

*International Civil Aviation Organization*



ICAO

**THE FOURTH MEETING OF MODE S DOWNLINKED  
AIRCRAFT PARAMETERS WORKING GROUP  
(MODE S DAPs WG/4)**

Video Teleconference, 29 – 31 March 2021

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**Agenda Item 3:** Sharing of State's implementation on Mode S and related issues, including the experience in Mode S Interrogator Identifier (II) Code usage in China

**RESEARCH ON MODE S INTERROGATOR CODES EXTEND TO  
SURVEILLANCE CODES IN CHINA**

(Presented by China)

**SUMMARY**

This paper shares the information about the investigation of SI transponders' current situation in relevant airspace, the test of Mode S radars' capability and the preliminary research on mechanism of II / SI codes allocation.

**1. INTRODUCTION**

1.1 At present, there are 140 secondary surveillance radars in service in China. Among them, 78 are Mode S radars, and 58 are capable of enhanced Mode S capability. There are 30 new secondary surveillance radars under construction, they are all enhanced Mode S radars.

1.2 These 78 Mode S radars in service with overlapping coverage can be allocated to different II codes and meet requirements. However, along with the new Mode S radars being put into service in eastern coastal areas, it is very difficult to allocate II code, II code resources are very few.

1.3 Considering that China will deploy a large number of Mode S radars in future, and China is adjacent to many countries, to avoid conflicts caused by the shortage of II code resources, China has started to research three aspects: the investigation of SI transponders' current situation in relevant airspace, the test of Mode S radars' capability and the preliminary research on mechanism of II / SI codes allocation. It is actively preparing for the mix operation of II/SI codes in China, and at the same time, China is actively working with ICAO in coordinating the distribution of II/SI codes.

**2. DISCUSSION**

*The difference between II code and SI code*

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2.1 The Mode S interrogator codes are used for data link communication with Mode S transponders. The interrogator codes are used for the uplink interrogation of the Mode S for identity to Mode S transponders. The value of II code ranges from 0 to 15, and that of SI code ranges from 1 to 63.

2.2 When the Mode S interrogator codes are allocated to II code, they can be correctly identified by all Mode S transponders. When the Mode S interrogator codes are allocated to SI code, they can be correctly identified by Mode S transponders with SI code capability, but can't be correctly identified by Mode S transponders without SI code capability. These Mode S transponders can only recognize the IC field, but overlook CL field. Therefore, the SI code will automatically default to "match" II code (the same IC field).

2.3 The lockout mechanisms of II code and SI code protocols are different. The protocols of controlling lockout commands are independent. When the interrogator code is allocated to SI code, the interrogator can apply lockout commands for transponders with SI code capability, and apply non-lockout commands for transponders without SI code capability. Therefore, if two Mode S radars with overlapping coverage areas are allocated to II code and SI code respectively, there is no loss of surveillance coverage to the radar with II code. Surveillance loss can only happen to the SI code radar, and this happens only in a certain combination of II code and SI code.

*The investigation of SI transponders' current situation in relevant airspace*

2.4 By default, Mode S transponders support II code capability. In order to deploy SI codes effectively, the Mode S transponders within SI code interrogators coverage should support SI code capability.

2.5 Although ICAO Annex 10 Volume IV states that all Mode S transponders must support the SI code by 1 January 2005. But there are still transponders that do not support SI code.

2.6 In January this year, China operated more than 10,000 flights per day, with domestic flights returning to 85 percent of the pre-epidemic levels, international flights include Hong Kong, Macao, and Taiwan regions to 24 percent of the pre-epidemic levels, and international overflights to 34 percent of the pre-epidemic levels. Based on the analysis of actual Mode S radar data during this period, it can be concluded that the proportion of Mode S transponders with SI code capability of aircraft flying in China is 95%.

*The test of Mode S radars capability*

2.7 ATMB of CAAC has organized the compilation of "The test outline of Mode S Radars' Supporting Capability", and has organized the Mode S capability tests in the following four aspects on six manufacturers' radars, including Nriet, Sun Create, Indra, Selex, Thales, and Eldis.

- II code test
- SI code test
- Test of SI code radars processing capability to non-SI code capable transponders
- All-call lockout override test

2.8 The tests result show that the Mode S radars of six manufacturers support target acquisition whether allocated to II code or SI code. And the tracks of target are smooth and normal.

2.9 Among all radars tested, Thales, Sun Create and Selex radars support the processing of non-SI code transponders, but whether or not allocated to all-call lockout protocols depends on the users. Indra radars were failed to do this test due to the test site conditions' problem.

2.10 Among all radars tested, the function of all-call lockout override is normal of Thales, Selex and Sun Create radars in both II codes and SI codes. To Indra and Nriet radars, the function of all-call lockout override is normal in II codes, but failed to do this function test in SI code because of no matching radars.

*The Preliminary Research on Mechanism of II / SI Codes Allocation*

2.11 At present, China is considering the Mechanism of II / SI Codes Allocation for all radars, which are in service, under construction, and in planning around China. We are trying to allocate all the other unallocated II/SI codes reasonably based on the minimum adjustment to the servicing radars allocated II code.

2.12 Giving that there are transponders without SI code capability, we will allocate II code and SI code with different IC fields to two Mode S radars with overlapping coverage areas. In this way, all radars can use both all-call lockout protocol and lockout commands under any conditions. It includes the following allocation mechanism:

- Two Mode S radars are allocated to different II code; or
- Two Mode S radars are allocated to SI code with different IC fields; or
- Two Mode S radars are allocated to II code and SI code respectively with different IC fields.

2.13 Considering that if there is a very dense area of Mode S radars, it is impossible to allocate II codes or SI codes to all radars that meet the requirements of Section 2.13. Therefore, before all Mode S transponders with SI code capability in relevant airspace, China plans to adopt an all-call lockout override protocol, or a non-lockout and intermittent lockout commands in cooperation with the allocated II code or SI code radars to deal with the interrogator codes conflict.

2.14 Also, it's worth noting that the all-call lockout override protocol can be applied independently, but the non-lockout or intermittent lockout commands must be applied at the same time for two radars with overlapping coverage.

2.15 Based on the results of this study, China will replan the allocation of II/SI codes for all radars in service, under construction and in planning. The allocation mechanism is preferentially according to the rule of Section 2.13, which will help to use the all-call lockout protocol. At the same time, China will actively coordinate with the ICAO Asia Pacific region with the latest II/SI codes allocation planning, and asks for permission.

**3. ACTION BY THE MEETING**

3.1 It is suggested that the meeting discuss the introduction of SI codes in the Asia Pacific region;

3.2 It is suggested that the meeting pay attention to the II/SI mix operation; and

3.3 It is suggested that the meeting discuss the coordinated resolution of II code conflicts.

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