Executive Summary

B-20001 Occurrence Investigation

On March 15th, 2018, an Aerospace Industrial Development Corporation (AIDC thereafter) airplane, type ASTRA SPX, registration number B-20001, took off from Taichung Chin-Chuan-Kang airport (Taichung airport thereafter), for target zone RCR-34 to conduct target towing mission Nº H-335. There were one captain, one first officer, and two mission operators, a total of 4 people onboard. The captain on the left seat was the pilot flying while the first officer on the right seat was the pilot monitoring.

When arriving at the mission zone, the airplane was first maintained between 5,000 ft. and 7,000 ft. for the flight crew to observe the weather. The mission was then called off due to the weather which prohibited target towing operation, in consequence, the flight crew requested runway 36 ILS approach to return to Taichung airport. Considering the estimated landing weight would be close to 20,700 lb., the airplane's allowed maximum landing weight, the flight crew opted for landing reference speed 133 knots, approach speed 143 knots, flaps 40 and slat down.

During the return trip, the captain mentioned "*both altitudes are a bit…. something wrong*" and "*i-a-s is not right either*", and the first officer replied, "*roger check*" and "*check normal*" respectively at 1858:26 hrs, when the airplane was at 6,400 ft. with speed 240 knots. At 1905:58 hrs, the flight was cleared to land by Taichung airport tower, and the flight crew was told wind direction 020 degrees at 6 knots. At 1907:56 hrs, the airplane

was at 2,100 ft. with speed 124 knots, the captain mentioned "*two sides the speeds differ quite a lot*" and the first officer replied "*roger one three two and one two four*", which was then followed by the captain's "*follow mine ias speed*." The captain called for "*okay runway in sight, landing*" at 1909:04 hrs, and disengaged autopilot at 1909:29 hrs. After the airplane descended through the minimum descent altitude, the ground proximity warning system (GPWS) was activated 6 times of "*glideslope*" aural warning between height above ground level from 280 ft. to 170 ft., the first officer once called out "*we are a bit low*". During that period, the airspeed was between 128 knots and 132 knots.

At 1910:03 hrs, the airplane touched down at Taichung airport runway 36 with speed of 123 knots, vertical acceleration 2.19g. The touchdown point was 780 ft. from the runway threshold, 40 ft. left from runway centerline. The airplane kept deviating to the left with approximately 1.5 degrees angle with respect to the centerline. The left main landing gear veered off the runway at 2,430 ft. from the threshold around 1910:12 hrs. The captain once mentioned "*they are not right, speeds are not right*" while the first officer replied "*yes*" during the period.

The maximum deviation from the runway edge line was 2.5 meters, and the airplane returned to runway at about 3,125 ft. from the threshold, decelerated without any issue, and vacated runway via W5 taxiway. It returned to AIDC's hanger around 1918 hrs. The airplane sustained minor damage with none onboard was injured.

According to the Republic of China (ROC) Aviation Occurrence

Investigation Act, and the content of Annex 13 to the Convention on International Civil Aviation, the Aviation Safety Council (ASC), an independent aviation occurrence investigation agency, was responsible for conducting the investigation. The investigation team also included members from the Taiwan Civil Aeronautics Administration (CAA) and AIDC. The US NTSB Accredited Representative and Gulfstream Aerospace Corporation Technical Advisors participated in the investigative process as well.

The 'Draft Final Report' of the occurrence investigation was, in accordance with the procedures, reviewed at ASC's 73rd Council Meeting on November 27, 2018, and then sent to relevant organizations and authorities for comments. After comments were collected and integrated, the Final Report was reviewed and approved by ASC's 75th Council Meeting on January 25, 2019.

There are a total of 14 findings from the Final Report, and 10 safety recommendations issued to the related organizations.

I. Findings as the result of this investigation

Findings related to probable causes

The occurrence airplane touched down at 1.5 degrees left with respect to runway centerline direction and it had rolled a total length of 1,650 ft. for 9 seconds before its left main gear veering off the runway. It appears that the pilot flying neither monitored nor corrected the airplane position and directional control, and the pilot monitoring

failed to remind the pilot flying, as the airplane kept deviating toward the left from the runway centerline.

Findings related to risk

1. The airplane's airspeed was below the landing reference speed during final approach, therefore the airplane was unable to maintain on the glide slope thus triggering several times of "glideslope" aural warning. This made the approach did not meet stabilized approach criteria, however, the flight crew did not perform a go-around immediately due to their overstretched the tolerance toward the limitation.
2. Upon deciding to call off the mission and return to the base, the flight crew did not verify the expected total landing weight and therefore causing an overweight landing. It could probably elevate the risks of structural damage, increasing deceleration distance, and overheating of the brake.
3. The airspeed indication of pilot flying (left side) was approximately 10 knots higher than pilot monitoring (right side) of the occurrence airplane during final approach, the difference from the indication could be affected by the invaded rain in the left static line.
4. The flight manual of the occurrence airplane did not contain corresponding procedures for the pilot to deal with the situations of "unreliable airspeed" and "miscompare warning of indicated airspeed".
5. The flight crew did not properly exercise the skills of crew resource management (CRM) and did not cross-check/compare the airspeed indications with standby airspeed indicator through crew coordination. The flight crew did not discuss the way how to use pitch and power setting to fly the airplane and did not get assistance from others either.

The pilot flying rushed to choose the left airspeed indicator, which had higher readings, as his reference before he could positively identify the erroneous speed. It not only caused the airplane's actual airspeed was lower than the proper approach speed but even lower than the landing reference speed during the final approach. As a result, the airplane was exposed to the risk of failing to maintain proper descent rate, further caused the airplane to go below the glide slope and the hard landing.

6. The captain's autocratic leadership, the first officer's hesitation to raise an objection during the decision-making process, and ineffective communication in the occurrence flight might attribute to the steep trans-cockpit authority gradient. The above would degrade flight crew's performances and lead to incorrect decisions and actions when they encountered unreliable airspeed, flight track below the glide slope, and left-deviation during the landing roll.
7. Although the CAA issued an updated advisory circular (AC) related to self-audit and abolished the pre-edition prior to the occurrence, the ADIC did not revise its the self-audit program accordingly and the CAA did not identify and correct the above deficiency either. The self-audit program of the ADIC prescribed the observation of line flight operations into non-periodic audit rather than periodic audit. The formal checklist, records keeping and long-term trend analysis are not in place for the observation of line flight operations.
8. The ADIC failed to maintain the flight crew recurrent simulator training records per training manual and to timely resolve the controversy of the related records-keeping or to revise the training manual. The periodic self-audit of the ADIC existed the following

findings identified by the investigation team: failure to follow the self-audit plan to conduct flight safety inspections, failure to identify the simulator training records keeping deficiency, and some of the inspection results not been clearly recorded.

9. The flight crew's certain operations did not conform to the SOPs or company policy, such as failure to precisely calculate the landing weight upon returning to the base, failure to execute a go-around while the approach was unstable, failure to make proper callouts including course deviation after touchdown. These not only elevated the risks of flight operations but also deprived the flight crew of opportunities to prevent the occurrence. The ADIC was lack of effective safety management measures to assure conformance with standard operating procedures by the flight crew.

Other findings

1. The occurrence flight crew were properly certificated and qualified in accordance with the Civil Aeronautics Administration and company requirements. No evidence indicated any preexisting medical conditions or alcohol that might have adversely affected the flight crew's performance during the occurrence flight.
2. The meteorological information issued by Taichung Airport before and after the occurrence showed that the weather conditions at the time of the airplane's approach were in line with the approach and landing standards of the type of the airplane and AIDC. The recorded wind speed per second of the runway 36 AWOS during the landing period were 0 to 2 knots. The weather was most likely not a factor in this

occurrence.

3. The airplane was properly certified and maintained in accordance with Civil Aviation Regulations. There is no evidence indicating that the relevant directional control systems of the airplane malfunctioned in the occurrence flight.
4. The static line for left ADC was drained approximately 5 ml of water during the post-occurrence testing. After draining the water, the operational test of altitude and the airspeed were both complied with the manual.

II. Safety recommendation

To Aerospace Industrial Development Corporation

1. Enhance flight crew's capability of situational awareness, monitoring, reminding and correcting for airplane directional control during landing. (ASC-ASR-19-02-001)
2. Review and reinforce safety management mechanism to identify and ensure the flight crew's compliance with the SOPs in respect to landing weight calculation, abnormal situation handling process, standard callout, go-around policy, and crew coordination. (ASC-ASR-19-02-002)
3. Request assistance from the airplane manufacturer to set up specific procedures, implementation, and training plan for the flight crew to deal with "unreliable airspeed" situation. (ASC-ASR-19-02-003)
4. Review and enhance the crew resource management training to avoid

autocratic leadership and adverse effect upon flight crew's performance due to steep trans-cockpit authority gradient, and to build up effective flight crew communication. (ASC-ASR-19-02-004)

5. Review and enhance the revision and implementation of the self-audit program, at least but not limited to following items: reference sources of the program, line flight operations observation, inspection checklists, records-keeping and trend analysis of the findings, and approvals process of self-audit results, etc.(ASC-ASR-19-02-005)
6. Review and enhance the flight crew training records management and the follow-up processes after receiving CAA advisory circulars. (ASC-ASR-19-02-006)

To Civil Aeronautics Administration, Ministry of Transportation and Communications

1. Supervise and ensure that AIDC enhances flight crew's capability of situational awareness, monitoring, reminding and correcting for airplane directional control during landing. (ASC-ASR-19-02-007)
2. Supervise and ensure that AIDC sets up specific procedures, implementation, and training plan for the flight crew to deal with "unreliable airspeed" situation. (ASC-ASR-19-02-008)
3. Enhance overseeing the ADIC at least but not limited to following items: flight crew training, self-audit operations, training records management, advisory circular receiving and follow-up process, and safety management to promote the compliance of standard operating procedures, crew resource management performance, and effectiveness and credibility of self-audit. (ASC-ASR-19-02-009)

To Gulfstream Aerospace Corporation

1. Establish procedures and/or guidance of Astra SPX type airplane for pilots to follow when unreliable airspeed indications occur. (ASC-ASR-19-02-010)