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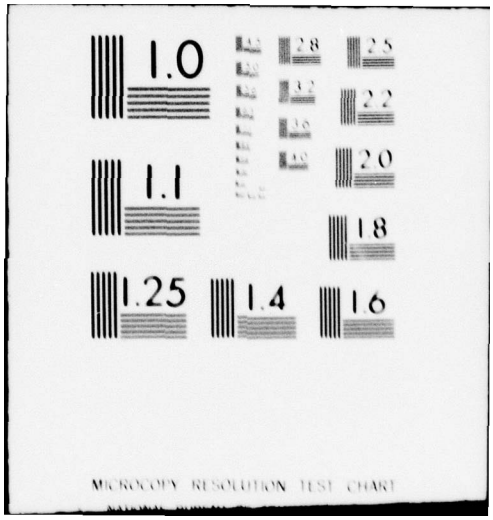
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HUMAN FACTORS IN THE SPECTRUM MANAGEMENT SYSTEM: I. INTRODUCTION AND FRONT END ANALYSIS

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DEPARTMENT OF NATIONAL DEFENCE - CANADA

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ABSTRACT

The Spectrum Management System is being developed by the Department of Communications to provide automated assistance to the processing of applications for licences to operate a mobile radio station. This report summarizes the human factors recommendations that were submitted under a contract with the Department of Communications during the initial design stages of the project. The system was to be installed for evaluation in a pilot experiment in a single office and the first part of the report covers recommendations for conduct and evaluation of this experiment. The second part of the report makes recommendations on the stage of the process termed the front end procedure, in which the initial application is processed and the data is entered into the computer for subsequent analysis. Subsequent reports will present recommendations relating to other stages of the Spectrum Management System process.

INTRODUCTION

THE SPECTRUM MANAGEMENT SYSTEM

The Spectrum Management System (SMS) is to be introduced into service by the Department of Communications (DOC) as a semi-automated procedure to assist in the issuing of licences for land mobile, base and general radio transmitters. The system is to be introduced initially as a method for issuing licences for land mobile transmitters only, and it is with the development of this phase that this report is concerned.

Licence applications submitted to DOC are handled by the district office for the geographic area in which the transmitter will be operated. The application can be for a new installation, and could be the first application for that customer or could be a new addition to a series of installations already being operated by him. All new applications from one customer are handled by DOC as one file, or transaction, with each application being considered a subtransaction within it.

All applications are renewed on a periodic basis, the renewal forms being mailed to the customers when submission is due. A large proportion of the district office work is thus concerned with the processing of routine renewals.

Applications must be submitted together with the fee for the service requested. This fee is established as an average fee value for this type of application, and the actual fee to be levied for a particular application is calculated accurately at a later time based on data generated during the processing of the application. The fiscal control of the licencing process is regarded as a matter of importance within DOC, and much of the work involved is aimed at determining the specific conditions that will apply to the licenced transmitter to ensure that the correct fee value is applied from the Table of Chargeable Changes.

The procedures involved in SMS fall into clearly defined steps according to the discrete stages in information handling between the initial application from the prospective user and the final step of issuing a licence to that applicant. These steps can be described as follows:

(1) Cash register. The processing of the application, whether received over the counter at a DOC district office or through the mail, and the handling of the fee submitted, is performed at a cash register located in the district office. This step creates the file of basic data upon which all subsequent steps build.

(2) Front end processing. The data on the application form are verified and entered into the computer file for that application. They are then subjected to administrative and technical checking procedures, involving technical calculations and specialist judgment.

(3) Frequency preselect. Frequencies can be preselected for testing by the computer for acceptability, through the use of the appropriate programmes.

(4) Electromagnetic compatibility checking. A lengthy and complex procedure is carried out to ensure that the frequency allocated will not interfere with any other frequency in use.

(5) Back end. Final administrative steps leading to the issuing of a licence, and statement of the fee finally determined with required cash adjustments to the fee submitted with the application.

DOC requested that DCIEM provide support to the SMS project in the form of advice and recommendations on the man-machine interface design of all phases of the licencing procedure, up to the fielding of the full-scale pilot experiment planned for spring 1978. This report outlines the approach taken in response to this request, and the recommendations submitted on the Cash Register stage are published separately (Brown, R., 1978). The stages of frequency preselect and electromagnetic compatibility checking were seen as being largely a computer programming task, with less man-machine interaction content than the earlier stages. Although much time was spent in discussion of these stages with SMS staff, the DCIEM contract expired before the computer programmes were written, and so no formal recommendations on frequency preselect and electromagnectic compatibility stages were submitted.

APPROACH TO THE STUDY

Investigation and Testing

The first phase of the approach involved gaining familiarity with the total licencing process, and with the design of the computer assisted procedures to be tested in the pilot experiment. This was to be achieved through:

(a) discussions with SMS project staff on experience gained on earlier preliminary evaluations, and on concepts developed and on progress achieved for the pilot evaluation:

(b) reading of the available documentation and reports on the licencing process and on the development of the Spectrum Management System:

(c) visits to district offices to study procedures currently used, to gain insight into the technicalities of the process and to become familiar with the attitudes of the operational personnel.

Each stage of the licencing process had to be defined in detail as to the procedures used, information to be processed and the inter-relationships of each stage to preceding and to subsequent stages. Limits imposed on potential modifications to the system during the introduction of automated aids, due to Department of Communications policy or to system constraints, had to be identified.

It was decided that the flow of information should be defined for the total licencing process; the sources for all necessary pieces of information used by the operational personnel should be determined; and the form in which it is made available and the form in which it must be logged in the system should be identified. This would establish any data transformations that must be made, whether by the operator or by the computer.

Identification of Problem Areas

Once each stage in the licencing process was defined, aspects of the operators' tasks that present problems of a man-machine interaction nature were identified. Four main aspects of the tasks had to be examined to ensure that the interface between the operator and the computer system was acceptable:

(1) The dialogue between the man and the machine involves entry of information that is accurate and understandable by the machine, and response from the machine that is unambiguous and clear to the operator. Fixed messages in the system (such as labels, key legends, documents and instruction) must be simple to understand in the operator's terms rather than in the system designer's terms.

(2) The procedures that are employed by the operator in the conduct of any part of the task must be free from unnecessary complexities and redundant steps. Procedures may be determined by the sequence of the flow of information and may be optimized by a redesign of that flow. They may be determined by the use of specific hardware components that are not designed optimally for the task, and optional hardware may be available that is more suitable. Procedures can be influenced by spatial arrangements of personnel and equipment in the work area, that cause inefficiencies that can be avoided by a simple office rearrangement.

(3) Items of equipment used during the licencing process in a district office must be designed according to accepted human engineering criteria, but these criteria have to be applied in such a way as to recognize the particular demands of the tasks that are being performed, and the environment, both physical and psychological, in which they are used.

(4) The information flow throughout the total process must be such as to allow adequate operator performance in terms of accuracy and convenience. Bottlenecks in information flow can develop when the required information is not readily available, is not available at the desired degree of accuracy, is not in the appropriate format, or is ambiguous. Problems also occur when it is unclear to the operator as to what action should be taken with information that is received or has been generated.

Proposed System Concepts for Pilot Experiment

Aspects of the SMS system design that were considered to create potential problems for the operator were discussed with the responsible SMS staff personnel. Potential solutions were presented to them, and discussion of the problem and the proposed solution uncovered any further details or constraints that may have been overlooked. Validity of the proposed solutions was determined and their acceptability established in terms of the system design through this continuing dialogue.

Since all stages of the licencing procedure are interrelated, modifications to one stage may affect other related stages. The functioning of the total process was maintained as the criterion, and all recommended procedures for individual stages were viewed in terms of how they improve both that stage and the total process.

Potential modifications to the SMS procedures that were shown to be necessary and valid were modelled for preliminary testing on the computer-display system at DCIEM. In this way general principles were fine tuned to the specific SMS application and environment. The results of these studies, consistent with the advice and opinions of the SMS project group personnel, then formed the basis of the DCIEM recommendations for the design of the man-machine interaction in SMS.

Recommendations for the Pilot Experiment

After each stage of the licencing procedure had been examined, and proposals cleared with the appropriate staff, an informal working paper was generated containing the DCIEM recommendations for an adequate man-machine interaction. These working papers form the basis of this and subsequent formal reports.

Some concepts were recommended that were of a general nature, applying throughout the total process, or to a philosophy of man-machine interaction that should be incorporated in all SMS development and implementation. These were discussed with each project group individually during the discussion of the specific details of the working paper.

Any recommendations that could not be adopted for the pilot experiment, due to limitations imposed by time constraints or existing system development, were presented as options in the working papers. After the pilot experiment, these options can be reviewed in the light of any noted deficiencies in procedures, and may form the basis of modifications to the final system.

Pilot Experiment Performance Measurements

Operator efficiency can be measured in several ways in a field evaluation. Operator attitudes can be assessed separately using questionnaire techniques. The use of these two approaches together can provide a comprehensive view of the acceptability of the procedures under review for both the operators and for the managers of the system.

Discussions were held with SMS staff to emphasize that the performance measures to be used in the pilot experiment should be defined, and a detailed list of the data that should be available from the evaluation for subsequent analysis should be programmed into the study. It was also pointed out that questionnaires should be developed for use during and after the study to provide additional information on operator attitude and opinion on specific aspects of the SMS process. Analysis of these data would produce the necessary information to assess the success of the pilot evaluation from a man-machine viewpoint.

ANALYSIS OF THE FRONT END

DESCRIPTION OF THE FRONT END PROCEDURE

It is stated in the SMS Front End Procedures Manual that there are five distinct procedures that are required to perform all the aspects of that part of the licencing process that is described as the front end. These are:

(1) The entry on a computer terminal of the information from the application forms for either a base station, a mobile unit or an antenna. It is recognized that there are other types of units for which applications would be submitted, but this discussion is limited to the processing of land mobile applications.

(2) The processing of these data to produce administrative checks. These are to include only a check for the acceptability of the equipment specified on the application form against the Radio Equipment List of approved items, and a check of the height of the antenna to determine whether approval for the installation must be obtained from the Ministry of Transport.

(3) The processing of the entered data to produce technical checks. Since the proposed transmitter-receiver-antenna system can be described technically by a series of descriptors that are to a degree inter-related and inter-dependent, the details provided on the application form can be compared and evaluated to ensure that these inter-dependencies are not violated.

(4) According to the nature of the applicant, the nature of the service applied for, and on whether it is a new or a renewal application a fee can be calculated for the licence.

(5) The capability must be provided for the subsequent ammendment of records that have been entered into the computer. This can be either to modifiy entries in a record that has been previously stored, or to make additions to a record that has been stored in an incomplete state.

(6) Outside of the procedures required for the entry of the application information into the computer in an accurate and checked form, there is a requirement for the inspection of stored files to reference an item of information.

This report will review these procedures as they will be implemented in the pilot experiment, and will specify those aspects of the design of hardware, software, and procedures that are required to improve the man-machine interaction. This review recognizes the different types of individuals who are employed in a DOC district office, and recommends the procedures or system design features accordingly.

DATA ENTRY

Personnel

The use of a typist is recommended for routine data entry of the front end information.

The entry of data into a computer is a routine clerical task that should only involve the straight transcription of items from a paper copy (usually) to the computer terminal. In this way the task will probably be performed reasonably quickly and accurately. A word of caution is appropriate, however, for those who would employ a trained typist to perform this task. When a typist makes a typing mistake, the error can be corrected by a backspace and an overstrike. If this is done on a display terminal, it appears to correct the error in a similar way, but does not in terms of the computer entry. Typists should be trained in the use of computer display terminals so that this type of entry error does not occur.

Preparation of Data

In order to ease the typist's work load, all the information should be readily available on the application forms, or procedures should exist for making it available. The data entry task can then be viewed as a simple transcription task that requires no decisions from the typist as to where to find the information, nor the form in which the data should entered.

The information that is provided on the forms may not be adequate in some instances. Some of the items may be missing, some may be obviously incorrect, and some may have to be amplified with additional technical details. In these cases, the typist should be able to immediately refer the application, together with the offending items, to a technical colleague who can provide the details. The use of a hard copy unit associated with the terminal would permit the typist to press a (PRINT) button to produce a paper copy of the series of items with which she has problems, and the responses that have been provided to that point. This can be appended to the file and, when filled in manually by the technical specialist, would be returned to the typist for further data entry.

Error Checking

It is recommended that provision be made for the availability of continuous and immediate error checking of entries as they are entered.

People make mistakes in filling out forms, and also in the transcribing of information from forms. Some of the information on the forms will be incorrect, and some of the correct information on the form will be transcribed incorrectly by the typist. The computer can check every entry to see that it is in a valid form and length. For example, items that should comprise 6 numerals can be checked and rejected if they do not contain 6 numerals. An item that should be a string of alphabetic characters of indefinite length, like a company name, can be so checked.

In addition, values can often be determined to fall within a specific range of values. If it is outside of this range, the system should question it by displaying a warning symbol to the typist. This will indicate to her that an entry has been made that is unacceptable. It would be checked against the application form, and if the two correspond, data entry would continue.

The typist cannot make decisions about the validity of the data being entered. She only transcribes what is on the form. The machine should alert her to the fact that there is bad data being entered, and she only can confirm to herself that she has copied correctly. The technical personnel will note the flagged entries on later inspection, and will resolve the problem. For efficient interaction with the system during data entry, the typist should be informed of the occurrence of one of these conditions when the associated data is entered. That is, there must be immediate feedback of any error condition during the data entry process.

Data Entry Format and Procedure

The format recommended for the entry of front end data is contained in Annex A. All information is organized in pages, each page containing items that are logically related. To some extent, these pages will correspond to the sections of the application form currently in use.

To initiate the entry of data, it must be specifed what type of record is being entered. This should be accomplished with the minimum of typing to reduce time and errors. Until the full range of types of applications is clarified, and they are adopted in the SMS system, it is recommended that a function key be allocated for selection of (LAND MOBILE), and 2 function keys be allocated for selection of (NEW) or (AMEND), the latter processing renewal applications. This should be followed by the entry of the transaction number and subtransaction number, available on the application form from the cash register processing. The entry procedure would thus be:

(LAND MOB) (NEW) 123456#1234 (* see footnotes)

At this point, the first page of entry items (or prompts) will be displayed.

All prompts will be written in inverse video, by preference, and be protected fields that prevent data entry in these areas. Positioning of the cursor in the entry area for the next prompt

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*(1) (NAME) will be used in this report to denote the use of a single function key.

*(2) The transaction and subtransaction numbers are 6 and 4 digits respectively. A discussion of this is contained below.

will be accomplished by depression of the key labelled (NEXT LINE). This would be similar in function to the normal tab key. Another key would be required to allow backward tab, that is, to allow the operator to move the cursor to the entry area above the one presently being used. This key would be labelled (PREV LINE). Once it has been entered, another depression of the (NEXT LINE) key will position the cursor at the start of the next entry area. If no entry is to be made in that area, further depression of the (NEXT LINE) key will leave it blank and position the cursor at the next entry area.

Two more function keys are required for selecting (NEXT PAGE) and (PREVIOUS PAGE). Selection of the next page will print the next succeeding item list for data entry, and the previous page permits going back to review or to amend previously entered data. On completion of the entry of the data for a transaction, the depression of the (ENTER) key should transmit the total entry from the terminal to the storage device or to the main frame.

Help Files for Data Entry

Should the individual performing the data entry task need assistance with an item, this can be provided quickly without interrupting the continuity of the task by the use of help files. The entry of a ? after the item would be used for the amplification of the item prompt. For example, if the prompt for COVERAGE was COV, the entry of ? after it would display the explanation of that item, as:

```
COV?
EXPECTED COVERAGE IN MILES
```

As further example, the ? in response to BUS NAT would display the explanation that it is the nature of the business that is required.

Further help can be obtained by entering the word help after the item, as

```
COV help
```

The response to this entry would be

```
TYPE YES (or Y) (CR) TO OBTAIN HELP WITH THIS ENTRY
OR
TYPE ? (CR) TO OBTAIN HELP WITH THIS SECTION OF THE APPLICATION
```

If Y (CR) is entered, the response would be

```
EXPECTED COVERAGE IN MILES IS FOUND FROM
```

40 log D miles= E-P-20log f+20log h(feet)+20log h(feet)
-L+10log(7.9x10)

TO RETURN TO WHERE YOU WERE TYPE (CR), OR GET MORE HELP WITH ? (CR)

If ?(CR) is typed, an explanation of the total section is presented, perhaps with a reference that can be used. For example, the above help request would produce the section of a technical manual that explains the computation of coverage from the ERP value on the application, and of the ERP from the coverage value on the application, and how they can be adjusted to eliminate non-correspondence.

For a bilingual version of this procedure, only the YES (or Y) (CR) would have to be changed to OUI (or O) (CR).

ADMINISTRATIVE CHECKS

Access to the administrative checks should be performed by the depression of a single function key, (ADMIN CHECKS). It is assumed that this procedure would be initiated subsequent to the completion of the data entry procedures, and would likely be performed by a technical staff member. The procedure would include the transaction and subtransaction numbers, as

(ADMIN CHECKS) 123456#1234

The data will have been checked automatically at the main frame after data entry. No question and answer is necessary, therefore, to obtain the results of these checks. The response to the (ADMIN CHECKS) key should be

(1) the display of the results of the checks, that is, the acceptability of the equipment after reference to the Radio Equipment List, and

(2) a statement as to whether approval will be required from the Ministry of Transport for the antenna.

(3) if invalid data has been found during the checks, a message should be displayed as

UNABLE TO PROCEED: XXX IS OUT OF RANGE
or: XXX IS INVALID

Any other items that may be included subsequently should be handled by the system in the same manner as those discussed above.

TECHNICAL CHECKS

Correction of Calculation Errors

One of the main functions performed by the technical checks for the earlier evaluations was related to the nature of the entries made. The application form asks the applicant to give the same value several times in different parts of the form, and in different units. The entry of these values requires that a check must be performed to ensure that the conversions and calculations made by the applicant are correct. The computer also performs the calculations and compares the result with the applicant's result, and discrepancies were previously interpreted as errors that had to be corrected.

It is assumed that such procedures will not be adopted in the pilot experiment. Any value should be entered only once during the data entry procedure, irrespective of how often it appears on the application form. Comparisons are not necessary, therefore. Calculations should not be performed by the applicant, and any that he does should be ignored. A computer can perform calculations more quickly and more accurately than a human, provided that the programme has been confirmed to be correct. Comparison of results of computations are not necessary, therefore.

Checks of Raw Data Inter-relationships

One aspect of the technical checks is concerned with the checking of inter-relationships between raw data values that are entered from the application form. The value for one item may infer a value, or range of acceptable values for another item. For example, there is a correspondence between the type and length specified for the transmission line and the value entered for transmission line loss.

Access to the technical checks procedures should be performed by a function key action, followed by entry of the transaction and sub-transaction numbers, as

(TECH CHECKS) 123456#1234

It is assumed at this point that these checks are performed in succession. It reduces the workload of the technical personnel if the system automatically displays the transaction and subtransaction numbers of the last operation (the administrative checks), when (TECH CHECKS) is keyed. In the example, the (TECH CHECKS) key would bring 123456#1234 automatically onto the screen for acceptance by a (CR), and if another transaction number was required, it would be entered by overtyping these numbers.

A clear statement should be displayed immediately as to the nature of any discrepancy found during the technical checks. This would be followed on the display by such questions as:

VALUE OF ANTENNA HEIGHT OUT OF RANGE
AND HT GIVEN: 1600 FT
TYPE A NEW VALUE, OR IF CORRECT (CR) - 160 ft -

At the end of this sequence, when all the test values have been entered, the system would indicate whether any discrepancies still remain. Further test values would be entered as above until the system statement indicated no further problems. This should be followed by the system question.

ENTER THESE VALUES IN FILE? Y/N

FEE CALCULATION

Entry into the fee calculation procedure should be achieved by depressing the (FEE) function key. The system has enough information at this stage to know what the fee should be. Fee calculation are relatively trivial in complexity, although important in the licencing process. They are dependent, in many instances, on the type of applicant, the nature of the service applied for, and on whether it is a new or a renewal application. A new application falls into a prescribed category, and renewals can be referred to the table of chargeable changes to find the fee automatically. Response to the (FEE CALC) key should be a system message.

FEE PAID $XXX
FEE ASSESSED $YYY
BALANCE DUE/OWING FROM APPLICANT $ZZZ

The operator should only have to enter (CR) to accept the fee calculation, or move the cursor to the FEE ASSESSED entry area and overtype with a value he deems more appppropriate.

AMENDMENT

Access to the amendment procedure should be perfomred by depressing the (AMEND) function key. Specification of the transaction to be amended would be as outlined above, that is the identifier would appear automatically to be accepted by a (CR), or overtyped with different transaction and subtransaction numbers.

(AMEND) 123456#1234

Page access is achieved by the (NEXT PAGE) and (PREVIOUS PAGE) keys, and the cursor can be stepped down the page to the item to be amended by the (NEXT LINE) key. Amending the information should be by overtyping the existing entry with the new information.

ENQUIRY

Access to the enquiry procedure should be performed by depressing the (ENQUIRY) function key, which would display the last used identifier, or a new transaction and subtransaction number could be entered. The entry would be as follows:

(ENQUIRY) 123456#1234(CR)

This should present page 1 of the referenced transaction, displaying all the items and the values that have been entered during data entry. The (NEXT PAGE) key would replace this with the display of page 2. Any page can be reviewed in this manner by stepping forward and backwards through the pages.

This procedure allows the individual to read the file only, and does not permit amendment of any information contained in it. The separation of this function from the amend function is justified only if there is an advantage in programming terms, such as avoiding the creation of back-up copies of the file whenever it it consulted without being modified. There is no stated requirement to have personnel who can have authority to read a file only, with no power to amend it.

RECORD ACCESS PROCEDURES

Financial Transaction Number

Access to records in the Daily File and the Temporary File (i.e. the file of applicants' records before a licence is issued) is to be based on the use of the financial transaction number (FT#). The use of the FT# was found to produce some problems.

FT# is designed for fiscal control purposes, and is a 20-digit number comprising the cash register number (2 digits), the transaction number (6 digits), the subtransaction number (4 digits) and the date (8 digits). Maintaining a 20-digit number in memory exceeds short-term memory capabilities, which are involved in the trascription process. Use of a number of this length will be subject to a high error rate, involving the known processes of digit transposition, digit confusion, omission of digits in the middle of a string, and reading errors. These errors are made more likely by the fact that different personnel in the district office will be responsible for different parts of the process, and so will be using only one or a few of these numbers, except for their use in the FT#.

It is improbable that the user will interpret the number as a collection of meaningful sub-components when entering the FT#. It will rather be regarded as a single 20-digit number with its own individual meaning. Self-verification procedures could be

employed to reduce the error rate in the use of the FT#. These would not prove to be reliable safeguards, however, due to the tendency for the same errors to be made during the verification process as were made during the data entry process.

Date

A review of the use of the FT# showed the date to be a crucial element, since it makes the transaction number and the subtransaction number unique. The date that is used is the date of the cash register operation, entered by the cash register clerk. There was no procedure established to ensure that the date was entered each fiscal day during cash register operation, and that it is entered correctly, in the correct format. There were no checks to avoid the common problems associated with entry of the incorrect month at month change-over, or the incorrect day after a holiday Monday. Any such errors would create an incorrect key for the retrieval of that record during any subsequent operations, since the FT# would be incorrect.

Transaction Number

The transaction number is currently designated as a 6-digit number, and the subtransaction number as a 4-digit number. Operators are thus required to enter a 10-digit number every time that they reference this item (see mode operations above). This size of number can only be justified if there could be 100,000 transactions conducted in a district office during a 2-week period (the period suggested for the recycling of the number). Each of these transactions would have to have the probability of having at least 1000 subtransactions within it to justify the use of 4 digits. This proves to be unlikely.

It is recommended that these numbers could be reduced in length with no loss of fincanical control. Since the date is part of the FT#, so making each day's transactions unique, the transaction number need only be large enough to cover the total number of transactions for a one day period. The subtransaction number need only be as large as the maximum number of subtransactions that can occur in any one transaction. This number is not time-limited, and should be determined by the SMS staff. It is recognized that there are a few customers with large accounts, such as the telephone company, where the number of subtransactions for the customer's single transaction number would be very large. The total system should not be overdesigned to cater to such exceptional cases, however.

Proposal for Records Access Procedure

The recommended procedure is based on the distinction between transactions and applications. Retrieval of records is concerned with the latter rather that the former.

All records for the total network of district offices are maintained in the central computer facility. When a file is accessed, the request must identify the district office and the required record. That record number need only be large enough to to allow for all possible applications within a designated time period without recyling. Let us assume that period to be one year. If there are never more than 1 million applications in anyone district office in one year (a reasonable assumption), but more than 100,000, then a 6-digit identifier will satisfy the requirement for record identification for one district office.

The procedure proposed is as follows. When an application is processed at the cash register, the next consecutive number would be assigned to it. This would be a 6-digit number that would be entered with the cash register information. It would also be imprinted on the application form by the cash register slip printer, and would be used for all record identification throughout the licencing procedure. During front end data entry this number would be entered as the identifier, (there is the suggestion that the cash register data may not be accessible via the computer during subsequent stages of the procedure) and the present FT# data would also be entered. This additional data, (the transaction number, the subtransaction number, the cash register number and the cash register operation date), are required for fiscal control purposes, and so will be available in the system. They are not appropriate identifiers for office use during record access, however.

Office procedures for record access would thus entail the use of a 6-digit number only, since the district office number, being a constant, can be transmitted automatically by the machine as digits 7 and 8.

There is a requirement to cater for the situation when a renewal of a licence is processed by a different office from the one that originally issued the licence. The office number, 2 digits appended to the end of the 6-digit identifier, would normally be appended automatically, and would assume the default value of the number of the district office involved. The operator could enter the office number manually however, which would over-ride the default value. All reference to a record in any stage of the process would thus use the same identifier. This would be independent of the procedure being performed, of whether a paper file procedure or a computer access procedure was being carried out, and of which district office was doing the work.

SYSTEM REQUIREMENTS

There are several aspects of the operator's tasks that have implications for the design of the system in general.

(1) Computer processing is required between data entry and any subsequent manipulation of the application. This manipulation is divided into 2 main parts, viz, checks and electromagnetic compatibility analysis. Since different staff members could be responsible for these discrete steps, there has to be a method of accessing a transaction record that has been processed by someone else, but with a minimum of inconvenience and effort.

This requires that a transaction record should be available whenever it is called up from a terminal. It is unacceptable to have the record unavailable because it is sitting in a temporary storage device awaiting transmission, in overnight batch processing, to the central computer facility. Due to the turnaround time of the service bureau that provides the computer facility, it may happen that the technical operator will be informed that the record has not been processed, although it is resident at that facility. The likelihood of this occurrence should be minimized.

(2) The procedures that are required for initial start-up of the system should be simple and require a minimum of procedural steps. It is a recognized procedure in dedicated computer systems to have a single switch, or pushbutton, that is depressed to load the programme, and run the required job. This button should be labelled (START). Such a procedure is required for the initial start-up of the system in the district office.

(3) Human operators of systems that run in an interactive manner, that is, the man and the machine responding to each other's behaviour, have a predictable tolerance to delays in response from the machine. On a computer display terminal, the system response should appear to be immediate. In fact, a one second delay of feedback to what has been entered is disrupting to efficient performance of continuous entry of data. In response to a query, or instruction, a four second delay is the extreme limit of tolerance. Beyond this time, a system message must be displayed to the operator indicating that the computer is busy and will respond soon. The printing of several lines of information on a display terminal at rates below 1200 baud is annoying and produces frustration and intolerance

of the system. A rate of 2400 baud is preferred, although not essential, for this situation. For a single line of information, 600 baud is acceptable and 1200 baud is desirable.

ANNEX A

DISPLAY FORMAT FOR DATA ENTRY OF A LAND MOBILE APPLICATION

Function key action: (MOBILE)
Function key action: (NEW)

The 6-digit identifier, imprinted on the application form, should be entered here to create a record for the new application. For a renewal application, it would retrieve the existing record. The transaction number, subtransaction number, transaction date and possibly the company code number are on the application form, and may have to be entered should the cash register data be unaccessible. The amount of fee received has also been entered at the cash register, but may have to be entered here.

PAGE 1

```
NAME     XXXXXXXX
ADDRESS     XX XXXXXXXXXX XXXXXXX
ENTER APPL TYPE   XX
        PRIVATE INDIVIDUAL:  PI
        FEDERAL GOVT       :  FG
        PROV GOVT          :  PG
        MUNICIPAL GOVT     :  MG
        COMMON CARRIER     :  CC
        CORPORATION        :  CO

BUS PHONE   XXX-XXXX
BUS NAT   XXXXXXXXXX
INCORP?   Y/N
```

PAGE 2

```
TX SITE NAME   XXXXXXXXXX
TX SITE LAT   XX XX XX
TX SITE LONG   XX XX XX
TX SITE ADDRESS     XXXXXXXXXXX

RX SITE NAME   XXXXXXXXX
RX SITE LAT   XX XX XX
RX SITE LONG   XX XX XX

COV   XX miles
MOB ERP   XX watts/dBW
```

PAGE 3

NAT OF SERV XXXXXXXXXX

DESIRED FREQ (MHZ) XXX XX
BWIDTH AND EMISSION TYPE XXXX

START HR XXXX
END HR XXXX

OF MOBS XX
RX FREQ (MHZ) XXX XX

PAGE 4

RAD MANUF XXXXXXXXXX
RAD TYPE XXXXXX
ANT GAIN X X
TYPE AND LENGTH OF TRANS LINE XXXXXXX XX
VERT POLAR? Y/N
HOR POLAR Y/N
ENTER POLAR TYPE XX XXXX

RAD HT ABOVE MSL (FT) XXX
GRND ELEV ABOVE MSL (FT) XXX

PAGE 5

TRANS LINE LOSS XX
OTHER LOSSES XX
REASON FOR OTHER LOSSES? XXXXXXXXX

TX DOC TYPE APPR # XXXXXXXXX
RX DOC TYPE APPR # XXXXXXXXX

APPL DATE XX XX XX
CAT OF SERV XX

Required Special (Function) Keys

PRINT	BASE	ADMIN CHECK
NEXT PAGE	MOB	TECH CHECK
PREV PAGE	NEW	DELETE
ENTER	AMMEND	ENQUIRY
NEXT LINE		FEE
PREV LINE		
NEXT RECORD		
PREV RECORD		

Note: This dialogue is based on documentation provided, and must be confirmed with field personnel to ensure acceptability and completeness of the terminology.