots stated that as they approached LaGuardia, they observed large areas of precipitation on the airplane’s weather radar and encountered light-to-moderate turbulence and strong winds during the arrival to the New York area. According to flight and cabin crewmember statements, the captain had previously briefed the flight attendant in charge (FAIC) that their descent in the New York area might be bumpy. The flight attendants indicated that at the captain’s suggestion, they prepared the cabin for landing and were seated in their jumpseats earlier than usual during the descent to land.

The Accident Report does not specify which Standard Arrival (STAR) Procedure was used. The KORRY 3 Arrival into LGA is an example of the arrival procedure that may be used by Flight 1431.

Download the KORRY3 arrival (http://204.108.4.16/d-tpp/0910/00289KORRY.PDF). Be sure to read page 2.

10. Complete the arrival portion of the Flightplan. (Fill in all the blank cells by consulting the STAR and by computation)

<table>
<thead>
<tr>
<th>Waypoint</th>
<th>Course to Next Waypoint (degrees)</th>
<th>Distance to Next Waypoint (nm)</th>
<th>Altitude Crossing at Waypoint</th>
<th>Speed at Waypoint (knots)</th>
<th>Flight Path Angle to Next Waypoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>GORDONSVILLE (GVE)</td>
<td>91</td>
<td>71</td>
<td>320</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COLIN</td>
<td></td>
<td></td>
<td>320</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PATUXENT (PTX)</td>
<td></td>
<td></td>
<td>320</td>
<td></td>
<td></td>
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<tr>
<td>GARED</td>
<td></td>
<td></td>
<td>320</td>
<td></td>
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</tr>
<tr>
<td>RIDGY</td>
<td>FL 270</td>
<td></td>
<td>320</td>
<td></td>
<td></td>
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<tr>
<td>SMYRNA (ENO)</td>
<td>FL 240</td>
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<td>320</td>
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<tr>
<td>SKIpy</td>
<td>FL 190</td>
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<tr>
<td>BESI</td>
<td>17000</td>
<td>320</td>
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<tr>
<td>EDJER</td>
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<td>320</td>
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<tr>
<td>DAVYS</td>
<td>13000</td>
<td></td>
<td>320</td>
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<tr>
<td>HOLEY</td>
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<td>320</td>
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<tr>
<td>BRAND</td>
<td>11000</td>
<td>250</td>
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<td></td>
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<tr>
<td>KORRY</td>
<td>10000</td>
<td>250</td>
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<td></td>
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<tr>
<td>ROBBINSVILLE (RBV)</td>
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<td>250</td>
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<tr>
<td>TYKES</td>
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<td>MINKS</td>
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<tr>
<td>RENUE</td>
<td></td>
<td></td>
<td>250</td>
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<tr>
<td>APPLE</td>
<td></td>
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<td>250</td>
<td></td>
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</tr>
</tbody>
</table>
11. GARED intersection is defined by the following radials

<table>
<thead>
<tr>
<th>VOR</th>
<th>Radial</th>
</tr>
</thead>
<tbody>
<tr>
<td>PATUXENT (PXT)</td>
<td>46 degree radial outbound</td>
</tr>
</tbody>
</table>

12. How many nautical miles is the ATLANTIC CITY (ACY) VOR from the GARED Intersection

______________________________________________________________________________
______________________________________________________________________________

13. BESSI intersection is defined by the following radials

<table>
<thead>
<tr>
<th>VOR</th>
<th>Radial</th>
</tr>
</thead>
<tbody>
<tr>
<td>WOODSTOWN (OOD)</td>
<td>85 degree radial outbound</td>
</tr>
</tbody>
</table>

14. If the aircraft is at GORDONSVILLE and is instructed to “[Fly] Direct to PATUXENT” how much shorter is the route (than if the flight proceeded to COLIN and the PATUXENT). Show all work.

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

15. If the aircraft is at RIDGY and is instructed to “[Fly] Direct to KORRY”.

a. Would the distance between RIDGY and KORRY be shortened or lengthened. Explain.
b. What is the effect on the Flight Path Angle required to go from RIDGY direct to KORRY. Is the Flight Path Angle increased or decreased. Explain.

c. Using what you know about Aircraft Dynamics and the relationship between Thrust, Drag, Weight, Flight Path Angle, which of these parameters should be changed to achieve the new Flight Path Angle. Use the equations of motion to explain your answer.
Section 1.1  History of Flight, Paragraph 5.

As the airplane approached LaGuardia, the pilots received radar vectors for the instrument landing system with distance measuring equipment (ILS DME) approach to runway 13. At 1611:57, the cockpit voice recorder (CVR) recorded the captain commenting about the 3° offset of the localizer course as he began to brief the details of the ILS DME runway 13 approach. At 1612:39, New York air route traffic control center advised the pilots to contact New York terminal radar approach control (TRACON); the first officer acknowledged and complied with the instruction. At 1613:30, the captain finished the approach briefing, stating in part, “glide slope’s unusable below two hundred feet...final approach course crosses runway centerline and twenty-seven hundred and fifty-four feet from threshold...”

16. Airspace Classes

a. What Class of airspace was the flight during the Cruise phase

b. Identify the type of ATC facility responsible for surveillance of the flight in the cruise phase of flight

c. What standardized procedures are used to coordinate flight trajectories in the cruise phase of flight (low altitude and high altitude)

d. What navigation equipment is used as the basis for these standardized procedures that are used to coordinate flight trajectories in the cruise phase of flight

e. What Class of airspace did the flight enter when it transitioned to the TRACON

f. What standardized procedures are used to coordinate flight trajectories in the TRACON
g. What navigation equipment is used as the basis for these standardized procedures that are used to coordinate flight trajectories in the TRACON
Section 1.1 History of Flight, Paragraph 6.

At 1633:28, the captain stated, “Still showing sixty-three knots [of wind] now.”

17. What is the importance of this information about the wind in the selection of the runways to be used. Explain.

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Section 1.1 History of Flight, Paragraph 6

At 1633:33, New York TRACON stated, “Delta five fifty-four, turn left heading one three zero...you’re three miles from LYMPS,...maintain three thousand until LYMPS...cleared ILS DME runway one three approach,” and the first officer acknowledged the clearance. At 1633:55, the first officer stated, “Yeah, I guess the wind’s gonna blow us over [to the localizer course],” and (at 1633:58) the captain responded, “I think you’re right.” (See figure 1 for a copy of the instrument approach chart used by the pilots of Delta flight 554.)

18. ILS/DME Approach (See Figure 1 on page 4)

Complete the pilot’s “approach briefing” for the instrument approach to LGA ILS/DME Runway 13.

“Lets fly the __________________ approach at La Guardia

The ILS/DME identifier is ____________ on frequency _________

The final approach course is ____________ degrees

The touchdown zone elevation for this runway is ____________ feet MSL

The Decision Height (DH) for the ILS approach is ____________ feet MSL.
The Minimum Safe Altitude (MSA) is ____________ ft to the east, and ____________ ft to the west.

The missed approach is straight ahead on the runway course. Climb to ____________ ft and turn _____________. Fly direct to _____________ navigation aid. At the intersection fly a holding pattern with ___left/right___ direction of turns.

As we perform the approach, the navaids used will be the _____________ ILS/DME on frequency _____________.

We will be arriving from the north-west to cross over LYMPS. LYMPS is located ______ nm from the ILS/DME. From LYMPS we will fly a course of _____________ degrees. We will cross LYMPS at ___________ feet.

The next waypoint is ________________. This waypoint is located at __________ nm from the ILS/DME. We will descent and cross this waypoint at ___________ feet.

The aircraft will then descend to _____________ feet at 4.4. nm from the ILS/DME, then continue on the glideslope through the Middle Marker (MM) 219 feet from the Touch Down Zone Elevation (TDZE) and 232 feet from Sea Level.

The runway threshold is ____________ nm from the ILS/DME.

The Decision Height (DH) is __________ from the TDZE and 263 feet from Sea Level.

Any questions?”
According to the CVR and pilot statements, about 1635, the flightcrew intercepted the localizer and glideslope and **received air traffic control (ATC) instructions to contact LaGuardia tower.** At 1635:23, the LaGuardia air traffic control tower (ATCT) transmitted, “Delta five five four, you’re number two, traffic to follow…two mile final, the wind now one zero zero at one two…one departure prior to your arrival…braking action reported good by [a 737]…low level wind shear reported on final by [a 737]…”

19. Identify the (a) type of ATC facility responsible for surveillance of the flight after the flight “contact[s] La Guardia tower.” (b) Which controller would be communicating with the pilots.

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______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

20. Explain what the controller means by “you’re number two”

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______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

21. Explain what the controller means by “one departure prior to your arrival”

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
At 1637:08, LaGuardia ATCT instructed a TWA airplane at LaGuardia, “TWA eighty-six thirty, wind one zero zero at one two, runway one three cleared for takeoff, traffic [on] three mile final runway one three.” The pilots of TWA 8630 acknowledged the takeoff clearance and advised that they were “rolling,” and at 1637:22, LaGuardia ATCT cleared Delta flight 554 to land. Two seconds after he acknowledged the landing clearance, the first officer advised the captain that he was “starting to pick up some ground contact.”

At 1637:29, the pilots of TWA 8630 indicated that they were rejecting the takeoff and needed to turn off the runway. LaGuardia ATCT responded, “TWA eighty-six thirty, make the first right turn, runway four two two…can you do that for me, sir?” then stated, “…if you could expedite, traffic on a two mile final…prevent him from going around.” According to CVR and pilot statement information, simultaneous with this transmission, the captain turned off the autopilot and advised the first officer “I’ve got the jet” (indicating that he was taking manual control of the airplane).

At 1637:41, one of the pilots of TWA 8630 stated, “TWA eighty-six thirty’s turning off,” and LaGuardia ATCT responded, “Thank you very much…say the reason for the abort, sir?” Five seconds later LaGuardia ATCT stated, “Just continue down the runway…make the first right turn on taxiway golf…when you get a chance let me know the reason for the abort.” At 1637:52, as the airplane descended through about 492 feet agl, flight 554’s CVR recorded an expletive on the captain’s channel, and the airplane’s descent rate (calculated from FDR data) shallowed briefly. During postaccident interviews, the captain stated that at the time of the expletive comment he was concerned that they might have to perform a missed approach because the TWA flight had aborted its takeoff, and he believed that it had not yet cleared the runway.

22. Explain what occurred with TWA 8630

23. What role (if any) did the TWA 8630 have in the accident
At 1638:13, the first officer advised the captain, “You’re getting a little bit high...a little bit above [the] glide slope...approach lights, we’re left of course.” The FDR data indicated that at 1638:13, the airplane was 1.39 dots high on the electronic glideslope and 0.39 dots left of the localizer, at 306 feet agl (319 msl).

24. Where was the aircraft relative to the glideslope and localizer when the First Officer made these comments?

25. What reason did the Captain give in the interview with the Accident Investigators for being “high”?

26. What do “dots” refer to on the with reference to the Glideslope and localizer
… at 1638:11, the captain stated, “I got the (REIL [runway end identifier lights])... approach lights in sight.”

At 1638:18, LaGuardia ATCT stated, “You are cleared to land, Delta five fifty-four,” and the first officer acknowledged the reissued landing clearance.

According to FDR data, at that time the autothrottle was disconnected and the captain reduced power manually. At 1638:20.6, the CVR recorded the sound of the ground proximity warning system (GPWS) announcing “minimums,” followed by, according to the CVR transcript, a “sound similar to that of windshield wipers increasing to full speed.” About 1 second later, the captain restated that he had the approach lights in sight.

27. What clearance is given by the controller to allow the flight to land?

28. What visual indication is required before a pilot can land the aircraft?

The captain began to reduce the engine power, and at 1638:25.6, the first officer stated, “speed’s good” and then, about 1 second later, “sink’s seven hundred.” At 1638:30.1, the captain stated, “I’ll get over there,” which he later explained referred to the airplane’s alignment with the runway. One second later, the first officer stated, “a little bit slow, a little slow.” According to postaccident interviews, the captain stated that the approach seemed normal until about 4 to 5 seconds before the initial impact, when “all of a sudden, [the] aim point shifted down into the
lights.” About 1638:33, as the captain was adding power and pitching up, the first officer stated, “Nose up,” and then at 1638:34.3, stated, “Nose up” again. At 1638:34.2 and 1638:35.7, the CVR recorded the sound of the GPWS “sink rate” warning, followed by sounds of impact at 1638:36.5.

The airplane struck the approach light structure and the vertical edge of the concrete runway deck, and then skidded approximately 2,700 feet down runway 13 on its lower fuselage and nose landing gear before it came to a stop. The nose landing gear came to a stop on the pavement, with the fuselage oriented on a 345 heading; the left wing extended towards the runway centerline, and the right wing extended over the wet, grassy area next to the runway.

29. On the Airport Diagram on the next page identify the following locations.
   a. Location of initial impact.
   b. Location of final resting
   c. Orientation of the aircraft at the final resting point.
According to the Accident Report, what role did the following have on the accident. Explain how each item could have contributed to the accident. Be sure to identify if the item affected pilot decision-making and/or the ability of the pilot to control the trajectory of the aircraft.

a. Vertical Speed Indicator had a lag (i.e. delay) in displaying information of 4 seconds

Section 1.6.2

Several of the MD-88 check airmen and flight instructors interviewed during the investigation stated that they believed that most Delta line pilots were unaware that the VSIs in the MD-88 were not instantaneous.

b. Meteorological Conditions/

Section 1.7.

Although VMC prevailed when Delta flight 554 departed Atlanta, the flightcrew stated that when the flight arrived in the New York area, it encountered the forecast IFR conditions. The pilots obtained ATIS information “Delta” during their approach to LaGuardia. It indicated winds out of 120 at 16 knots, visibility of 1¼ miles in heavy rain and mist, and an overcast cloud layer at 1,300 feet. It also advised that the ILS DME approach was in use, with airplanes landing and departing on runway 13.

Weather observations made at LaGuardia between 1627 and 1651 indicated a broken cloud layer at 800 feet, visibility between ½ and 1 mile in heavy rain and fog or mist, and easterly winds at 12 to 14 knots.
c. Runway Visual Range

Section 1.7.2

Investigation revealed that the RVR was taken out of service sometime after the accident because of a problem with the line that ran between the receiver and the computer, where the RVR values were recorded. According to FAA airways facilities (AF) personnel, this anomaly might have resulted in slight inaccuracies in the recorded RVR values.

The minimum RVR value estimated about 1637 was 2,800 feet. ATC records indicate that at 1636, LaGuardia ATC advised traffic that runway 13 RVR at touchdown was 3,000 feet, while RVR during landing rollout was 2,200 feet.

Post accident interviews with air traffic controllers revealed that they first observed Delta flight 554 as it neared the runway threshold; the distance between the ATC tower cab and the approach end of runway 13 is approximately 2,800 feet. According to the ILS DME runway 13 instrument approach plate, the minimum RVR required for the approach is 2,400 feet.

d. Windshear

Section 1.7.3

Examination of the ATC transcripts for the local control frequency revealed that between 15:25 and 15:45, about an hour before the accident, there were numerous pilot reports of windshear, and the flightcrews of four flights executed missed approaches while attempting to land on runway. The ATC transcripts revealed that these missed approaches were attributed to wind conditions.
e. Airport Information (Layout of Runway as seen from the air)

Section 1.10

The approach ends of runway 22 and runway 13 extend on an elevated deck above the Rikers Channel portion of Flushing Bay. The extended portion of the runways is constructed of asphalt and concrete laid out on steel piers, the approach end of which is covered by orange and white plywood panels that extend vertically toward the water. Runways 22 and 13 are equipped with approach lighting systems built on stanchions and accessible by catwalks, which extend farther into the bay from the end of the runway deck.

f. Runway 13 Information

Section 1.10.1

According to ATC operational records, the average prevailing winds at LaGuardia are northwesterly. Because the winds are generally out of the northwest, and because of other operational considerations, runway 13 (the landing runway for Delta flight 554) is used less frequently than the other runways. Runway 13 was equipped with high intensity runway lights (HIRL), centerline lighting, REIL, medium intensity approach light system, runway alignment indicator lights, and visual approach slope indicator (VASI) lights.

g. Runway 13 Runway Lights Spacing

Section 1.10.1.1
Post accident measurement of the runway light spacing on runway 13 revealed that the runway lights were installed at irregular intervals, even where no other ground utilization considerations (crossing runways, taxiways, etc.) existed. The runway light spacing distances varied, with the most common distances between lights falling between 120 feet and 170 feet.

h. Runway 13 VASI Information

Section 1.10.1.3

The VASI light system for runway 13 is a two-bar VASI system, which may be used by pilots as a visual aid for maintaining an approximate 3 degree glidepath to the touchdown point on the runway. .... According to the pilots of flight 554, when the airplane descended below 200 feet agl and the electronic glideslope was considered unusable, they were in visual conditions; however, they did not observe either bar of the VASI lights during their descent to the runway. Post accident interviews with the pilots of the four airplanes that landed on runway 13 just before flight 554 revealed that none of them recalled observing the VASI lights during their approach/landing. However, none of the pilots interviewed (including the flightcrew of flight 554) recalled specifically seeking VASI light guidance during their approach to land.

i. Delta Airlines Flight Operations Manual (FOM)/Stabilized Approaches

Section 1.17.2

As mentioned previously, several Delta MD-88 check airmen/flight instructors and the pilots of Delta flight 554 stated that Delta’s manuals did not contain a formal definition of a stabilized approach, and that the only specific guidance concerning pilot actions during an unstabilized approach was located in the windshear guidance section. A review of Delta’s flight and pilot manuals supported their statement; although the word "stabilized" and the terms "stabilized
approach" and “unstabilized flightpath” appear several times, the manuals did not define these terms, nor did they prescribe stabilized approach criteria.

j. Monocular Vision and Airman Medical Certification

Optometrists indicated that traditionally, bifocal, and even trifocal, spectacles have been prescribed for individuals who need both distant and near vision correction. However, they indicated that with increasing frequency, optometrists are prescribing MV contact lenses in place of bifocal spectacles for these individuals.

According to USAF medical personnel when an individual has symmetrical binocular vision, the brain fuses the two images presented by the eyes into a single image, resulting in three-dimensional vision, which aids in the determination of distance from objects in the environment (depth perception). USAF medical personnel also reported that although the brain is able to fuse the images presented through bifocal spectacles normally, it is unable to fuse the disparate images presented through MV contact lenses normally, which can result in monocular vision in individuals wearing MV contact lenses. Additionally, the USAF medical personnel indicated that the eye wearing MV contact lens correction for near vision will present a blurred image to the brain when used for distance vision; although the brain will try to accommodate by “suppressing” the blurred image, that accommodation is rarely complete.
31. Safety Questions
   a. What is the purpose of Reason’s Swiss Cheese Model

   b. What do the “layers” of cheese represent?

   c. What do the “holes” in the “layers” of cheese represent?

   d. According to the model, when do accidents occur?
32. Bonus Questions:

a. Do you think the content of the media reports do justice to accident reports? Explain.

b. What do you think should be the minimum criteria for the content for reporting on accidents? Explain.