Report 97-007

Air Traffic Control communications system failure

Christchurch Area Control Centre

3 April 1997

Abstract

On Thursday 3 April 1997, at 1912 hours, the Airways Corporation communications network system suffered a failure which caused a temporary loss of all Air Traffic Control very high frequency radio communications in the Wellington Sector.

Subsequent modifications to the system and procedures will reduce the chance of a similar failure.

A safety issue identified was the inadequacy of the "communications failure" information in the Instrument Flight Guide for pilots, in the case of a failure of communications from Air Traffic Control.

1. Factual Information

1.1 At 1912 hours on 3 April 1997 an incident occurred in the Airways Corporation Christchurch Area Control Centre (ACC) which caused a temporary loss of Air Traffic Control communications between Christchurch and Wellington. No in-flight difficulties were caused, but four departing aircraft at Wellington were held on the ground for approximately ten minutes.

1.2 Services disrupted included radar and very high frequency (VHF) radio signals, data and voice messages.

1.3 Each VHF radio frequency had a main, an alternate and a standby channel. The main and alternate channels were diversified within the multiplex network (Mux) system, while the standby channel was a substantially separate system, using a separately powered transmitter. In the case of the Wellington Control frequencies, however, the link from the air traffic controller in Christchurch to the Wellington transmitter was also within the Mux system.

1.4 The Mux system was commissioned in 1993. Multiplex signals were carried on digital circuits between seven nodes located in Control Centres or Towers throughout the country, to provide the main Air Traffic Services communications system. It was managed from Christchurch ACC, where two nodes were installed.

1.5 At the time of the incident, a management terminal connected to one of these nodes was having some software reloaded, to correct a minor technical problem. Another management terminal, connected to the other node, was controlling the network.

1.6 During the software loading process the terminal reacted to a software mismatch in the node by taking the node off-line, and all the services connected to this node were lost. Shortly afterwards, the diverse services to Wellington, which included the Wellington Sector alternate and standby frequencies, were also lost. These frequencies were not connected to the failed node, but were routed through it. Automatic rerouting of these frequencies commenced, causing alarms to occur.

1.7 The technician working with the terminal recognised the problem, and acted promptly to physically disconnect it from the network, thus limiting the extent of the disruption. Automatic rerouting of services continued, and the majority of services were restored by 1918 hours. The failed node was returned to service after being manually powered off and back on, and all services were restored by 1925 hours.

1.8 No management terminal software maintenance of this sort had been carried out on the system since it was commissioned, and the system reaction was not anticipated either by Airways Corporation, or by the manufacturer's agent in New Zealand.

1.9 The equipment, known as the MegaMux TMS (Transport Management System), was manufactured in the United States by General DataComm Incorporated, and is used by several other organisations in New Zealand. The Airways Corporation application is the only one as an Air Traffic Services network.

1.10 After the incident Airways Corporation rearranged the Wellington alternate VHF radio channel so that it was not routed through both nodes in the Christchurch ACC, thus improving the diversity of the system.

1.11 Airways Corporation have also begun a project to carry the standby VHF radio links on a circuit which is separate from the Mux system, to further increase the diversity of these links.

1.12 The Instrument Flight Guide (IFG) part of the New Zealand Aeronautical Information Publication (AIP), in its EMERGENCY section, carried advice for pilots on procedures to follow in the event of communications failure. These procedures were based on the circumstance of the failure of the radio equipment in one aircraft, and advised its pilot what to do. There was no procedure advocated for pilots in a situation where a number of aircraft could be affected at the same time by a failure of communications from Air Traffic Control.

2. Analysis

2.1 This incident was of concern because a major loss of Air Traffic Control communications with aircraft could have a significant potential for creating a risk of collision. In this case the incident caused no in-flight difficulties because it occurred at a time of day when traffic at Wellington was light, and because most services were restored within six minutes.

2.2 The technician who was reloading software on the management terminal which initiated the incident evidently responded quickly and appropriately to limit the extent of the problem and then to reinstate the system. Without his quick response to disconnect the terminal physically, there was a likelihood that the software mismatch would have led to the other nodes around the system progressively going off-line, thus causing the whole network to fail.

2.3 While the Mux system was capable of automatically rerouting services in the case of most system component failures, the speed of response was limited by the number of services associated with the failed node. The network was substantially functional, however, within six minutes. This node responded to the technician's actions and was reinstated, permitting the full restoration of services within 13 minutes.

2.4 The reason why the terminal software maintenance caused the node to fail was not established. Since no previous maintenance had been required, this was the first opportunity for the problem to occur, resulting in the unanticipated outcome. Evidently there is a need for a revised procedure for terminal software maintenance to be undertaken, either when the terminal is separated from the network, or at times when there is no traffic.

2.5 The architecture of the system, which caused the Wellington Sector VHF radio alternate and standby channels to be routed through the same node as the main channel, had resulted in less than optimum diversity. This was highlighted in this incident when all the radio communications channels were lost for six minutes. While the subsequent action taken by Airways Corporation to reroute the alternate channel was appropriate, it would be prudent to review the whole system in this regard, to ensure that maximum opportunities for diversity have been taken.

2.6 The ideal with a standby channel is to have a discrete system with a battery powered radio, separate microphone and aerial, so that while its performance may be limited in comparison with the main and alternate channels, it should be available as a back-up facility in most circumstances. Where a function such as Wellington Control is operated remotely from Christchurch ACC, the stand-alone nature of a standby radio is inevitably reduced by the need for a link between the air traffic controller and the radio. In this case, this link was made within the Mux network, alongside the alternate channel. This common element did mean that the standby channel was also lost in this incident, and indicated a weakness in the system. The action taken by Airways Corporation to establish a separate link is appropriate, and should improve the system redundancy when it is installed.

2.7 The "communications failure" section of the IFG is the guide to pilots on what to do when radio communications with Air Traffic Control are lost. The information in that section is pertinent to the situation of one aircraft suffering a failure of its radio equipment, while Air Traffic Control and other aircraft can continue normal communications. This is the most likely type of failure to occur, so it is appropriate that the information is prominent and readily accessible. It is probable, however, that the advice given would be inadequate for a situation where a failure of communications from Air Traffic Control occurred while several aircraft in IMC were under control at the time, perhaps on arrival and departure in a Terminal Manoeuvring Area. In such a situation pilots might need to arrange the separation and sequencing of their aircraft mutually with no assistance from Air Traffic Control.

2.8 This incident has demonstrated that a failure of Air Traffic Control communications is a possibility, however much diversity is designed into the system and that some additional advice to pilots is needed to ensure that a basic level of safety and orderliness can be maintained. As a result a safety recommendation was made to the Director of Civil Aviation, that the scope of the "communications failure" advice in the IFG be expanded to address actions in the event of a failure of communications from Air Traffic Control.

3. Findings

Findings and any recommendations are listed in order of development and not in order of priority.

3.1 The Airways Corporation communications network failure was an unanticipated result of software maintenance action.

3.2 The consequent failure of all Wellington Sector Air Traffic Control VHF radio frequency channels was associated with the architecture of the system, which compromised the available diversity.

3.3 The "communications failure" section of the IFG did not provide pilots with information and advice adequate for a failure of communications from Air Traffic Control.

4. Safety Recommendation

4.1 It was recommended to the Director of Civil Aviation that he:

4.1.1 review the "EMERGENCY" section of the IFG with a view to ensuring that the scope of the "communication failure" part of that section is sufficiently comprehensive to provide pilots with information and advice on actions to be taken in the event of a failure of communications from Air Traffic Control. (059/97)

4.2 The Director of Civil Aviation responded as follows:

4.2.1 It is expected that the review of the relevant section of the Instrument Flight Guide will be initiated before the end of 1997, consultation with industry will take place early in the first half of 1998 and agreed changes would be in place by 30 June 1998. The timing of these matters is, to a large extent, governed by the AIRAC publishing cycle.

15 October 1997

Hon W P Jeffries
Chief Commissioner

Glossary of aviation abbreviations

AD	Airworthiness Directive
ADF	automatic direction-finding equipment
agl	above ground level
AI	attitude indicator
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
amsl	above mean sea level
AOD	aft of datum
ASI	airspeed indicator
ATA	actual time of arrival
ATC	Air Traffic Control
ATD	actual time of departure
ATPL (A *or* H)	Airline Transport Pilot Licence (Aeroplane *or* Helicopter)
AUW	all-up weight
^{o}C	degrees Celsius
CAA	Civil Aviation Authority
CASO	Civil Aviation Safety Order
CDI	course deviation indicator
CFI	Chief Flying Instructor
C of A	Certificate of Airworthiness
C of G (*or* CG)	centre of gravity
CPL (A *or* H)	Commercial Pilot Licence (Aeroplane *or* Helicopter)
DME	distance measuring equipment
E	east
ELT	emergency location transmitter
ERC	Enroute Chart
ETA	estimated time of arrival
ETD	estimated time of departure
^{o}F	degrees Fahrenheit
FAA	Federal Aviation Administration (United States)
FL	flight level
ft	foot/feet
g	acceleration due to gravity
GPS	Global Positioning System
h	hour
HF	high frequency
hPa	hectopascals
hrs	hours
HSI	horizontal situation indicator
HT	high tension
IAS	indicated airspeed
IFR	Instrument Flight Rules
IGE	in ground effect
ILS	instrument landing system

IMC	instrument meteorological conditions
in	inch(es)
ins Hg	inches of mercury
kg	kilogram(s)
kHz	kilohertz
KIAS	knots indicated airspeed
km	kilometre(s)
kt	knot(s)
LAME	Licensed Aircraft Maintenance Engineer
lb	pound(s)
LF	low frequency
LLZ	localiser
Ltd	Limited
m	metre(s)
M	Mach number (e.g. M1.2)
^{o}M	degrees Magnetic
MAANZ	Microlight Aircraft Association of New Zealand
MAP	manifold absolute pressure (measured in inches of mercury)
MAUW	maximum all-up weight
METAR	aviation routine weather report (in aeronautical meteorological code)
MF	medium frequency
MHz	megahertz
mm	millimetre(s)
mph	miles per hour
N	north
NDB	non-directional radio beacon
nm	nautical mile
NOTAM	Notice to Airmen
NTSB	National Transportation Safety Board (United States)
NZAACA	New Zealand Amateur Aircraft Constructors Association
NZDT	New Zealand Daylight Time (UTC + 13 hours)
NZGA	New Zealand Gliding Association
NZHGPA	New Zealand Hang Gliding and Paragliding Association
NZMS	New Zealand Mapping Service map series number
NZST	New Zealand Standard Time (UTC + 12 hours)
OGE	out of ground effect
okta	eighths of sky cloud cover (e.g. 4 oktas = 4/8 of cloud cover)
PAR	precision approach radar
PIC	pilot in command
PPL (A *or* H)	Private Pilot Licence (Aeroplane *or* Helicopter)
psi	pounds per square inch
QFE	an altimeter subscale setting to obtain height above aerodrome
QNH	an altimeter subscale setting to obtain elevation above mean sea level
RNZAC	Royal New Zealand Aero Club
RNZAF	Royal New Zealand Air Force
r.p.m.	revolutions per minute
RTF	radio telephone or radio telephony

s	second(s)
S	south
SAR	Search and Rescue
SSR	secondary surveillance radar
°T	degrees true
TACAN	Tactical Air Navigation aid
TAF	aerodrome forecast
TAS	true airspeed
UHF	ultra high frequency
UTC	Coordinated Universal Time
VASIS	visual approach slope indicator system
VFG	Visual Flight Guide
VFR	visual flight rules
VHF	very high frequency
VMC	visual meteorological conditions
VOR	VHF omnidirectional radio range
VORTAC	VOR and TACAN combined
VTC	Visual Terminal Chart
W	west