RTCA Special Committee 186, Working Group 3
ADS-B 1090ES MOPS Maintenance
Meeting #26

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Requirement for Barometric Pressure Setting (BPS) data in BDS 6,2
In Response to Action Item 25-21
Revision 1

Prepared by: Damian Mills
NATS Ltd, UK

Summary
Since SC-186 WG 3 and EUROCAE WG51 SG1 has been re-started there has been considerable interest shown in providing Selected Altitude information via ADS-B Extended Squitter. This paper provides justification for including aircraft Barometric Pressure Setting data in addition to Selected Altitude within BDS 6,2 and further discusses the need to include the Mode bits.

1 Introduction

Since SC-186 WG 3 and EUROCAE WG51 SG1 has been re-started there has been considerable interest shown in providing Selected Altitude information via ADS-B Extended Squitter. Numerous papers have been presented, culminating in a summary and proposal for incorporating this change documented in paper 1090-WP25-08, presented by Rockwell Collins at the Brussels meeting on 17-20th February 2009.

At the Brussels meeting it was agreed that Selected Altitude based on MCP/FCU derived data should be included in BDS 6,2 as proposed in 1090-WP25-08.

Part of the proposed changes included in 1090-WP25-08 included the provision of Barometric Pressure Setting (BPS) data such that the ground domain had visibility of the datum used by the aircraft pressure altimeter. Although there was broad agreement that provision of this data provided a benefit, concern was raised that it may be seen as outside of the intended purpose of BDS 6,2 which is to provide aircraft intent data.

This paper is in response to Action Item 25-21 to provide justification in support of the inclusion of BPS data as part of the proposed changes to BDS 6,2. As part of this action, this paper also touches on the need for inclusion of the Mode bit settings, e.g VNAV, Alt Hold, Autopilot engaged.

2 Background

In the UK, NATS Ltd has provided Selected Altitude data to Terminal Airspace Controllers since 2005. This data is currently obtained through a network of Mode S radars, utilizing data extracted via BDS 4,0. The provision of this data to controllers has resulted in a significant reduction in the number of 'level busts' whereby climbing or descending aircraft exceed their cleared flight level.

Although the situation has improved due to the use of Selected Altitude, the situation still exists today as a result of the pilot not using the correct Barometric Pressure Setting as he crosses the transition level, moving from 'Flight Level' based in 1013.25 mb to Altitude based on local QNH or vise versa.

As well as the application in Terminal Airspace described above, Air Services Australia have pointed out that the application is broader than this. Whenever the QNH is entered incorrectly, the aircraft will not be at its correct altitude. If this information is not transmitted, no one outside the cockpit will be aware of the discrepancy. The responsibility for ensuring the correct QNH is entered in the aircraft clearly rests with the flight crew. However, if the information is available and can be easily processed on the ground, then it may be used to provide another safety layer.

Given that ADS-B is being increasingly used as an alternative to radar, it is desirable for it to provide equivalent information. BPS may be obtained through Mode S and should therefore be made available via ADS-B.

This paper has been coordinated with Air Services Australia, who have confirmed their support for including Barometric Pressure Setting in the revised Target State and Status Message.

3 Justification to include BPS

a. Classification of BPS as 'Intent Data'

Selected Altitude is clearly 'intent' data. However, in order for this data to be of use in reducing level busts, the ground systems needs to know what datum the aircraft is working to. Without this knowledge the intent data in terms target altitude can be misinterpreted. For this reason, it is proposed that as in BDS 4,0 the BPS data must be presented with the Selected Altitude data in BDS 6,2 such that the true intent of the aircraft is understood.

b. Identification and Correction of Incorrect Baro Pressure Setting

NATS R&D Section recently analysed data from one Mode S radar over a two week period looking for potential level busts occurring as a result of incorrect Barometric Pressure Setting. In Fig.1 below is an example of one occurrence.

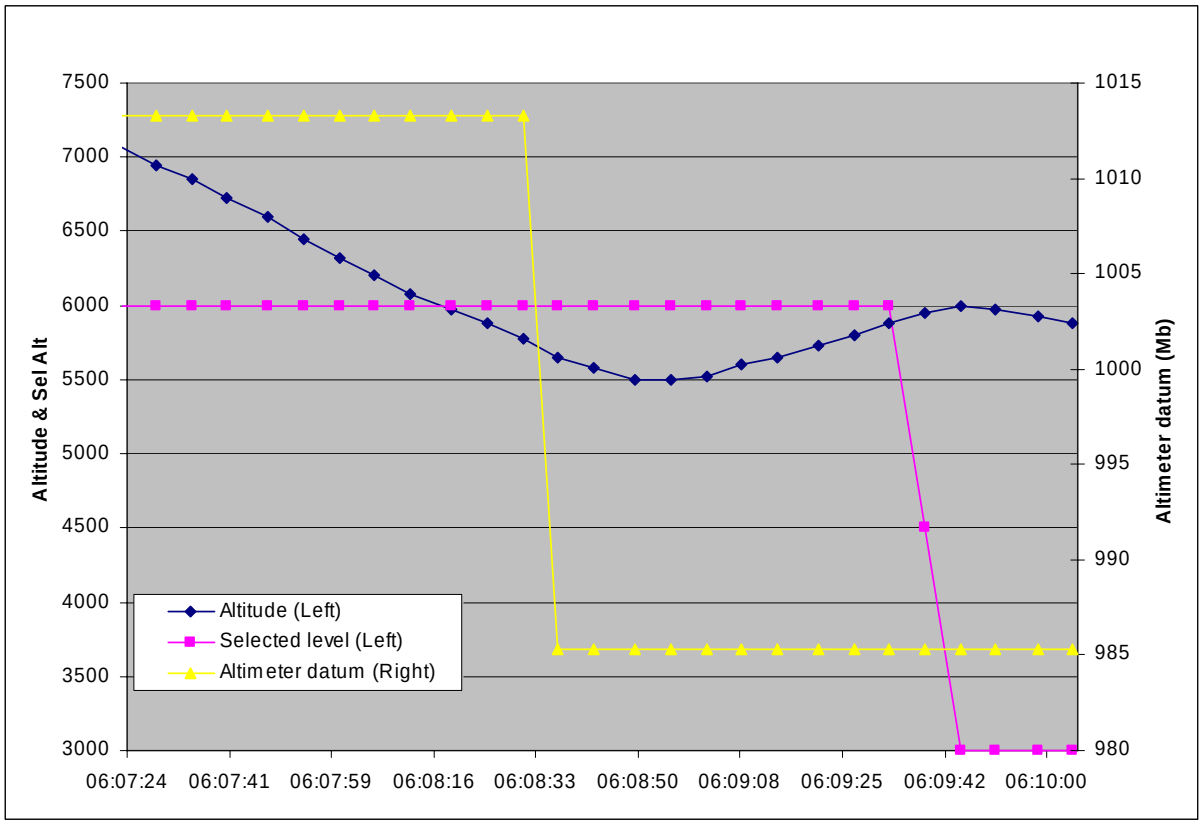

Fig. 1

Commentary:

In this example, looking at the dark blue line, it can be seen that the aircraft is descending towards its cleared level. Pressure on the day is low, with a local QNH of 985 mb. As the aircraft descends it remains on standard pressure of 1013.25 mb. The aircraft continues to descend below his clearance by around 250' at which point the pilot changes from standard pressure to local QNH. The aircraft descends a further 250' until it levels and then climbs to comply with his minimum clearance.

It is worth noting that the pressure difference of 28.25mb equates to approx 850'. In other words, the aircraft could have descended a further 350' if the pressure datum change had been delayed further.

This example is not an isolated case, the results of the two week study are summarized below in Table 1 showing the number and extent of the level busts. Over the two week period a total of 33 level busts were identified.

Callsign	Operator; type & nation	Date & time	Level bust amount
####	####	18/01/2009 05:25	525' in descent
####	####	18/01/2009 14:05	425' in climb
####	####	18/01/2009 14:50	450' in climb (FL210!)
####	####	19/01/2009 10:29	550' in climb
####	####	19/01/2009 12:24	1000' in climb
####	####	19/01/2009 13:37	1000' in climb
####	####	19/01/2009 14:02	450' in descent
####	####	19/01/2009 21:16	425' in climb
####	####	20/01/2009 17:20	550' in descent
####	####	20/01/2009 17:38	425' in climb
####	####	21/01/2009 06:50	325' in descent
####	####	21/01/2009 09:59	300' in descent
####	####	21/01/2009 10:06	300' in climb
####	####	21/01/2009 22:11	475' in descent
####	####	22/01/2009 06:07	500' in descent
####	####	22/01/2009 07:00	400' in descent
####	####	22/01/2009 10:51	775' in climb
####	####	22/01/2009 13:18	775' in climb
####	####	22/01/2009 13:25	600' in climb
####	####	22/01/2009 14:03	375' in climb
####	####	22/01/2009 16:12	300' in climb
####	####	22/01/2009 19:52	450' in climb
####	####	22/01/2009 20:50	800' in climb
####	####	23/01/2009 09:43	450' in climb
####	####	23/01/2009 12:37	350' in climb
####	####	23/01/2009 13:40	400' in climb
####	####	23/01/2009 21:19	700' in climb
####	####	24/01/2009 10:34	350' in descent
####	####	25/01/2009 10:34	600' in descent
####	####	25/01/2009 14:55	325' in climb
####	####	25/01/2009 17:57	450' in descent
####	####	26/01/2009 06:41	525' in descent
####	####	26/01/2009 11:11	425' in descent

Table 1

NATS ground systems are in the process of being upgraded to automatically check the barometric pressure setting of aircraft in Terminal Airspace using data from Mode S radar. In the event an inconsistency is found an alert will be flagged to the controller. It is critical that ADS-B as the future surveillance system, includes the capability to provide this data also.

4 Justification to include Mode Settings

At the Feb 09 Brussels meeting there was some discussion as to whether Mode bits (Autopilot engaged, VNAV, Alt Hold, Approach) should be included in the revised BDS 6,2. There was a view that as FMS selected altitude was not likely to be available for some time, there was no need to broadcast the mode bits.

However, from a ground system perspective, it is desirable to have knowledge of what system is in control of the aircraft. For example, if FMS Altitude were to be broadcast, then knowledge on the ground that the FMS is controlling the vertical profile would be used to inhibit the Selected Altitude display to the controller.

Although it would be preferable to receive the mode bits on the ground, if this is not feasible, it would be acceptable as a minimum to retain bit 8 'Selected Altitude Type' as proposed in 1090-WP-25-08, such that the ground segment can decide how to process and display the received Selected Altitude data.

5 Recommendations

The use of down linked Selected Altitude in UK terminal Airspace has reduced the number of level busts significantly. However, the use of Selected Altitude to reduce the number of level busts is only of benefit when the pilot has selected the correct pressure datum. Hence the baro pressure setting should be seen as part of the provision of the Selected Altitude intent data, not a separate piece of information. The use of down linked BPS is expected to reduce the number of level busts still further, resulting in a significant reduction and maybe even eradication of these occurrences.

NATS UK and Air Services Australia jointly make the following recommendations for consideration by SC186 WG3 / WG51 SG1:

Recommendation 1:

Selected Altitude as proposed in 1090-WP-25-08 using MCP/FCU data should be included in the proposed update to the 1090 MOPS.

Recommendation 2:

BPS as proposed in 1090-WP-25-08 should be included in the proposed update to the 1090 MOPS with the following change:

1090-WP-25-08 proposed a resolution of 4mb. This equates to approximately 120ft. Spare bits are available within BDS 6,2 and it is proposed two of these are used to improve the resolution of this field to 1mb, or 27ft.

Recommendation 3:

Mode setting bits as proposed in 1090-WP-25-08 should be included in the proposed update to the 1090 MOPS such that the ground systems can derive the actual intent of the aircraft.

Recommendation 4:

If the group is not able to adopt recommendation 3, then a minimum alternative is to retain bit 8 ‘Selected Altitude Type’ as proposed in 1090-WP-25-08, such that the ground segment can decide how to process and display the received Selected Altitude data.