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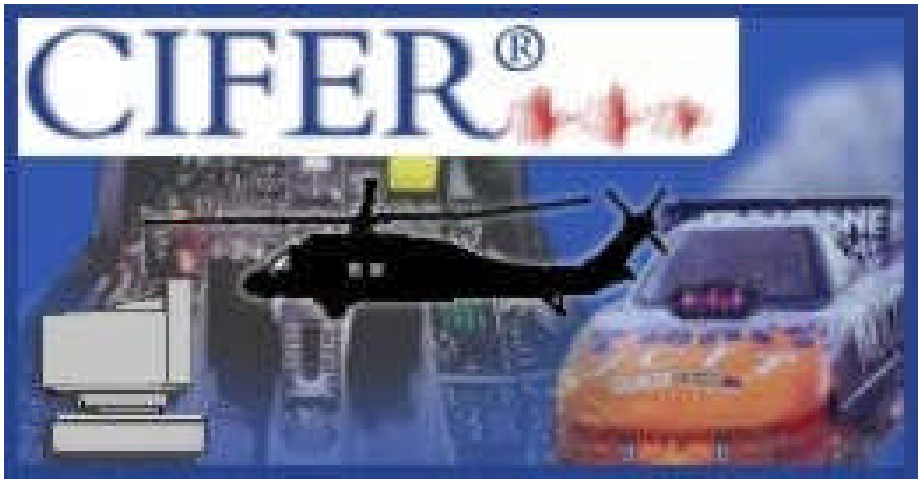


# Comprehensive Identification from FrEquency Responses

**An interactive facility for system identification and verification**

# CIFER® WINTEL Software User's Manual

**(Version 4.2.00 or later)**

CasalCorp gratefully acknowledges the extraordinary contributions of Dr. Mark Tischler and Mr. Dexter Hermstad in the continuing success and growing capabilities found in the CIFER® software system.

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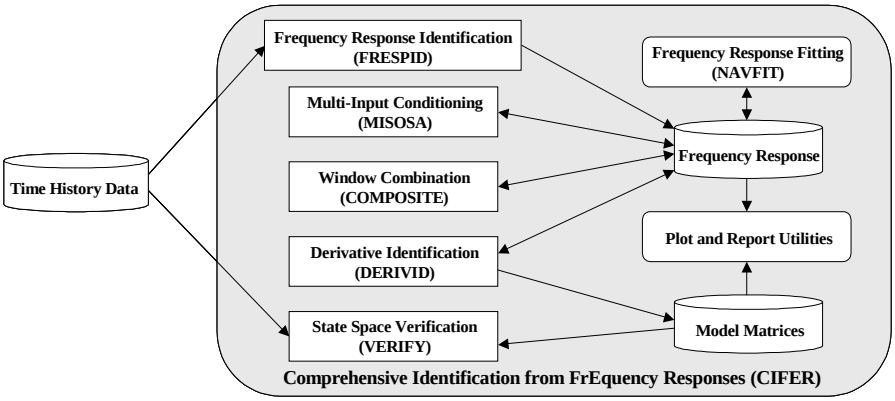
# CIFER / WINTEL Software Users' Manual



## 1. Introduction

CIFER® is the world's premier System Identification solution. The CIFER® system, shown in **Figure 1-1**, is a high-performance interactive and complete software facility used for a wide range of systems synthesis, optimization, and validation. While the software suite can be executed as a stand-alone tool, interface provisions are made for common external data sets on input (e.g., Data Acquisition standards, MATLAB) and plotting/reporting tools on output. The capability also exists for individual users to integrate to their custom or proprietary data sets through a published intermediate format and template. This supports ASCII, telemetry-encoded, or even binary level data samples.




- **FRESPID -** Frequency Response Identification
- **MISOSA -** Multi-Input Conditioning
- **COMPOSITE -** Multi-Window Averaging
- **DERIVID-** Generalized Stability Derivative Identification (from frequency responses)
- **VERIFY-**State Space Model Verification
- **NAVFIT -** Calculates Low-Order Transfer Function (from hi-order transfer function or frequency response data)
- **Screen Subsystem -** User Interface
- **Utilities Suite -** Special functions, plotting, conditioning, etc.
- **DB Subsystem -** Raw, Intermediate, Processed data and indexing

***Figure1-1: The Top-Level CIFER® Product Organization***

In the past, CIFER®'s primary use has been for high-performance aerodynamic systems/controls modeling, analysis, test, and optimization. It has also been uniquely proven for handling qualities and related analyses; particularly for frequency-domain intensive ADS-33 referenced specification and testing. Vibration analysis; flutter analysis; wind tunnel and flight test characterizations; and simulator development, validation, and optimization are just a few of its other past and continuing uses. Other high value CIFER® adaptations are not based on how it has been used, though. Rather it is based on what CIFER® does. ***For any measurable system excitation/response set (time or frequency domain), CIFER® assesses the frequency content and produces an accurate mathematical description of that system's complex dynamic behaviors.*** With its strong basis in proven signal processing and analysis techniques, CIFER® uses extend well beyond the flight/vehicle development and test regime.

**Figure 1-2** depicts the overall CIFER® process. This is an empirically based technique, operating on measured excitation data (continuous or pulse) and system responses. For our purposes the system/subsystem/component can be of any size or domain, so long as it can be instrumented to collect the needed signal data.

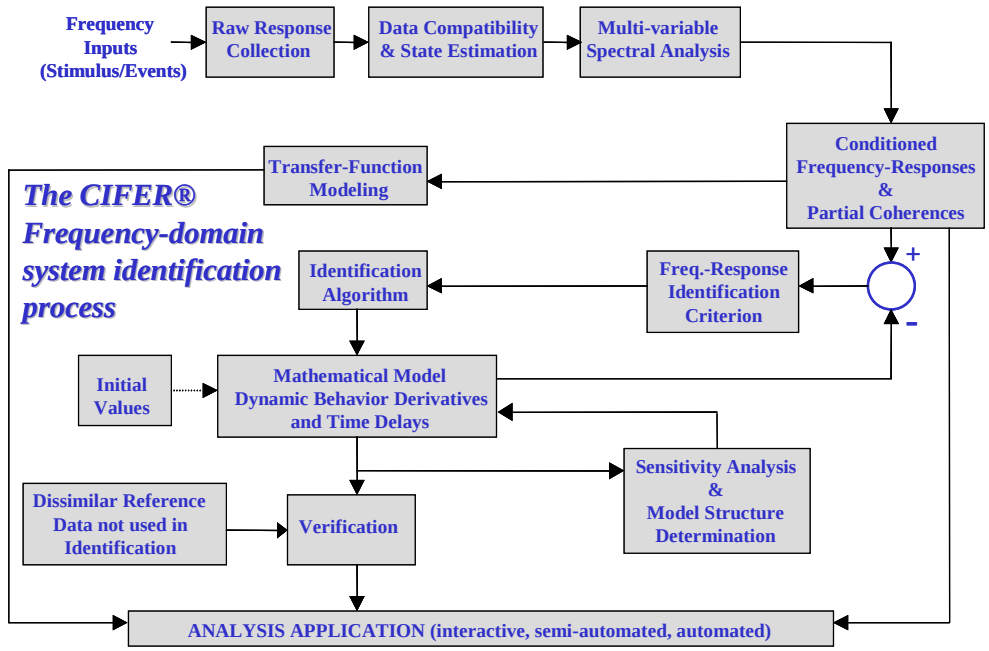



***Figure 1-2: "CIFER® is based not only on sound science, but on sound engineering"***

Other important aspects of our use of CIFER®'s processing features in our approach include:

- **Tools and results exercised and proven over 14 years of use; recognized as world best-in-class for applications addressing real-world problems in real-world conditions**
- Significant relevant data and experience can be supplemented with minimal additional effort and cost to any future program(s)
- Non-real-time and real-time analysis directly supported
- Directly relevant identification algorithms are highly exercised and tuned
- Flexible and interactive definition of identification model structures
- **Non-Parametric Modeling directly supported – no *a priori* assumptions are needed about the "system" order, structure, or composition**
- Fully automated weighting function selection based on frequency-response accuracy
- Built-in and reliable parameter accuracy metrics provides added confidence in results over spectral region of interest and importance
- Integrated procedure for identification and model structure determination
- Time-domain verification of models, including identification of offsets and biases

## *1.1 'Case Methodology'*

As discussed in this User's Manual, the term 'case' refers to all of the user inputs required for a single execution of any program (FRESPID, MISOSA, and so on). A complete set of inputs is saved and can later be retrieved via a user-defined case name. This mechanism is implemented for all the major computational programs in the **CIFER®** software system, except NAVFIT.

Case information is contained in various commons and is read from or written as records on the database. The parameters for DERIVID and VERIFY were divided into several sub-categories; e.g. MODel parameters, SENsor coefficients, F-matrix values, etc. Each subcategory is stored in a separate file used by both DERIVID and VERIFY. Specialized utility programs also use these data records as needed.

Case names may be up to 8 characters, although DERIVID allows 12 characters. Since case names are used as the prefix of various file names, DO NOT use names with any character which will cause a file naming error when an extension is added. Also, DO NOT use underscores in case names since underscores are added by the software to create frequency response names.

When all variables are set to the user's satisfaction, the program submits a job to the batch queue to do the computations. The name of the batch job is the case name preceded by a 3-character code specifying the parent program. For example, a FRESPID job computing frequency responses for the XVLATSWP case will be called FRE XVLATSWP. The user will be notified when the job completes, and a log file will be created. Files of the form progr_case.COM.next# and progr_case.OUT.next# will be produced and saved in the batch directory identified by the active SIFDEF file (see Section 5). For example, FRE_XVLATSWP.COM.01 and FRE_XVLATSWP.OUT.01.

## *1.2 Time History Data (THD) Files and CIFER® Databases*

***It is essential to recognize the distinction between THD files upon which CIFER® operates and frequency response databases produced by those operations.*** The frameworks for each are produced with installation. Pointers to the databases (*.dat and*.idx) and to type-dependent time history files (such as *ct or *.mat) for a given analysis or session are formed via the SIFDEF construction discussed later in this manual (sections 1.3 and 5).

The usual first step in using CIFER® is the analysis of time history data with the FRESPID utility. CIFER® implements four built-in mechanisms for accessing time history data files. The user selects between these methods via his response to the "`Time history source:`" query on FRESPID screen three. These time histories can come from a variety of sources and schemes, but the most common are:

- CIFER Binary - individual files containing one channel of data, associated with one parameter
- CIFERTEXT or CTDIF – comma or space-delimited text file with header and a matrix of parameters and their data
- Site-specific data formats and exchange mechanisms (linked via READMIS)
- A third-party application (EXCEL and MATLAB directly supported)

We discuss each of these next. There remain several NASA-specific time history schemes, including TRENDS and FLYTE, but these are no longer widely used so are not discussed further.

Please note that CIFER® does NOT rewrite time histories back to the originating source.

A time history is uniquely identified by the aircraft, flight, event, and channel name. Start and stop time within the time history record may also be specified. Depending on the format this may be in the file itself, or via a CIFER® Program screen. Given these items and a code indicating which database scheme to use, the time history interfaces can go read the correct file(s)/records(s) and return an array of data.

### *1.2.1 CIFER Binary (Type 1)*

`File` – This corresponds to a simple "binary" data file format of the type used in the sample time history files distributed with the CIFER® package. These files consist of a single vector of floating point data, structured in such a way that they can be read by the following simple FORTRAN code segment[1]:

```
DO i=1, npts
    READ( lun ) data(i)
END DO
```

Because Type 1 time history files contain only the data points themselves, the user must enter the time step between samples[2] (in seconds) in the corresponding field of FRESPID screen three.

Finally, CIFER® requires that Type 1 time history files must be stored in a specialized directory tree structure, based upon "flight number" and "event". This tree is rooted at the location pointed to by the CIFER® environment variable THLOC. **Figure 1-3** illustrates a typical directory tree containing Type 1 files.

Note the manner in which the flight and event numbers are encoded into the subdirectory names and file names. In addition to the flight and event number parameters, the file name itself encodes a third parameter, the data channel name, as follows:

**`<channel>E<event no>.<flight no>`**

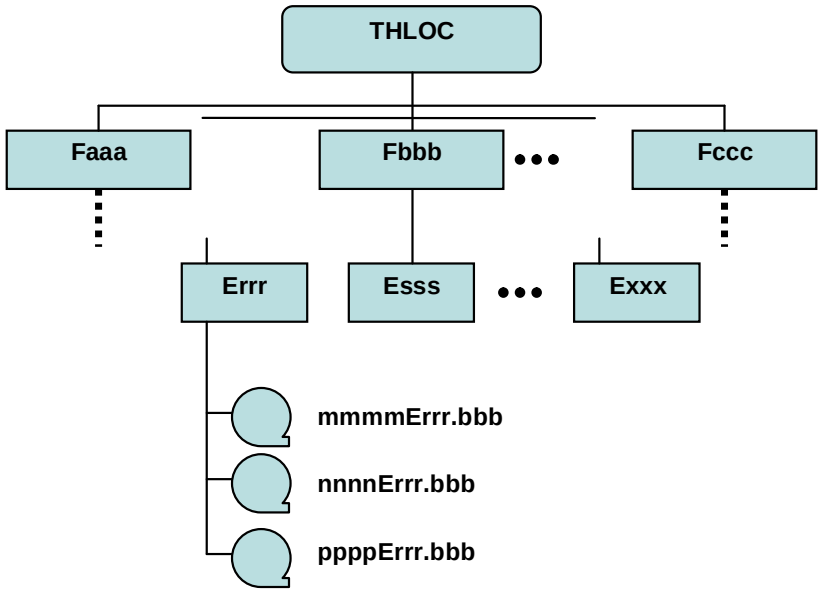



***Figure 1-3:***

***Typical Type 1 Time History Directory Tree***

***F = Flight Number***

***E = Event Number***

The CIFER® software system comes with a variety of utilities to assist the user in this file organization. One of those is mvhistories, which aids in creating this tree of CIFER® time histories. If all files are correctly named and reside in a single directory, then invoking this utility will create subdirectories and move the files into their proper places.

---

[1] Note that, as far as the record structure of the data file is concerned, this is most definitely *not* equivalent to the "implied loop" form `READ(lun) (data(i), i=1, npts).`

[2] CIFER always assumes that data are equally spaced in time.

### *1.2.2 CIFERTEXT (Type 5) or CTDIF (Type 8)*

CIFER® WINTEL now supports a more compact and exchangeable ASCII input format that combines all channels needed for an analysis. These formats are similar, with the only effective difference being the header information.

**CIFERTEXT Format**

CIFERTEXT files follow this simple effective format:

Record 1 : A floating point number representing the sampling period (delta time)

Record 2 : A list of channel names separated by spaces and/or tabs

Record 3 : Floating point values, separated by spaces and/or tabs. Each line should contain as many values as there were channel names defined in Record 2.

**Figure 1-4** shows a sample of a CIFERTEXT file.

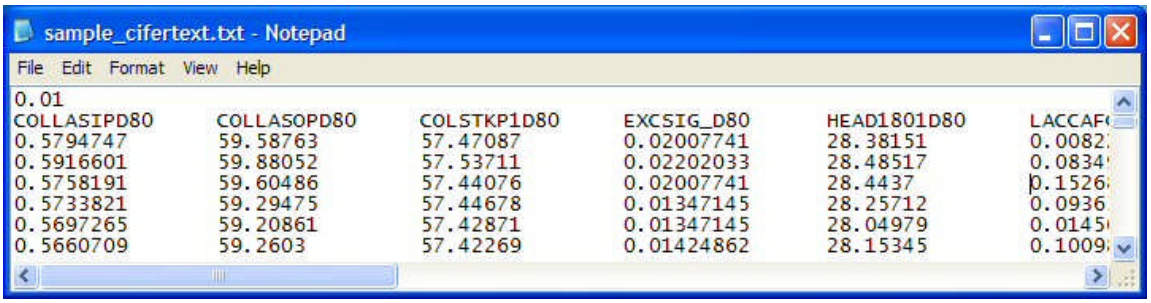



***Figure 1-4: CIFERTEXT file sample***

**CTDIF Format**

CTDIF varies from the CIFERTEXT format only in the details of the header:

Record 1 : User defined (e.g., flight/event references)

Record 2 : User defined (e.g., analysis-specific keywords)

Record 3 : User defined (e.g., a text description of the file)

Record 4 : A list of channel names separated by spaces and/or tabs

Record 5 : Floating point values, separated by spaces and/or tabs. Each line should contain as many values as there were channel names defined in Record 4.

In CTDIF, "time" is often one of the channels (first column suggested) for the DT reference.

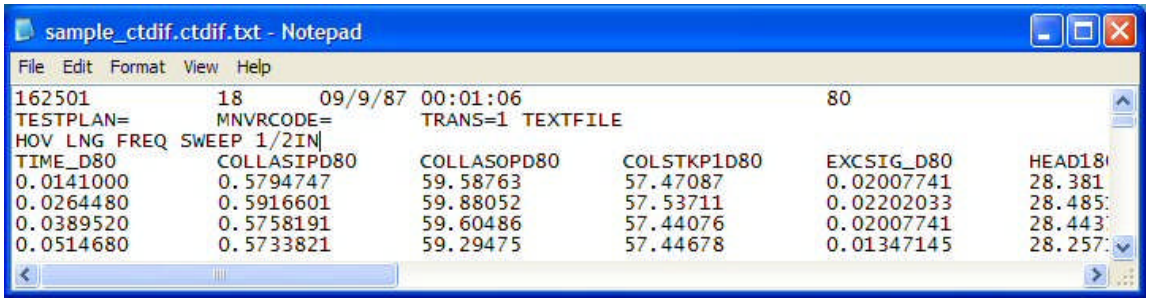



***Figure 1-5: CTDIF file sample***

To complete the THD files link for your analysis session, when you select Types 5 or 8 for the time history source, you will be presented with screen 3B (not shown in the CIFER® User's Manual, but illustrated as **Figure 1-6**). On this screen you are asked to provide a filename for each flight number and event number combination that you have specified on previous screens.

### *1.2.3 READMIS (Type 4)*

The formats of this type time history files are completely user defined. In order to access these files, CIFER® will call a user-supplied routine named READMIS (an acronym for READ MIScellaneous data formats). In the WINTEL version of CIFER®, the READMIS routine must be structured as a Dynamic Link Library (DLL). This library may be compiled independently of the CIFER® code, and need only be placed in the CIFER® "bin" directory in order to become available to CIFER® at runtime.

Because a user who works with several types of time history files could easily forget exactly which READMIS DLL was currently in use, the READMIS library must also implement a "READMIS_IDENT" function which, when queried by CIFER®, will provide a user-defined identification string. This string will be displayed on CIFER® screen three next to option "4", in place of the word "READMIS".

Beyond these requirements, CIFER® places *no restrictions* on the structure of the READMIS library or the manner in which the time history data itself is accessed or stored. In particular, there is *no requirement* that the data be stored in files which are named and arranged in a directory hierarchy such as was one shown in Figure 1-3.

The call arguments for the READMIS routine are well documented in the header block for the 'READMIS stub' (a sample READMIS code provided with this package, see below), however, a few further comments about time history data organization are in order here. As noted in the case of Type 1 time history data files described above, CIFER® regards time history data as organized around the parameters 'flight number', 'event number' and 'channel name'. And indeed, the READMIS arguments **flightNo**, **eventNo**, and **channel** convey exactly this information into the READMIS module.

Once again, when you select option 4 for the time history source, you will be presented with screen 3B (not shown in the CIFER® User's Manual, but illustrated here; see **Figure 1-6**). On this screen you are asked to provide a filename for each flight number and event number combination that you have specified on previous screens. This filename information will be made available to READMIS via the **filename** argument.

Of course, your READMIS data may not reside in individual files at all — it may be located in a database or grouped in some other fashion in container objects. Thus, it is important to realize that, for Type 4 time history data, CIFER® makes no use of these various pieces of information, other than to pass them to your READMIS routine. You may encode *any* type of information into these parameters that will help you locate your data. For example, it may be more appropriate for your purposes to associate a *directory path* with each "flight number" and "event number" pair, rather than a file name. (Or, you may choose to enter nothing at all — it is not necessary to enter "file names" if you have no need for an additional qualifier.)

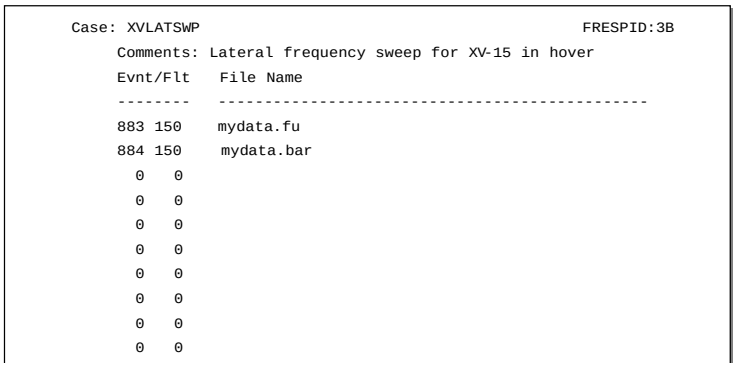



***Figure 1-6: FRESPID Screen 3B***

## The READMIS DLL Projects

In order to generate a READMIS DLL for use with the CIFER® package, the user will need to have access to an integrated development environment (IDE) capable of building standard Win32 DLL modules. Although any IDE with this capability may be used, the CIFER® package is distributed with sample projects for two common WINTEL IDE's: Visual C/C++ and Digital Equipment Corporation's Visual Fortran 90. If you have either of these IDE's, you need only open the appropriate project, insert code specific to your data access requirements into the READMIS template or "stub", and select 'Rebuild All' from the 'Build' menu. If you wish to use an IDE other than one of these, you may still be able to use the template modules as a starting point for your development efforts.

In addition to the template modules, each project contains an actual working sample READMIS program, which may be substituted for the READMIS stub code when building the project. This fully functional READMIS program will generate a DLL that *duplicates* the operation of the Type 1 option. That is, it will read Type 1 time history files from the directory tree rooted at THLOC in exactly the same manner as would be the case if option one were selected in response to the "Time history source?" query on screen three.

All of these modules, both the templates and the code for the Type 1 READMIS samples, are meticulously documented. Each is a self-contained tutorial covering everything you will need to know in order to implement your own READMIS code. However, as you approach the task of constructing your READMIS module, please realize that it is precisely because of the depth of this documentation that these programs may seem somewhat formidable; appearances notwithstanding though, there is actually very little coding required to produce a usable routine.

## Organization of the Project Directories

The READMIS projects are located in the directory `$cifroot/source/readmis`, in the folders `readmis_f90` and `readmis_c`. The directory structure of each is identical; the structure of the `readmis_c` directory tree for the MATLAB Binary READMIS library is shown in **Figure 1-7** [3].

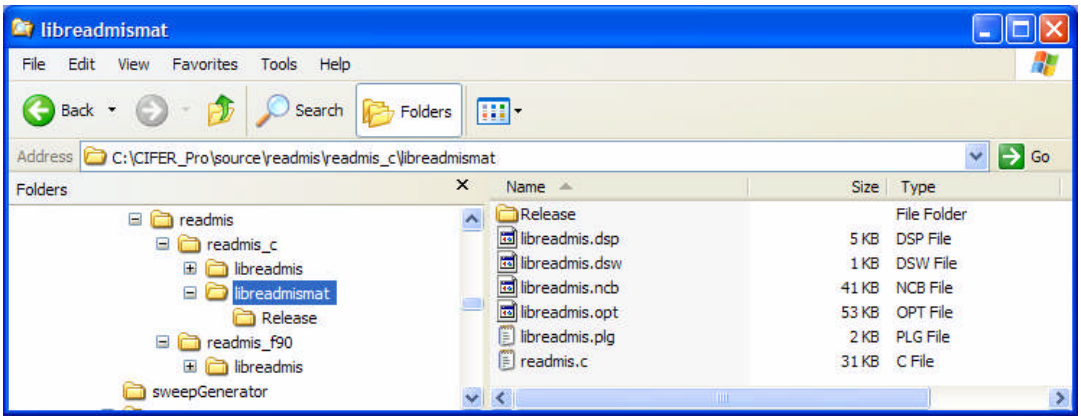



***Figure 1-7: READMIS Directory Tree***

In the case of the C-language project, the files `readmis.c.STUB` and `readmis.c.TYP1`, located in the `$cifroot/readmis/readmis_c` directory, contain respectively the code for the template READMIS routine and the sample Type 1 emulation READMIS routine.

---

[3] Some files may appear with different icons on other machines.

To build either of these modules using the predefined project, simply copy the desired file into the *$cifroot/readmis/readmis_c /libreadmis* directory and rename it to `readmis.c`. (The procedure is analogous for the Fortran project. The corresponding files are `readmis.for.STUB` and `readmis.for.TYP1`.)

The IDE may be launched by double-clicking on the file `libreadmis.dsw`, located in the *$cifroot/readmis/readmis_c/libreadmis* directory. Selecting 'Rebuild all' from the 'Build' menu will compile, link and install the resulting DLL into the CIFER bin directory. (Should it become necessary to perform the installation manually, the DLL may be found in the *$cifroot/readmis/readmis_c/libreadmis/ Release* directory, once the build operation has been successfully completed.)

**Implementing a READMIS Routine**

As noted above, the sample and template READMIS files are completely documented and should provide all the information that you will need to implement a site-specific version. This section provides only a brief overview of the issues which must be addressed during that process; they are as follows:

- You will be required to provide a 14-character "ident string" which will be used to identify the READMIS DLL on FRESPID screen three. This string may contain any information you wish. Its purpose is to serve as a mnemonic aid to help you determine, at runtime, which DLL you are using.

- The READMIS routine will be called in two different "modes" as CIFER executes. The mode is indicated by the value of the **mode** argument to the READMIS call. If **mode**=1, CIFER expects READMIS to return, in the **DELTAT** argument, the time step between data elements. (*It is important that no actual time history data be returned when* **mode**=1.)

- When READMIS is entered with **mode**=2, CIFER will expect it to return the actual time history data in the **ARRAY** argument. The number of data points provided must be returned in the **NPTS** argument, and this number must be less than or equal to the maximum array size as given by the **arraysiz** argument. (This dimension is nominally 100,000 points, although implementation may vary from platform to platform.)

The areas of the template file which must be modified to meet these requirements are clearly marked. To see an actual example of a functioning READMIS routine, examine the `readmis.TYP1` file for the language of your choice.

### *1.2.4 Third Party Software Interfaces*

CIFER® may be connected to data generated from 3rd party software such as EXCEL, MATLAB, LabView, OriginLab, and the like. This is best done by exporting the data sets from the external application into one of the ASCII formats just described (CIFERTEXT or CTDIF). Most modern analysis and simulation software is capable of this directly or using simple utilities. Alternatively, a READMIS DLL may be constructed specific to the as-formatted data (discussed next). Finally, if the data is already in binary channels as described in section 1.2.1 then these can be organized into the needed directory structure, and linked by pointing to the directory through Setup Utilities.

**Installing the MATLAB DLL**

Recognizing the widespread use of MATLAB in the engineering and science enterprises that CIFER® supports, a pre-constructed MATLAB READMIS DLL is delivered with the standard installation. Only one READMIS DLL may be attached at a time.

Please note that standard MATLAB (not binary) data may be exchanged via simple extractions into CIFER®'s ASCII formats: CIFERTEXT or CTDIF.

The purpose of this DLL is to provide the means to read MATLAB Binary data. The MATLAB binary file must contain a "time" (lower case) array and arrays of the same size as "time" for all channels to be read. The DT (delta-time) is the average of the time steps, but each time step should be as near DT as possible. Differences of up to two percent from DT are allowed. This MATLAB binary file can be created via the MATLAB command:

```
save file.mat time chan1 chan2 chan3 ... chann
```

where "..." is not the MATLAB continuation indicator but signifies channels 4 through n-1 by whatever name.

These files are portable between platforms.

The following instructions replace the default READMIS DLL with the MATLAB DLL. The basic requirements to begin are:

The MATLAB DLL: libreadmis.dll.matlab

MATLAB libraries need to be known at run time if the MATLAB binary reader READMIS DLL is the active READMIS library.

If MATLAB libraries are not available, the MATLAB binary reader READMIS DLL MUST not be the active READMIS library.

First, save the current DLL:

Using the MKS Unix shell (accessible directly or by launching CIFER, then exiting – leaving the Unix window open and active)

```
cd $cifbin
mv libreadmis.dll libreadmis.dll.fstub
```

Please Note: If another libreadmis is already installed, then save it to an appropriate name instead of libreadmis.dll.fstub, e.g., libreadmis.dll.ctdif. Remember that the ID is displayed on screen FRESPID:3.

Next, obtain the new MATLAB binary reader READMIS DLL, and install (again using the MKS Unix shell)

```
cd $cifbin
mv <where you put the file>/libreadmis.dll.matlab libreadmis.dll
```

If you deposited the file directly into $cifbin:

```
mv libreadmis.dll.matlab libreadmis.dll
```

Add MATLAB DLLs to the runtime environment (again using the MKS Unix shell):

```
export PATH="${PATH};<your MATLAB directory>\bin"
```

Example:

```
export PATH="${PATH};C:\MATLABR11\bin"
```

Note: It may be desirable to change the PATH environment variable as shown in the Installation Guide and Release Notes so the MATLAB DLLs are available every time a CIFER shell is started.

### *1.2.5 Byte Swapping (Big-Endian-Little-Endian Conversions)*

Some CIFER® users must migrate their databases and analyses between Unix and WINTEL platforms. To facilitate such exchanges, the needed databases now are portable among Unix and WINTEL CIFER® version 4.1.00 and above. Before these versions, the generally big-endian architecture of most Unix systems and the little-endian architecture of PCs running either Windows or Linux meant that data created on one could not be read by CIFER® on the other.

Byte-swapping software has been added to overcome this problem. No matter where or when the database was created or last modified, it is portable between platforms as long as the installed version of CIFER® used to read the database meets the version 4.1.00 requirements.

Swapping is done transparently when records are read from the database; records are always written without swapping. As a database is copied between the two types of machine, and records are updated, it is likely and acceptable that records of both *-endian will exist.

Remember that a database comprises a data file (*.dat) and an index file (*.idx). If ftp is used to transfer a database, use binary mode. This should go without saying for the binary data file, but it is also important to use this mode for the index file. Otherwise, when an index file is copied to a Windows machine in ASCII mode, a DOS end-of-record character is added to every line, breaking the database software.

## *1.3 Frequency Response Database & Naming Conventions*

The core of the CIFER® analysis technique is the generation, conditioning, fitting, and combining of frequency responses from control and output time histories. Frequency responses, such as those produced by FRESPID, are generated either as stand-alone ASCII files or are written to the CIFER® frequency response database. The latter provides a more compact storage method and stores information about how the frequency response was generated. However, because of the file format, the data is not directly human-readable and can be accessed only via the CIFER® software. (Note that the 'print frequency response utility' allows generation of an ASCII file containing frequency response values from the database.) The format of these files is:

| | |
|---|---|
| Record 1: | Descriptive information about the frequency response |
| Record 2-n: | Frequency, magnitude, phase, coherence, gxx, gyy, gxy, real part of response, imaginary part, error (one record per frequency value) |

Related CIFER® matrix sizes are defined as follows:

[M] = ns x ns

[F] = ns x ns

[G] = ns x nc

[Tau] = no x nc

[H] = no x ns

[Xi] = no x nc

where, ns = number of states (max of 40)
no = number of outputs (max of 20)
nc = number of controls (max of 10)

A frequency response, then, consists of a set of arrays and descriptive information The arrays contain the frequency values, frequency response magnitude, phase, coherence etc. The attributes summarize how and when the response was created. In order to keep track of frequency responses the following naming system is used.:

case_pgm_windows_inchan_outchan

where,

**case** is the case name (typically up to 8 characters)

**pgm** is the source program (always 3 characters: FRE, MIS, COM, DER, VER, or NAV); DERIVID can also produce DTA as the program.

**windows** is the string indicating the window(s) used (5 characters)

**inchan** is the user-defined control/input channel (up to 4 characters)

**outchan** is the user-defined observer/output channel (up to 4 characters)

As the user progresses through the CIFER® programs, additional frequency responses are generated at each step. All intermediate responses are kept. Frequency responses are overwritten only when the user reruns a program using a previous case.

Note: Consistency problems may result if you change case information after you have already used results from an earlier (different) version of the same case name. For instance, if you have already run FRESPID, MISOSA, and COMPOSITE for a particular window size and you then rerun FRESPID changing window parameters for an existing case and window, you will probably cause yourself grief .... unless you continue on and rerun MISOSA and COMPOSITE using the new frequency responses.

As an example of the generation of frequency responses by CIFER®, consider this sample run of FRESPID, MISOSA, and COMPOSITE.

For a case involving two controls, four outputs, and five windows, FRESPID creates the following 40 frequency responses:

**XVLATSWP_FRE_A0000_AIL_P**
**XVLATSWP_FRE_0B000_AIL_P**
**XVLATSWP_FRE_00C00_AIL_P**
**XVLATSWP_FRE_000D0_AIL_P**
**XVLATSWP_FRE_0000E_AIL_P**
**XVLATSWP_FRE_A0000_AII._R**
**XVLATSWP_FRE_0B000_AII._R**
**XVLATSWP_FRE_00C00_AIL_R**
**XVLATSWP_FRE_000D0_AIL_R**
**XVLATSWP_FRE_0000E_AIL_R**
**XVLATSWP_FRE_A0000_AIL_AY**
**XVLATSWP_FRE_0B000_AII._AY**
**XVLATSWP_FRE_00C00_AIL_AY**
**XVLATSWP_FRE_000D0_AIL_AY**
**XVLATSWP_FRE_0000E_AIL_AY**
**XVLATSWP_FRE_A0000_AII._VDOT**
**XVLATSWP_FRE_0B000_AIL_VDOT**
**XVLATSWP_FRE_00C00_AIL_VDOT**
**XVLATSWP_FRE_000D0_AIL_VDOT**
**XVLATSWP_FRE_0000E_AIL_VDOT**
**XVLATSWP_FRE_A0000_RUD_P**
**XVLATSWP_FRE_0B000_RUD_P**
**XVLATSWP_FRE_00C00_RUD_P**
**XVLATSWP_FRE_000D0_RUD_P**
**XVLATSWP_FRE_0000E_RUD_P**
**XVLATSWP_FRE_A0000_RUD_R**
**XVLATSWP_FRE_0B000_RUD_R**

**XVLATSWP_FRE_00C00_RUD_R**
**XVLATSWP_FRE_000D0_RUD_R**
**XVLATSWP_FRE_0000E_RUD_R**
**XVLATSWP_FRE_A0000_RUD_AY**
**XVLATSWP_FRE_0B000_RUD_AY**
**XVLATSWP_FRE_00C00_RUD_AY**
**XVLATSWP_FRE_000D0_RUD_AY**
**XVLATSWP_FRE_0000E_RUD_AY**
**XVLATSWP_FRE_A0000_RUD_VDOT**
**XVLATSWP_FRE_0B000_RUD_VDOT**
**XVLATSWP_FRE_00C00_RUD_VDOT**
**XVLATSWP_FRE_000D0_RUD_VDOT**
**XVLATSWP_FRE_0000E_RUD_VDOT**

In addition, if cross-correlation of inputs is requested, then the following responses are also computed (you must generate these if you are going to run MISOSA):

**XVLATSWP_FRE_A0000_AIL_RUD**
**XVLATSWP_FRE_0B000_AIL_RUD**
**XVLATSWP_FRE_00C00_AIL_RUD**
**XVLATSWP_FRE_000D0_AIL_RUD**
**XVLATSWP_FRE_0000E_AIL_RUD**

Running MISOSA to condition the AIL responses for RUD (20 responses, one for each output and window) generates:

**XVLATSWP_MIS_A0000_AIL_P** (uses AIL_P, AIL_RUD)
**XVLATSWP_MIS_0B000_AIL_P**

**etc.**

**XVLATSWP_MIS_A0000_AIL_R etc.**
**XVLATSWP_MIS_A0000_AIL_AY etc.**
**XVLATSWP_MIS_A0000_AIL_VDOT etc.**

If you want to condition the responses for other inputs, you must rerun MISOSA with a different primary input. COMPOSITE will then combine frequency responses for the five windows:

**XVLATSWP_COM_ABCDE_AIL_P**
**XVLATSWP_COM_ABCDE_AIL_R**
**XVLATSWP_COM_ABCDE_AIL_AY**
**XVLATSWP_COM_ABCDE_AIL_VDOT**

# 2. System Requirements

## 2.1 Operating System

This version of CIFER® and its supporting components should run on any NT4, W2K, or XP WINTEL workstation or server system. CIFER® is also available with equivalent functionality for Unix Operating Systems (Solaris, IRIX), Linux, and MAC OS9 (requires 3rd party software).

No attempt has been made to test CIFER® on Windows 95, 98, or ME and no representation is made as to CIFER®'s suitability for use on such systems.

## 2.2 Program Versions

You may see some differences between actual program/utility screens shown in this manual and the actual displays. Some of the Program User descriptions provided in this manual are for earlier versions of the CIFER® software version. The purpose and functionality of each program/utility screen is generally unchanged.

## 2.3 Single and Multiple User CIFER® Systems

A single user CIFER® installation is one in which only one person of the (perhaps) many people with accounts on the system, actually uses CIFER®. On such a system, ***it is recommended*** but unnecessary to create separate user configurations and directory structures in order to segregate the operational environments of multiple users. If the standard setup is retained you will create databases and customized data input routines directly within the primary CIFER® directory tree without fear of impacting others. *However, you must then ensure that this data is saved and restored properly when applying any future CIFER® version updates.*

However, on systems which support multiple CIFER® users, it is necessary to duplicate, on a per user basis, certain portions of the primary CIFER® directory structure in order to provide segregated areas for the storage of user data. In these installations, the ***cifroot*** environment variable will point to the primary CIFER® directory (as created during installation), while the ***cifhome*** environment variable will point to the root of each individual user's CIFER® directory tree. These "per user" directory trees are *not* subtrees of the primary CIFER® directory, but rather, are usually located in the user's own directory. (For a more complete explanation, including specific instructions on creating these user directories, see the CIFER® Installation Guide and Release Notes – Version 4.1.00 or later.)

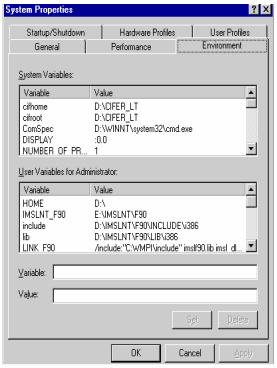



***Figure 2-1***
***Environment Tab of the (WINTEL) System Applet***

# 3. Summary of CIFER® Programs

CIFER® for the WINTEL platform is distributed as a set of (executable) Programs, scripts, and data. As already introduced the main Programs consist of FRESPID, MISOSA, COMPOSITE, DERIVID, NAVFIT, VERIFY, and a range of specialized utilities (administrative, analytical). This section provides a brief overview of each. Each of these programs and utilities is completely described later in this document.

| | |
|---|---|
| **FRESPID** | Page 1 – Select Case and Aircraft (session indexes) |
| Frequency Response IDentification | Page 2 – Enter Controls (up to 10 inputs) and Observers (up to 20 outputs) |
| | Page 3 – Enter flights and events to be analysed (start/stop times optional) |
| | Page 4 – Define composite control (input) channels and units |
| | Page 5 – Define composite observers (output) channels and units |
| | Page 6 – Set desired combinations of input/output to compute (incl. ALL) |
| | Page 7 – Condition input time histories |
| | Page 8 – Set up window parameters (manual or automatic) |
| | Page 9 – Set plotting options |
| | Page 10 – Launch frequency responses calculations |
| **MISOSA** | Page 1 – Select Case and Aircraft (session indexes) |
| Multi-Input Conditioning | Page 2 – Check/Change session setup, incl. controls, outputs, and windows |
| | Page 3 – Set desired combinations of input/output to compute (incl. ALL) |
| | Page 4 – Set up plots |
| **COMPOSITE** | Page 1 – Select Case and Aircraft (session indexes) |
| Multi-window Averaging | Page 2 – Check/Change session setup, incl. controls, outputs, and windows |
| | Page 3 – Set desired combinations of input/output to compute (incl. ALL) |
| | Page 4 – Set up plots |
| **DERIVID** | Page 1 – Select Case and Aircraft (session indexes) |
| Generalized Stability Derivative Identification from Frequency Responses | Page 2 – Set up links to matrix names [ M, F, G, Tau, H(s) ] |
| | Page 3 – Present model parameters: state names, observers, controls |
| | Page 4 – Set desired combinations of input/output to compute (incl. ALL) |
| | Page 5 – Edit sensor coefficients (alternate method) |
| | Page 6 – Name the responses used in the identification (semi-automatic) |
| | Page 7 – Name the responses used in the identification (manual) |
| | Page 8 – Specify the terms of the M Matrix |
| | Page 9 – Specify the terms of the F Matrix |
| | Page 10 – Specify the terms of the G Matrix |
| | Page 11 – Specify the terms of the T Matrix |
| | Page 12 – Establish named derivatives in M Matrix |
| | Page 13 – Establish named derivatives in F Matrix |
| | Page 14 – Establish named derivatives in G Matrix |
| | Page 15 – Establish named derivatives in T Matrix |
| | Page 16 – Fix the H matrix, and launch analysis |
| | Others |

| | |
|---|---|
| **VERIFY** | Page 1 – Select Case and Aircraft; choose DERIVID or VERIFY |
| State Space Model Verification | Page 2 – Set up links to matrix names [ M, F, G, Tau, H(s) ] |
| | Page 3 – Present model parameters (subset of DERIVID model parameters) |
| | Page 4 – Display sensor coefficients for all observer/control combinations |
| | Page 5 – Display M Matrix elements |
| | Page 6 – Display F Matrix elements |
| | Page 7 – Display G Matrix elements |
| | Page 8 – Display H(s) Matrices (output structure for VERIFY) |
| | Page 9 – Display H Matrix elements |
| | Page 10 – Display j Matrix elements |
| | Page 11 – Display T Matrix elements |
| | Page 12 – Set up source of control channels (time history data) |
| | Page 13 – Set up source of observer channels (time history data) |
| | Page 14 – Modify control channel for "this" model record |
| | Page 15 – Estimate bias for "this" element of the state equation |
| | Page 16 – Model observer channel for "this" model record |
| | Page 17 – Select part or all of the time history sample |
| | Page 18 – Condition time histories |
| **NAVFIT** | Interactive calculation of low order transfer function calculation from high order transfer function or frequency response data. |
| Frequency response analysis utilities | 7 – RMS Utility |
| | 8 – Handling Qualities and Stability Margins |
| | 9 – Frequency Response Arithmetic |
| Program Parameter utilities | 14 – Read ASCII Matrix File(s) |
| | 15 – Read ASCII Response into the Database |
| | 19 – QPLOT: Plot Frequency Responses |
| | 20 – Print Frequency Response Values |
| Database and Setup Utilities | 11 – Change CIFER Defaults |
| | 12 – Case Directory |
| | 13 – Case or Response Delete Utility |
| | 16 – Select Aircraft/Analysis (SIFDEF file) |
| | 17 – Create Aircraft (Create new db or create SIFDEF for existing db) |
| | 18 – Search Frequency Response db |
| | 27 – Database Case Copy |
| | 28 – Database Share (not available on WINTEL) |
| | 29 – Database Compress |
| Results Utilities | 31 – Plot DERIVID Results |
| | 32 – Plot VERIFY Results |
| | 33 – Tabular DERIVID Reports |
| | 34 – Tabular VERIFY Reports |
| | 35 – Print DERIVID or VERIFY Results |
| | 36 – Case Plotting Utility |
| | 37 – DERIVID or VERIFY Matrix Reports |
| | 38 – Eigenvalue Utility |
| | 39 – DERIVID Parameter Dump |

# 4. Running CIFER@

Once you have completed the installation of the CIFER® package, made any necessary manual adjustments to the XVision transport protocols (see Section 3 of the CIFER® Installation Guide and Release Notes; IGRN), and rebooted your machine, you should be able to invoke CIFER® either by double-clicking the shortcut that the installer placed on your desktop[4], or by selecting the START>Programs> Cifer>CIFER Shell menu item (**Figure 4-1**). Note that two different methods for starting CIFER® may give you slightly different CIFER® windows with different properties (e.g., a CIFER® window started via the desktop shortcut may be physically shorter than a CIFER® window started from the Start menu).

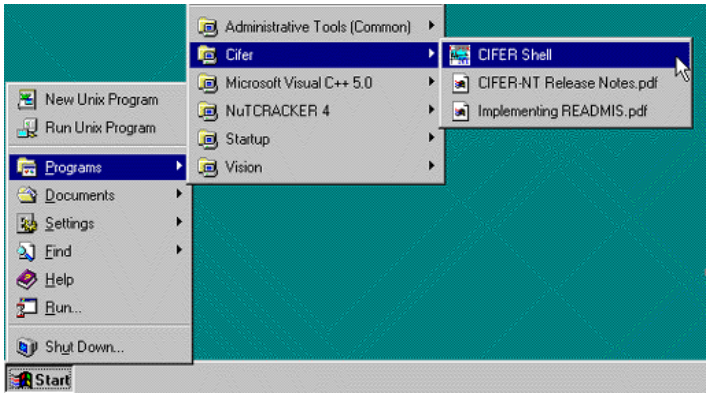



***Figure 4-1: Starting the CIFER® Shell***

When you launch CIFER®, you are actually starting an MKS Korn shell which then ultimately executes the main CIFER® script, after first running several intermediate scripts to set up CIFER®'s environment. This startup process is discussed at some length in Section 5.5 of the IGRN, in connection with CIFER®'s environment variables. Here, it is sufficient to note that you will see a screen similar to the one shown in **Figure 4-2** — the CIFER "splash" screen. Depressing carriage return will then take you to CIFER's main menu screen (**Figure 4-3**), from which you may selectively execute individual CIFER utilities[5].

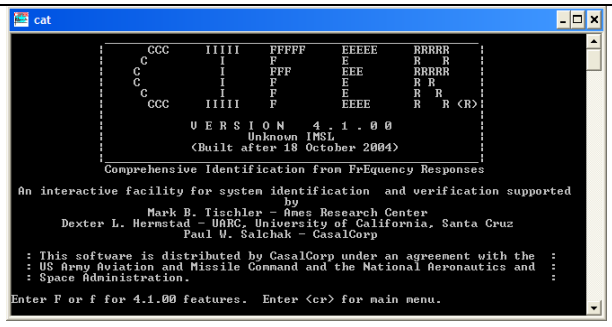



***Figure 4-2: CIFER® Splash Screen***

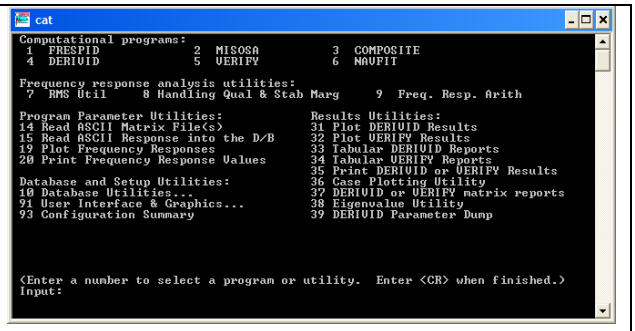



***Figure 4-3: CIFER® Main Menu***

When you have finished your CIFER® session, you will find your cursor at the "input prompt" of the CIFER® main menu screen. To exit CIFER®, simply enter a carriage return and you will be returned to the Korn shell from which CIFER® was initiated. This is a useful

[4] If you do not wish to have the CIFER® shortcut on your desktop, it may be safely deleted.

[5] It is not the purpose of this document to discuss in detail the operation of CIFER®'s various components. For an introduction to these programs please see volumes 1 and 2 of the *CIFER® Class Notes*.

environment from which to manipulate CIFER® output files, re-launch CIFER®, or perform any other tasks for which you find a Unix-like command line interface well suited. You will find that most Unix tools and editors are available, and that features such as "pipes" and background processing work as you would expect. Furthermore, all CIFER® environment variables are defined and available for use, making manipulations of CIFER® directories and files quite straightforward. To restart CIFER® from within the shell, type `'cifer'` (lower case) at the command prompt. To exit the shell entirely, type any one of `'exit'`, `'logout'`, or `'bye'`.

## 4.1 Customizing the CIFER® Shell Window

As they are installed, the CIFER® shortcuts present a somewhat vanilla interface in which important features such as "cut and paste" and scrolling are disabled. You will almost certainly find your CIFER® user experience more productive if you take a few moments to enable some of these features. Note, however, that the operations described in this section will require administrative privilege, since you will be enabling these features for all users of these system-wide shortcuts.

Begin by launching an instance of the CIFER® shell from either the desktop or START menu shortcuts. Right click on the title bar of the menu and select "Properties". Next select the "Options" tab (**Figure 4-4**). Then, check the box labeled "Quick Edit Mode".

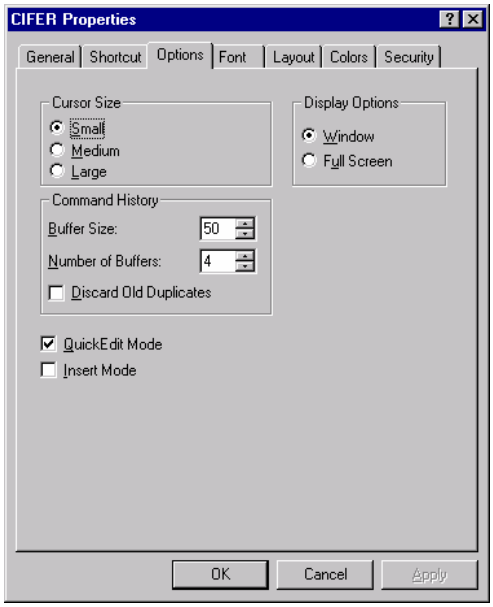



***Figure 4-4: Enabling "Quick Edit Mode"***

With this mode enabled you will be able to capture screen text into the paste buffer by depressing the left mouse button and dragging across the desired text to highlight it, and then releasing the left mouse button to select the highlighted text. Next you can capture the selected text by *right-clicking*. Captured text may be subsequently inserted at the cursor position by *right-clicking* a second time. This maneuver is very useful for duplicating complicated CIFER® frequency response names!

To enable scrolling, select the "Layout" tab of the Properties panel (**Figure 4-5**). In the "Screen Buffer Size" pane, enter a suitably large value (e.g., 1000 lines) for the "Height"; however, leave the "Width" set to 80 columns. Next, in the "Window Size" pane, enter a number of lines sufficient to give the shell window the screen coverage you would like; again, do not alter the width of the window.

There is one remaining customization which you may wish to consider when setting up your CIFER® shortcuts. As it is installed, the CIFER® shell will always launch with white (actually grayish) lettering displayed on a black background. This arrangement can be modified to any desired combination (e.g., black lettering on a white background) by making suitable adjustments in the "Colors" tab of the property panel (**Figure 4-6**).

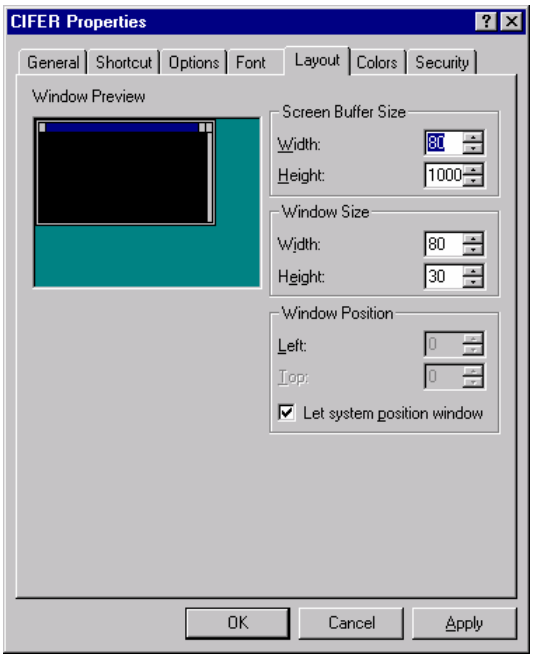



***Figure 4-5: Enabling Scrolling in the CIFER® Shell***

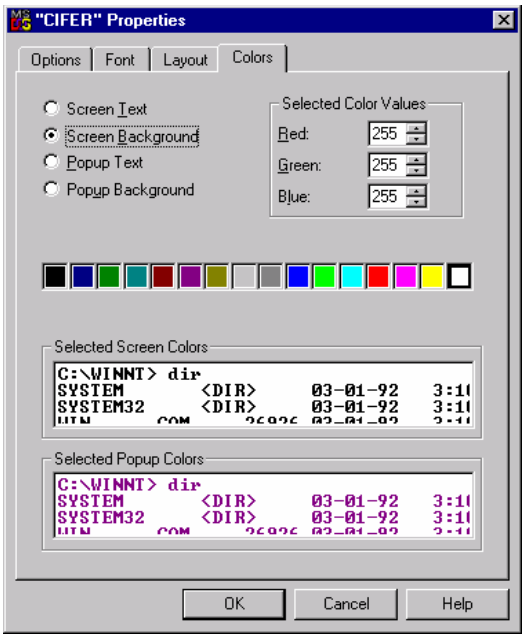



***Figure 4-6: Setting CIFE®R Shell Background and Forearound Colors***

Finally, click "OK" to close the property panel. When you do so, a dialog will appear asking if you wish to apply the changes only to the current window, or to the shortcut that launched the window. You should select the latter in order to have the changes take effect for all subsequent launches of CIFER® from *that* shortcut. (You should then launch CIFER® from the other of the two shortcuts installed by the setup, and repeat these steps to establish the proper defaults for it as well.)

## *4.2 The CIFER® Keyboard Interface*

Many CIFER® utilities interact with the user via a series of data entry screens that make use of cursor addressing. Each screen contains a number of data input fields interspersed with descriptive text. The user can navigate from field to field within a screen using combinations of the **arrow**, **tab** and **return** keys. Once the data content of a screen's fields is satisfactory, the user can proceed to the next screen by depressing the **F1** key. CIFER® does not make use of the computer's pointing device ("mouse").

**Table 4a** summarizes the functions[6] (on a typical keyboard) of the various navigational keys used by CIFER®;

*Data Entry*. Once the user has navigated to a field, the procedure for data entry is straightforward. In general, all printable characters will appear in the field as they are typed. It is important to remember that casenames, control names, and the like [i.e. names of things] must match exactly from use to use (including case). In addition please recognize that in this version some CIFER® command and option selections remain case sensitive. However the authors are removing this restriction and this should be a minimal encounter for the current user. Finally along with the standard numeric keys, on most keyboards the numerical keypad can also be used for data entry provided the "Num Lock" has been set.

The double-width "Backspace" key located above the return key (see Figure 6-7) is the character rubout key; it will delete the character immediately to the left of the cursor. The small "Delete" key, located in the six-key cluster above the arrow keys, can be used to delete the *entire contents of a field*.

**NOTE:** A very important change was implemented for CIFER® Version NT12. Except in the extended editing features described immediately below, the first keystroke in a field will wipe out that field. This is the behavior of the Unix version, and some users who were familiar with it requested that it be implemented in the Windows version also.

*Extended Editing Features.* One CIFER® utility, the "QPLOT" program (utility 19), has an optional data entry protocol which is designed to provide additional editing features in order to facilitate the entry of long frequency response names. These features are *only* available in screen one of QPLOT. In this situation, all of the descriptions given in Table 4a remain valid, but the additional capabilities described in **Table 4b** also apply.

**Table 4a: CIFER® Keyboard Navigation and Data Entry**

| | |
|---|---|
| **tab, right arrow** | Move data entry focus right by one field. If currently in right-most field of a screen row, then wrap to left-most field in the next screen row. |
| **left arrow** | Move data entry focus left by one field. If currently in left-most field of a screen row, then wrap to right-most field in the previous screen row. |
| **return, enter, down arrow** | Move data entry focus down to the most closely (vertically) aligned field in the next row. When issued from the last line of the screen, the focus will wrap to the top of the screen. |
| **up arrow** | Move data entry focus up to the most closely (vertically) aligned field in the previous row. When issued from the top line of the screen, the focus will wrap to the bottom of the screen. |
| **any printing character** | Appears in the data field as typed (case sensitive). |
| **backspace** | Deletes the character to the left of the cursor. |
| **del** | Deletes the *entire* content of the current data entry field. |

[6] Users familiar with the Unix version of CIFER® will recall that keyboard mappings could be adjusted in order to compensate for the vagaries of the many keyboard types encountered on those platforms. This type of customization is *not* required on Windows platforms, since the mappings provided by NuTCRACKER are consistent across all systems.

| | |
|---|---|
| **F1** | Accepts the data on the current screen as entered and proceeds to the next screen. |
| **F2** | Presents a secondary navigation menu on the last line of the terminal screen. The menu's options are<br>**`Continue Backup Main Exit Update`**<br>Selection of items on this menu may be made via the right or left arrow keys, or by typing the first letter of the desired entry. Once an entry has been selected, depress F1 to accept. "Update" is an exception. Type "T" or "F" to enable or disable a database update, respectively, to be done after selection of an entry. It is not possible to select this item via the arrow keys, nor does typing "U" have any effect. |
| **F3** | This key is only used in specialized situations; see for example, Class Notes Vol 2, DERIVID operations, screen 4. |
| **F4** | Presents a secondary navigation menu of the form:<br>**`Go to:`**<br>to which the user may respond with a screen number followed by the F1 key or the RETURN key. Screen numbers entered at this prompt may be outside of the range of actual screen numbers for the program; e.g., "99" will take you to the end of the data entry segment for most of the CIFER utilities. |

**Table 4b: QPLOT Augmented Data Entry Features**

| | |
|---|---|
| **CTRL-A** | Moves cursor to the left end of the current field. |
| **CTRL-D** | Moves cursor to the right end of the current field. |
| **CTRL-G** | Moves cursor left by one character. |
| **CTRL-L** | Moves cursor right by one character. |
| **CTRL-O** | Enters character insert mode. Any printable character typed will be *inserted* directly above the cursor. |
| **<ESC>** | Exits character insert mode. |
| **any printing character** | In normal mode, *overwrites* the character directly above the cursor. In character insert mode, the character is *inserted* directly above the cursor, moving the right portion of the line one character to the right. |
| **backspace** | Deletes the character immediately to the left of the cursor, and drags the right portion of the line one character to the left. |
| **del** | Deletes the *entire* line, even if the cursor is positioned in the interior of the line. |

# 5. Getting Started - Setting Up Databases and SIFDEF files

This section will provide an overview of CIFER® databases and the procedures for creating them. SIFDEF files will be described, and the relationship between databases and SIFDEF files will discussed. Finally, a detailed example of the creation of a user database and its associated SIFDEF file will be given.

## *5.1 Organization and Content of CIFER® Databases.*

The CIFER® package consists of a large number of independent utilities which interact by accessing information stored in a common database. An individual CIFER® user may have many such databases, each dedicated to a particular project or even a particular engineering analysis within a project. Each database is given a unique ***aircraft ID*** [7] at the time that it is created. An aircraft ID is a string of up to eight characters. Valid characters include alpha-numeric characters, dashes, and underscores; blanks are not allowed.

Physically, a database consists of a data file (binary) and an index file (ASCII). These files are named `<ARCRFT>.dat` and `<ARCRFT>.idx` respectively. Here the symbol `<ARCRFT>` represents the aircraft ID. (For a detailed discussion of CIFER®'s files and associated environment variables, see section four of this document.)

CIFER® databases can contain many types of data records. The following list, while not exhaustive, describes some of the primary data types and the nomenclature associated with them:

- **Frequency Responses.** Frequency responses (FR) are probably the single most common type of record in the database. These records result from the analysis of time history data by CIFER® utilities such as FRESPID, COMPOSITE, and MISOSA. Utilities that deal with frequency responses (as either input or output data elements) rely on a specific naming convention to identify them in the database. The basic format of an FR name is

  **`<casename>_<program>_<windows>_<input>_<output>`**

  where

  | | |
  |---|---|
  | <casename> | is a user defined alpha-numeric string of up to eight characters. |
  | <program> | is a three character designator for the utility that created the data (e.g., FRE ⇒ FRESPID). |
  | <windows> | is a five character string that indicates which windows were active when the response was computed. Each of the five positions corresponds to a specific window, in order, A — E. If a window is inactive (not used) in the computation, a *zero* appears in its slot. Thus the string 'AB000' would indicate that only windows A and B were used to compute the response. |
  | <input> | is a user defined string that identifies the input control (four character maximum). |
  | <output> | is a user defined string that identifies the output control (four character maximum). |

[7] Of course CIFER is not restricted to the analysis of aircraft data. CIFER originated as an engineering facility for the design of aircraft control and stability augmentation systems. As a result, much of the nomenclature used in the CIFER interface is based on aircraft engineering terminology.

- **Case Data.** When performing an analysis with a CIFER® utility, the user will assign a *casename*[8] to the analysis. Then as he enters data on the utility's various input screens, it will be saved to the database under that name. This "case data" allows CIFER® programs to recall the user's input parameters, thereby minimizing the amount of re-keying required to modify and rerun a case.
- **Model Matrices.** The database contains the various matrices (M, F, G, H, and Tau) used to describe DERIVID models.
- **DERIVID and VERIFY Results.**

It is probably worth mentioning at this point that raw time history data is *not* stored in the CIFER® database. CIFER® provides a set of built-in "hooks" for inputting time history data directly into FRESPID and VERIFY – the only two CIFER® programs which deal directly with time domain data. Information on the time history data formats was provided earlier in this document (Section 1.2) and is not repeated here.

## *5.2 The Purpose of the SIFDEF file.*

The SIFDEF file is a Korn shell script file which is executed during the CIFER® startup process (see section 5.5). It provides definitions for several environment variables (Table 3b) which inform CIFER® component utilities of the locations of the database, time history data files, batch and plot output directories, and the units in which on-screen results should be displayed.

From the user's point of view, the SIFDEF file provides a mechanism for grouping together the files associated with a particular project. This is because, in addition to the items described above, the SIFDEF file defines the ***'ARCRFT'*** environment variable, which contains the *aircraft ID* mentioned in section 7.1, and an associated ***'ANALYSIS'*** environment variable, which contains a user supplied string. (This string is limited by the same rules that govern the aircraft ID; see above.) These two quantities uniquely identify the SIFDEF file and therefore become a "shorthand label" for its contents.

A CIFER® user may have several SIFDEF files, each of which can be used to set up the CIFER® environment for work with a particular aircraft/analysis combination. To distinguish among these files, CIFER® names each file according to the scheme:

**`SIFDEF.<ARCRFT>.<ANALYSIS>`**

where `<ARCRFT>` is a file name extension string which is equivalent to the aircraft ID declared in the SIFDEF file. Similarly, `<ANALYSIS>` is an extension string formed from the definition of the `ANALYSIS` environment variable contained in the file.

Of course there can be only one *active* SIFDEF file at any given time during a CIFER® session. This file is uniquely named `"SIFDEF"`, without any extensions. This active SIFDEF file is a copy of one of the available *"parent"* files, i.e., one of the SIFDEF files that is named according to the convention described above.

CIFER® is installed with a special set of "vanilla" active and parent SIFDEF files called the `"default.default"` SIFDEF files. These files set the aircraft ID string to "default" and the analysis string to "default". One of the first tasks a new user must accomplish is the customization of these files for his own use. To this end, CIFER® provides the utilities under "Database Utilities..." (main menu item #10, see Figure 10 below), which can be used to modify the contents of SIFDEF files.

---

[8] FRESPID, COMPOSITE and MISOSA casenames may be up to eight alpha-numeric characters; DERIVID and VERIFY casenames may be up to 12 characters in length.

It is important to understand that these utilities *never* make changes *directly* to the parent SIFDEF files; only the active SIFDEF file is modified. Then, once the changes are complete, the modified active SIFDEF file is saved back into the parent file. Furthermore, this arrangement means that the only way to create a new aircraft/analysis pair (i.e., a new SIFDEF parent file) is to edit the currently active SIFDEF file and then save it as a new file. This process will be illustrated in the next section.

## 5.3 EXAMPLE: Creating A Database and Associated SIFDEF Files

In this section we will create a database for the example aircraft "MY_FLYER". We will assume that two separate time history data sets for this aircraft are to be analyzed. Assuming further that each of these data sets resides in its own separate directory tree, we will create two SIFDEF files, one for each data set. Finally, we will discuss the modifications which would be required in this scheme if the results of each analysis were to be stored in a separate database.

*The Procedure*. After starting CIFER®, select utility 10 from the main CIFER® menu screen. You will then see a screen *similar* to the one shown in **Figure 5-1** (active SIFDEF may vary depending upon your normal settings).

The first step will be to create the database for MY_FLYER. Since the "Create Aircraft (Create new database or create SIFDEF for existing db)" utility (#17) will store information into the SIFDEF file pertaining to the new database, we will use the currently active SIFDEF file as a template for this new SIFDEF file. Remember, this is only a copy of the parent SIFDEF file, and hence it can be modified without concern for loss of existing data. If you would like to use another SIFDEF file as the template, you first must select it. When you select utility #16 ("Select Aircraft/Analysis (Select SIFDEF file)") you will be shown a list of available SIFDEF files; depress carriage return to dismiss the list and then choose the default selection by depressing carriage return again. When you return to the submenu screen, the "status line" (may be shown in reverse video) would indicate that another SIFDEF file is active if you had specified a different SIFDEF file.

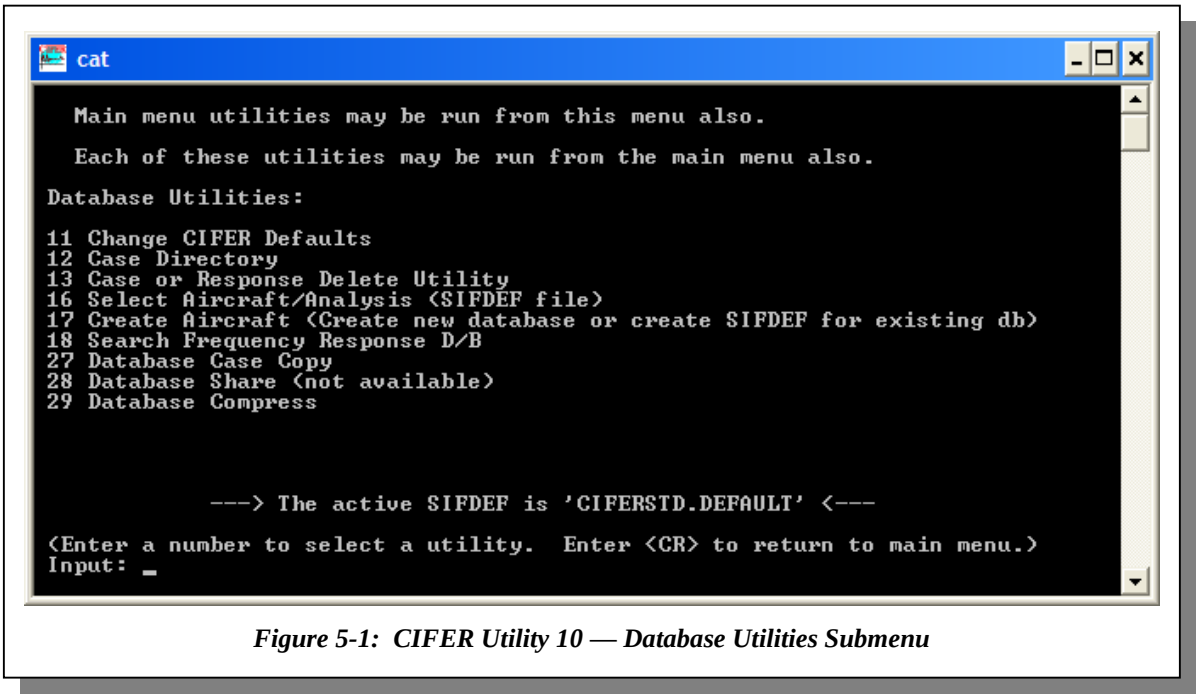



***Figure 5-1: CIFER Utility 10 — Database Utilities Submenu***

Next select the "Create Aircraft (Create new database or create SIFDEF for existing db)" utility (#17). You will be asked first to enter the directory in which the database files are to be created. You may choose any directory that already exists and for which you have write permission. For now, simply accept the defaults and proceed to enter the name of the aircraft ("MY_FLYER") at the next prompt. A final carriage return will bring you, once again, to the Database Utilities submenu screen.

The status line will now read

**`---> The active SIFDEF is 'MY_FLYER.default' <---`**

Note that the "Create Aircraft (Create new database or create SIFDEF for existing db)" utility has changed the aircraft portion of the SIFDEF file name extension. *It is important to realize that the status line shows only where the active SIFDEF file was saved; this does not mean that the extension of the original parent file has been altered.* But, before using the new SIFDEF file, we must adjust the location of the time history data, since one of the goals of this example is to set up analyses that draw from two distinct sets of time history data.

Proceed by selecting utility #11 ("Change CIFER Defaults"). You will next see a screen from which you can edit the contents of the active SIFDEF file (**Figure 5-2**; your actual settings and paths may vary). Navigate to the "`Time history loc`" field and enter the directory path to your data (in this example, `E:\cifer\data\th\Set_1)`. When you are satisfied, press the 'F1' key to accept the screen; you will be returned to the "Database Utilities" submenu.

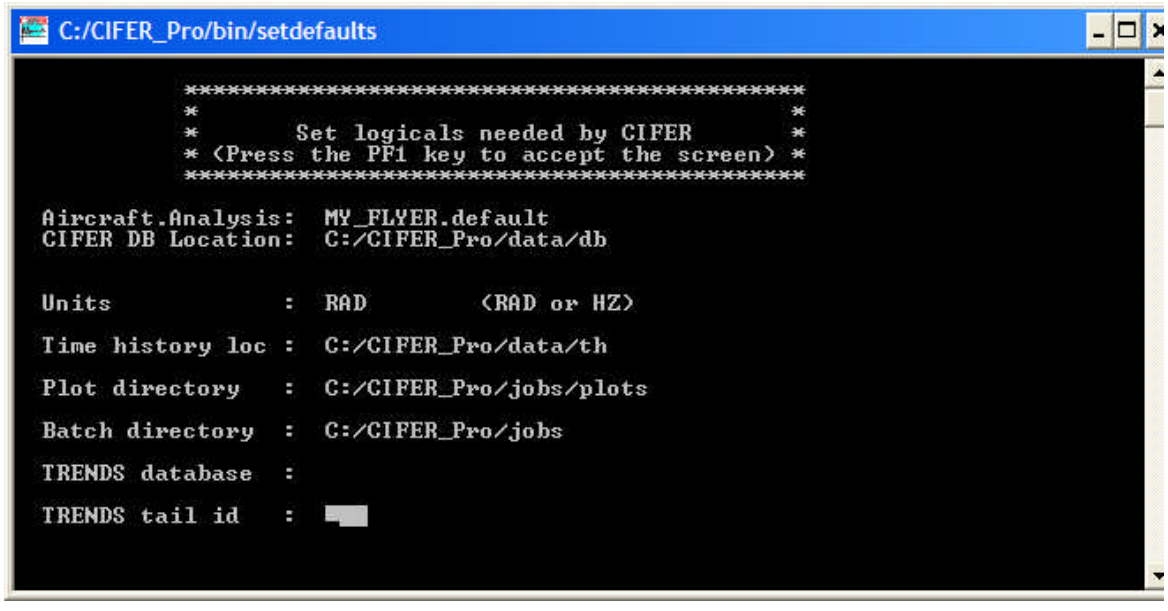



***Figure 5-2: Editing the Active SIFDEF File***

In order to complete the first portion of the setup, the only remaining task is to change the name of the analysis from 'default' (as indicated by the status line) to something suggestive of the origin of the time history data. (Note that it is, unfortunately, not possible to edit the analysis name from within the screen editor utility #11.)

To change the name of the analysis, we will save the active SIFDEF as, say, `SIFDEF.MY_FLYER.TH1` as follows: You will be shown a list of available SIFDEF files for

aircraft MY_FLYER; depress carriage return to dismiss the list and then type TH1 and effect the selection by depressing carriage return again. Upon the completion of this operation, we are returned to the submenu screen, but the status line now reads

**---> The active SIFDEF is 'MY_FLYER.TH1' <---**

**which is the desired result.**

If this were the extent of the task that we had set for ourselves in this example, we could end here by depressing a carriage return to take us back to the main CIFER® menu screen and we could begin our analysis of the data.

However, we originally set out in this example to construct a single database and *two* SIFDEF files: one for each of two sets of time history data. In order to complete that example we must now create a second SIFDEF file. Work done while this second SIFDEF file is active will use the same aircraft database, MY_FLYER, but will take its time history data from a second set of files located in, say, E:\cifer\data\th\Set_2. In this case we will use the "aircraft.analysis" combination "MY_FLYER.TH2" as the SIFDEF name.

So, instead of depressing the carriage return to return to the main menu, we immediately select utility #11, "Change CIFER Defaults", and again edit the "Time history loc" field. Only this time we insert the path to the second set of time history data. (Note that the "Aircraft.Analysis" field will still show "MY_FLYER.TH1" at this point. This is of no concern, since we will change the analysis name when we save the edited SIFDEF file. Remember too, we are only editing the active *copy* of MY_FLYER.TH1; the original has not been modified.)

After accepting the edited screen by depressing 'F1', dismiss the list of SIFDEF files, and save the modified file with an analysis name of TH2. The status line should then read

**---> The active SIFDEF is 'MY_FLYER.TH2' <---**

From this point forward, you may designate one or the other of these files as the active SIFDEF file using utility #16, "Select Aircraft/Analysis (SIFDEF file)".

*Advanced Topic*. The preceding discussion illustrated a relatively straightforward application of "analysis tags" to distinguish between two SIFDEF files which each target the same database. The next logical extension of this scenario would be to the case where the user wished to store the results of his CIFER® analyses for the two time history data sets in *separate* databases.

Since both data sets pertain to the *same* aircraft, logic requires that we *not* use different aircraft IDs , but, on the other hand, the aircraft ID is the sole determinant of the database file name; the analysis tag does not enter into the database name. Thus, the only reasonable way to modify the above scenario to incorporate independent database files for each set of time history data would be to store the databases in *separate directories.*

This can be easily accomplished at the point when the databases are created, i.e., when you run utility #17 ("Create Aircraft (Create new database or create SIFDEF for existing db)"). When you are asked to enter the directory in which to create the database, simply choose a directory structure that reflects the analysis tag that will be associated with the SIFDEF file under construction. For example when creating the database for the first SIFDEF above, you might choose the directory E:\cifer\data\db\MY_FLYER\TH1\ instead of accepting the default. (Remember, though: database directories *must* already exist or creation will fail.) Finally, it may also be worth noting that utility 17 will automatically update the database location field in the active SIFDEF whenever you enter something other than the default directory while creating a new database file.

# 6. Working with CIFER© Graphics Output

## *6.1 Hints and Tips for On-Screen Graphics*

As has already been mentioned in this guide, WINTEL CIFER®'s on-screen graphics are generated via an X Window display server. A key concept in the X Window paradigm is "focus", that is, which screen object (usually a window) will receive any user generated input (e.g., keystrokes, mouse clicks, etc.). The default focusing method for the SCO X server distributed with CIFER® is termed "implicit focus", which means that the cursor need only be located within the boundary of the X window in order for it to "have the focus", or, *conversely, the cursor need only wander away from the window for it to lose focus.* (This stands in contrast to regular WINTEL windows, which operate by "explicit focus", wherein the user is required to click within the window in order to activate it.)

The concept of focus is important in WINTEL CIFER® graphics operations because it is necessary (in two of the three WINTEL CIFER® graphics configurations) for the graphics window to have the focus before it can be dismissed. *CIFER® graphics windows (in configurations 1 and 2) are dismissed* (returning focus to the CIFER® input screen) *by typing a carriage return while the graphics window has focus.* This means that if your mouse wanders away from the window boundary, nothing will happen when you depress carriage return! Also, if the title bar of the plot window reads "Hit RETURN to close & continue", *do not* dismiss the graphics window by clicking the window's "close box", because this will cause the parent CIFER® utility to immediately exit.

Users familiar with Unix versions of CIFER® will know that those systems support several operational modes which allow multiple plot windows and persistent plot windows. Due to limitations inherent in the NuTCRACKER/WINTEL interface, these modes were only recently implemented in the WINTEL version. The default WINTEL CIFER® mode is to support a single plot window that must be dismissed (by hitting the RETURN key) before interacting with CIFER® again. You can select your preferred mode via utility 91 (available in CIFER® main menu).

Please note that on some systems, plots do not automatically pop to the top when generated (i.e., they can be obscured by other windows). Check the Windows status bar if you don't see your plot (the icon corresponding to the plot should appear in the status bar; if so, you can click on it to bring the plot forward).

*Working with plot windows.* Although it may not be apparent at first glance, CIFER® plot windows *are* resizable. Simply move the cursor to the border of the window and it will change into a bi-directional arrow, indicating that resizing is available. (Once you finish the resizing, be sure to return the cursor to the interior of the window in order to retain focus!)

After you have resized a plot window, there are several keyboard commands which are available for manipulating the aspect ratio (remember, the plot window must have focus). These controls are defined in **Table 6a**.

If you are using an WINTEL CIFER® graphics configuration that allows multiple plots to appear on the screen (configurations 2 and 3 allow this) then plots can accumulate quickly. If you wish to close all of your plot windows quickly you can type the following (at the Unix command prompt):

```
$PERL $cifscripts/close_all_xplots
```

| Table 6a: Graphics Window Aspect Ratio Adjustment Controls | |
|---|---|
| **R** | Restores the graphics window to default size. |
| - | Makes one dimension of the window smaller in order to restore the default aspect ratio. |
| + | Makes one dimension of the window larger in order to restore the default aspect ratio. |

## 6.2 Hints and Tips for PostScript Graphics

In addition to the on-screen graphics CIFER® generates using the X Window system, most CIFER® utilities produce graphical output in PostScript form as well. These files can be quite large and can consume *significant* amounts of time and printer resources if they are printed directly. For that reason, you may wish to develop a capability for previewing them and extracting the frames of interest for printing. You may even wish to move beyond this simple capability, and develop techniques for "editing" individual plot frames in order to render them suitable for publication. This section will offer some suggestions for utilities that may be of use in addressing these issues.

A diagram of the idealized post-CIFER®-execution graphics workflow is depicted in **Figure 6-1**. Of course the degree to which the real-world workflow matches this schematic will depend significantly upon one's choice of software.

Possible software candidates for performing the first of the operations (previewing plots) depicted in Figure 6-1 are *Ghostscript* and *GSview*, freely downloadable packages maintained by GNU and Aladdin. (Ghostview is included with the CIFER® software system installation for versions 4.0.05a or later).

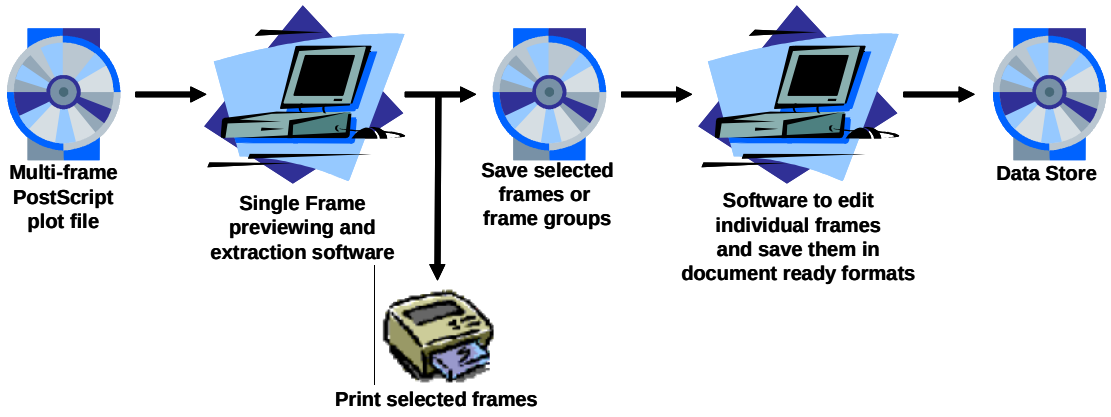



***Figure 6-1: Idealized Graphics Workflow***

A more complete and integrated set of utilities can be used; such as higher end document processing applications like Adobe Acrobat[9] (which includes Distiller) and Adobe Illustrator. These commercial products provide a seamless path from CIFER®'s multi-frame PostScript output files through plot preview, frame extraction, printing, editing, and encapsulation for document insertion. **Figure 6-2** illustrates the workflow as realized with these products.

[9] Adobe Acrobat should not be confused with Adobe Acrobat Reader, which is a free utility for viewing portable document format (PDF) files.

The first step in this process utilizes the Acrobat Distiller utility to convert the raw PostScript graphics output file into a "portable document format" (PDF) file. This is a fast operation, taking generally only a few seconds even for relatively large files (e.g., ~150 plots). As illustrated in Figure H-2, the resulting PDF file becomes the primary input source for either of two possible post-processing scenarios: a previewing, extraction and/or printing workflow, or an editing/document preparation workflow. In addition, once the raw graphics files have been converted to PDF format, they can be easily shared with colleagues, regardless of platform type, since the free Acrobat Reader utility is available for every major platform and OS. (As an added advantage, the PDF files are usually 50% – 70% smaller than the original PostScript plot files, making them easier to transmit electronically.)

In general, the easiest way to prepare a CIFER® plot for insertion into desktop or web publishing documents (e.g., documents prepared with Microsoft Word, PowerPoint, or other page layout/presentation software), is to convert it to an encapsulated PostScript (EPS) document. An EPS format file is a special type of PostScript file that can contain only a *single* "page image" which is specially "encapsulated" to allow it to be placed and rendered *within* another PostScript page. This file format is the format preferred by most page layout programs for use when importing figures and illustrations into PostScript documents.

Adobe Illustrator will allow you to read any frame of interest from a multi-frame PDF plot file and save it as an encapsulated PostScript file. Of course, in addition to this simple format conversion, you can make various editing changes as might be required to meet your publication constraints. Using Illustrator's editing features, you can, for example, scale and/or rotate the plot[10], change any or all label fonts, and add or delete labels and annotations.

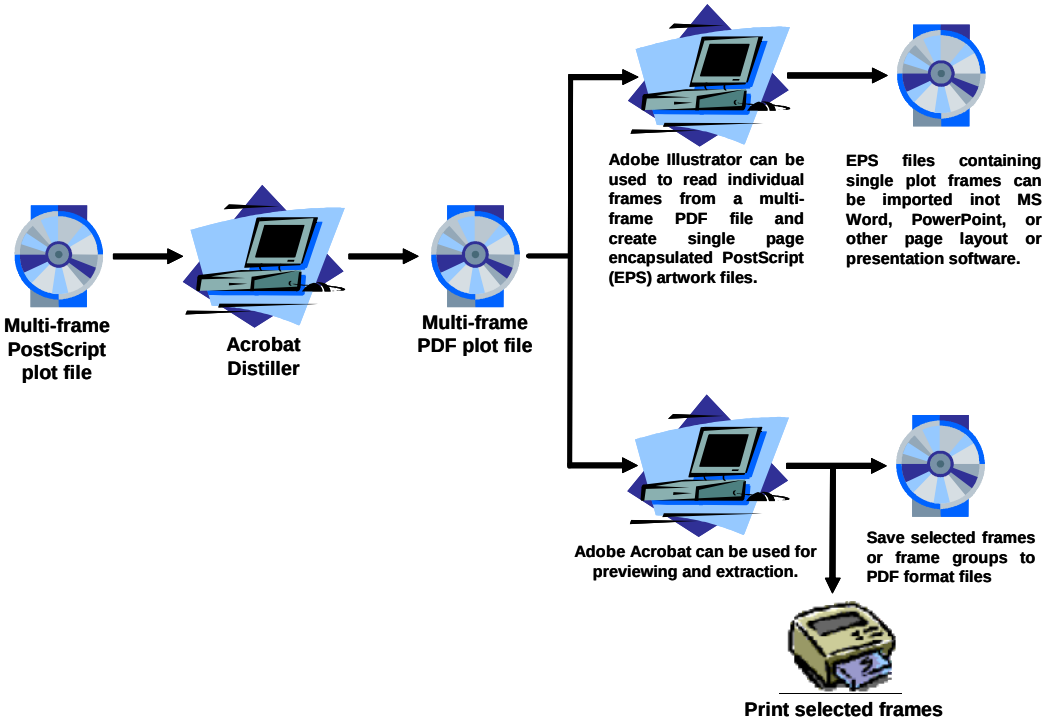
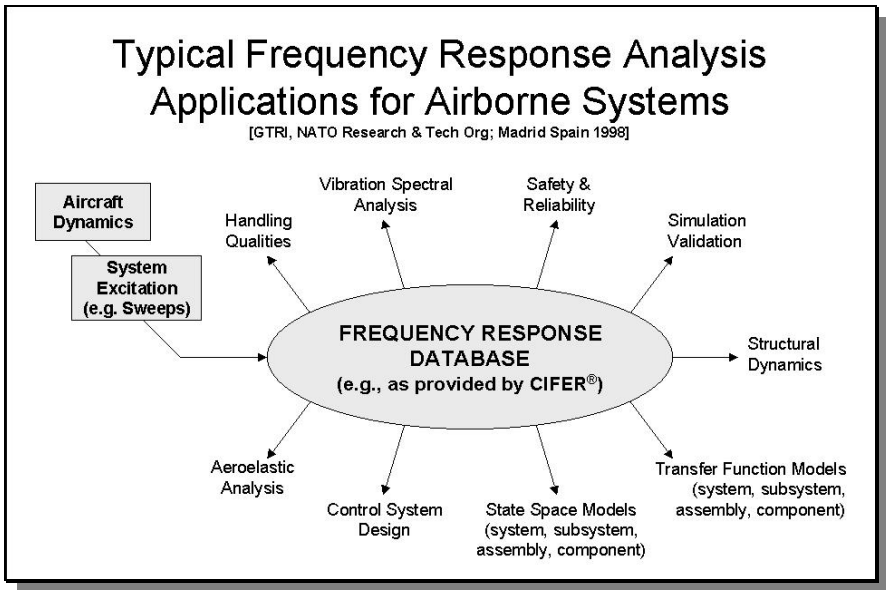



***Figure 6-2: CIFER Graphics Workflow Using Adobe Distiller, Acrobat, and Illustrator***

[10] Although plots can be rotated easily in both Adobe Illustrator and Acrobat, you may wish to consider selecting "Portrait" mode on CIFER®'s plot setup screens ("Landscape" mode is the default) when generating large numbers of plots for publication.

# 7. Examples

A wide range of examples of CIFER® use have been published. A benchmark book on Frequency Domain System Identification by Dr. Mark Tischler will also be available from AIAA in 2006; the reader is promoted to watch for this important and valuable tool!




In this section we provide examples to assist both the new user gain familiarity with CIFER® features, and the experienced user to refresh. The reader is also promoted to periodically revisit CasalCorp's CIFER® Support Area (www.casalcorp.com) for new examples, document updates, and related publications.

## *7.1 Models and Components*

These examples are under construction, and will be provided with a future version of this User's Manual. See also the CIFER® Primer (publication pending).

## *7.2 CIFER® and Unstable or Nonlinear Systems*

*(Contributed by Dr. Mark Tischler)*

One of the most common misconceptions about (frequency domain) system identification in general is the notion that it can only be effective for stable mode systems. In other words, one assumes that the Bode diagram of an unstable system response has no meaning because of an erroneous belief that the techniques demand that any transients must decay or die out before a sinusoidal response results.

***This conclusion is simply incorrect!*** The source of the confusion is a common interpretation that the frequency response only has meaning when a constant sinusoidal input can produce a constant sinusoidal output. This is a very simple way of thinking about the frequency response determination process for a stable system, bit it is not how a frequency response is defined.

The frequency response IS defined and has complete meaning and validity for stable or unstable systems. The definition is simply the substitution of s->jw. There is a huge amount of literature published on this point from as far back as the 1940s, addressing frequency response methods that include unstable systems (Bode, Nichols, Nyquist, and many others). All helicopters and most modern aircraft have unstable modes. This just means that there is a gain reduction margin and a gain increase margin in the control system. Part of the problem is that current standard control systems don't address this very much.

So yes, frequency methods are appropriate for both stable and unstable systems. That is the point; the only requirement is to ensure that the output does not blow up. This means that the excitation source (pilot, SAS, simulation) must regulate the input to be sure that the response is bounded. That is an easy requirement to meet, but disallows a steady sine wave input to an unstable system since this would indeed result in an unbounded response (a nuance that is another aspect of the common confusion on this point).

Many examples of frequency response methods for design and analysis of flight vehicles that contain unstable modes are thus to be found in the literature (X-29 is a particularly good reference since it is highly unstable; real-time frequency response methods were used to validate stability margins in flight).

That said, it is critical to take care with plotting and interpreting the Bode plots for systems that have either zeroes or poles in the right half plane. The danger is that many engineering packages such as MATLAB produce a plot that needs to be shifted by 360 degrees. Also, depending on the pole-zero configuration, the right-plane situation (aka "no-minimum phase transfer-function") will require the use of the zero-degree crossing as the criterion rather than the -180. Again, MATLAB's plotting routines are not smart enough to pick this up. If instead you use a root-locus plot in conjunction with the Bode plot on even a simple example [e.g., 1/(s-1)] this will be clear.

In short, as with most engineering challenges, the unstable systems DO have an impact on the design of experiments and testing methods. Again, they do NOT invalidate in any way the meaning of the frequency response results or methods.

## *7.3 Using CIFER® as a Signal Processor*

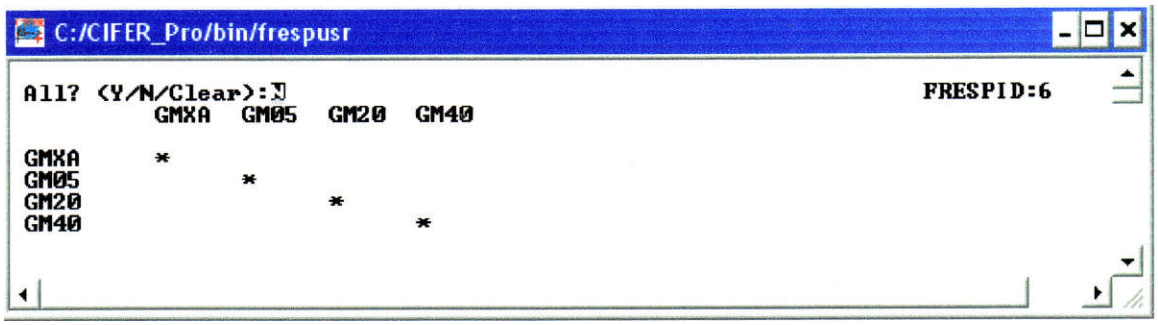
*(Contributed by Dr. Jeff Lusardi, Dr. Mark Tischler, and Dexter Hermstad)*

One of the least utilized and most powerful aspects of the CIFER® software system is its use as a signal processor for feature observation, extraction, or trending.

In many applications of CIFER®'s analysis facilities the user seeks to extract a mathematical description of the response dynamics of a vehicle from flight-test data. For such applications, the COMPOSITE program combines the individual window results to achieve a set of consistent spectral functions (Gxx, Gyy, and Gxy) that together yield a frequency response of minimum random error and that track the coherence of the most reliable frequency-response data.

By contrast, signal processing applications require an accurate estimate of the autospectra of an isolated signal, and the coherence of input-to-output pairs is not a consideration. This is accomplished by specifying the input equal to the output in FRESPID. For this case, COMPOSITE does not use coherence weighting, but the weighting due to window length is retained.

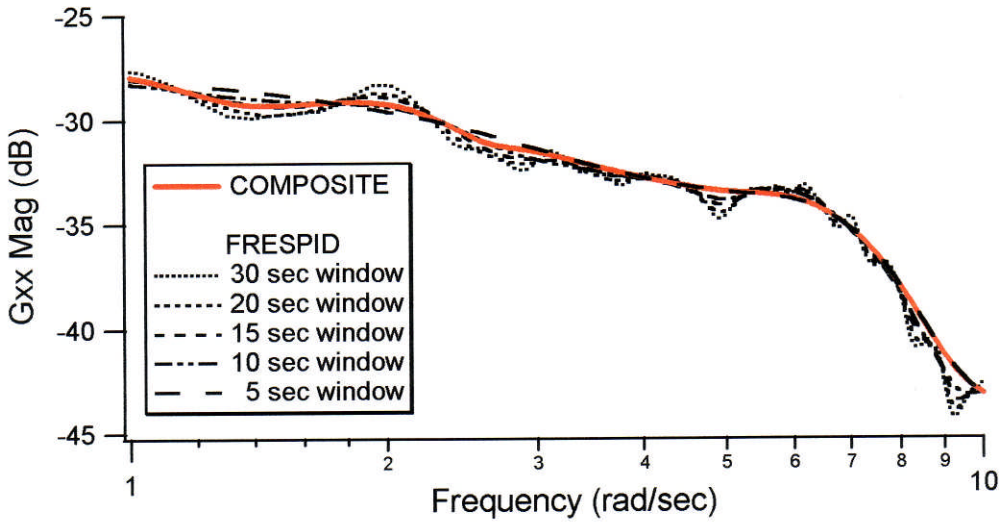
This is illustrated in the following signal processing example, where estimates of the autospectra of four time histories (GMXA, GM05, GM20, and GM40) are desired. The figure shows the input-output pairings for this case from FRESPID screen 6.




***FRESPID screen 6 with input-output pairing for signal processing.***

The FRESPID frequency responses are then combined in COMPOSITE, where both the coherence and random error are calculated for each window. With the input equal to the output (as per the figure), all the windows will have unity coherence at all frequencies, and weighting based on coherence is not used by the algorithms in COMPOSITE, but the benefit of averaging based on window length is retained.

The next figure is a plot of the resulting autospectra of one of the time histories, GM40 from COMPOSITE, and for the individual windows from FRESPID. The figure clearly illustrates that the desired results have been obtained from COMPOSITE: a smooth autospectra that tracks the autospectra from the longer windows at low frequencies, and tracks the autospectra from the shorter windows at high frequencies.




***COMPOSITE and FRESPID input autospectra.***

## *7.3 The X15 Database*

A standard CIFER® installation is delivered with a fully populated XV15 database, with both hover and forward flight conditions represented. This is used as a reference for both the detailed descriptions of CIFER® Programs and Utilities that follow (Section B of this Software User's Manual), and for the lab exercises provided with CasalCorp's CIFER® Training Series (CD/DVD set). Please consult that Training Series manual for a complete description of the XV15 Test Cases and data bases.

# SECTION B –

# CIFER® PROGRAMS AND UTILITIES