CHAPTER 5
JOB AIDING

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5.1 INTRODUCTION

Human-centered job-aids can greatly impact the performance of maintenance and inspection personnel as well as aviation safety inspectors. Our experiences with the Performance Enhancement System (PENS) project would be very useful to the aviation industry. Three separate projects were conducted that used various PENS-related job aiding concepts. In one project, we developed a job aid to support the audit conducted by the Coordinating Agency for Supplier Evaluation (CASE). The second project developed a job aid that incorporated the AFS Job Task Analyses (JTA), which are paper-based sets of information that comprise the steps and resources required by the aviation safety inspector (ASI) to perform inspection activities. These JTAs were used to develop a computer based job aid prototype (Inspector's Task Book) to support the ASIs. Finally, we created a prototype job-aid for the Civil Aeromedical Institute (CAMI) to collect and distribute data on alcohol and drug test results. This report outlines all these activities. A pen-computer based application was also developed in the research program in partnership with United Airlines. That project has been reported in Chapter 6.

5.2 THE CASE JOB-AID: TRANSITION OF PENS CONCEPTS TO INDUSTRY

The success of the Performance Enhancement System (PENS) has brought the aviation industry's attention to the possibilities of supporting mobile maintenance technicians and auditors with portable computing technology. During the last year we have worked with a partner airline to field and evaluate a prototype job aid, and then transition that prototype to an operational system. The following is a description of the features of the job aid and the results of the field evaluation.

5.2.1 Airline Partner's Needs

Our partner airline has a group of Vendor Surveillance Analysts within its Technical Standards office. They use a variety of forms to document the results of their quality assurance audits. Also, they have standards that support the criteria of their audits. These standards are based in-part upon Federal regulations (Federal Aviation Regulations, Airworthiness Directives, etc.). The Vendor Surveillance group is responsible for auditing companies who supply materials and services to the airline. They ensure that those companies are in compliance with Federal guidelines and with industry standards. Our partner airline is a member of the Coordinating Agency for Supplier Evaluations (CASE). The CASE organization is a consortium of airlines that pool their resources and share audit data. If a CASE member, e.g., our partner airline, evaluates a supplier and certifies that the supplier is in compliance with Federal regulations and CASE standards, then other CASE members know that they can use the supplier without having to perform their own audit. CASE provides auditing forms and standards to its members. There are currently six CASE forms, although this number changes as new forms are added and old forms are retired.

The partner airline also has a group of Compliance Auditors who focus their investigations upon company maintenance bases. This group uses the same types of mechanisms (i.e., checklists and standards) in performing their duties. The Compliance Auditor group is responsible for ensuring that our partner airline's maintenance operations are in compliance with Federal guidelines and with its own standards. The Compliance Auditors use approximately 32 forms.

Based on our discussions with the partner airline, it was evident that both audit tasks have data collection and documentation reference requirements that could be addressed by the technologies employed in the Performance Enhancement System research.

5.2.2 Software Prototype

Two prototype job aids were developed - one for Vendor Surveillance Analysts (CASE Job Aid) and one to support the Compliance Auditors. These prototypes were developed for use on pen computers. It was hypothesized that pen computers would provide the auditors an ease of use similar to that of the clipboards they normally use. Data collected with the job aids are stored in databases and can be printed out in standard report formats or exported to Microsoft Word. This is a vast improvement over the current method of manual transcription of handwritten paper forms. The reduction in paper work realized from use of the job aid results in considerable time savings.

For the CASE job aid, we developed an application that contains four of the forms Vendor Surveillance Analysts use most frequently. The forms are separated because a vendor will normally provide just one type of the supplies or services that the auditors are responsible for reviewing. An example is shown in Figure 5.1. The application allows an inspector to identify whether a vendor is in compliance and to make a comment for each item on the form, as shown in Figure 5.2.

Figure 5.1 Form to Collect Audit Data

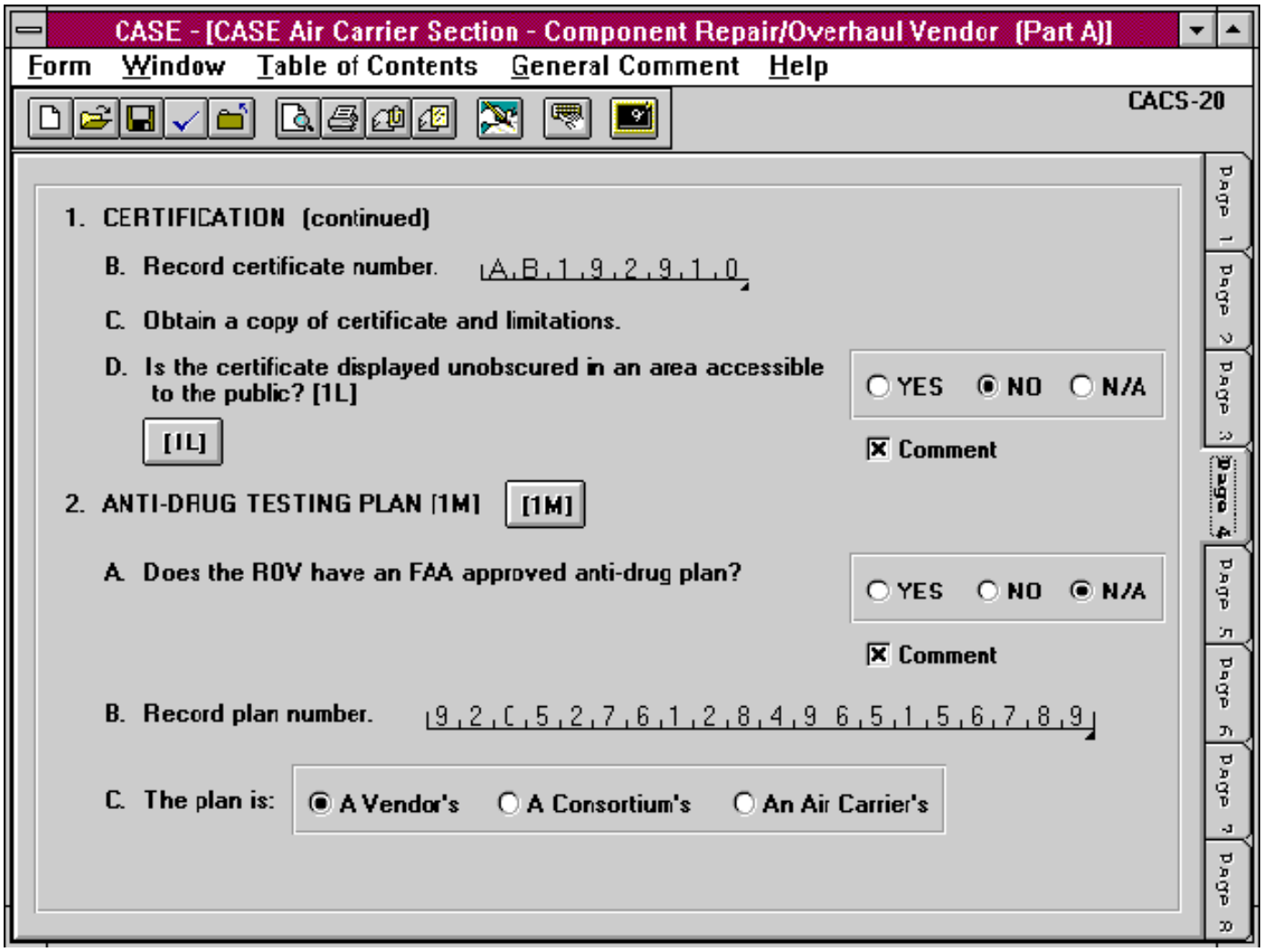
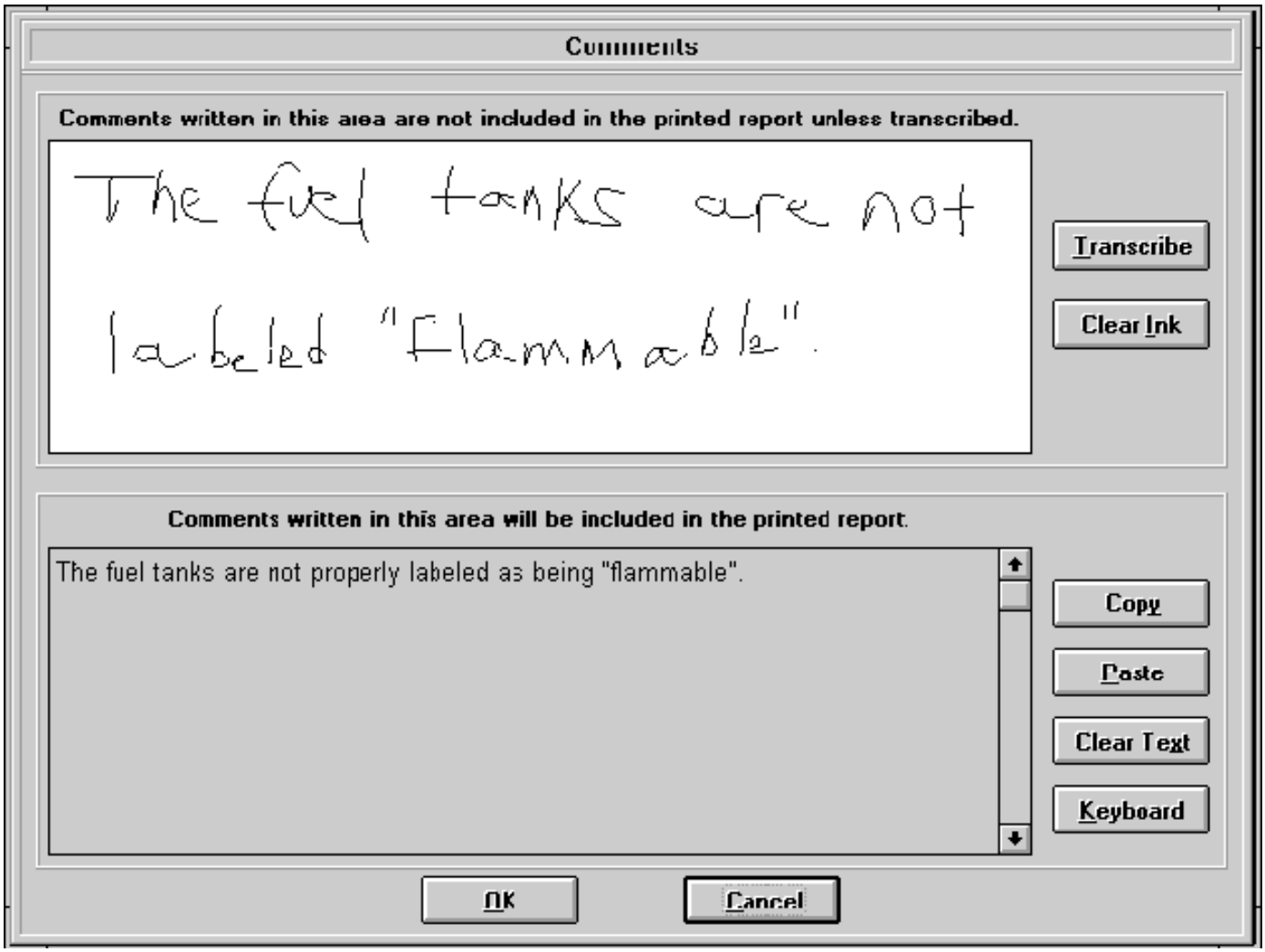


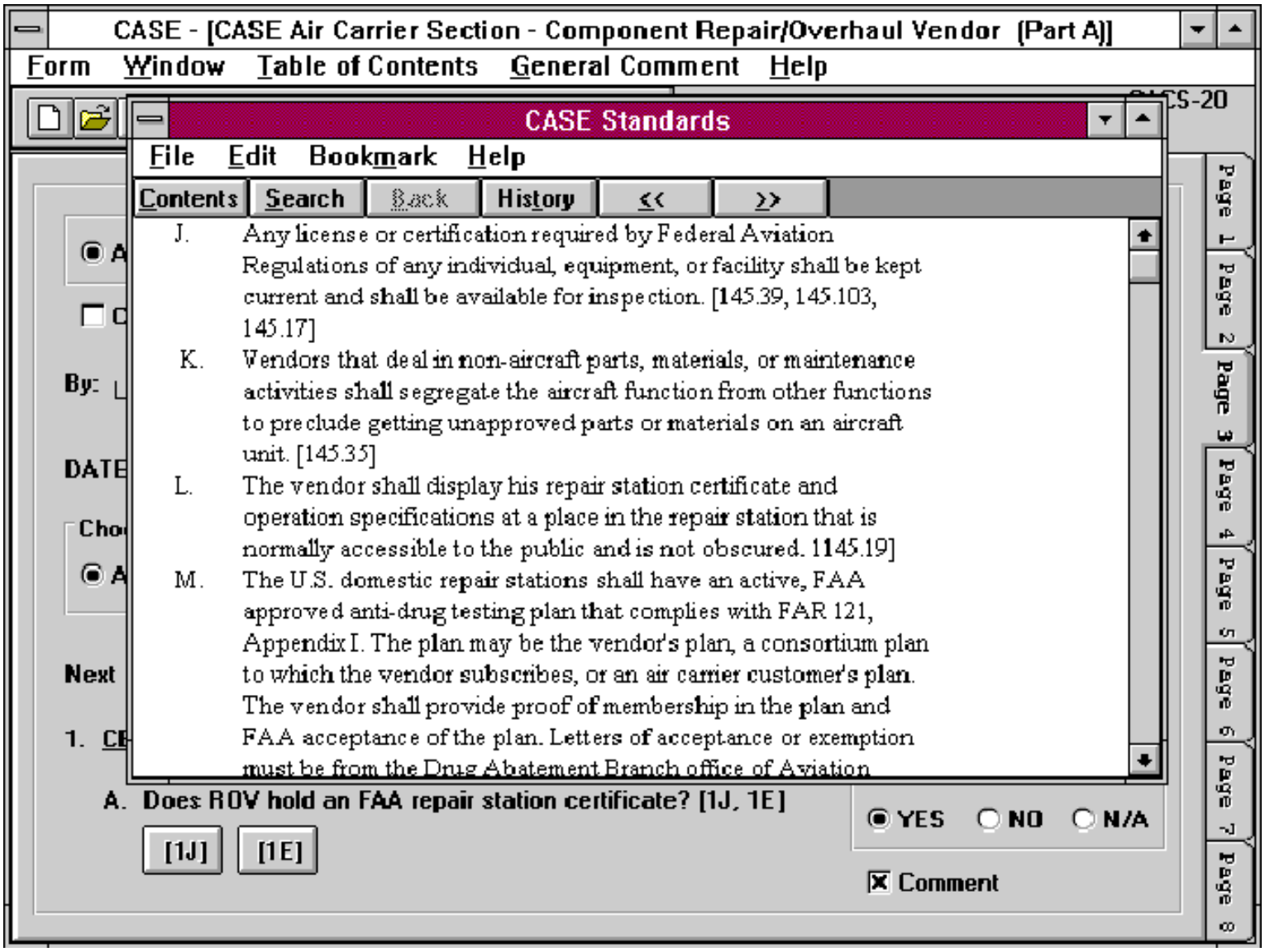
Figure 5.2 Dialog Box to Make Comments on Each Form



The application also contains links to the CASE standards appropriate to the questions on the auditing forms. This allows an auditor to access the standards for reference while performing an audit. As shown in Figure 5.1 there is a button next to a surveillance item ("Does the ROV have an FAA approved anti-drug plan?") that identifies the standard. When an auditor clicks on the button, the standard appears in Windows Help, as shown in Figure 5.3. Auditors liked this capability because they could read the standard and because they could copy and paste it into their reports. Whereas their reports previously contained the auditor's recollection of the standard, they now contain the standard's exact wording.

We developed a similar application for the Compliance Auditors. Unlike the Vendor Surveillance application, forms are saved in "sessions" (i.e., all forms used in a given audit are saved together). This difference in design results from the fact that a given maintenance facility of our partner airline normally performs several different types of maintenance and requires multiple forms. Because the content of the forms is proprietary to our partner airline, we cannot publish examples. However, the format and content are very similar to the Vendor Surveillance forms.

Figure 5.3 The Case Standard is Displayed Appropriate to The Question on The Audit Form.



5.2.3 Evaluation

Both prototype systems were fielded for evaluation with auditors from the partner airline. Pen computers loaded with the job aid software were provided to the auditors for use during field inspections. The software also was loaded on the auditor's desktop workstations. This allowed auditors to both use the software on the road, and to familiarize themselves with it in the office. The evaluation period lasted approximately ninety days, ending in April 1995.

The Vendor Surveillance auditors (CASE audits) were very enthusiastic about the prototype audit software, and used it on several of their audits. Their favorite features were (1) the portability of the equipment, (2) the ability to record comments that become integrated into output reports, and (3) the on-line standards which can be easily accessed and copied into comments. The evaluating auditors estimated that use of the job aid reduced the total time to perform an audit by 25 - 30 %. In general, the auditors said that they saw a definite utility for this type of technology in their field.

The fielding of the Compliance Audit prototype did not go according to plan, due to scheduling changes at the partner airline. As it turns out, our partner airline closed twenty-one of its over forty maintenance bases in the period during which the prototype was being created. As a result, there was only one Technical Standards audit scheduled during the evaluation period. The Compliance Auditors did spend some time reviewing the software, but not through any practical field use.

Evaluators indicated that the Compliance Audit prototype suffered from the lack of standards on-line. Of course, this was due to the partner airline's reluctance to let us put their proprietary information on-line. Another shortcoming identified in the prototype related to the fact that the compliance criteria and checklists change frequently. There is no mechanism in the prototype to easily modify the contents of the checklists. While a software developer could make the changes, it would be extremely difficult for an end user to do it. This makes maintenance of the software an expensive task. The evaluators indicated that they would like to have the capability to author the on-line checklists themselves.

The Vendor Surveillance auditors (CASE audit) expressed similar concerns about the inability to modify checklist contents. However, the CASE checklists and standards are fairly stable. Thus modifications would be infrequent and minor.

The only features of the software that the evaluating auditors were unhappy with were associated with pen computing technology. The transcription capabilities of the software, for converting both handwritten data and handwritten comments to typed text, were unsatisfactory to the auditors. Also, when they attach a keyboard to the computer for typing, they had difficulty in placing the mouse pointer with the pen. It switched back and forth between a handwriting and point-and-click device every time the pen was touched to the screen, impeding the process of editing a document. It was the general opinion of the auditors that a standard laptop computer *without* Pen Windows (and hence a mouse or trackball point-and-click device) would be more convenient to use.

5.2.4 Development of Operational System

Based on the results of the field evaluation, it was decided that the CASE Vendor Surveillance prototype software would be developed into an operational software system for delivery. The CASE evaluators were pleased with the prototype, and indicated that it would play a useful role in performing field audit tasks.

It was also decided that no further development would take place on the Compliance Audit prototype. Because of restrictions on the availability of standards information, and because of a limited amount of usage during the evaluation period, we determined that it would not be feasible to construct a useful operational system from this prototype.

The CASE software system was developed as a final output to this research task. The CASE system was based upon the CASE prototype software. Enhancements were made to the prototype as a result of the findings of the field evaluation. The major modification involved the dismantling of pen computing technology -- the software can now run on any laptop or desktop PC without the need for Windows for Pen Computing. Other modifications include:

- The addition of summary reporting: Summary reports are printouts of just the comments that a user made during an audit. Such reports provide a concise description of those specific areas in which a vendor did not perform as expected.

- Additional file management utilities: Over time the number of records contained in the hard disk of the auditors portable platform can become extensive. The ability to remove outdated audit records from the database was provided with this modification.

- General comments areas: Users requested a space to put comments that did not apply to any one area on the audit checklist. The general comments area stores such comments. General comments are printed out at the end of the complete checklist report, and at the top of the summary report.

- On-line Help: This module provides standard user help information, and serves to round out the operational software system.

5.2.5 Presentation and Distribution of Software

The CASE software system was presented to members of the CASE consortium, at their semi-annual meeting in May 1995. The software was presented to an assembly of each of the consortium's three sections. In total the prototype was seen by approximately 120 representatives from major commercial airlines, aircraft manufacturers, and aerospace/marine repair organizations. During the presentations, extra copies of the *Human Factors Issues in Aircraft Maintenance and Inspection '95* CD-ROM were distributed to meeting attendees. The CD-ROM contains a demo program that describes the features of the CASE software.

The CASE software was well received by each audience. Many attendees expressed a desire to see a greater use of technology in their job tasks, and look forward to the release of the software as a part of the next Office of Aviation Medicine CD-ROM.

The CASE software system was released as a part of the *Human Factors Issues in Aircraft Maintenance and Inspection '96* CD-ROM. From this CD-ROM users are able to install the operational software and databases so that they can then run the program from their local hard disks.

5.3 CAMI JOB AID FOR COLLECTION AND DISTRIBUTION OF DATA

The Office of Aviation Medicine (AAM) recommended that the Civil Aeromedical Institute's (CAMI) Toxicology and Accident Research Laboratory would benefit from the creation of a data collection and distribution application for alcohol and drug test results. The goal was to provide improvements such as a prototype data collection, data distribution and information display application that would run on Windows PC-compatible computers. This research laboratory stores and analyzes toxicology data derived from tissue and fluid samples collected from aircraft crew members who are suspected to have been flying while intoxicated. These individuals may or may not have been involved in an aircraft accident or incident. The Flight Standards Service is responsible for collecting such data and communicating it to Civil Aeromedical Institute (CAMI) as part of normal accident and incident investigation procedures.

The laboratory sent forms and instructions to the field offices in the Fall of 1994. To date, however, the laboratory has not received any data from the field. It was proposed that the usability of the forms issued by the laboratory could be greatly improved by implementing them in a user friendly software application. Because the forms are very simple and require data that the inspectors already collect in the course of such investigations, they were prototyped very quickly. The data collected would then be sent to the laboratory via a modem and a bulletin board system.

We developed a toxicology information and drug report job aid software that promises to provide an improved means of collecting data, data distribution, and information display for Flight Standard Service (AFS) personnel and communicating it to Civil Aeromedical Institute's Toxicology and Accident Research Laboratory.

The CAMI job aid will improve the means of collecting data by eliminating the cumbersome paper/pencil method. The data collected by AFS will be sent to the Civil Aeromedical Institute via modem and bulletin board system. The data collected is saved and displayed on electronic forms compatible with the Civil Aeromedical Institute standards. The software was developed with the assumption that the users are familiar with MS Windows.

5.3.1 CAMI Job Aid Prototype

The purpose of this task was to develop a working prototype that would demonstrate the ability to collect and distribute data from drugs and alcohol test results in an efficient and effective manner. The prototype followed the Microsoft GUI standards to interactively guide the users through the task and allow users to collect and distribute data properly.

In designing the prototype, it was with the understanding that it must conform to the MS Windows GUI standard and be able to add any features to assure that both novice and expert users can use the software with minimal assistance and training.

The CAMI job aid is a single stand-alone application. It is a multiple-document interface (MDI) application and contains a main window (Figure 5.4). The main window contains a menu bar, tool bar, and status bar. The menu functions correspond to the tool bar functions. The user can either select File-Create New Report or click the New Report button  to create a new report, or File-Open Existing Report or click Exiting Report button  to open an existing report. The same applies for printing  and saving  . Clicking on the new button brings up the Report Information requesting Inspector ID, date of report, and report ID (Figure 5.5). When all the information is completed, clicking the OK button brings up the Accident/ Incident Report form (Figure 5.6). Data is collected by entering it in the Accident/Incident Report form. When all data are filled in, clicking the save button on the toolbar will save the current information to the database. If users want to work with data that has been collected previously, they may select the Existing Report button or from the menu select File-Open Existing Report which will pop up an Existing Report dialog (Figure 5.7).

Double-clicking on a particular report will bring up the Accident/Incident Report form with data that has been saved. If any changes are made to the form, the user will be notified that data have been changed and asked to save them.

The print function button on the toolbar applies to the printing of Accident/Incident Report form only. Users may print the current form or formatted text from the menu.

5.3.2 CAMI Job Aid: Strengths and Weaknesses

This section describes the strengths and weaknesses of the CAMI job aid as well as description of possible future enhancements.

CAMI Job Aid Strengths

This prototype demonstrates features that make data collecting and retrieving an easy job for inspectors. The CAMI job aid was developed with the look and feel of a standard Windows word processor to make using the software easy for novice as well as expert users. By conforming the Windows standard, we are optimistic that the CAMI job aid will be received well.

The data collected by CAMI will reside in one location and can be accessed via not only CAMI software itself, but also by other tools such as MS Access as a means of getting to the data.

CAMI Job Aid Weaknesses

Due to the short development time, this prototype only shows some of the features that enhance the way data are collected and distributed electronically. The noticeable feature that CAMI job aid lacks is the inability to delete an existing record from the database.

Another weakness is the lack of on-line help that can be resolved with additional development and support resources.

Figure 5.4 Main Window for CAMI Job Aid

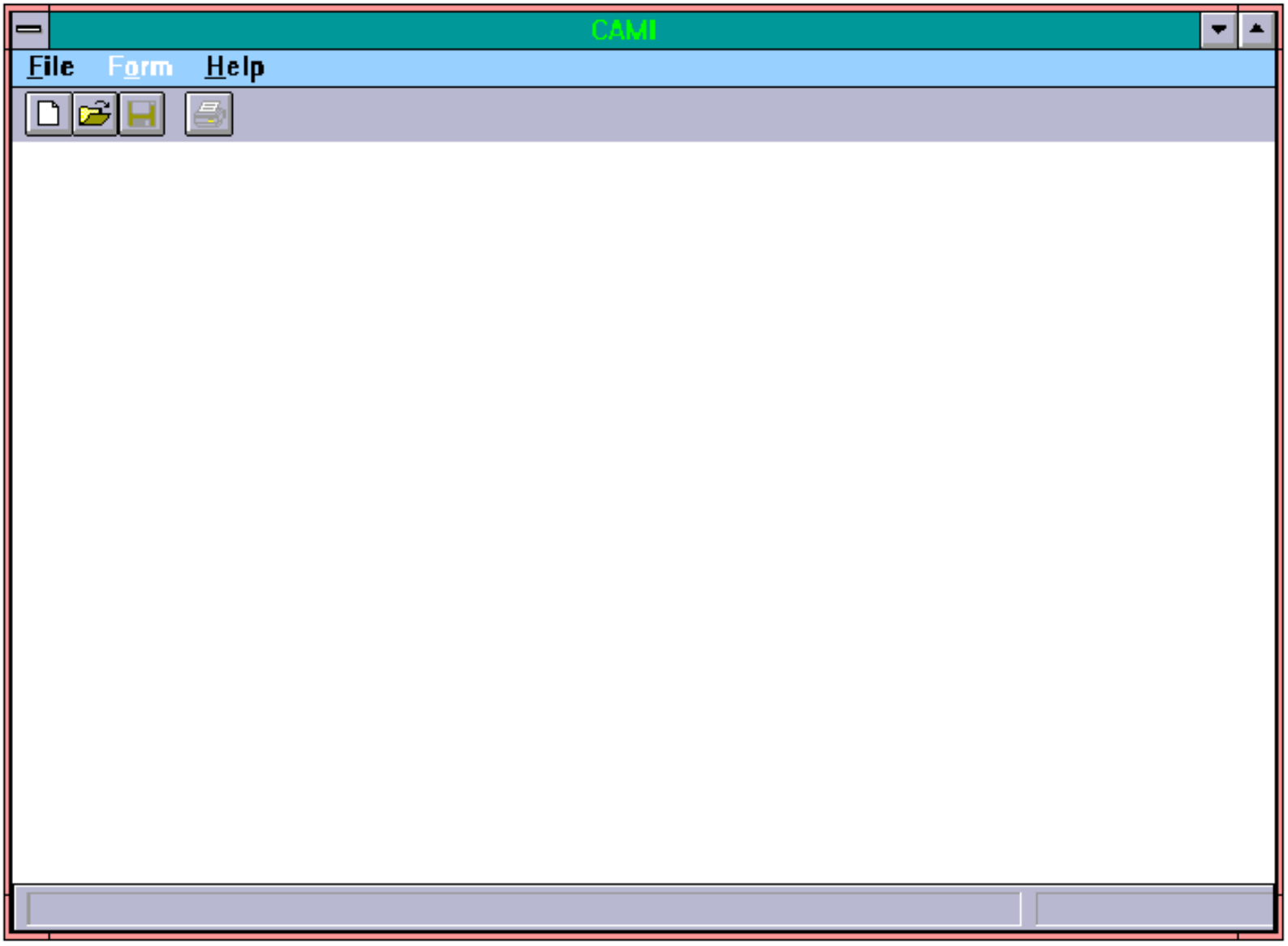


Figure 5.5 Report Information

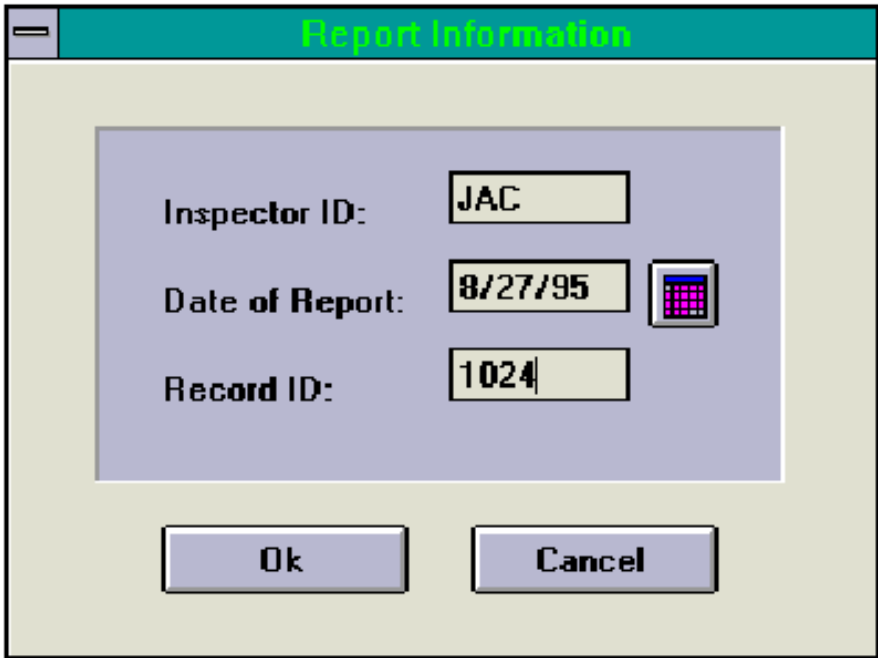


Figure 5.6 Accident/Incident Report form

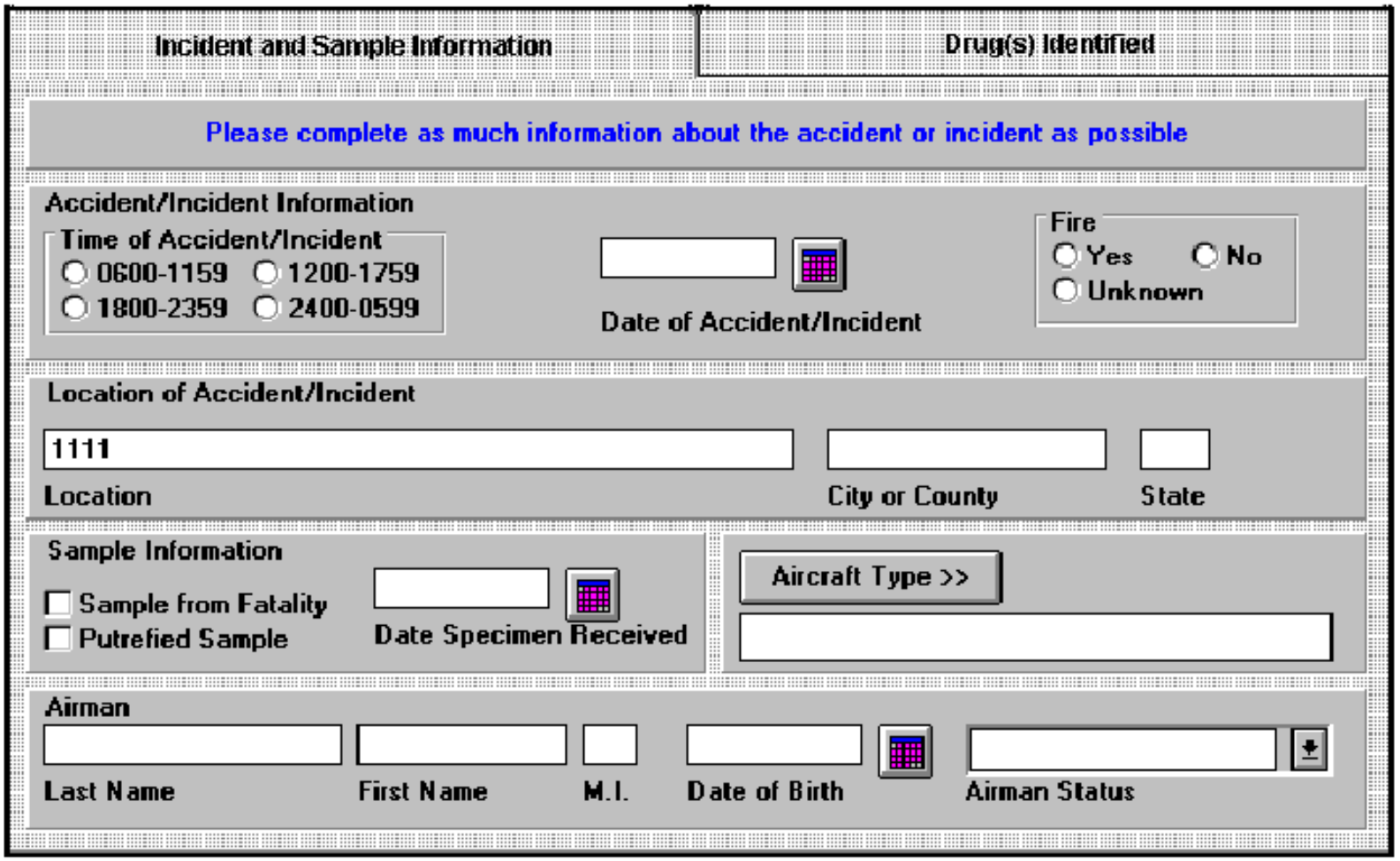
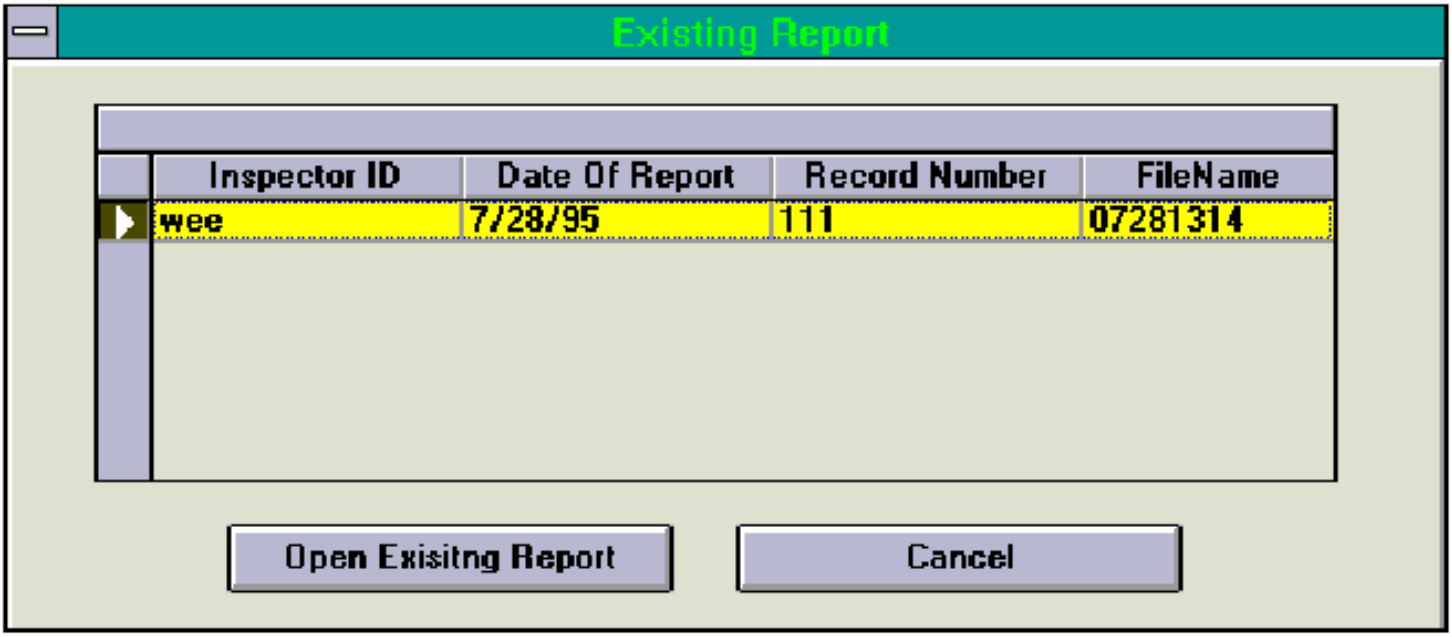


Figure 5.7 Existing Report Information



Possible Future Features

Additional forms may be added to the existing software if and when needed. It would be advantageous to automate the process of upload/download of CAMI data.

5.4 JOB TASK ANALYSIS: INSPECTOR'S TASK BOOK

The Job Task Analyses (JTAs) hold the promise of providing a great deal of assistance to inspectors who must perform activities infrequently. The JTAs list all of the resources and steps required for an AFS Aviation Safety Inspector (ASI) to perform a variety of inspection and investigation activities. These JTAs would be invaluable in the field. The purpose of this task was to develop a working prototype job aid to demonstrate the capability to provide on-line display of JTA reference sheets.

This prototype job aid used the capabilities of MS Windows and the MS Windows GUI standards not only to show the task sheets on the screen, but also interactively to guide an inspector through the task and allow him to automatically access on-line documentation related to that task. We called this prototype the Inspector's Task Book (ITB).

To be included in the Inspector's Task Book (ITB) several JTAs were converted from their paper versions so that they can be accessed in conjunction with the Performance Enhancement System (PENS) software now called the On-line Aviation Safety Inspection System (OASIS). The ITB was developed in a manner similar to Microsoft (MS) Windows Help. Thus, the JTAs in the ITB can be accessed at any time while performing an inspection. Ideally, the JTAs would also contain links to the policy guidance systems, but the commercial vendors providing policy guidance can not support such capability yet.

5.4.1 The Inspector's Task Book: Design Fundamentals

In designing the ITB prototype job aid for the JTA program, we developed a set of fundamental considerations which will maximize the usability and utility of the program.

Because the ITB operates in MS Windows, it must conform to all MS Windows GUI standards. This allows both veteran and novice users to learn the system with minimal training, and cooperates well with other MS Windows programs.

This program is one component of a suite of tools envisioned by Galaxy Scientific for the enhancement of FAA inspections. As such, the ITB was built to dovetail with other tools in the OASIS suite, primarily the Inspector's Field Kit (IFK). The IFK provides access to all the forms for an inspection activity.

The ITB provides quick, context-sensitive access to the IFK. This allows the user to switch to the inspection activity suggested by the current job task analysis. Likewise, the IFK provides a path back to the ITB, such that the current inspection activity may be viewed in light of the appropriate job task.

Also, since these two utilities together provide a solid, structured approach to aviation inspections, they must coexist in the MS Windows environment in a way that allows the user to switch back and forth between the two. The ITB was designed to be small enough to be seen on the screen along with the IFK without interfering with the inspector's use of either program.

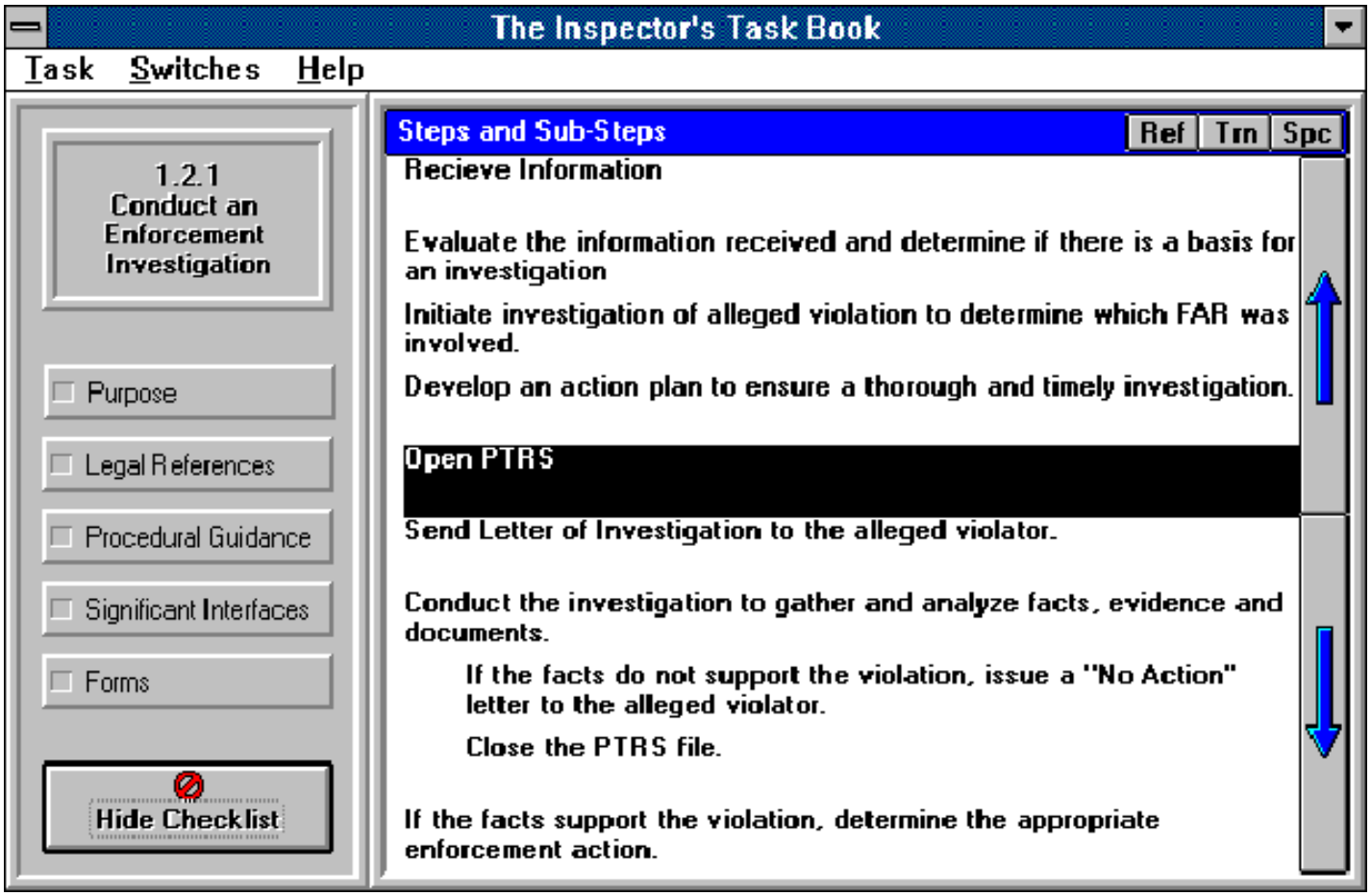
5.4.2 The Inspector's Task Book: Description of the Prototype

The Inspector's Task Book (ITB), in its normal configuration, is contained in a single, small window that may fit conveniently to one side of the user's screen. It contains a standard MS Windows title bar and menu bar. The body of the window contains the title of the selected job task analysis along with a series of buttons that provide detailed information about that task (*see* Figure 5.8). These buttons include those for the purpose of the task, legal references pertaining to the task, procedural guidance annotations appropriate to the task, significant interfaces encountered during the performance of the task, and forms that will be used during the execution of the task. By clicking on any of these buttons, the user will be shown the details provided in the job task analysis.

Figure 5.8 The Main Window for the Inspector's Task Book

To show the separate steps and sub-steps involved in the completion of the task, ITB utilizes an "expanding window". When the **Show Checklist** button is clicked, the width of the main window expands to show a list of the required steps (*see* Figure 5.9). By highlighting a particular step and clicking on the **Ref** (Reference), **Trn** (Training) or **Spc** (Specialization) buttons, the user will see pop-up details for the step.

Figure 5.9 The Inspector's Task Book, with Expanded Window



Selection of a particular job task analysis is accomplished through the **Task** menu (**Task** - **New**). This will display a hierarchical list of all available JTA sheets, from which the user selects the particular task to be displayed.

The inspector can switch to the IFK through the **Task** menu (**Task** - **Field Kit**). The program determines which activity number is suggested by the current job task, or, if multiple activities are supported, it presents the user with the list of possible activities. Once the activity is determined, the IFK will be launched, automatically beginning with that activity.

5.4.3 The Inspectors Task Book: Software Development

Tools Used

- **Visual Basic Pro** - Visual Basic was our language of choice for this prototype. It allows us to quickly put together fully functional applications in a minimum amount of development time. The "Pro" version adds extra controls (e.g., Outline) to the standard list of VBX controls that come with the standard VB package.

- **VB HelpWriter** - In earlier evaluations (during the development of IFK), we found VB HelpWriter to be an easy-to-use, fully featured, WYSIWYG help creation utility. It also supports automatic generation of glossaries and help contexts, through unique links to Visual Basic.

- **Paradox 3.5** - Development with the Paradox 3.5 database is one of the requirements of the IFK, due to the current widespread usage of that package among existing FAA systems. We chose to use this database in the development of the ITB in an effort to avoid incompatibilities with other PENS utilities.

Tools Not Used

- **TrueGrid Pro -** In order to implement the steps and sub-steps as a checklist, we purchased and evaluated a checklist VBX called TrueGrid Pro. This third-party control is a full-featured checklist add-on. It was selected for its ability to use buttons, drop-down lists, and other controls within the grid. We discovered, however, that its wide range of functionality also created a poor development interface, in that the control of its features is difficult. Instead, we decided to implement the steps list using the standard Visual Basic controls.

5.4.4 Inspectors Task Book: Strengths And Weaknesses

This section explores some of the strengths and weaknesses of the ITB prototype, as well as a description of possible future enhancements to the program.

ITB Strengths

This prototype demonstrates some of the features that will make it an indispensable tool for guiding users through an inspection task. The implementation as a Microsoft MS Windows program and the adherence to MS Windows standards allow the ITB to take advantage of facilities inherent to the MS Windows operating system. MS Windows has proven itself to be a user-friendly environment, allowing experienced users to switch from one program to another without a significant learning curve, and allowing beginning users to quickly learn the program through intuitive actions. This implementation also allows possible connections to built-in resources such as printing and communications.

Another strength is the ITB's compactness. The presentation of the window as a small, stay-on-top window with buttons to activate only the required information, allows it to show as much information in as small and unobtrusive manner as possible.

One of the greatest strengths is the way in which the ITB interacts with other tools in the PENS applications, most notably with the Inspector's Field Kit. By building inspection tools which interact with each other and which share information, Galaxy Scientific is creating a computerized environment which will ultimately aid in all aspects of the process of aviation inspection.

ITB Weaknesses

Due to the short development time and the availability of certain tools, this prototype can only demonstrate the basic functionality of the on-line JTA information.

Conspicuously absent are direct links to on-line documentation such as the inspector handbooks, which are referenced in each of the job task analyses. By clicking on a particular procedural guidance annotation or legal reference for example, the user would expect to be able to view the text associated with that reference. Currently, such references are not available on-line. However, the program was developed with the software hooks for such an interface. When these documents become available, they may be easily integrated into the existing prototype.

Approximately 10 job task analyses have actually been implemented into the ITB prototype. These tasks were arbitrarily selected from available information. Before the ITB may be regarded as a truly useful program, the remaining 500+ JTAs must also be imported into the program's database. This requires a level of cooperation and coordination between Galaxy Scientific and the developers of the JTA information. This is currently being explored.

Another shortcoming of the prototype is the absence of direct form links into the IFK. Many of the job task steps and sub-steps refer directly to particular forms that must be completed in the course of a task. However, since both the IFK and the ITB have limited forms and task information completed, such a linkage is not yet possible, but will be developed as the two programs evolve.

Finally, there have been no formal tests of the ITB program. A testing effort to prove the viability of this program would necessarily include both usability studies and field testing, neither of which have been included in the initial scope of the project.

Possible Future Features

In addition to addressing the aforementioned weaknesses in the program, the ITB would be enhanced by the addition of further functionality.

The ability to highlight and check off completed tasks, to add comments and to save this information will allow the inspector to keep better records of the job task. These records could be saved and recalled later for tracking purposes or to aid in future inspections.

Any information gathered in the course of performing a job should also be shared with other utilities in the PENS suite of tools. Such information sharing will be defined as the development of the series progresses.