Lessons Learned From Recent Incident

Singapore Aviation Safety Seminar 2019

7 March 2019

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Outline

1. Update on TSIB
2. Lessons learned from a recent incident

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UPDATE ON TSIB

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Transport Safety Investigation Bureau (TSIB)

- AAIB was restructured to become TSIB on 1 August 2016 to include marine safety investigation
- 11 air safety investigators, 4 marine safety investigators, 1 rail safety investigator and 3 support officers
- Expanding to cover certain land transport vehicles

Transport Safety Investigations Act

- New omnibus legislation
  - Passed on 6 August 2018
  - Single legislation to govern the conduct of safety investigations
  - Replacing the investigation legislation in Part IIA of the Air Navigation Act on Accidents and Incidents Investigation
  - Developing subsidiary legislation

Scope of TSI Act

- Aviation
- Marine
- Land
  - Domestic and international rail (in future), e.g. MRT, Sky train at Changi Airport, Sentosa monorail
  - When directed by the Minster for Transport – Incidents involving buses on public bus services contract with LTA

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Air turn back due to fuel discrepancy

LESSONS LEARNED FROM A RECENT INCIDENT

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Synopsis

- “FUEL DISAGREE” appeared one hour into flight on a B777-200ER (Extended Range Operation)
- Fuel quantity onboard calculated by FMC (departure fuel - fuel burnt off) < fuel measured by the aircraft FQIS. The difference between the two was increasing
- After consulting home base, return to Singapore, aircraft landed without incident
- Manual check on fuel quantity discovered that the aircraft was about 41 tons extra

What happened before departure (1/2)

- Arrival fuel was at 5.5 tons, departure fuel was 86 tons. Only need to uplift 80.5 tons of fuel
- Bowser record showed fuel uplifted was 121.5 tons, about 41 tons extra
- However, FQIS showed 86 tons
- Huge discrepancy - manual check on fuel quantity was required

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What happened before departure (2/2)

- Magnastick check was performed and the fuel quantity was found tallied with FQIS, i.e., 86 tons
- Bowser operator was convinced that he might have forgotten to reset the fuel counter before the start of refueling and adjusted his fuel uplifted
  - Note: It was found out later that the bowser system would prevent the start of refueling if the fuel counter is not reset to zero

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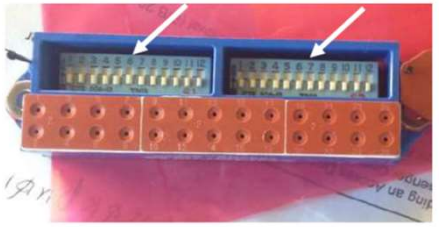
B777 fuel tank arrangement

- B777 aircraft has different fuel tanks arrangement for B777-200 and B777-200ER (extended range)
- Centre tank of -200ER is bigger than -200, the difference is 40.5 tons

(In tonnes)	Boeing 777-200	Boeing 777-200ER
Center tank	36.612	77.063
Left tank	27.460	28.227
Right tank	27.460	28.227



- The Program Switch Module (PSM) setting dictates the fuel tank variant
- PSM communicates with fuel quantity processing unit (FQPU) the type of fuel tanks arrangement

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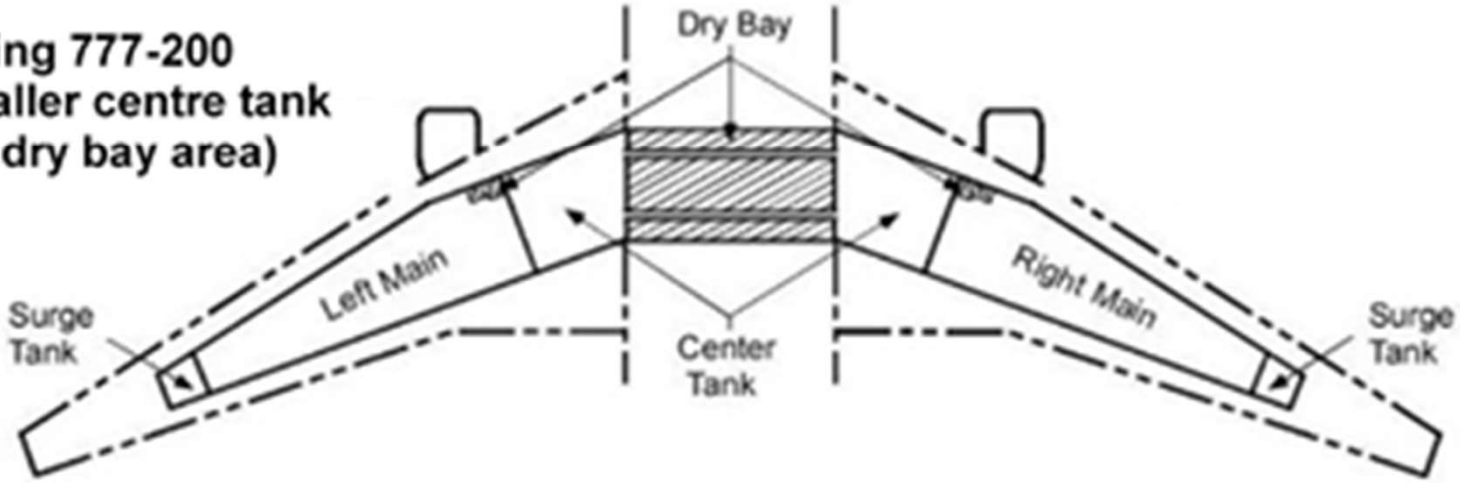
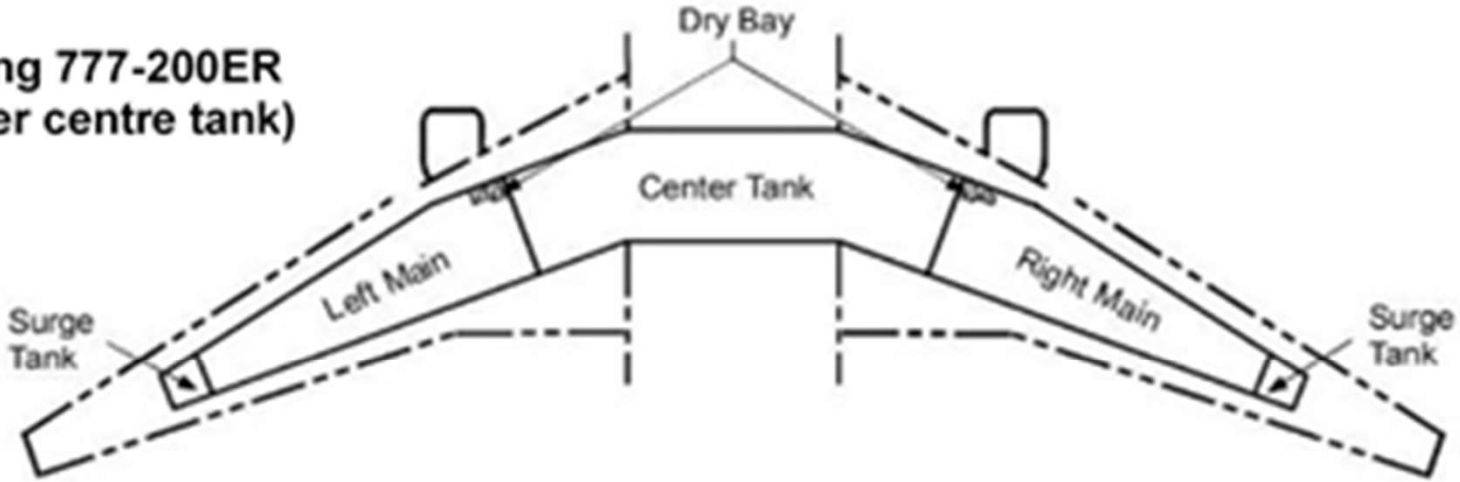
777 Fuel Tank Arrangement

Boeing 777-200
(smaller centre tank with dry bay area)



Boeing 777-200ER
(larger centre tank)



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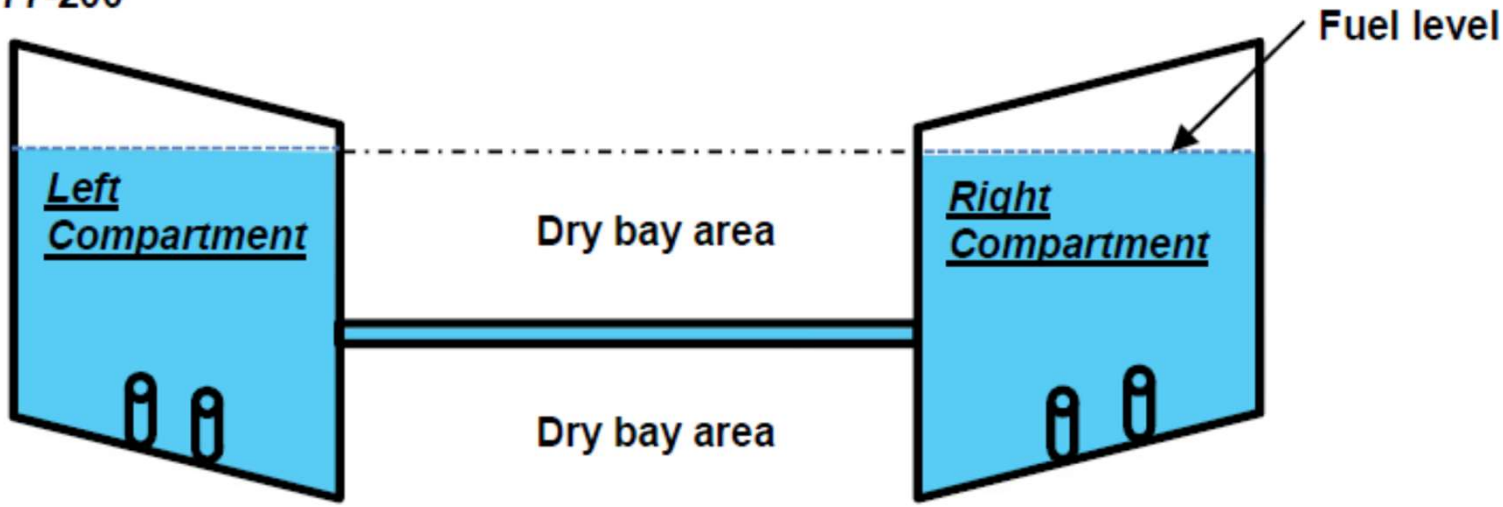
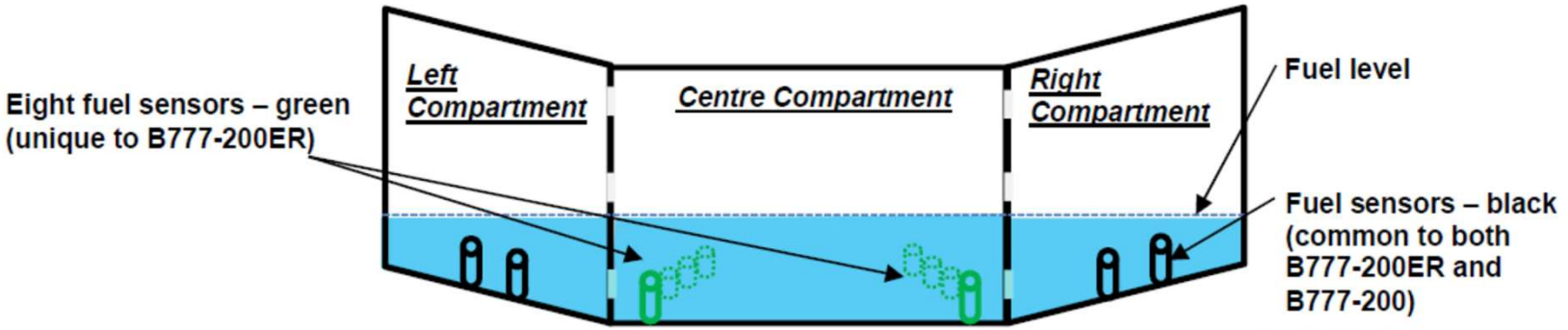
Fuel quantity sensors arrangement

2) B777-200



1) B777-200ER



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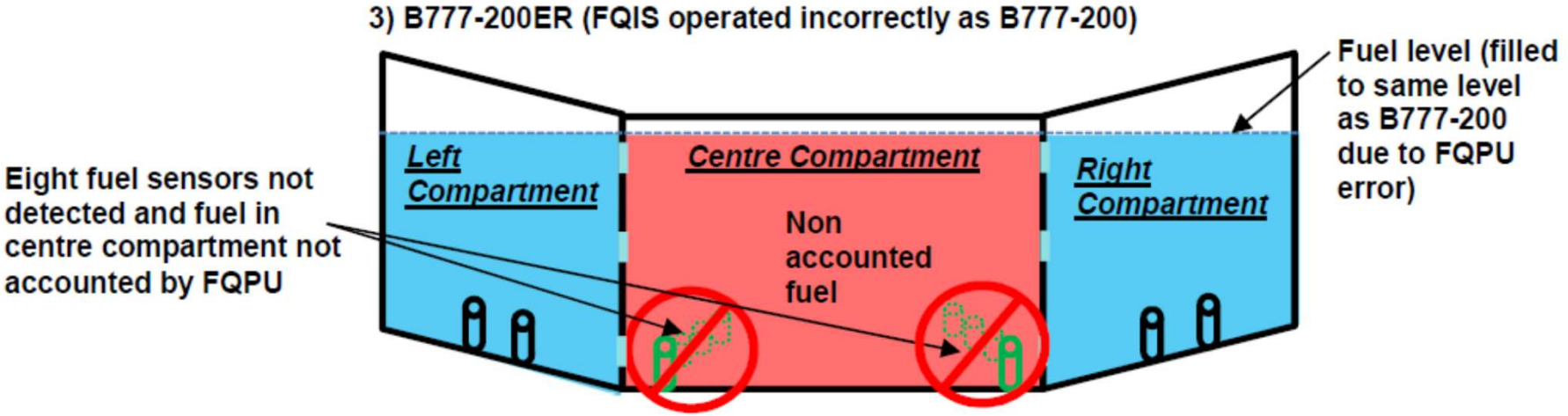
Fuel sensors not detected



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Example of magnastick in fuel tank

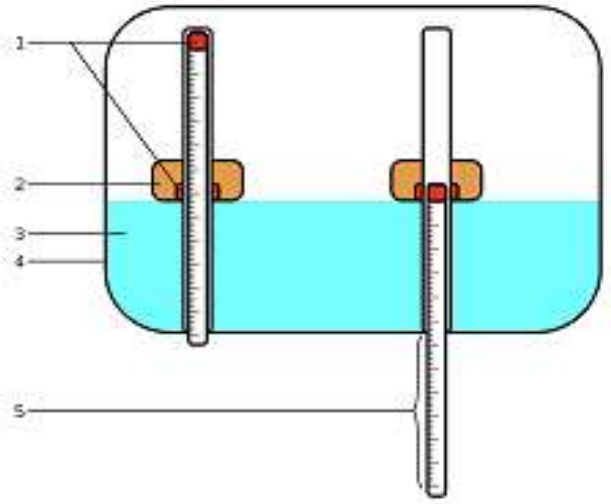

Diagram showing the operation of a floatstick to indicate fuel remaining in an aircraft fuel tank:

1 - magnets

2 - float

3 - fuel in tank

4 - fuel tank wall

5 - indication of remaining fuel in tank when floatstick is pulled down.

Key findings

- Aircraft FQPU was likely operating in B777-200 mode instead of the B777-200ER
  - 40.5 tons of fuel uplifted into center tank was not calculated by FQIS
- Manual fuel quantity check (Magnastick) was not carried out properly by ground staff
  - Refueling training was only carried in out theory during initial training, no recurrent training
  - No practical training on Magnastick check
- Bowser operator not familiar with bowser operation

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Improvements

- MRO conducted a once off refueling refresher training and competency assessments for their personnel
- Practical training on taking magnastick reading also provided using a fuel tank simulator training tool
- Ground staff were reminded to consult their managers whenever they were not familiar with any tasks assigned
- Boeing upgraded subsequent versions of the FQPU to be able to detect and prevent incorrect program pins configuration of the PSM

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Recommendations

- Fuel is a critical element for aircraft operation
  - Should magnastick check be performed independently by more than one qualified person just like other critical system on the aircraft?
- Magnastick check is seldom required and to ensure technicians are confident and competent in performing the task
  - should this be included in refresher training?

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What more we wish to have

- Can the aircraft system be smart enough to detect or alert the flight crew or maintenance crew when there is a mismatch between the aircraft model referenced by the FQIS and the actual aircraft model?
  - Boeing reviewed two areas of potential safety concerns pertaining to overfuelling, caused by the FQIS referencing an incorrect aircraft model, namely, runway overrun in a rejected take-off and insufficient climb capability. Boeing determined that the aircraft would have sufficient safety margin in both scenarios and did not consider that the scenarios presented a safety hazard.

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What could have done better

- Completing the investigation in a shorter time
  - Better control over the coordination with the stakeholders
  - Lengthy discussions with stakeholders – MRO, regulator, aircraft manufacturer
  - Unable to conclusively determine that it was the PSM fault

THANK YOU

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