

G STECKLY

SPECTRUM CONTROL
an effective
Radio Spectrum Quality Control and Service Programme

Prepared by
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SPECTRUM CONTROL
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Mandate

As a result of the last audit of the Department's operations programmes, ADMST requested DGTR to develop a comprehensive model of the "enforcement" results area encompassed under the sector's spectrum management responsibility. This package presents that model and its related performance criteria which will be submitted to ADMST for a pre-audit in early July 1982.

When approved by ADMST, the Spectrum Control programme, based on the model, will be implemented in the Regions during the 1982/83 fiscal year. The management manual will be revised prior to programme implementation in order to allow sufficient time for regional adjustment to the current philosophy of Spectrum Control. Subsequently, work procedures will be co-ordinated by DOS for inclusion in a manual that will replace the existing enforcement RIM's.

ACKNOWLEDGEMENTS

Our gratitude is extended to all personnel who displayed a creative interest in our project, and a special appreciation is extended to the following: Dave Lyon, Mike Connolly, Jim Cummings, John Fraser, and Dave Thomas.

Maurice Nunas

ABSTRACT

Due to the increased demand on the Radio Frequency Spectrum (RFS), which is a limited resource, the Department's statutory responsibility for managing this resource is becoming more complex. At the same time the financial and human resources required are becoming harder to obtain. Our responsibility as spectrum managers is to ensure the Canadian right of access to the RFS, and to enhance spectrum utilization. We fulfill this responsibility through activities related to spectrum planning, authorization, and spectrum control.

Spectrum planning activities (spectrum planning and engineering), the corporate component of spectrum management, are performed to ensure Canada's continuing and future spectrum requirements, which ensures that maximum benefit will be obtained from the spectrum by Canadian users. Some examples of these activities are

- a) regulation development and revision,
- b) frequency allocation planning, comprising present and future planning of spectrum allocations through the consideration of user trends and their possible socio-economic impact,
- c) development of licensing standards and procedures for radio stations,
- d) representation at international radio conferences, and
- e) development and maintenance of specialized computer data bases.

Licensing and certification activities (authorization), an operational component of spectrum management, address our statutory responsibility to license and certify radio stations and to examine and certify radio operators. Some activity examples are

- a) assignment of radio channels,
- b) testing of radio equipment for conformity to licensing or exemption standards,
- c) licensing and certification of radio stations, and
- d) examination and certification of radio operators.

With the assistance of computer-aided processing techniques, most of these activities are accomplished from offices, accessible to the public, throughout the country.

Spectrum Control activities, also an operational component of spectrum management, involve the maintenance of spectrum quality through spectrum quality control and spectrum services. An integral part of our spectrum control activities are

- a) finding a suitable balance between the preventive medicine approach and the reactive approach of spectrum maintenance,
- b) reviewing and modifying established tolerance levels used to gauge spectrum activity, and
- c) reducing resource burn while maintaining the quality of the radio spectrum.

Our statutory requirement to ensure spectrum quality is addressed in Spectrum Control by measurement techniques, data analysis and corrective programmes as well as the provision of certain services to spectrum users. For example,

- a) measurement programmes, radio inspections and spectrum surveillance of occupied radio channels,
- b) analysis, comparing data obtained from measurement programmes and certain service activities to accepted standards, office files and data base records, and
- c) corrective programmes, based on the results of the data analysis, appropriate spectrum planning and engineering activities are implemented.

The following paper represents a comprehensive package of how the Department should approach Spectrum Control.

SPECTRUM CONTROL MANUAL

Spectrum Services
and
Spectrum Quality Control

PART I
"General Overview"

SPECTRUM CONTROL

* INTRODUCTION

1. The ADMST strategic objective found in section 3-2-1 of the Management Manual states "To establish and maintain spectrum quality by achieving an appropriate level of adherence to legislation and regulations while fostering self discipline by the users, and minimizing the administrative burden on the Department", it is this objective that forms the basis for Spectrum Control.

1.1 In order to understand the principles of spectrum control, one must consider both the nature of the radio frequency spectrum (RFS) and the principles of spectrum management. Many models have been devised to help us understand the nature of the RFS, one of the most common examples is the "infinite straight line". This model depicts the spectrum as an infinitely thin straight line with an infinite number of points on it. The lowest point represents direct current and the highest point represents the highest frequency. Each finite point in between represents a frequency; groups of these points are combined into bands and each band may serve a different purpose. Numerous departmental publications use this model, or at least a part of it, the best known being the wall chart "Frequency Allocations In Canada". Unfortunately, thinking of the RFS, using this model only leads to an understanding of the frequency variable component of a more complex equation. For example, geographical separation and interference radius are two other important variables. The spectrum must be managed taking into account these three main variables plus a host of others.

1.2 Another model of the RFS (see figure 1), one which is more conducive to understanding spectrum control, is to think of all the frequencies over all the geographical areas as being contained within a sphere. Within this sphere is another sphere which contains only those stations which are individually known to us, in other words licensed stations. Inside the first sphere but outside the second sphere there is a third much smaller sphere. The stations represented by this third sphere are the unlicensed stations associated with the licensed stations; for example, additional unlicensed mobiles in a licensed system. Also

contained within the largest sphere is another sphere representing the stations which are exempt from licensing. We do not know the value of the variables concerning each exempt station but generically, we do know their technical characteristics. The remaining volume in the largest sphere represents the stations about which we know nothing, unlicensed stations and unoccupied spectrum. Throughout this entire model, there are small dots. These dots represent radio interference. Within the spheres representing licensed and exempted stations discrepancies occur, these are depicted by the symbol "X".

* This introduction section will appear in a future edition to RIM-1.

SPECTRUM
MANAGEMENT

2. Spectrum management is the job of managing the "universe" represented by this model. Simply stated, spectrum management is composed of Authorization, Spectrum Control and Spectrum Planning and Engineering.

Authorization

2.1 While the objectives for authorization are already stated in the management manual and described by ROMIS, for the purpose of understanding Spectrum Control the relationship of authorization to this process is

- 1) issuing licences for new stations and converting the unlicensed stations into licensed stations in a manner compatible with the rest of the known environment; and
- 2) certifying radio operators to ensure that they operate stations in a manner which will avoid the occurrence of imperfections and complaints (dots).

For spectrum control purposes the main function of this process is an orderly fashion of frequency assignment the result of which is contained in a data base; licences, certificates and fees are of secondary importance.

Spectrum
Control

2.2 Spectrum Control is defined as the process of ensuring that the radio spectrum is available for those who need to use it. Given unlimited resources, the spectrum managers' job would be to eliminate the interference, complaints, etc. (dots) and the unlicensed stations of both types, and then ensure that the variables concerning each station remain known and acceptable, in other words eliminate all the X's. Alas, our resources are limited; consequently, our efforts at spectrum control are designed to maintain an acceptable level of adherence to the radio regulations and technical standards of the Department. Generally, our strategy has two main elements

- 1) to control spectrum quality, we sense the quality of the spectrum through sampling techniques aimed at using the minimum resource level required to obtain the necessary degree of confidence, then implement corrective action of a type and magnitude consistent with the nature of the problems discovered (see 2.2.1); and
- 2) we respond to public need, where required, with an appropriate service. Many of these are done on a cost recovery basis (see 2.2.2) and any corrective action implemented is conducive to improving the service.

Spectrum
Quality
Control

2.2.1 Spectrum Quality Control is to determine the state of the radio environment, analyze the data obtained to identify any problem areas requiring correction, and to plan and implement corrective action programmes. This is accomplished by the following activities:

Sensory

- Inspection Radio Stations;
- Spectrum Surveillance;
- Licensing Compliance;
- Directed Investigations;

Corrective (see also Spectrum Planning and Engineering).

- Enforcement

2.2.1.1 For the purpose of sampling techniques the terms surveillance and inspection are described as follows:

- 1) surveillance is a sensory activity used to provide certain data for the evaluation of the state of the radio environment. This data is obtained by the off-air observation of frequencies to determine from each frequency observed, the following parameters:
 - a) operating frequency,
 - b) modulation percentage or deviation,
 - c) bandwidth,
 - d) radio operating procedures, and

- 2) inspection is a sensory activity used to provide certain data for the evaluation of the state of the radio environment. This data is obtained by visits to radio stations to determine at each station visited, the following parameters:
 - a) station location,
 - b) type of radio equipment,
 - c) antenna system details,
 - d) operating frequency,
 - e) modulation percentage or deviation,
 - f) transmitter output power,
 - g) station documents,
 - h) number of associated unlicensed stations.

Spectrum
Services

2.2.2 Services are provided on request to users of the radio frequency spectrum, and to non users who are affected by it, through the following activities:

- Ship Surveys;
- Ministerial Enquiries;
- Investigations Services;
- Investigations Radio Communication Systems;
- Investigations General Public;
- Surveillance Services; and
- Surveys - AM/FM/TV/CATV (not sampling).

Spectrum
Planning and
Engineering

2.3 Spectrum Planning and Engineering is the development and implementation of regulations, policies and standards, and the provision of guidance to the public for interpretation of these regulations, policies and standards e.g., seminars to instruct radio operators in the proper use of radio.

Spectrum
Control
Model

3. As an aid to understanding the spectrum control process, a model has been prepared (see figure 2). This model shows the spectrum control process, its component parts, and its relation to the authorization process.

Elements
of Spectrum
Control

3.1 It can be seen from the central portion of this model that sensory activities are the first part of the quality control process. Quality control is composed of four distinct elements

- 1) sensing, which is comprised of two parts; these are sampling and directed activities

- 1) sampling activities consist of inspections, spectrum surveillance and the measurement of licensing compliance. These are ongoing activities, the resource level for which is set at the minimum amount necessary to yield meaningful data. During a sensory activity a comparison is made of the perceived parameters of each individual station, against established standards. This determines whether or not a discrepancy exists and the type of follow-up action required. As a secondary function discrepancies observed are followed up to ensure correction, and normally is undertaken by the working level radio inspector under the activity by which it was determined, and
 - ii) directed activities are investigations undertaken to find out more about suspected problem areas. These are usually implemented at the request of the supervisor or manager during the same fiscal year that the samples were taken;
- 2) analysis, although the diagram shows analysis as a single entity, there are two phases. Phase one is the analysis of separate collections of data which flow from each area. For example data from inspections, surveillance, licensing compliance, various services, public consultation, etc., are each analyzed separately to identify any trends, exceptional cases, problem areas etc. Such analysis is generally performed by the enforcement supervisors for each area under their jurisdiction. This analysis is done against standards and the report made to their superiors serves to highlight the worst cases. Such reports might be used locally to decide whether or not to undertake directed investigations to collect additional data. The second phase is more closely associated with the management process. This analysis consists of the district managers and deputy director discussing the individual analysis from phase one and deciding which problems are wide spread, which require resource shifts for immediate treatment and which should be treated in the planning phase for inclusion in subsequent MYOP's or operational plans.

- Phase 1 analysis is essentially the supervisors last step in each activity and is therefore part of the activity. It can be thought of as taking place individually in each of the arrows which leads from the other activities to the analysis activity.

- Phase 2 is on a much higher plane and should not be considered in the light of specific units of production. The output of phase 2 analysis should be a ranked list of problems requiring consideration at planning time.

NOTE: In addition, data for analysis are gathered from the authorization results area and some of the services activities (e.g. investigations - general public and investigations - radiocommunication systems). Other services (e.g. ship surveys on behalf of DOT) provide little or no meaningful data for spectrum control. These activities because they are not random in nature are not considered to be part of the sensory activities.

3) planning, which is a managerial activity during which the results of the analysis, the data base, and the data from services, sensory activities and directed investigations are used to formulate plans for corrective action; and

* 4) corrective action and preventive medicine activities, which are ongoing. These activities are increased, within resource limitations, in proportion to the degree to which adverse spectrum conditions are perceived to be beyond acceptable tolerances. Some examples of corrective activities are

a) user self-discipline through preventive measure programmes, and projects to deal with major problems identified from the analysis of data obtained i.e.,

* We recognize that corrective action as presented by this paper includes activities that relate to certain KRA's within the DRA of Spectrum Planning and Engineering. This DRA is presently under review.

- i) seminars,
- ii) press releases,
- iii) attendance at radio user meetings,
- iv) meetings with radio equipment suppliers/installers,
- v) spectrum user awareness through student projects,
- vi) media campaigns,
- vii) formal user consultation,
- viii) individual station visits,

b) regulation changes; or

c) enforcement (prosecutions/suspensions revocations).

SUMMARY

4. The entire process is summarized as follows: inspectors, through spectrum surveillance and inspections sense the state of the environment. They follow-up and correct any individual problems encountered, and output statistical data concerning these activities. In addition, where preliminary data indicates a significant problem, managers may obtain additional data by instituting investigations directed at obtaining additional data. Analysis of this data pops up danger flags when acceptable parameters are exceeded. It is the analysis of data from services, authorization and other fields that is used to formulate plans for corrective programmes. The corrective programmes are usually planned to be undertaken in a subsequent fiscal year; however, very serious problems might be addressed during the same fiscal year by re-allocating the resources used for the preventative medicine programmes. The sensory activities repeat according to a schedule and are used to gauge the success of corrective programmes. Concurrently, some services are provided, upon request, to treat specific individual cases which have not been remedied by the general corrective programmes.

RELATIONSHIP TO ROMIS

5. Had the enforcement review been undertaken prior to the development of ROMIS then that system would undoubtedly have been structured differently; nevertheless, although some inconsistencies will be evident, for the most part there should be little conflict.

Reporting

5.1 The relationship of the spectrum control activities to ROMIS is as follows: sensory is reported under the appropriate activity; analysis and planning are part of the managerial KRA; and corrective measure programmes are implemented under Spectrum Engineering/Client Services, Projects or Enforcement KRA's. This information is provided only as a guide. For complete instructions the ROMIS manual should be referred to. Areas of conflict should be brought to the attention of both DAP and DOS-P.

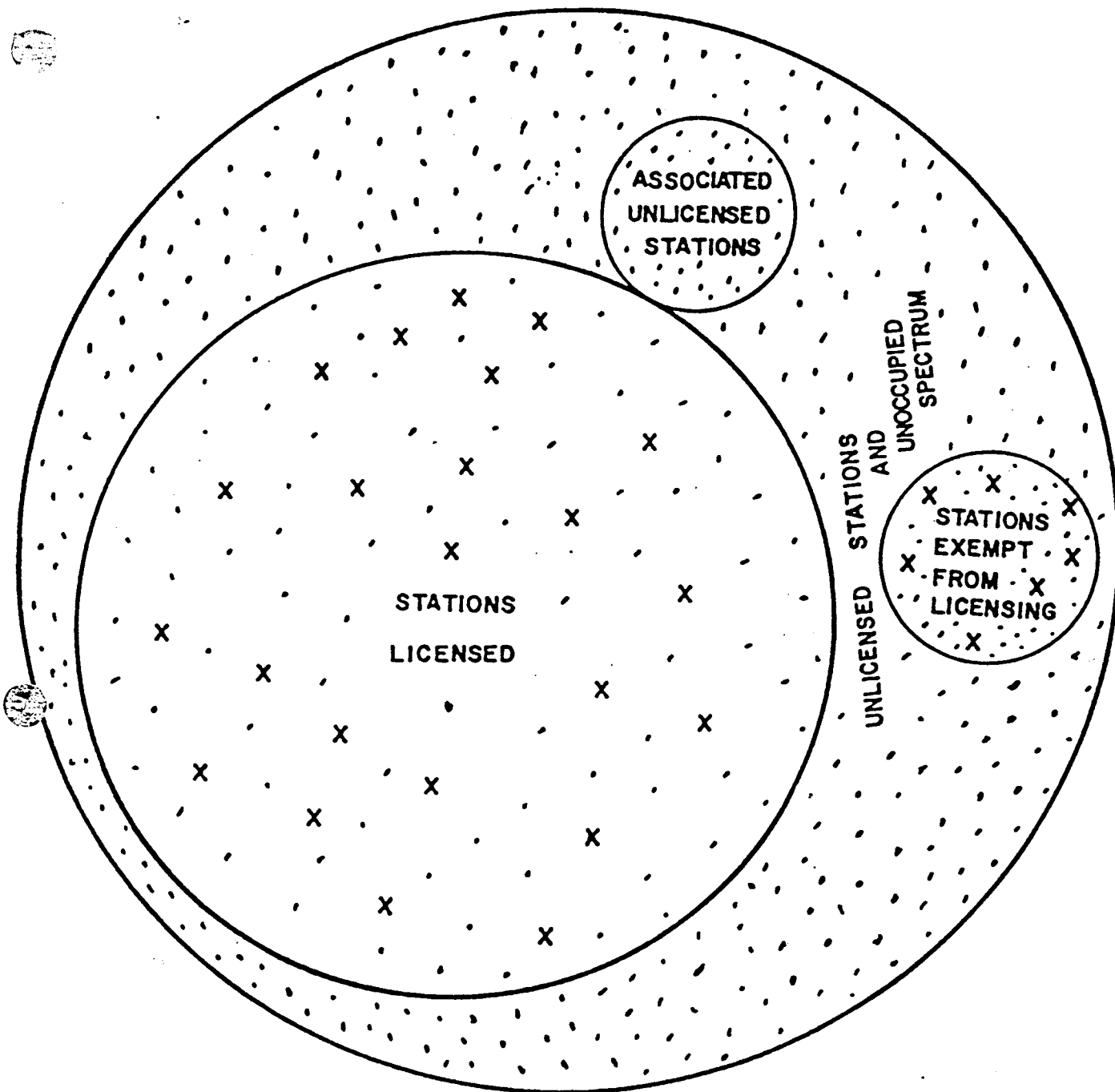


FIGURE 1

MODEL OF THE RADIO FREQUENCY SPECTRUM

NOTE: In figures 1 and 2, the models shown are based on the combined input provided by the regional offices and DOS. Suggestions that will enhance the clarity of these models would be appreciated.

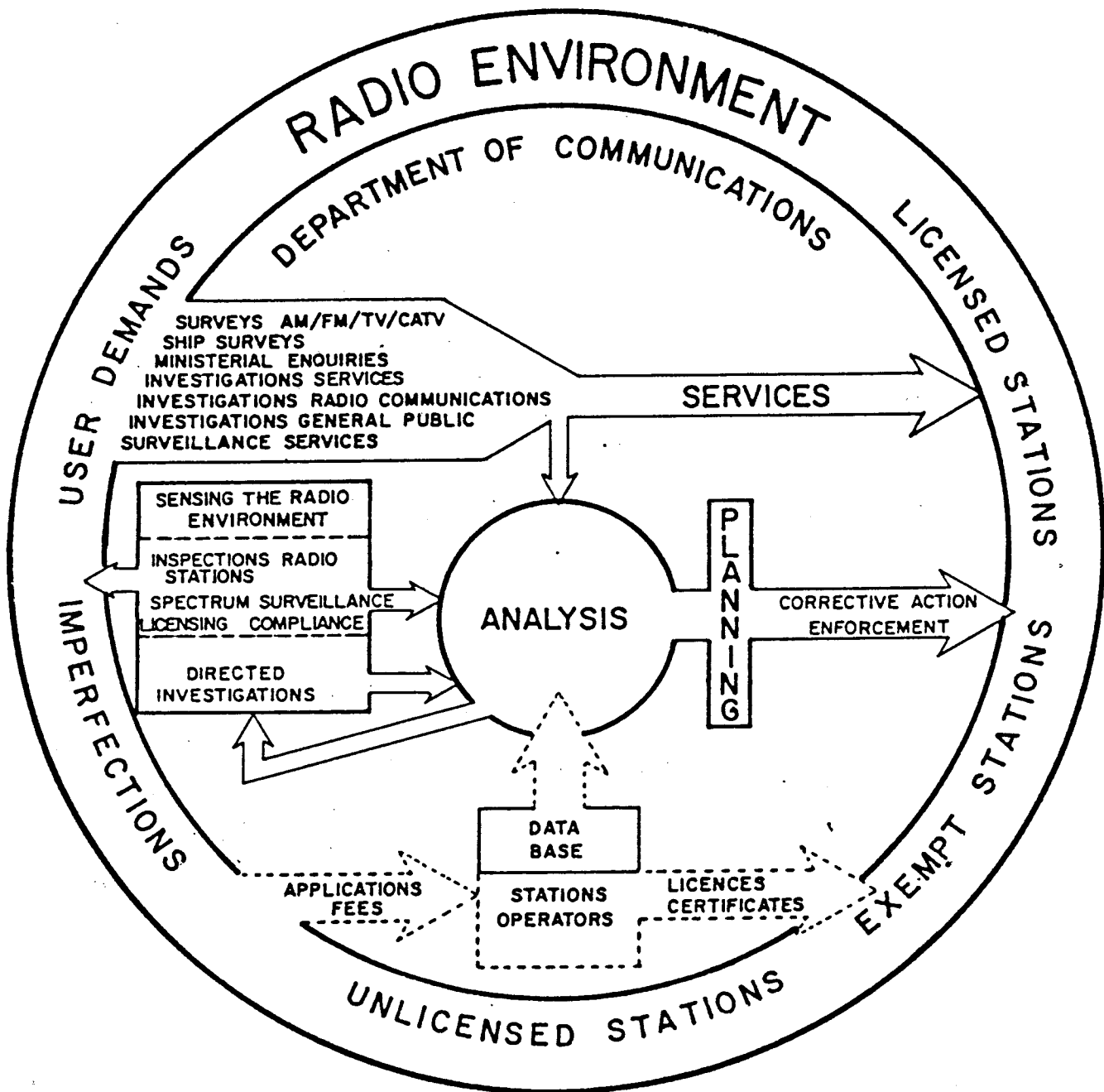


FIGURE 2

MODEL OF SPECTRUM CONTROL PROCESS

PART II
"Activities"

SPECTRUM SERVICES

INSPECTIONS BROADCAST.
~~Surveys~~ AM/FM/TV/CATV

Activity

GENERAL

1. This section contains information and procedures to be followed by all Regional and District Office Radio Inspectors when surveying AM/FM/TV/CATV broadcast undertakings.

Definition

1.1 An AM/FM/TV/CATV survey is an on site and/or off air verification and evaluation of a broadcast undertaking's equipment installation, technical parameters and performance.

Objective

1.2 To survey selected broadcasting undertakings, on behalf of the Director Broadcasting Regulations in order to provide him with the necessary technical and operational reports concerning broadcasting undertakings which require issuance of technical construction and operating certificates (TCOC) for the renewal of their respective broadcasting licences.

Performance Indicator

1.2.1 a) For an AM/FM or TV station

- i) a survey is undertaken 9 months prior to the expiry date of the station's TCOC, and
- ii) a report of the survey is provided to the Director Broadcasting Regulations at least 6 months prior to the expiry date of the station's TCOC.

b) For a CATV system

- i) a survey is undertaken 2 to 6 months prior to the CRTC public hearing for the renewal of the system's broadcasting licence, and
- ii) a report of the survey is provided to the Director Broadcasting Regulations 9 to 13 months prior to the expiry date of the system's broadcasting licence.

1.2.2 A survey unit time excluding travel of

- a) AM - 13.4 hours
- b) FM - 6.3 hours
- c) TV - 7.3 hours
- d) CATV - 29.0 hours

SPECTRUM SERVICES

Activity

Ship Surveys

GENERAL

1. This section contains information and procedures to be followed by all Regional and District Office Radio Inspectors when surveying ship radio stations. These directives and procedures are based on policy, directives and guidelines established by the Department of Transport for ships compulsorily fitted with radio. The reader is asked to refer to pertinent policy statements in the following Canadian Coast Guard documents: Instructions to Inspectors of Compulsory Fitted Ship Station Radio Installations (TP1896), Standards for MF and HF Radio Installations and Related Equipment 1981 (TP2872), Equipment Specifications for Ship Radio Stations (TP1182), and Equipment Specifications for VHF Ship Radio Stations (TP1183).

Definition

1.1 A ship survey is the on site verification and evaluation of the radio installation on a Canadian or foreign ship to ensure that the installation meets national and international requirements provided in Acts, regulations, conventions or agreements involving safety at sea or the management of the Radio Spectrum involving Canadian ship stations.

Objective

1.2 To provide on behalf of the Department of Transport, under ministerial appointment number 101790, a radio survey service upon the request of ship owners, agents, or DOT officials, when the ships are required by national and/or international regulations to be fitted with and operate a designated radio complement to satisfy established safety standards.

Performance Indicator

1.2.1

- a) For ships engaged in either Domestic or International voyages a ship survey is started within 3 days of receipt of the request for a survey, and
 - i) for a ship involved on an international voyage the survey is completed within 5 days of receipt of the request for survey, or
 - ii) for a ship involved on a domestic voyage the survey is completed within 4 days of receipt of the request for survey.

1.2.2

A survey unit time excluding travel of

- a) ships engaged in Domestic voyages - 5 hours, and
- b) ships engaged in international voyages - 7.5 hours.

SPECTRUM SERVICES

Activity

Ministerial Enquiries

GENERAL

1. This section contains information for all regional and district office personnel when conducting an investigation to respond to a ministerial enquiry.

Definition A

1.1 A Ministerial Enquiry is the action taken following the receipt of any enquiry or complaint addressed to the Minister or Deputy Minister, or an enquiry or complaint from an elected representative of the federal or provincial government addressed to the Regional Director.

1.1.1 Enquiries or complaints can cover a wide scope of departmental activities, such as: interference investigations, denial of licence applications, assessment of amateur and professional examinations, frequency congestion, poor reception of radio signals, attempts by municipalities to regulate antennas, practices and procedures not being applied in a standardized manner by different offices across the country, use of abusive language over the air, etc.

Objective

1.2 To initiate an immediate investigation to obtain information, to respond to an enquiry or to resolve a complaint addressed to the Minister, Deputy Minister or Regional Director.

Performance Indicator

- 1.2.1
- a) Results reported to regional office within 10 working days of receipt of the complaint or enquiry by the Regional Director.
 - b) Results reported to DOS for onward processing by DGTR and ADMST within 15 working days of receipt of complaint or enquiry by ADMST.

1.2.2 It is unrealistic to specify a performance unit time for ministerial enquiries due to the difference between the tasks associated with this activity.

SPECTRUM SERVICES

Activity

Investigations Services

GENERAL

1. This section contains information and guidelines for all regional and district office personnel responsible for conducting an investigation under this activity.

Definition

1.1 Investigation services includes the tasks associated with an investigation to determine compliance with Departmental regulations, standards or specifications, or the provision of technical assistance to outside organizations such as C.R.T.C., Department of National Defence, Department of Transport, Department of Revenue, police or industry.

1.1.1 This activity can include action such as the investigation into the service provided by a particular broadcasting station, measurement of the sound level of commercial messages, provision of technical assistance to police agencies etc., but excludes tape recordings made on behalf of the CRTC as well as misrouted interference complaints from the general public, attributed to a lack of awareness of the services offered by our Department.

Objective

1.2 To investigate as resources permit, on a cost recovery basis pursuant to the Financial Administration Act (APFO-6), on behalf of outside organizations the compliance of suspected radio apparatus or stations with Departmental regulations, standards or specifications, or to provide technical assistance to these organizations in order to enforce any regulations connected to the operation or installation of radio apparatus or stations.

Note: Cost recovery is subject to approval at the Regional Director level.

Performance Indicator

1.2.1

- a) Within 5 working days of receipt of a request for our service, the client is advised of our ability to accommodate the request.
- b) Results reported to client within 15 working days from the date the request is approved.

1.2.2 It is unrealistic to specify a performance unit time for investigation services due to the difference between the tasks associated with this activity.

SPECTRUM SERVICES

Activity	Investigations Radio Communications Systems	
GENERAL	1.	This section contains information and procedures to be followed by all Regional and District Office Radio Inspectors responsible for investigating problems associated with radiocommunication systems.
Definition	1.1	This activity includes all tasks associated with complaints involving the use of radiocommunication systems.
	1.1.1	When an interference problem hampers the efficient operation of a safety system it should be treated with the highest priority. An on site visit would be warranted for critical cases. This activity includes complaints or requests with respect to harmful interference to station reception.
	1.1.2	General public interference complaints linked to the operation of a radiocommunication system are considered part of the activity "Investigations General Public".
Objective	1.2	To use the minimum amount of resources necessary to
		1) investigate radio station related technical or operational complaints when reported by station licensees or their representatives in order to isolate the problem; and
		2) provide data, for analysis by spectrum managers, which would be instrumental in developing programmes aimed at lowering the occurrence of radiocommunications systems complaints.
Performance Indicator	1.2.1	a) Investigation initiated within 30 days of receipt of the complaint. b) Investigation completed within 30 days after beginning it.
	1.2.2	An investigation unit time excluding travel of 4.5 hours.

SPECTRUM SERVICES

Activity	Investigations General Public
GENERAL	1. This section contains information and procedures to be followed by all Regional and District Office Radio Inspectors responsible for investigating general public complaints.
Definition	1.1 This activity includes all tasks involving complaints or requests of technical assistance from the general public which are not identified in the other activities. 1.1.1 In the case of interference, the service offered to the public will be advisory in nature with respect to cases in which the complainant's equipment appears to be faulty, or technical in nature with respect to the suppression of interference sources. These investigations can include interference problems involving radio reception.
Objective	1.2 To use the minimum amount of resources necessary to 1) investigate radio and TV interference complaints to private receiving stations reported to our sector by the general public in order to isolate the problem; and 2) provide data, for analysis by spectrum managers, which would indicate trends and be instrumental in developing programmes aimed at lowering the occurrence of general public complaints.
Performance Indicator	1.2.1 a) Investigation initiated within 30 days of receipt of the complaint. b) Investigation completed within 30 days after beginning it. 1.2.2 An investigation unit time excluding travel of 3.0 hours.

SPECTRUM SERVICES

Activity

Surveillance Services

GENERAL

1. This section contains information and procedures to be followed by all regional and district office radio inspectors when conducting surveillance services.

Definition

1.1 Surveillance services means the action taken during the monitoring, measuring, recording analysis and reporting of signals present in specified frequency bands or on specific frequencies following a request originating outside our sector (ADMST). This activity is performed on a cost recovery basis pursuant to the Financial Administration Act (APFO-6).

Objective

1.2 To provide a surveillance service to organizations outside of our sector, when resources permit, on a cost recovery basis pursuant to the Financial Administration Act (APFO-6). Some examples of outside organizations requiring surveillance services are the CRTC, Department of National Defence, Department of Transport and police or industry.

Note: Cost recovery is subject to approval at the Regional Director level.

Performance Indicator

1.2.1

- a) Within 5 working days of receipt of a request for our service, the client is advised of our ability to accommodate the request.
- b) Results reported to client within 15 working days from the date the request is approved.

1.2.2 It is unrealistic to specify a performance unit time for surveillance services due to the difference between the tasks associated with this activity.

SPECTRUM QUALITY CONTROL

Activity	Inspections Radio Stations
GENERAL	1. This section contains information and procedures to be followed by all regional and district office staff for the inspection of licensed radio stations.
Definition	<p>1.1 A radio station inspection means the verification and on-site evaluation of a radio station as regards compliance of its location, its installation and its technical and operational performance with the licence application accepted and the authorization granted by the Minister, in addition to the regulatory provisions pertaining thereto, in order to allow prompt corrective action, if required.</p> <p>1.1.1 The licensed radio population is sub-divided into various sample groups for inspection purposes. These sub-groups may be based on</p> <ol style="list-style-type: none">1) licence classification (i.e., land-fixed, broadcast, etc.);2) groupings within a classification (i.e., new and amended land-fixed stations); or3) geographic area (i.e., land-fixed stations within a congested zone).
Objective	<p>1.2 To sense the quality of the radio environment, as occupied by licensed radio stations, through on-site visits to a determinate number of radio stations selected by a recognized sampling plan.</p> <p>Strategies of this activity are</p> <ol style="list-style-type: none">1) to provide certain technical and operational data required for the assessment of the Radio Spectrum;2) to obtain a measurement of the degree to which licensees have installed their radio systems in accordance with the parameters they applied for as recorded in the ALS data base and <u>where discrepancies are noted to arrange for remedial action;</u> and3) to show Departmental presence among the various Radio Spectrum user groups.
Performance Indicator	<p>1.2.1 To complete in time for the 5 month, 9 month and year end review, the inspection of a scheduled number of stations that are taken from a sample.</p> <p>1.2.2 An inspection unit time excluding travel of 2.4 hours.</p>

SPECTRUM QUALITY CONTROL

Activity	Spectrum Surveillance
GENERAL	1. This section contains information and procedures to be followed by all regional and district radio inspectors when conducting Spectrum Surveillance.
Definition	1.1 Spectrum Surveillance is the measurement and analysis of certain technical and operational characteristics of randomly selected authorized Canadian frequency assignments between 10 kHz and 890 MHz. It is accomplished through signal interception and is conducted in accordance with an approved annual plan.
Random Sample	1.1.1 A "random sample" is defined as a sample in which each station within an area has an equal chance of being selected. In those cases where a second or future sample is to be conducted, those stations previously selected will again form part of the universe from which the sample is selected.
Objective	1.2 To sense the quality of the radio frequency spectrum, through off-air surveillance of a determinate number of frequencies selected by a recognized sampling plan. Strategies of this activity are 1) to provide certain technical and operational data required for the assessment of the Radio Spectrum; 2) to obtain a measurement of the degree to which licensees operate their radio systems in accordance with the parameters they applied for as recorded in the ALS data base and <u>where discrepancies are noted to arrange for remedial action; and</u> 3) to maintain a moderate profile among the various Radio Spectrum user groups.
Performance Indicator	1.2.1 To complete in time for the year end review the monitoring of a scheduled number of assigned frequencies that are taken from a sample. 1.2.2 A surveillance unit time excluding travel of 1.0 hour.

SPECTRUM QUALITY CONTROL

Activity

Licensing Compliance

GENERAL

1. This section contains information and procedures to be followed by regional and district office personnel when determining the compliance of radio stations, in selected populations, with the regulatory requirement governing authorized use of the radio spectrum.

Defintion

1.1 Licensing compliance is the determination of the ratio of the unauthorized spectrum use within a given service to the authorized spectrum use within that same service.

1.1.1 Some examples of this activity are

- a) transport truck/GRS weigh scale operations,
- b) sweeps of the maritime mobile environment,
- c) airport surveys of aircraft,
- d) GRS house to house visits, and
- e) surveillance of unassigned radio channels.

Objective

1.2 To measure the unauthorized use of the radio spectrum within a given area in order to specify lost revenue and spectrum management implications attributable to such populations.

Performance Indicator

1.2.1 a) Contact of 15 stations per day during the performance of this activity.
b) Surveillance of 50 unassigned channels per week.

1.2.2 It is unrealistic to specify a performance unit time for licensing compliance due to the difference between the tasks associated with this activity.

SPECTRUM QUALITY CONTROL

Activity Directed Investigations

GENERAL 1. This section contains information and procedures to be followed by all regional and district office radio inspectors when conducting directed investigations.

Definition 1.1 A directed investigation is the action taken as initiated by spectrum managers for the purpose of spectrum quality control.

Objective 1.2 The objective of this activity is to gather technical or operational data, when required, to complement the data previously obtained from inspection or surveillance activities in order to provide management with a focused assesment on the use of the Radio Spectrum and as deemed necessary, (to provide investigations into areas not covered by other activities.)

Sample

** SECONDARY OBJECTIVE WHICH WE MAY HAVE ELEVATED IN IMPORTANCE THROUGH ADDITION OF "TYPE" CODING*

Performance Indicator 1.2.1 For operational purposes, results of the investigation are processed within 10 working days of procurement.

1.2.2 It is unrealistic to specify a performance unit time for directed investigations due to the difference between the tasks associated with this activity.

SPECTRUM QUALITY CONTROL

Activity

Enforcement

GENERAL

1. This section contains information and procedures to be followed by all regional and district office radio inspectors when conducting an Enforcement action.

Definition

1.1 The activity Enforcement can be defined as the legal action taken by the Department on behalf of the Minister against an individual or company for non-compliance with applicable provisions of the Radio Act or Regulations made thereunder. This action involves the process whereby court proceedings are undertaken or the rights and privileges granted by the Minister are removed by the Minister.

1.1.1 Within this activity are four separate and distinct punitive measures

- 1) prosecution - court proceedings are taken;
- 2) forfeiture - transferral of seized equipment from the courts to the Crown following the successful conclusion of court proceedings which concern the disposition of radio apparatus;
- 3) suspension - the temporary removal, normally 90 days, of ministerial authority from a specific licence or certificate; and
- 4) revocation - the permanent removal of ministerial authority from a specific licence.

Objective

1.2 To guarantee the effective management of the Radio Spectrum by ensuring adherence to the provisions of the Radio Act and Regulations in an equitable and consistent manner when co-operative measures initiated by the Department have failed to produce a desired effect on a spectrum user in deliberate violation of the Radio Act.

Performance Indicator

1.2.1

- a) Legal opinion received within 30 working days of the decision to prosecute.
- b) Charges under Criminal Code, laid within 3 months.
- c) Charges under Radio Act, laid within 1 year.

1.2.2 It is unrealistic to specify a performance unit time for enforcement due to the difference between the tasks associated with this activity.

SAMPLING PLAN
and
PROCEDURE

The Assistant Deputy Minister Spectrum Management and Government Telecommunications (ADMST) of the Department of Communications has among his numerous responsibilities the task of managing the Radio Spectrum. Five regions across the country and a co-ordinating section within the Sector's Headquarters are available to assist ADMST with this task.

Part 1 of the Spectrum Control Manual describes on a macro level the composition of Spectrum Management and its quality control portion contained within Spectrum Control. The sampling plan and procedure of application introduced hereafter are part of the sensing process as described in Part 1 of the Spectrum Control Manual sections 3.1(1)(i) and 3.1(1)(ii).

SAMPLING PLAN

The requirement to make maximum use of our limited resources inspired the introduction of this sampling plan and procedure by the five regions and Headquarters. The sampling plan is adopted from the work of Herbert Arkin, Professor, Business Statistics as described in his book "Handbook of Sampling For Auditing and Accounting" Volume 1 - Methods. It consists of an easily applicable table (see Appendix A) as derived from the following formula*:

$$n = \frac{p(1 - p)}{(SE/t)^2 + [p(1-p)/N]}$$

where n = required sample size
 t = confidence level
 SE = desired or allowable sampling error
 N = field size (population to be sampled)
 p = maximum anticipated rate of occurrence

The table shown in Appendix A is based on a confidence level of 90% (t = 1.65) and a sampling error of ± 4% or ± 5% depending upon the expected occurrence rate of the attribute considered within the population to be sampled. The sampling error is an indication of how far the sample results obtained might deviate from the value that could be obtained by a 100 per cent check.

The anticipated rate of occurrence is an estimation of the expected percentage of occurrence of a particular event to be measured in a given population e.g., in terms of discrepancies associated with radio stations that are to be inspected or monitored, this figure could indicate the expected number of radio stations whose operating frequencies might be out of tolerance.

* Herbert Arkin, Handbook of Sampling for Auditing and Accounting, Volume 1, McGraw-Hill Book Company, Inc., 1963, Technical Appendix.

The confidence level is an overall statement that the results found as taken from the sample reflect faithfully upon the population as a whole. It is further supported by the sampling error, which is a statement of the accuracy of the sample results or, in other words, the deviation around the average value of the attribute within the population.

During the implementation year of this procedure, the anticipated rate of occurrence for the inspection and surveillance programmes will be fixed at 30%, thereby, requiring the mandatory use of the appropriate column of the table contained in Appendix A. Based on the measured data, as inputted to ROMIS** during the implementation year, this figure may be increased or decreased for subsequent years.

Appendix B contains a supplementary set of tables which can be used to forego the requirement to inspect the entire sample. At the earliest possible time, as dictated by the size of the completed sample to date and the rate of occurrence within this completed portion of the sample, an analysis can be realized of the population as a whole and the results of this analysis can then be stated, within specified upper and lower limits, with a confidence level of 90%. These tables, if used effectively, can lead to appreciable resource savings provided that the items within the sample are inspected in their random number sequence.

Samples drawn from radio station populations can be partitioned in their random sequence and scheduled within the applicable inspection or surveillance programme in such a manner that the projected interim decision points could coincide with the five months, nine months and year end review periods. This would allow for the effective use of resources, in that the first partition of any sample scheduled to be measured before the five month review period would not necessarily have to be measured in compliance with its random number sequence, provided that the entire partition is measured. The second and final partitions, if necessary, could be measured in the same manner for the nine months and year end reviews. For example, a sample size of 200 could be partitioned as follows:

size of 1st partition for five months review	84
and if necessary	
size of 2nd partition for nine months review	66
and if necessary	
size of final partition for year's end	50

** Regional Operations Management Information System.

SAMPLING PROCEDURE

Before applying the sampling plan to the activities "Inspections Radio Stations", or "Spectrum Surveillance" several factors have to be considered such as the type of service to be sampled, the geographic area of concern, the station populations attached to each service within this geographic area, the reason for sampling within a particular service and the ease of extracting or identifying the stations to be sampled from the Department's licence data base.

In the past, operations staff within the regions have been involved with the inspection and surveillance of radio stations found within four service categories

- a) land fixed,
- b) land mobile,
- c) aeronautical, and
- d) maritime mobile.

Considering that the aeronautical and maritime mobile services are of a fixed parameter nature i.e, power and frequency, and that the data obtained from past surveillance and inspection activities within these services have been of little value to quality control, it has been decided that they will not be considered in this procedure. Our main concern is the application of quality control to the land fixed service of the radio spectrum; and, by so doing a major portion of the land mobile service will be affected. This precludes the requirement to sample stations separately within the land mobile service.

In view of the above, the following postulate has been developed to implement our recognized sampling plan. This postulate lends itself to the sampling for the inspection* of non-broadcasting radio stations or for the surveillance* of radio channels within the land-fixed service.

The following definitions are provided for reference when applying the sampling procedure:

- a) Land-Fixed Radio Station Population is the population of land-fixed stations, new, revised and existing, performing one of the following services:
 - i) private commercial;
 - ii) restricted public commercial;
 - iii) provincial government;

* For definition of the terms surveillance and inspection refer to the Spectrum Control Manual, Part I, section 2.2.1.1.

- iv) municipal;
- v) private commercial automatic repeater;
- vi) private commercial receiving, and
- vii) aeronautical mobile.

- b) Land-Fixed New and Revised Radio Station Population is comprised of two groups of stations
 - i) land fixed new which is the group of stations that have been licensed during the previous or current fiscal year, and
 - ii) land fixed revised which is the group of stations whose radio station licences have been technically amended (requiring the submission of form 16-16) during the previous or current fiscal year.
- c) Land-Fixed Existing Radio Station Population is that group of stations licensed prior to the previous fiscal year and whose radio station licences have not been technically amended (requiring the submission of form 16-16) during the previous fiscal year.

1. INSPECTIONS RADIO STATIONS

a) Land-Fixed New and Revised Stations

- (i) on an annual basis, from any Metropolitan area as set out in schedule V of the General Radio Regulations, Part I one sample of the land-fixed new and revised radio station population will be drawn and each station within this sample will be inspected if necessary, and/or
- (ii) on an annual basis, from any non-overlapping shaped area, within the boundaries of a given district office, containing 2000 square km ** and a minimum land-fixed radio station population of 200 stations one sample of the land-fixed new and revised station population will be drawn and each station within this sample will be inspected if necessary, or
- (iii) a district office whose boundaries do not encompass a Metropolitan area as set out in (i) or a land-fixed radio station population as set out in (ii) will from the land-fixed new and revised radio station population within its boundaries, draw annually one sample of these stations and inspect each station within this sample if necessary.

b) Land-Fixed Existing Stations

- (i) once every three years, from any Metropolitan area as set out in Schedule V of the General Radio Regulations, Part I one sample of the land-fixed existing radio station population will be drawn and each station within this sample will be inspected if necessary, and/or
- (ii) once every three years, from any non-overlapping shaped area, within the boundaries of a given district office, containing 2000 square km ** and a minimum land-fixed radio station population of 200 stations one sample of the land-fixed existing station population will be drawn and each station within this sample will be inspected if necessary, or
- (iii) a district office whose boundaries do not encompass a Metropolitan area as set out in (i) or a land-fixed radio station population as set out in (ii) will from the land-fixed existing radio station population within its boundaries draw once every three years one sample of these stations and inspect each station within this sample if necessary.

2. SPECTRUM SURVEILLANCE

Frequencies Assigned to Land-Fixed Radio Stations

- (i) once every two years, from any Metropolitan area as set out in Schedule V of the General Radio Regulations, Part I one sample of the frequencies assigned to the land-fixed radio stations will be drawn and each frequency within this sample will be monitored if necessary, and/or
- (ii) once every two years, from any non-overlapping shaped area, within the boundaries of a given district office, containing 2000 square km ** and a minimum land-fixed radio station population of 200 stations one sample of the frequencies assigned to the land-fixed radio stations will be drawn and each frequency within this sample will be monitored if necessary, or
- (iii) a district office whose boundaries do not encompass a Metropolitan area as set out in (i) or a land-fixed radio station population as set out in (ii) will from the land-fixed radio stations within its boundaries draw once every two years one sample of their assigned frequencies and monitor each frequency within this sample if necessary.

NOTE: Areas not identified in 1. and 2. will not be sampled. If problems develop from station populations within these areas, they will be addressed on a case by case basis, as they are received, by the service activities identified in Part 1, section 2.2.2 of the Spectrum Control Manual.

Let's take the following example of a land-fixed existing radio station population of 2000 stations and

- a) determine the sample size,
- b) partition the sample, and
- c) decide at the five months review whether to continue the measurement of the sample.

As previously stated the rate of occurrence for any attribute will be fixed at 30% for the implementation year. If we refer to the table in Appendix A for an expected rate of occurrence not over 30% and a sampling error of $\pm 5\%$, a population size of 2000 would require a sample size of 205.

** An area of 2000 square km is approximately equal to an area encircled by a 25 km radius.

This sample size of 205 stations can be appropriately partitioned, keeping its random number sequence, to correspond to the five months and nine months review. For this example, the partitioning will be as follows:

1st partition for five months review	88
2nd partition for nine months review	68
3rd partition for year's end	49

If after the completion of the 1st partition, the measured data indicates that a given discrepancy was found at 15 stations which would indicate a rate of occurrence of 17%, and the acceptable tolerance level for that discrepancy is established as 25% then the appropriate table in Appendix B can be used.

Referring to Appendix B and the table "Rate of Occurrence in Sample 17%" we can see that for a sample size of 90 (taking the larger size rather than interpolating)* and a field size of 2000 that the occurrence rate of this discrepancy would be somewhere between 11.0 and 24.7%.

It can then be stated with 90% confidence that the discrepancy measured is present in not less than 11.0% or more than 24.7% of the 2000 stations sampled. The district manager should at this point make the decision to stop the inspection; however, if the upper portion of this limit had exceeded the established tolerance level of 25% and depending on the magnitude by which this tolerance was exceeded, he can decide to continue with the inspections or stop them.

* Herbert Arkin, Handbook of Sampling for Auditing and Accounting, Volume 1, McGraw-Hill Book Company Inc., 1963, pp. 122 and 123.

CONFIDENCE LEVEL 90%

Sampling Error		Expected Rate of Occurrence (P)							
		Not Over 5%	Not Over 10%	Not Over 15%	Not Over 20%	Not Over 30%	Not Over 40%	Not Over 50%	Over 50%
		+4%	+4%	+4%	+5%	+5%	+5%	+5%	
Population Size	Sample Size	Sample Size	Sample Size	Sample Size	Sample Size	Sample Size	Sample Size		
200	58	95	104	92	120	140	130		
300	64	101	126	110	130	140	143		
400	67	111	141	121	145	158	162		
500	70	117	151	129	157	171	176		
600	71	122	159	135	165	182	187		
700	73	126	165	139	172	190	196		
800	74	128	170	143	178	197	203		
900	74	131	174	146	182	202	209		
1,000	75	133	178	148	186	207	213	See NOTE 2	
1,100	75	134	181	150	189	211	218		
1,200	76	136	183	152	192	214	221		
1,300	76	137	185	153	194	217	224		
1,400	76	138	187	155	196	220	227		
1,500	77	139	189	156	198	222	230		
1,600	77	139	191	157	200	224	232		
1,700	77	140	192	158	201	226	234		
1,800	77	141	193	158	202	228	236		
1,900	78	141	194	159	204	229	237		
2,000	78	142	195	160	205	230	239		
2,500	78	144	199	162	209	236	245		
3,000	79	145	202	164	212	240	249		
3,500	79	146	204	166	214	242	252		
4,000	79	147	205	166	216	244	254		
5,000	80	148	207	168	218	247	257		
7,500	80	150	210	170	221	252	262		
10,000	80	150	212	171	223	254	264		
20,000	81	152	214	172	225	257	267		
50,000	81	152	215	173	227	259	270		

- NOTE: 1. To obtain sample sizes for population sizes between those given in this appendix use the next higher population size or the formula shown on page 1 of the text.
2. Use the column whose percentage value corresponds closest to the value obtained from the solution of this formula $(100-P)$.

Sample Reliability for Relative Frequencies
for Random Samples Only

Rate of Occurrence in Sample 2%

And Sample Size is:	For Field Size of:													
	500		1,000		1,500		2,000		10,000		50,000		100,000 & over	
	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit
50	.2%	8.9%	.2%	9.1%	.1%	9.1%	.1%	9.2%	.1%	9.3%	.1%	9.3%	.1%	9.3%
80	.4	6.6	.4	6.8	.3	6.9	.3	6.9	.3	7.0	.3	7.0	.3	7.0
90	.5	6.1	.4	6.4	.4	6.4	.4	6.5	.3	6.6	.3	6.6	.3	6.6
100	.5	5.8	.4	6.0	.4	6.1	.4	6.1	.4	6.2	.4	6.2	.4	6.2
120	.7	5.2	.6	5.5	.5	5.5	.5	5.6	.5	5.7	.5	5.7	.5	5.7
140	.8	4.8	.6	5.1	.6	5.2	.6	5.2	.5	5.3	.5	5.3	.5	5.3
150	.8	4.6	.7	4.9	.6	5.0	.6	5.0	.6	5.1	.6	5.1	.6	5.1
160	.8	4.5	.7	4.8	.7	4.9	.7	4.9	.6	5.0	.6	5.0	.6	5.1
180	.9	4.3	.8	4.6	.8	4.7	.7	4.7	.7	4.8	.7	4.8	.7	4.8
200	1.0	4.0	.8	4.3	.8	4.4	.8	4.4	.7	4.5	.7	4.5	.7	4.6
250	1.2	3.7	1.0	4.0	.9	4.1	.9	4.2	.9	4.3	.9	4.3	.8	4.3
300			1.2	3.5	1.1	3.7	1.1	3.7	1.0	3.8	1.0	3.8	1.0	3.8
400			1.3	3.2	1.3	3.3	1.2	3.4	1.1	3.5	1.1	3.5	1.1	3.5
500			1.4	2.9	1.4	3.1	1.3	3.2	1.2	3.3	1.2	3.3	1.2	3.3
600			1.4	2.9	1.4	2.9	1.4	3.0	1.3	3.1	1.3	3.2	1.3	3.2
700			1.5	2.8	1.5	2.8	1.4	2.9	1.3	3.0	1.3	3.1	1.3	3.1
800					1.5	2.8	1.5	2.8	1.4	2.9	1.4	3.0	1.4	3.0
900					1.5	2.7	1.5	2.7	1.4	2.9	1.4	2.9	1.4	2.9
1,000					1.6	2.6	1.6	2.6	1.4	2.8	1.4	2.8	1.4	2.8
1,500									1.5	2.6	1.5	2.7	1.5	2.7
2,000									1.6	2.5	1.6	2.6	1.6	2.6
3,000									1.7	2.4	1.7	2.4	1.6	2.4

