

Aircraft Serious Incident Report

In-Flight Crew Incapacitation

Asiana Airlines

A321-200, HL8071

**During Approach to Kaohsiung International
Airport(KHH) in Taiwan(60NM North)**

29 Oct. 2019

This aircraft serious incident report has been prepared in accordance with the Article 25 of the Aviation and Railway Accident Investigation Act of the Republic of Korea.

According to the provisions of the Article 30 of the Aviation and Railway Accident Investigation Act, it is stipulated;

The accident investigation shall be conducted separately from any judicial, administrative disposition or administrative lawsuit proceedings associated with civil or criminal liability.

And in the Annex 13 to the Convention on International Civil Aviation, Paragraphs 3.1 and 5.4.1, it is stipulated as follows:

The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of the activity to apportion blame or liability. Any investigation conducted in accordance with the provision of this Annex shall be separate from any judicial or administrative proceedings to apportion blame or liability.

Thus, this investigation report shall not be used for any other purpose than to improve aviation safety.

In case of divergent interpretation of this report between the Korean and English languages, the Korean text shall prevail.

Aircraft Serious Incident Report

Aviation-Railway Accident Investigation Board, In-Flight Crew Incapacitation, Asiana Airlines, HL8071, A321-200, During Approach to Kaohsiung Int'l Airport in Taiwan, 29 Oct. 2019, Aircraft Serious Incident Report, ARAIB/AIR1906, Sejong Special Self-governing City, Republic of Korea

The Aviation and Railway Accident Investigation Board (ARAIB), Republic of Korea, is a government organization established for independent investigation of aviation and railway accident, and the ARAIB conducts accident investigation in accordance with the provisions of the Aviation and Railway Accident Investigation Act of the Republic of Korea and Annex 13 to the Convention on International Civil Aviation.

The objective of the investigation by the ARAIB is not to apportion blame or liability but to prevent accidents and incidents.

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In-Flight Crew Incapacitation

- Operator: Asiana Airlines
- Manufacturer: Airbus
- Type: A321-200
- Registration Mark: HL8071
- Location: 60NM North of Kaohsiung Int'l Airport in Taiwan
(24°72'N / 120°62'E)
- Date & Time: 29 Oct, 2019, Approximately 19:08(KST)¹⁾

Synopsis

On 29 Oct. 2019, Asiana Airlines AAR717(A321-200, HL8071), a scheduled passenger flight, took off at Incheon Int'l Airport(ICN) bound for Kaohsiung Int'l Airport(KHH) in Taiwan. During approach to destination airport, the first officer suffered from loss of consciousness. The captain declared an emergency and controlled the aircraft by himself, which he later landed at Kaohsiung Int'l Airport at 19:31.

Damage to the aircraft as well as injuries to persons were not found due to this serious incident.

The Taiwan Transportation Safety Board(臺灣國家運輸安全調查委員會, hereafter referred to as "TTSB"²⁾), an accident investigation agency in Taiwan, interviewed the captain and the first officer and reported the occurrence of a serious incident to the International Civil Aviation Organization(ICAO). TTSB delegated the authority of investigation to the Aviation and Railway Accident Investigation Board(ARAIB³⁾), an accident investigation authority in the Republic of Korea.

1) Unless otherwise indicated, all times stated in this report are Korean Standard Time(UTC+9)

2) Taiwan Transportation Safety Board(TTSB)

3) Aviation and Railway Accident Investigation Board of the Republic of Korea

The Aviation and Railway Accident Investigation Board(hereafter referred to as "ARAIB") determines that the cause of this serious incident was 「loss of consciousness of unknown cause」.

Contributing to the serious incident were 「① Lack of awareness about sleep deprivation ② Lack of individual fatigue management ③ Lack of safety culture in the organization and safety mindset of its employees when it comes to fatigue management」

As a result of the investigation, the ARAIB makes four safety recommendations to Asiana Airlines.

1. Factual Information

1.1 History of Flight

On 29 October 2019, Asiana Airlines AAR717(A321-200, HL8071, hereafter referred to as "HL8071"), a scheduled passenger flight, took off at 16:34 KST(Korean Standard Time) from Incheon International Airport(ICN) bound for Kaohsiung International Airport(KHH) in Taiwan. There were a total of 154 persons on board including 9 crew members and 145 passengers. The aircraft was flying as planned route. At the time of the event, the aircraft was approaching and descending to the destination airport, Kaohsiung International Airport in Taiwan.

There were no significant weather changes along the route of HL8071. About 30 minutes before arrival, the captain who was performing pilot monitoring(hereafter referred to as "PM⁴") gave an approach briefing with the co-pilot, after which the captain took the role of pilot flying(hereafter referred to as "PF⁵"). About 20 minutes after the shift, the captain asked the destination weather and the co-pilot punched in the request on ACARS(Aircraft Communications Addressing and Reporting System). While the co-pilot was waiting for a printout, he suddenly lost his consciousness at 19:09.

The captain used verbal and physical stimuli(call and touch) as judgement tools to confirm the first officer's consciousness, saying "What's going on?". As the captain was quite sure of the first officer's incapacitation, he asked one of the cabin crew members to come into the flight deck. When two cabin crew members showed up in the cockpit, the captain instructed them to push the incapacitated pilot's chair backwards so as not to interfere any

4) Pilot Monitoring(PM): Monitoring external condition and flight instruments

5) Pilot Flying(PF): Controlling the aircraft

instruments, and to look for any medical professionals on board. Once the captain had controlled imminent matters, he declared an emergency(MAYDAY) due to the pilot's unconsciousness.

The cabin crew entering the flight deck by the captain's call had hard time pushing the seat of the incapacitated pilot due to unfamiliarity with seat adjustment. In few seconds, the purser (SCCM: Senior Cabin Crew Member) who had worked in the cabin entered the cockpit and tried again as instructed by the captain, thereby pushing the incapacitated pilot's seat backwards.

The purser grasped the condition of the first officer. According to the report from the purser, the first officer was pale, in cold sweats, and the pilot's body was drooped. When the purser touched the pilot's arms, he could not sense any tension of muscle. The purser loosened the ties and belts, applied oxygen mask, and massaged limbs as first aids. Soon after the first aid action, the pilot's condition improved - pallor and cold sweats vanished and responded question and moved arms.

After a few minutes of the purser's first aid action, the captain asked the purser to take the pilot out of the cockpit. About 19:19, the purser confirmed the first officer could move by himself and guided him to a passenger seat located in the front of the cabin.

The purser loosened his tie and belt and administered oxygen from the portable oxygen bottle in the cabin and massaged the limbs.

The cabin crew made an announcement seeking medical professionals, twice with time interval. After the second announcement, one of the passengers identified himself a medical doctor. The doctor took a look at

the pilot and told the purser to keep giving him oxygen, which later had him stabilized. According to the observation report of the purser, the pilot appeared to get better and showed no unusual symptoms.

About 19:30, the aircraft arrived at the destination, Kaohsiung Int'l Airport without further event. When the aircraft reached the gate, the paramedic who was on standby asked questions about the patient's condition. The paramedic found that the patient's condition was not so urgent and advised the purser of his opinion and the purser decided to give priority to passengers.

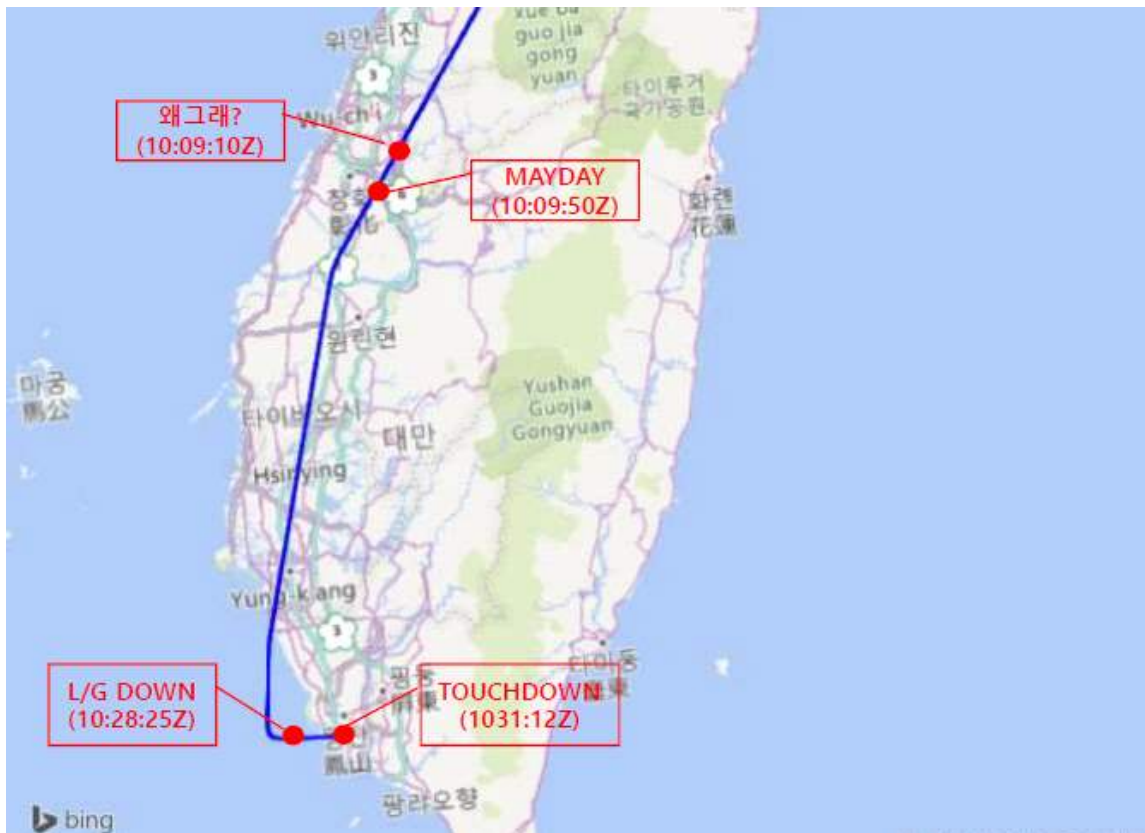
After the passengers left the aircraft, the paramedic exchanged a conversation with the pilot (who was once incapacitated) about his condition. The paramedic checked blood pressure, body temperature and blood sugar. Afterwards, they withdrew without any special measures and airport officials proceeded with alcohol test on all the crew members and the results turned out to be normal.

The TTSB interviewed both the flight crew and cabin crew.

Flight No.	AAR717
DATE	29 Oct. 2019
Point of Departure / Point of Arrival	ICN(+9)/KHH (+8, KAOHSIUNG)
Scheduled Time of Departure(STD) / Scheduled Time of Arrival(STA)	07:35/10:30(UTC)
Actual Time of Departure(ATD)/ Actual Time of Arrival(ATA)	07:34/10:35(UTC)

[Table 1] Basic Flight Information

The flight path from the moment of serious incident occurred till HL8071 arrival is as shown in [Figure 1].



[Figure 1] HL8071 Flight Path After Occurrence

1.2 Injuries to Persons

Except the pilot incapacitation, there were no injuries.

1.3 Damage to Aircraft

There was no damage due to this accident.

1.4 Other Damage

No other damages were found.

1.5 Personnel Information

1.5.1 Captain

The captain(male, age 47) held various valid licenses⁶⁾ including air transport pilot license required for aircraft operation.

As a Korean national, the captain was hired by Asiana Airlines on 15 Feb. 2008. After the initial training, he was assigned as a First Officer of A320 fleet then had transition training on B747. He was promoted to a captain on 9 Feb. 2018. Since then he has worked as a captain on A320 till the day of the event.

The captain have flown on B747 and A320 and accumulated 9,893 total flight hours including 4,026 hours in A320 and 3,520 hours as a captain in A320. He had flown 57 and 9 flight hours in the 90 and 7 days, respectively.

According to the training record, he had passed SIM check (simulator-based flight training and check) where the captain was evaluated on crew incapacitation scenario (even-numbered year item) on 5 Jun. 2018. He also passed SIM check (odd-numbered year items) on 22 May 2019.

He stated that he had not drink alcohol or take any illegal medication in the 24 hours before the flight.

6) Air Transport Pilot License No.: 11-005301(Issued on 21 Apr. 2017), Airman Medical Certificate Issue No.: 062-22369(Valid Until: 31 Oct. 2020), Radio Operator License No.: 07-34-2-0241, Level 4 ICAO English Proficiency Certificate(Valid Until: 12 May 2020)

1.5.2 First Officer

The first officer(male, age 27) held valid various licenses⁷⁾ including commercial pilot license required for aircraft operation.

The first officer had accumulated 836 total flight hours, including 532 hours in A320 airplane. He had flown about 86 and 7 hours in the 90 and 7 days, respectively.

The first officer was hired by Asiana Airlines on 9 Apr. 2018 and completed initial training course which included crew incapacitation. He passed line check on 18 Feb. 2019 and appointed as first officer in A320.

He had taken initial ground school course where he had about stress and fatigue management class. He had also received fatigue management class of recurrent training on 22 Aug. 2019 in the latter half of the year.

In the 72 hours before the serious incident, he had flown about 4 hours for three days in a row from 26 April to 28 April. On 29 April, he went to office at 09:00 a.m. on the day of the event and flew from Incheon Int'l Airport to Kaohsiung Int'l Airport in Taiwan. He stated that he had not drink alcohol or take any illegal medication in the 24 hours before the flight.

7) Commercial Pilot License No.: 12-011690(Issued on 15 Mar. 2018), Airman Medical Certificate No.: 062-20723(Valid Until: 31 Oct. 2019), Radio Operator License No.: 13-34-1-0004, Level 4 ICAO English Proficiency Certificate(Valid Until: 28 Sept. 2020)

1.6 Aircraft Information

Manufactured by Airbus, France, HL8071 was delivered to Asiana Airlines on 17 Aug. 2016 and has been operated since then.

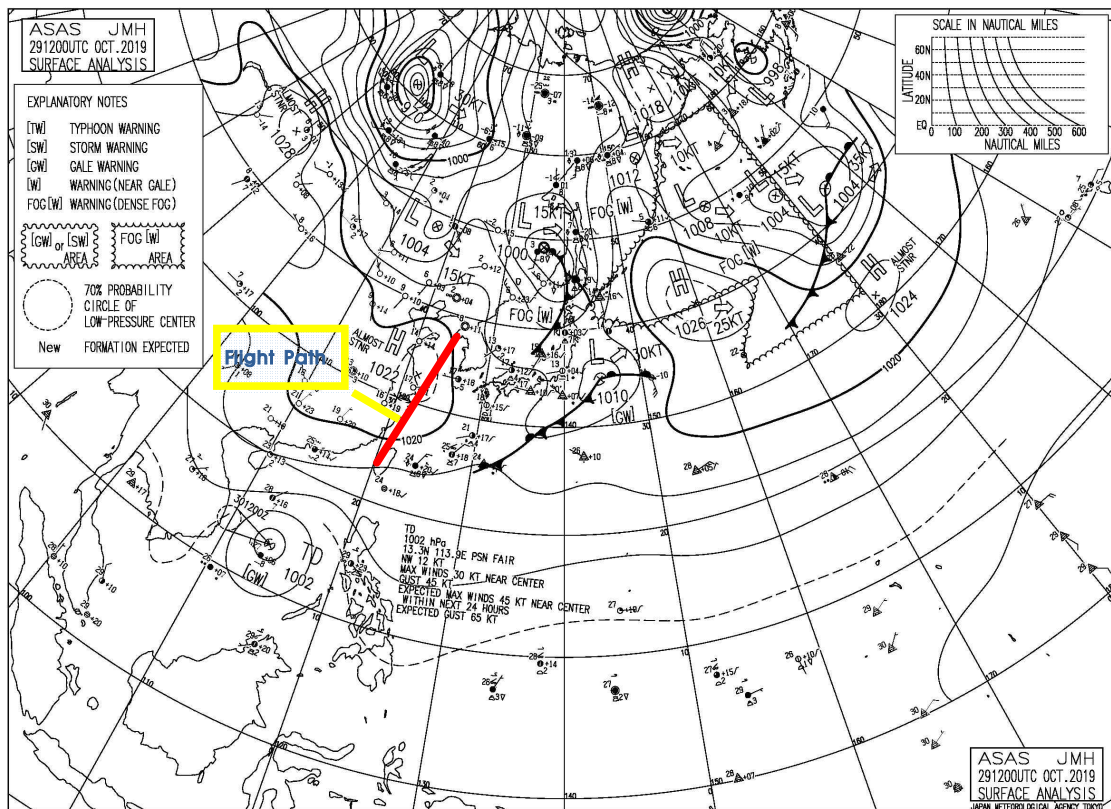
MANUFACTURER	AIRBUS
MODEL	A321-200
MSN	7266
DATE OF DELIVERY	2016-08-17
NATIONALITY AND REGISTRATION	REP OF KOREA, HL8071
NAME OF THE OWNER	BOC
NAME OF THE OPERATOR	AAR
CERTIFICATE OF REGISTRATION	
NUMBER	2016-108
ISSUING AUTHORITY	Ministry of land, Infrastructure and Transport
ISSUANCE DATE	2016-08-17
VALID TO	
CERTIFICATE OF AIRWORTHINESS	
NUMBER	IS16023
ISSUING AUTHORITY	Ministry of land, Infrastructure and Transport
ISSUANCE DATE	2016-08-20
VALID TO	
TOTAL HOURS SINCE NEW	12513:50
TOTAL CYCLES SINCE NEW	5191
LAST INSPECTION TYPE ,DATE	2A-Check ,2019.10.24
ENGINE	V2500
MAX TAKEOFF WEIGHT	196,211 lbs
MAX LANDING WEIGHT	166,448 lbs
TAKEOFF WEIGHT FOR AAR717	173,600 lbs
LANDING WEIGHT FOR AAR717	155,700 lbs

[Table 2] Aircraft Information

1.7 Meteorological Information

Weather forecast at the destination airport on the day of the event(10:30Z) is as follows: wind direction 350 degrees and 8kts of wind velocity, 10km of visibility, scattered cloud at 1,600ft, temperature of 27°C and atmospheric pressure of 1,012mb.

At 21:00(12:00 UTC) on the day of the occurrence, weather chart is as shown in [Figure 3]. Weather conditions seem to be normal along the flight route(Korea-Taiwan).



[Figure 2] Weather Chart

1.8 Aids to Navigation

No issues were reported in relation to aids to navigation.

1.9 Communication

Communication between HL8071 and ATC was normal.

1.10. Aerodrome Information

No issues were found in relation to this serious incident.

1.11 Flight Data Recorders

Data saved in the flight data recorders(Flight Data Recorder and Cockpit Voice Recorder) was used to confirm the route trajectory of the aircraft and to confirm the time and the initial response in the aircraft.

1.11.1 Flight Data Recorder

Based on the data saved in the flight data recorder, the route trajectory of the aircraft was confirmed.

1.11.2 Cockpit Voice Recorder

The time and details of the initial response measures in the aircraft were confirmed through the transcript of the audio data recorded in the HL8071 cockpit voice recorder. The recordings of the CVR and the ATC communication were cross-referenced to identify the time and actions.

1.12 Wreckage and Impact Information

No damage was found due to this serious incident.

1.13 Medical and Pathological Information

After passengers disembarked from HL8071 at Kaohsiung Int'l Airport, The medical staff on standby checked the incapacitated pilot (body temperature, blood pressure, blood sugar and etc.). They confirmed the results of medical check were in normal range. Subsequently, airport authorities measured his blood alcohol level and the results were normal.

In consideration of the possibility of gastroenteritis which is the most frequent factor of crew incapacity, the investigation requested the airline to conduct a stool examination as immediate as possible. Right after the pilot returned home base, the stool examination was conducted twice that the result turned out to be normal.

In an interview with the investigators, the affected pilot stated he had felt dizziness and powerlessness, could not stay upright in the seat, recognised verbal stimuli but could not respond. The affected pilot remembered most of the captain's actions, the sequence of cabin crew entering, and actions.

The cabin crew first faced the affected pilot, told that the pilot was in pallor and cold sweats and could not respond but vaguely focus when questioned.

The purser who also attended the affected pilot, stated that the pilot was in pallor and cold sweats, his body was drooped. When the purser touched the pilot's arms, he could not sense any tension of muscle.

The purser loosened the ties and belts, applied oxygen mask, and massaged limbs as first aids. Soon after the first aid action, the pilot's condition improved - pallor and cold sweats vanished and responded question and moved arms.

A doctor of the airline's medical department met the pilot the day after the serious incident. The pilot went through detailed medical examinations⁸⁾ and consultations with neurologists and cardiologists at an external specialized medical facility over a period of 1 month. After the process, the medical officer of the operator presumed the state of the pilot as 'Vasovagal Syncope' or 'Epilepsy suspect'.

In accordance of 14.F of the Aviation Medical Examiner's manual, the medical examiner of the operator submitted the case as pending decision. The judging board of Airman Medical Certificate decided the case 'unfit due to loss of consciousness of unknown cause'.

1.14 Fire

N/A

1.15 Survival Aspects

The aircraft uneventfully landed and both the crew and passengers disembarked normally.

1.16 Tests and Research

No additional tests and research were required.

8) Electroencephalogram/EEG check, Head-up tilt test, Echocardiogram, Sleep deprived EEG, MRI/MRA of brain

1.17 Organizational and Management Information

1.17.1 Operator's Flight Crew Manual

In the course of the investigation, investigators reviewed the operator's policy and flight procedure regarding crew incapacitation. The airline's Flight Operations Manual(FOM)⁹⁾ and Flight Crew Technique Manual(FCTM)¹⁰⁾ published by the manufacturer suggest the following operation standards in case of crew incapacitation.

Flight Operations Manual 5.9.1 describes the recognition of incapacitation, actions in response to incapacitation and considerations. The following description is summarized statement of flight operations manual.

- Recognition of incapacitation
- Takeover flight controls of an aircraft
- Use the autopilot system as much as possible
- Seek immediate assistance from cabin crew
- Manually lock shoulder harness of the incapacitated pilot to stop from moving
- Push the seat completely aft and recline the seat back
- Be cautious not to endanger any controls and switches when isolating unconscious flight crew
- Cabin manager shall check if a type qualified company pilot is on board to replace the incapacitated crew member
- Contact company/OCC to receive medical assistance or diversion
- Land at an Enroute alternate airport as soon as practical
- If the flight crew is alone, declare emergency
- Although one of flight crew is incapacitated during final approach

9) FOM(Flight Operations Manual): Operator's manual providing airline policies and standards

10) FCTM(Flight Crew Technique Manual): Manual provided by manufacturer related to aircraft operation

or landing, approach and landing can be made continuously by the remaining flight crew if it safe to do so

- If a time-consuming first aid is required, perform treatment outside the cockpit
- Cabin manager asks for a help by identifying if the doctor or nurse is boarded as passenger
- Land as soon as possible after declaring emergency
- Plan an Auto Coupled Approach if necessary

As shown in [Figure 3], FCTM issued by the manufacturer incorporated the following statement: 'If one flight crew member does not feel well, he must inform the other flight crew member'. However, it was not included in the operator's FOM.

FLIGHT CREW INCAPACITATION
Ident: PR-AEP-MISC-00018202.0001001 / 30 AUG 18 Applicable to: ALL
GENERAL Flight crew incapacitation is a real safety hazard that occurs more frequently than many of the other emergencies. Incapacitation can occur in many forms, that range from sudden death to partial loss of function. Sometimes the flight crew does not have any symptom before incapacitation.
DETECTION In order to help with the early detection of flight crew incapacitation, the Crew Resource Management (CRM) principles should be applied: <ul style="list-style-type: none">- Correct crew coordination that involves routine monitoring and aural crosschecks. The absence of standard callouts at the appropriate time may indicate incapacitation of one flight crewmember- If one flight crewmember does not feel well, he must inform the other flight crewmember.

[Figure 3] Flight Crew Technique Manual(FCTM)

1.17.2 Operator's Cabin Crew Manual

Responses to flight crew incapacitation are included in the Cabin Crew Manual 2.1.5.

- In a situation where one cockpit crew is unconscious and cannot perform the duty, another cockpit crew shall decide the work-ability of the cockpit crew and ask for help to cabin crew via interphone.
- Cabin crew gives first aide treatment to the unconscious cockpit crew.
- If the first aide treatment takes time, then it shall be performed outside the cockpit.
- If there is a doctor among passengers, then ask for help. And request that proper medical treatment can be provided right after landing.

1.17.3 Safety Management System Manual

The operator published the Safety Management System Manual and has employed¹¹⁾ Safety Management System Manual(SMSM) to promote the safety of operation.

The operator reviewed the incident in accordance with the safety management system manual. The incident was analyzed in many aspects such as safety hazard identification, risk assessment, acceptability depending on the level of risk factors and possibility of mitigation.

Asiana Airlines notified this serious incident to all flight and cabin crew members in order to prevent similar recurrence. It emphasized procedures in response to in-flight crew incapacitation. The actions taken by the operator are mentioned in detail in the following paragraph of the analysis.

11) SMSM: The first draft was approved by the Ministry of Land, Infrastructure and Transport and published on 26 Aug. 2008 and revised on 12 Jul. 2019.

1.17.4 Flight Crew Training

Asiana Airlines has provided ground school course in the first and second half of the year as described in the Chapter 4(Flight Crew Training and competency test) of Flight Crew Training Regulation(FCTR).

The airlines has offered fatigue management in the first half of 2019 recurrent training and health management in the latter half of the year.

Classroom class about crew incapacitation is normally conducted in the second half of odd-numbered year while simulator training is provided every three years. Flight crew is evaluated on the SIM check based on incapacitation scenario in even-numbered year.

Hired by Asiana Airlines in 2018, the first officer completed initial training course and received training for crew incapacitation.

1.17.5 Cabin Crew Training

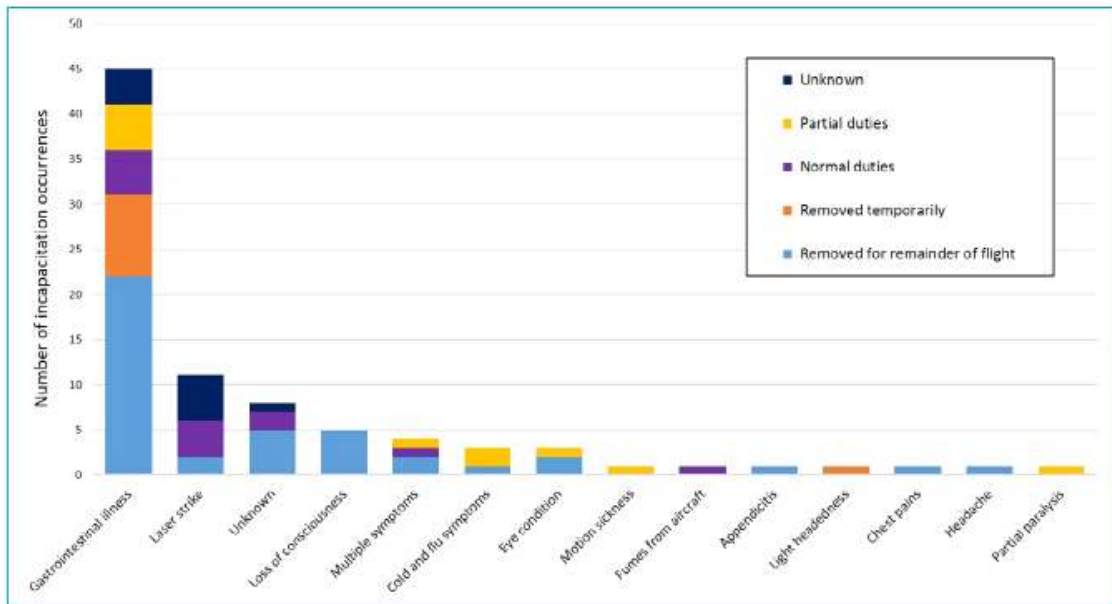
After completing safety and service training course in accordance with cabin crew training program which is authorized by the Ministry of Land, Infrastructure and Transport, a cabin crew can be assigned to perform flight duty.

Safety training is comprised of several courses including aviation safety act, airline's policy, standards of cabin crew duty, emergency response procedure, crew coordination and first aid. Cabin crew training includes details of flight crew incapacitation.

1.18 Case Study of Crew Incapacitation

There has been no record reported in the Republic of Korea when it comes to crew incapacitation. However, investigators were able to find case study of crew incapacitation including research paper¹²⁾ published by Australian Transport Safety Bureau(ATSB) in 2016 and serious incident report(AIFN/0006/2015) written by the United Arab Emirates(UAE) investigation authority.

According to ATSB report(AR-2015-096), there have been 86 cases of flight crew (Transport category) incapacitation during the research period from 2010 to 2014. About more than 50% of the incapacitation occurrences were related to gastroenteritis such as food poisoning. Five cases were related to crew unconsciousness. (See Figure 4)

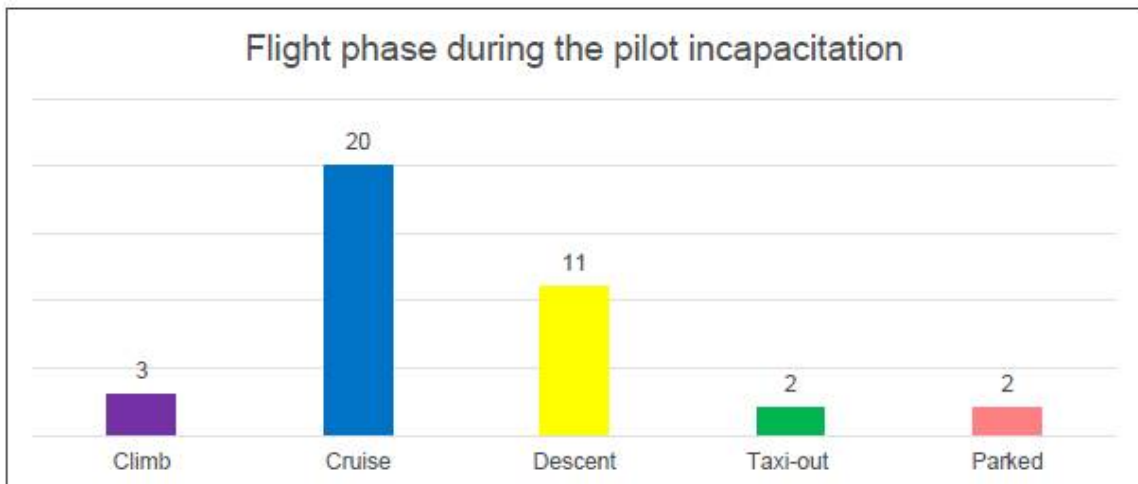


[Figure 4] Cause of Crew Incapacitation (ATSB Research Report)

12) Australian Transport Safety Bureau(ATSB) Research Report(AR-2015-096): Pilot Incapacitation Occurrences from 2010 to 2014, 2016

ATSB concluded that the practice of ensuring all pilots on the same flight eat different meals prior to and during the flight has been an effective defence preventing all pilots on the same flight becoming incapacitated at the same time. To ensure the flight is under control, it is important that pilots have been trained adequately to manage cases of pilot incapacitation.

The frequency of the occurrence is one incident about 34,000 flights in Australia and one incident about every 61,000 flights in the UAE. From 2017 to 2019, flight departures of Korean flag carriers were more than 500,000. This incident is the first recorded case.



[Figure 5] Frequency of each flight phase during pilot incapacitation
(UAE Accident Investigation Report)

According to the UAE report as shown in [Figure 5], crew incapacitation commonly occurred in cruise and descent phase of a flight. The investigation relayed both reports to the operator for reference. The operator changed the simulator training profile of the pilot incapacitation from climb phase to descent phase.

2. Analysis

2.1 General

ARAIB reviewed Asiana Airlines' flight and cabin crew actions against crew incapacitation, which resulted in aircraft serious incident that occurred to HL8071. ARAIB investigators looked at the operation of safety management system of Asiana Airlines and preemptive measures to prevent similar recurrences.

2.2 Response to Crew Incapacitation

2.2.1 Actions Taken by Crew

Based on flight data recorders(FDR, CVR), the crew members took actions as shown in [Table 3].

SQ	Flow	Time	Action	Reference
1	Transfer control	10:06:50	'I have control' Captain takes control	Normal operation
2	Check crew incapacitation	10:09:10	What's going on?	FOM, FCTM
3	Cabin crew assisted	10:09:25	Intercom among crew members	FOM, CCM, Crew Statement
4	Separated control column	10:09:36	Move seat backwards Hard to push it backwards	FOM
5	Emergency declaration	10:09:50	Pilot saying 'mayday' Contact with ATC	FOM, CVR, Crew Statement
6	Asking if there is a doctor on board	10:10:57	Cabin Announcement	FOM, CCM, Crew Statement
7	Emergency action taken by cabin crew	10:11:12	Observing the pilot's condition and take emergency action	FOM, CCM, Crew Statement
8	Separated control column	10:11:22	Cabin crew pushed the seat backwards	FOM, CCM, Crew Statement
9	Maintained safe flight		Captain performing PF	FOM, FCTM, Crew Statement

10	Request medical assistance	10:14:09	Communication between pilot and ATC Ground medical assistance by ATC	FOM, CVR, Crew Statement
11	Instruct him to move to cabin	10:19:37	Move to Cabin Cockpit Door Closed	FOM, CCM, Crew Statement
12	Approach Check List	10:20:03	Approach Check List	
13	Crew Treatment		Cabin Crew's Medical Treatment	FOM, CCM, Crew Statement
14	Onboard Medical Professional's Help		Checked by a medical professional on board	FOM, CCM, Crew Statement
15	Landing Briefing	10:28:48	Pilot's Self-briefing	FOM, CVR, Crew Statement
16	A/P Release	10:29:39	Auto Coupled Approach Recommended But Released	FOM, CVR
17	Communication to Notify Situation		Communication between Crew and Ground Staff	FOM, CCM, Crew Statement
18	Airport Medical Professional Treatment		-	
19	Drug Test		Alcohol Test by Airport Authority	

[Table 3] Response to Crew Incapacitation

2.2.2 Flight Crew's Duty Performed

Three minutes before the first officer's incapacitation, the captain took over the controls and performed as PF. In accordance with flight operations manual(FOM), the captain performed the following duties: recognition of incapacitation, request cabin crew's assistance, emergency declaration, asking for a medical professional on board, request for ground medical assistance.

Flight crew technique manual(FCTM) emphasizes crew resource management(CRM) to be reflected in order to identify crew incapacitation promptly. The following statement enables pilots to predict a situation and it needs to be incorporated into flight operations manual(FOM).

If one flight crewmember does not feel well, he must inform the other flight crewmember.

The captain released automatic pilot system and landed. Both flight operations manual (FOM) and flight crew technique manual (FCTM) recommend pilots to implement auto landing not to be overwhelmed by heavy workload. In such situation, auto landing needs to be addressed as a preferred method with explanation in training.

According to the suggestion of Medical experts, people are normally recovered in less than a minute after vasovagal syncope. However, it is recommended not to stand up shortly within at least 15 minutes. Accordingly, if one of the crew members goes through vasovagal episode, he or she is advised to leave the flight deck with a 15-minute time interval. Crew incapacitation training also needs to be performed based on this scenario.

2.2.3 Cabin Crew's Duty Performed

Cabin crew members have performed the following duties: cabin crew's flight deck access, incapacitated crew's seat adjustment as instructed by the captain, observing incapacitated crew, moving him to cabin, first aid, asking medical professional for a help and coordination with ground crew.

The following statements are listed in the flight operations manual(FOM) but it was not included in the operator's cabin crew manual.

- Manually lock shoulder harness of the incapacitated crew to stop from moving.
- Push the seat completely aft and recline the seat back.
- Be cautious not to endanger any controls and switches when

isolating unconscious flight crew.

- Cabin manager shall check if a type qualified company pilot is on board to replace the incapacitated crew member.
- Contact company/OCC to receive medical assistance or diversion.

According to the documents¹³⁾ issued by International Airport Transport Association(IATA), cabin crew are expected to take on the following duties as shown in [Figure 6] in case of pilot incapacitation.

- Tighten and manually lock the shoulder harness of the incapacitated crew member;
- Slide the seat fully aft;
- Recline the seatback;
- Liaise with the other flight crew member on further action and consider:
 - First aid;
 - Call for medical assistance;
 - Removal of the incapacitated crew member from the flight deck, if advisable to prevent:
 - o Injury to the incapacitated crew member;
 - o Damage to or interference with flight deck controls.

Source: CABIN OPERATIONS SAFETY BEST PRACTICES GUIDE 2ND EDITION 2015, IATA

[Figure 6] Cabin Crew's Duty Expected in Case of Pilot Incapacitation(IATA)

Even though the frequency of this type of serious incident is low, cabin crew manual needs to provide a procedure to which cabin crew may refer in case of crew incapacitation.

The cabin crew training manual(ICAO DOC 10002) published by International Civil Aviation Organization(ICAO) defines six subordinate tasks in case of flight crew incapacitation and recommends associated training to be implemented.

13) Cabin operations safety best practices guide, 2nd edition, 2015, IATA

5.5.7 Flight crew incapacitation

Task 1.7: Apply flight crew member incapacitation procedures	
Sub-tasks	
1.7.1	Respond to call from the flight crew
1.7.2	Move the incapacitated flight crew member away from the controls
1.7.3	Secure the incapacitated flight crew member
1.7.4	Administer first aid
1.7.5	Assist the remaining flight crew member (pilot-in-command), as instructed
1.7.6	Complete the applicable documentation

[Figure 7] Flight Crew's Duty Expected in Case of Pilot Incapacitation(ICA0)

Cabin crew attempted to recline the incapacitated pilot's seat back as instructed by the captain but they were not familiar with seat adjustment. In order to respond to flight crew incapacitation as quickly as possible, cabin crew should also be trained about how to adjust pilot's seat and how to take incapacitated pilot from the flight deck.

Flight Operations Manual 5.9.3.1 defines as follows: Contact company/OCC to receive medical assistance or diversion. It is quite challenging for medical experts on the ground to take actions without knowing patient's physical conditions including blood pressure, temperature and blood sugar.

There is an 'Emergency Medical Kit' on board, which includes stethoscope, thermometer and sphygmomanometer that are supposed to be used by medical professionals. Hence, if no medical professionals are on board, it would be difficult for cabin crew to check vital signs and take actions.

According to ICAO DOC 10002 8.1.4 Cabin Crew Training Regulations, ICAO suggests to consider cabin crew's use of some of the equipment on board in the event a medical professional is not on board.

8.1.4 Cabin crew should be familiar with the contents of the medical kit carried on the aircraft (refer to *Preparation of an Operations Manual* (Doc 9376)) and support a health care professional who volunteers assistance. Cabin crew may also need to use some of the equipment contained in the medical kit in the event a health care professional is not on board (e.g. thermometer, delivery pack, masks).

Some other airlines place medical equipment (such as stethoscope, thermometer, sphygmomanometer and etc.) outside the 'Emergency Medical Kit' in case a medical professional is not on board so that cabin crew are able to check patient's basic physical conditions by measuring temperature, blood pressure, pulse and blood sugar. Measured data taken by a cabin crew may be delivered through aircraft communication for medical assistance. A medical service in such a scope requires substantial effort and further training.

2.3 Fatigue Management

2.3.1 Fatigue Management Regulations

Manual for the oversight of fatigue management approaches(ICAO Doc 9966¹⁴) pursues a change into proactive process by making the most of fatigue management system with various factors incorporated such as biorhythm, schedule pattern and etc.

14) DOC9966: Manual for the oversight of fatigue management approaches, 2020, 2nd Edition, 2nd Version, ICAO

According to the Aviation Safety Act Article 56 of the Republic of Korea, an air operator shall select at least one of the following methods: prescriptive method or proactive method. The former is to comply with set limitations on flight hours, duty hours, rest period. The latter is a method of building and operating a fatigue risk management system.

The operator has opted for a prescriptive method of fatigue management which suggests legal restrictions. Crew's schedules were checked on the day of the event and properly managed in accordance with the regulations.

Specific regulations associated with approval of fatigue risk management system can be found in Article 128(2) Enforcement Rules of Aviation Safety Act and it became effective in December 2020.

2.3.2 Personal Fatigue Management

Based on the incapacitated crew's daily life before flight, he slept for about two hours per day for three days. He probably would have high level of fatigue since sleep debt was accumulated.

According to the Oversight of Fatigue Management Approaches(ICAO Doc 9966), paragraph 2.2.1 mentions 'How you function versus how you feel' as follows.

HOW YOU FUNCTION VERSUS HOW YOU FEEL

For the first few days of severe sleep restriction (for example, 3 hours in bed), people are aware that they are getting progressively sleepier. However, after several days they no longer notice any difference in themselves, even though their alertness and performance continues to decline. In other words, as sleep restriction continues, people become increasingly unreliable at assessing their own functional status.

According to the Flight Operations Manual 2.2.10.1, all flight crew members must maintain a physical and mental condition suitable for performing flight duties. If any flight crew member is unable to conduct a duty, captain is responsible for avoiding from performing a flight duty.

FOM 2.2.10.1 Physical Conditions for Flight Crew Member

- A. All flight crew members must maintain a physical and mental condition suitable for performing flight duties.

- D. Captain is responsible for taking actions for following items.
 - 1) Taking an action to avoid from performing a flight duty if any crew member is unable to conduct a duty due to injury, sickness, fatigue, influence of alcohol, medicine or drugs, etc.
 - 2) Plan to land at the nearest suitable airport if flight crew member's ability to perform duty is significantly deteriorated due to fatigue, sickness or lack of oxygen.

Nevertheless, it would be hard to predict and ask questions about personal physical conditions unless a crew member who does not feel well informs his or her conditions. The phrase 'If one flight crewmember does not feel well, he must inform the other flight crewmember' in the flight crew technique manual (FCTM) underscores the importance of open communication among crew members and enables them to share their opinions freely.

As described in Manual for the Oversight of Fatigue Management Approaches(ICAO Doc 9966), crew members may encounter hardship to express their physical status under unreliable judgement. Furthermore, crew members might not voluntarily mention their personal issues when an organization emphasizes strong work ethics and has rigid hierarchy.

In order to prevent such issues from being worsened, operators or people in aviation industry should improve their awareness about safety culture. In that way, a simple event leading up to an accident may be avoided.

The Fatigue Management Guide for Airline Operators, 2nd Edition 2015 which was developed in collaboration between IATA¹⁵⁾, ICAO and IFALPA¹⁶⁾ to describe the benefits of napping during a duty period that can help improve attention and performance. It is so called 'Controlled rest' on the flight deck, which is an effective countermeasure in response to fatigue experienced during operations. Fatigue management guide Appendix C mentions specific conditions and procedures to utilize 'controlled rest' as a means.

According to the paper¹⁷⁾ published by Flight Safety Foundation(FSF), EASA¹⁸⁾ member states in Europe, Middle Eastern countries, Australia, Canada, Singapore and etc. permit 'Controlled rest' while some countries such as U.S. do not.

Annex IV Commercial Air Transport Operations of EASA regulations¹⁹⁾ has defined²⁰⁾ 'Controlled Rest' as follows.

15) IATA: International Air Transport Association

16) IFALPA: International Federation of Air Line Pilot's Association

17) 'Controlled rest on the flight deck', 2018, Research Paper, Flight Safety Foundation

18) EASA: European Aviation Safety Agency

19) Commission Regulation (EU) No 965/2012 of 5 October 2012-Air Operations

20) CAT.OP.MPA.210 Crew members at stations

CAT.OP.MPA.210 Crew members at stations*(a) Flight crew members*

- (3) During all phases of flight each flight crew member required to be on duty in the flight crew compartment shall remain alert. If a lack of alertness is encountered, appropriate countermeasures shall be used. If unexpected fatigue is experienced, a controlled rest procedure, organised by the commander, may be used if workload permits. Controlled rest taken in this way shall not be considered to be part of a rest period for purposes of calculating flight time limitations nor used to justify any extension of the duty period.

Procedures for practical operation are suggested in the subordinate regulations(GM1 CAT.OP.MPA.210)²¹⁾ as follows.

GM1 CAT.OP.MPA.210 Crew members at stations

MITIGATING MEASURES – CONTROLLED REST

- (a) This GM addresses controlled rest taken by the minimum certified flight crew. It is not related to planned in-flight rest by members of an augmented crew.
- (b) Although flight crew members should stay alert at all times during flight, unexpected fatigue can occur as a result of sleep disturbance and circadian disruption. To cover for this unexpected fatigue, and to regain a high level of alertness, a controlled rest procedure in the flight crew compartment, organised by the commander may be used, if workload permits and a controlled rest procedure is described in the operations manual. ‘Controlled rest’ means a period of time ‘off task’ that may include actual sleep. The use of controlled rest has been shown to significantly increase the levels of alertness during the later phases of flight, particularly after the top of descent, and is considered to be good use of crew resource management (CRM) principles. Controlled rest should be used in conjunction with other on-board fatigue management countermeasures such as physical exercise, bright cockpit illumination at appropriate times, balanced eating and drinking, and intellectual activity.
- (c) Controlled rest taken in this way should not be considered to be part of a rest period for the purposes of calculating flight time limitations, nor used to justify

21) Acceptable Means of Compliance(AMC) and Guidance Material(GM) to ANNEX4 PART CAT

any duty period. Controlled rest may be used to manage both sudden unexpected fatigue and fatigue that is expected to become more severe during higher workload periods later in the flight. Controlled rest is not related to fatigue management, which is planned before flight.

- (d) Controlled rest periods should be agreed according to individual needs and the accepted principles of CRM; where the involvement of the cabin crew is required, consideration should be given to their workload.
- (e) When applying controlled rest procedures, the commander should ensure that:
- (1) the other flight crew member(s) is (are) adequately briefed to carry out the duties of the resting flight crew member;
 - (2) one flight crew member is fully able to exercise control of the aircraft at all times; and
 - (3) any system intervention that would normally require a cross-check according to multi-crew principles is avoided until the resting flight crew member resumes his/her duties.
- (f) Controlled rest procedures should satisfy all of the following criteria:
- (1) Only one flight crew member at a time should take rest at his/her station; the restraint device should be used and the seat positioned to minimise unintentional interference with the controls.
 - (2) The rest period should be no longer than 45 minutes (in order to limit any actual sleep to approximately 30 minutes) to limit deep sleep and associated long recovery time (sleep inertia).
 - (3) After this 45-minute period, there should be a recovery period of 20 minutes to overcome sleep inertia during which control of the aircraft should not be entrusted to the flight crew member. At the end of this recovery period, an appropriate briefing should be given.
 - (4) In the case of two-crew operations, means should be established to ensure that the non-resting flight crew member remains alert. This may include:
 - (i) appropriate alarm systems;
 - (ii) on-board systems to monitor flight crew activity; and
 - (iii) frequent cabin crew checks. In this case, the commander should inform the senior cabin crew member of the intention of the flight crew member to take controlled rest, and of the time of the end of that rest; frequent contact should be established between the non-resting flight crew member and the cabin crew by communication means, and the cabin crew should check that the resting flight crew member is awake at the end of the period.
 - (5) There should be a minimum of 20 minutes between two subsequent controlled

rest periods in order to overcome the effects of sleep inertia and allow for adequate briefing.

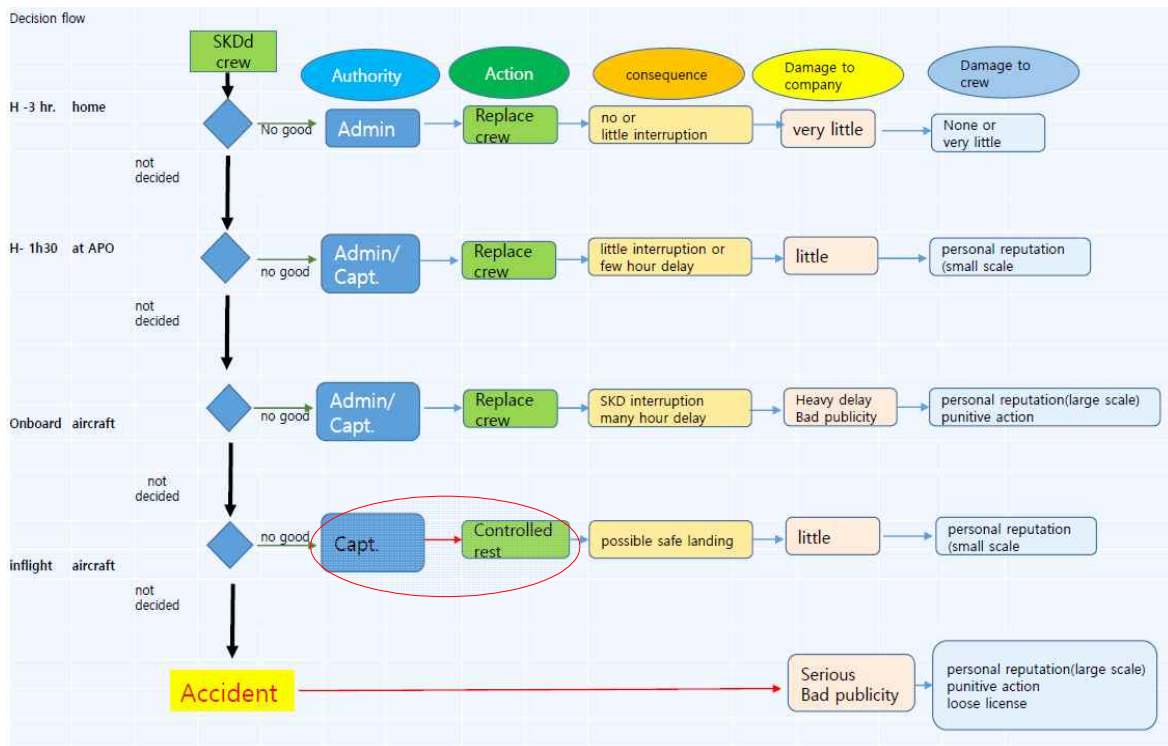
- (6) If necessary, a flight crew member may take more than one rest period, if time permits, on longer sectors, subject to the restrictions above.
- (7) Controlled rest periods should terminate at least 30 minutes before the top of descent.

Some operators in Europe comply with EASA regulations and reflect the above guidance with one extra requirement which is '*A Fatigue Report Form*'. In the event of controlled rest, a fatigue report must be completed providing details of usage which enables FRMS to monitor individual roster cycles for further analysis.

[Figure 8] shows a flow chart about crew's situational awareness and defence mechanism. The correct decision making and coordination at early stage shall lead to prevent flight disruption and negative development.

However, it is hard to judge one's physical condition correctly if a crew member faces sleep debt as mentioned ICAO DOC9966, which obviously reduces reliability of situation awareness.

Even though a crew member is aware of the situation, the rigid organizational culture which may lead to potential blame, peer pressure and their tarnished reputation, could obstruct communication within the organization where crew members are concerned.



[Figure 8] Situation Process and Defense Mechanism

Pilot replacement in flight is impossible unless there is an augmented crew. For that reason, 'controlled rest' described in Fatigue Management Guide(FMG) seems to be the only option to avoid potential fatigue risks.

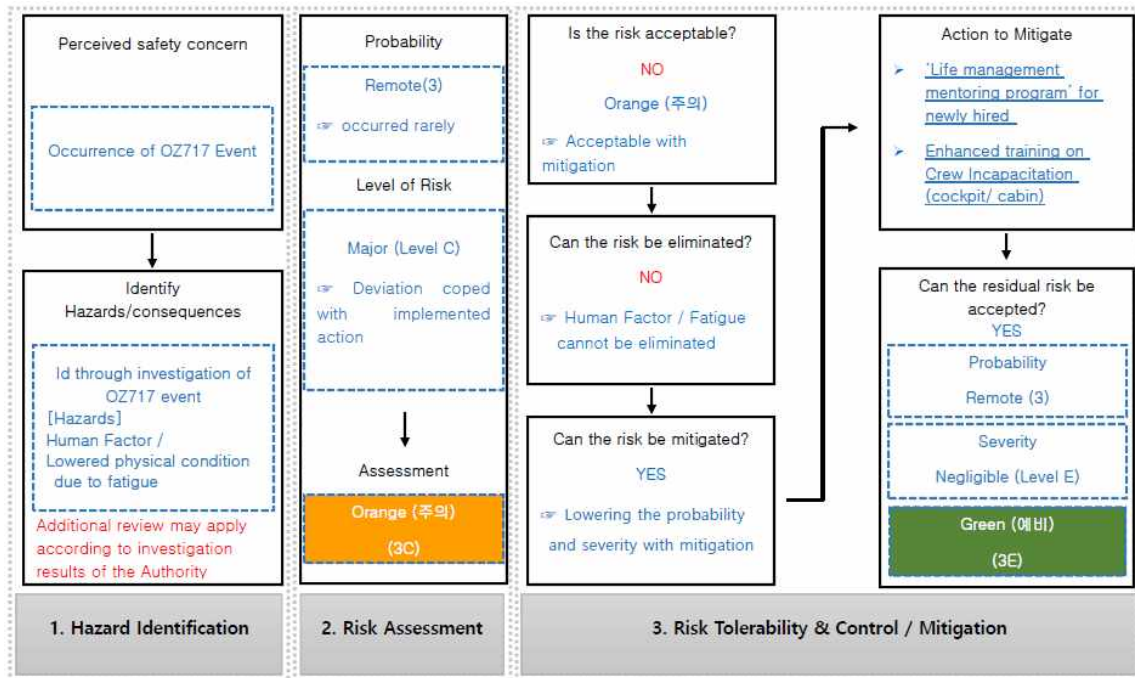
The absence of proper procedure and organizational acknowledgement of 'controlled rest' makes it difficult for a pilot to allow 'controlled rest'. Such situation discourages a crew member to utilize 'Controlled Rest' even though he or she does not feel well. Accordingly, there needs to be a systematic measure for decision makers (flight crew) to make a sensible decision.

In order for flight crew to have a clear understanding of situation, open communication and respond to situation, it is required to improve safety culture of cockpit by providing mitigation tools such as 'controlled rest'.

2.4 Operator's Safety Management System

After the serious incident occurred, the operator has held its own safety committee to identify issues, measure risk factors, endure risk, take mitigation measures and analyze action results as prescribed in safety management system manual. As a result, the operator performed improvement activities for two actions taken to mitigate risk factors.

1. Provide personal life management program for newly employed first officers
2. Enhance training in response to crew incapacitation (operations/cabin)



[Figure 9] SMS Risk Analysis and Process of Mitigation Measure

Among the tasks determined by the operator, there is a 'personal life management program'(Airmanship) to be provided to newly employed first officers. The operations headquarters has organized a small group of

mentor in safety operations team, which gives an opportunity to meet others both on an airplane and ground. The program enables new flight crew to adapt to the organization and their duties. It also helps to give an advice on effective management of pattern of life for safe flight. The program was introduced to new first officers during training and has been implemented by flight crew operation team of each aircraft type.

Training enhancement for crew incapacitation was reflected in 2020 training. The operator changed SIM training scenario of pilot incapacitation from takeoff phase to the descent phase where the frequency of occurrence is high. It would be desirable to further extend the training scenario till landing.

In addition, 'fatigue management and risk of sleep debt' were covered in aerospace physiology class in ground training and a training video of 'How to handle crew incapacitation' was circulated to all crew members.

Although procedures in cabin crew manual were emphasized in recurrent training, Some of specific duties and roles are not presented in the manual as mentioned in 2.2.2. For that reason, the Cabin Crew manual is required to be revised.

3. Conclusions

3.1 Findings

1. HL8071 flight crew held valid pilot licenses and airmen medical certificates required for operation. There were no special factors of health conditions, which could have affected the flight.
2. The captain held a valid certificate for operation. He had passed all annual SIM check. He had SIM check on crew incapacitation scenario in 2018.
3. The first officer held valid certificates for flight operation. His duty roster was in compliance with the operator's fatigue management standards on the day of the event. For about 72 hours before the incident, he slept for about two hours on a daily basis and fatigue might have been accumulated.
4. The flight crew had been trained for CRM, fatigue management, emergency procedure and response to turbulence.
5. The aircraft was manufactured by Airbus, Germany and the operator introduced the aircraft on 17 Aug. 2016. The operator obtained airworthiness certificate and registered the aircraft through legal process.
6. The flight on the day of the event was not encumbered by weather conditions on flight route and at destination airport.
7. The captain recognized the first officer's incapacitation and declared an emergency and notified it to Air Traffic Control. He requested right of way and asked medical assistance for the situation.

8. Cabin crew responded to crew incapacitation as prescribed in cabin crew manual. Actions taken by cabin crew were not partly listed in the manual so that they were not able to prepare for medical assistance from the ground through communications. Cabin crew duties for crew incapacitation should be incorporated in manual and the relevant training is considered to be conducted.
9. The captain used autopilot and continued flying after the incapacitated crew left flight deck. He performed approach check list by himself and converted to manual control system just before landing and landed without difficulty. In case the flight crew is solely responsible for landing, flight operations manual(FOM) and flight crew technique manual(FCTM) recommend flight crew to implement auto landing to avoid heavy work load.
10. After the aircraft arrived in destination airport, airport medical professionals found the incapacitated pilot not in serious condition at that time. Passengers disembarked from the airplane first and medical professionals checked and judged no additional treatment was needed.
11. Kaohsiung Airport Authority measured the blood alcohol level of crewmembers and the results turned out to be normal.
12. Asiana Airlines excluded the crew from flight roster and proceeded with detailed medical examinations. The medical officer of the operator presumed the state of the pilot as 'Vasovagal Syncope' or 'Epilepsy suspect'.
13. After the incident, the operator changed the simulator training scenario of pilot incapacitation from takeoff phase to the descent phase where the frequency of occurrence is high. It would be desirable to further extend the training scenario till landing.

14. The operator has provided a 'personal life management program for newly employed first officers' (airmanship) and organised a mentoring group for new flight crews life management.
15. Flight Crew Technique Manual(FCTM) underscores the application of Crew Resource Management(CRM) which encourages flight crew who feel unwell to inform their physical conditions in order to identify potential risks of crew incapacitation. It all needs to be reflected in Flight Operations Manual(FOM).
16. Pilot replacement in flight is impossible unless there is augmented crew. For that reason, 'controlled rest' described in Fatigue Management Guide(FMG) seems to be the only option to avoid potential fatigue risks. The operator needs to set policy and procedures to implement the controlled rest.

3.2 Cause

The Aviation and Railway Accident Investigation Board(ARAIB) determines that the cause of this serious incident was 「loss of consciousness of unknown cause」

Contributing to the serious incident were 「① Lack of awareness about sleep deprivation ② Lack of individual fatigue management ③ Lack of safety culture in the organization and safety mindset of its employees when it comes to fatigue management」

4. Safety Recommendations

ARAIB issues safety recommendations according to the investigation results of this serious incident - crew incapacitation - occurred to HL8071 during approach to Kaohsiung Int'l Airport in Taiwan on 29 Oct. 2019.

4.1 To Asiana Airlines

1. Emphasize each crew member's responsibility to manage fatigue and provide a means of fatigue management in detail. (AIR1906-1)

* Sleep debt risk, prevention of fatigue accumulation, solutions against extreme fatigue and etc.

2. 'Condition notification' described in FCTM must be incorporated in FOM. The operator needs to review the concept of 'Safety culture' in the organizational perspective and promote it. (AIR1906-2)

3. Considering the 'controlled rest' impact on accident prevention, the operator needs to set the policy and procedure of the 'Controlled rest'. (AIR1906-3)

* Refer to Appendix C/Fatigue Management Guide for Airline Operators 2nd edition, 2015

4. Specify procedure for crew incapacitation in cabin crew manual and implement relevant training. (AIR1906-4)