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Transition Documentation on a Three-Element High-Lift Configuration at High Reynolds Numbers—Database

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Contents

Summary

The present report details how the hot-film and related pressure data are organized for the hot-film test in the Low Turbulence Pressure Tunnel, NASA Langley Research Center, August 1996. Data processing codes to access the data in an efficient and reliable manner are described, and limited examples are given on how to access the database and store acquired information.

1. Database Guidelines

The database contains information obtained as part of the High Lift Flow Physics Experiment I, in the Low Turbulence Pressure Tunnel (LTPT), NASA Langley Research Center in Hampton, Virginia, in August 1996. In the project, the objective was to document physical properties of importance to the performance of a two-dimensional high-lift configuration. The emphasis was on code validation rather than configuration optimization. The experiment concerned pressure distributions and transition locations (both discussed here) to support the use of Reynolds stress measurements. In NASA's nomenclature, it is denoted LTPT Test 397. McDonnell Aircraft (MDA) uses the notation LB546k.

Two accompanying Contractor Reports exist: a user's manual for the data acquisition system [1,2] and a report with analysis of the data [3].

The information in the complete database is split into two main parts:

Pressure Database

The pressure database contains all pressures and reference conditions measured during the experiment. The database is, in the present ASCII format, roughly 10 MB in size. The present document only includes the pressure information deemed necessary to assess the transition interpretation, and in the rest of this document the term database will generally refer to the hot-film database.

Hot-Film Database

The hot-film database contains the output from surface hot films used in the transition documentation part of the experiment. The database consists of raw binary hot-film data, along with processed ASCII data. As described later, the "raw" hot-film data are bulky, approximately 18 GB, as compared to the pressure database of 10 MB.

For practical purposes, it is useful to process the binary data to a level where essential statistical information has been processed and is available in ASCII files. A typical 60-MB binary data file is thus reduced to a 200-250 kB ASCII file containing the most essential information. The present database is comprised of the reduced ASCII files.

A set of computer codes (see Section 2.0) are available to access the binary data and generate the ASCII files. Additionally, documents describing the data, codes, and characteristics are available.

The following guidelines have been followed:

- All binary data are available as recorded and are organized according to the chronology of data acquisition.

- The database and the access codes are provided with information to guide the user through the setup conditions that use default values and checks of the input. By allowing the user to override the default values, a means of checking for errors or inaccuracies in the database is provided.

- The codes operating on the primary (binary) data
    a. are capable (exercising options) of adjusting the time tagging of the data to make interpretation and sorting easier.
    b. are NOT capable of adjusting or changing or deleting any data; any correction is performed in the MERGE code or later.

- The output files include information allowing the user to identify exactly what data was used (through record name) and to what extent (data set and number of samples).

- The codes, in many cases, allow the creation of user-induced correlations, time-shifts, and so on, which are not considered part of the primary data and are not saved for use with any subsequent code.

2. Database Organization

Figure 1 shows the organization of the ASCII database available on CD. Each rectangle is a folder. The nine codes are grouped in one folder. They are executables on a Macintosh, written in FutureBasic. The PROCESSING code provides an overview of how the codes work together. The EXABYTEREAD code was used to read the 18 GB of binary data and output the statistical properties in an ASCII format, the files in the HL.HF.ascii database folder. The code PRESSUREREAD processed the raw pressure data and produced the files in the folder HL.PR.ascsif database. The code MERGE created distributions of pressure coefficients and hot-film statistics found in the merged database. The 2 files in HF.Transition were created manually and are interpretation of the data.

The folder, HF.Codes, contains all access codes:

CONVECT	Used to process output crosscorrelation data from EXABYTEREAD. Contains information on sensor locations and produces an output file that allows plotting of correlation data.
DANTEC	Simulator for the hot-film anemometry bridge.
EXABYTEREAD	Used to process and examine binary hot film data.
HOOKUP	Simulator for the hot-film hookup used in the experiment.

LOGBOOK	A “micro” search engine to locate data with desired reference conditions and identify data sets. Contains information on the hot-film test and the subsequent test with clean model.
MERGE	Used to merge ASCII pressure data from PRESSUREREAD and ASCII hot-film data from EXABYTEREAD.
PRESSUREREAD	Used to read ASCII SIF files of pressure data and process it for input into MERGE. Also creates LOADS data files.
PROCESSING	Code to be used as a Readme for the database; identifies codes and their input/output files.
WAKEREAD	Used to read ASCII SIF files of wake data obtained during the hot-film experiment.

The following folders contain data from the experiment:

HF.dragsif.database	Contains data from wake rake traverses. Filename: **r0**<Polar>**0**<Point>**.dat**, e.g. r0070051.dat Format: ASCII SIF.
HF.drag.database	Contains wake data processed using WAKEREAD Filename: **HF.DRAG** (<Point>**)a**=<Alpha>**.**<Config>**.**<Mach>**,**<Re> e.g. HF.DRAG(53)a=12.30P30N.0.2,9 Format: Tab-delimited ASCII text.
HF.HF.ascii.database	Contains processed (using EXABYTEREAD) hot-film data corresponding to the pressure data in the Points. The data are organized in 11 folders, corresponding to combinations of Configuration, Mach number, and Reynolds number used as input for MERGE. Format: Comma-delimited ASCII text.
HF.PR.ascsif.database	Contains the pressure data to be processed with PRESSUREREAD. Filenames **asc**<Run>. Format: ASCII SIF.
HF.merged.database	Contains time-averaged, merged hot-film and pressure data for plotting of distributions on the three elements. These files are the main sources of information suitable for transition analysis. Format: Tab-delimited, spreadsheet ASCII text.
HF.Transition.data	Contains interpreted flow features/transition locations for the most important test cases. Format: Tab-delimited, spreadsheet ASCII text.

RE.PR.ascsif.database Contains pressure files from runs when the Reynolds stress measurements were done. Covers run subsequent to the contents of the HF.PR.ascsif.database.

Format: ASCII SIF.

The following sections contain a description of the hot-film data organization, in raw binary form and processed statistical properties. Figure 2 illustrates the files, buffers, records and data sets, and explains how they are related.

2.1 File Convention

The hot-film data were acquired by using two EXABYTE tape drives running simultaneously, recording data from System A and System B. The records are organized as described in the MCARS User's manual [2]; only limited information is given here, and it is assumed that some of the nomenclature and definitions are known.

The files are created when the data are read from the EXABYTE tapes (see Section 5). For practical purposes, they are most often 60 MB in size, containing 30 complete buffers, or 480 records. The records in the files are numbered, starting with m=1 and normally having m=480 as the last record. Due to the procedure for reading the EXABYTE tape, the files normally start with the beginning of a buffer.

The content of tape A has 7 channels of hot-film signals and an eighth channel containing the embedded time code. Tape B contains recorded signals from 7 additional channels of hot-film signals from System B, along with information on the banks (groups of channels) run on systems A and B, respectively.

Each record is 131,072 bytes long. The first 512 bytes are the header used to provide identification and reference information such as zero-offsets [1]. However, even though the header is somewhat different in each record, part of the information is only updated every buffer (8 records), and since the information is generated on the Sun workstation, it does not always reflect the true status of the hot-film system. Thus, reliable interpretation of data is most conveniently done after merging the files from the two systems so that header and embedded bank and time information have been verified.

2.2 RECORD Convention

Each record in the database has its unique name, which is recorded along with the statistical output from the codes. It is possible at any stage to revalidate or enhance the data. Typically, this means that the same record can be reanalyzed using more recent techniques if the need arises.

The convention is as follows:

Since System A and System B files are separate, the record name applies to both:

<Date><file letter><record number in file.

For example 5c039 or 5c39 was recorded on August 5 and can be found in the file 5_.hfc (System A or B) and is record 39 in that file.

Each record is 131,072 bytes long (1024 points over 20 msec, 20-msec nonsampling and then another sampling period, etc.). Total time to sample one record is (20+20)* 8 msec = 320 msec.

2.3 BUFFER Convention

The data acquisition system has 2 buffers, each 1 MB in size that accommodates 8 records of 131,072 bytes each. The data in a buffer are sampled over a time period of 8 * 320 msec=2.56 sec to sample. While one buffer is being read, the other is being filled, and vice versa. It takes approximately 4 seconds to write a buffer to tape; hence, a “quiet” period of 1.4 - 1.5 sec exists while the last portion of the buffer is being stored, but no sampling is done. This process (along with the number of records per buffer) is easily observed through the on-line display of time when running the EXABYTEREAD code.

Note that in the header of each buffer, the (Sun) time is only updated every 8 seconds (approximately), that is, every 16 records (i.e. every second buffer). The bank information is updated every buffer, and the Sun record number is updated every record, except when the Sun record number is a multiple of 255, as described in Section 5.4.

2.4 DATA SET Convention

The record has 8 data sets, the (first 7 containing 1024 values, and the 8th containing 992 samples) continuously sampled simultaneously across all 7 channels. The notation in the EXABYTEREAD code for the data sets within a record is iss=1 to 8.

2.5 BANK Convention

To allow a large number of sensors to be used by the anemometry system, there is a switching capability that allows both power and signals to be switched in groups, or banks, of 7. With 7 banks of sensors, each of the Systems, A and B, can handle a total of 49 sensors, 7 at a time. Figure 3 illustrates how the data associated with the hot-film measurements can be retrieved and will be discussed in the section on accessing data.

2.6 POINT Convention

A Point is data associated with one wind tunnel condition; that is one configuration, one Reynolds number, one Mach number and one angle of attack. Pressure data were taken with the MODCOMP system once each Point.

2.7 RUN Convention

A Run is data taken during a sequence of angles of attack. The Run number will be the same for all Point numbers in the sequence. A Run corresponds to one configuration, one Reynolds number, and one Mach number. The sequence of angles of attack is referred to as a Polar. The ASCII SIF files in the database are organized by Run number.

3. Experiment Information

This section contains the most essential information regarding the experiment and setup. For a thorough discussion of experimental features, consult the Analysis report and the User's manual for the codes and the anemometry system.

3.1 Coordinate Systems

All coordinates tabulated and discussed in the database are nested, that is, cruise condition. All lengths in the tables are given nondimensionalized by the cruise-condition chord, 22 in. (except spanwise information, which is nondimensionalized by the 36-inch span of the wind tunnel).

The coordinate system is left-handed Cartesian, with the longitudinal coordinates having x/c=0 at the leading edge of the slat, y/c normal to the chordwise line, positive on the suction side. Although the Cartesian system is convenient for plotting, it is not necessarily the most physically correct.

A coordinate system, along the physical surface of each element, s/c, is used:

s/c=0 for y/c=0.

s/c is positive on the upper (suction) side of each element.

3.2 Rigging

Rigging is defined as translation and rotation of the leading (slat) and trailing (flap) elements from the nested (cruise) configuration. The three configurations used in the present experiment were designated by configuration names and defined as follows (see fig. 4):

Configuration	30P/30N	30P/30AD	30N/35T
Slat Gap [%]	2.95	2.95	2.95
Slat Overhang [%]	-2.5	-2.5	-2.5
Slat Angle [deg]	30.0	30.0	30.0
Flap Gap [%]	1.27	1.5	0.95
Flap Overhang [%]	0.25	0.25	0
Flap Angle [%]	30.0	30.0	35.0
Point	1 - 244 and 420 or higher	245 - 355	356 - 417

3.3 Run Procedure

This section contains important characteristics of the procedure used in the runs. Typically, the runs were performed as polars, that is, they maintained tunnel static pressure and Mach number and took data at a number of fixed angle-of-attack settings. Figure 5 shows a typical procedure covering runs 7 through 9.

- The tunnel was pressurized to the desired pressure to attain the prescribed Reynolds number.
- Zeros were taken before and/or after the runs and at the static pressure typical of the run to obtain the proper zero-flow heat loss for the desired Reynolds number.

- The desired connector set (1, 2, or 3) was hooked up, and the anemometry system was switched on.
- The tunnel was started and stabilized at the desired Mach number and Reynolds number. The spanwise pressure distribution was monitored and sidewall suction was adjusted to make the spanwise pressure distribution as uniform as possible. Note that for angles of attack above 16 degrees, no additional adjustment to the sidewall suction was applied.
- When the prescribed tunnel conditions were attained, hot-film data acquisition was initiated and pressure data (a Point) was taken with the MODCOMP system, which meant staying at hot-film bank settings for 15 seconds at a time and selecting the combinations of banks for Systems A and B, respectively:
- 1-1 (System A on bank 1 and System B on bank 1), 2-2, 3-3, 4-4, 5-5, 6-6, and 7-7. Thus, each POINT of pressure corresponds to roughly 90 seconds of hot-film data. The 15 seconds acquisition time for each combination provided at least two full buffers, usually three.
- The angle of attack would then be changed, and the next POINT in the same POLAR was acquired.

In the initial part of a test, there was concern that it might not be possible to repeat angle of attack accurately to overlay the data for the three-connector sets. To investigate, a few points were taken where the connector sets were changed doing a run. The results of these tests indicated that the repeatability of the angle of attack was fully adequate, and the polars were done one per connector set in the main portion of the experiment.

In the very last part of the experiment, the hot-film sheets were stripped off the model, and "clean" pressure runs were performed. Results can be found in the pressure database since it includes this part of the test.

In many of the runs, wake rake data were taken, and the holder for the Reynolds stress probe was positioned close to the model to determine probe interference. This interference has been noted in the LOGBOOK code but has not been used to exclude any of the data.

4. Database

By running the PROCESSING code and the stand-alone codes DANTEC, which simulates the hot-film anemometry bridges, and HOOKUP, which simulates the hookup arrangement used in the remainder of the anemometry system, an overview of the organization of the database is obtained.

The purpose of the database is to make the original data from the experiment available to the user and allow re-examination of processed data. Re-examination is done through the use of three main codes: LOGBOOK, PRESSUREREAD, and EXABYTEREAD.

The assumed entry point is the user's interest in a specific configuration and an approach to analyze data at a specific Reynolds number and Mach number.

To determine which data sets to examine, it is convenient to use the LOGBOOK code, in which the parts of the database used via the PRESSUREREAD and EXABYTEREAD codes are given.

4.1 Database Set-Up Procedure

The following procedure was used to prepare the database:

- The binary files were created from the Exabyte tapes. These files contain all the available data, valid and invalid.
- A version of the EXABYTEREAD code was used to generate tab-delimited statistical data, including embedded time for the system A files and the bank information from the system B files.
- The database hard-wired in the LOGBOOK code contains the elements required to relate (or hookup) the configuration and tunnel condition selection to the actual pressure and hot-film data. The next items describe the procedure followed to create the "hooks":

1. The manual logbook containing the date, polar and point number, as well as Reynolds number, Mach number, and angle of attack was entered. Comments regarding the test were included where applicable.
2. The PRESSUREREAD code was used to create the relation between Point number and MODCOMP Timecode.
3. The hot-film system operator's logbook provided the start and stop time for the anemometer system appropriate for the Modcomp times and the Point definitions. In addition, entries were made to cover data taken when no pressure data were recorded, such as the zero-flow conditions taken at least once per day. The connector set that was used and the hookup sensor arrangement that was used were also entered into the database.
4. It was found that the only reliable means of providing a unique, contiguous numbering system for the hot-film data was to use the date, file sequence, and record number because

- The Sun record number reset at least once during the experiment, and it was found that the Sun record number repeated once every 256 records.
- The embedded time was not always available and accurate due to the D/A and A/D (Digital-to-Analog and Analog-to-Digital) conversions.
- The header time was off by more than 2 minutes.

4.2 Database Record Numbering System

The numbering system to identify a record is as follows:
<date><system><file><record>
<1 or 2 numbers> <a or b> <a through t> <1 through 480 or more>

The numbering system may be used to identify the actual data point:
<date> <system> <file> <record>.<data set> <sample>
<1 or 2 numbers> <a or b> <a through t> <1 through 480 or more> <1 through 8> <1 through 1024>

Example:

7b219 means data taken on August 7, being a part of the second data file (b) with record number 219. Through use of references like this in the final result files, it is possible to relate the output data to the original data.

7b219.40997 means data set number 4, sample number 997.

4.3 Database Organization Procedure

The entire database was examined, and the first and last records associated with a certain test point were identified. As mentioned in Section 2.1, the hot-film data were read from the tapes in blocks of 60 MB, irrespective of the experimental conditions, which meant, in some cases, that the hot-film data associated with a pressure point may start in one file and end in the next. The EXABYTEREAD code handles this, allowing data from different input binary files to be "patched" together again.

The criteria used for organizing the database were:

- Positive identification of the embedded time. If the embedded time was not determined (for whatever reason, the output showed zeros); the break point in some cases could be identified by examining the voltages, which would demonstrate a step change at a time break. This identification was used as the initial identification of Points.

- The next step was to use the b-files and revise the Point-association based on the header time. Although not up-to-date like the embedded time, it could be assumed that records with the same time in the header were part of the same buffer; that is, it was possible to use this criterion as a better verification of data sorting than the embedded time. The appropriate time shift determined for the experiment has been introduced in the code.

- The database resides on CDs with copies available on 1 GB Jaz-drive cartridges used with a Macintosh computer.

The following rules are used for the organization of the database:

- Each Jaz-cartridge contains binary data files up to 960 MB; it is important to be able to add tools and work without moving the files from the cartridge.

- The data are sorted by day, and the Jaz cartridges are sorted sequentially/chronologically for each day; each holds up to 960 MB of binary data:

  Jaz-1 System A files a through p (Up to 16 binary files)

  Jaz-2 System B files a through p (Up to 16 binary files)

  Jaz-3 System A files q through t (Up to 4 binary files)

  Jaz-4 System B files q through t (Up to 4 binary files)

If Jaz-3 contains less than 450 MB of data, Jaz-4 is included in Jaz-3.

Example:

7a.hfq where <date> <System> .hf <sequence>

On August 7, one Exabyte tape was made that contained data from each of the two systems, A and B. The file in question is the 17th file from System A. The q file will be on Jaz-3 since it is the A system.

In addition to the binary data, each cartridge contains:

- an ASCII *STAT* file (tab-delimited) with the header time and information on the data
- an ASCII *volts* file (tab-delimited) with the embedded time as well as time-averaged voltages and standard deviations for all channels
- an *errors & warnings* file which includes all comments on the data quality
- an executable version of the EXABYTEREAD code that was used to create the ASCII files

The names of the ASCII files correspond to the letter name of the binary file with one exception: the t file. Since the size of this binary file varies widely, up to several hundred MB, the corresponding ASCII file is broken up into several pieces, each except the last one being 480 records long, so that the resulting file is of reasonable size for most spreadsheets.

Note that these files were created by using (*kmax*=) 1024 samples from the first data set (*iss*=1) of each record; that is, the DC voltage and standard deviation should be quite accurate, while both skewness and flatness should be close to "final" value, obtained if all samples were used. The files contain enough data to make an assessment of the functionality of the system possible.

5. EXABYTE File Specifics

The file structure is unchanged from what was used in the NASA TSRV 737 High Lift Flight experiment [2]. Sampling rate, filters, gains, and data acquisition procedures are exactly the same. The only difference in the flight and the present LTPT experiment was the method of data acquisition. In the LTPT experiment, acquisition was halted between each pressure point where the flight experiment used continuous recording. In the LTPT experiment, it was necessary to manually note the sensor arrangement number (1=standard; 2=cove) and the connector set that was chosen (1, 2, or 3).

In reality, the system has more flexibility than used because any of the 12 connectors could be combined in any setup [1]. This utility was never used in the experiment, but the HOOKUP code contains the feature and illustrates how it can work.

The following sections describe some of the file parameters. The section on the EXABYTEREAD contains more details regarding the processing of each of the parameters.

5.1 Header Time

Header time is the computer time of the Sun workstation. In the current test, it was approximately 2 minutes different from the time-code-generated (embedded) time, which is adjusted as mentioned next. The number in the header is in seconds (since January 1, 1970).

The time code generator provides the day of the year, but not the year; therefore, proper interpretation of the header time requires the code to know what year it is. Specifying the year is accomplished by using the filename convention. As described under EXABYTEREAD, the code checks the filename and determines which experiment the data are from.

5.2 Embedded Time

Embedded time is the accurate time-code-generated time included as channel 8 on System A. Note that it contains the day (unlike the time code information passed via the MODCOMP, in which the day had to be omitted for transfer reasons) and time needed to have 10 msec accuracy. However, as will be discussed in Section 7.2, the embedded time code is not perfect because it includes a D/A conversion, analog amplification, and subsequent A/D conversion (as well as the complicating fact that there was no strobe on the system).

5.3 Time Correlation

The time used for the correlation with pressure data was the time-code-generated, Greenwich Mean Time, GMT (Zulu) time, which was fed into both the anemometer system and the MODCOMP computer. Since the header time in the files is the Sun time and there is a 2 minute difference, EXABYTEREAD has an option to adjust the time read before it is displayed, which brings the displayed header time into agreement with the embedded start time of a buffer to within 2 seconds.

Based on the System A records 5a2-66, 13a16-160, and 21q16-112 (see definition of record names), the difference was 138 seconds on August 5, 147 seconds on August 13, and 153 seconds on August 21. If the time adjustment option is invoked in EXABYTEREAD, the time is shifted 133 + <Date> seconds; that is, 138 seconds on August 5, 146 seconds on August 13, and 154 seconds on August 21.

Time delay from the start of the last record in a buffer to the start of the subsequent first record of the next buffer was confirmed to be within 1.70 to 1.75 seconds for the records listed.

The pressure files contain two time indications, both presumably taken at the time when the pressure data have been averaged. One is the embedded time (day not included), and the other is the MODCOMP computer's own time tag, usually put on all SIF files. This time is local time, which in August is 4 hours behind GMT.

Examination of the data for August 5,13, and 21 shows that in addition to the 4-hr difference, the MODCOMP is 440 seconds behind the Embedded GMT. Thus, for data points where the pressure file did not provide the embedded time, or in the last part of the test when the embedded time was not recorded (since the hot-film system was no longer hooked up), the GMT can be estimated from the MODCOMP time (to within 10 seconds) adding 4 hours, 7 minutes, 20 seconds.

5.4 Sun Record Number

The Sun Record number, which is generated in the data acquisition code on the Sun, provides a means of finding data. It starts from 1 at the beginning of the tape (or at reboot) and runs consecutively throughout the recording. It is contained in the header and is the only reliable way of synchronizing the data as far as records are concerned. It has one flaw: every 255 records it does not update, and there will be two records with identical Sun record number but as is clearly evident, different data.

6. TAPE READ on Sun

The existing database was generated through direct reading of the Exabyte tapes by using the TR96 code on the Sun. For various reasons, it was not possible to read the data in a uniform manner, and some of the peculiarities are described below.

The TR96 code assumes that the data on the tape have been recorded in 1996. It reads the header time, which is given as seconds from January 1, 1970 and subtracts the number of seconds from then until January 1, 1996 to make the time compatible with the embedded time.

The code is set up to read a number of specific start and stop times to be used for data analysis. These are normally generated in PCFILE, and the input to the TR96 code is a text string, which is interpreted as time by the code. Up to 20 time segments can be specified.

In the 737 flight tests, the Exabyte tape was left on at all times, and there would therefore be large portions of the tape unread since only specific flight conditions were of interest. In the LTPT experiment the tape was paused between recordings (generally 2 minutes or less; ideally, 7 banks at 15 seconds each).

The user inputs a file name to run the TR96 code. The nomenclature chosen for the current experiment was as follows:

<day><system>.hf<sequence letter>

<day>	Date of the measurements; 8 means August 8, 1996 and so on
<system>	a for System A and b for System B
.hf	Means the binary file contains hot-film data
<sequence letter>	assigned to distinguish each time element

6.1 File Names

The code has letters a-t; that is, 20 files can be generated. If more time segments are specified, the codes jump past the next set of records and will put all remaining requested time into one big file named

<day><system>.hf<blank>

6.2 Data Rate

The code assumes that data are generated at a rate of 16 records in 6 seconds. This rate may (or may not) have been true for the 737 experiment. It was found that the value for the LTPT experiment is closer to 10.5 records in 6 seconds. The code determines the desired reading length in number of records by taking the end time minus the start time, computing the number of seconds, assuming 16 records in 6 seconds, and reading the estimated desired number of records without actually checking the end time. This feature creates a problem for analysis of the present experiment.

6.3 Sun Record Number

As mentioned above, the numbers 255, 510, and so on are repeated, and this repetition is thus not an easy way of selecting data. However, correlating System A and System B results is no problem since the pattern is consistent.

Note that when the TR96 code runs, it displays, for example, "131,072 bytes read from record 480." In reality it does not read the Sun record number; it gives the sequence record it has encountered. The Sun record number is not always unique on a tape since it is occasionally reset.

6.4 Tape Drive Oddities

When reading on other tape drives with different compression schemes, odd results can appear. For example, in one instance the drive pulled off 65,536 bytes per record, and instead of 480 records only 240 were read.

Another oddity was observed when a 4-byte record was read along with the 65,536 bytes. This problem can be handled through use of the sync word FAF3 to shift the pointer to the correct start of the records. At most, 1 record of data is lost.

6.5 Start Time

The code uses the header time to select data. It translates the desired time into seconds and reads the beginning of the header every record until the desired time is smaller than the time found. Since the header updates every buffer, normal procedure in the Boeing 737 test was to select a time 8 seconds before the desired start time to make sure the desired time was actually part of the extracted data.

In the present test, the Sun time and the embedded time, used as correlation with the pressure data, were off by 2 minutes, making it difficult to create individual files. Also, the length was critical, a time that is a little too short would mean losing data on bank 7 (usually); a time a little too long would mean reading into the next time segment.

7. Database Generation and Validation

7.1 Sun-Extraction of the Data Files

Instead of modifying the code and verifying that the modifications were working, the database was generated by running the TR96 code using artificial entries, the goal being to pull off ALL data EXACTLY as recorded; that is, no skipped records or records read twice.

This goal was accomplished through the following means:

- The first time given in the PC file was at least one day too early; therefore, TR96 begins reading from the start of the tape.
- Each time segment was chosen to be 3 minutes (up to and including the 19th, corresponding to files a through s). This segment would provide roughly 5 minutes of data or, more accurately, 480 records since 3 [minutes] * 60 [seconds] * 16/6 [rec/sec] = 480 [rec].

- Each subsequent start time is equal to the previous element stop time—in reality the only matter of importance is the 3-minute length.
- The 19 first time elements provide 9120 records (although the last Sun record number included (found in the s file) is 9085 due to the 35 Sun record number repeats), and the length of the t file in minutes is set up long enough to capture the rest of the tape. For most cases that means 30 minutes, which accommodates another 4800 records. The file can get bulky, but since EXABYTEREAD reads the file with random access, the limitation only plays any role for transferring or handling the files. It is more cumbersome to read from a CD one file of 600 MB than a couple of 60 MB files.

7.2 Comparing Header Time and Embedded Time

The embedded time is the correct time to use when merging with the pressure data. However, since it is not easily accessible in the binary file and because there are tolerance problems, it is necessary to define the data blocks by using a combination of the header time and the embedded time to make sure the interpreted embedded time is correct.

The correction of header time involves the following steps:

Step 1. The start and end of the buffer is identified as the time span from the change in header time to the next change. In examining the data, it is clear that neither time nor bank indication will change within a buffer, and to recover a buffer at a time is the natural entity. Buffer length should be 16 records.

Step 2. The time increment from the previous buffer is determined. If it is considerably more than 8 seconds, it is assumed that there has been a pause in recording.

Step 3. The time line for the embedded time is examined for zeros (time synchronization not possible) and reversals (time code indicating decrease in time). These features are not uncommon because the embedded time, in reality, is a digital signal converted to analog, subject to electronic noise and voltage mean drift and thereafter digitized again. Some days the recorded time code was more noisy than others and the deviations could be found both in hours, minutes, and seconds. (The values come as subsequent samples and hence any of them can be subject to the noise.)

Step 4. Based on the expected time difference between the embedded time and the header time, the valid time segments are identified.

Step 5. In the MERGE code, the time line for each record is “filled in” or corrected so that the time for the start of each record is given.

Step 6. Based on the time line, an assessment is made as to whether the data in the buffer are contiguous. If more than one data set has been requested, the following additional steps are carried out:

Step 7. The start time for each data set is identified as above. The time line for each record is determined, based on the available times.

Step 8. Based on the time line, an assessment is made whether the data in the record are contiguous.

7.3 Validating Anemometry Data

The EXABYTEREAD code checks the anemometry data at several levels. However, all checking is done on the integers that make up either the zero-offsets or the dynamic AD-converted data.

The zero-offset is available to the MERGE code through the STAT file; therefore, most of the verification is performed in MERGE, while the *Errors & Warnings* file contains warnings but retains the values.

7.4 Zero Offsets

Since the zero offsets and the actual anemometry data may be obtained either at zero-flow conditions or with flow, there may be a large difference between zero-offset values for different files. If the zero offset was obtained during zero-flow conditions, the average value (displayed when running the code) will be in the range 160 to 170. If it was obtained during flow, it will be around 250, that is, close to saturation. However, even if it reaches the maximum possible value of 255, it does not constitute a problem because its function in the system merely is to provide an analog back-off voltage to bring the input to the AD converter within appropriate bounds. Consequently, only a zero value for a given sensor will result in a warning.

7.5 A/D Converter Saturation

While traditionally moderate standard deviation is a sign that there are no saturation problems, the fact that the dynamic data are NOT AC-coupled makes it necessary to examine every sample that is used in the generation of the statistical data. Since the zero offset may be quite different from the time-averaged bridge voltage, this difference results in a bias in AD converter values that may cause saturation even with a moderate level of standard deviation.

For the EXABYTEREAD code, the approach chosen is that within the *kmax* samples used for each data set, any saturation value will result in a warning and will provide the number of positive and/or negative occurrences found. Saturation is considered to occur when the counts reach 8188 or -8188, that is, 4 counts from full-scale in either direction. ANY value reaching this number of counts will result in a warning, and because the statistical values are incorrect, the voltage standard deviation is reset to zero. Thus, the statistical information used in MERGE will consider the data invalid, while the detailed information is still available in the SIGN files.

7.6 Anemometer Bridge Saturation

In certain cases the anemometer bridge itself will saturate. This saturation is determined from the current through the bridge and the bridge voltage; the power supply can only provide 191 mAmp per channel—if this 191 mAmp is exceeded, the bridge will not work properly. Depending on the sensor and zero offsets, this may happen earlier or later than AD saturation, and it is therefore necessary to check for it in MERGE. However, EXABYTEREAD issues a warning if it appears close to the approximate limit.

7.7 Anemometer Bridge Shutdown

In a shutdown case there is no output from the anemometer bridge, which may occur if the cold resistance of the sensor is so high that the prescribed resistance on the bridge arm is high enough without a need for the electronics to feed current (and heat up the film). Due to the zero offset, there will still be a nonzero output voltage.

8. Accessing the Database

Figure 6 illustrates the hierarchy of codes and files and provides an overview of how to relate the information. This section contains a description of the various access codes. The access codes are EXABYTEREAD, PRESSUREREAD, and MERGE. The PROCESSING code should be run to give a more thorough knowledge of the database structure.

To access the hot-film data and merge it with the pressure data, it is necessary to first identify the test point of interest, using, for example, the LOGBOOK code.

8.1 LOGBOOK Code

This section briefly describes the LOGBOOK code to be used in the High-Lift Flow Physics database. The code produces a MENU file that relates Configuration and hot-film sensors/anemometry hookup to the wind tunnel conditions. This file is to be used as input to the PRESSUREREAD and EXABYTEREAD codes or as a stand-alone search file for the database.

The code does not use any input file; all information is “hardwired” in the code as data statements. Also, unlike most of the other codes, this one does not have an eventloop and is terminated when the job is done by using returns and negative entries, not (<Apple><period>).

The information in the code is based on the daily log kept by Ben Anders, supplemented by the hot-film information and notes provided by Eric Roback and Sheryl Johnson.

8.1.1 Operation

Launch the code, and four options appear:

8.1.1.1 “Flip through.” If this option is chosen, the code will expect a number entry of 1 through 415 to be given. The number corresponds to the entry number in the logbook. Each entry has either pressure data, hot-film data, or both. The entry number does not correspond to the Point number since zero flow measurements are included.

By entering a number, the information relating to the entry is displayed. All information should be self-explanatory except for the following:

Sensorchoice: *Standard*, corresponds to Arrangement 1 in the HOOKUP code, that is, the configuration used in the first part of the test to determine transition locations.

Coves means the Arrangement 2 in which the sensors in the cove regions were used.

Bare model–no hot films corresponds to the runs made at the end of the experiment after the wing was stripped from hot-film sensors and cleaned up. These data have been included in the database to enable assessments of the film’s effect on the configuration performance.

Start time and Stop time	Time in hr:min:sec for start and stop times of record Exabyte data. This is GMT and is the time tag used both in the raw hot-film files and the SIF files, allowing correlation of hot-film data with the pressure data. Normally, this recording time interval is close to 90 seconds, while the anemometry system stepped through sensor banks 1 through 7 (see the HOOKUP code).
Data type:	*hf* = hot-film data
	pr = pressure data
	wr = wake rake data

Hit **Return**, and the next entry will appear.

If a number larger than 415 is entered, the code will show zeros/invalid results.

Exit the loop by entering a negative number.

8.1.1.2 "Database." If this option is chosen, it is possible to identify data points meeting certain criteria. This option has a very crude selection routine.

The code displays:
"Configuration 1-30/30N, 2=30P/30AD 3=30P/35T"
Answer 1, 2, or 3

Code display:
Input Reynolds number [mill] 5,9,12, or 15"
Answer 5,9,12, or 15.

Code display:
"Cases found, no alpha or Mach limits imposed:" <number of entries found>
"Input Angle of attack, minimum & maximum, -1 for sweeps"
Answer <Minimum alpha> , <Maximum alpha>

If only one value is entered, a single value will be used in the search.

Code display:
"Input Mach number, minimum & maximum"
Answer <Minimum Mach number> , <Maximum Mach number>

If only one value is entered, a single value will be used in the search.

Code display:
"k i Point Mach Re Alpha Connector Arrangement Start time Stop time"
followed by the entries found that meet the combined criteria given.

Hit **Return** and the code will start over at the configuration selection above. A negative number (followed by **Return**) will exit the code.

8.1.1.3 "SUN file." This option creates a file called "strstpa0.dta" in the folder you select (the code will not let you choose another name) and is suitable for use on the SUN to extract raw (binary) hot-film data from the Exabyte tapes.

The code will ask for a day input and will produce a file containing all existing start/stop times for that day. Viewed in Simpletext, the file looks odd, but it is set up to work on a Sun and will look different using the text editor VI there.

8.1.1.4 "MENU file." This choice will produce a MENU file for the experiment. A default time-stamped filename is given that can be changed by the user.

8.2 EXABYTEREAD Code

The present chapter describes the EXABYTEREAD code and the analysis performed to determine the characteristics of the hot-film signals. Note that this code is used to analyze both the Boeing 737 flight experiment and the LTPT wind tunnel test.

While it may be advantageous to perform statistics on parameters such as time-series, for simplicity, statistics is performed directly on voltages assumed to be a result of the physical conditions.

In the present section, some guidelines are given for running the EXABYTEREAD code, along with information on the characteristics of the processing.

An example of the operation of the different codes used to build up the processed database is given in Section 7.

8.2.1 Input

After launching the code, the user is prompted to provide the following:

Run number This is a number that can be the polar number or some other suitable identifier. Does not affect processing. If a negative number is entered, the Run number can be used to bypass filename conventions.

Point number A number used for identification, assumed to provide a link to the pressure points defined in the experiment. Since the pressure database is based on Point number, and the Point number is part of the output STAT filename, it is desirable to take care entering the correct Point number.

System 1 = A; 2 = B. This has an influence on processing because the eighth channel is handled differently if it contains timecode information (System 1 or A) or contains bank information (System B or 2).

Next, the user is prompted to select a filename. This selection is made with a dialog box. All output files from the EXABYTEREAD code will end up in the folder that is selected using this dialog box.

As mentioned above, the same code is used to process data from the LTPT experiment as well as the "original" 737 flight experiment. For the LTPT experiment, the user should select a file of form

<date><system>.hf<letter> denoting the sequence of binary file. Example 5a.hfc means data were acquired on August 5 from anemometer system A, and is the third file in the sequence that day.

The code uses the filename to determine which experiment the file is from, and unless it recognizes the filename, it will ask the user for another name. If necessary, this check can be omitted through setting the Run number negative. If the code determines that the data are from the LTPT experiment, it will use the hard-wired information on hookup for that experiment, displaying sensor number and the sensor location, along with the channel number in the graphics portion of the code.

The code also checks the filename for the system (A or B), and if it does not agree with the already indicated system in question, the user is asked to resubmit the filename.

The user is next prompted to input which connector set was used, 1, 2, or 3. There is nothing in the file itself or anywhere else in the system that can be used to give this information automatically (i.e., logbook notes exist, but no physical parameter in the system has been set), so there is no way to check what the user is assuming. As a help, the connector set used according to the logbook has been hardwired into the code, and the following alternatives can be used:

0 option The code will automatically choose the prescribed connector, based on the record numbers provided.

-1 option The code will display the logbooks noted connector sets for that day, along with the file and record number they are associated with.

Next, choose 1, 2, or 3 for a known connector set, 0 to use the automatic assignment, or -1 to see possible sets.

The arrangement, standard or cove, is automatically determined by the code based on the date of the data acquisition. The arrangement is displayed only in the graphics window.

Next, the user is prompted to provide start record, *mstart*. Normally the file contains 480 records that are numbered 1 through 480. If the user wants to use the hot-film results together with pressure, the LOGBOOK will already have been used to determine which records to use for the data (the tables in the present manual also provide this information).

After *mstart* has been entered, *mmax*, the last record to be processed, will be entered.

The code now checks whether the prescribed connector set agrees with the one entered and indicates whether the connector set changed between *mstart* and *mmax*. This check will be invoked again in the setup structure window if the values of *mstart* and/or *mmax* are altered.

Since the binary hot-film data have been split into 60 MB blocks, irrespective of what pressure point the data belongs to, it is sometimes necessary to extract data through the end of one file and the beginning of the following file. The EXABYTE code can append data from a second file to the original one, as will be described later.

8.2.2 Setup structure window

The user is next provided with a graphic description of the currently chosen setup for the data reduction, which allows the alteration of most of the setup parameters; both the existing input and the default values are available. The window shows the 8 data sets in each record, with the header information shown as a thin segment to the left.

The green bar and the list above it show the default setup of parameters:

mstart	initial record number for analysis (default mstart=1)
mmax	last record number for analysis default mmax=20)
isetstart	the first dataset (iss) analyzed (default isetstart=1)
isetend	the last dataset (iss) analyzed (default isetend=1) as default is isetstart=isetend=1; only one data set is analyzed
kmax	number of samples used in each dataset analyzed (default is kmax=1024)

If the filename indicates that the data are from the LTPT experiment, one additional parameter is displayed:

connectorset connector set, 1, 2, or 3 is either input or determined automatically. If it is believed that the logbook data contained in the hard-wired database of the code are erroneous, the value can be overridden after mstart and mmax have been entered. The connector set can be changed to 1, 2, or 3. (Here 0 or -1 input is not acceptable.)

The values of the parameters can be altered by clicking on the parameter name or value. An edit field allows the user to type in a different value. The edit field is closed through the use of the carriage return. The code shows some intelligence in judging the user's answers; for example, it will refuse to let the *mstart* be larger than *mmax*, but beware of uncharted combinations that may occur.

When the processing parameter characteristics are as desired, the default output parameters should be examined. These are changed through clicking on the corresponding buttons. A filled red button indicates an active feature.

graphics A toggle switch used if there is a desire to display the direct signals used for the analysis. Default is zero. Toggled. For details, see Section 6.2.4 on how to use the graphics features. Using the graphics option does not in any way alter the processing of the data. It is intended entirely as a means of exploring the raw signals and their properties and to build confidence in the statistical parameters.

comma delimited/tab delimited These buttons concern the output statistics file, i.e., STAT file, which is always generated by the EXABYTEREAD code. The two buttons are mutually exclusive. Only one of them can be chosen (red) at any time. Clicking on the other one will cause the user to select either tab delimited or comma delimited output.

signal file This option is chosen (red) if a signal output is desired. Default is no signal. This option takes time, both in extracting the data as well as in the analysis. Three forms of the signal file exist. The files are called **Stab.**, **Scom.**, and **Stec.**, respectively:

tab	Tab delimited (default) lists reference parameters in the top, including average, standard deviation, skewness, and flatness. The sample number and the 7 AC outputs are listed in counts in the next 7 columns.
com	Comma delimited contains the same information as the tab-delimited but uses a comma to separate the data.
tec	Tecplot file, including the header information used in tecplot files. Reference information in the top section, most of it as comments (preceded by #). Then continuous data are written in 9 columns and separated by zones. Each zone is identified by record (m) and dataset (iss). The first column is sample number (k=1 to kmax). The second is time in milliseconds from the start of the record. The seven last columns contain the actual anemometry signal's AC component. The user of the tecplot file can produce plots in voltage rather than in counts using the value for ADslope.

The OK button, a yellow button on the far right of the screen, is selected to start processing the data. There will be a display of the initial header information, and later, when one record (or dataset) has been processed, the statistical results are displayed.

8.2.3 Execution

In the default mode, the code will run, generating the statistics at approximately 2.5 seconds per record on an Apple Quadra 800.

The output to the screen is two similar lines containing:

m	record number, not written anywhere in the file; usually 1-480.
recordPos&	the position (in the file) of the first byte of the record, i.e., part of the header. A large number.
Sync	the sync word FAF3 (hexadecimal) will appear in the header to indicate valid data.
day	day in the year (from the header) 218-234 corresponds to August 5 through August 21, 1996.
hr	hour (from the header)
min	minutes (from the header)
sec	seconds (from the header)
SUN counter	Sun record number (with its deficiencies noted elsewhere) from the header
Sys A bank#	bank of System A (from header)
Sys B bank#	bank of System B (from header)
zero-offset	average of zero-offsets for the time segment requested (0-255 corresponding to the DA value determined in a preceding zero-offset run)

Notice that the header may indicate a bank change for System A or System B before it is actually implemented. Thus, in EXABYTEREAD output, it is necessary to examine both the A and B system files before conclusions are drawn regarding signals; the header may have indicated one bank as active while the signal is actually from another set of sensors. As will be described in the MERGE section (8.4), the most straightforward approach to the data is to consider any discrepancy in header and embedded bank number as a disqualifier for the data in question.

The second line will have an additional number:

- If the file is from System A, it will include the embedded time in seconds and tens of milliseconds.
- If the file is from System B, it will show zero, with an extra line beneath that provides the embedded bank information.

If a signal file has been requested, the execution will halt while the code is writing to disk. However, the signal output option allows the interested user to access ANY data in the database for examination or other processing. If the signal output is chosen and only one record is requested, the signal file will be produced automatically.

If more than one record is requested, the output signals will be in one file, but for each record processed, the user must re-verify that he/she wants to save the data.

In each case the columns denote the channel number. The statistical information is listed in the first few lines. Data are entered according to sample number for each signal.

The signal files are given a name starting with SIGN and including the date and time of the record generation.

8.2.4 Processing parameters

The selection of output parameters of the code is chosen with execution speed and value with a transition indicator in mind.

In the following, the definitions of output parameters are given, followed by the output format itself.

Definitions

Instantaneous signal	$U + u$
Time-averaged signal	U
Probability density	$B(u)$

Statistical moments

2nd **standard deviation:** σ

where the Variance is $\sigma^2 = \overline{u^2} = \int u^2\, B(u)\, du$

3rd **skewness factor:** $S = \overline{u^3} / \sigma^3$

where $\overline{u^3} = \int u^3\, B(u)\, du$

4th **Kurtosis:** $K = \overline{u^4}/\sigma^4$ (or flatness factor)

where $\overline{u^4} = \int u^4\, B(u)\, du$

Other statistics

Autocorrelation function: $\rho(\tau) = \int u(t)\, u(t+\tau) / \int u2(t)$

The autocorrelation function is normally evaluated, and although it is not practical to output the entire function, two products of the analysis are saved:

Taylor microscale

This scale is determined from the second derivative of the autocorrelation function at zero time shift ($\tau = 0$). The implementation in the code is to use an integral based on the time series shifted two samples and corresponds roughly to the corner frequency of the low-pass filters of the system (25 kHz).

Integral scale

This scale is an integral of the autocorrelation function either until it is zero or until there are 62 samples. The latter limit is set due to the anemometry system's power supplies, which has disturbance peaks that might destroy the measurement (62 samples means a time delay of 1.24 msec, i.e., 800 Hz, which is twice the fundamental disturbance frequency of 400 Hz). The user can easily verify the behavior of the autocorrelation function by using the signal output feature.

The definitions of the Taylor microscale and the integral scale are given in Tennekes and Lumley [4].

Parameters NOT included:

Intermittency has not been included in this code because its determination is not a clearly defined mathematical entity. The intermittency depends, in general, on the low-frequency cutoff of the dynamic signal, and no general definition exists. The key is to properly define a laminar/turbulent interface in the signal; therefore, it is important to define an intermittency, along with a "qualifier" or threshold information that can indicate if the determined statistic is a true or false.

zero crossings

Although zero crossings are important to determine features like burst frequencies, proper threshold settings are needed. Therefore zero crossings are omitted.

spectra

Spectra are omitted mainly due to the extensive time required for their processing but also because it requires more than a single value to extract the essential information.

The SIGN-files (in comma-delimited form) can be used as input to a separate code (not provided) that allows analysis with these techniques as well as with conditional sampling techniques.

8.2.5 Output format

Four types of output files exist, all in ASCII format. These were described in more detail previousy:

STAT Contains statistical parameters along with a complete set of reference information. Mainly for use in MERGE. This file is always generated; default is comma-delimited. Not suitable for spreadsheets. Filename has time stamp extensions so that it is not overwritten.

VOLTS Contains statistical information in terms of DC (bridge) voltage and standard deviation [mvolts] of fluctuating voltage. Always generated. Suitable for spreadsheet - tab-delimited. This file is overwritten.

SIGN Tab- or comma-delimited. The default is tab-delimited. Contains some reference information and statistics. Suitable for spreadsheets. Filename has time stamp extensions (which means it is not overwritten).

e & w Errors and warnings file contains comments that text generated during the processing, indicating deviations observed. This file is overwritten.

8.2.6 Graphics

If graphics has been selected, the completion of each record's processing will switch to a graphics display of the record's contents in terms of time series or statistical data as a function of the record. The main purpose is to provide the user with a possibility of monitoring the actual data behind the statistical numbers, and the graphics capability is therefore limited. It is anticipated that any further illustration of the signals will be done through the use of standard plotting routines.

While the graphics is displayed (until the OK button is clicked), the data processing is halted, and the processing estimate time will be unrealistic.

The graphics window is interactive and responds to mouse clicks and keyboard entries. It has four different modes, TIME, AUTOCORRELATION, CROSSCORRELATION, and HISTOGRAM.

Some keyboard entries are these:

.. Signals are moved up and down or to the sides using the keyboard arrows, 20 pixels per keyboard input.

.. Changing the vertical scale is done using the + and - keys, 25% each time.

.. Changing the horizontal scale is done using the * and / keys, 25% each time.

a Display autocorrelation when crosscorrelation is used. Toggled.

s Display the statistical and reference information for the dataset. Toggled.

v Displays numerically a portion of the autocorrelation or crosscorrelation functions. Toggled.

z Used to activate mouse dragging of the signal in the horizontal direction. Toggled.

The statistical information is as follows:

i	sensor number, 1 - 359
x.film	x-location of film, nondimensionalized by chord; x=0 at slat leading edge
s.film	s-location of film, nondimensionalized by chord; s=0 at y=0 on the element
Volts	DC (bridge) voltage of the film
Std.dev.	standard deviation [mVolts]
Skewness	skewness coefficient
Flatness	flatness coefficient (or kurtosis)
Channel	1-7; anemometer channel in this system.
Delay	operated in TIME option by radio buttons to the right.

The reference information is as follows:

file	input filename
m	record number in file (usually 1 - 480)
iss	data set within the record (1 - 8)
day	day of the year
hr	hour (header)
min	minute (header)
sec	second (header)
arrangement	sensor hookup; 1=standard, 2=coves
connectors	connector set 1, 2, or 3 (user input)
System	anemometer system 1=A; 2=B
Bank	anemometer bank for system, 1 - 7 (header)

The information of arangement, system, and bank has been combined to provide the sensor number and location. Note that at this point the System A data files do not have the bank information, and it is necessary to be careful with the interpretation to make sure that the data are really from the sensors that are indicated.

8.2.6.1 TIME series. As the default (unless selected differently in the setup window), the graphics window will display a time series (sample number 1 through kmax) of the AC component of all seven signals.

There is no display of scales and the axes do not display any grid.

The values are displayed when the mouse is moved over the points of interest with the button down. The value displayed is that of the mouse location, not necessarily a sample. Depending on the plot choice, the mouse button, while being held down, will display three numbers representing the values: sample number (k), time [msec], and voltage [mVolts].

Each signal can be switched on or off independently by clicking the radio button next to the channel number. The button is toggled. Each signal is assigned a color automatically. A symbol may be used to show the individual samples for any displayed signal by clicking in the box. The size of the symbol is 3 pixels by default but can be changed by clicking on the size box.

The **kstart** and **kend** boxes allow display of a limited set of the samples (default kstart=1 and kend=kmax), which allows more rapid execution of the display or selection of "features" to be clearer. Changing the values of **kstart** and **kend** does not affect the computed statistics.

To the right of the symbol boxes are radio buttons marked + and -. These allow horizontal shifting of each individual signal, 1 sample at a time. Signal shifting allows "conditional sampling" of the signals to detect certain events and correlations. This number tells how many sample shifts each signal has been given. For example, the feature can be used to correlate start and/or end of a turbulent burst to estimate the propagation and growth.

The feature is not a replacement for proper conditional sampling; it is provided to help learn typical signal characteristics.

Another issue of importance is the noise levels of the signals and the ever-recurring question of whether an observed feature of the signal is caused by the limitations and peculiarities of the hot-film system or the recording technique, or if it is indeed a flow property that is observed.

To have a basic smoothing technique available, the graphics TIMESERIES display is equipped with a filter button (toggled). When clicked, a 5-point smoothing filter is switched on and off for ALL 7 seven channels. Note that this does not in any way alter the output of the code, statistics, or signals; the graphics routine merely displays a filtered copy of the original data.

8.2.6.2 AUTOCORRELATION. Clicking on the AUTOCORRELATION button will display the autocorrelation function of the currently displayed signals in a window (toggled). The computation uses kmax-32 points, and the value at the axis is 1.

The function is displayed for all signals selected with the TIME series radio buttons, and the switching on and off feature is also available in this mode.

This display is intended to help assess the validity of the computed Taylor microscale and the integral scale, which are indicated on the plot. Notice that generally low signal levels will give a "noisy" function, just like the signal itself gets "jagged." The reason is that the quietest laminar signals have a resolution in which the standard deviation is roughly 8 counts (3 bits of information), and the autocorrelation loses its meaning.

The autocorrelation function is computed for display only, and the output is not saved.

8.2.6.3 CROSSCORRELATION. Clicking CROSSCORRELATION will prompt the user to input any two channels from the file. The crosscorrelation between the signals will be displayed, making it possible to obtain a valid set of data to determine the transfer function between different sensors.

To check the numbers, choose the cross-correlation between the same signal; it should be unity at zero time shift (identical to the autocorrelation function). The cross-correlation function uses kmax-64 points because it is computed up to 32 samples positive and negative shift.

The crosscorrelation function is also computed for display only, the output is not saved, and like the autocorrelation, the crosscorrelation has accuracy problems.

8.2.6.4 HISTOGRAM. Clicking the HISTOGRAM button will display a histogram of the kmax AC signals, nondimensionalized by the standard deviation.

The user is prompted to input a channel, and the histogram plots values from -5 to 5 times the standard deviation. The filled black symbols signify values within the standard deviation. Note that if the standard deviation is low (approx. 2 mVolts), the resolution of 0.3 mVolts for the signals means that splitting the data into 0.1 sigma(i) bins causes resolution problems for the display; that is, some of the bins will be empty due to the resolution limitations of the data.

The histogram is intended to provide an indication of the existence of intermittency and the shape of the skewness.

The histogram is computed for display only, and the output is not saved. The histogram button is toggled.

8.2.7 Appending additional records

After the prescribed records have been processed and written to file(s), the user is prompted to choose an option:

0=finish	Choosing this option will close all files and finish execution of the application
1=another run	The user will be prompted to choose another set of records from the same input file. This option is suitable to check bank validity, spurious results, and to verify repeatability.
2=append data	The user will be asked to input another file so that more records can be appended to the data already processed.

As mentioned earlier, practical limitations caused the database to be split into (nominally) 60-MB binary files. Thus, it may be necessary at times to collect data from more than one input file to provide a full coverage of all banks for any particular pressure point number.

Appending data may be done from any point in any file, except that it assumes the zero offsets to be unchanged and no connector change should have occurred. This information is not checked in the code.

The resulting file will have four parameters put in between the output records:

mstart	(in the new file)
mmax	(in the new file)
infilename	(of the new file)
kmax	(for new processing)

The dataset has been made as complete as possible. It gives the user the freedom to change kmax or the records being used, but still enables the person using the file to note the origin of discrepancies that may occur.

8.2.8 *Noise and filtering*

The transfer function for the entire system, from film, through bridge, signal conditioning, analog multiplexing, analog zero offset, and AD conversion is not readily accessible; 14 channels of anemometry are set up to handle 294 films, and although each film is trackable and to some extent possible to calibrate, the dynamic response is a critical issue.

The noise level can be observed in two different conditions:

- Zero-flow conditions

In zero flow runs, it appears that the standard deviation is roughly 5 mVolts for all sensors. The waveform is very distinct, with a repeat pattern occurring at roughly 5800 Hz.

- Flow conditions

Flow conditions can be explored in the laminar regions of the configurations. Often a low-frequency component is present (particularly in the slat's and main element's stagnation regions), and the standard deviations are 1.5 - 2 mVolts. The disturbance pattern has a higher frequency, around 12000 Hz (well below the 20 kHz analog Chebyshev filter and the 50-kHz sampling rate.) No phase relation between channels has been observed for this high-frequency disturbance.

The resolution of the 14-bit AD converter is 2.5/8192 Volts/sample = 0.305 mVolts/count. Thus, the standard deviation corresponds to approximately 5 counts, and great care must be exercised in drawing conclusions at this signal level. There are indications that the noise is due to the coax cable (rather than twisted pair) and the use of a single-ended connection.

For the purpose of the present experiment and to provide transition locations, it is sufficient to assume that regions of standard deviation levels around 1.5 - 2 mVolts are laminar without any clear, high-frequency content.

A quadratic smoothing filter (see Hamming [5]) over 5 points were used, according to the formula:

$$sf(k,i) = [\ 7\ s(k-2,i)+24\ s\ (k-1,i) + 34\ s(k,i) + 24\ s(k+1,i) + 7\ s(k+2,i)] \ / \ 96$$

where s(k,i) is the AC value of the sample number k, channel i, and sf(k,i) is its filtered equivalent. The percent sign % denotes double precision integer.

8.3 PRESSUREREAD Code

The purpose of the PRESSUREREAD code is to allow the pressure files generated by the Modcomp system of LTPT to be read and transformed into a format appropriate for merging the hot-film data with the pressure data.

The input files used are ASCII type Standard Interface Format, SIF files generated by using the COMBO code of LTPT. These files contain one segment with the parameter names followed by records of 6 values per line data for the different parameters. While the SIF files contain both "raw" pressure values and pressure coefficients, only the "raw" values in engineering units are used. The

ASCII SIF-files are read sequentially once the header has been read. There are 1918 elements, and a line is read in at a time as a string. Next, each string is split into its elements i=1 through 6.

8.3.1 User interface

When the code is launched, a window appears to allow setting and displaying the different input and output parameters/options as well as generation of different versions of the pressure coefficients. All settings should be done before the RUN button is clicked and the actual processing is done.

8.3.2 Input files

<u>SIF file</u>

Single point means that one single measurement point (or record in the SIF file) will be read. This method is useful, for example, when comparing data for different configurations or Reynolds numbers having the same angle of attack.

Single polar means that the entire polar is processed, and if output files are generated, separate files for each point will be generated. If both PRES, FAC, and spreadsheets are selected, a single input file containing a polar of 9 points will create 27 output files.

8.3.3 Processing

The processing in PRESSUREREAD converts measured pressures to pressure coefficients according to three schemes:

- Cp wt. cal. — The coefficients are generated by using the wind tunnel calibration factor CFSP (which is a function of sidewall suction) found in the input sif file, the standard mode of operation for the wind tunnel.
- Cp original — Sets CFSP to 1; that is, no wind tunnel calibration is included. Note that this process uses a PINF that is not altered from the measured pressure in any way; therefore, the Mach number will be somewhat different than in the corrected case.
- Cp special — Assumes that the stagnation point at the slat sees the true total pressure and, based on the theoretical expression for the stagnation pressure, determines the proper reference level for the pressure coefficients.

Only one scheme may be used at a time, selected through mouse clicks.

Examination of the SIF file will reveal that the pressures used as a basis for the pressure coefficients are ESP pressures adjusted by DESPREFAN. The pressure coefficients included in the SIF file are not used.

Note that “bad” (malfunctioning) pressure taps in the SIF files are identified as a 999 [psi] value. In PRESSUREREAD these points are still included in the output files to make the arrays constant throughout the processing scheme and to maintain the identification of the bad pressure taps. However, in the spreadsheet output, they have been removed to facilitate plotting.

8.3.4 Output files

There are two types of output files that are toggled on and off using mouse clicks

PRES	contains the reference information, along with the pressure distribution on the model
FAC	contains the reference information, along with the pressures measured on the ceiling, floor, and sidewalls of the tunnel as well as information on the suction mass flow.

Output files are text files with either a tab delimiter or a comma delimiter, selected by using mouse clicks. The file names are automatically generated but do not indicate whether the delimiter is a comma or tab. The default is comma delimited.

Note that the files do not normally contain any explanation regarding their contents (unlike the SIF files with their header). Instead, the data structure is defined in the template. If a tab delimiter is used, the PRESSUREREAD code has the option of including the parameter name in the actual file. Including the parameter name will make it unusable as an input file to MERGE, and the filename is given the prefix: x, i.e., xFAC and xPRES to stow them far away from the "proper" files.

Filenames are as follows:

For pressure distributions: PRES.<Run>.<Point>.<Date>.<hrminsec>

For facility information: FAC.<Run>.<Point>.<Date>.<hrminsec>

If both file types are created, they will have identical time stamps. As a default, both files are generated, but either or both may be omitted by using the appropriate option.

8.3.5 Spreadsheet

By default the spreadsheet is not active. If it is clicked, the options will appear. The spreadsheet is used to allow export of the data to spreadsheet codes that are available to the user, such as Excel and Cricket Graph, among others. The output may differ in terms of parameters but has been produced by using the selected processing scheme.

Optional outputs are these:

Cp	pressure coefficients
M	Mach number
p	pressure [psi]
p/pt	pressure nondimensionalized by the total pressure

The latter two are independent of assumptions regarding Mach number or tunnel reference conditions. As mentioned, bad points have been omitted.

The spreadsheet outputs all the data based on the physical element. This means that a spreadsheet application like Cricket Graph, which plots in value order, may have problems with the main element numbering. The output from MERGE is more suitable for such "composite" plots. Spreadsheets are always tab-delimited.

Note that the x-coordinates of the spreadsheet distinguish between the front portion of the elements and the cove regions. This distinction is necessary to obtain reasonable plots using Cricket Graph.

The option "Headers" should be selected to define column contents to be read in Excel. In Cricket Graph the headers will cause all columns to be of alphabetic format, which makes the column format change necessary to plot the data.

8.3.6 Display of pressure coefficients

The numerical values of the pressure coefficients display option are off as a default but may be switched on with a mouse click. Thirteen options exist, the values displayed being Tap number, x./c (nested) in percent, and pressure coefficient value, Cp. Note that bad taps are retained in Display, given a pressure coefficient value of more than 100. (The pressure 999 [psi] is treated as if it were real when the coefficients are computed.)

Chordwise		Spanwise		Facility	
LC	slat	LS	slat	C	ceiling
				E	
WC	wing under slat			F	floor
				L	
BC	wing box			W	sidewalls
TC	wing tail	TS	wing tail		
FC	flap main row	FS	flap main row		
FC1	flap extra row	FS1	flap trailing edge row		

Any of the options are toggled by using mouse clicks. Each segment is displayed numerically, and the display halts, waiting for a carriage return. Input of a negative number will switch off the display and return to the setup screen.

8.3.7 Display of SIF file contents

The contents of the ASCII SIF file can be examined by using this option. For practical purposes, the records are considered as 323 lines of 6 values each, rather than the 1938 values in a string.

Three sources of information exist for display; each is individually toggled:

names provides the parameter names in the file - displayed red. These names are "hard-wired" into the code; that is, the actual header is not read. Because the data reduction works with fixed positions of the variables, it is essential to know what values are actually used. Using the prescribed set of ASCII SIF files, the file and the "hard-wired" information should be identical. The actual SIF file can be viewed in any word processor; however, there are 8 names per line compared to the data segment's 6 per line.

strings provides the text string found in the file - displayed blue. It is an exact copy of the string in the actual file.

values provides the interpretation of the file to values - displayed black. It is the value set used by the code for processing.

When this option is used, the start line of the display is chosen as well as the number of lines after the RUN button is selected. If no number of lines is given, the default value of 11 lines is used.

The entire contents of a record is shown selecting 1,10,20, and so on until reaching 320 in the sequence, viewing 10 lines (60 values) at a time. If a negative line number is input, the display option is switched off, execution continues, and the code returns to the set-up screen. If an entire polar has been selected, the display will remain switched off through the remainder of the execution.

name search allows examination of any single parameter in the SIF file. The user is asked for the name of the parameter (which has to be exact). The code searches for it and displays its line and element number and its current value. The next action on the set-up screen will remove the display. Until RUN is pushed, no data are read in, and the current value (usually 0) at the memory location is displayed.

8.3.8 Run

The RUN and REPEAT selections are the only actions that process and store data.

RUN is used to read in and process data from a SIF file. If the same dataset is to be re-evaluated, the REPEAT button is used. When the RUN button is clicked, the execution starts.

single point

Single point is suitable to compare data from different polars, to determine Reynolds number effects, the effects on configuration changes, and so on. If a single point is requested, the user will be asked to decide which one. Since the pressure files are arranged one per polar, the PRESSUREREAD code will determine which file should be opened and will display which Points are included in it. The selection is either accepted or altered by the user.

Unless it is changed during subsequent single-point runs, the parameter selection criteria will remain in effect.

Single polar is usually suitable to process a batch of test points and provide input data for the next code, MERGE. Note that a separate output file is produced for each point; depending on the polar number, the result will be a variable number of files. Note that MERGE expects the input file to be comma delimited. MERGE will require extra time to interpret a tab-delimited file.

select input SIF-file

Whether single point or single polar, the user is next prompted to select an input file. This file may have any name and may or may not reside in the same folder. Any output file from the PRESSUREREAD code will be placed in the same folder as the input SIF file.

The input file MUST be an ASCII file with the exact parameter list of the template. The PRESSUREREAD code checks a few parameter names and will display a warning (and will also write it into any requested output files) in the file's bad data flag parameter.

The code will display, as it reads the records and output, the time and conditions of the points selected. The initial reading of the parameter list takes some time.

REPEAT is used to re-examine a test point. Note that if a polar has been analyzed, the data set available is from the last pressure point read from the ASCII SIF file. REPEAT is suitable to create comparisons of pressure distributions by using different processing options or to check data before it is written to files.

After execution, the code returns to the options screen and another selection from the database can be made by using RUN, or reprocessing can be done with a different processing scheme or output choice by using REPEAT.

The program execution can be interrupted by using (the not very elegant but effective) Apple<period>. However, this option does not work during execution when the code is halted to display a listing or dump. A <return> will let the execution continue; entering a negative number will cancel the displays and let execution finish and return to the set-up window.

The code has no graphic display of data. Not displaying data is deliberate since the data set is not complete without the appropriate hot-film data. The main purpose of the PRESSUREREAD and EXABYTEREAD codes is to provide a means of processing the raw data to make it usable for subsequent analysis. For graphic (and numeric) displays of complete dataset comparisons, the MERGE code and output files should be used.

8.4 MERGE Code

The input files used for MERGE are comma-delimited; STAT files for hot-film data and PRES files for pressure data.

8.4.1 Hot-film data

Any number of input files can be used, but they are assumed to cover the same time interval or approximately the same tunnel conditions and high-lift configuration, i.e., normally the hot-film data associated with a pressure point.

The data are normally read in pairs, a-files and corresponding b-files (from System A and B, respectively). The file format is strict to its elements and structure but allows some alternatives regarding units.

Typically, there are six input files with flow conditions, and if zero-flow conditions are to be included in the analysis, it is necessary to supply six more zero-files, OR the pre-test calibration data are used. In the latter case, the zero-flow voltages determined during test setup are used to represent the zero-flow heat loss to the substrate.

The input files contain the data according to the anemometer channel (1 through 14) with which it has been obtained. Records are analyzed as they are read. The header bank information is used to identify that a change has occurred (i.e., the operator has switched to a different set of sensors). When a change is detected, the MERGE code will skip the first two records, the last two records, and store the average of the rest in the array positions determined by the connector set and bank identifier. Note that if the input file contains information from the same bank in two separate time sections, the last one will be stored.

Normally, a maximum of six input files are used. The MERGE code will only deal with whatever data it is given. In certain cases, more than six input hot-film files may be given. One example is data from the very last part of the test, when the hookup arrangement was changed to explore the cove regions. In this case, data from more than 294 locations on the configuration will be available.

8.4.2 Omitting data

Data are omitted from the output for the following reasons:

- Based on the zero-offset of the system, the mean voltage may be saturating the AD converter. MERGE defines a maximum and minimum voltage level corresponding to saturation and excludes data outside the limit. The saturation should, in most cases, have been detected in EXABYTEREAD, resulting in a zero standard deviation.
- If the standard deviation is zero, the data are rejected.
- Bank identification is available both in the header and in the channel 8 of System B (embedded bank information). The two are compared for each record and a warning issued. However, since it may be possible to run an A-file without the corresponding B-file, or a different B-file, the data are not excluded.
- Questionable data that fall within one of the following categories are tagged:

1. Mean and Standard deviation exceed maximum voltage. AD saturation problem.
2. Mean and Standard deviation below minimum voltage. AD saturation problem.
3. Mean bridge voltage below 1 volt. Bridge balance problem.
4. Flatness factor above 25 or below -25. Electronic noise (spikes).
5. Data include elements with bank identification inconsistencies.
6. Data include elements with time code inconsistencies.
7. Entire A and B files were taken at different instants.

Interpretation of experimental data as function of space is done by using the connector set used (1 through 3), the arrangement (1-standard and 2-coves), and the corresponding selection of channel and banks, to cover all possible data points. The statistical data and the pressure coefficients are sorted according to their physical location. Data from Arrangement 1 and 2 may be used together since the MERGE code has the film numbering, coordinates, and hookup tables hardwired.

The sequence of assigning values is as follows:

1. The bank (1 - 7) and channel (1 - 7), together with the System (A or B), determines which of the 1 - 98 hooked up sensors the data belong to.
2. The connector definition (given by the operator) 1 to 3 determines which set of sensors is hooked up (connection box outside tunnel).
3. The arrangement number (1 to 2) is determined by the MERGE code based on the date identified in the data file; it uses the header time, not any of the information input at the time of EXABYTE file creation.

Thus, to obtain a complete coverage of data, first run the data that corresponds to arrangement 2 and data will be stored at 294 locations. Then run arrangement one for the same connector sets; 294 other points are stored, some are new and most of them overwrite the arrangement 2 information because some sensors will be active under both arrangements.

8.4.3 Pressure data

The pressure data of the input file are available as pressure coefficients. Only limited checking is performed because most of the verification has been done already in the PRESSUREREAD code.

8.4.4 Display and graphics

Currently no display or graphics exists for the code.

8.4.5 Output files

The output of the MERGE code is organized as a spreadsheet with a minimum of reference information. The file contains information obtained from the hot-film and pressure measurements.

The user is prompted to provide a filename, whereupon the MERGE code adds a time tag. Only experimental data considered to be correct are included; therefore, data from some sensors will be omitted. Also, one column includes warnings regarding the quality of certain data points.

The output file is organized to make plotting easy and contains the following columns:

<u>Hot-film data</u>

1. Sensor — This is either hot-film sensor number (1-359) or pressure tap (-).
2. x/c — Longitudinal Coordinate of hot film or pressure tap, nested, x/c=0 at the leading edge of the slat; x/c=1.0 at the trailing edge of the flap.
3. y/c — Vertical Coordinate of hot film or pressure tap, nested; y/c=0 on the apex of the slat and trailing edge of the flap.
4. s/c.flap — Length along the surface of the flap; s/c.flap=0 for y/c=0 and is positive on the suction side.
5. s/c.main — Length along the surface of the main wing; s/c.main=0 for y/c=0 and is positive on the suction side. Not accurate in cove region.
6. s/c.slat — Length along the surface of the flap; s/c.slat=0 for y/c=0 and is positive on the suction side. Continues into the slat cove for negative s/c.slat values.
7. mean — Mean bridge signal (voltage) [Volts] over kmax samples.
8. Std.dev — Standard deviation [mVolts] about Mean for kmax samples. For laminar flows, this is typically a measure of the noise level of the hot-film signal.
9. skewness — Third statistical moment coefficient of signal. Characterizes the asymmetry of the signal. In a transitional flow, the skewness goes from close to zero, negative/positive, passing through zero when the intermittency is 0.5 and at the end of transition; then opposite of the initial deviation and at the end of transition close to zero again.

10. flatness	Fourth statistical moment of signal. Also called Kurtosis. For Gaussian distributions, 3. High values found for transitional flows.
11. microscale	From the autocorrelation function. The Taylor microscale [msecs], determined from the second derivative of the autocorrelation function at zero time shift. Here determined from samples shifted 2 units. (Corresponds to 0.04 msec, which is close to the highest frequency before the Chebyshev corner frequency.)
12. Integralscale	Integral of the autocorrelation function to zero correlation or, in some cases, 64 samples, whichever occurs first.

If the autocorrelation function was omitted in the EXABYTEREAD processing, columns 11 and 12 will contain zeros.

<u>Pressure data</u>

13. -Cp.flap	Negative of pressure coefficient on the flap
14. -Cp.main	Negative of pressure coefficient on the main
15. -Cp.slat	Negative of pressure coefficient on the slat
16. -Cp.flapx	Negative of pressure coefficient on the flap, secondary row

9. Example and Tutorial

In the present section, an example of how the database can be accessed is given:

Step 1. Determine desired high-lift configuration and wind tunnel reference conditions. In this case we choose 30P/30N, Mach=0.2, Re=9 million, and 8 degrees angle of attack.

Step 2. Run the LOGBOOK code to select the names of hot-film and pressure data files. To obtain a complete set of data (yet excluding the cove sensors), we need 6 hot-film files: 3 from System A and 3 from System B. If we also want to explore the results from the cove regions, more files using sensor arrangement 2 need to be included.

Launch LOGBOOK, and select search mode **2** = Database **<Return>**

Select configuration **1** =30P/30N **<Return>**

Input Reynolds number [million]: **9** **<Return>**

The code indicates that 141 entries (test points, zero flow conditions, etc.) have been found.

Input Angle-of-attack [degrees]: **8** **<Return>**

Input Mach number: **0.2** **<Return>**

The code returns a list containing the entries that match all these criteria.

A screenshot may be used to record this list. Use **<shift><Apple>3** to make a snapshot that can be viewed with Simpletext. It is automatically labeled Picture 1 (or higher) etc. and is put into the main folder of the Mac.

We see that the following datasets may be suitable:

Item	Point	Connector	Sensor arrangement	
2	51	1	1	
13	62	2	1	
22	71	3	1	
379	421	1	2	Include for cove info.
388	430	2	2	Include for cove info.
419	463	N/A	N/A	Include to compare pressure distributions with and without the film sheet present.

Exit the code using -1 Quit code

To include all the relevant hot-film data, 10 film files would be needed. We decided to use only the standard setup, i.e., 6 files. Six pressure files are available. For simplicity, we use only Point 51 since all should be the same.

The repeatability can be checked separately. If this is desired, the PRESSUREREAD code can be run to produce the input files for MERGE. Then MERGE is run to produce the spreadsheet files. MERGE does not need a hot-film input. It will take any number of files (up to six, as mentioned previously), and only display/output the data received.

Step 3. To determine the location of the hot-film data, run LOGBOOK once more.

Choose 1=flip through

Enter the entry numbers, and the following information can be found:

Item	Point	Connector	Polar	Start record	End record
2	51	1	7	5_.hfc 82	5_.hfc 209
13	62	2	8	5_.hff 66	5_.hff 193
22	71	3	9	5_.hfh 146	5_.hfh273
And to include the cove sensors:					
379	421	1	55	21_.hfc 48	21_.hfc 100
388	430	2	56	21_.hfg 304	21_.hfh 143

Here _ means a or b, depending on which system is used.

Notice that all but the very last data can be found in single files.

When the flip-through mode is used, holding down the return key flips the display forward to the next logbook entry. If a certain entry is desired, it can be entered followed by return. A negative entry quits the code.

For pressure files, we see that pressure data (with hot-film sheet present) can be found in Polars 7, 8, and 9, as well as 55 and 56.

For simplicity, we only use Point 51 in Polar 7.

Step 4. Run PRESSUREREAD

Launch the code, select single point and comma delimited PRES file.

Select RUN and the code will open a dialog window to select a file to open. Since Point 51 is part of Polar 7, the information of interest is found in the ASCII SIF-file asc7 in the HL.HF.database folder.

Select record number 2, which is the 8-degree case.

It is also possible to extract all the pressure files needed for the entire polar by choosing Full polar. The code then will create separate, identifiable files for each of the Points.

Step 5. Run EXABYTEREAD

According to the information found in the LOGBOOK, the hot-film data corresponding to the pressure data are found in six files:

5a.hfc, record 82 through 209 for System A
5b.hfc, record 82 through 209 for System B

5a.hff, record 66 through 193 for System A
5b.hff, record 66 through 193 for System B

5a.hfh, record 146 through 273 for System A
5b.hfh, record 146 through 273 for System B

Locate the data on two CDs for System A and System B, respectively. Copy the six files to Mac memory since the CDs are write-protected and the code puts all output files in the same folder as the input files.

Launch EXABYTEREAD.

Enter Run number: 0 Any number may be entered to identify the output files. (For simplicity, it could be a short number.)

Enter Point number: 51 (pressure point number)

Enter System: 1 (Corresponding to System A)

Next, a dialog box opens, allowing the user to choose an input file.

Locate and select
5a.hfc
and open it.

The code checks the filename and prompts the user for Connector set information (set is 1, 2, or 3).

Enter: 0 for automatic selection.
Provide start record, mstart: 82
Provide last record, mmax: 209

The setup structure window appears with the complete set of run parameters.

Unless a change is desired, select Return.

Selecting Return will cause EXABYTEREAD to analyze the first 1024 samples from each of the records, starting with record 82 of the file, and will put the statistical information into a comma-delimited file.

If graphics is selected, it is possible to examine the raw signal. However, this is a time-consuming endeavor and should be done separately from data processing for merging with pressure data.

Execution proceeds and displays the results one record at a time.

When processing is finished, one may either quit (=0), start processing of other data from the same file (=1), or append more data from another file (=2).

Choose 0 since no more data from the file is needed.

Repeat the processing, using the corresponding b-file and the four other files, by using the appropriate record numbers:

Files 5a.hff & 5b.hff, mstart= 66 and mmax=193
and 5a.hfh & 5b.hfh, mstart=146 and mmax= 273

There will now be six files of hot-film statistical data and one file of pressure data.

Step 6. Run MERGE

Launch the MERGE code.

Enter the first file, corresponding to Connector set 1, System A. As the file is read, significant information is displayed for each record processed. The next time the dialog box appears, the System B file is entered. After reading the data in, the MERGE code will average and sort the information, and assign the information to a physical location on the model rather than to a channel in the measurement system.

If more hot-film data are needed, the file pairs for Connector sets 2 and 3 are entered. After adding the pressure file, the input sequence is stopped. The user provides a name and selects a folder for data storage, and the data are written to a tab-delimited file suitable for analysis in a spreadsheet application.

10. Conclusions

The database has been created to allow retrieval of data as needed in the future because it is set up with access codes and is independent of the acquisition of other database handlers and software. If the need arises, the software can be ported to other platforms. The User's Manual for the anemometry system describes the data in sufficient detail to port the reading code for the binary data. The intention is also that published data can be checked for validity whenever a need arises.

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Appendix

Database Sorted by Configuration

In this appendix the data are sorted into configurations and day of testing. It reveals the complete, existing data sets. In cases where there is a repeat pressure run, data may not be included. In most cases, pressure runs and complete hot-film sets are included if more than one is available.

Pressure data are denoted Point-1, Point-2, or Point-3, where 1, 2, and 3 correspond to the hot-film connector set used.

Hot-film data are denoted Film-1, Film-2, or Film-3, where 1, 2, and 3 correspond to the hot-film connector set used.

The record names are abbreviated, omitting the date in front. For example, Point 50 was taken on August 5, and the corresponding hot-film data records are 5b450-5c81, abbreviated to b450-c81.

The original pressure data written as SIF files are organized according to polar, and below each set of point numbers, the corresponding SIF filename is given; for example, asc007 means that the corresponding pressure data were taken as part of polar 7.

A.1 30P/30N is the standard configuration used for the main portion of the testing, one series in the beginning of the test and one in the last.

August 5 , 1996

One complete data set at intermediate Reynolds number, standard Mach number was completed, along with a repeat series to explore the repeatability of the angle of attack (and other tunnel conditions) to verify whether or not polars could be run or if the connectors had to be changed at each angle of attack.

Configuration: 30P/30N
Mach number: 0.2
Reynolds number: 9 million

a	Point-1	Point-2	Point-3	Film-1	Film-2	Film-3
4	50	61	70	b450-c81	e418-f65	h18-h145
8	51	62	71	c82-c209	f66-f193	h146-h273
10	52	63	72	c210-c337	f194-f321	h274-h417
12	53	64	73	c338-c449	f322-f449	h418-i033
16	54	65	74	c450-d97	f450-g97	i34-i161
19	55	66	75	d98-d225	g98-g209	i62-i289
21	56	67	76	d226-d369	g210-g337	i290-i417
22	57	68	77	d370-e33	-	i418-j65
23	58	69	78	e34-e161	g338-h17	j66-j177
	asc007	asc008	asc009			

Configuration:		30P/30N					
Mach number:		0.2					
Reynolds number:		9 million					
a	Point-1	Point-2	Point-3	Film-1	Film-2	Film-3	
4	-	80	79	-		j322-j480	j178-j321
8	-	81	-	-		k2-k129 -	
10	82	-	-	k130-k289		-	-
12	83	-	-	k290-k417		-	-
16	-	84	-	-		k418-l65	-
19	-	-	85	-		-	l66-l193
21	-	-	86	-		-	l194-l321
22	-	87	-	-		l322-l419	-
23	88	-	-	l450-m97		-	-
			zeros	-		m98-m209	m210-m353
____	asc010	asc010	asc010				

August 6, 1996

One data set at intermediate Reynolds number, standard Mach number was completed as a repeat series to explore the repeatability of the data. The BLT was put in position in several of the runs (check). No data were obtained for connector set 1.

Configuration:		30P/30N				
Mach number:		0.2				
Reynolds number:		9 million				
a	Point-1	Point-2	Point-3	Film-1	Film-2	Film-3
4	-	95	100	-	b32-b223	d48-d239
8	-	96	101	-	b224-b415	d240-d431
10	-	-	-	-	-	-
12	-	-	104	-	-	e368-f79
16	-	98	103	-	c128-c319	e176-e367
			zeros	-	-	f80-f271
		asc011	asc012			

August 7, 1996

Two complete data sets at intermediate Reynolds number, high and low, and at high Mach numbers were run.

Configuration:		30P/30N				
Mach number:		0.15				
Reynolds number:		9 million				
a	Point-1	Point-2	Point-3	Film-1	Film-2	Film-3
4	110	120	129	b96-b287	e464-f175	j144-j335
8	111	121	130	b288-b479	f324-g47	j336-k63
10	113	122	131	c1-c191	g48-g255	k64-k255
12	114	123	132	c192-c399	g256-g463	k256-k463
16	115	124	133	c400-d111	h64-h271	k464-l175
19	116	125	134	d112-d319	h272-h463	l176-l383
21	117	126	135	d320-e31	h464-i175	l384-m95
22	118	127	136	e32-e239	i176-i383	m96-m287
23	119	128	137	e240-e463	i384-j143	m288-n15
	asc014	asc015	asc016			

Configuration: 30P/30N
Mach number: 0.23
Reynolds number: 9 million

a	Point-1	Point-2	Point-3	Film-1	Film-2	Film-3
4	138	146	154	n16-n207	p464-q175	t225-t431
8	139	147	156	n208-n431	q176-q367	t624-t815
10	140	148	157	n432-o63	q368-r79	t816-t1023
12	142	149	158	o64-o255	r80-r271	t1024-t1087
16	143	150	160	o256-o447	r272-r463	t1329-t1519
19	144	151	161	o448-p191	r464-s175	t1520-t1679
21	145	152	162	p192-p383	s240-s463	t1680-t1887
	asc017	asc018	asc019			

<u>August 8, 1996</u>

Two complete data sets at low and high Reynolds number; standard Mach numbers were run.

Configuration: 30P/30N
Mach number: 0.20
Reynolds number: 5 million

a	Point-1	Point-2	Point-3	Film-1	Film-2	Film-3
4	178	188	197	a48-a239	e49-e240	j340-k64
8	179	189	198	a240-a431	e241-e432	k65-k256
10	180	190	199	a432-b143	e433-f160	k257-k448
12	181	191	200	b144-b335	f161-f368	k449-l176
16	182	192	201	b336-c79	f369-g80	l177-l384
19	183	193	202	c80-c271	g81-g272	l385-m112
21	186	194	203	d145-d336	g273-g464	m113-m304
22	185	195	204	c400-d144	g465-h176	m305-n32
23	187	196	205	d337-e48	h177-h400	n33-n240
			zeros	o145-o336	n433-o144	n241-n432
	asc022	asc023	asc024			

Configuration: 30P/30N
Mach number: 0.20
Reynolds number: 12 million

a	Point-1	Point-2	Point-3	Film-1	Film-2	Film-3
4	208	217	224	o337-p48	s177-s343	t1089-t1233
8	209	218	225	p49-p256	s388-t80	t1295-t1456
10	211	219	226	p385-q112	t81-t247	t1457-t1614
12	212	220	227	q113-q304	t281-t447	t1676-t1791
16	213	221	228	q305-r16	t483-t626	t1868-t1982
19	214	222	229	r17-r208	t674-t848	-
21	215	223	230	r209-r400	t849-t1051	t2239-t2247
22	216	-	-	r465-s176	- -	
			zeros	t2674-t2864	t2497-t2497	t2428-t2428
	asc025	asc026	asc027			

August 9, 1996

Two complete data sets at a very high Reynolds number, close to standard Mach numbers, were run.

Configuration:		30P/30N				
Mach number:		0.18				
Reynolds number:		15 million				
a	Point-1	Point-2	Point-3	Film-1	Film-2	Film-3
4	233	237	241	b304-c15	d200-d415	e448-f159
8	234	238	242	c16-c207	e416-e127	f160-f351
16	235	239	244	c208-c399	e128-e239	f352-g63
			zeros	g448-h159	g256-g447	g64-g255
	asc028	asc029	asc030			

August 12, 1996

The model rigging was changed to 30P/30AD. One complete data set was run.

Configuration:		30P/30AD				
Mach number:		0.20				
Reynolds number:		9 million				
a	Point-1	Point-2	Point-3	Film-1	Film-2	Film-3
			zeros	a1-a127	a128-a351	a352-b63
4	251	261	271	b74-b255	f128-f319	j1-j191
8	252	262	272	b261-b445	f320-g47	j192-j383
10	253	263	274	b464-c173	g48-g255	k80-k287
12	254	264	277	c183-c383	g256-g463	k288-k479
16	255	265	279	c407-d95	g464-h175	l1-l191
19	256	266	280	d112-d287	h176-h367	l192-l415
21	258	267	281	e1-e207	h368-i79	l416-m159
22	259	268	282	e208-e399	i80-i287	m160-m367
23	260	269	283	e400-f127	i288-i479	m368-n79
			zeros	o1-o120	n288-n480	n80-n287
	asc032	asc033	asc034			

A.2 30P/30AD

August 13, 1996

The tests continued with 30P/30AD. One complete data set at standard Reynolds number, high Mach number was run.

Configuration:		30P/30AD				
Mach number:		0.23				
Reynolds number:		9 million				
a	Point-1	Point-2	Point-3	Film-1	Film-2	Film-3
			zeros	a320-b47	a128-a319	a1-a127
4	287	295	303	b48-b223	f144-g15	j16-j207
8	288	296	304	b224-b383	g16-g287	j208-j400
10	289	297	305	b384-c127	g288-h15	j401-k111
12	290	298	306	c128-c335	h16-h207	k112-k303
16	291	299	307	c336-d47	h208-h399	k304-l15
19	292	300	308	d48-d239	h400-i111	l16-l182
21	293	301	309	d240-d431	i112-i303	m1-m127
22	294	302	310	d432-e143	i304-j15	m128-m351
	asc036	asc037	asc038			

August 14, 1996

The tests continued with 30P/30AD. One complete data at low Reynolds number, standard Mach number was run.

Configuration:		30P/30AD				
Mach number:		0.2				
Reynolds number:		5 million				
a	Point-1	Point-2	Point-3	Film-1	Film-2	Film-3
			zeros	a336-b47	a128-a335	a1-a127
4	-	324	337	-	f324-g47	j368-k94
8	314	325	338	b242-b431	g48-g175	k95-k287
10	315	327	339	b432-c143	g416-h127	k288-k479
12	316	329	340	c144-c335	h128-h334	l1-l223
16	317	330	341	c336-d63	h336-i47	l224-l415
19	318	331	342	d64-d239	i48-i239	l416-m127
21	319	333	343	d240-d431	i240-i447	m128-m319
22	321	334	344	d432-e159	i448-j159	m320-n31
23	322	336	345	e160-e360	j160-j367	n68-n271
			zeros	o192-o399	n464-o191	n272-n463
	asc040	asc041	asc042			

A.3 30P/35T

<u>August 19, 1996</u>

The third configuration (rigging) was used, 30P/35T, and runs were made at Standard and low Reynolds number and standard Mach number.

Configuration: 30P/35T
Mach number: 0.2
Reynolds number: 9 million

a	Point-1	Point-2	Point-3	Film-1	Film-2	Film-3
			zeros	a336-b47	a128-a335	a1-a127
4	356	369	379	b48-b255	f400-g110	j320-k47
8	357	370	380	b256-b447	g111-g303	k48-k239
10	358	371	381	b448-c159	g304-h31	k240-k463
12	359	372	382	c160-c353	h32-h223	k464-l175
14	366	373	383	e368-f79	h272-h479	l176-l383
16	360	374	384	c354-d63	i1-i191	l384-m95
19	361	376	385	d64-d255	i192-i383	m96-m303
21	363	377	386	d256-d447	i392-j95	m404-n15
22	364	378	387	d448-e191	j96-j303	n16-n159
23	365	-	-	e192-e367	-	-
	asc049	asc050	asc051			

Configuration: 30P/35T
Mach number: 0.2
Reynolds number: 5 million

a	Point-1	Point-2	Point-3	Film-1	Film-2	Film-3
4	389	398	407	n368-o79	r288-r479	t1072-t1263
8	390	399	409	o128-o335	s1-s190	t1264-t1455
10	391	400	411	o336-p47	s191-s383	t1456-t1663
12	392	401	412	p48-p255	s385-t95	t1664-t1855
14	393	402	413	p256-p447	t96-t287	t1856-t2047
16	394	403	414	p448-q159	t288-t479	t2048-t2239
19	395	404	415	q160-q367	t480-t671	t2240-t2431
21	396	405	416	q368-r95	t572-t863	t2432-t2639
22	397	406	417	r96-r287	t864-t1071	t2640-t2831
			zeros	t3232-t3360	t3024-t3231	t2832-t3023
	asc052	asc053	asc054			

A.4 30P/30N

August 21, 1996

Configuration: 30P/30N
Mach number: 0.2
Reynolds number: 5 million
Arrangement: Coves

a	Point-1	Point-2	Point-3	Film-1	Film-2	Film-3
			zeros	a448-b181	a128-a447	a1-a127
4	420	429	-	b309-b361	f464-g303	-
8	421	430	-	c48-c100	g304-h143	-
10	422	433	-	c312-c480	h304-i142	-
12	423	435	-	d73-d248	i143-i463	-
16	424	436	-	d296-d480	i464-j287	-
19	425	437	-	e21-e239	j288-k111	-
21	426	438	-	e240-e463	k112-k431	-
22	427	439	-	e464-f223	k432-l287	-
23	428	-	-	f224-f463	-	-
			zeros	m208-m399	l288-l479	m1-m207
	asc055	asc056				

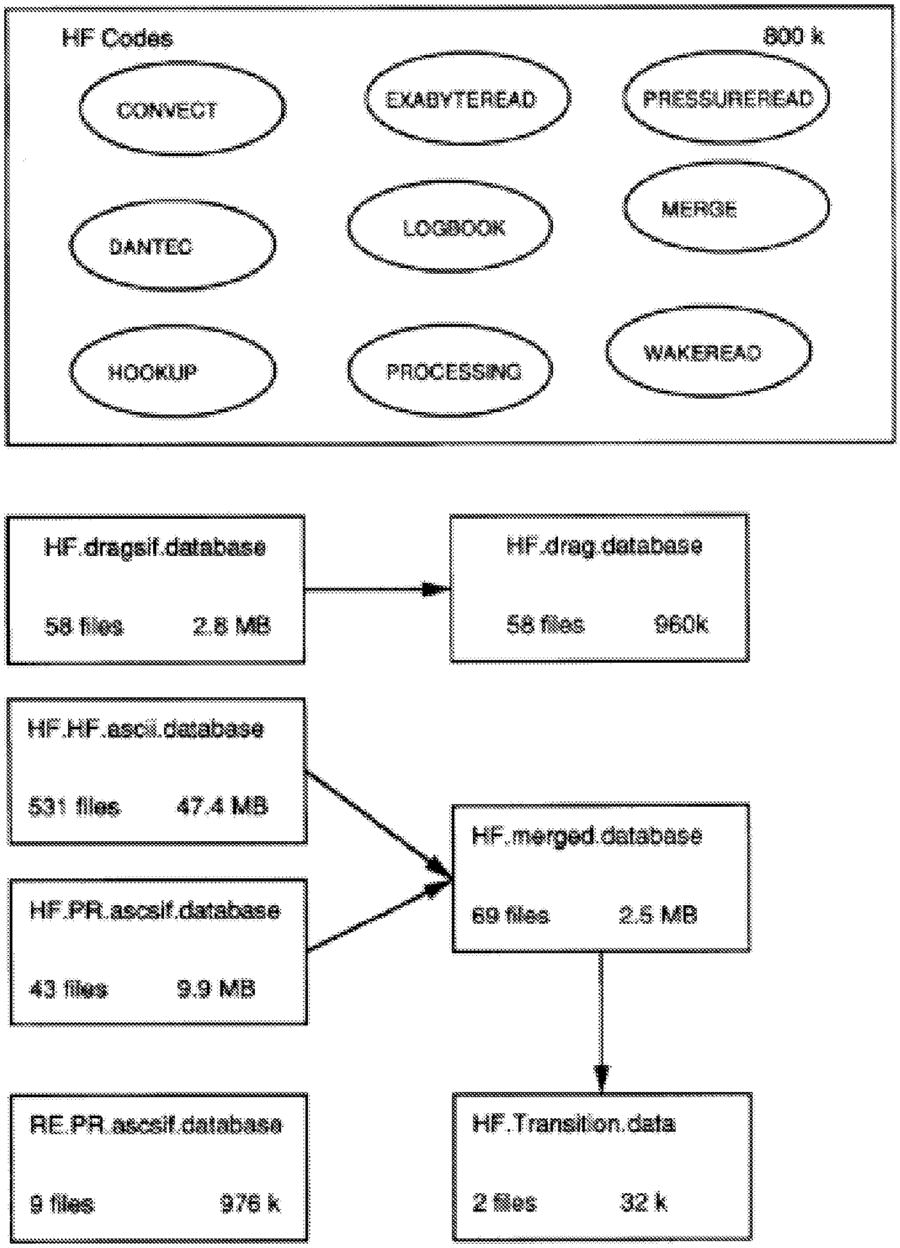

Figure 1. Database organization.

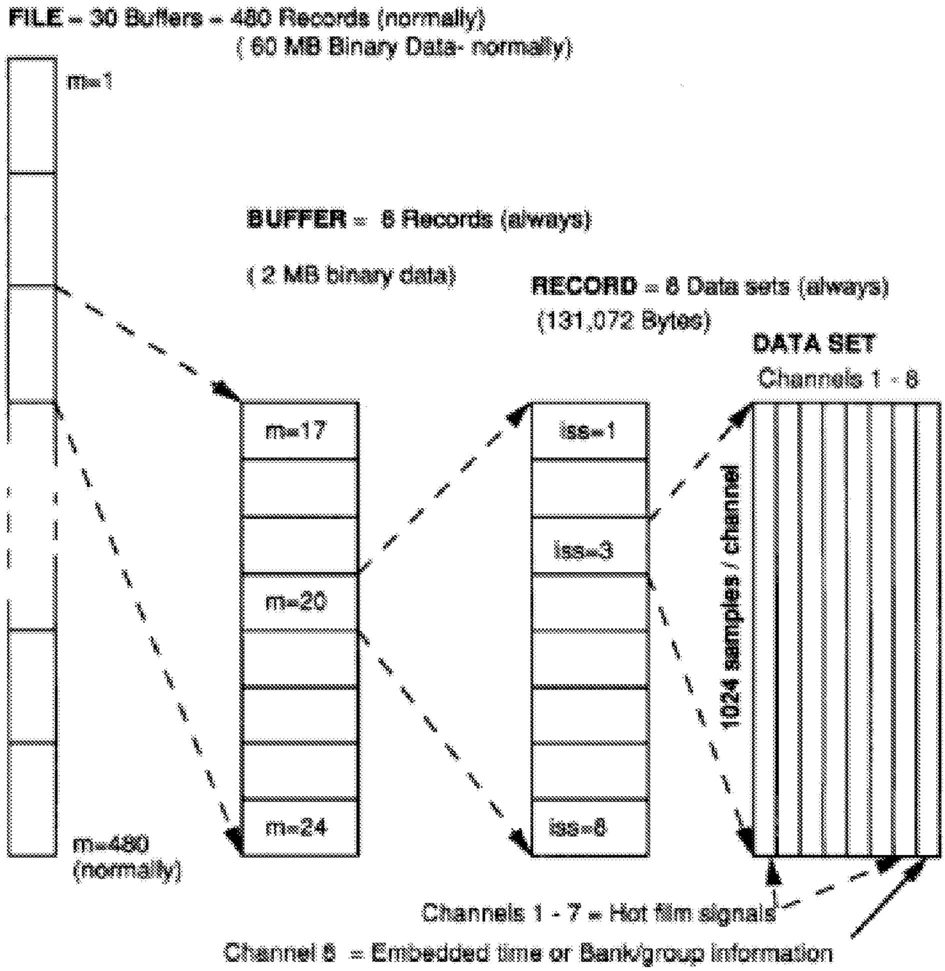

Figure 2. Files, buffers, records, and data sets.

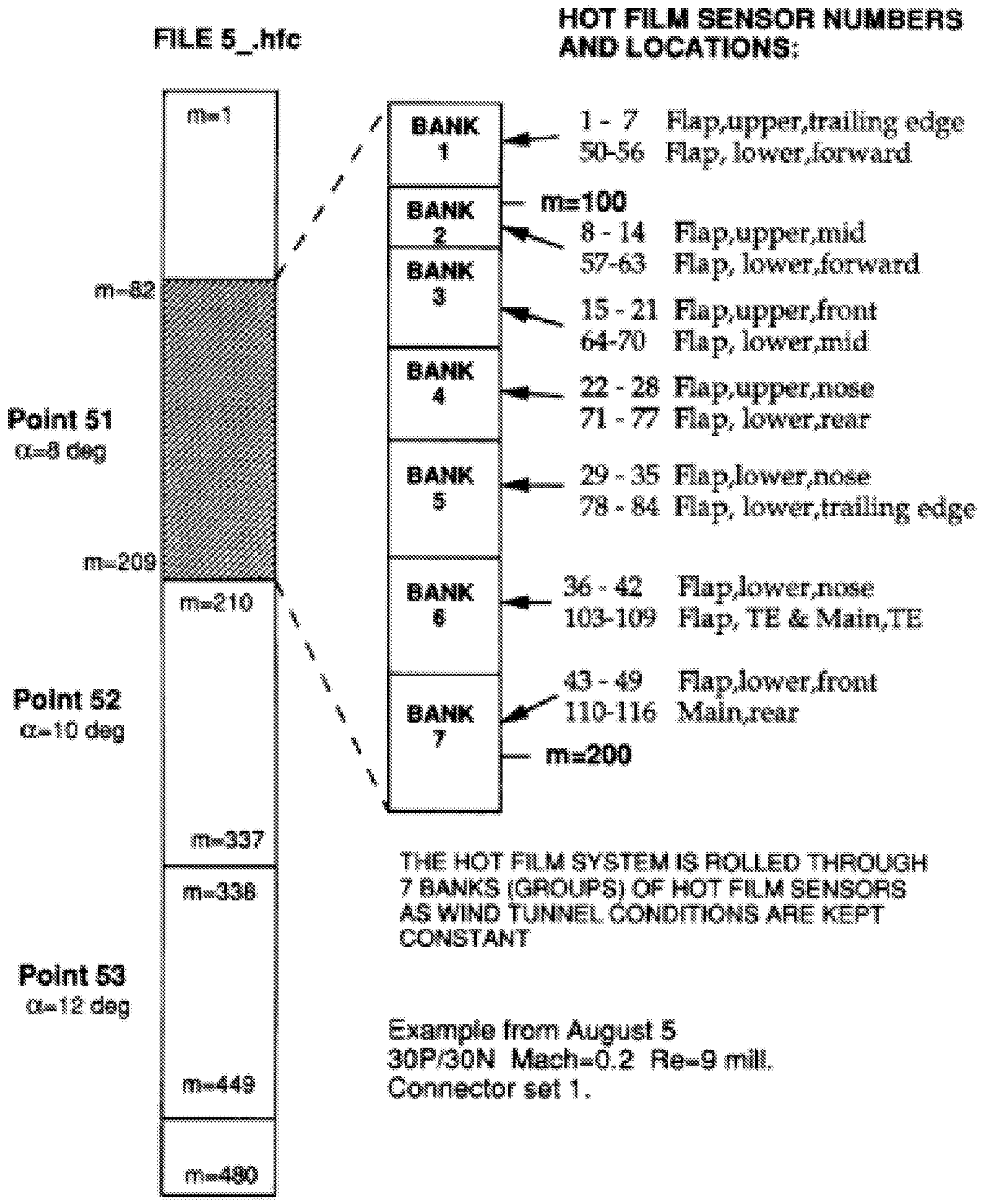

Figure 3. Pressure points and hot-film data.

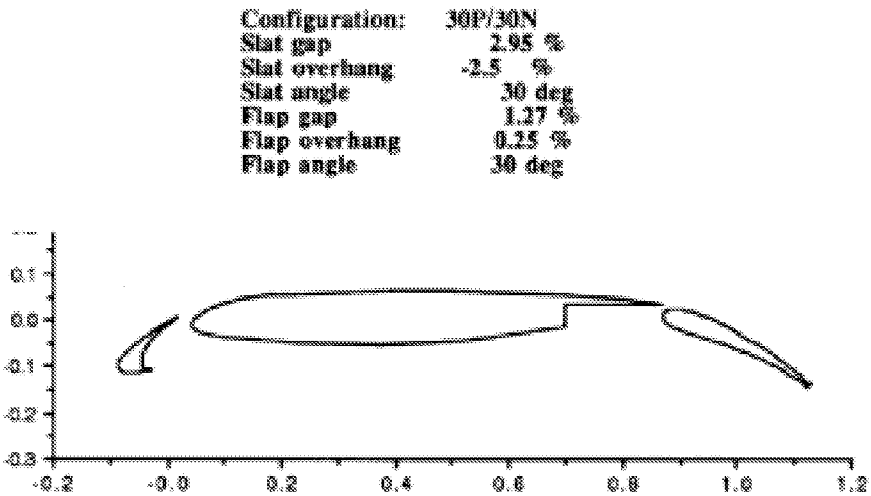

Figure 4. MDA 3-element high-lift model, 30P/30N rigging.

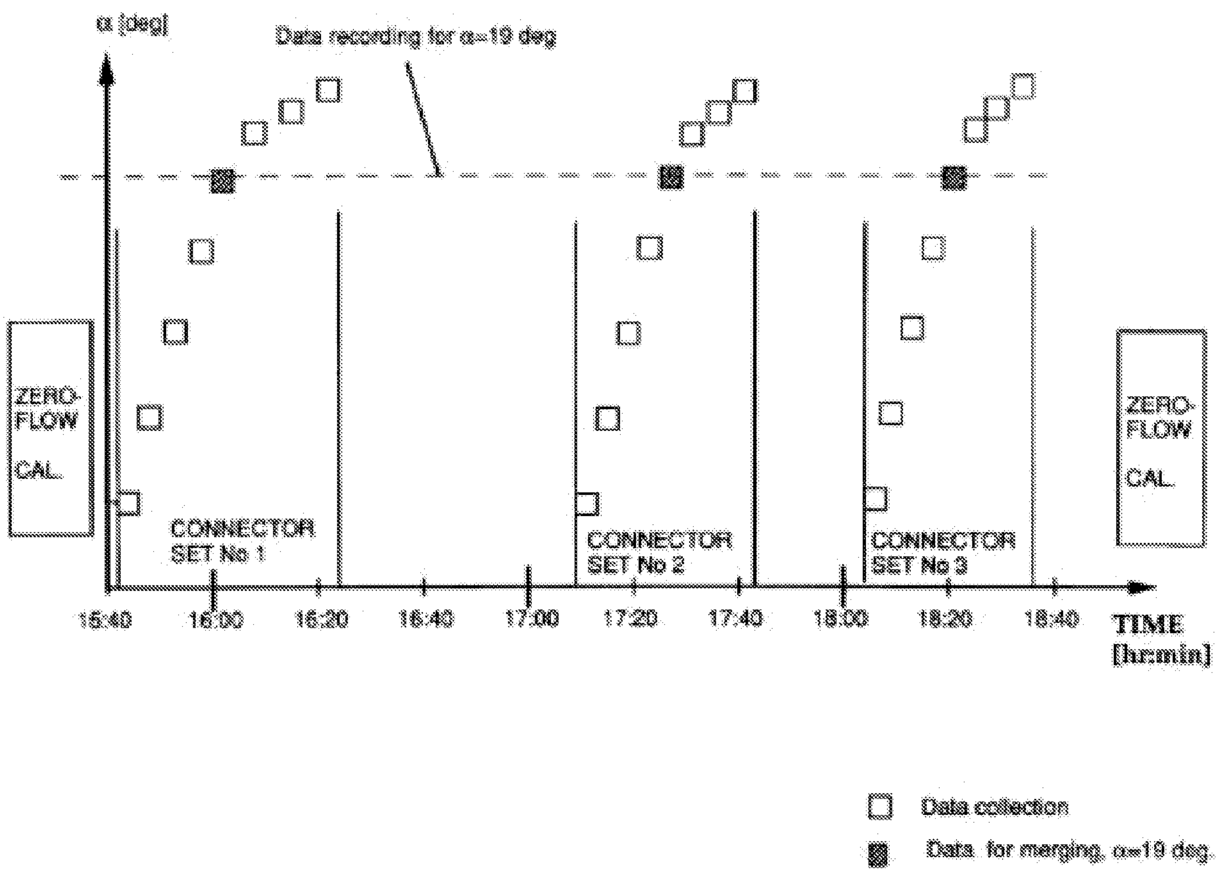

Figure 5. Run procedure – collection of hot-film data through switching connector sets.

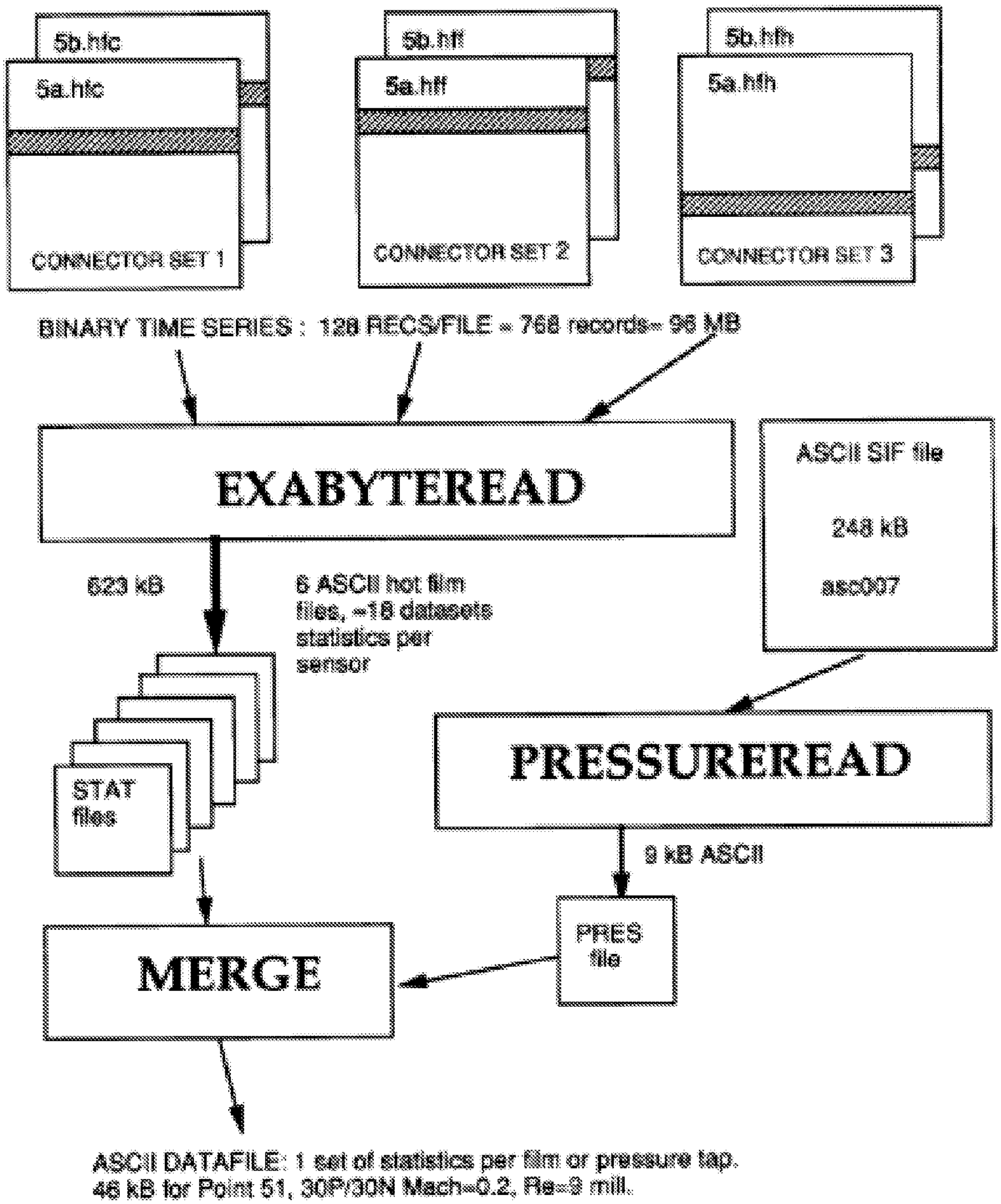

Figure 6. Data processing, compression, and access.

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13. ABSTRACT ***(Maximum 200 words)***
A 2-D high-lift system experiment was conducted in August of 1996 in the Low Turbulence Pressure Tunnel at NASA Langley Research Center, Hampton, VA. The purpose of the experiment was to obtain transition measurements on a three element high-lift system for CFD code validation studies. A transition database has been created using the data from this experiment. The present report details how the hot-film data and the related pressure data are organized in the database. Data processing codes to access the data in an efficient and reliable manner are described and limited examples are given on how to access the database and store acquired information.

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