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THESIS

AN ANALYSIS OF THE INGRES DATABASE
MANAGEMENT SYSTEM APPLICATIONS PROGRAM
DEVELOPMENT TOOLS AND PROGRAMMING
ENVIRONMENT

by

James Frank De Stael

December 1986

Thesis Advisor:

C. Thomas Wu

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An Analysis of the INGRES Database Management System
Applications Program Development Tools and Programming
Environment

by

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requirements for the degree of

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ABSTRACT

This study examines the database application programming environment presented by the Applications-By-Forms (ABF) subsystem of the INGRES database management system (DBMS). The development of a bibliographical search and report application program is discussed. The operation of the application program is described. Positive and negative aspects of the ABF programming environment are examined. The use of INGRES Query Language (QUEL) and Operation Specification Language (OSL) are also discussed.

TABLE OF CONTENTS

I. INTRODUCTION -----	6
A. INGRES/MENU -----	8
B. INGRES/QUERY: QUERY-BY-FORMS (QBF) -----	9
C. INGRES/FORMS: VISUAL-FORMS-EDITOR (VIFRED) -----	11
D. INGRES/REPORTS: REPORT-BY-FORMS (RBF) -----	12
E. INGRES/GRAPHICS: GRAPH-BY-FORMS (GBF) -----	13
F. INGRES/APPLICATIONS: APPLICATIONS-BY-FORMS (ABF) -----	14
II. DEVELOPMENT PROJECT DESCRIPTION -----	16
A. PROJECT OBJECTIVES -----	16
B. PROJECT DESCRIPTION -----	16
C. THE PROGRAMMING ENVIRONMENT -----	26
III. SUMMATION AND RECOMMENDATIONS -----	29
A. LANGUAGES -----	29
B. HELP SCREENS -----	32
C. CURSOR CONTROL -----	32
D. EFFICIENCY CONSIDERATIONS -----	33
E. OPERATIONS IN OSL -----	33
F. FIELD ATTRIBUTES -----	34
G. MISCELLANEOUS -----	35
H. CLOSING COMMENTS -----	39
APPENDIX A. FIGURES -----	40

APPENDIX B. OSL CODE SEGMENTS AND INGRES/VIFRED FORMS DESCRIPTIONS -----	71
LIST OF REFERENCES -----	120
BIBLIOGRAPHY -----	121
INITIAL DISTRIBUTION LIST -----	122

1. INTRODUCTION

INGRES is a minicomputer-based database management system (DBMS) developed and distributed by Relational Technologies Incorporated (RTI). This work assumes that the reader is familiar with the various classes of data bases and therefore, without any further explanation of the various database classifications [Ref. 1], it is simply stated that INGRES is classified as a relational database ¹. The noteworthy feature of INGRES is its visually oriented user interface. Rather than presenting the user with the "normal" text oriented display, INGRES presents the user with a form with which to insert (append) data into the data base or with which to extract (query) data from the data base. As has been seen from the user interface research done by XEROX PARC, Apple Corporation's Macintosh Division, and others, there is an increasing trend toward more visually oriented user interfaces. Chernicoff [Ref. 2] explains this trend as a reflection of the philosophy at the Macintosh Division that the user interface should be one which presents the user with a "metaphor for life" hence the

¹ As opposed to a hierarchical, network, or other type of database.

Macintosh "desk top" with its associated icons for trash, files, documents, and so forth. Although not as elaborate as the Macintosh interface, INGRES does present the database user with its own "metaphor for database life" and its associated icon is the form. As explained by RTI [Ref. 3], "A form is similar to a paper form that you fill in. A computer form appears on the CRT of the terminal, and it provides blank spaces in which the computer displays information or you enter information." In addition to providing the user with the form for data entry and manipulation, INGRES also provides the "report" and the "graph" for the formatting of data output into a variety of formats. The INGRES DBMS is composed of several subsystems which will be described briefly in the remainder of this chapter. The purpose of this thesis is to examine and critique the INGRES subsystem called Applications-By-Forms (ABF), which purportedly permits the user to build independent database applications programs through the manipulation of screen based forms. The examination and critique of the INGRES subsystem Applications-By-Forms (ABF) will be accomplished by the development of an independent database applications program. The development project is described in chapter two and the results are presented in Chapter III.

A. INGRES/MENU

INGRES/MENU is best described as the top or executive level of the INGRES system. The user is presented with a form (Figure 1) from which he may access any of the various INGRES subsystems. INGRES is particularly easy to use in this mode due to the abundance of on-line help facilities at all levels, beginning with this topmost level. Some of the fundamental knowledge the user must know is that a screen is actually composed of two entities, a form and a menu. This conglomerate is called a frame. The user utilizes cursor control keys to move the cursor to an item on the form and then presses the "menu" key to select an operation to perform from the menu at the bottom of the screen. The operation is specified by typing the first one or two unique characters of the command's name followed by the "return" or "enter" key. The menu key is generally the "escape" key on most terminals. This method of selecting an item and an operation to perform on it is consistent throughout INGRES.

In Figure 1, the menu is the line that reads, "Go History CommandMode DBswitch Shell Help Quit". The remainder of the screen is the form from which items are chosen by placing the cursor on the same line as the item and then depressing the menu key to select an appropriate action.

Figure 1 illustrates all of the subsystems that may be chosen from the executive level. Many of the subsystems

form related groups by virtue of the similarity of their effects. For instance, "REPORT", "RBF", and "SREPORT" are all part of the INGRES system that pertains to the formatting of reports for data output. They will be described briefly below. Similarly, "Query", "QBF", and "QUEL" are all methods of formulating a command to retrieve user specified data from the database.

B. INGRES/QUERY: QUERY-BY-FORMS

INGRES Query-By-Forms (QBF) facilitates routine operations on a database. These routine operations are:

Query - the retrieval of data from the database.

Append - the adding of data to the database.

Update - the changing, usually for the purpose of correction, data in the database.

Delete - the removal of data from the database.

These data manipulations are accomplished on INGRES forms. There are two methods of obtaining a form on which to operate. First, since relational systems are generally thought of as storing data in tables, INGRES can and does use the information from the table associated with the particular database and query to construct a default form. The second option is for the user to create a customized form. There are several methods for creating customized forms, but the simplest method is to utilize INGRES/FORMS: Visual-Forms-Editor (VIFRED), discussed below. The default forms are only satisfactory if the query is relatively

simple (i.e., has few elements) or no one other than the creating user will be seeing the form.

Additionally, QBF includes a "Join Definition" phase which enables the user to define joins between tables in a relational database, selecting only those elements desired for display.

Figure 2 illustrates the opening screen of QBF when called from the screen of Figure 1 (INGRES MENU). If the user simply orders INGRES to proceed at this point, by issuing the "Go" command without entering a form name, then the screen appears as in Figure 3. This is the top level screen of the INGRES/QBF subsystem. All of the INGRES subsystems may be entered directly from outside the INGRES system, i.e., directly from the UNIX operating system shell, by typing the appropriate system shell level command. If QBF is entered in this fashion then Figure 3 is the first screen seen by the user.

Queries may be made based on either a previously defined form which has been assigned a QBF name, a table in the relation, or a defined join definition by issuing the commands "QBFname", "Table", or "JoinDef", respectively. These commands are executed from the command menu of Figure 3.

C. INGRES/FORMS: VISUAL-FORMS-EDITOR (VIFRED)

VIFRED is the INGRES utility system which allows the user to either customize the default forms provided by QBF and other INGRES subsystems, or build a form completely from scratch. There are a few terms which require explanation. Any form in INGRES is constructed of trim elements and fields. Trim is text which appears on the screen in the form of explanatory notes, instructions, etc. Fields are those portions of the screen which either display or receive data. A field has two components, a title, which is also considered to be trim, and a data window which either displays or receives data. As with most common computer languages, data elements have types such as character, floating point, and integer. The capabilities of VIFRED are primarily the following:

- Editing the textual parts of a form, including trim elements and field names.
- Moving elements, trim or field, from one place to another on a form. The title (trim) and data window can be moved separately.
- Add new trim elements and fields.
- Delete existing trim elements and fields.
- Edit a field's attributes.

The above operations are also consistent with and comparable to those in the INGRES REPORT subsystem. Figure 4 illustrates the opening screen of QBF when called from the screen of Figure 1 (INGRES MENU). If the user simply orders

INGRES to proceed at this point, by issuing the "Go" command without entering a form name, then the screen appears as in Figure 5. This is the top level screen of the INGRES VIFRED subsystem. If VIFRED is entered directly from the UNIX operating system then Figure 5 is the first screen seen by the user.

D. INGRES/REPORTS: REPORT-BY-FORMS (RBF)

The RBF subsystem is the complement to the QBF subsystem. RBF will provide a default format for data output in a fashion similar to that of QBF. The user also has the option of editing the appearance and content of the default report forms or constructing one from scratch, also similar to the capability of the QBF subsystem. RBF has a visual forms oriented user interface. RTI [Ref. 3, pg 4-12] lists the following as the characteristics of a report that may be modified using INGRES RBF:

- content and placement of the report's title
- content and placement of the column headings
- display formats for data items in columns
- page length (number of lines per report page)
- underlining
- how rows of data are sorted in the report

RBF is only one means of formatting and producing database reports using INGRES. Another is the REPORT-WRITER. RTI describes the REPORT-WRITER as ". . . an

extensive program that provides maximum flexibility in specifying and formatting data for reports." This increased flexibility however, comes at the expense of the visual, forms oriented user interface. In order to take advantage of the increased flexibility available through the INGRES REPORT-WRITER, the user must learn INGRES's own Report Specification Language (RSL). RBF does provide a generous subset of the report formatting capabilities of INGRES REPORT-WRITER. Figure 6 illustrates the opening screen of QBF when called from the screen of Figure 1 (INGRES MENU). If the user simply orders INGRES to proceed at this point, by issuing the "Go" command without entering a form name, then the screen appears as in Figure 7. This is the top level screen of the INGRES RBF subsystem. If RBF is entered directly from the UNIX operating system then Figure 7 is the first screen seen by the user.

E. INGRES/GRAPHICS: GRAPH-BY-FORMS (GBF)

INGRES GBF is a forms-based graph definition facility. It provides the user with the capability to format data output from a database into the form of graphs and charts instead of, or in addition to, tabulated report format. INGRES GBF also provides the user with some editing capabilities with respect to the final form and appearance of the various graphs and charts. RTI [Ref. 3, pg 4-14] indicates the user determinable features of GBF to be :

- the data to be graphed
- the type of graph to be used (e.g., bar chart, pie chart, scatter plot or line chart)
- line types, dot types, crosshatch patterns
- content and placement of the graph's title
- content and placement of the graph's legend (optional)

GBF is not installed at all INGRES installations and is not installed on the Naval Postgraduate School Computer Science Department's UNIX/INGRES system.

F. INGRES/APPLICATIONS: APPLICATIONS-BY-FORMS (ABF)

INGRES Applications-By-Forms (ABF) enables the INGRES/database applications programmer to develop and compile database applications programs that will run independently of the INGRES system. RTI insists that ABF can be used to develop an applications program without requiring the developer to know a programming language. The database program development can be accomplished solely via the INGRES forms based visual interface. There are however, limitations to the level of sophistication or intricacy of an applications program developed under this interface. INGRES has provided an extension in the form of a small Operations Specification Language (OSL) for those developers who desire to "write" programs of greater sophistication than may be developed through the forms interface alone. INGRES also provides for the incorporation of modules and

procedures written in more conventional programming languages such as COBOL, FORTRAN, PASCAL, C, and BASIC.

An application program developed exclusively through the INGRES forms interface tends to take the form of sequences of INGRES queries and system commands. This limits the flexibility of such a development. In order to realize a higher degree of flexibility in program performance it is necessary to learn the INGRES OSL. This small language is not difficult to learn, consisting of approximately 100 words or less. The use of OSL is particularly required if user defined forms, frames and menus are to be used in the application. The degree to which inclusion of modules written in conventional languages enhances applications program development depends on the proficiency of the individual programmer.

Figure 8 illustrates the opening screen of ABF when called from the screen of Figure 1 (INGRES MENU). If the user simply orders INGRES to proceed at this point, by issuing the "Go" command without entering a form name ², then the screen appears as in Figure 9. This is the top level screen of the INGRES/QBF subsystem. If ABF is entered directly from the UNIX operating system shell, then Figure 9 is the first screen seen by the user.

² Although a form name is optional, INGRES will not proceed without an application program name.

II. DEVELOPMENT PROJECT DESCRIPTION

A. PROJECT OBJECTIVES

The objectives of the development project were two-fold. First, it was necessary to exercise the INGRES Application-By-Forms (ABF) subsystem in order to make a fair, objective assessment of its capabilities and shortcomings in building an application program. Therefore, the first objective was objectivity.

Secondly, the project itself needed a database related application. It was determined that a bibliographical search and report builder would serve the purpose of a database-type application. This would also slightly extend the objective served by modestly exercising the INGRES Report-By-Forms (RBF) subsystem as well.

B. PROJECT DESCRIPTION

The development project assumed the form of a bibliographical search and report builder and was called "references". The program consists of a number of "forms" defined under the INGRES Visual Forms Editor (VIFRED). INGRES "forms" are subsequently combined with "menus" to form "frames". A frame then equates to what a program user sees on the terminal screen. The menus are built with code

segments using INGRES ABF's Operation Specification Language (OSL) and INGRES's version of Query Language (QUEL).

The specific functions performed by the program "references" (the name is not capitalized in deference to UNIX operating system convention) are best presented by "walking" through an execution of the program and addressing the various program functions as they arise. RTI has adopted the convention of calling the <Esc> key the "MENU" key, due to its RTI-imposed function of placing the cursor in the menu line at the bottom of the terminal screen. The same convention will be followed throughout the remainder of this thesis.

1. Topframe .

The first frame, called "Topframe", is shown in Figure 10. Its menu is too large to appear on the screen and so the INGRES system places a right angle bracket, ">", at the right end of the menu, indicating that the menu continues off the screen to the right. Pressing the "MENU" key results in the same frame, but with the appearance of the commands which could not be seen before (Figure 11). Note also, that there now appears a left angle bracket, "<", at the left end of the menu to indicate that the menu now continues off the screen to the left.

From Topframe the user may obtain help on the various menu selections via "MenuHelp", obtain help on how

to move the cursor around the screen via "CursorHelp", select a function from the main menu appearing on the screen above, generate a "Report" of bibliography type references which may be output to either a terminal screen or a line printer, or "Quit" the program without generating a report. If "Quit" is selected, any data rows that were selected for inclusion in an output report during the course of program execution are returned to their original state, i.e. "unmarked".

2. Topics

Selecting "T" for Topics (subject list) results in the display shown in Figure 12. There are more "Catcodes" and "Category Names" than can appear in the table on the screen. INGRES provides for the scrolling of data in tables. ABF automatically includes the INGRES scrolling facilities in any application program produced with INGRES ABF. <Ctrl> F is used to scroll down the table a screen at a time. <Ctrl> G is the complement of <Ctrl> F. <Ctrl> J scrolls down a line at a time and <Ctrl> N scrolls down an entry at a time. <Ctrl> K is the complement of <Ctrl> J. All of the INGRES scrolling functions can be found in the help facility "CursorHelp" which appears in every screen and is described briefly in a later paragraph in this chapter. Selecting "End" at this point (and in every other screen in this application program) would return execution to the previous screen. "MenuHelp" is intended to be unique to

each screen; containing an explanation of the menu items and options available from the particular screen and its associated menu. "Titles" provides a list of titles in the database whose table entries contain a matching entry for the "Catcode" from whatever row the cursor is on at the time "Titles" is selected.

3. Titles

Placing the cursor on the first row of the table in Figure 12 (Catcode = H5) and selecting "Titles", causes the screen of Figure 13 to appear. This screen's table field also contains more entries than will fit in the table on the screen and may be scrolled in the same manner as the last screen. All menu selections at the bottom of the screen are the same as those in the previous screen and perform the same functions, except one. The "Titles" menu item has been replaced by one called "View". The purpose of "View" is to permit the user to select a title in the table field of Figure 13 by scrolling to it as before and then examine the pertinent details that the database contains regarding that particular entry. Scrolling to the first item in the table field of Figure 13, pressing the Menu key, typing "V" or "v", and pressing <Return> yields the display of Figure 14.

4. Viewform

The display of Figure 14 is called "Viewform". This is essentially the bottom level of the application. At this point the user may simply view the most important elements

of the database entry for this title and then back out via the "End" menu function, or "Save" the entry in a customized bibliography file. Selecting "Save" marks the entry for inclusion in the output report "bibliography.report". "bibliography.report" is assembled as the user departs the program from the entry frame (Figure 10) by selecting the menu item "Report" (vice "Quit") in that frame. The output report is written to the directory from which the program is run, which in most cases should be the user's own directory. The user may also unmark any entry that has been previously marked via the "Save" function by selecting "Unsave". There is no limit to the number of times an entry may be marked and unmarked via "Save" and "Unsave". The functions of the remaining menu items remain the same. The frame is departed via the "End" command. Three successive selections of end returns the user to the entry level frame. The next item to examine is the menu item "Keyword".

5. Keyword

Figures 15 through 17, all illustrate the "Keyword" screen. In the previous series, data entry selections were made by "pointing" at the item of interest in a list of similar items and then selecting from a menu, a function to perform on that item. In "Keyword", the user may input a key word or phrase that should appear in the title of any articles of interest, such as "QUEL" or "INGRES" or "RELATIONAL DATABASE". All titles in which the key word or

phrase appears will be listed in the table field on the screen. Although it is not reflected in the illustration, the "Word/Phrase:" field is highlighted in reverse video to draw attention to the fact that this is a required entry. The system (INGRES) will also give an explanatory error message if an attempt is made to bypass a required entry field. The "Keyword" screen initially appears as in Figure 15. Having specific knowledge of a relatively unique word in the sample database, it is typed in the "Word/Phrase:" field. The "Keyword" screen now appears as in Figure 16. The <Return> key has not yet been pressed at this point. Upon pressing <Return> a number of internal actions are carried out, a search for titles containing the input word or phrase is executed, and the resulting titles are returned in the table field. The "Keyword" screen now appears as in Figure 17. The table field entry reveals that there was only one database entry that satisfied the query and further that there was no entry in the "month" column of the relation table for this particular row. Moving the cursor to a title in the table, pressing the Menu key, typing "V" or "v", and pressing <Return> will again bring up the "Viewform" screen of Figure 14. The functions of the remaining menu items remain the same. Selecting "End" returns execution to the main menu.

6. Authors

The search for an article by a particular author begins with the "Authors" frame shown in Figure 18. The prospective user is advised by the text on the screen that initials are not required, but are desirable. The reason for this is obvious, in that initials will increase the uniqueness of the query and return a result closer to that which was both expected and desired. The format is critical, however, also as noted in the text on the screen. The various menu selections are relatively self explanatory. Two menu selections will be "demonstrated", "Author's name Only" and "Author's name and month and year (All) . . ."

7. Author's name Only

The "Author's name Only" screen is shown in Figure 19. The field labeled "Author:" is a mandatory entry field just as was the "Word/Phrase:" field of Figure 15. The "Author" field has all the same attributes of the "Word/Phrase:" field, including reverse video. This screen also executes its function as soon as the entry is completed and the <Return> key is pressed. A list of titles by the author of interest (who is not necessarily the only author of the article) is returned in the table field provided. Using the cursor control functions described earlier and discussed further below, any title in the table field may be scrolled to and viewed (and subsequently saved for a report, if desired). Selecting "End" returns execution to the

"Authors" frame. Using the <Tab> key to move back to the "Author:" field and typing in another name followed by <Return> will execute another query. The functions of the remaining menu items remain the same.

8. Author and Month and Year

Figure 20 illustrates the "Author and Month and Year" frame. The purpose of discussing this frame is that it contains multiple required entry fields. They are sequenced such that when the "Author:" field entry has been completed with the customary <Return>, the cursor automatically proceeds to the "Month:" field and then to the "Year:" field. Neither of these fields requires a <Return>. These fields "execute" as soon as they are full. To fill the "Month:" field requires a standard three letter abbreviation for a month such as "JUN" for June, "DEC" for December, and so on. An arbitrary limit has also been set on the "Year:" field entries. The only values allowed are those four digit integers between 1800 and 2200. Any values outside this range will be rejected with an appropriate error message. As soon as the "Month" field has received an acceptable three letter abbreviation for a month the cursor advances to the "Year:" field. As soon as the fourth acceptable digit is input, the retrieval begins. The functions of the remaining menu items remain the same. The next selection to be discussed is the "Publications" menu item which closely parallels the "Authors" selections.

9. Publications

The "Publications" frame is illustrated in Figure 21. The selection of items from this menu is identical in all respects to that of the "Authors" menu described above. Only the execution of the first selection, "Publication's name only", will be discussed.

10. Publication's name only

Figure 22 illustrates the "Publication's name only" screen. The "Publication:" field is a mandatory entry field and in keeping with the adopted convention it is in reverse video on the terminal screen. There is one significant difference between the "Publications" series of queries and those of "Authors" and "Keywords" described above. The difference is that this series only executes exact match queries (EMQ's) on the "Publication:" field. This requires the exact name of the publication with only one space between each word (because that was the convention adhered to when the data entries were put in the database). The figure illustrates an example using the publication name INFORMATION & MANAGEMENT. In this case two titles were returned from the sample database.

11. Report

The menu item "Report" in Figure 11 is perhaps the most important of all of the selections in the application's main menu. "Report" is one of the two ways in which to exit the program "references". When the program is exited via

the "Report" command all of the "Saved" entries are assembled into a bibliography report format and placed in a file called "bibliography.report", in the user's directory. The name is coded into the program and is therefore invariant. A subsequent running of the program will result in the new report overwriting the old report, if the old report is not first renamed. The file name "bibliography.report" is not sacrosanct and may be changed to any legal file name with no adverse effects to the content or format of the file. After the report is assembled and written to the file "bibliography.report" a final screen appears to remind the user what the name of the file is and where to find it. At this point press <Return> to exit the program.

12. Quit

Quit is the method for exiting the program without generating a report or the file "bibliography.report". When "Quit" is executed all previously "Saved" files are first restored to "Unsaved" condition and the program then terminates without further ado.

13. CursorHelp

Figure 23 is actually the entire file "keyhelp.txt". It cannot all be viewed at once as illustrated in this figure, but may be scrolled through utilizing the commands provided by INGRES/ABF at the bottom of the screen. The type of help provided by "MenuHelp" is

slightly different from that of "CursorHelp" but the functioning is identical. "MenuHelp" is not yet implemented for all screens.

14. Database Maintenance

The bibliographical search and report system described above does not include an integral facility for updating the database. This was done by design for the purpose of maintaining database integrity. The database administrator (DBA) will be responsible for ensuring that appropriate entries are added to or deleted from the database. This can easily be accomplished through INGRES Query-By-Forms (QBF) by first invoking QBF and subsequently entering the QBF name "form3" when prompted for a Table or QBF name. QBF provides all the functions necessary to add, delete, or update items in the database. An INGRES VIFRED forms description of the elements that comprise "form3" can be found at the end Appendix B.

C. THE PROGRAMMING ENVIRONMENT

A frame is the basic screen oriented user interface in INGRES. The applications programmer, working from within the ABF environment, builds the two basic components of a frame, the form and the OSL specification for the frame. These two components are then combined, also from within ABF, to form frames. Figures 24 and 25 illustrate the Application Definition frame. The items in the menu at the

bottom of the frame indicate the range of operations available from within ABF. If the user selects "Rtingres", the screen of Figure 1 appears, providing access to all of the INGRES subsystems. "Options" permits the user to select the text editor to be used to edit the ".osl" files. The ".osl" files provide the menu selections for the frame to which it belongs, and contains the OSL and QUEL statements required to perform the actions indicated by the menu item names. "Define" and "Create" are used to initiate new applications or frames or to edit or redefine already existing frames. "Destroy" is used to destroy either a frame at a time or an entire application. "Go" is used to run an application that is still in the development stage, particularly one that hasn't yet been compiled to a ".exe" file. "limage" is the command to compile an application to an executable (.exe) file. Figure 26, the "User-Specified Frame Definition" frame, provides the remainder of the facilities required to develop an application. Of particular importance in this frame are "Compile", "Edit" and "Vifred". "Vifred" permits access to the forms editor to edit the form for the current frame without having to leave ABF. Edit allows for direct entry into the chosen editor with the appropriate ".osl" file as the object to be edited. "Compile" permits compiling of ".osl" files for the purpose of checking for syntax and other related errors. Although beyond the scope of this thesis, a comment

regarding VIFRED is in order. Much of what can be done with an application is the result of the wide variety of attributes that may be edited into a form through the use of VIFRED's attribute editor, a frame from which is illustrated in Figure 27. Finally, although INGRES provides many ways to initiate a relation table in the database, there is probably none easier than by the selection of the "Table" option in the rtingres menu. The table information frames for the two tables which form the underlying relations for the sample database of this application, "descript2" and "bibindex", are shown in Figures 28 and 29, respectively.

III. SUMMATION AND RECOMMENDATIONS

Overall the INGRES Application-By-Forms (ABF) subsystem was found to be straightforward, easily understood, and easily used once the initial learning curve was passed. The initial task of gaining familiarity with the system is not an insignificant one. The first bit of wisdom gained by the experience of this development project is that it is necessary to learn nearly the entire INGRES system in order to make effective use of all of the facilities INGRES offers. In fact, it is necessary to learn the entire system in order to make effective use of just a portion of the system, and to know which is the appropriate portion to utilize for a given task. While it is true that an application may be built with the INGRES/ABF reference manual in hand, by modifying existing code in the examples in the manuals, such an approach results in applications of severely limited scope.

A. LANGUAGES

In addition to an overall systems knowledge, the prospective application programmer must allocate some time to gain familiarity with the languages used by the system. These are the Report Specification Language (RSL), the

Operations Specification Language (OSL), and Query Language (QUEL).

RSL is used primarily in conjunction with the INGRES Report-Writer and Report-By-Forms (RBF) subsystems. RSL is very similar in syntax and semantics to OSL, discussed below. RSL will not be discussed further since its systems lie outside the scope of this thesis.

OSL is the language used in ABF to specify the menu items at the bottom of the screen, which is called a frame in INGRES. The majority of the later chapters of the Applications-By-Forms User's Guide [Ref. 4] contain a combination tutorial and reference manual for OSL. OSL statements are collected into files with a ".osl" suffix to enable the INGRES system to identify its source code files. OSL commands can be, and usually are, combined with QUEL statements in order to broaden the scope and power of menu functions. The structure of OSL code segments is reminiscent of "C" code segments, beginning and ending with the curly brace. However, OSL is semantically at the opposite end of the scale from "C", resembling macros in the effect of its commands. OSL statements take the form of words and phrases such as "return", "resume field", "callframe", "callproc", "exit" and so forth. OSL's primary function is to direct the flow of control throughout an INGRES application program. As implied previously, OSL is

generally supplemented by QUEL statements in order to have a menu selection specified in OSL perform a data retrieval, update, or some similar database function for which QUEL is designed.

INGRES QUEL is similar in syntax and semantics to the many other existing versions such as that offered by DBASE II and III. The reader is referred to any generally available text on the subject. QUEL, OSL, and RSL are all small but powerful languages designed for a specific, narrow purpose. Since they are small and the syntax is straightforward, it is easy to gain an appreciable measure of familiarity with them in a relatively short period of time.

In summary, with respect to languages, the prospective INGRES applications programmer must either possess, or gain a working knowledge of QUEL and OSL in order to write the ".osl" modules required to bring function to menus. Once this aspect is mastered it is a simple matter to change the menu items in any given frame/screen by simply changing a few OSL statements and recompiling the ".osl" file.

B. HELP SCREENS

ABF, actually OSL, provides a uniquely easy to use facility for including help screens. The OSL command syntax is "helpfile ' *subject* ' ' *filename* '", where "*subject*" is a character string which will be inserted into the INGRES

system error message "Sorry -- cannot open help file on 'subject'". This message is displayed in the event that the system cannot locate the actual text file, "filename", containing the information for the help screen. "filename" should contain the entire path designation required for the system to find the file. The ability to easily provide the end user with on-line help/assistance facilities encourages the application programmer to do so. This of course tends to foster more "user helpful", if not "user friendly" software.

C. CURSOR CONTROL

A very positive aspect of developing programs with ABF is the fact that the same cursor control features available to the applications programmer in the programming environment, are inherited by the application written in this environment, and are subsequently available to the end users of the application. All that remains is to make the end user aware of the capability and perhaps provide some on-line help, as was done in the application "references" with the menu item "CursorHelp", which is available on every screen.

D. EFFICIENCY CONSIDERATIONS

The response time of a database query is at least in part related to the storage structure of the data. Although not strictly a feature of ABF specifically, INGRES provides

some latitude in the selection of an appropriate storage structure for a given application. The default structure is the heap, but several others are available. RTI has provided some guidance on this issue with respect to the options available in the INGRES system [Ref. 5, chap 17].

E. OPERATIONS IN OSL

The frames used in an application program may have primarily one of two origins; Query-By-Forms (QBF) frames and User-Specified frames. User-Specified frames provide the applications programmer with a considerable amount of latitude in both how a frame appears and how the frame operates. The operations in a User-Specified frame fall into three categories: menu items, field activations and initializations. Examples of all three of these methods of operation can be found throughout the program "references". RTI [Ref. 4,pg 9-11] provides the following explanations of these three categories of operations:

Menu items are the most common type of operation in a forms application. They provide the operations that appear in the menu at the bottom of the screen. By selecting a menu item, the user can execute the indicated operation. Such an operation could include a variety of specific actions, and could be a combination of database and forms manipulations.

Field activations are less common, but nonetheless very useful. Field activations occur when an end-user enters a value in a field and then tries to move to the next field. If the application designer has defined a field activation on that field, then the operation specified is carried out.

An *initialization* occurs when a field is first displayed. Although initializations can cause any action to occur, they are normally used to set up the frame.

An example of a *field activation* occurs in "references" in the frames under "Authors" and "Publications" which contain fields for month and year entries. An example of an *initialization* occurs in the "View" frame. The code for this field activation is found in the OSL file "viewframe.osl". Menu items, as RTI remarks, are common and found throughout the application.

F. FIELD ATTRIBUTES

The ability to edit a field's attributes was mentioned previously but deserves a section in the summary as well. This facility is actually a part of another INGRES subsystem, the Visual Forms Editor (VIFRED). VIFRED is the medium through which the forms, which make up the majority of that which is visible in a frame, are created and revised. It is highly recommended that the applications programmer become intimately familiar with the VIFRED subsystem. Mastering VIFRED will open an entirely new dimension in screen and field control through the proper utilization of field attribute editing. An examination of the menu of attributes that may be controlled, Figure 27, should serve to illustrate the point. There is at least one item in this list which is of limited utility, however. The ability to provide a default value for a field is severely

limited in its usefulness when it is for display purposes only. In the "Keyword" frame of the program "references", a default value of the wild card character, "*", was provided for the "Word/Phrase:" field, which is also a mandatory field. When the frame appears on the screen, the asterisk appears in the "Word/Phrase:" field, but pressing <Return> only results in a system message to the effect that this is a mandatory field and an entry is required. This indicates that INGRES does not recognize the default value in a field as a legitimate query object. This fact is not well documented, if at all.

G. MISCELLANEOUS

1. Word Wrap

The user will note, probably with some degree of subliminal irritation, that text in text fields does not word wrap. This shortcoming is not uniform throughout the INGRES system. Although the ability to have text word wrap does not occur in the QBF or ABF associated subsystems, it is available in the RBF associated subsystems. Among other things, what this means to a user of an application such as "references" is that any text the user views in frames on the screen will not word wrap, but the output report "bibliography.report" will have its text neatly word wrapped. INGRES is in a constant state of revision and

perhaps a future version will uniformly offer the option to have text fields word wrap.

2. Regularity Violation

It is probably a bit strong to accuse RT1 of a violation of the regularity principle [Ref. 6, pg 527], but they have come close in their "Vifred" menu selection in the ABF "User-Specified Frame Definition" frame, Figure 26. In normal operation of the VIFRED subsystem, it is possible to "copy" an existing form, for whatever purpose, perhaps modification into a slightly different version of the same form. The method (undocumented) for copying a form is simply to enter VIFRED and arrive by whatever fashion at the "Forms Catalog" frame, Figure 30. Move the cursor to the form to be copied and select the "Edit" menu item. When the form appears on the screen, edit it as desired and then select "Save". The "Save" screen, Figure 31, will then appear with the old form's name in the "form name:" field. In this instance, the name may be changed at this point and "Save" selected from the menu. The old form from which the new form was made is still in the forms catalog as is the new form. The sequence of events just described to copy a form cannot be accomplished if VIFRED was entered via the ABF "User-Specified Frame Definition" frame's "Vifred" menu item. When the user/programmer arrives at the "Save" frame and attempts to change the name of the form, an error message appears indicating that this is not a permissible

action and that the form name is for display only. The reader is left to form his or her own opinion.

3. Retrieve Lockout

The problem described here is not fully understood, but is described for the purpose of forewarning a potential applications programmer about a possible "glitch" in the system. The User-Relation table field description for the relation "descript2" is shown in Figure 28. During the course of developing the program "references", several attempts were made to execute an imbedded QUEL retrieve of various items of the relation descript2 using other items from the relation, i.e., "retrieve descript2.title where descript2.author = 'ADIBA'," for example. All queries were handled satisfactorily except for one which always failed to compile in a ".osl" file. The query which always gave a syntax error was any query containing descript2.key as the object of the query, i.e., "retrieve descript2.key where descript2.author = 'ADIBA'." As can be seen from Figure 28, there is nothing different about this column in the relation, descript2, except that it is the first one. The INGRES Reference Manual [Ref. 7] indicated that the word "key" was not a reserved word. There exists the possibility that INGRES considers the first column in any relation to be a "key" or "index" item as discussed in [Ref. 7,pg 2-24] and additionally that retrievals are not permitted on designated or default indexes. That is only speculation, however, with

no other evidence or documentation to substantiate the hypothesis.

4. Default Editor

ABF either contains or calls a default editor when the "Edit" function is called on a frame. ABF does provide for the programmer the opportunity to change the default editor for the duration of the current session through the "Option" menu item. The problem arises that the default editor cannot be permanently changed by the user and the editor that RTI has chosen is not well known at this installation. It is neither "vi" nor "ex", but does appear to be a line editor similar to "ex". Since ABF is a "programming environment", it would not seem unreasonable for the applications programmer to be permitted to designate his/her own default text editor on a semi-permanent basis. This suggestion is offered in the spirit of providing the user of the programming environment with a more congenial atmosphere in which to work.

H. CLOSING COMMENTS

Overall INGRES ABF was found to provide an extremely flexible application programming environment. The system is not difficult to learn from the standpoint of complexity or understanding, but the sheer bulk of the systems manuals is at first intimidating. It is noted that version 4.0 has arrived at this installation and that the manuals have been

reduced by half. It should be noted one last time that it is considered necessary for an applications programmer to learn the majority of the subsystems, unlike a casual user who only needs to learn QBF in order to make forms oriented queries. Once the initial learning curve has been surmounted, the system provides a very complete and comfortable application programming environment.

APPENDIX A. FIGURES

INGRES/MENU

Database: biblio

To run a highlighted command, place the cursor over it and select the "Go" menu item.

Commands	Description
QUERY	RUN simple or saved QUERY to retrieve, modify or append data
REPORT	RUN default or saved REPORT
QBF	Use QUERY-BY-FORMS to develop and test query definitions
RBF	Use REPORT-BY-FORMS to design or modify reports
ABF	Use APPLICATIONS-BY-FORMS to design and test applications
TABLES	CREATE, MANIPULATE or LOOKUP tables in the database
VIFRED	EDIT forms by using the VISUAL-FORMS-EDITOR
QUEL	ENTER interactive QUEL statements
SREPORT	SAVE REPORT-WRITER commands in the reports catalog

Go History CommandMode DBswitch Shell Help Quit

Figure 1 INGRES/MENU's executive level menu

INGRES/MENU

Database: biblio

QUERY-BY-FORMS Information

Enter a table name, a qbfname, or a joindef name:

Change default options if desired:

Type ("table", "qbfname", "joindef" or "any"): any

If a table is specified, indicate if a table field is to be used
("y", "n"): n

Select the "Go" menu item to start QUERY-BY-FORMS.

Go Help End

Figure 2 Initial QBF screen from within INGRES/MENU

QBF - Start-Up Frame

Query-By-Forms (QBF) is an interactive interface for adding, deleting, changing and viewing data in your database.

You may get a catalog of QBFNames, JoinDefs, or Tables in your database to serve as a basis for editing and viewing. In summary, they are:

- QBFName - a name that combines a joindef or table name with a form name. QBFNames are created in VIFRED.
- JoinDef - a stored specification of joins between tables, and rules governing how to update data in QBF.
- Table - a table or view in your database.

From each of the catalogs, you can browse names, and choose one to serve as a basis for editing or viewing.

Additional utility commands on this menu are:

- Help - displays help on QBF and your terminal key functions.
- Quit - leaves QBF.

QBFNames JoinDefs Tables Help Quit :

Figure 3 INGRES QBF Start-up frame

INGRES/MENU

Database: biblio

VISUAL-FORMS-EDITOR Information

Enter a form name, table name or joindef name:

Change default options if desired:

Type ("form", "table", "joindef"): form

Select the "Go" menu item to start VISUAL-FORMS-EDITOR.

Go Help End

Figure 4 Initial VIFRED screen from within INGRES/MENU

VIFRED - Forms Catalog

Name	Owner
addrform	destael
projform	destael
stafform	destael
taskform	destael

Position cursor over the name of the form you wish to select, then use the menu to perform the appropriate operation on that form.

Create Destroy Edit Rename Utilities Find Top Bottom >

Figure 5 INGRES VIFRED Forms Catalog frame

INGRES/MENU

Database: biblio

REPORT-BY-FORMS Information

Enter a table name or a report name:

Change default options if desired:

Type ("report", "table", "any"): any
Suppress RBF status messages ("y", "n")? n

For report on table above, enter report style
("block", "column", "wrap" or "default"): default

Select the "Go" menu item to start REPORT-BY-FORMS.

Go Help End

Figure 6 RBF initial screen from INGRES MENU

RBF - Reports Catalog

Position cursor over the name of a report, then use the appropriate menu item to perform an operation on that report.

Name	Owner	RBF?	Last changed
sublist	destael	Yes	4-nov-86 22:50

Create Destroy Edit Rename Utilities Find Top Bottom >

Figure 7 RBF Reports Catalog frame

INGRES/MENU

Database: biblio

APPLICATIONS-BY-FORMS Information

Enter an application name:

Select the "Go" menu item to start APPLICATIONS-BY-FORMS.

Go Help End

Figure 8 Initial ABF screen from within INGRES/MENU

APPLICATION DEFINITION

APPLICATION CREATION INFORMATION:

Application Name : references
Application Creator : destael

Date Created : 18-nov-86:17:52
Date Modified : 19-nov-86:17:02

Source Code Directory : /work/destael/reference

Frame
frame3a
frame3ay
frame3an
frame3amy

Procedure

Define Go Create Destroy Image Rtingres Options Help >

Figure 9 INGRES ABF Application Definition frame

*** Welcome to REFERENCES ***

Would you like to see:

- <T> A list of Topics (subject list)
- <K> A list of titles containig a Key word or phrase
(i.e. such as "DATABASE" or "FOURTH GENERATION LANGUAGE")
- <A> A list of titles based on some combination of Author and
month and/or year
- <P> A list of titles based on some combination of Publication and
month and/or year

CursorHelp MenuHelp Topics Keyword Author Publication > :

Figure 10 Topframe (left half of menu)

*** Welcome to REFERENCES ***

Would you like to see:

- <T> A list of Topics (subject list)
- <K> A list of titles containig a Key word or phrase
(i.e. such as "DATABASE" or "FOURTH GENERATION LANGUAGE")
- <A> A list of titles based on some combination of Author and
month and/or year
- <P> A list of titles based on some combination of Publication and
month and/or year

< Publication Report Quit :

Figure 11 Topframe (right half of menu)

Subject List

Catcode	Category Name
H5	DATABASE MAINTENANCE - OTHERS
I1	DISTRIBUTED DATABASES
I2	DISTRIBUTED DATABASE MANAGEMENT SYSTEMS
I21	SDD-1
I22	HETEROGENOUS DISTRIBUTED DBMS'S
I3	DESIGN, MODELING AND EVALUATION OF DISTRIBUTED DBMS'S
I31	FILE AND PROCESS ALLOCATION
I32	SYSTEM DESIGN OF DISTRIBUTED DBMS'S

CursorHelp MenuHelp Titles End :

Figure 12 Topics (subject list) frame

Category Code: H5

Category: DATABASE MAINTENANCE - OTHERS

Titles
FLASH : A LANGUAGE-INDEPENDENT, PORTABLE FILE ACCESS SYSTEM
A MODEL FOR AUTOMATIC FILE AND PROGRAM DESIGN IN BUSINESS APPLICATION SYSTEM
GENERALLY APPLICABLE DATA-FILE SOFTWARE
GIS AND FILE MANAGEMENT

CursorHelp MenuHelp View End :

Figure 13 Titles frame

Press <CTRL> F to view bottom of page.

Month: MAY Article Description Year: 1980

Title: FLASH : A LANGUAGE-INDEPENDENT, PORTABLE FILE ACCESS SY
STEM

Authors: ALLCHIN, J.E., KELLER, A.M., WIEDERHOL, D.G.

Publication: PROCEEDINGS OF ACM-SIGMOD 1980 INTERNATIONAL CONFERENCE
ON MANAGEMENT OF DATA

Abstract:

A brief description (synopsis) of the article, not to exceed 1500 characters is to be inserted here...

CursorHelp MenuHelp Save UnSave End :

Figure 14 Viewframe

*** Listing of Titles Containing a Key Word or Phrase ***

Word/Phrase: *

Month	Year	Title

CursorHelp MenuHelp View End :

Figure 15 Keyword (initial) frame

*** Listing of Titles Containing a Key Word or Phrase ***

Word/Phrase: 'GIS'

Month	Year	Title
	1966	GIS AND FILE MANAGEMENT

CursorHelp MenuHelp View End

Figure 17 Keyword (final) frame

*** Authors ***

Would you like to construct a list of titles based on:

- <O> Author's name Only
- <Y> Author's name and Year of publication of his/her article
- <M> Author's name and Month of publication of his/her article
- <A> Author's name and month and year (All) of publication of his/her article

*** Note ***

When entering the author's name the syntax is: "LASTNAME,F.M.". Initials are not required but are desirable. There should be NO SPACES.

CursorHelp MenuHelp Only Year Month All End :

Figure 18 Authors frame

*** Month, Year, and Title of Article Based On Author's Name Only ***

Author: 'ADIBA'

Month	Year	Title
SEP	1978	ISSUES IN DISTRIBUTED DATA BASE MANAGEMENT SYSTEM: A TECHNICAL OVERVIEW
OCT	1980	AN OVERVIEW OF THE POLYPHEME DISTRIBUTED DATABASE MANAGEMENT SYSTEM
SEP	1978	A DISTRIBUTED DATA BASE SYSTEM USING LOGICAL RELATIONAL MACHINES

CursorHelp MenuHelp View End

Figure 19 Author Only frame

*** Titles Based On Author, Month, and Year ***

Author: «DIB»

Month: SEP

Year: 1978

Title
ISSUES IN DISTRIBUTED DATA BASE MANAGEMENT SYSTEM: A TECHNICAL OVERVIEW
A DISTRIBUTED DATA BASE SYSTEM USING LOGICAL RELATIONAL MACHINES

CursorHelp MenuHelp View End

Figure 20 Author and Month and Year frame

*** Publications ***

Would you like to construct a list of titles based on:

- <P> Publication's name only
- <Y> Publication's name and Year of publication
- <M> Publication's name and Month of publication
- <A> Publication's name and month and year of publication (<A>||)

NOTE: Put only single spaces between words in publication names.

CursorHelp MenuHelp PubName Year Month All End :

Figure 21 Publications frame

*** Month, Year, and Title of Article Based On Publication Name Only ***

Publication: INFORMATION & MANAGEMENT

Month	Year	Title
OCT	1978	GENERALLY APPLICABLE DATA-FILE SOFTWARE
DEC	1979	THE STATE OF THE ART IN DISTRIBUTED DATABASES

CursorHelp MenuHelp View End :

Figure 22 Pub Name Only frame

HELP -- Command-Key Mapping for QUERY-BY-FORMS INFORMATION

Command	Control/Function Key	Explanation
Menu	ControlESC	Go to or scroll through the menu line
Scrollup	^F	Go to next page of table or form
Scrolldown	^G	Go to previous page of table or form
Nextfield	Tab	Go to the next field
Previousfield	^P	Go to the previous field
Scrollleft	^O	Scroll form to the left
Scrollright	^U	Scroll form to the right
Startfield	[Go to start of current field
Endfield]	Go to end of current field
Leftchar	^H	Move left one space
Rightchar	^L	Move right one space
Downline	^J	Move down one line
Upline	^K	Move up one line
Nextword	^B	Move forward one word
Previousword	^R	Move backward one word
Mode	^E	Switch edit mode - insert/overstrike
Redraw	^W	Redraw the screen
Deletechar	^D	Delete character under cursor
Rubout	Delete	Delete character to left of cursor
Editor	^V	Start system editor on field
Newrow	^N	Move to first column on next row
Clear	^X	Clear field or menu input
Clearrest	Return	Clear field from cursor to end
Duplicate	^A	Duplicate last value entered
Printscreen		Write current screen to file
Go		
Help		
End		

NextPage(^F) PrevPage(^G) Find Top Bottom Help End

Figure 23 CursorHelp frame text file

APPLICATION DEFINITION

APPLICATION CREATION INFORMATION:

Application Name : references
Application Creator : destael

Date Created : 18-nov-86:17:52
Date Modified : 15-dec-86:02:03

Source Code Directory : /work/destael/reference

Frame
kvfr
pubframe
pofr
pmfr

Procedure

Define Go Create Destroy Image Rtingres Options Help > :

Figure 24 Application Definition frame (left half)

APPLICATION DEFINITION

APPLICATION CREATION INFORMATION:

Application Name : references
Application Creator : destael

Date Created : 18-nov-86:17:52
Date Modified : 15-dec-86:02:03

Source Code Directory : /work/destael/reference

Frame
kwfr
pubframe
pofr
pmfr

Procedure

< Help Quit :

Figure 25 Application Definition frame (right half)

User-Specified Frame Definition

Frame Name : endfr	Creation Date : 14-dec-86:15:51
Usage : USER	Modification Date : 14-dec-86:16:39
Form : endform	Return Type : character ("integer", "float", "character", or "none")

Define Compile Destroy Edit Print Vifred Help End :

Figure 26 Frame Definition frame

VIFRED - Attributes for Field

Attribute	Set
Box Field	n
Keep Previous Value	n
Mandatory Field	y
Reverse Video	y
Blinking	n
Underline	n
Brightness Change	n
Query Only	y
Force Lower Case	n
Force Upper Case	y
No Auto Tab	n
No Echo	n
Display Only	n
END OF ATTRIBUTES	

Default Value for Field:

Internal Name for Field (12 characters only):
authors

Validation Check to Perform on Field:

Validation Error Message:

Color: Ø

Next Previous Help End

Figure 27 VIFRED Field Attributes Editing frame

Information on table descript2

Column Name	Data Format	Key No.
key	c7	
authors	c110	
title	c165	
publication	c110	
volume	i1	
number	i1	
month	c3	
year	i2	
pages	c9	
catcode	c3	
synop	text(1500)	
reptout	c1	

Owner: destael
 Number of Columns: 12
 Number of Rows: 63
 Table Type: USER RELATION
 Storage Structure: heap
 Row Width: 1914
 Journaling: Disabled

NewTable Find Top Bottom Help End

Figure 28 Database Relation Table "descript2"

Information on table bibindex

Column Name	Data Format	Key No.
catcode	c3	
catname	c6#	

Owner: destael
 Number of Columns: 2
 Number of Rows: 22
 Table Type: USER RELATION
 Storage Structure: heap
 Row Width: 63
 Journaling: Disabled

NewTable Find Top Bottom Help End

Figure 29 Database Relation Table "bibindex"

VIFRED - Forms Catalog

Name	Owner
authform	destael
ay	destael
endform	destael
form3	destael
kw	destael
pn	destael
pnj	destael
po	destael
pubform	destael
py	destael
subj	destael
titles	destael
topform	destael
viewform	destael

Position cursor over the name of the form you wish to select, then use the menu to perform the appropriate operation on that form.

Create Destroy Edit Rename Utilities Find Top Bottom >

Figure 30 VIFRED Forms Catalog frame

VIFRED - Save Form

This frame is used to save the form definition in the database. You should enter the name for the form here.

Form Name : viewform

A QBFName with the same name as the form will be created for a new form created from a table or joindef.

Save Forget Help

Figure 31 VIFRED Form Save frame

Form name: topform
Form owner: at
Number of columns on screen: 80
Number of lines on screen: 18
Number of fields: 0
Number of trim strings: 9
Date last modified: 15-dec-86

FIELD DESCRIPTIONS

/* None */

/* File: topframe.osl */

```
"CursorHelp" = {  
    helpfile "Cursor Control"  
        "/work/destael/reference/keyhelp.txt";  
}  
"MenuHelp" = {  
    helpfile "Opening Frame"  
        "/work/destael/reference/tophelp.txt";  
}  
"Topics" = {  
    callframe subjfr;  
}  
"Keyword" = {  
    callframe kwfr;  
}  
"Author" = {  
    callframe authframe;  
}  
"Publication" = {  
    callframe pubframe;  
}  
"Report" = {  
    callframe endfr;  
}  
"Quit" = {  
    message "restoring database to original condition...";  
    sleep 2;  
    range of d is descript2;  
    replace d (reptout="N");  
    message "Bye-bye y'all";  
    sleep 2;  
    exit;  
}
```

99

/* INGRES form description for authform */

*** Authors ***

Would you like to construct a list of titles based on:

- <O> Author's name Only
- <Y> Author's name and Year of publication of his/her article
- <M> Author's name and Month of publication of his/her article
- <A> Author's name and month and year (All) of publication of his/her article

*** Note ***

When entering the author's name the syntax is: "LASTNAME,F.M."
Initials are not required but are desirable.
There should be NO SPACES.

Form name: authform
Form owner: at
Number of columns on screen: 80
Number of lines on screen: 19
Number of fields: 0
Number of trim strings: 11
Date last modified: 13-dec-86

FIELD DESCRIPTIONS

/* None */

```
/* File: authfram.osl */

"CursorHelp" = {
    helpfile "Cursor Control"
        "/work/destael/reference/keyhelp.txt";
}
"MenuHelp" = {
    helpfile "Authors-etc Frame"
        "/work/destael/reference/authhelp.txt";
}
"Only" = {
    callframe aofr;
}
"Year" = {
    callframe ayfr;
}
"Month" = {
    callframe amfr;
}
"All" = {
    callframe anyfr;
}
"End" = {
    return;
}
```


Field name: keytitle
Type of field: table field

Field name: month
Field title: Month
Display format: c3
Special display attributes: Display only, Force upper case
Type of field: column in table fieldcat
Default value:
Validation check:
Validation error message:

Field name: year
Field title: Year
Display format: i4
Special display attributes: Display only
Type of field: column in table field
Default value:
Validation check:
Validation error message:

Field name: title
Field title: Title
Display format: c165.55
Special display attributes: Display only, Force upper case
Type of field: column in table field
Default value:
Validation check:
Validation error message:

```

/* File: aofr.osl (author only frame osl module) */

"CursorHelp" = {
  helpfile "Cursor Control"
    "/work/destael/reference/keyhelp.txt";
}
"MenuHelp" = {
  helpfile "Author-Only Frame"
    "/work/destael/reference/aohelp.txt";
}
field authors = {
  authors := "*" + authors + "*";
  ao.keytitle := retrieve (month = descript2.month,
    year = descript2.year, title = descript2.title)
    where (descript2.authors = authors);
  resume field keytitle;
}
"View" = {
  callframe viewframe (title := keytitle.title);
  resume field keytitle;
}
"End" = {
  return;
}

```


FIELD DESCRIPTIONS

Field name: authors

Field title: Author:

Display format: -c110.55

Special display attributes: Mandatory field, Reverse video, Force upper case

Type of field: regular

Default value:

Validation check:

Validation error message:

Field name: month

Field title: Month:

Display format: c3

Special display attributes: Mandatory field, Reverse video, Force upper case

Type of field: regular

Default value:

Validation check: month in ["JAN", "FEB", "MAR", "APR", "MAY", "JUN", "JUL", "AUG", "SEP", "OCT", "NOV", "DEC"]

Validation error message: Month must be standard 3-letter abbreviation.

Field name: keytitle

Type of field: table field

Field name: year

Field title: Year

Display format: i4

Special display attributes: Display only

Type of field: column in table field

Default value:

Validation check:

Validation error message:

Field name: title

Field title: Title

Display format: c165.55

Special display attributes: Display only, Force upper case

Type of field: column in table field

Default value:

Validation check:

Validation error message:

```

/* File: amfr.osl (author-month frame osl module) */

"CursorHelp" = (
  helpfile "Cursor Control"
    "/work/destael/reference/keyhelp.txt";
)
"MenuHelp" = (
  helpfile "Author-Month Frame"
    "/work/destael/reference/amhelp.txt";
)
field "authors" = (
  authors := "" + authors + "";
  resume field month;
)
field "month" = (
  am.keytitle := retrieve (year = descript2.year,
    title = descript2.title)
    where (descript2.authors = authors
      and descript2.month = month);
  resume field keytitle;
)
"View" = (
  callframe viewframe (title := keytitle.title);
  resume field keytitle;
)
"End" = (
  return;
)
"CursorHelp" = (
  helpfile "Cursor Control"
    "/work/destael/reference/keyhelp.txt";
)
"MenuHelp" = (
  helpfile "Author-Month-Year Frame"
    "/work/destael/reference/amyhelp.txt";
)
field "authors" = (
  authors := "" + authors + "";
  resume field month;
)
field "month" = (
  resume field year;
)
field "year" = (
  amy.keytitle := retrieve (title = descript2.title)
    where (descript2.authors = authors
      and descript2.month = month
      and descript2.year = year);
  resume field keytitle;
)

```

```
"View" = (  
  callframe viewframe (title := keytitle.title);  
  resume field keytitle;  
)  
"End" = (  
  return;  
)
```


FIELD DESCRIPTIONS

Field name: authors

Field title: Author:

Display format: -c110.55

Special display attributes: Mandatory field, Reverse video, Force upper case

Type of field: regular

Default value:

Validation check:

Validation error message:

Field name: year

Field title: Year:

Display format: -i4

Special display attributes: Mandatory field, Reverse video

Type of field: regular

Default value:

Validation check: year >= 1800 and year <= 2200

Validation error message: Year must be 4-digit format between 1800 & 2200

Field name: keytitle

Type of field: table field

Field name: month

Field title: Month

Display format: c3

Special display attributes: Display only, Force upper case

Type of field: column in table field

Default value:

Validation check:

Validation error message:

Field name: title

Field title: Title

Display format: c165.55

Special display attributes: Display only, Force upper case

Type of field: column in table field

Default value:

Validation check:

Validation error message:

```

/* File: ayfr.osl (author-year frame osl module) */

"CursorHelp" = {
  helpfile "Cursor Control"
    "/work/destael/reference/keyhelp.txt";
}
"MenuHelp" = {
  helpfile "Author-Year Frame"
    "/work/destael/reference/ayhelp.txt";
}
field "authors" = {
  authors := "" + authors + ";";
  resume field year;
}
field "year" = {
  ay.keytitle := retrieve (month = descript2.month,
    title = descript2.title)
    where (descript2.authors = authors
      and descript2.year = year);
  resume field keytitle;
}
"View" = {
  callframe viewframe (title := keytitle.title);
  resume field keytitle;
}
"End" = {
  return;
}

```


Field name: month
Field title: Month:
Display format: c3
Special display attributes: Mandatory field, Reverse video, Force upper case
Type of field: regular
Default value:
Validation check: month in ["JAN", "FEB", "MAR", "APR", "MAY", "JUN", "JUL", "AUG", "SEP", "OCT", "NOV", "DEC"]
Validation error message: Month must be standard 3-letter abbreviation.

Field name: year
Field title: Year:
Display format: -i4
Special display attributes: Mandatory field, Reverse video
Type of field: regular
Default value:
Validation check: year >= 1800 and year <= 2200
Validation error message: Year must be 4-digit format between 1800 and 2200

Field name: keytitle
Type of field: table field

Field name: title
Field title: Title
Display format: c165.55
Special display attributes: Display only, Force upper case
Type of field: column in table field
Default value:
Validation check:
Validation error message:

```
/* File: amyfr.osl (author-month-year frame osl module) */
```

```
"CursorHelp" = {  
  helpfile "Cursor Control"  
  "/work/destael/reference/keyhelp.txt";  
}  
"MenuHelp" = {  
  helpfile "Author-Month-Year Frame"  
  "/work/destael/reference/amyhelp.txt";  
}  
field "authors" = {  
  authors := "" + authors + "";  
  resume field month;  
}  
field "month" = {  
  resume field year;  
}  
field "year" = {  
  amy.keytitle := retrieve (title = descript2.title)  
    where (descript2.authors = authors  
      and descript2.month = month  
      and descript2.year = year);  
  resume field keytitle;  
}  
"View" = {  
  callframe viewframe (title := keytitle.title);  
  resume field keytitle;  
}  
"End" = {  
  return;  
}
```


Field name: keytitle
Type of field: table field

Field name: month
Field title: Month
Display format: c3
Special display attributes: Display only, Force upper case
Type of field: column in table field
Default value:
Validation check:
Validation error message:

Field name: year
Field title: Year
Display format: i4
Special display attributes: Display only
Type of field: column in table field
Default value:
Validation check:
Validation error message:

Field name: title
Field title: Title
Display format: c165.55
Special display attributes: Display only, Force upper case
Type of field: column in table field
Default value:
Validation check:
Validation error message:

```

/* File: kwfr.osl (key word frame osl module) */

"CursorHelp" = (
  helpfile "Cursor Control"
    "/work/destael/reference/keyhelp.txt";
)
"MenuHelp" = (
  helpfile "Key Word Frame"
    "/work/destael/reference/kwhelp.txt";
)
field "keyword" = (
  keyword := "*" + keyword + "*";
  kw.keytitle := retrieve (month = descript2.month,
    year = descript2.year, title = descript2.title)
    where (descript2.title = keyword);
  resume field keytitle;
)
"View" = (
  callframe viewframe (title := keytitle.title);
  resume field keytitle;
)
"End" = (
  return;
)

```


FIELD DESCRIPTIONS

Field name: subjlist
Type of field: table field

Field name: catcode
Field title: Catcode
Display format: c3
Special display attributes: Display only, Force upper case
Type of field: column in table field
Default value:
Validation check:
Validation error message:

Field name: catname
Field title: Category Name
Display format: c60
Special display attributes: Display only, Force upper case
Type of field: column in table field
Default value:
Validation check:
Validation error message:

```
/* File: subjfr.osl (topics (subject list) frame osl module) */
```

```
initialize = {  
    subj.subjlist := retrieve (catcode = bibindex.catcode,  
        catname = bibindex.catname);  
    resume field subjlist;  
}  
"CursorHelp" = {  
    helpfile "Cursor Control"  
        "/work/destael/reference/keyhelp.txt";  
}  
"MenuHelp" = {  
    helpfile "Subject List Frame"  
        "/work/destael/reference/subjhelp.txt";  
}  
"Titles" = {  
    callframe titlefr (catcode := subjlist.catcode;  
        catname := subjlist.catname);  
}  
"End" = {  
    return;  
}
```

/* INGRES form description for titles (titles-by-category form) */

Category Code:

Category:

Titles

Form name: titles
Form owner: at
Number of columns on screen: 80
Number of lines on screen: 33
Number of fields: 3
Number of trim strings: 0
Date last modified: 14-dec-86

FIELD DESCRIPTIONS

Field name: titlelist
Type of field: table field

Field name: title
Field title: Titles
Display format: c165.55
Special display attributes: Display only, Force upper case
Type of field: column in table field
Default value:
Validation check:
Validation error message:

Field name: catcode
Field title: Category Code:
Display format: c3
Special display attributes: Display only, Force upper case
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: catname
Field title: Category:
Display format: c60
Special display attributes: Display only, Force upper case
Type of field: regular
Default value:
Validation check:
Validation error message:

```
/* File: titlfr.osl (titles-by-category frame osl module) */
```

```
initialize = {  
  titles.titlelist := retrieve (title = descript2.title)  
    where (descript2.catcode = catcode);  
  resume field titlelist;  
}  
"CursorHelp" = {  
  helpfile "Cursor Control"  
    "/work/destael/reference/keyhelp.txt";  
}  
"MenuHelp" = {  
  helpfile "Titles Frame"  
    "/work/destael/reference/titlhelp.txt";  
}  
"View" = {  
  callframe viewframe (title := titlelist.title);  
  resume field titlelist;  
}  
"End" = {  
  return;  
}
```

/* INGRES form description for pubform (selection-by-publication name form) */

*** Publications ***

Would you like to construct a list of titles based on:

- <P> Publication's name only
- <Y> Publication's name and Year of publication
- <M> Publication's name and Month of publication
- <A> Publication's name and month and year of publication (<A>!!)

NOTE: Put only single spaces between words in publication names.

Form name: pubform
Form owner: at
Number of columns on screen: 80
Number of lines on screen: 20
Number of fields: 0
Number of trim strings: 8
Date last modified: 15-dec-86

FIELD DESCRIPTIONS

/* None */

```
/* File: pubfr.osl (publications selection frame osl module) */
```

```
"CursorHelp" = (  
  helpfile "Cursor Control"  
    "/work/destael/reference/keyhelp.txt";  
)  
"MenuHelp" = (  
  helpfile "Publication-etc Frame"  
    "/work/destael/reference/pubhelp.txt";  
)  
"PubName" = (  
  callframe pofr;  
)  
"Year" = (  
  callframe pyfr;  
)  
"Month" = (  
  callframe pmfr;  
)  
"All" = (  
  callframe payfr;  
)  
"End" = (  
  return;  
)
```


Field name: keytitle
Type of field: table field

Field name: month
Field title: Month
Display format: c3
Special display attributes: Display only, Force upper case
Type of field: column in table field
Default value:
Validation check:
Validation error message:

Field name: year
Field title: Year
Display format: i4
Special display attributes: Display only
Type of field: column in table field
Default value:
Validation check:
Validation error message:

Field name: title
Field title: Title
Display format: c165.55
Special display attributes: Display only, Force upper case
Type of field: column in table field
Default value:
Validation check:
Validation error message:

```

/* File: pofr.osl (publication name only frame osl module) */

"CursorHelp" = {
  helpfile "Cursor Control"
    "/work/destael/reference/keyhelp.txt";
}
"MenuHelp" = {
  helpfile "Publication-Only Frame"
    "/work/destael/reference/pohelp.txt";
}
field "publication" = {
  po.keytitle := retrieve (month = descript2.month,
    year = descript2.year, title = descript2.title)
    where (descript2.publication = publication);
  resume field keytitle;
}
"View" = {
  callframe viewframe (title := keytitle.title);
  resume field keytitle;
}
"End" = {
  return;
}

```


Field name: month
Field title: Month:
Display format: c3
Special display attributes: Mandatory field, Reverse video, Force upper case
Type of field: regular
Default value:
Validation check: month in ["JAN", "FEB", "MAR", "APR", "MAY", "JUN", "JUL", "AUG", "SEP", "OCT", "NOV", "DEC"]
Validation error message: Month must be standard 3-letter abbreviation.

Field name: keytitle
Type of field: table field

Field name: year
Field title: Year
Display format: i4
Special display attributes: Display only
Type of field: column in table field
Default value:
Validation check:
Validation error message:

Field name: title
Field title: Title
Display format: c165.55
Special display attributes: Display only, Force upper case
Type of field: column in table field
Default value:
Validation check:
Validation error message:

```
/* File: pmfr.osl (publication name and month frame osl module) */
```

```
"CursorHelp" = {
  helpfile "Cursor Control"
  "/work/destael/reference/keyhelp.txt";
}
"MenuHelp" = {
  helpfile "Publication-Month Frame"
  "/work/destael/reference/pmhelp.txt";
}
field "publication" = {
  resume field month;
}
field "month" = {
  pm.keytitle := retrieve (year = descript2.year,
  title = descript2.title)
  where (descript2.publication = publication
  and descript2.month = month);
  resume field keytitle;
}
"View" = {
  callframe viewframe (title := keytitle.title);
  resume field keytitle;
}
"End" = {
  return;
}
"CursorHelp" = {
  helpfile "Cursor Control"
  "/work/destael/reference/keyhelp.txt";
}
"MenuHelp" = {
  helpfile "Publication-Month-Year Frame"
  "/work/destael/reference/pmyhelp.txt";
}
field "publication" = {
  resume field month;
}
field "month" = {
  resume field year;
}
field "year" = {
  pmy.keytitle := retrieve (title = descript2.title)
  where (descript2.publication = publication
  and descript2.month = month
  and descript2.year = year);
  resume field keytitle;
}
```

```
"View" = {
    callframe viewframe (title := keytitle.title);
    resume field keytitle;
}
"End" = {
    return;
}
```


FIELD DESCRIPTIONS

Field name: publication
Field title: Publication:
Display format: -c110.55
Special display attributes: Mandatory field, Reverse video, Force upper case
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: year
Field title: Year:
Display format: -i4
Special display attributes: Mandatory field, Reverse video
Type of field: regular
Default value:
Validation check: year >= 1800 and year <= 2200
Validation error message: Year must be 4-digit format between 1800 & 2200

Field name: keytitle
Type of field: table field

Field name: month
Field title: Month
Display format: c3
Special display attributes: Display only, Force upper case
Type of field: column in table field
Default value:
Validation check:
Validation error message:

Field name: title
Field title: Title
Display format: c165.55
Special display attributes: Display only, Force upper case
Type of field: column in table field
Default value:
Validation check:
Validation error message:

```
/* File: pyfr.osl (publication name and year frame osl module) */
```

```
"CursorHelp" = {  
  helpfile "Cursor Control"  
  "/work/destael/reference/keyhelp.txt";  
}  
"MenuHelp" = {  
  helpfile "Publication-Year Frame"  
  "/work/destael/reference/pyhelp.txt";  
}  
field "publication" = {  
  resume field year;  
}  
field "year" = {  
  py.keytitle := retrieve (month = descript2.month,  
    title = descript2.title)  
    where (descript2.publication = publication  
      and descript2.year = year);  
  resume field keytitle;  
}  
"View" = {  
  callframe viewframe (title := keytitle.title);  
  resume field keytitle;  
}  
"End" = {  
  return;  
}
```


Field name: month
Field title: Month:
Display format: c3
Special display attributes: Mandatory field, Reverse video, Force upper case
Type of field: regular
Default value:
Validation check: month in ("JAN", "FEB", "MAR", "APR", "MAY", "JUN", "JUL", "AUG", "SEP", "OCT", "NOV", "DEC")
Validation error message: Month must be standard 3-letter abbreviation.

Field name: year
Field title: Year:
Display format: -i4
Special display attributes: Mandatory field, Reverse video
Type of field: regular
Default value:
Validation check: year >= 1800 and year <= 2200
Validation error message: Year must be 4-digit format between 1800 and 2200

Field name: keytitle
Type of field: table field

Field name: title
Field title: Title
Display format: c165.55
Special display attributes: Display only, Force upper case
Type of field: column in table field
Default value:
Validation check:
Validation error message:

```

/* File: pmyfr.osl (publication name and month and year frame osl module) */

"CursorHelp" = {
  helpfile "Cursor Control"
    "/work/destael/reference/keyhelp.txt";
}
"MenuHelp" = {
  helpfile "Publication-Month-Year Frame"
    "/work/destael/reference/pmyhelp.txt";
}
field "publication" = {
  resume field month;
}
field "month" = {
  resume field year;
}
field "year" = {
  pmy.keytitle := retrieve (title = descript2.title)
    where (descript2.publication = publication
      and descript2.month = month
      and descript2.year = year);
  resume field keytitle;
}
"View" = {
  callframe viewframe (title := keytitle.title);
  resume field keytitle;
}
"End" = {
  return;
}

```

/* INGRES form description for viewform (view the current title) */

Press <CTRL> F to view bottom of page.

Month: Article Description Year:

Title:

Authors:

Publication:

Abstract:

Form name: viewform
Form owner: at
Number of columns on screen: 80
Number of lines on screen: 39
Number of fields: 6
Number of trim strings: 2
Date last modified: 13-dec-86

FIELD DESCRIPTIONS

Field name: month
Field title: Month:
Display format: c3
Special display attributes: Display only, Force upper case
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: year
Field title: Year:
Display format: -i4
Special display attributes: Display only
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: title
Field title: Title:
Display format: -c165.55
Special display attributes: Display only, Force upper case
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: authors
Field title: Authors:
Display format: -c110.55
Special display attributes: Display only, Force upper case
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: publication
Field title: Publication:
Display format: -c110.55
Special display attributes: Display only, Force upper case
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: synop
Field title: Abstract:
Display format: c1500.72
Special display attributes: Display only
Type of field: regular
Default value:
Validation check:
Validation error message:

```
/* File: viewframe.osl (view the current title frame osl module) */
```

```
initialize = {  
  viewform := retrieve ( authors = descript2.authors,  
    month = descript2.month, year = descript2.year,  
    publication = descript2.publication, synop = descript2.synop )  
  where ( descript2.title = title );  
}  
"CursorHelp" = {  
  helpfile "Cursor Control"  
  "/work/destael/reference/keyhelp.txt";  
}  
"MenuHelp" = {  
  helpfile "View Frame"  
  "/work/destael/reference/viewhelp.txt";  
}  
"Save" = {  
  replace descript2 (reptout = "Y") where descript2.title = title;  
  message "Entry marked for inclusion in bibliography report file";  
  sleep 2;  
}  
"UnSave" = {  
  replace descript2 (reptout = "N") where descript2.title = title;  
  message "Entry UNmarked...will NOT appear in bibliography report file";  
  sleep 2;  
}  
"End" = {  
  return;  
}
```

/* INGRES form description for endform (closing screen (after report generation) form) */

FINAL SCREEN

REPORT GENERATION COMPLETE

Your report is now in your directory
in a file named "bibliography.report"

Press <RETURN> to continue:

Form name: endform
Form owner: at
Number of columns on screen: 80
Number of lines on screen: 19
Number of fields: 1
Number of trim strings: 5
Date last modified: 16-dec-86

FIELD DESCRIPTIONS

Field name: leave
Field title: to continue:
Display format: -c1
Special display attributes: No echo
Type of field: regular
Default value: x
Validation check:
Validation error message:

```
/* File: endfr.osl (closing frame (after report generation) osl module) */
```

```
initialize = {  
  message "Generating your report...";  
  sleep 3;  
  message "Press return when prompted to do so...";  
  sleep 3;  
  call "report" ("flags" = "-s", "file" = "bibliography.report",  
    "report" = "bibliography", "param" = "reptout=Y");  
  range of d is descript2;  
  replace d (reptout="N");  
  resume field leave;  
}  
field "leave" = {  
  exit;  
}
```

/* INGRES form description for form3 (relation "descript2" data entry form) */

Article Description

Title:

Authors:

Publication:

Volume:	Number:	Month:	Year:
Pages:	ReptOut (Y/N):	Catcode:	Key:

Abstract:

Form name: form3
Form owner: at
Number of columns on screen: 80
Number of lines on screen: 40
Number of fields: 12
Number of trim strings: 1
Date last modified: 12-dec-86

FIELD DESCRIPTIONS

Field name: key
Field title: Key:
Display format: c7
Special display attributes: Force upper case
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: authors
Field title: Authors:
Display format: -c110.55
Special display attributes: Force upper case
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: title
Field title: Title:
Display format: -c165.55
Special display attributes: Force upper case
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: publication
Field title: Publication:
Display format: -c110.55
Special display attributes: Force upper case
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: volume
Field title: Volume:
Display format: f6
Special display attributes: None
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: number
Field title: Number:
Display format: f6
Special display attributes: None
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: month
Field title: Month:
Display format: c3
Special display attributes: Force upper case
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: year
Field title: Year:
Display format: f8
Special display attributes: None
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: pages
Field title: Pages:
Display format: c9
Special display attributes: None
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: synop
Field title: Abstract:
Display format: c1500.72
Special display attributes: None
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: catcode
Field title: Catcode:
Display format: c3
Special display attributes: Force upper case
Type of field: regular
Default value:
Validation check:
Validation error message:

Field name: reptout
Field title: ReptOut (Y/N):
Display format: -c1
Special display attributes: Reverse video, Force upper case
Type of field: regular
Default value: N
Validation check: reptout in ["Y","y","N","n"]
Validation error message: This field must be either "Y" or "N"

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