NAL TM-319T

UDC 551.551:
629.7.017

TECHNICAL MEMORANDUM OF NATIONAL AEROSPACE LABORATORY

TM-319T

Operational Experiences Related to Severe Turbulence Between September 1973 and August 1975

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November 1976

NATIONAL AEROSPACE LABORATORY

CHŌFU, TOKYO, JAPAN

Operational Experiences Related to Severe Turbulence Between September 1973 and August 1975*

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ABSTRACT

This paper represents the severe turbulence data encountered by civil transports between September 1973 and August 1975. This programme was conducted in accordance with the task assigned to the members in the report of the 10th Meeting of ICAO Airworthiness Committee, paragraph 6:3.3(6), and the flight recorder data in excess of 1g incremental acceleration were collected by the airlines.

Six events were obtained in total, one of which had a very long patch of turbulence, 31 minutes, showing apparently to be continuous. The others were mostly much shorter, and two of them seemed to be discrete.

概　　要

ICAO 耐空性委員会，第10回会議で出された宿題に答えて，我国の民間輸送機が運航中に激しい乱気流に遭遇した場合の資料が収集された。

資料収集は 1973 年 9 月から 1975 年 8 月の間行われ，パイロット・レポートに基づいて，乱気流によって 1 g 以上の上下加速度増分を経験した飛行が選ばれて，日本航空，全日本空輸，東亜国内航空より合計 6 件の資料（フライト・レコーダの記録およびパイロット・レポート）が提出された。

1 件は乱気流の持続時間が 31 分と非常に長く，上下加速度は比較的定常で，いわゆる連続乱気流と考えられるものであった。他の 5 件の乱気流の持続時間ははるかに短くすべて 5 分以下であり，その内 2 件は弧立突風の様相を示していた。

1. INTRODUCTION

The 10th meeting of the ICAO Airworthiness Committee recommended to include the PSD method in the guidance material, Chapter 1, Section 3, Part III of the Airworthiness Technical Manual. It was also recognized in the meeting that there was a pressing need for continued research into the veracity of spectral treatment as well as into other promising gust treatments such as Jones' method, and several tasks on this problem were assigned to all members in the Report of the 10th meeting, paragraph 6:3.3.

In accordance with the task in paragraph 6:3.3(6), operational experiences related to severe turbulence were collected encountered by civil transports between September 1973 and August 1975.

Severe turbulence was defined to be in excess of 1g incremental normal acceleration, and flight recorder data which include the severe turbulence records were selected based on the pilot reports.

2. COLLECTED DATA

Six events of severe turbulence were obtained in total. Analog records of the flight recorders were traced using a profile projecter of 20 magnifications. The traces except the Event No. 5 are shown from

* Received October 4, 1976

** First Airframe Division

page 4 to 9 together with the pilot comments. The inclusive description of the events is given in Table 1.

3. DISCUSSION

The acceleration traces due to turbulence show that the 6 events can be divided into 3 different groups. The first group is the Event No. 2, which had a very long patch length of turbulence of 31 minutes. The turbulence was comparatively stationary throughout the patch and Fig. 2 shows only a part of it. Event No. 2 is considered to be the typical sample of continuous turbulence.

The second group, the Event No. 1, No. 3 and No. 6, had much shorter patch length from 2 to 5 minutes, but the turbulence patches still seemed to be stationary.

The third group is the Event No. 4 and No. 5. Although the figure of the Event No. 5 is not presented in the report, the acceleration traces of those 2 events were not stationary, but rather intermittent or discrete, especially in the Event No. 5.

Precisely speaking, the practical phenomena of turbulence are neither ideally continuous nor discrete. Both the PSD method and discrete method are only the mathematical means of representing the turbulence by statistically equivalent model for the design of aircraft strength.

Therefore, it is of course necessary to get the basic knowledge on the character of the individual sample of turbulence. But, for the research on the veracity of continuous and discrete method, continued efforts are more important of collecting the operational experiences related to severe turbulence and analyzing the statistical data under the various geographical and meteorological conditions, with various types of aircrafts.

event No. and date	airplane and T.O.W. (lbs)	route and time	time of turbulence encountered and flt phase	peak normal acceleration (absolute, g) positive /negative	turbulence patch length (minutes)	mean altitude (ft)	mean IAS (kts)
No. 1 Oct '73	YS-11A 50,500	Takamatsu (18:43L) to Tokyo (20:34L)	20:03L cruise	+1.8/+0.2	2.6	10,500	195
No. 2 Dec '73	B747 587,000	LosAngeles (17:43Z) to Honolulu (23:04Z)	19:27Z cruise	+1.5/+0.4	31.2	30,000	320
No. 3 Feb '74	DC-8 241,300	Osaka (08:45Z) to Taipei (11:42Z)	10:00Z cruise	+1.7/+0.6	4.6	26,500	340
No. 4 Apr '74	DC-8 246,200	Sapporo (14:01L) to Tokyo (15:30L)	15:15L descent	+2.1/−0.1	2.3	17,500	270
No. 5 Mar '75	YS-11A 49,500	Ube (10:59L) to Tokyo (13:03L)	11:17L cruise	+1.0/−0.2	0.5	11,000	210
No. 6 Jun '75	DC-8 218,600	Osaka (09:07Z) to Tokyo (11:02Z)	10:40Z descent	+1.7/+0.3	4.8	33,000	290

Table 1 Inclusive description of turbulence events

Event No.1
Route: Takamatsu/Tokyo – October 1973

Pilot comment: While in cruise at 11,000 ft, about 15 NM west of Oshima, light turbulence was encountered first. A minute later, sudden severe shaking occured, followed by light turbulence and then air became smooth. The subsequent variation in altitude and indicated airspeed were 300 to 400 ft and 10 to 15 kts, respectively.

Although no radar echo was recognized, cumulus and cumulo-nimbus clouds with top to 12,000 ft and diameter of 10 NM lied 10 to 15 NM west of Oshima. Outside air temperature was +2 to +3°C and wind 260 to 280°/20 kts.

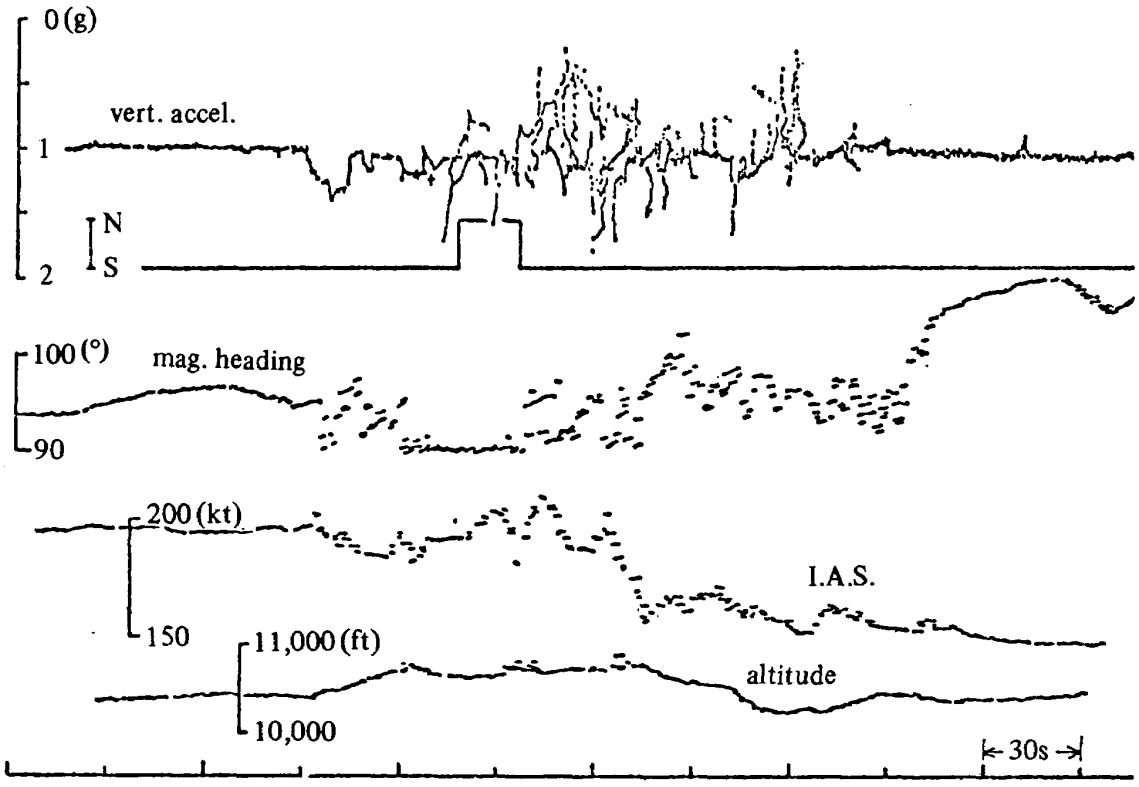

Fig. 1 Records of severe turbulence, Event No. 1

Event No. 2
Route: Los Angeles/Honolulu – December 1973

Pilot comment: A period of moderate to severe continuous turbulence (clear air turbulence) lasting approximately 32 minutes was encountered during the cruise at 31,000 ft and 128°W. When the aircraft felt shaking and rolling, seat belt sign was turned on and made cabin announced, since cabin meal service had already started. Few minutes later, autopilot was selected to "turbulence" mode. However, intensity of turbulence was still getting worse. Then, all cabin crew were advised "Interrupt service, occupy your own seat". In spite of speed reduction to recommended severe turbulence penetration speed, controls of the aircraft for attitude, speed, altitude etc. were felt difficult. Advised flight engineer pushing event switch on flight recorder, and requested SFO to descend 28,000 ft immediately.

Just 12 o'clock over head, UAL 191 was flying 35,000 ft. Descent clearance to 28,000 ft was given minutes later. UAL's situation was seemed same as they requesting climb 37,000 or 39,000 ft "expediting" were listened through radio. Squarked in log book "moderate to severe turbulenced". After passing 136°W, air became smooth and cabin services were restarted and completed.

No passengers nor crew were injured. However, about 1/3 of E compartment passengers got air sickness. 10 to 15 of them seemed heavy. This significant weather report was relayed to Flt 62 near Honolulu through company radio. Stand-by doctor inspected passengers after arrival at Honolulu. The aircraft and flight recorder were also inspected.

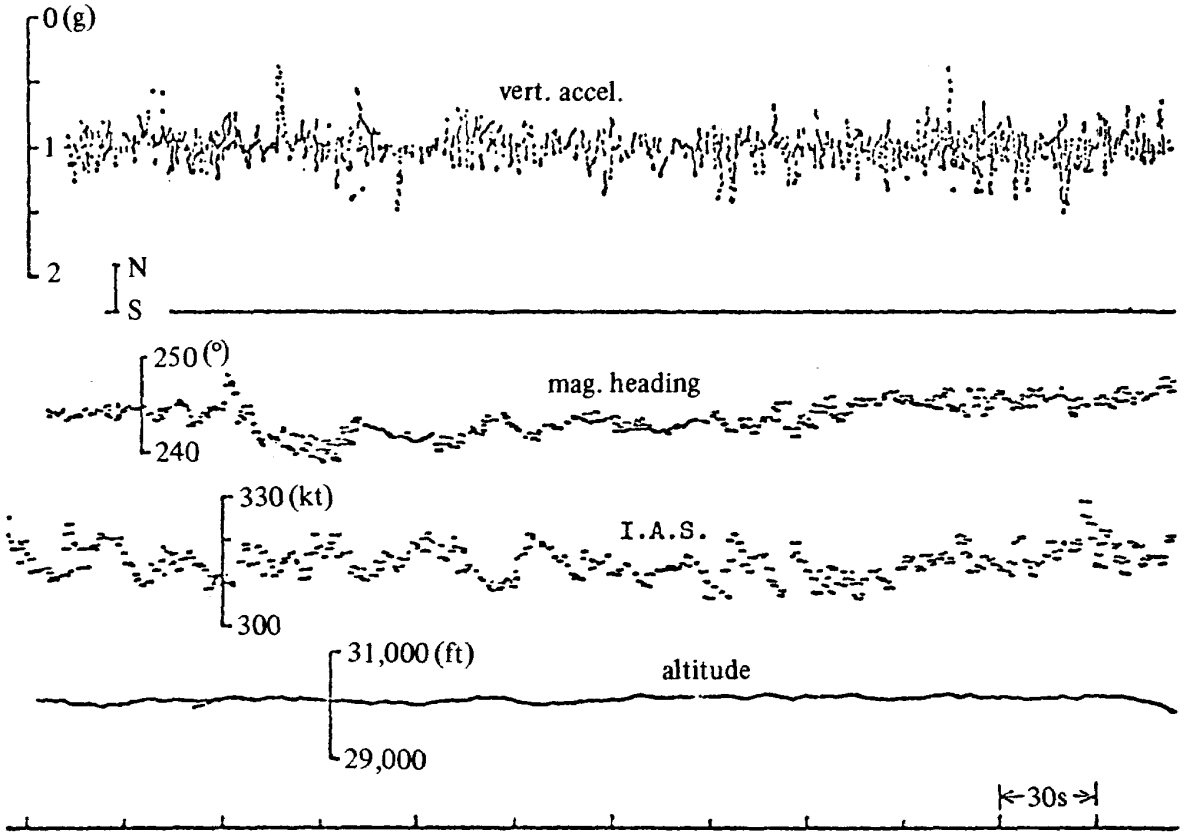

Fig. 2 Records of severe turbulence, Event No.2

Event No. 3
Route: Osaka/Taipei – February 1974

Pilot comment: While in cruise at 26,500 ft and 17 NM southwest of Kagoshima, heavy turbulence was experienced for approximately 2 minutes. All passengers and crew had fastened seat belts. There were no injuries nor damages.

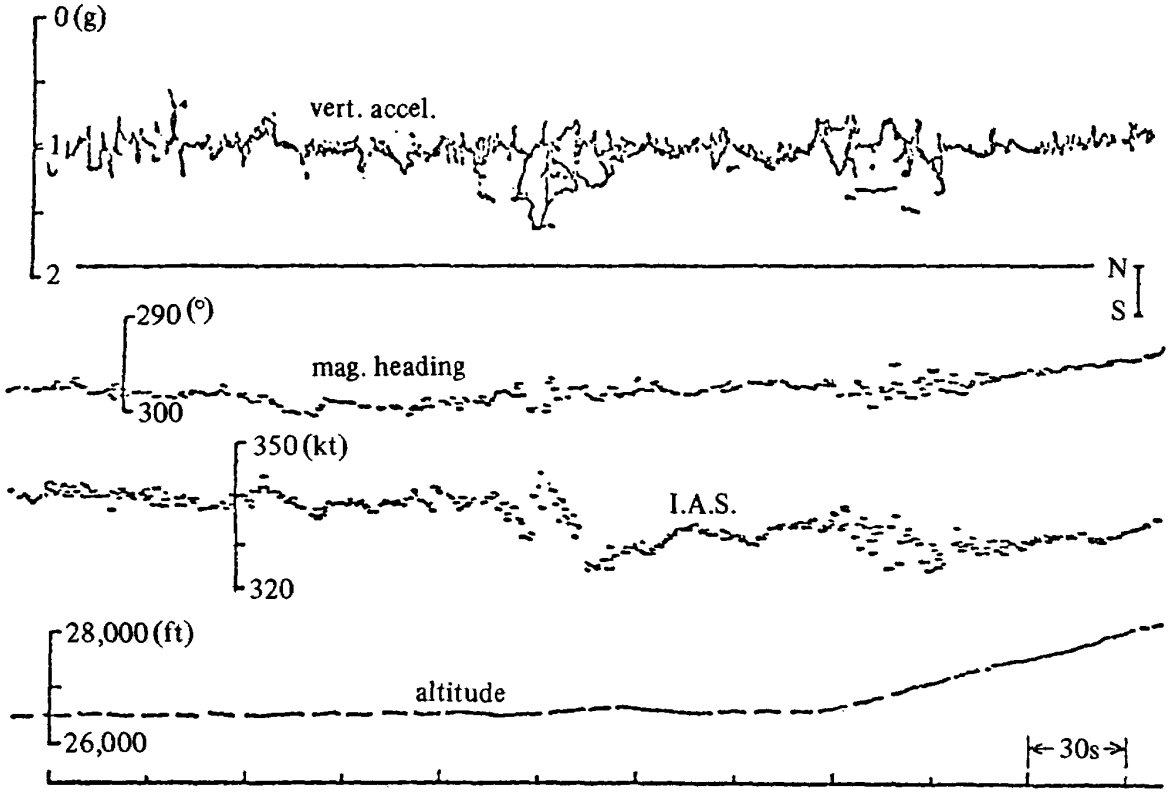

Fig. 3 Records of severe turbulence, Event No. 3

Event No. 4
Route: Sapporo/Tokyo – April 1974

Pilot comment: During the descent into Tokyo, 30 NM south of Daigo, moderate turbulence was encountered. Cumulus clouds obstructed the passage and could not be avoided.

The altitude and indicated airspeed of the aircraft in the turbulence were 20,000 ft and 250 kts, respectively. Autopilot was released and yaw damper was on. Seat belt sign was on, since light continuous turbulence had started prior to the descent.

2 stewardesses bumped their heads against the ceiling while sitting in the rear jump seats without seat belts to conduct a passenger to the toilet. They were inspected after arrival.

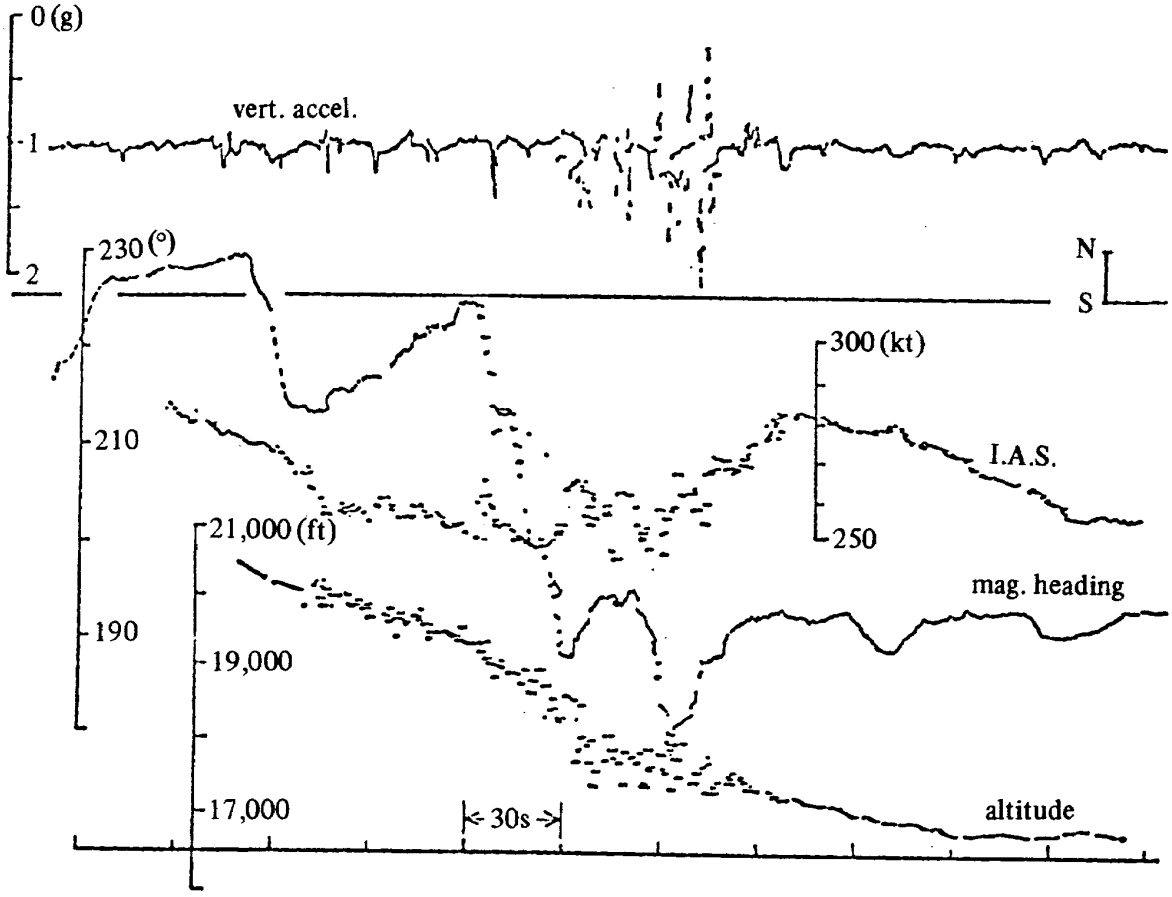

Fig. 4 Records of severe turbulence, Event No. 4

Event No. 5
Route: Ube/Tokyo – March 1975

Pilot comment: During the cruise at 11,000 ft, about 5 NM short of Iwakuni, a sudden patch of turbulence was encountered, giving a peak normal acceleration of −0.2 g (absolute). Acceleration records showed no significant variation in positive side.

Seat belt sign was on, since cumulus clouds at 10,000 ft were increasing near Iwakuni with top upto 11,000 ft and the aircraft had started shaking lightly. The aircraft was not equipped with autopilot nor yaw damper.

(no figure)

Event No. 6
Route: Osaka/Tokyo – June 1975

Pilot comment: During the inbound into Tokyo, moderate to severe turbulence (clear air turbulence) was encountered at 33,000 ft between Oshima and Miyakejima.

Descent clearance was down to 21,000 ft, and the aircraft flew between 33,000 ft and 29,000 ft, and 280 kts IAS. The aircraft was inspected after arrival at Tokyo. No passengers were injured.

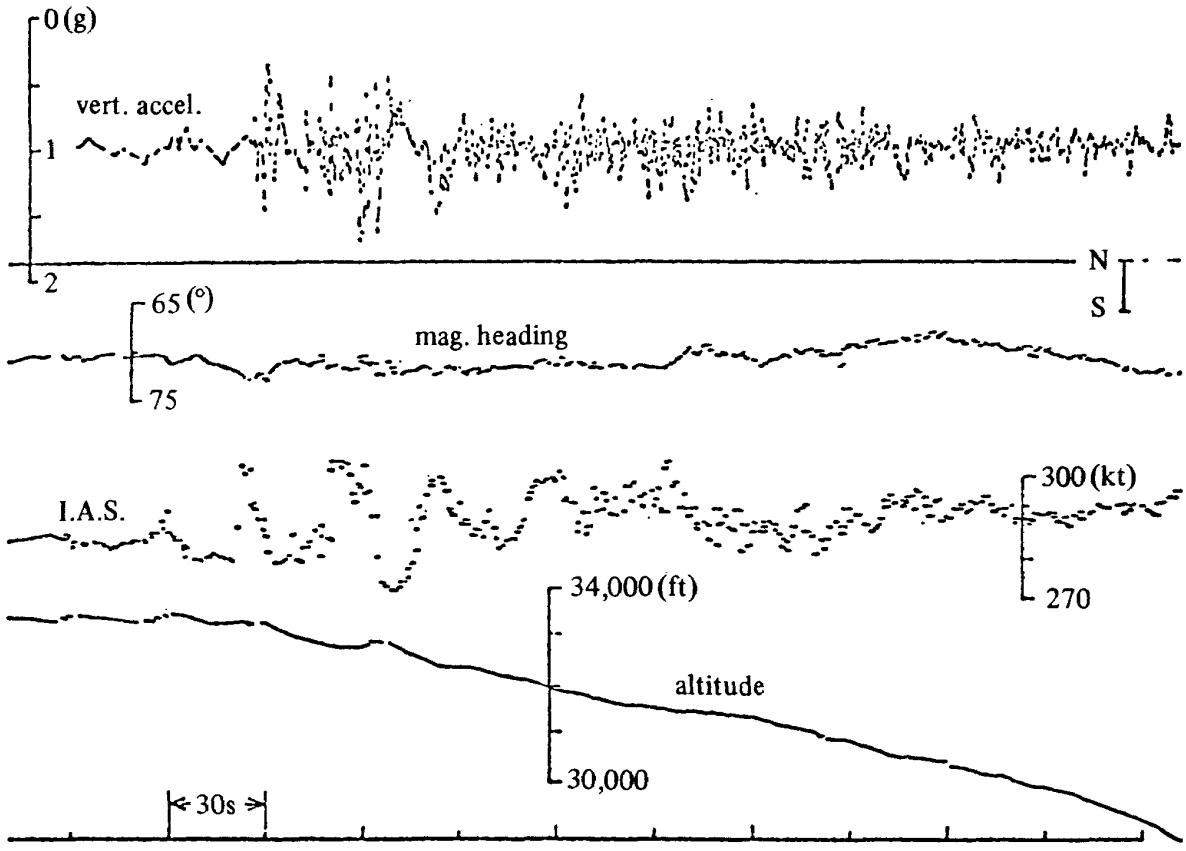

Fig. 5 Records of severe turbulence, Event No. 6

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AEROSPACE LABORATORY
TM-319T

航空宇宙技術研究所資料319T号(欧文)

昭和51年11月発行

発行所　航空宇宙技術研究所
東京都調布市深大寺町1,880
電話 武蔵野三鷹(0422)47-5911(大代表)
印刷所　株式会社　共進
東京都杉並区久我山4-1-7(羽田ビル)

Published by
NATIONAL AEROSPACE LABORATORY
1,880 Jindaiji, Chōfu, Tokyo
JAPAN

Printed in Japar