Executive Summary
GE 5111 Occurrence Investigation

On July 1st 2013, Trans Asia Airways flight GE 5111, an ATR 72-500 aircraft, registration B-22806, a schedule revenue passenger flight, took off from Taipei Song-Shan airport for Mekong airport of Penghu Island with 2 flight crew, 2 cabin crew, and 72 passengers onboard. After takeoff at 1618h from Song-Shan airport, an overheat caution "OVERHEAT AIR" was illuminated at the instrument panel, the crew requested ATC for air turn back to Song-Shan airport. When beginning to perform abnormal procedures, an "ELECTRIC SMOK" warning sounded and the flight crew declared "Pan Pan" and requested immediate return to land. The aircraft landed safely at 1631 without further incident.

During initial climb, when the aircraft started to turn at 2,500 feet, the flight crew felt cockpit temperature began to rise and hot air was blown out from cockpit air condition ventilation outlet, behind the instrument panel, and behind the wall panel. A white vapor like moisture was presented in the cockpit. The flight crew attempted to manually adjust the air condition temperature and reset Pack 1 and engine #1 bleed without success, hot air was continuously vented. In the mean time, temperature indication at upper flight compartment and duct had reached the maximum value of unity.

At 1620:57h, when the aircraft climb to 4,000 feet, a master caution sounded and flight crew considered the caution was due to engine #1 bleed overheat. The captain instructed the first officer to request Taipei Approach radar vector to Song-Shan airport. During the interview, Captain stated that the heat inside the cockpit was not endurable and their attempts to reset Pack #1 and engine bleed were made but without any success; therefore, an air turn back to

origin was decided.

At 1622:04h (1m07s after master caution), the aircraft was at 5,300 feet, the flight crew had not yet begun to conduct Engine #1 bleed overheat procedures, continuous master warning sounded and ELCE SMK red light at CAP was illuminated, Captain disengaged autopilot and change to manual flight. At 1622:18h (8 seconds after autopilot disengagement), the captain instructed the first officer to request emergency descent, the first officer declared “pan pan”
Both flight crews stated during the interview that, they believed there was no electrical smoke, therefore memory items were not executed and oxygen masks and goggles were not donned. When the aircraft descending thru 3,000 feet, the flight crew opened in sequence AVIONICS VENT EXHAUST MODE… OVBD and AIR FLOW… HIGH. The vapor then disappeared and the warning light stop illuminated and temperature back to normal level. The flight crew informed the ATC to cancel their emergency but due to the situation was still not clear; the crew would like to return. The flight landed safely at 1631h and taxied to gate.

According to Article 6 of the ROC Aviation Occurrence Investigation Act, and the content of Annex 13 to the Convention on International Civil Aviation (Chicago Convention), which is administered by the International Civil Aviation Organization (ICAO), the Aviation Safety Council (ASC), an independent agency of the ROC government responsible for civil aviation occurrences investigation, after confirmation of this occurrence, organized a team to conduct the investigation. The investigation team also included members from operator, Trans Asia Airways, Civil Aeronautics Administration Taiwan and the state of manufacture, represented by France BEA (Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile) including technical advisor from ATR.

Investigation Report was published after the Investigation Draft Report finished on October, 2013 and the final draft was send to parties after the approval at the 8th Council Meeting on December, 2013. Investigation Report was published after approval by the ASC council members on February 25, 2014, at the 10th Council Meeting.

There are 19 findings and 3 safety recommendations as the result of this investigation.

The Safety Council presents the findings derived from the factual information gathered during the investigation and the analysis of the occurrence. The findings are presented in three categories: **findings related to the probable causes, findings related to risk, and other findings.**

Findings related to the probable causes identify elements that have been shown to have operated in the occurrence, or almost certainly operated in the occurrence. These findings are associated with unsafe acts, unsafe conditions, or safety deficiencies that are associated with safety significant events that played a major role in the circumstances leading to the occurrence.

Findings related to risk identify elements of risk that have the potential to degrade aviation safety. Some of the findings in this category identify unsafe acts, unsafe conditions, and safety deficiencies, including organizational and systematic risk, that made this occurrence more likely; however, they cannot be clearly shown to have operated in the occurrence alone. They also identify risks that increase the possibility of property damage and personnel injury and death. Further, some of the findings in this category identify risks that are unrelated to the occurrence, but nonetheless were safety deficiencies that may warrant future safety actions.

Other findings identify elements that have the potential to enhance aviation safety, resolve an issue of controversy, or clarify an issue of unresolved ambiguity. Some of these findings are of general interest and are not necessarily analytical, but they are often included in ICAO format accident reports for informational, and safety awareness, education, and improvement purposes.

Finding(s) related to the probable causes

Hot air was continuously vented from air condition outlet, due to malfunctioning Pack #1 duct temperature sensor and temperature limiter that caused the modulating valve kept opening in the occurrence flight; as a result, temperature in the cockpit remained high. The flight crew did not shut off pack #1 immediately which enabled to stop hot air from continuously flowing into the cockpit.

Findings related to risk

1. Flight crew did not conduct SMOKE abnormal procedures when vapor was present during initial climb. A safer way could have been done was if they had conducted SMOKE procedures immediately to ensure their own safety, established fluent communication prior to verify whether the vapor was a kind of smoke or not. (1.18.1, 1.18.4, 2.3.1)
2. When the aircraft climbed over 4,000 feet and master caution sounded, the flight crew were not able to identify it was duct overheat. If they had worked through the abnormal procedures of engine bleed overheat or duct overheat, and shut off the affected pack system, they could have stopped the hot air from coming into the cockpit. (1.6.5, 1.11.2, 2.2.1, 2.3.2)
3. After ELECTRIC SMOK warning was present, a safer way

should be execute smoke procedure memory items then identify the source. (1.18.1, 1.18.4, 1.18.5, 2.3.3)

4. The Flight Operation Manuals and the Flight Crew Training Manual of ATR and Trans Asia Airways related manuals did not elaborate guidelines to verify smoke and provide procedures to follow when source of smoke is not clear. (1.17.1,1.17.2,1.18.1,1.18.4,1.18.5,2.3.1,2.3.4)
5. Trans Asia Airways related training did not request flight crew to execute smoke procedures when source of smoke is not clear. (1.17.1,1.17.2,1.18.1,1.18.4,1.18.5,2.3.1,2.3.4)
6. After ELECTRIC SMOK warning was present, the flight crew requested emergency landing to ATC, the captain disengage autopilot due to not enabling to see ADU display, however the captain did not inform the first officer his disengagement of autopilot; ATR Flight Operation Manual SMOK procedure required to maintain autopilot on. (1.11.1,1.18.4,2.3.3)
7. Both ATR Flight Operation Manuals and Trans Asia Airways Flight Crew Operation Manual smoke procedures and air condition smoke procedures did not elaborate procedures to eliminate the smoke, thus there was no guidance for the flight crew to expel the hot air/vapor out of cockpit. (1.18.1,2.3.3)

<u>Other Findings</u>

1. Air temperature coming from pack valve should be in normal range before entering secondary heat exchanger. (2.2)
2. Post-event tests on pack valve, air flow modulating valve, compressor, and condenser returned normal. (2.2)
3. Due to an oversaturated state (in the cockpit), the condensed water in the duct and un-condensed vapor from the water extractor came from engine bleed might made liquid water

remained in a vapor form in the cockpit possible. (1.6.4.1, 2.2.2)

4. The investigation team could not confirm that the amount of water vapor had reached an oversaturated state in the cockpit. The above statement only presented one of the possibilities that hot vapor was generated in the cockpit.
5. The vapor that contained water triggered ELECTRIC SMOK warning when passing smoke detector. (1.6.4.1, 2.2.2)
6. After pack overheat master caution was presented, the flight crew could have verified it was duct overheat if they had applied correct fault identification and call outs. (1.6.5, 1.11.2, 2.3.2)
7. When duct overheat caution was presented, the flight crew was communicating with ATC and had not begun QRH procedures when ELECTRIC SMOK warning showed up. (1.11.1,1.18.4,2.3.3)
8. The procedure execution could have been more efficient if the flight crew had referred ATR FCTM to assign PF conducted ATC communication so that PM could execute QRH when the overheat caution was presented. (1.18.1, 1.18.4, 1.18.6, 2.3.3)
9. The Trans Asia Airways flight crew' smoke procedures related training did not include condition verified of ELECTRIC SMOKE which activated by air condition smoke source. (1.17.2, 1.18.4, 2.3.4.1)
10. The ATR Flight Operation Manual does not contain some of those suggested by FSF or there exists certain content deviation. (1.18.2, 2.3.5)
11. A safety recommendation to EASA jointly issued by the

investigation agencies at Hungary, Denmark, and Italy in August 2012 suggested a review on emergency procedures on smoke elimination on ATR aircraft. However, this recommendation is still under study and conclusions not made yet. (1.18.3, 2.3.5)

Safety Recommendations

Both Trans Asia and Civil Aviation Authority have proposed, and accomplished their respective safety actions in responses to the findings raised by ASC during the investigation.

To Avions de Transport Regional (ATR)

1. Use the FSF research as a reference to review the appropriateness and completeness of the design philosophy of ATR smoke procedures, including: use bigger font that are more distinguishable, evaluate oxygen mask and goggle application as required or set items, evaluate adding diversion as an option in the procedure and list the operation consideration during an emergency landing situation.
2. Review the deviation between Flight Operation Manual and Flight Crew Training Manual regarding flight crew task sharing principles during abnormal and emergency situation.
3. Review the emergency procedures in Flight Operation Manual that do not include smoke elimination, revise as appropriate so that flight crew can execute smoke procedures more efficiently.

Safety Actions Accomplished or Being Accomplished

Trans Asia informed by email on February 16, 2014 that improvement measures were made regarding the safety recommendations of enhancing training on smoke procedures, including flight crew familiarization with judging and handling the scenario that ELECTRIC SMOK warning may be activated by air condition smoke, the safety enhancement activities are as follow.

Trans Asia has revised the smoke procedures in its ATR Flight Crew Training Manual, requesting flight crew to conduct SMOKE procedures memory items immediately prior to verify the smoke source, the above items has incorporated into annual Proficiency Training and Proficiency Check so that flight crew could familiarize with relevant system characteristics and procedures to improve the efficiency of procedure execution during training and evaluation.

Trans Asia revised related ATR Flight Crew Training Manual which required flight crew to conduct SMOKE procedures memory items immediately when unknown vapor appears, prior to warning signal sounds and flight crew is unclear of the source. Flight crew should apply Air Condition Smoke Procedures or Electrical Smoke Procedures when the smoke source is clear or CAP warning sounds. Flight crew also requires executing task-sharing and callouts more efficiently according to FOM Sec. 3.8 *Task-sharing Principles* and Sec. 7.3 *Callout Standards* respectively. In annual PT/PC, exam items shall include task-sharing between the crew, fault identification, and appropriateness of timing on declaring emergency. On January 1st, 2014, FOM edition 39, Sec. 3.8 *PF/PM Duty and Responsibilities*, was revised to assign PF

responsible for communication during abnormal and emergency situation.