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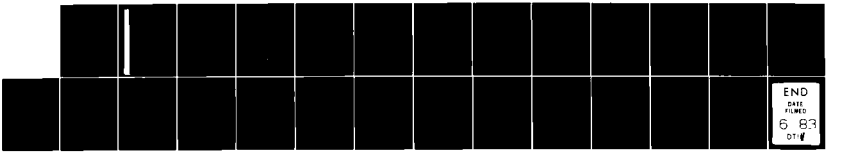

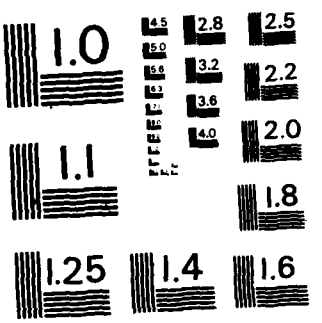

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Aerodynamics Technical Memorandum 348

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J.S. DROBIK

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Aerodynamics Technical Memorandum 348

PROCEDURES FOR PROCESSING AFTRAS FLIGHT DATA TAPES FROM ARDU

by

J.S. DROBIK

SUMMARY

The procedures required to read and process seven-track copies of dynamic flight test data tapes recorded by ARDU using AFTRAS are described. The programs were developed by the Aircraft Behaviour Studies - Fixed Wing group to prepare the data for subsequent detailed analysis on the ARL DEC system-10 (1070). The programs described transfer raw data from tape to disc, process the raw data, provide plots or data tables and reformat the data for input into other programs.

Problems in handling and storing the large files are discussed and programs for packing the data for storage and unpacking for later use, are also described.

POSTAL ADDRESS: Director, Aeronautical Research Laboratories,
P.O. Box 4331, Melbourne, Victoria, 3001, Australia.

CONTENTS

1. INTRODUCTION

The flight test recording system used by the RAAF Aircraft Research and Development Unit (ARDU) is the Aircraft Flight Test Recording and Analysis System (AFTRAS) as described in Reference 1. This Technical Memorandum describes the procedures required to read and process the seven-track copies of the ARDU flight tapes, using the ARL DECsystem-10 (1070).

The procedures detailed are for 7-track tapes from ARDU which have been specifically used to extract records of Nomad and Mirage flight data prior to analysis. The tape formats for these aircraft differ, but the program automatically adjusts for either. Each flight on a tape consists of three magnetic tape files. The first two files contain the header (e.g. title, channel calibration co-efficients and recording details); the third contains the raw data.

Problems in reading the tapes appear to be due primarily to unreliability of the tape drives. Unfortunately the condition of the drives coupled with heavy loading of the system during prime time can cause long delays in transferring the raw data to disc. Attempts to read tapes are therefore best done outside prime time when drive problems are less prevalent. Replacement of the aging ARL computer system is due to occur in 1984.

Outlined in the pages are the four steps required :

(1) copying n records (2.5 seconds of flight per record) onto disc - (program TAPES)

(2) processing raw data - (program FLIGHT)

(3) plotting and printing data (programs TRANS, REFORM)

(4) packing raw data to reduce storage requirements - (programs PACK, HEADER, UNPACK).

All programs, except TRANS, are stored on a disc pack OSSA: in a sub-file directory [1020, 1240, TAPES]. Program TRANS is run from system area PUB:.

2. PROCESSING PROGRAMS

2.1 Transferring Raw Data from Tape to Disc - TAPES

TAPES is an interactive program which reads a required number of records (2.5 seconds of data each) from the AFTRAS tape onto a disc file which is named RXXXX.YYY where XXXX is the number of the first record and YYY is the number of records being copied. In

addition to this a flight summary file called FLTZZZ.SUM is created on disc, where ZZZ is the flight number. This summary contains information on flight details, channels recorded, calibration data and a record/event map for the records transfered. The summary of the whole tape may be obtained without processing any records; this is a useful guide to the particular tape size and details (See Appendix B for method).

The program TAPES was written for 7-track tapes from ARDU and has been used to extract Nomad and Mirage data to date. The tape formats for these aircraft differ but the program recognizes this and adjusts accordingly. The tapes supplied by ARDU are copies of the original flight tapes. The Nomad tapes have only one flight on each magnetic tape whereas the Mirage tapes have up to six. A tape with more than one flight presents a problem for the program because if the tape is not at the correct file mark the job will abort. (Refer to Appendix B).

Appendix A summarizes information on the tapes which contain dynamic flight test data of interest for the Nomad and Mirage aircraft.

A typical sequence of computer commands required to mount a chosen tape and read the required data is shown below. The example is for a Mirage tape where the second flight is required. Typical problems encountered when attempting to read the tape include HUNG DEVICE, PARITY ERROR, MAG TAPE NOT POSITIONED CORRECTLY, OR DATA IS NOT FLIGHT DATA and FIRST I-P FROM MAG TAPE GAVE EOF. These errors are most often associated with reading the second or third flight on a Mirage tape. Typical examples are shown in Appendix B along with a successful run.

Example:

Tape Mounting (i.e. 7-track tape where the tape number is not a general ARL Computer Centre tape number):

```
.PLE CHECK PLE MX M/ARL TAPE 19
```

Assign mag-tape drive number after operator responds with tape mounted and drive number, e.g. drive zero.

```
.AS MTA0
```

Since this tape is a Mirage example and the flight to be processed is the second on the tape, the tape must be advanced past the file marks used within the first flight and between the first and second flight. Program PIP has the facility to advance a tape and in this instance the tape must be advanced two file marks.

```
. R PIP
* MTA0 (M02A)=
* ↑C
```

The tape is now positioned correctly thus program TAPES can be run.

```
. RU TAPES
  MAG TAPE ON WHICH DRIVE : Ø
  ABOUT TO PROCESS FLIGHT 40
  DO YOU WISH TO PROCESS ANY CHANNEL READINGS? (Y OR N): Y
  START PROCESSING AT RECORD NO.? (1,2,...): 151
  PROCESS HOW MANY RECORDS?: 5Ø
     50 RECORDS PROCESSED
  O-P FILE 'RØ151.Ø5Ø' CREATED ON DISC.
```

If the answer to PROCESS ANY CHANNEL READINGS is N then the output consists of a summary for the whole tape only; whereas in the example above both RØ151.Ø5Ø and a summary file of the records transferred, FLTØ4Ø.SUM, are produced. It is advisable to restrict the number of records to around fifty or fewer, otherwise files become too large to operate on and store. A 50-record file requires a storage area of around 3500 Blocks and due to the size, the time for copying between devices is significant. Also if the file is plotted in full the plots are unwieldy and scales unsatisfactory.

Appendix B contains an example of the teletype dialogue obtained from TAPES.

2.2 Processing Raw Data - FLIGHT

The interactive program,FLIGHT, reads in the raw data file produced by TAPES (RXXXX.YYY) and then allows a selection of the records to be made. These can either be calibrated or uncalibrated. The flight summary provides the co-efficients to the calibration curve polynomials and these can be checked, if required, for obvious errors before FLIGHT calibrates the data.

The output of program FLIGHT is in a TRANS-compatible format. Titles and variable names are automatically read into the output file which is named TXXXX.YYY where XXXX is the number of the first record selected and YYY the number of records selected. A summary file SXXXX.YYY is also created. The summary file contains the flight title, and then it lists all channels, their name, units, maximum and minimum values and the calibration polynomial co-efficients. A record/event map for the records processed follows.

A typical sequence of computer commands required to produce a TRANS formated file of a selection of records is summarized below.

The file containing the raw data may be stored on another device at a lower sub-file directory level. This is useful if a large number of magnetic tapes are read and stored temporarily on a disc pack. The example below illustrates the use of program FLIGHT when obtaining calibrated data for twenty of the fifty records from the input file.

```
. RU FLIGHT
  FILE WAS NOT FOUND...
* R0151.050 $

  DO YOU WANT RAW(R) OR CALIBRATED(C) DATA IN THE 'TRANS' FILE? C
  DO YOU WANT ALL RECORDS 151 TO 200? N
  NOMINATE FIRST AND LAST RECORD NOS: 155,194
     STARTING TO PROCESS RECORD 155
     ...      ..   ...     ...  ...
     STARTING TO PROCESS RECORD 194
  O/P FILES S0155.040 AND T0155.040 CREATED
```

Appendix B contains the full teletype terminal dialogue obtained from running FLIGHT.

2.3 Plotting and Printing Data - TRANS

The program TRANS is a general purpose output program which can provide output by way of plots or columns of data. TRANS is documented in Reference 2, and a working knowledge is assumed. The output file from FLIGHT is used as the input file and all titles relevant to the particular file are stored by DATA statements in FLIGHT hence variable names, titles and units are automatically inserted.

2.3.1 Plotting File

A typical sequence of TRANS commands required to produce a plot file is summarized below.

Due to the TRANS requirement for an input file to be format AAAAA.DAT the TRANS input file produced by FLIGHT must be renamed as the extension is unacceptable.

```
.REN T0155.DAT = T0155.040
```

TRANS can now be run in the normal manner. The program is stored on system area PUB:

```
.RU PUB: TRANS
   I/P FILENAME = T0155

* PLS
  STRIP PLOTS:
  BLKS
  3,4,18,19,20
  21,24,25
  ++  (carriage return, line feed)
* GOE
** RUNNING
* EXIT  (or continue as in 2.3.2)
```

Output file TØ155.PLT is now available for plotting on the Calcomp plotter. An example of a plot is shown in figure 1.

2.3.2 Data File

Program TRANS has the facility to produce a data file made up of columns of selected variables. Heading information (e.g. variable name and block number) precedes the columns, or blocks, of data which are written for a set of 50 time intervals. The header information is repeated, then the next 50 time intervals of data and so on. This layout is suitable for perusal but impractical as input for another program. Program REFORM was written to reformat the data so that all blocks are listed across the page without any intervening information. The program allows up to 100 columns (blocks) with each block written using 1PE12.4 format.

An example of TRANS commands required to produce a data file are shown below. It would be normal to create the TXXXX.COL file before exiting from TRANS after having done strip plots. The example is therefore a continuation of the previous example.

```
* PRC
  PRINTING IN COLUMNS:
  BLKS
  1,2,3
  ++
  IS O/P TO TTY REQRD: N
* GOE
* EXIT
```

The output to this segment of TRANS is TØ155.COL. This file is then used as the input to REFORM. An example follows.

```
. RU REFORM
  FORØ1.DAT NOT FOUND ... ENTER NEW FILE
* TØ155.COL $
```

The output file is simply FORØ2.DAT and this contains the heading and uninterupted columns of data. The maximum number of columns is 100.

2.4 Packing and Unpacking Long Files

The program PACK reduces the storage space required after transferring magnetic tape data to disc. The number of blocks required is reduced by approximately 2/3 and the smaller files lead to a significant reduction in the overheads involved in transferring large disc files.

Program PACK strips the header blocks (title, units, calibration polynomial coefficients etc.) from the raw data file RXXXX.YYY and condenses the data by storing 3 channels per word in binary to form a file SQXXXX.YYY. XXXX and YYY have the same meaning as in section 2.1. The program HEADER reads the header block and stores the information in a separate file HEADER.DAT which is subsequently renamed HEADER.AAA where AAA represents the flight number. The HEADER.AAA file is the same for all groups of records from a particular flight hence it is stored only once.

The program UNPACK recreates the files in the original form RXXXX.YYY for use in program FLIGHT. Program UNPACK takes the packed data, unpacks it, then gets the header information and concatenates the two to reform RXXXX.YYY.

A typical sequence of computer commands required to pack and unpack a raw data file on disc is shown below. (See also Appendix B).

The header blocks for the particular flight are obtained first of all.

```
. RU HEADER
  % FILE WAS NOT FOUND ... ENTER NEW FILE SPECS.
* RØ151.Ø5Ø$
  HEADER FILE HEADER.DAT CREATED.
```

To identify header file for a particular flight rename it so as to indicate flight number e.g. Nomad Flight 31A.

```
. REN HEADER.31A = HEADER.DAT
```

The data is now packed

```
. RU PACK
    FORØ1. FILE WAS NOT FOUND ... ENTER NEW SPECS.
* RØ151.Ø5Ø $
  STARTING TO PROCESS RECORD 151
  ...      ..   ...     ...  .
  STARTING TO PROCESS RECORD 200
  CONDENSED RAW DATA FILE SQØ151.Ø5Ø CREATED.
```

The packed file SQØ151.Ø5Ø is 1129 blocks as compared to 3210 in the raw state (65% reduction). The packed file can now be stored on a disc pack in a sub-file e.g. [1020, 1240, NOMAD, SQ31A]. For ease of identification HEADER.31A is the first file stored and the groups of records follow.

The packed data file can be recreated if required for FLIGHT by running the program UNPACK. The input files are the packed data file and header file.

The program is simply run as shown below.

```
. RU UNPACK
  FOR01.DAT FILE WAS NOT FOUND ... ENTER NEW SPECS
* SQ0151.050 $
  HEADER.DAT FILE WAS NOT FOUND ... ENTER NEW SPECS
* HEADER.31A $
  RECORD NO. 151
  ...   ..  ...
  RECORD NO. 200
  RAW DATA FILE R0151.050 CREATED
```

Once the restored raw data has been used it can deleted to reduce storage, the condensed file still remains.

3. STORAGE AND CPU TIME REQUIREMENTS

The data tapes, due to their size, present problems in running and storage. The BATCH mode of operating is used when transferring whole tapes to disc, and these can be directly written on to a dedicated disc pack.

An example of the storage requirements is provided by Nomad Tape 3. Flight 31 on tape 3 is made up of 1346 records (i.e. 3365 seconds or 56 minutes) of data. The raw data when transferred to disc by way of a number of RXXXX.YYY files occupies 86,255 blocks. When packed the storage requirement is reduced by 65%, to 30,407 blocks. The packed files can be more readily transferred between devices and when required for FLIGHT, they can be easily unpacked.

When transferring tapes to disc it is best to copy the whole tape onto disc in blocks of 50 and then plot out several channels. The plots provide a means of identifying events suitable for analysis, unacceptable events (e.g. channel failures, aborted manoeuvres etc.) are easily eliminated. Once suitable events are found these small sections can be copies onto disc and stored, depending on size, in packed or unpacked form.

The next resource used extensively in copying tapes to disc is the CPU time. Examples of times have been collected and averaged on the PDP DECsystem-10. The following times are approximate and have been gathered over two years by way of BATCH and interactive on-line modes of running. Times are for processing 50 records (125 seconds) of data.

PROGRAM	TAPES	FLIGHT	PACK	HEADER	UNPACK
CPU (min:sec)	3:0	6:0	5:0	:03	4:0

Thus extrapolating for a flight tape of 1350 records the tape to disc CPU time via TAPES is approximately 1.4 hours. Running programs FLIGHT and TRANS more than quadruples the CPU time given that only half a dozen variables are plotted.

4. CONCLUDING REMARKS

This Technical Memorandum describes procedures developed for processing large amounts of flight data provided on magnetic tape via the ARDU AFTRAS. Some of the handling and computing time problems involved have been illustrated. The method employed in transferring all files to disc, calibrating the data, plotting, then selecting segments of interest for analysis appears to be the most satisfactory available. Running the suite of programs using BATCH mode overcomes many problems present in on-line day-time running such as mag-tape drive errors, need for dedicated disc packs and the limited CPU time available.

REFERENCES

1. Aircraft Flight Test Recording and Analysis System (AFTRAS). ARDU TN Gen 11, November 1977.

2. Nankivell, P.G. and Gilbert, N.E., A General Purpose Output Program for Use in Simulation. ARL/Aero Note 367, December 1976.

APPENDIX A

NOMAD AND MIRAGE TAPES

a. Nomad

Tape	Flight	Manoeuvre	Number of Records
1	21	Short Period Oscillations - aft C.G.	958
2	22	Short Period Oscillations - forward C.G.	914
3	31A	Dutch Roll Oscillations - forward C.G.	1346
4	31B	Dutch Roll Oscillations - forward C.G.	113
5	31C	Dutch Roll Oscillations - forward C.G.	*
6	32A	Dutch Roll Oscillations - aft C.G.	853
7	32B	Dutch Roll Oscillations - aft C.G.	425

* Tape 5 suffered from reading errors, only up to record 2 was successfully read.

b. Mirage

Tape	Flight	Manoeuvre	Number of Records
16	30	Roller Coaster	829
	32		*
19	39		*
	40		433
	41		521

* The Mirage tapes listed above are of interest in view of the flight dynamic manoeuvres recorded on the tapes. Other ARDU tapes are available but these, and flights 32 and 39 above are related to performance trials.

APPENDIX B

EXAMPLES OF DIALOGUES AT TELETYPE TERMINAL

Program TAPES

The first examples illustrate some of the types of errors that may be encountered in running the program TAPES. The tape is Mirage tape 19, hence the need to advance over the file marks.

```
.AS MTA1
MTA001 assigned

.R PIP

*MTA1:(M#2A)=
*^C

.RU TAPES


MAG-TAPE ON WHICH DRIVE? (0,1,2,3) : 1

%FRSDEV Parity error
Unit=1 MTA1:/ACCESS=SEQIN/MODE=IMAGE

Name   (Loc)     <<---  Caller  (Loc)    <#Args>  [Arg Types]
IOLST. (404264) <<---  IDF+4(25624)     <#0>     []
IDF    (25620)  <<---  MAIN.+7(24034)   <#0>     []

? Job aborted

END OF EXECUTION
CPU TIME: 0.34  ELAPSED TIME: 34.04
EXIT

.
```

```
.RU TAPES


MAG-TAPE ON WHICH DRIVE? (0,1,2,3) : 1

MAG-TAPE NOT POSITIONED CORRECTLY, OR DATA IS NOT FLIGHT DATA
STOP

END OF EXECUTION
CPU TIME: 1.22  ELAPSED TIME: 12.60
EXIT

.



.RU TAPES


MAG-TAPE ON WHICH DRIVE? (0,1,2,3) : 1
ABOUT TO PROCESS FLIGHT  39
DO YOU WISH TO PROCESS ANY CHANNEL READINGS? (Y OR N) : Y
START PROCESSING AT RECORD NO.? (1,2,...) : 1
PROCESS HOW MANY RECORDS? : 15

ABOUT TO READ FILE 2

ABOUT TO READ FILE 3
%FRSDEV Device error
Unit=1 MTA1:/ACCESS=SEQIN/MODE=IMAGE

Name    (Loc)     <<---  Caller  (Loc)     <#Args>  [Arg Types]
IOLST.  (404264)  <<---  CHANNS+4(24271)   <#0>     []
CHANNS  (24265)   <<---  MAIN.+31(24056)   <#0>     []

? Job aborted


END OF EXECUTION
CPU TIME: 6.58  ELAPSED TIME: 56.66
EXIT

.
```

A successful run is shown below. In this case the tape is advanced six spaces so as to position the tape at the beginning of Flight 41.

```
.REW MTA1

.R PIP

*MTA1:(M#6A)
*^C

.RU TAPES


MAG-TAPE ON WHICH DRIVE? (0,1,2,3) : 1
ABOUT TO PROCESS FLIGHT  41
DO YOU WISH TO PROCESS ANY CHANNEL READINGS? (Y OR N) : Y
START PROCESSING AT RECORD NO.? (1,2,...) : 483
PROCESS HOW MANY RECORDS? : 10

ABOUT TO READ FILE 2

ABOUT TO READ FILE 3
   10 RECORDS PROCESSED
   10 RECORDS PROCESSED

O-P FILE 'R0483.010' CREATED ON DISK

END OF EXECUTION
CPU TIME: 48.38 ELAPSED TIME: 12:53.60
EXIT

.
```

The following example illustrates the use of program TAPES to extract a summary only of all records on a flight tape.

```
.RU TAPES


MAG-TAPE ON WHICH DRIVE? (0,1,2,3) : 1
ABOUT TO PROCESS FLIGHT  40
DO YOU WISH TO PROCESS ANY CHANNEL READINGS? (Y OR N) : N

ABOUT TO READ FILE 2

ABOUT TO READ FILE 3
   10 RECORDS PROCESSED
   20 RECORDS PROCESSED
   30 RECORDS PROCESSED
   40 RECORDS PROCESSED
   50 RECORDS PROCESSED
   60 RECORDS PROCESSED
   70 RECORDS PROCESSED
   80 RECORDS PROCESSED
   90 RECORDS PROCESSED
  100 RECORDS PROCESSED
   "    "         "
   "    "         "
   "    "         "
  280 RECORDS PROCESSED
  290 RECORDS PROCESSED
  300 RECORDS PROCESSED
  310 RECORDS PROCESSED
  320 RECORDS PROCESSED
  330 RECORDS PROCESSED
  340 RECORDS PROCESSED
  350 RECORDS PROCESSED
  360 RECORDS PROCESSED
  370 RECORDS PROCESSED
  380 RECORDS PROCESSED
  390 RECORDS PROCESSED
  400 RECORDS PROCESSED
  410 RECORDS PROCESSED
  420 RECORDS PROCESSED
  430 RECORDS PROCESSED

EOF ON I-P MAG-TAPE
  433 RECORDS PROCESSED

O-P FILE 'FLT040.SUM' CREATED ON DISK

END OF EXECUTION
CPU TIME: 17.12  ELAPSED TIME: 2:32.04
EXIT

.
```

Program FLIGHT

Program FLIGHT is now run and in this example all records on the raw data disc file are calibrated and output on a file in TRANS format.

```
.RU FLIGHT


%FRSOPN File was not found
Unit=1 DSK:FOR01.DAT/ACCESS=SEQIN/MODE=ASCII

Enter new file specs. End with an $(ALT)
*R0483.010$

DO YOU WANT RAW(R) OR CALIBRATED(C) DATA IN THE 'TRANS' FILE? C

DO YOU WANT ALL RECORDS 483 TO 492? Y

STARTING TO PROCESS RECORD  483
STARTING TO PROCESS RECORD  484
STARTING TO PROCESS RECORD  485
STARTING TO PROCESS RECORD  486
STARTING TO PROCESS RECORD  487
STARTING TO PROCESS RECORD  488
STARTING TO PROCESS RECORD  489
STARTING TO PROCESS RECORD  490
STARTING TO PROCESS RECORD  491
STARTING TO PROCESS RECORD  492
O/P FILES  S0483.010 AND T0483.010 CREATED

END OF EXECUTION
CPU TIME: 1:26.47  ELAPSED TIME: 5:7.92
EXIT

.
```

Programs HEADER and PACK

The header file is stripped from the raw data file and then renamed to identify header file with particular flight number.

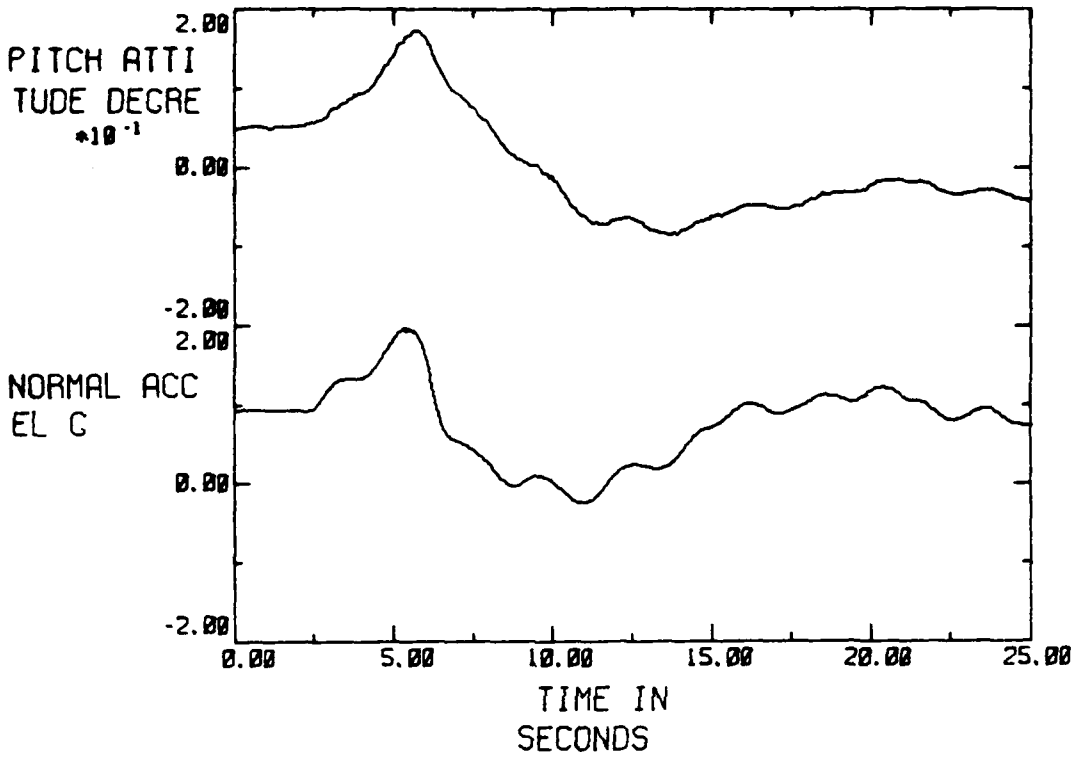
The raw data file is then packed.

```
.RU HEADER


%FRSOPN File was not found
Unit=1 DSK:FOR01.DAT/ACCESS=SEQIN/MODE=ASCII

Enter new file specs. End with an $(ALT)
*R0483.010$

HEADER FILE HEADER.DAT CREATED

END OF EXECUTION
CPU TIME: 4.71  ELAPSED TIME: 36.86

.REN HEADER.41=HEADER.DAT
Files renamed:
DSKC:HEADER.DAT



.RU PACK


%FRSOPN FIle was not found
Unit=1 DSK:FOR01.DAT/ACCESS=SEQIN/MODE=ASCII

Enter new file specs. End with an $(ALT)
*R0483.010$

STARTING TO PROCESS RECORD  483
STARTING TO PROCESS RECORD  484
STARTING TO PROCESS RECORD  485
STARTING TO PROCESS RECORD  486
STARTING TO PROCESS RECORD  487
STARTING TO PROCESS RECORD  488
STARTING TO PROCESS RECORD  489
STARTING TO PROCESS RECORD  490
STARTING TO PROCESS RECORD  491
STARTING TO PROCESS RECORD  492
CONDENSED RAW DATA FILE SQ0483.010 CREATED

END OF EXECUTION
CPU TIME: 1:3.35  ELAPSED TIME: 8:57.66
EXIT
```

Program UNPACK

The packed data file if required for input to FLIGHT must be unpacked. This example illustrates the use of program UNPACK.

```
.RU UNPACK


%FRSOPN File was not found
Unit=1 DSK:FOR01.DAT/ACCESS=SEQIN/MODE=ASCII

Enter new file specs. End with an $(ALT)
*SQ0483.010$

%FRSOPN File was not found
Unit=2 DSK:HEADER.DAT/ACCESS=SEQIN/MODE=ASCII

Enter new file specs. End with an $(ALT)
*HEADER.41$

RECORD NO. 483
RECORD NO. 484
RECORD NO. 485
RECORD NO. 486
RECORD NO. 487
RECORD NO. 488
RECORD NO. 489
RECORD NO. 490
RECORD NO. 491
RECORD NO. 492
RAW DATA FILE  R0483.010 CREATED

END OF EXECUTION
CPU TIME: 59.45  ELAPSED TIME: 6:42.60
EXIT

.
```



TS1657 FLIGHT NO: 41 DATE: 25OCT79 ARDU EDN *R 483- 492

T: STEADY TURNS.WIND UP LIFT BOUNDARY TURNS. 000

FIG.1 EXAMPLE OF PLOTS OBTAINED via TRANS

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14. Descriptors	15. COSATI Group
Flight tests Manuals Data reduction Data processing Mirage III-O aircraft Nomad aircraft	0104 0902

16. Abstract

The procedures required to read and process seven-track copies of dynamic flight test data tapes recorded by ARDU using AFTRAS are described. The programs were developed by the Aircraft Behaviour Studies - Fixed Wing group to prepare the data for subsequent detailed analysis on the ARL DEC system-10 (1070). The programs described transfer raw data from tape to disc, process the raw data, provide plots or data tables and reformat the data for input into other programs.

Problems in handling and storing the large files are discussed and programs for packing the data for storage and unpacking for later use, are also described.

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This page is to be used to record information which is required by the Establishment for its own use but which will not be added to the DISTIS data base unless specifically requested.

16. Abstract *(Contd)*

17. Imprint

Aeronautical Research Laboratories, Melbourne.

18. Document Series and Number	19. Cost Code	20. Type of Report and Period Covered
Aerodynamics Technical Memorandum 348	52 7770	

21. Computer Programs Used

TAPES
FLIGHT
PACK
HEADER
UNPACK
REFORM

(all Fortran)

22. Establishment File Ref(s)

END

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