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Project Report
ATC-33
Revision 1

Provisional Message Formats for the DABS/NAS Interface Revision 1

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10 October 1974

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CHANGE 1

Changes have been made in FAA-RD-74-63A (Project Report ATC-33, Rev. 1), "Provisional Formats for the DABS/NAS Interface," 10 October 1974.

Please change your copy of the subject report in accordance with the attached listing.

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Page No.	Paragraph No.	Line No.	Change
6	2.2.2, No.2		After last line, insert new line, "Data Link Capability Request (for a new DABS aircraft)".
7	2.2.2, No.6	1-4	Delete the four lines under Number 6 and replace with the single line, "Controller Alert Notice."
9	3.2	9	Change 2000 bits to 2032 bits.
11	4.1.3	1	Change bit 7 to bit 5.
17	4.1.4	2	Change bits 66-77 to bits 79-90.
17	4.1.5	4	Change to "1 = Radar reinforced"
18	4.1.11	1	Change bit 11 to bit 44.
18	4.1.12	1	Change bit 12 to bit 45.
18	4.1.13	1	Change 6-bit to 4-bit.
19	4.2.1	1	Change bit 11 to bit 44.
20	4.2.2	1	Change bit 30 to bit 45.
20	4.2.3	1	Change bit 31 to bit 46.
21	4.3	1 & 4	Change Table 4-1 to Table 4-2.
22	5.1.1	2	Change 2000 bits to 2032 bits.
26	5.2.1		Add the following sentence immediately below the figure: "The end flag of one frame can also serve as the beginning flag of the following frame."
30	Table 5-1		Delete "1000 0010 IPC Command Notice". After "All Radar Data Request" insert line: "0000 0010 Data Link Capability Request".

Page No.	Paragraph No.	Line No.	Change
31	Figure 5-1		After "All Radar Data Request" insert: "Data Link Capability Request" | 0 0 0 0 0 0 1 0 | DABS Address | 1 8 9 32
32	Figure 5-2		Delete the format and title of the IPC Command Notice. Change the Controller Alert Notice format to: | 1 0 0 0 0 0 1 1 | Defined in FAA-EM-74-4, Ref [4] | 1 8 Delete the footnote.
33	5.3.3.1.3	1	Change "consecutively" to "unambiguously".
39	5.3.3.2.7		Delete paragraph and title.
39	5.3.3.2.8		Renumber to 5.3.3.2.7.
39	5.3.3.2.9		Renumber to 5.3.3.2.8.
40			Add the following reference: [4] "Multi-Site Intermittent Positive Control Algorithms for the Discrete Address Beacon System." MTR-6742, The MITRE Corporation, FAA-EM-74-4.

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16. Abstract

This document defines formats for messages which are to be transmitted between DABS and NAS facilities (en route or terminal). These messages include one-way Surveillance Reports to NAS and two-way Communications Messages. The latter support data link functions between NAS and DABS-equipped aircraft, as well as aiding in the monitoring and control of DABS sensors.

These message formats will be used in the design and construction of interface equipment and ground data links for prototype system test and evaluation at NAFEC during Phase II of the DABS Development Program; and, with modifications resulting from this test and evaluation effort, will form the basis for the operational implementation of DABS.

This document supersedes FAA-RD-74-63, dated 25 April 1974.

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TABLF OF CONTENTS

SECTION 1

INTRODUCTION

The DABS system is being designed to upgrade the surveillance data and introduce data link communications into NAS Facilities, both En Route (NAS Stage-A) and Terminal (ARTS-II and III). The system is a network of DABS sensors, each of which is linked to one or more NAS facilities. It is the purpose of this report to define the kinds of information which flow in each direction across the interfaces between a DABS sensor and a NAS facility. Further, for each type of message, a format is defined and the coding of each data block is specified.

The formats given here and the associated link procedures place requirements on the interface design. Actual design of interface equipment is beyond the scope of this report.

In reporting data to and receiving inputs from NAS, each DABS sensor operates independently of its neighbors. Yet, to carry out its surveillance and communications functions, the operation of a DABS sensor must be coordinated with the other sensors in the network.

This "network management" is carried on within the sensors, and the required exchanges of data flow between sensors, rather than between a sensor and a NAS facility. The message formats described herein are used for these inter-sensor message types, as well as those between the sensors and

NAS Facilities. However, the detailed characteristics of inter-sensor messages are not discussed in this report.

Briefly, the network management function within a sensor performs all tasks needed to: 1) maintain knowledge of the status of neighboring sensors, 2) keep track of which sensors have surveillance responsibility for each DABS target, 3) perform target handovers between neighboring sensors, 4) interchange surveillance data between sensors in cases of prolonged target fades, and 5) handle all incoming and outgoing messages needed to manage the functions listed.

SECTION 2

SUMMARY OF MESSAGE TYPES

2.1 SURVEILLANCE REPORTS

Surveillance reports containing unsmoothed target measurements are sent on a one-way channel from a DABS sensor to a NAS facility on a once-per-scan-per-target basis. Several fixed-length formats are used.

2.1.1 DABS Report

A Surveillance report based on replies from a DABS transponder uses the 91-bit DABS format. The principal data in this format are unsmoothed slant range and azimuth, reported altitude, time in storage, and the unique DABS address. Also included are several control bits indicating if: a) an emergency ATCRBS code is present, b) the return is radar reinforced, and c) the DABS sensor is currently serving as the primary sensor for the target (with respect to delivery of synchronized interrogations, altitude echo data, and pilot-originated data link messages). Other indicators are also supplied.

The DABS format is also used to report radar data which correlate with a particular DABS target track, in a scan during which no valid DABS replies are received.

2.1.2 ATCRBS Report

A Surveillance report based on replies from an ATCRBS transponder uses the 91-bit ATCRBS format. The basic data include unsmoothed slant range, azimuth, time in storage, Mode 3/A Code and Mode-C altitude, if available. The surveillance data are reported with DABS-compatible precision. Other data and control fields currently used in the Production Common Digitizer (PCD) formats are retained. In addition, the sensor surveillance file number (with which the reported data have been correlated) and a correlation confidence indicator are included for tracked targets. The surveillance file number will uniquely identify an ATCRBS target and may be used by the NAS facility as an aid in its track correlation process.

The ATCRBS format is also used to report radar data which correlate with a particular ATCRBS target track, in a scan during which insufficient ATCRBS data are received.

2.1.3 Radar Report

A Surveillance report based on radar returns which do not correlate with any beacon track, uses the 52-bit radar format. This format is identical with the "search message" of the present PCD format. At the request of a NAS facility, a DABS sensor will send all such PCD search messages, whether or not they correlate with beacon tracks.

2.1.4 Other PCD Reports

The DABS sensor will pass on to NAS, without processing, all other received PCD messages, using 52-bit formats. These include the Strobe, Map, Status, and Search RTQC Target reports.

2.2 COMMUNICATION MESSAGES

Communication formats are defined on two levels, "Frame Formats" (Sections 5.1 and 5.2) and "Link Data Fields" (Section 5.3).

2.2.1 Frame Formats

Frame formats are the outer-level message structures needed to carry out transfer procedures on the link: the transmission of a message to a receiving station, the testing of that message by the receiving interface to determine its acceptability, the issuance of an acceptance or rejection response by the recipient, and further action (in case of a rejection or no response) by the transmitting station. The structures described here to provide for these procedures are a subset of those defined for the Common ICAO Data Interchange Network (CIDIN). These include six types of "commands" or link transfers: Exchange (to send data), Enquire (to ask for re-transmission of a missing response), Reset (to re-initialize message numbering), Accept (to signify receipt of a valid command), Reject because of a parity error, and Reject for some other reason. Acceptance and rejection criteria are based on the frame format requirements which are tested by the interface of the receiving station, and not on an inner-level interpretation of message contents. Each frame carries several fixed-length fields of control data relating to interface functions. These include the address of the receiving or sending station, a frame sequence number, a command type code, a frame check sequence (error detection code), and flags to denote the beginning and end of the frame. Formats and coding are defined for each of these control data fields in Section 5.1 and 5.2. Message data (as distinguished from control data), if present, are given in a variable-length Link Data Field. Interface procedures place no constraints on the coding of a Link Data Field.

2.2.2 Link Data Fields

When the interface of a receiving station has accepted an Exchange command, the control data fields are stripped off and the Link Data Field becomes the inner-level message. At this inner level, there are many types of messages, divided into several classes:

1. NAS-to-DABS Uplink Messages:

   Tactical Uplink Message (to a DABS aircraft)

   ELM Uplink Message (to a DABS aircraft)

   Request for Downlink Data (from a DABS aircraft)

   ATCRBS ID Request (to a DABS aircraft)

   Message Cancellation Request (of a previous Uplink Message)

2. NAS-to-DABS Status/Control Messages:

   Test Message (to a DABS sensor)

   Test Response Message (to a DABS sensor)

   Altimeter Correction Message (to a DABS sensor)

   NAS Failure/Recovery Message (to a DABS sensor)

   All Radar Data Request (to a DABS sensor)

3. NAS-to-DABS IPC Operational Messages:

   (To be defined)

4. DABS-to-NAS Sensor Response Messages:

   Message Rejection/Delay Notice (with respect to a DABS aircraft)

   Uplink Delivery Notice (with respect to a previous Uplink Message)

5. DABS-to-NAS Downlink Messages, each from a DABS aircraft:

   Tactical Downlink Message

   ELM Downlink Message

   Pilot Acknowledgment (of an Uplink Message)

   Data Link Capability Message

   ATCRBS ID Code Message

6. DABS/IPC-to-NAS Operational Messages:

   IPC Command Notice, giving the contents of IPC commands being sent to one or more DABS aircraft

   Controller Alert Notice, identifying IFR aircraft in conflict (2-minute warning)

7. DABS-to-NAS Performance/Status Messages:

   Test Message (from a DABS sensor)

   Test Response Message (from a DABS sensor)

   Status Message

   Track Alert Message (from a DABS sensor on a given target)

8. DABS/IPC-to-NAS Recording System Messages:

   Duplicate Uplink Message (copy of an IPC message to a DABS aircraft)

   Duplicate Message Delivery Notice (copy of a notice to IPC with respect to a previous Uplink Message)

Each of these message types is identified by a type code, which serves to specify the format. Section 5.3 defines the format for each message type in terms of a fixed sequence of data blocks, and gives the definition and coding for each data block.

SECTION 3

SIGNAL CHARACTERISTICS

The data link between a DABS sensor and a NAS facility shall consist of two different channels: a one-way channel for Surveillance data and a full duplex channel for Communications. Each of these channels may in turn contain several parallel links as needed to support a particular data rate.

3.1 SURVEILLANCE SIGNALS

The Surveillance channel carries Surveillance data from the sensor to all users. The required data rate for the channel is dependent on the traffic environment and configuration of a particular DABS sensor, and is therefore not given here. The use of parallel channels to achieve a particular capacity in a modular fashion is acceptable provided compatibility with NAS facilities is insured.

The signal formats used for Surveillance resemble those currently used by the Production Common Digitizer (PCD). Reports shall be transmitted in 13 bit sequences, 12 bits being data and the 13th an odd parity bit. Idle characters are required between messages and shall also be transmitted when no message is waiting.

Electrical Signal characteristics and interface characteristics shall conform to the standards given in MIL Spec 188C, as defined in FCC Tariff 260.

Message formats for the Surveillance channel are given in Section 4.

3.2 COMMUNICATIONS SIGNALS

The communications data link shall be a two-way channel with a capacity of 2400 bits/sec in each direction. The interface hardware shall provide all control data fields, timing, etc. necessary to exercise control over the channel.

Signal formats (and interface procedures) used for Communications shall conform to the usage of the Common ICAO Data Interchange Network (CIDIN), as specified by the Automated Data Interchange System Panel (ADISP) [2]. Messages shall be transmitted as bit sequences not shorter than 32 bits and not longer than 2000 bits, separated by idle characters. Each such sequence contains a 16-bit error detection code.

Electric signal characteristics shall conform to MIL Spec 188C, as defined in FCC Tariff 260.

Message formats for the Communications channel are given in Section 5.

SECTION 4

SURVEILLANCE MESSAGE FORMATS

Surveillance reports are issued by a DABS sensor to an NAS facility on a once-per-scan-per-target basis, using the data link and interface hardware described in Section 2.1. The message formats used for beacon reports are modifications of the present PCD formats, with the data transmitted in 13-bit sequences (12 data bits followed an odd parity bit). Between reports, at least one idle character is transmitted, each consisting of the 13-bit sequence 000 111 111 111 1.

Beacon data are reported in either of two 91-bit formats, according to the different sources of target information: DABS or ATCRBS. These beacon formats are also used to report radar data which correlate with a beacon track, in the case where beacon data are missing on a particular scan. When radar data do correlate with a beacon track and beacon data are present, the beacon data are reported with a "radar reinforced" tag and the radar report is normally suppressed. The specification of the DABS and ATCRBS formats is given in Table 4-1.

Uncorrelated radar data are reported in a 52-bit format, shown in Table 4-2 under the heading "Search" message. Also shown are three other messages which may be received from the PCD, the Strobe, Map, and Status reports. All of these messages are sent to the NAS in the same format in which they are received. The Strobe, Map, and Status messages do not occur on a per scan basis but are sent whenever they are received, without processing by the DABS sensor.

4.1 DABS SURVEILLANCE FORMAT

The DABS format consists of 91 bits (seven 13-bit words). Each data field (except for spare and parity bits), as shown in Table 4-1, is briefly defined in the following paragraphs.

4.1.1 Test Indicator (Bit 1)

The test bit, as presently defined in a PCD format, signifies a test mode rather than an operational report.

4.1.2 Format Identifier (Bits 2-4)

The code value 111 identifies the report as a 91-bit message in the DABS format.

4.1.3 P/S Indicator (Bit 5)

Bit 7 is used to indicate whether the reporting sensor is "primary" or "secondary" with respect to the target. Primary status indicates that the sensor is carrying out several functions which are omitted by secondary sensors: transmissions of synchronized interrogations, transmission of altitude echo data, and readout of pilot-originated air-to-ground data link messages:

1 = Primary

0 = Secondary.

Table 4-1. Surveillance Message Formats - Beacon

Bit	DABS	ATCRBS
1	Test	Test
2	1	1
3	1	1
4	1	0
5	P/S	Mode 3/A
6	Mode C	Mode C
7	S	SPI (Ident)
8	Radar Reinf.	Radar Reinf.
9	Code 7700	Code 7700
10	Code 7600	Code 7600
11	FAA	FAA
12	Radar Substitution	Radar Substitution
13	PARITY	PARITY
14	↑ MSB = 128	↑ MSB = 128
15		
16		
17		
18		
19		
20	Range	Range
21	(nmi.)	(nmi.)
22		
23	(cont.)	(cont.)
24		
25		
26	PARITY	PARITY

S = Spare bit

Table 4-1. (Continued)

Bit	DABS	ATCRBS
27		
28	Range (nmi.) (cont.)	Range (nmi.) (cont.)
29	LSB=0.0078	LSB=0.0078
30	MSB = 180	MSB = 180
31		
32		
33		
34	Azimuth	Azimuth
35	(deg.)	(deg.)
36		
37		
38		
39	PARITY	PARITY
40		
41		
42		
43	LSB=0.044	LSB=0.044
44	Alert	Confidence
45	FR	Code in Transition
46	S	False Target
47	S	S
48	MSB = 1	MSB = 1
49	Time in Storage	Time in Storage
50	(sec.)	(sec.)
51	LSB = 1/8	LSB = 1/8
52	PARITY	PARITY

Table 4-1. (Continued)

Bit	DABS	ATCRBS		
53			A_4	
54			A_2	
55			A_1	
56	DABS	Mode 3/A	B_4	
57	Address	Code	B_2	
58			B_1	
59			C_4	
60			C_2	
61			C_1	
62			D_4	
63			D_2	
64			D_1	
65	PARITY	PARITY		
66				Possible spares
67				(ATCRBS only)
68		ATCRBS		
69		Surveillance File		
70		Number		
71				
72				
73				
74				
75				
76				
77				For Radar Substitution
78	PARITY	PARITY		(Bit 12 = 1)
79	Sign: 0=Pos, 1=Neg	Sign: 0=Pos, 1=Neg		MSB = 16
80	MSB=102400	MSB=102400		Run Length (ACP)
81		ft.		LSB = 4
82	Mode C	Mode C		S
83	Altitude	Altitude		S
84	(feet)	(feet)		S
85				S
86				S
87				S
88				S
89				S
90	LSB = 100	LSB = 100		S
91	PARITY	PARITY		PARITY

Table 4-2. Surveillance Message Formats - PCD.

Bit No.	Search	Strobe	Map	Status	Search RTQC TGT
1	TEST	TEST	TEST	TEST	1
2	0	0	0	0	0
3	0	0	0	0	0
4	1	1	0	0	1
5	1	1	0	1	0
6	0	0	0	1	0
7	1	0	0	0	1
8	1	0	Map Variation	0	0
9	0	Strobe Variation		0	0
10	0			0	0
11	FAA	FAA	FAA	FAA	FAA
12	AF	AF	AF	AF	AF
13	PARITY	PARITY	PARITY	PARITY	PARITY
14	MSB=128	MSB=128	MSB = 128	Radar Alarm	0 MSB=128
15				Beacon Alarm	0
16				CD Alarm	0
17	Range	Range	Range Start	0	0 (Range)
18	(nmi)	(nmi)	(nmi)	0	0 (nmi)
19				AIMS Alarm	0
20				Standby Radar Alarm	0
21				Standby Beacon Alarm	1
22				Standby CD Available	0
23				0	0
24	LSB=0.125	LSB=0.125	LSB = 0.125	HPG Reg. Line Alarm	0 LSB=0.125
25	0	0	0	0	0
26	PARITY	PARITY	PARITY	PARITY	PARITY

Table 4-2. (Continued)

Bit No.	Search	Strobe	Map	Status	Search RTQC TGT
27	MSB=2048	MSB=2048	MSB=2048	HPG Req. Parity Alarm	MSB=2048
28				0	
29				DSG Alarm	
30	Azimuth	Azimuth	Azimuth	0	Azimuth
31	(ACP)	(ACP)	(ACP)	0	(ACP)
32				0	
33				0	
34				Sens. Det. On	
35				R. L. Discr. On	
36				Normal Sector 3	
37				Normal Sector 2	
38	LSB = 1	LSB = 1	LSB = 1	Normal Sector 1	LSB = 1
39	PARITY	PARITY	PARITY	PARITY	PARITY
40	AIMS Present	MSB=256		Outer Contour	MSB=256
41	MSB AIMS Code			Inner Contour	
42	LSB AIMS Code	Run Length		Fixed Map On	Run Length
43	MSB=16	(ACP)	Range Stop	High Speed Timing Alarm	(ACP)
44	Run Length (ACP)		(nmi)	1/2 Scan Inhibit Alarm	
45	LSB = 4			Buffer Overload Alarm	
46	MSB = 4	LSB = 4		0	LSB = 4
47		MSB = 2		0	MSB = 2
48	Time in Storage			0	
49	(sec.)	Time in Storage		Sensitive Sector 3	Time in Storage
50		(sec.)	LSB=0.125	Sensitive Sector 2	(sec.)
51	LSB=1/8	LSB=1/8	0	Sensitive Sector 1	LSB=1/8
52	PARITY	PARITY	PARITY	PARITY	PARITY

4.1.4 Mode C Indicator (Bit 6)

Bit 6, labeled "Mode C," indicates the presence of an altitude field in bits 66-77. Every roll-call DABS report will contain altitude; however, the presence of a "one" in bit 6 indicates a report based on DABS All-Call replies only, which do not include altitude.

4.1.5 Radar Reinforced Indicator (Bit 8)

Bit 8 indicates whether the beacon track is currently reinforced by a radar return which correlates with the track.

0 = No radar correlation

1 - Radar reinforced.

4.1.6 Code 7700/Code 7600 (Bits 9-10)

A "one" in either bit 9 or 10 flags the presence of the emergency ATCRBS codes 7700 or 7600, respectively.

4.1.7 FAA Indicator (Bit 11)

Bit 11 is reserved in all surveillance formats to indicate whether or not the data are of interest to NAS facilities. This bit will normally be set to "one."

4.1.8 Radar Substitution Indicator (Bit 12)

The radar substitution field indicates whether the report contains beacon data or correlated radar data (but not both; for both, see Section 4.1.5):

0 = DABS beacon data

1 = Radar data.

4.1.9 Range (Bits 14-25, 27-29)

Range is encoded as a 15-bit binary integer with MSB = 128 nmi. This field has been expanded with respect to the PCD format to provide greater precision (0.0078 nmi increment).

4.1.10 Azimuth (Bits 30-38, 40-43)

Azimuth is a 13-bit binary integer with MSB = 180^{o} and LSB = 0.044^{o}.

4.1.11 Alert Indicator (Bit 44)

A "one" in bit 11 signifies that the pilot's "Alert" signal has been set and read out. This signal is a more general indicator of an emergency condition, and is interpreted by the DABS sensor as a request to have Mode 3 A code read out.

4.1.12 Flight Rules Indicator (Bit 45)

Bit 12 indicates whether the DABS aircraft is operating under visual or instrument flight rules:

0 = IFR

1 = VFR .

4.1.13 Time in Storage (Bits 48-51)

This 6-bit field indicates elapsed time between the beacon returns and the outputting of the report, with an LSB equal to 1/8 sec.

4.1.14 DABS Address (Bits 53-64, 66-77)

DABS target address is a 24-bit field. Codes will be assigned to represent each transponder uniquely.

4.1.15 Mode C Altitude (Bits 79-90)

Altitude is a 12-bit signed binary integer with LSB = 100 ft. The data are not pressure-corrected.

4.1.16 Run Length (Bits 79-81)

For Radar Substitution reports only (as signified by bit 12 = 1), bits 79-90 are not interpreted as Mode C Altitude. Instead, bits 79-81 contain radar run length, as given in the PCD search message received by the DABS sensor. (See the search message format in Table 4-2.)

4.2 ATCRBS SURVEILLANCE FORMAT

As shown in Table 4-1, the ATCRBS report format is also 91 bits in length, as identified by a 11 code in bits 2 and 3. Bit 4 contains a 0 to distinguish the format from DABS. The control bits are similar to those described above for the DABS format, but with differences as noted in bits 5, 7, 44, 45, and 46. Bits 5 and 7 are used for a Mode 3/A indicator and SPI (Ident). Other indicators unique to ATCRBS are defined below. The data fields which encode range (bits 14-25, 27-29), azimuth (bits 30-38, 40-43), time in storage (bits 48-51), Mode C altitude (bits 79-90), and Run Length for the case of Radar Substitution (Bits 79-81), are all identical with corresponding fields of the DABS format.

4.2.1 Confidence Indicator (Bit 44)

Bit 11 indicates whether the ATCRBS data reported have been correlated with track (see Section 4.2.5) with high or low confidence.

1 = High confidence

0 = low confidence.

4.2.2 Code in Transition Indicator (Bit 45)

A "one" in bit 30 signifies that the ATCRBS code of the report does not match that of the track with which it has been correlated.

4.2.3 False Target Indicator (Bit 46)

A "one" in bit 31 signifies that sensor surveillance processing has tagged the reported target as false.

4.2.4 Mode 3/A Code (Bits 53-64)

The 12-bit field contains the ATCRBS code in standard PCD format, whenever the Mode 3/A Indicator (bit 5) equals 1.

4.2.5 Surveillance File Number (Bits 66-77)

Bits 66-77 contain a Surveillance File number. This field provides the NAS facility with a unique ATCRBS track correlation as performed by a particular DABS sensor, whether or not the target is using a discrete Mode 3/A code. The coding is a binary 12-bit integer and is "locally unique" for a particular sensor, in the sense that the same number will not be assigned to more than one track at a time. The coding is not common among DABS sensors; i.e., two DABS sensors simultaneously tracking the same ATCRBS target will report it using different file numbers. The value of all zeros is reserved to indicate an uncorrelated ATCRBS target report.

4.3 RADAR AND OTHER PCD SURVEILLANCE FORMATS

The format for uncorrelated radar reports, as shown in Table 4-1 as the Search message, is 52 bits in length. The 52-bit messages are distinguished from the 91-bit beacon reports by a "00" code in bits 2-3. Four other 52-bit formats are also given in Table 4-1: the Strobe, Map, Status, and Search RTQC Target messages. These types are distinguished from each other by their code patterns in bits 4-10.

Each of these formats is identical with the corresponding PCD format as received by the DABS sensor. Messages in these formats are not processed by DABS (except for the Search message) but are passed on to NAS unaltered. The Search message is normally forwarded unaltered when the data do not correlate with a beacon target report or track. If the radar data correlate with a track, they are forwarded after re-formatting into a beacon message (the Radar Substitution case). If the radar data correlate with a beacon report, they are not forwarded (the Radar Reinforcement case). An exception to this procedure occurs when a NAS facility sends a Communications message which causes all radar data reports to be forwarded (see Section 5.3.3).

SECTION 5

COMMUNICATION MESSAGE FORMATS

Transmission of communication message between the sensor and an ATC facility will be done in conformance with the formats and procedures of the Common ICAO Data Interchange Network (CIDIN) for a balanced point-to-point configuration of two stations. The stations shall be referred to here as the transmitting and receiving stations (rather than "primary" and "secondary"). In other respects, the CIDIN terminology will be used. These formats and procedures are described in the Report of the 4th ADIS Panel [2], with amendments approved by the Air Navigation Commission [3]. Detailed procedures to be used in carrying on message exchanges between stations are not given here, but are contained in [2].

5.1 FRAME FORMATS

5.1.1 General

The basic unit of transmission is a frame which is a bit sequence containing not fewer than 32 bits and not more than 2000 bits. Since all messages between DABS sensors and NAS facilities (and their interface-generated responses) fall within these limits, there is an exact correspondence between a frame and a message. The frame format consists, in general, of 7 "sequences" or data blocks, as shown below:

5.1.3 E (Enquire) Command

An Enquire Command is issued by a transmitting station to enquire about a previously issued command, when no response to the command has been received within a time-out period. It has the effect of asking again for a response. The Frame Sequence No. used is not the next number in sequence but the referenced number of the original command.

Flag	Receiving Station Address	Referenced Frame Sequence No.	E	FCS	Flag

Note that the Link Data Field is absent.

5.1.4 R (Reset) Command

A Reset Command is issued by a transmitting station to cause the receiving station to re-initialize its frame sequence numbering. A standard code is entered in the Frame Sequence No. field.

Flag	Receiving Station Address	Dummy Frame Sequence No.	R	FCS	Flag

5.1.5 A (Accept) Response

An Accept Response is issued by a <u>receiving</u> station after it receives one or more X or R commands which satisfy all of the interface hardware acceptance tests. (These tests are described briefly in connection with the

Data Link Control Field (over Flag, Address, Control) — Data Link Control Field (over Frame Check Sequence, Flag)

Flag	Address	Control:		Link Data Field (LDF)	Frame Check Sequence (FCS)	Flag
		Frame Sequence No.	Command Code			

Flag is a specific code which marks the beginning and end of every frame. Address denotes either the transmitting or the receiving station, depending on the Command Code. Frame Sequence No. is a serial numbering of the message or of a referenced message, depending on the Command Code. Command Code specifies one of six possible types, three of which are called commands (messages from the transmitting to the receiving station) and three others which are called responses (messages from the receiving station to the transmitting station, with respect to some previous command). Link Data Field contains message data for one command type. Frame Check Sequence is an error-detection code for the frame. The coding for each of these fields is described in Section 5.2 below. However, it is first necessary to define further the specific formats for each of the six command types.

5.1.2 X (Exchange) Command

An Exchange Command is used to send data (in a Link Data Field) from the transmitting to the receiving station. A Frame Sequence No. (assigned sequentially) is used, as shown in the format:

Flag	Receiving Station Address	Frame Sequence No.	X	LDF	FCS	Flag

Reject responses below.) The Frame Sequence No. used references the highest numbered accepted command.

Flag	Receiving Station (Own) Address	Referenced Frame Sequence No.	A	FCS	Flag

The "Receiving Station Address" refers to the station receiving the original command, i.e., the station sending the response. This convention applies to the other response types as well (N_1 and N_2).

5.1.6 N_1 (Reject) Response

An N_1 Reject Response is issued by a receiving station when a frame fails the parity check test, i.e., a Frame Check Sequence error is detected. The Frame Sequence No. used references the lowest numbered unaccepted command.

Flag	Receiving Station (Own) Address	Referenced Frame Sequence No.	N_1	FCS	Flag

The error recovery procedures to be followed by each station when an N_1 or N_2 Reject is received (or when no response is received) are given in detail in the ADISP/4 Report [2].

5.1.7 N_2 (Reject) Response

An N_2 Reject Response is issued by a receiving station when a frame fails an interface acceptance test other than Frame Check Sequence. The specific type of error detected is identified by the coding of the N_2 field.

Flag	Receiving Station (Own) Address	Referenced Frame Sequence No.	N_2	FCS	Flag

Four specific error conditions are identified: 1) invalid command code, 2) incorrect Frame Sequence No., 3) Frame format error, and 4) receiving station is already in an error state which prevents it from accepting a new command frame.

5.2 FRAME DATA BLOCKS

5.2.1 Flag

The Flag character at the beginning and end of every frame is the standard 8-bit sequence:

0	1	1	1	1	1	1	0

This Flag code also serves as an idle character on the link, i.e., it is transmitted continuously in the absence of message traffic, serving as an indicator that the link is functioning.

It should be pointed out that CIDIN provides for code and byte-independent transmissions, i.e., there are no reserved characters that could not be part of the message. To prevent the Flag sequence from occurring in a message, a zero is inserted after every five 1-bit sequences by the transmitting station and is removed by the receiving station before "unpacking" the message. These operations are part of the task of the interface.

5.2.2 Address

The Address is an 8-bit sequence. Codes are presently undefined, except that the final bit shall be a 1.

5.2.3 Frame Sequence Number

Either of two formats may be used for encoding Frame Sequence No. The basic format is a 4-bit sequence containing a binary integer from 0 to 15. The extended format is a 12-bit sequence as follows:

4 bits (low-order)	1 0 0 1	4 bits (high-order)

The choice between these formats depends directly on the message buffer size of the stations (i.e., maximum number of frames which may be in transit) which in turn relates to the expected level of message traffic between the stations. For a given pair of stations, a single format will be chosen.

For the Reset Command, the dummy Frame Sequence No. consists of all zeroes. The Accept Response to a Reset Command contains a dummy Frame Sequence No. of all ones. The Frame Sequence No. of an N_2 Response is limited to four (low-order) bits.

5.2.4 Command Code

The Command sequence is a 4-bit field encoded as follows:

X:	1 0 0 0
E:	1 1 0 0
R:	1 1 1 1
A:	1 1 0 0
N_1:	1 0 0 0

For the Reject Response N_2, there are four codes, according to the reason for the rejection:

Invalid command code:	0 0 0 1	0 1 0 0
Incorrect sequence no.:	0 0 0 1	0 1 1 0
Frame format error (X frame with no LDF; E or R frame with LDF):	0 0 0 1	0 1 0 0
Secondary error status (e.g., buffers unavailable):	0 0 0 1	0 0 1 0

5.2.5 Link Data Field

Link Data Fields are present in X Commands only. For X Commands, Link Data Field formats are defined in Section 5.3.

5.2.6 Frame Check Sequence

The Frame Check Sequence is a 16-bit field containing a cyclic redundancy code. The encoding algorithm is applied to the entire contents of the frame excluding Flag sequences and all zero bits inserted and deleted to achieve code and byte independence. The generating polynomial for the FCS code is

$$X^{16} + X^{12} + X^5 + 1.$$

5.3 LINK DATA FIELDS

5.3.1 General

The Link Data Field, as defined in Section 5.1 above for an X Command, contains the actual message data which the sender wishes to communicate to the receipient. There are many different types of messages, as listed in Section 2.2.2. The interpretation of the Link Data Field format and coding is dependent on the particular message type. In the rest of Section 5.3, the formats of the various types of DABS-to-NAS and NAS-to-DABS messages are described in terms of data blocks, and the definitions and coding of the data blocks are given.

5.3.2 Link Data Field Type Codes

For each of the messages defined in Section 2.2.2, Table 5-1 gives a value of a Type Code, which always appears as the first data block in a Link Data Field. These codes are 8 bits in length, the first 4 of which are a prefix which refers to a logically similar group of message types. It should also be noted that the code assignment scheme encompasses numerous other types of messages (which go between 2 or more DABS sensors); hence, the codes shown in Table 5-1 refer only to the subset of messages between DABS sensors and NAS facilities.

5.3.3 Data Block Formats

The data block formats for each NAS-to-DABS and DABS-to-NAS message type are shown in Fig. 5-1 and Fig. 5-2, respectively. A brief discussion of each field follows.

Table 5-1. Link data field type codes.

		Prefix	Suffix	
NAS-to-DABS	Uplink Messages	0010	0001	Tactical Uplink
		0010	0010	ELM Uplink
		0010	0011	Request for Downlink Data
		0010	0100	ATCRBS ID Request
		0010	0101	Message Cancellation Request
	Status/Control Message	0110	0001	Test
		0110	0010	Test Response
		1001	1011	Altimeter Correction
		1001	1001	NAS Failure/Recovery
		1001	1010	All Radar Data Request
	IPC Operational Messages	1000	(To be defined)	
DABS-to-NAS	Sensor Response Message	0011	0001	Message Rejection/Delay Notice
		0011	0010	Uplink Delivery Notice
	Downlink Messages	0100	0001	Tactical Downlink
		0100	0010	ELM Downlink
		0100	0011	Pilot Acknowledgment
		0100	0100	Data Link Capability
		0100	0101	ATCRBS ID Code
	IPC Operational Messages	1000	0010	IPC Command Notice
		1000	0011	Controller Alert Notice
		1000	(Others to be defined)	
	Sensor Performance/ Status Messages	0110	0001	Test
		0110	0010	Test Response
		0110	0100	Status Message (format to be defined)
		1001	1100	Track Alert Message
	IPC Recording System Messages	1100	0001	Duplicate IPC Uplink Message
		1100	0010	Duplicate IPC Message Delivery Notice

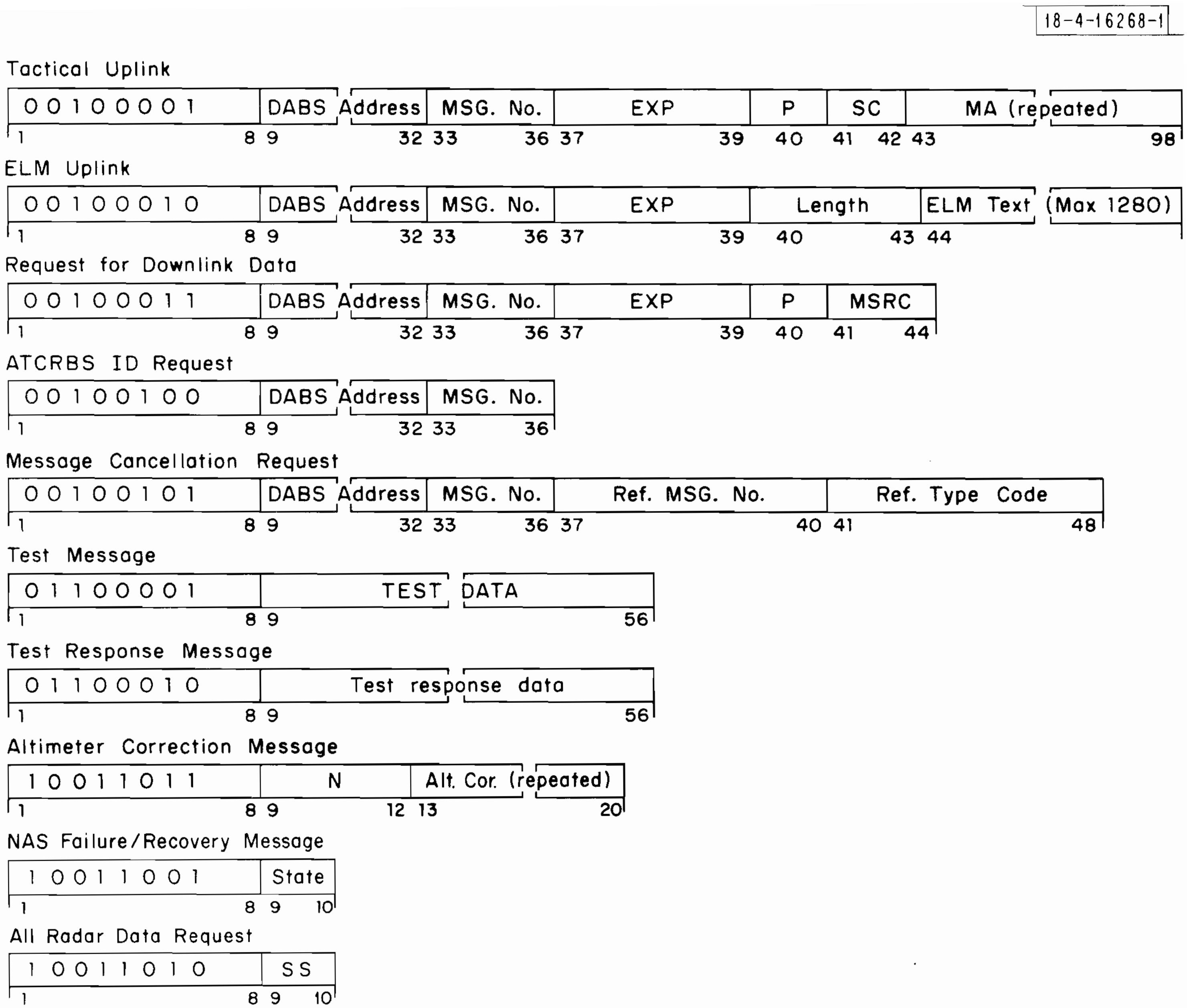

Fig. 5-1. Data block formats for NAS-to-DABS messages.

18-4-16269-3

Message Rejection Notice

0 0 1 1 0 0 0 1	DABS Address	Ref. Msg. No.	Qual.
1 – 8	9 – 32	33 – 36	38

Message Delivery Notice

0 0 1 1 0 0 1 0	DABS Address	Ref. Msg. No.	DI
1 – 8	9 – 32	33 – 36	37

Tactical Downlink

0 1 0 0 0 0 0 1	DABS Address	MB
1 – 8	9 – 32	33 – 88

ELM Downlink

0 1 0 0 0 0 1 0	DABS Address	Length	ELM TEXT (Max. 1280)
1 – 8	9 – 32	33 – 36	37

Pilot Acknowledgment

0 1 0 0 0 0 1 1	DABS Address	PBUT
1 – 8	9 – 32	33 34

Data Link Capability

0 1 0 0 0 1 0 0	DABS Address	Capability
1 – 8	9 – 32	33 – 38

ATCRBS ID Code

0 1 0 0 0 1 0 1	DABS Address	ATCRBS ID
1 – 8	9 – 32	33 – 44

IPC Command Notice

1 0 0 0 0 0 1 0	DABS Address *(1st)	MA (to 1st A/C)	DABS Address *(2nd)	MA (to 2nd A/C)
1 – 8	9 – 32	33 – 88	89 – 112	113 – 168

Controller Alert Notice

1 0 0 0 0 0 1 1	DABS Address *(1st)	DABS Address *(2nd)	Miss
1 – 8	9 – 32	33 – 56	57 – 62

Test Message

0 1 1 0 0 0 0 1	TEST DATA
1 – 8	9 – 56

Test Response Message

0 1 1 0 0 0 1 0	TEST RESPONSE DATA
1 – 8	9 – 56

Track Alert Message

1 0 0 1 1 1 0 0	DABS Address	Range (1st)	Azimuth (2nd)	Range (1st)	Azimuth (2nd)
1 – 8	9 – 32	33 – 47	48 – 60	61 – 75	76 – 88

Duplicate IPC Uplink Message

1 1 0 0 0 0 0 1	DABS Address	MSG. No.	EXP	P	SC	MA (repeated)
1 – 8	9 – 32	33 – 36	37 – 39	40	41 – 42	43 – 98

Duplicate IPC Message Delivery Notice

1 1 0 0 0 0 1 0	DABS Address	Ref. Msg. No.	DI	Ref. Sender ID
1 – 8	9 – 32	33 – 36	37	38 – 41

*ATCRBS ID may substitute

Fig. 5-2. Data block formats for DABS-to-NAS messages.

5.3.3.1 NAS-to-DABS Data Blocks

5.3.3.1.1 Type Code

The Type Code Block is an 8-bit control block which begins every Link Data Field. The code values are shown explicitly in Fig. 5-1, and have been summarized in Table 5-1.

5.3.3.1.2 DABS Address

DABS Address is the unique 24-bit identification code of a DABS-equipped aircraft. The coding is the same as that used in Surveillance Reports (see Section 4.1).

5.3.3.1.3 MSG. No.: Message Number

Message Number is a 4-bit binary integer consecutively numbering all types of Uplink Messages addressed to a particular DABS target. The all-zeros code is excluded so that 15 messages can be distinguished at a time. Note that MSG. No. is not included in message types not addressed to an aircraft.

5.3.3.1.4 EXP (Expiration)

EXP is a 3-bit block encoding "Time to Expiration" of a message (for uplink messages only). It is binary integer, with the values 1 through 7 representing the number of scans for which delivery should be attempted. The zero code is not used.

5.3.3.1.5 P: Priority

Priority is a 1-bit block giving a user-supplied priority tag (for certain uplink messages only).

1 = Urgent

0 = Standard

5.3.3.1.6 SC: Segment Count

Segment Count is a 2-bit binary integer block present in Tactical Uplink messages. Its value is one less than the number of segments to be transmitted on the gound-to-air-link; thus SC = 11 signifies a 4-segment multiple-segment message (ILM).

5.3.3.1.7 MA: Comm-A Message Text

MA is a 56-bit block occurring in Tactical Uplink messages. It is repeated in a message as many times as specified by the value of SC. MA contains an 8-bit control subfield followed by a 48-bit data subfield. The control bits specify such things as cockpit device address, pilot acknowledgment request, and ILM device control [1].

5.3.3.1.8 Length

Length is a 4-bit block present only in an ELM message. It is a binary integer specifying the number of 80-bit segments comprising the ELM Text block. It value is one less than the number of segments.

5.3.3.1.9 ELM Text

ELM Text is a variable length ELM data field. Its length is a multiple of 80 bits with a maximum of 1280 bits corresponding to a sequence of 16 consecutive Comm-C ground to-air transmissions, each carrying an 80-bit MC field of text.

The coding of the ELM Text block is dependent on the airborne I/O device and is not constrained by the DABS system.

5.3.3.1.10 MSRC: Message Source

Message Source is a 4-bit block present only in a Request for Downlink Data. It identifies the airborne data device from which readout is wanted. MSRC = 0000 is not used, and MSRC = 0001 signifies a request for aircraft data link capability readout; other codes are not presently assigned.

5.3.3.1.11 REF. MSG. No.: Referenced Message Number

Referenced Message Number is a 4-bit binary integer, present only in a Message Cancellation Request. It represents the number of the message whose cancellation is being requested.

5.3.3.1.12 REF. TYPE CODE

Referenced Type Code is the 8-bit Type Code block corresponding to a message whose cancellation is being requested.

5.3.3.1.13 Test Data

Test Data is a 48-bit block present only in a Test Message. Coding is undefined at present.

5.3.3.1.14 Test Response Data

Test Response Data is a 48-bit block present only in a Test Response Message. Coding is undefined at present; it may contain certain status information or it may simply be an echo of the data in an DABS-to-NAS Test message.

5.3.3.1.15 N: Index Number

N is a 4-bit binary integer present only in an Altimeter Correction message. Its value is one less than the number of Altitude Correction blocks which are present.

5.3.3.1.16 ALT. COR.: Altimeter Correction

Altimeter Correction is an 8-bit data block containing the value of a barometric pressure correction for a particular geographic area. The number of such correction blocks in a message (value of N plus 1) is standard for a given NAS facility-DABS sensor pair. The geographic interpretation of each such correction is also a sensor parameter fixed by pre-arrangement with the NAS system. Coding is: Sign, 3-bit BCD, 4-bit BCD (to cover the range -79 to +79 hundreds of feet).

5.3.3.1.17 State

State is 2-bit data block occurring only in a NAS Failure/Recovery Message. It is used to inform a DABS sensor of a change in the operational status of a NAS facility.

00 Not used

01 Failure

10 Recovery from failure

11 Recovery from failure with loss of data base.

5.3.3.1.18 SS: Start-Stop Parameter

SS is a 2-bit data block used only in an All Radar Data Request. It is intended to change the sensor operating mode with respect to dissemination of radar surveillance data which reinforce beacon data. (Uncorrelated radar reports and reports which correlate with a beacon track for which current beacon data are missing are always sent.)

00 Not used

01 Start sending all radar data

10 Stop sending all radar data

11 Not used

5.3.3.2 DABS-to-NAS Data Blocks

DABS-to-NAS data block formats are shown in Fig. 5-2. The following blocks have already been defined as NAS-to-DABS blocks: Type Code, DABS Address, Referenced Message Number, Length, ELM Text, MA, Test Data, Test Response Data, Message Number, Exp, P, and SC. Definitions of the remaining blocks follow.

5.3.3.2.1 Qual: Qualifier

The Qualifier is a 2-bit block present in a Message Rejection/Delay Notice only.

00 = Target not on file (rejection)

01 = Target not in track state S4 (delay)

10 = Not used

11 = Not used .

5.3.3.2.2 DI: Delivery Indicator

The Delivery Indicator is a 1-bit block present in a Message Delivery Notice only. It reports on the success of a referenced Uplink message, with the following coding:

0 = Message successfully delivered

1 = Message expired, undelivered .

5.3.3.2.3 MB: Comm-B Message Text

MB is a 56-bit downlink Tactical message text, similar to the uplink MA block. It contains 8-bits of control data (including a device source code and possible ILM control bits) and 48 data bits. This text may be, (a) automatic data readout at ground request, (b) a pilot initiated message, or (c) pilot acknowledgments to uplink ATC messages.

5.3.3.2.4 PBUT: Pilot Button Signal

PBUT is a 2-bit block containing the pilot response to a previously received uplink message (for which an acknowledgment was requested). It is encoded as follows:

01 = Will comply

10 = Cannot comply .

5.3.3.2.5 Capability

Capability is a 6-bit block indicating the capability of the designated DABS aircraft. Coding is undefined at present. If the Capability code indicates the presence of any downlink (Comm-B or ELM) capability, then further specification of that capability is needed. This is obtained by the NAS facility using a Request for Downlink Data message with MSRC = 0001.

5.3.3.2.6 ATCRBS ID

ATCRBS ID is a 12-bit block giving the 4096-code value from a DABS transponder. The coding is the standard Mode 3/A format used in Surveillance Reports on ATCRBS targets (see Table 4-1).

5.3.3.2.7 Miss

Miss is a 6-bit block giving the miss distance as predicted 2 minutes ahead by the IPC function, for the aircraft identified in the Controller Alert Notice. Coding is undefined at present.

5.3.3.2.8 Ref. Sender ID: Referenced Sender ID Code

Referenced Sender ID Code is a 4-bit block occurring in the Duplicate IPC Message Delivery Notice. It is included specifically to cover the case in which a sensor has delivered an IPC uplink message originating at a remote IPC facility, and it enables the NAS facility receiving the duplicate delivery notice to reference the message without ambiguity. Coding is undefined at present.

5.3.3.2.9 Range (1st or 2nd), Azimuth (1st or 2nd)

The range and azimuth fields, respectively 15 and 13 bits long, in the Track Alert Message, are the measured ranges and azimuths of the two targets that are involved in the duplicate address alert situation.

REFERENCES

[1] P.R. Drouilhet, Ed., "Provisional Signal Formats for the Discrete Address Beacon System," Project Report ATC-30, Rev. 1, Lincoln Laboratory, M.I.T. FAA-RD-74-62 (25 April 1974).

[2] Report of "Automated Data Interchange System Panel (ADISP), -Fourth Meeting," ICAO, ADISP-WP-84 (7 November 1972).

[3] "Action taken by the ANC on the Recommendations for COM Procedures arising from the 4th Meeting of the ADIS Panel," ICAO Memorandum SP 24/1-64 (1 March 1974).