ATMOSPHERIC ENVIRONMENT SERVICE

# FIRE WEATHER PROGRAM IN BRITISH COLUMBIA

by

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# FOREWORD

This manual describes the Fire Weather Forecast Program in British Columbia. It is intended mainly as a manual to assist users in interpreting the Fire Weather Forecasts. It is intended also to assist Atmospheric Environment Service (AES) personnel, particularly Presentation Technicians, who provide service to the forest industry and fire control agencies.

Mr. Steve Nikleva of the Scientific Services Unit, Pacific Region, Atmospheric Environment Service first wrote this manual in 1970. Numerous changes in procedures have been instituted since then making revision of the manual necessary. This 1975 revision was prepared by H. W. Raynor of the Fire Weather Forecast Unit of the Pacific Weather Central and D.A. Faulkner of the Scientific Services Unit, Vancouver.

Since Canada is "going Metric" and the AES is in the forefront of this change, tables and formulae are included in this manual for conversion from imperial units (miles, feet, etc.) to SI or Metric units (kilometre, metres, etc.). SI stands for International System of Units, the system now almost universally accepted throughout the world.

March 1975

# INTRODUCTION

## Requirement for a Meteorological Service to Forestry

British Columbia is one of the world's leading producers of wood products, and the importance of the forests to the provincial economy is reflected by the magnitude of the annual value of forest industry shipments, approximately 1.2 billion dollars. One half of every dollar created in British Columbia comes from the forests. The industry employs more than 80,000 people directly, and provides a livelihood for ten of thousands more who serve the industry's requirements. In many parts of the province, the entire economy is dependent on this resource.

There has been a gradual rise in awareness of the value of our forests, and today forest land is regarded as a source of renewable forest crops. The Provincial Forest Service has the responsibility for protecting and making best use of this resource, and "total land management" and "sustained-yield forestry" are now the basis for forest policy.

Protection of the forests from fire, insects and disease is becoming increasingly important. Forest values are rising due to increased utilization and greater demand for lumber, pulp and other wood products. In addition the general public, governments and industry are realizing more and more the value of the forests for "non-consumptive" uses and benefits. These include such things as recreation, watershed protection and fish and wildlife protection.

Millions of seedlings are now planted each year to produce new crops of trees. As it requires 80-100 years for the crop to mature and the timber to be harvested, the value of the crop increases with age, and there is a corresponding increase in the need for protection.

## Provision of Meteorological Service to Forestry

Weather information is important in all aspects of forestry, but it is in fire protection that meteorology makes its most significant contribution. The Atmospheric Environment Service (AES) has accepted the responsibility for providing forestry with a specialized service which includes fire weather forecasts, forecasts of fire danger indices, and consultation services.

The program for all of these services in B.C. is coordinated by the Scientific Services Unit, AES, Pacific Region, one of whose members is designated as the "Forestry Meteorologist". Requests for additions to, or changes in existing services of a continuing nature should be directed to him. He may be reached at

Scientific Services Unit
Department of the Environment
Atmospheric Environment Service, Pacific Region
739 West Hastings Street
Vancouver, B.C. V6C 1A1

Telephone: 666-1170, Area Code - 604

Consultation involving the application of meteorology to forestry is also one of the functions of the Forestry Meteorologist and he provides liaison with government and industry protection agencies and assists in training fire control personnel.

Day to day forecast services are provided by Field Services Directorate, AES. Basic forecasts for most of B.C. originate from the Pacific Weather Central at Vancouver in which is located a specialized Fire Weather Forecast Unit (FWFU). Forecasts for some peripheral areas (Northern B.C. and Peace River District) are provided through the Weather Offices at Whitehorse and Edmonton.

The FWFU is in operation during the fire season, May 1 to September 30, and has two main functions:

> First, to furnish specialized fire-weather forecasts as support for the forest fire prevention activities of government and private agencies;
>
> Second, to provide consultation service by giving advice or forecasts for specific locations to enable fire control personnel to interpret properly the local variations in the weather.

The fire weather forecaster can be reached by telephone at the FWFU between the hours of 6 a.m. and 4 p.m. PDT, Monday through Friday. He is also available on weekends if the fire danger is high, or if important fires are burning. When the fire weather forecaster is not on duty the telephone connects directly to the public weather forecaster in the Pacific Weather Central. In this way, a 24-hour fire weather service is provided. The fire weather forecaster may be contacted at:

> Fire Weather Forecast Unit
> Pacific Weather Central
> Vancouver International Airport, B.C.
>
> Telephone 273-2370, Area Code 604
> Telex 04-54553

A number of satellite Weather Offices in B.C., listed below, provide local forest interests with a direct access to presentation of forecasts, current and past data, etc. These offices are staffed by presentation technicians who have a good knowledge of basic meteorology. Their function is to make weather information available to the many users in their district and they are fully capable of providing assistance in forecast localization.

Weather Offices are located at the following centres:

| | Telephone | Area Code |
|---|---|---|
| Victoria* | 656-3377 | 604 |
| Kamloops | 376-2160 | " |
| Penticton | 492-0539 | " |

| | Telephone | Area Code |
|---|---|---|
| Prince George | 963-9330 or 963-7737 | 604 |
| Terrace | 635-3224 | " |
| Port Hardy | 949-6559 | " |
| Fort St. John | 785-4304 | " |
| Fort Nelson | 774-6461 | " |

* Meteorologist on duty 5 days a week.

During the fire weather season, AES Presentation Technicians are assigned to BC Forest Service (in 1975 to the Nelson, Kamloops, Cariboo and Prince Rupert Districts). These Technicians provide a direct consultation service to the Forest Service which will increase the effectiveness of the Forest Fire Forecast Service.

## Principles of Fire Control

(This section gives a good over-view of the fire control problem. It is taken directly from the AES report "Meteorological Services for Forest Fire Control" by S. Nikleva, P.M. Paul and L.B. MacHattie).

The basic furel that makes a forest fire possible is the dead woody material on the ground (fallen needles, leaves, branches, etc.) which the forester calls duff or litter. When the duff is dry enough to burn it carries the fire; locally it may provide enough heat to dry and kindle the needles and branches of standing trees, thus initiating a crown fire. A crown fire will only very rarely continue to burn without assistance from an underlying ground fire. That is, if the duff is too wet to burn, a crown fire is extremely unlikely.

Fires in hardwood forests are in a different class from those in softwood forests. In summer the duff in hardwood forests is generally too damp to burn, because it is so thoroughly sheltered from direct sunshine and wind. Only before the leaves come out in the spring and after they fall in the autumn are fires common. While the leaves are on the trees, hardwood forests are often considered to be somewhat of a fire break. The main concern in Canada is with fires in coniferous forests.

The damage done by a forest fire depends on the depth to which the duff burns. If only the very top needles burn and no crown fire occurs, the damage to standing trees will be minimal and the net effect may even be beneficial, from a forestry viewpoint (through elimination on undesirable, competing vegetation). Such fires are relatively easy to control. But when a thick layer of the duff (and a thick layer on the outside of branch wood and logs on the forest floor) is dry enough to ignite readily, the fire burns much hotter, is harder to stop and of course does much more damage.

The rate of spread of a forest fire (in a given type of forest), depends mainly on the dryness of the fuel and on the wind speed, (it varies roughly as the square of the wind speed). The amount of fuel per acre has little direct effecton rate of spread; but indirectly high fuel densities are likely to result in more crowning and more spotting (ie. starting of new fires by embers blowing ahead of the fire proper), thus on a gross scale causing more rapid fire spread.

A rough average for the rate of forward (downwind) spread of forest fires is 0.1 miles per hour. Only a very few fast moving fires attain an average speed as high as one mile per hour. Characteristically fires advance in bursts, so short period (less than one hour) speeds may be considerably greater. A fire burning in a calm is roughly circular in shape, (assuming uniform fuel distribution and topography), a fire burning under a steady wind become elliptical. If the wind direction should then shift 90°, one of the long sides, till then a slowly advancing flank of the fire, suddenly becomes the rapidly advancing head of the fire, and the area burnt mounts rapidly. Such wind shifts are obviously of critical importance.

The main principle of forest fire suppression is to break the continuity of the fuel bed, usually by scraping away the duff layer (down to mineral soil) to make a control line around the fire. The width of the scraped line may be as narrow as one foot, but it can be very effective. Most forest fires in Canada are suppressed by interrupting the ground fire. When a fire is crowning the head of the fire is usually not tackled directly; instead action is directed towards keeping the sides and rear from extending until the head of the fire stops crowning, as it usually will at night, if not before, then an intensive effort is made to put a line across in front of it. The effectiveness of a fire control line can be increased by a procedure called "burning out", whereby the remaining fuel between the control line and the fire is burned out by a fire which is lit along the inside edge of the control line. After the spread of a forest fire has been stopped, the perimeter of the burned area needs to be patrolled till enough water has been put on or enough rain has fallen to extinguish the fire. If the fuel has dried in depth before the fire began, it takes a surprisingly large amount of rain to extinguish all glowing embers. Without this patrol action, apparently dead fires are likely to spring to life during the next spell of dry weather - as many fire control men know from unhappy experience.

Air tankers are being used to an increasing extent to drop water or fire retardant around small fires, to keep them from spreading, until men can get there on the ground and complete the work of fire control. In some cases fires may be extinguished from the air, but this is exceptional.

Obviously it is easier to extinguish small fires than large, so early detection of fires is important - increasingly so, the more conductive the weather is to rapid fire spread. A network of manned towers used to be the basis of fire detection; aircraft patrols are being used increasingly and will soon, if they have not already, become the primary means of fire detection. Most fire detection is still done visually, but airborne infrared scanners are being tried. Even with these efficient detection procedures being used by forest services, a significant proportion of fires is still reported first by the general public.

Efficient use of men and equipment in forest fire control requires knowing the variation in the degree of forest flammability from day to day, and from area to area. The Canadian Forest Fire Weather Index is in general use throughout Canada for this purpose. It is a system of tables, developed by the Canadian Forestry Service, for calculating several sub-indices (eg. FFMC, ADMC) as well as the FWI (fire weather index) itself. The input for these tables is:

(a) weather observations (of 24 hour accumulated precipitation, current wind speed, relative humidity and temperature) taken at noon local standard time in a clearing, and,

(b) the month of the year.

Hence the FWI is really a meteorological parameter, although by definition it is "a numerical rating of potential fire intensity in a standard fuel type".

Low relative humidity (30% say) and high surface wind speeds may result in very serious fires -- as in Alberta during the week of May 18-25, 1968. More usually drought is a prerequisite to a bad fire situation, because during droughts ignition agents are more likely to light on suitable fuel and when a fire does develop it is more difficult to suppress. Since droughts develop slowly, it can be useful to prepare daily maps of current drought indices; these may be used as a basis for moving men and equipment to potentially dangerous areas.

Although some fire control personnel may work around the clock, the main fire suppression effort is made during daylight hours. Aircraft support is restricted almost completely to the daylight hours. Hence the demand for meteorological service is concentrated in two periods:

(a) early morning (0700-0900) when decisions concerning the current day's activities are made definite, and
(b) late afternoon (1500-1700) when plans are made for the following day's operations.

## The Canadian Forest Fire Behaviour System

The Canadian Forestry Service (CFS) has developed a Fire Danger Rating System that is now in use throughout Canada. The system integrates weather parameters affecting fire danger into a number of indices designed to meet the needs of protection agencies. Tables of indices and information about the indices may be obtained from

Pacific Forest Research Centre
506 West Burnside Road
Victoria, B.C. V8Z 1M5

A brief description of the various indices taken from the CFS publication, Canadian Forest Fire Weather Index follows:

1. Fine Fuel Moisture Code (FFMC) - This is a numerical rating of the moisture content of litter and other cured fine fuels in a forest stand. This code is suitable for use as an indicator of the relative ease with which fires will ignite.

2. Duff Moisture Code (DMC) - This is a numerical rating of the average moisture content of loosely compacted organic layers 2" to 4" deep.

3. Drought Code (DC) - This is a numerical rating of the average moisture content of deep, compact, organic layers. This code is suitable for use as a guide for long range presuppression and preparedness activities over large areas.

4. Initial Spread Index (ISI) - This is a numerical rating of the relative fire spread which can be expected immediately after ignition in a standard fuel type.

5. Adjusted Duff Moisture Code (ADMC)* - This is a numerical rating of the total amount of fuel available for combustion. This code is suitable for use as a guide for short term presuppression and preparedness activities.

6. Fire Weather Index (FWI) - This is a numerical rating of potential fire intensity in a standard fuel type. This code is a guide to daily preparedness and suppression activities.

*N.B. ADMC is now more commonly referred to as the "The Buildup Index" or "BUI", and the two terms are used interchangeably.

The above descriptions show that each index has a particular application, hence a particular usefulness depending on the problem at hand.

The Fire Weather Index(FWI), since it is an integration of all the other indices (see Block diagram in Appendix E), is probably the most useful and is most commonly used. The BC Forest Service and the CFS have made a study of the relation between two indices (FWI, BUI) and actual fire occurrences in BC. This study has enabled them to determine danger rating classes of nil, low, moderate, high and extreme for ranges of FWI's and BUI's.

Note that the higher the FWI, (or any other index), the greater the danger rating.

Computation of the BUI is an integral step in the calculation of the FWI; however, the BUI by itself provides useful information as it represents the moisture content in the medium and heavy fuels. Since the moisture content of the fuels indicates the total energy available for combustion, the BUI is an indicator of potential energy release from a fire.

Unlike the FWI which varies markedly with changes in wind speed or with fairly small amounts of rainfall, the BUI reflects weather conditions that have occurred over a long period of time. Consequently, it has a fairly slow response to daily weather changes.

More complete discussions of the indices may be found in the two CFS publications:

Structure of the Canadian Forest Fire Weather Index - C.E. Van Wagner

An Interpretive Guide to the Canadian Forest Fire Behaviour System - B.D. Lawson

The block diagram (Appendix E) indicates the parameters used, and the method employed, to calculate the various indices.

## Fire Weather Forecasts

### Forecast Localization

Weather zones and reference points: In a mountainous area such as British Columbia, the provision of meteorological information is a difficult task. This is particularly so in fire protection because its requirements for meteorological information are extremely varied. In some instances, information on average conditions over fairly large areas is required, for example, in assessing fire danger indices for recreational closure decisions. At other times, detailed information for specific sites is necessary, for instance, in fighting individual forest fires or in broadcast burning.

The FWFU attempts to meet these diverse meteorological needs of fire protection organizations by employing a forecast system based on a framework of carefully chosen weather zones and reference points.

Weather zones are broad areas of the Province which generally have fairly homogeneous fire weather conditions. These zones have been delineated by foresters and meteorologists familiar with the specific areas. The location of the weather zones and their assigned zone numbers are shown in Fig. 1 Appendix A.

A reference station is selected so that there is a good correspondence between the weather occurring at the reference point and the weather occurring at most other localities in the zone. This enables a forecast user to interpret the forecast for his location in terms of the forecast for the reference point.

In addition supplementary stations have been selected to help depict the variation in fuel moisture and fire danger in each zone.

The reference points and supplementary stations are listed and plotted in Appendix A. Each station is identified by a two or three digit number formed from the weather zone number and the station number.

Localizing the reference point forecast to specific sites is an essential requirement in a mountainous area such as British Columbia. Although the reference point-weather zone system provides a partial solution to this problem, a keen interest by the user in the local weather behaviour remains an indispensable requirement for making the most effective use of the forecast.

Variation of Temperature and Relative Humidity with Elevation: Adjustments to the reference point forecasts of relative humidity and temperature for the difference in elevation between the reference point station and the operating site can be accomplished in some cases by reference to Figs. 2 and 3 in Appendix A.

Temperature and relative humidity values of most concern to fire protection organizations occur during the afternoons of warm sunny days, and at most of these times the air in the lower atmosphere is fairly well-mixed. Under these conditions the vertical variation of temperature and relative humidity can be predicted by means of the graphs in Figs. 2 and 3. It should be

emphasized that this technique must be used with caution because it will give a good approximation only on those days when turbulent mixing of the air occurs. Two exceptions should be noted:

First, when subsidence occurs, which is a general descending motion of the air in the atmosphere, an abnormal situation exists, and rather than an increase there may be a decrease in humidity with height.

Second, in coastal areas there is often a shallow layer of moist air near the water surface with fairly dry air above this moist marine layer. Along the immediate coast, the air in the lower levels may not mix with the air aloft and low humidities can then occur on the tops of the mountain ridges. When either of the above situations exists, it is mentioned in the fire weather forecast.

## Forecast Elements and Terminology

To make best use of the forecast, it is necessary that the user have a clear understanding of a number of technical terms that have a specialized meaning in meteorology. Some of the more common terms used by the forecaster are explained below:

### Sky Condition

Clear - 2/10 or less of the sky covered by cloud

Scattered clouds or sunny - 3/10 to 5/10 of sky covered by cloud

Cloudy - 6/10 to 8/10 of sky covered by cloud

Overcast - 9/10 or 10/10 of sky covered by cloud

The use of the qualifying adjective "thin" indicates high clouds which do not have much effect on temperatures; precipitation does not fall from this high cloud type.

### Relative Humidity

The forecast value of relative humidity in the reference point coded forecast refers to the 1 pm (PDT) value of relative humidity expected at the reference point station during the day.

In addition, the trend of the change expected in minimum relative humidity values on successive days is included in plain language. For example, if the lowest value of relative humidity expected tomorrow is higher than the lowest value of relative humidity reported today, we indicate this by the statement increasing humidities. Similarly, if the minimum relative humidity expected tomorrow is less than the minimum relative humidity reported today, a statement will be included in the forecast stating that humidities are decreasing.

Under normal conditions the decrease in temperature at night will result in a high value of the relative humidity in the early morning. This is referred to as normal overnight recovery. However, some weather patterns are accompanied by subsidence, and the general downward motion of the atmosphere results in a drying of the air mass. This effect is often most pronounced at higher elevations, and during the night. Under these subsidence conditions

the humidity during the early morning may not be much different from daytime values. When this is expected to take place a statement of poor overnight recovery would be included in the reference point forecast.

## Temperature

The temperature value included in the coded forecast is the 1 pm (PDT) temperature expected at the reference point.

The temperature trend in the plain language portion of the forecast refers to the change expected in maximum temperature values on successive days.

## Wind

The reference point coded forecasts contain the maximum hourly average wind speed expected at that location during the forecast period.

The wind speed in the forecast refers to the speed expected at a standard anemometer height of 10 meters.

The speed is given in miles per hour except when speeds are less than 16 km/h in which case the term LIGHT may be used.

If strong gusty winds are expected, mention of the maximum gusts may be included in plain language at the end of the reference point forecast.

Wind direction is forecast to eight points of the compass and specifies the direction from which the wind is blowing; however, because of the variable direction of light winds, the direction may be forecast as variable for winds less than 16 km/h.

The plain language forecast contains a statement on the maximum hourly average wind speed and direction. This wind forecast applies to broad areas and attempts to give the overall condition. It is the wind expected in exposed areas which do not have pronounced topographical effects.

The trend in the general wind pattern is also included in the forecast to aid in estimating the change in wind at a particular site.

## Precipitation

At present,it is not possible to issue precipitation amount forecasts with the degree of accuracy which would make them useful for forestry purposes. However, verification results have confirmed the usefulness of forecasting the probability of occurrence of rain. This figure is included in the reference point forecast and refers to the percent probability of rain occurring at the specific reference point station during the forecast period.

## Fire Weather Indices

The actual values of fire weather indices are calculated by computer at the FWFU and are included daily in the Fire Weather Forecast.

Forecast values are also calculated using the forecasts of temperature, relative humidity and wind. However, it is extremely difficult to accurately forecast precipitation amounts for B.C. This is not as serious as it may first seem, because when rain occurs the hazard drops substantially, and a forecast of rain usually provides sufficient information on the change in fire danger for protection purposes. Therefore when the probability of rain is expected to exceed 50%, forecasts of the indices are omitted and the forecast values are replaced by the term RAIN, or the abbreviation RN.

### Lightning

Forecasts include information on expected lightning frequency and activity. To provide an indication of the ignition potential of lightning storms, the weather office forecast includes, when possible, information on whether the lightning storm is of the wet or dry type.

The FWFU receives reports of lightning from Atmospherice Service and military observing stations, radar surveillance units and commercial aircraft. This current information on lightning occurrences may be obtained by contacting the FWFU, or the nearest Weather Office listed above.

### Remarks

When merited, plain language remarks are added to the reference point forecasts to provide additional information on rainfall amount, timing of wind shifts, overnight recovery, lightning, frontal passages or other important fire weather developments.

### Five Day Outlook

A general outlook of weather conditions for the next five days is included in the morning forecast.

## Routine Fire Weather Forecasts:

### Forecast Regions

For forecasting purposes the weather zones have been grouped into nine forecast regions. The weather zones contained in each region are listed below and depicted in Fig. 1 Appendix A.

| Forecast Regions | Weather Zones |
|---|---|
| South Coast | 1 - 5 |
| North Coast | 6 - 8 |
| Northwestern B.C. | 9, 30 |
| East Rockies | 10, 11, 29 |
| Omineca | 12, 13, 28 |
| Prince George-Quesnel Lakes | 14, 15, 16, 18, 19 |
| Interior Plateau | 17 |
| Southeastern B.C. | 22 - 27 |
| South Interior | 20, 21 |

## Morning Forecast

The morning forecast is issued at 7 a.m. PDT seven days a week for the purpose of supplying protection personnel with a detailed forecast for the current day. Each forecast region contains a plain language statement describing the main weather systems affecting the district and the changes that are expected to occur in the various weather elements. In addition, for each of the reference point stations in the district, a coded forecast follows the heading:

| FCST | FCST | FCST | PROB |
|---|---|---|---|
| TMP | RH | WND | PCPN |

where FCST TMP = 1 pm (PDT) temperature (degrees Celsius)
FCST RH = 1 pm (PDT) relative humidity (percent)
FCST WND = 1 pm (PDT) wind speed (miles per hour in 1975, km/h after April 1, 1976)
PROB PCPN = probability (percent) of rain occurrence

The forecast is valid for the current day. When applicable, comments on windshifts, precipitation amounts, thunderstorms, lightning, overnight recovery of relative humidity, fire weather indices, etc. are included as plain language remarks.

## Afternoon Forecast

The afternoon forecast is issued at 3 p.m. PDT. It is normally available five days per week; however, additional forecasts are issued on weekends if the British Columbia Forest Service is on stand-by due to high fire danger or if extensive slash burning is taking place.

The forecast is valid for the remainder of the day and the following day.

The format of the afternoon forecast is similar to that of the morning forecast. However, additional information is supplied and the heading is as follows:

| FCST | FCST | FCST | PROB | FFMC | DMC | DC | ISI | BUI | FWI | BUI | FWI |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TMP | RH | WND | PCPN | TDA | TDA | TDA | TDA | TDA | TDA | TMW | TMW |

Where

FCST TMP = temperature forecast (degrees Celsius) for 1 PM PDT the next day

FCST RH = relative humidity forecast (percent) for 1 PM PDT the next day
FCST WND = wind forecast (miles per hour in 1975, km/h after April 1,1976)
PROB PCPN = percent chance of rain for that spot for the next day
FFMC TDA = fine fuel moisture code calculated from the 1 PM PDT observations today
DMC TDA = duff moisture code calculated from the 1 PM PDT observations today
DC TDA = drought code calculated from the 1 PM PDT observations today
ISI TDA = initial spread index calculated from the 1 PM PDT observations today
BUI TDA = build-up index calculated from the 1 PM PDT observations today
FWI TDA = fire weather index calculated from the 1 PM PDT observations today

BUI TMW = build-up index for tomorrow calculated using the forecast values for temperature, relative humidity and winds

FWI TMW = fire weather index for tomorrow calculated using the forecast values for temperature, relative humidity and winds

For supplementary stations the indices FFMC, DMC, DC, ISI, BUI and FWI are calculated using today's 1 PM PDT observations. They are transmitted with the forecast under the appropriate headings.

Smoke Management Forecasts

Forecasts to aid foresters in assessing potential smoke pollution from slash burning, have been issued since 1973 for varying periods for special areas in the province based on requests from the BC Forest Service. They are issued at 10 AM, PDT daily.

The forecasts consist of four main parts;

1. Mixing Height - the maximum depth of convective mixing expected that day due to natural heating by the sun.

2. Wind speed and direction at 2, 5 and 10 thousand feet above ground level

3. Ventilation Index - the mixing height multiplied by the average wind in that layer. This produces a numerical value which is related to the ventilation or the ability of the atmosphere to disperse pollution from a source. For convenience this is scaled from 0 to 100 and divided into classes which are

| | |
|---|---|
| 0 - 33 | Poor |
| 34 - 45 | Marginal |
| 46 - 55 | Fair |
| 56 - 66 | Good |
| 66 -100 | Excellent |

4. Outlook - trend in the ventilation expected due to changing winds and mixing heights.

Revision of Forecasts

If there are unexpected weather developments which may affect fire protection operations, forecasts will be revised. The following conditions require an amendment to the forecast:

1. Wind speed forecast is in error by 16km/h or more;
2. Relative humidity forecast is in error by 10% or more if the forecast value is less than 50%;
3. Significant changes expected in frontal activity, lightning, precipitation, etc.

Indices in Chart Form

Throughout the fire weather season, the FWFU prepares charts depicting the BUI and the DC in the Province. Once weekly, these charts showing normal values and percent of normal values are transmitted on the AES facsimile network to the Weather Offices listed on Page 3, and to a few BCFS District Offices.

Charts are also sent by mail and may be obtained on request from the FWFU.

Special Forecasts

Special forecasts to provide information for critical slash burning operations, or to assist officials engaged in fire suppression duties, are issued on request by telephone or Telex.

Forecast Distribution

To provide an effective service, the forecasts must be distributed quickly to the user. The following methods are used:

1. Atmospheric Service meteorological teletype circuits carry all forestry forecasts issued and users may obtain this information by telephone from stations on the network. A list of these stations is included in Appendix C.

2. British Columbia Forest Service Ranger Stations receive forecasts from their district offices, and they will make this information available to the forest industry.

3. Forecasts are sent to Canadian Press for distribution to radio stations via their Broadcast News Service.

4. Forecasts can be delivered by Telex Service. In most cases the recipient assumes the transmission costs and the Telegraph Company bills subscribers according to the length of message. A preferential rate is obtained by ordering through the FWFU. To eliminate the forestry user receiving forecasts from unwanted areas, all items in the forecasts are numbered so that the user may request only the specific information he requires. For example, a user of the forestry forecast in Fernie, B.C. would normally request only item 6 in the forecast program. He would then receive the morning and afternoon forecast for the Southeastern B.C. Forecast Region and any revisions to the forecast for that district. Forecasts for smoke management are also available.

## Fire Weather Observations

Because of the nature of the meteorological data available determines the type of forecast service that is feasible, the acquisition of data is an essential part of the forecast program.

In British Columbia, meteorological information from the Atmospheric Environment Service observing network is insufficient to provide adequate support for a fire weather forecast service for the forested areas. However, the British Columbia Forest Service and the forest industry have established weather observing stations to meet their particular fire protection needs, and these stations are used by the FWFU to supplement the AES network.

The Atmospheric Environment Service cooperates with various agencies in establishing an adequate observing network to supply the current information needed for the fire weather forecasting service.

The British Columbia Forest Service supplies information to the FWFU from 30 stations daily, and reports from a further 20 stations are obtained from industry.

The primary network consists of a total of 39 stations; this is made up of 14 BCFS stations, six industry stations, and 19 AES stations. Primary network observing stations are the designated reference points in the fire weather forecast. Therefore, in order to provide a continuous forecast service throughout the fire season, it is necessary to receive regular reports from primary network stations from May 1 to the end of September or later, if the fire season is still in effect.

The secondary observing network contains an additional 46 stations. Most of these stations report for the entire fire season. Because of the extreme variability in weather elements over British Columbia, the additional information provided by the secondary network is essential.

Weather reports from British Columbia Forest Service ranger stations and lookouts are collected by radio in each of the six forest districts. The district offices then relay these reports to the FWFU by Telex Service.

Industry reports are received by the individual companies' existing communication channels, teletype, Telex or telephone service, and relayed to the Fire Weather Forecast Unit.

## Metric Conversion Program

The Atmospheric Environment Service is one of the lead agencies in the Metric Conversion Program. The program of changes as they affect Fire Weather Forecasts is as follows:

April 1, 1975 - Temperatures in forecasts will be in degrees Celsius (C)

September 1, 1975 - Rainfall measurements at AES stations will be in millimetres (mm).

April 1, 1976 - Wind speeds and speeds of weather systems will be in kilometres per hour (km/h)

- Distances will be in kilometres (km).

To assist users during the change-over period, tables and formulae for conversion are included in Appendix D.

## Appendix A

### Reference Point and Subsidiary Stations

| Weather Zone No. | Reference Point Stations | Supplementary Stations |
|---|---|---|
| 1 | 1 - Tofino<br>2 - Port Hardy | 3 - Franklin River<br>4 - Zeballos |
| 2 | 1 - Gordon River<br>2 - Menzies L/O<br>3 - Gold River | 4 - Woss Camp<br>5 - Port Alberni<br>6 - Sooke |
| 3 | 2 - Benson L/O<br>3 - Comox | 4 - Landford |
| 4 | 1 - Hope<br>2 - Alta Lake | 3 - Harrison L/O<br>4 - Squamish Camp<br>5 - Abbotsford<br>6 - Grouse |
| 5 | 1 - Toba Camp | 2 - Squamish Ranger Station<br>3 - Powell River<br>4 - Bute Inlet<br>5 - Knight Inlet |
| 6 | 1 - Prince Rupert | 2 - Ethelda Bay<br>3 - Sandspit |
| 7 | 1 - Firvale | |
| 8 | 1 - Terrace | 2 - Kemano<br>3 - Kitimat |
| 9 | 1 - Dease Lake | 3 - Whitehorse |
| 10 | 1 - Fort Nelson | |
| 11 | 1 - Chetwynd | |
| 12 | 1 - Germansen Landing | 2 - Mackenzie<br>3 - Fort St. James<br>5 - Ingenika |
| 13 | 1 - Smithers | 2 - Fraser L/O<br>3 - Granisle<br>4 - Burns Lake<br>5 - Grassy Plains<br>6 - Houston |
| 14 | 1 - Hudta Lake Camp | 2 - Prince George |
| 15 | 1 - Aleza Lake | |
| 16 | 1 - Valemount | |
| 17 | 1 - Puntzi Mountain<br>3 - Williams Lake | 2 - Begbie L/O<br>4 - Andrews Bay<br>5 - Clinton |

| Weather Zone No. | Reference Point Stations | Supplementary Stations |
|---|---|---|
| 18 | 1 - Horsefly | 2 - Quesnel |
| 19 | 1 - Blue River | 2 - Warren L/O |
| 20 | 1 - Hamilton L/O<br>2 - Pemberton<br>3 - Kamloops R/S | 4 - Princeton<br>5 - Lytton<br>6 - Kamloops Airport |
| 21 | 1 - Kelowna | 2 - Gerry L/O |
| 22 | 1 - Revelstoke | 2 - Mica Creek<br>4 - Downie Creek |
| 23 | 1 - Golden | |
| 24 | 1 - Nakusp | 2 - Lardeau |
| 25 | 1 - Kettle Valley | 2 - Beaverdell |
| 26 | 1 - Castlegar | 2 - Salmo |
| 27 | 1 - Cranbrook<br>5 - Invermere | 2 - Elko<br>3 - Natal<br>4 - Canal Flats |
| 28 | 1 - Nass Camp | 2 - Tenas L/O |
| 29 | 1 - Fort St. John | |
| 30 | 1 - Liard | 2 - Watson Lake |

Weather station identification numbers are the weather zone number and the number of the station on this list. e.g.,

Toba Camp is 51
Beaverdell R/S is 252

Figure 1

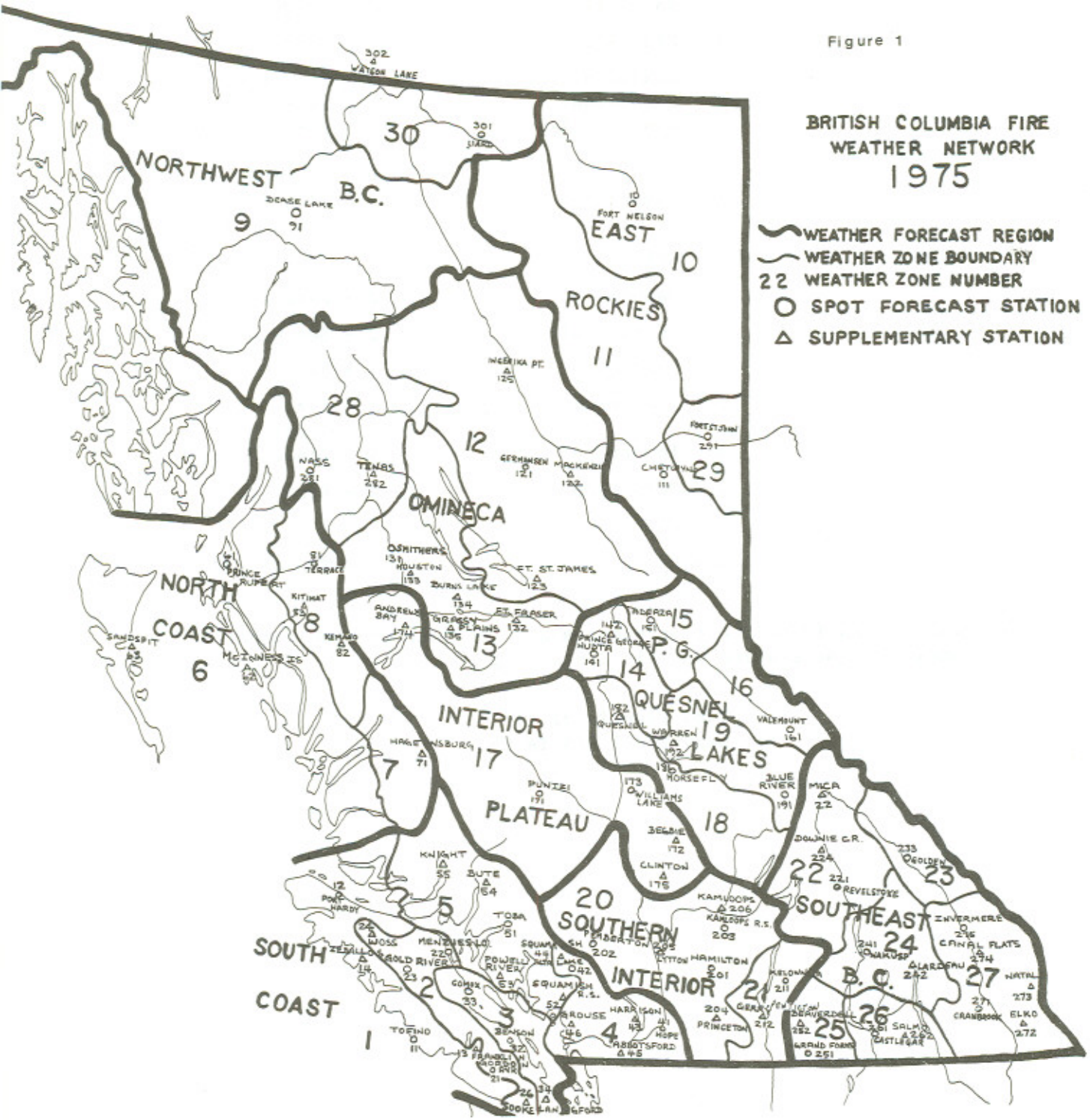
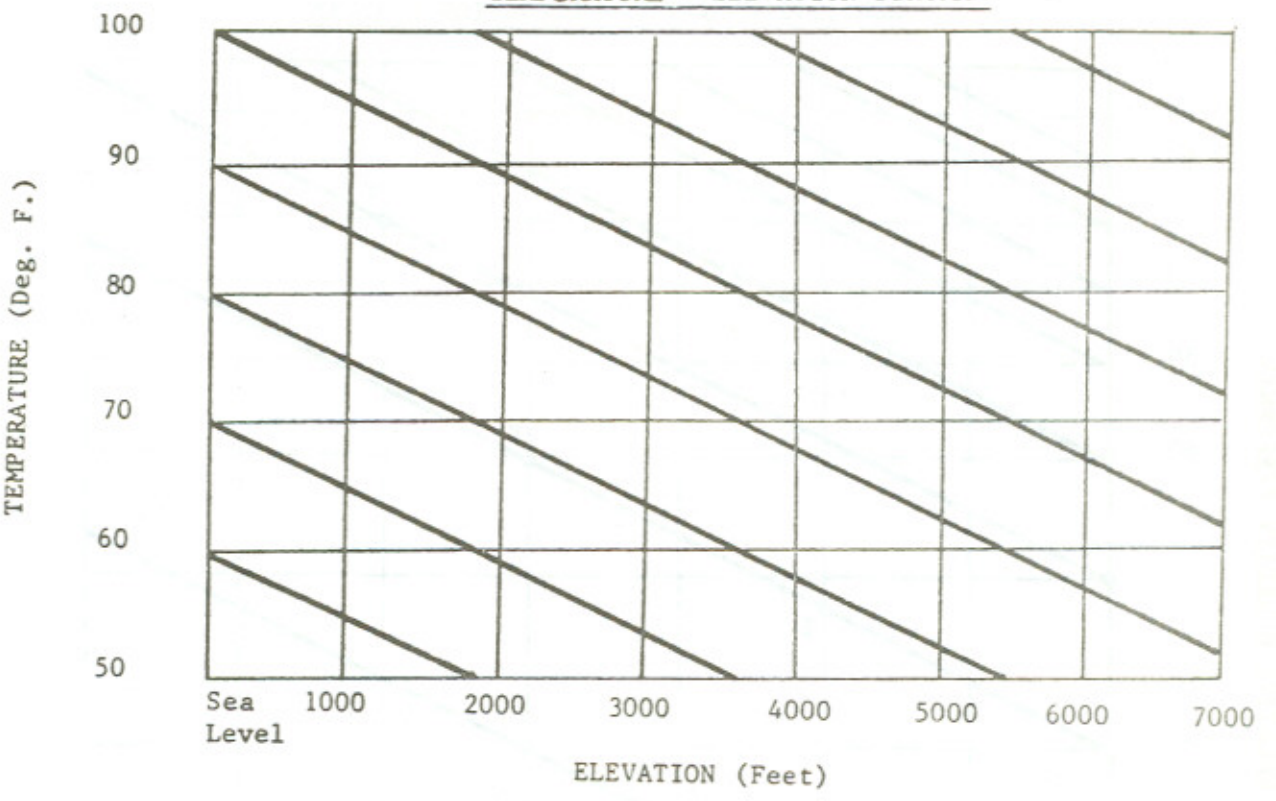

BRITISH COLUMBIA FIRE WEATHER NETWORK
1975
WEATHER FORECAST REGION
WEATHER ZONE BOUNDARY
22 WEATHER ZONE NUMBER
SPOT FORECAST STATION
SUPPLEMENTARY STATION
NORTHWEST B.C.
9
EAST ROCKIES
10
11
30
28
12
29
OMINECA
NORTH COAST
8
6
INTERIOR PLATEAU
17
7
QUESNEL LAKES
19
P. G.
15
14
16
13
18
SOUTH COAST
1
2
3
5
SOUTHERN INTERIOR
20
4
SOUTHEAST B.C.
22
23
24
25
26
27
21
WHITEHORSE
WATSON LAKE
FORT NELSON
DEASE LAKE
PRINCE RUPERT
TERRACE
KITIMAT
SANDSPIT
MASSET
SMITHERS
HOUSTON
BURNS LAKE
FT. ST. JAMES
FT. FRASER
PRINCE GEORGE
QUESNEL
WILLIAMS LAKE
100 MILE HOUSE
HORSEFLY
VANDERHOOF
FORT ST. JOHN
DAWSON CREEK
CHETWYND
MACKENZIE
GERMANSEN
MCLEOD LAKE
NASS
TELKWA
HAZELTON
KAMLOOPS
KAMLOOPS R.S.
CLINTON
BEGBIE
PUNTZI
BLUE RIVER
MICA
VALEMOUNT
REVELSTOKE
GOLDEN
DOWNIE CR.
KNIGHT
BUTE
TOBA
POWELL RIVER
SQUAMISH
SQUAMISH R.S.
WOSS
ZEBALLOS
GOLD RIVER
MENZIES BAY
COMOX
CAMPBELL R.
BROUSE
HARRISON
HOPE
ABBOTSFORD
PRINCETON
KELOWNA
VERNON
BEAVERDELL
GRAND FORKS
SALMO
CASTLEGAR
NELSON
CRANBROOK
INVERMERE
CANAL FLATS
LARDEAU
NATAL
ELKO
TOFINO
PORT HARDY
BENSON
FRANKLIN RIVER
COOKE CHANNEL
PEMBERTON
LYTTON
HAMILTON

Fig. 2

TEMPERATURE - ELEVATION DIAGRAM

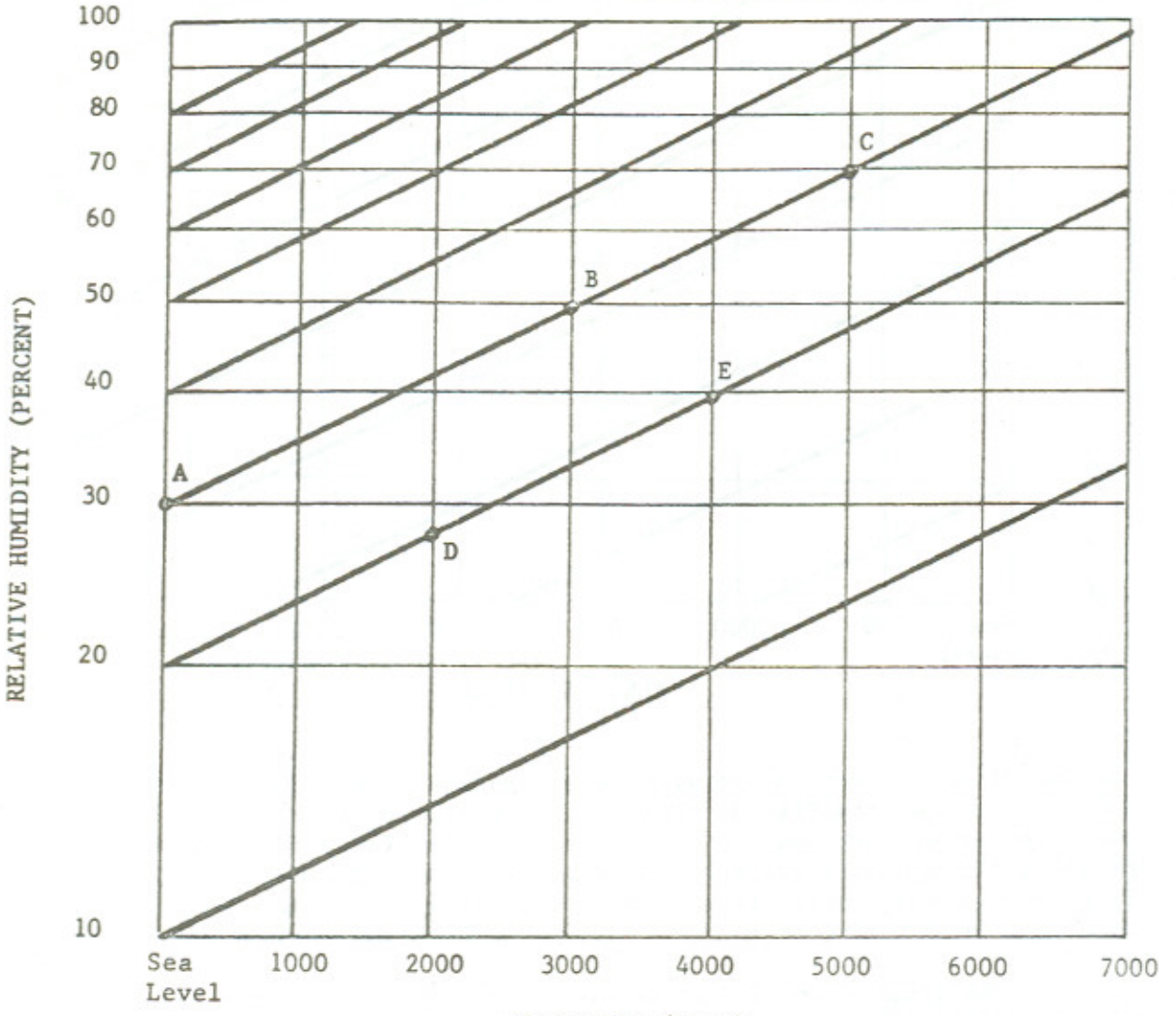



The variation in temperature with height in a well-mixed atmosphere can be obtained from Fig. 3. First, find the point given by the observed temperature and the station elevation. Next, follow the diagonal through this point to the new elevation. The horizontal line through the intersection of the diagonal and the new elevation will give an estimate of the temperature expected at the new elevation.

e.g. If the temperature at sea level is $80^{o}F$ we would expect a temperature of $58^{o}F$ at an elevation of 4000 feet.

Fig. 3

RELATIVE HUMIDITY - ELEVATION DIAGRAM




(For Surface Temp. of 85°F.)

In a well-mixed atmosphere, an estimate of the variation in relative humidity with height can be obtained from Fig. 4 by the following procedure:

Choose the diagonal passing through the known values of relative humidity and elevation and follow this diagonal to the new elevation. Read the relative humidity corresponding to this elevation from the horizontal line passing through the intersection of the diagonal and the new elevation.

e.g. R.H. is 30% at sea level (Point A). We would expect an R.H. of 50% at 3000 ft. (Point B) and a relative humidity of 70% at 5000 ft. (Point C).

e.g. The R.H. at a station which is located at 2000 ft. is reported as 28% (Point D). We would expect an R.H. of 40% at stations at an elevation of 4000 ft.

APPENDIX "B"

## Forecast Examples

### Afternoon Forecast

FPCN30 CYVR 282145
FIRE WEATHER FORECAST FOR THE SOUTH COAST FOR TUESDAY SEPTEMPBER 27, 1974
WEATHER ZONES 1 2 3 4 5 HIGH PRESSURE AREA EXPECTED TO BUILD OVER
COAST ON TUESDAY TO BRING CLEARING TONIGHT. MAINLY SUNNY TUESDAY.
WINDS NORTHWEST 20. WEDNESDAY OUTLOOK.....RAIN.

| | FCST TEMP | FCST RH | FCST WND | PROB PCPN | FFMC TDA | DMC TDA | DC TDA | ISI TDA | BUI TDA | FWI TDA | BUI TMW | FWI TMW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOFINO AP | 10 | 61 | NW15 | 30 | 57 | 3 | 31 | 0 | 5 | 0 | 6 | 1 |
| PT HARDY AP | 9 | 66 | NW10 | 40 | 54 | 1 | 44 | 1 | 3 | 0 | 3 | 0 |
| GORDON RVR | 8 | 67 | SW15 | 20 | 45 | 4 | 205 | 0 | 7 | 0 | 8 | 1 |
| MENZIES LO | 8 | 30 | NW20 | 30 | 48 | 6 | 88 | 0 | 6 | 1 | 8 | 1 |
| GOLD RVR | 9 | 57 | NW 8 | 20 | 56 | 5 | 59 | 1 | 8 | 0 | 9 | 1 |
| BENSON LO | 6 | 15 | NW15 | 10 | 54 | 4 | 121 | 1 | 10 | 2 | 11 | 1 |
| COMOX AP | 11 | 58 | NW12 | 15 | 56 | 7 | 387 | 1 | 12 | 0 | 15 | 1 |
| HOPE AP | 10 | 49 | NW20 | 20 | 58 | 16 | 382 | 1 | 30 | 1 | 30 | 5 |
| ALTA LK | 5 | 66 | NW 8 | 10 | 25 | 13 | 389 | 0 | 23 | 0 | 24 | 0 |
| TOBA CMP | 10 | 15 | W10 | 10 | 30 | 18 | 382 | 0 | 28 | 1 | 28 | 1 |

| | FFMC | DMC | DC | ISI | BUI | FWI |
|---|---|---|---|---|---|---|
| FRANKLIN RVR | 52 | 4 | 5 | 1 | 4 | 0 |
| ZEBALLOS | 41 | 6 | 10 | 1 | 6 | 0 |
| WOSS CMP | 46 | 5 | 300 | 1 | 14 | 1 |
| PT ALBERNIE | 15 | 8 | 335 | 0 | 15 | 0 |
| SOOKE COOP | 17 | 8 | 330 | 0 | 16 | 0 |
| LANGFORD | 42 | 15 | 571 | 0 | 29 | 0 |
| HARRISON LO | 41 | 13 | 352 | 0 | 16 | 1 |
| SQUAMISH CMP | 40 | 7 | 314 | 0 | 13 | 0 |
| ABBOTSFORD | 21 | 13 | 497 | 0 | 24 | 0 |
| GROUSE MTN | 32 | 8 | 322 | 0 | 15 | 1 |
| SQUAMISH RS | 34 | 3 | 194 | 0 | 7 | 0 |
| POWELL RVR | 48 | 5 | 348 | 0 | 10 | 0 |
| BUTE | 45 | 6 | 310 | 1 | 14 | 1 |
| KNIGHT | 35 | 10 | 285 | 0 | 18 | 1 |

END

Morning Forecast

FPCN33 CYVR 251345
FIRE WEATHER FORECAST FOR PRINCE GEORGE QUESNEL LAKE FOR WEDNESDAY SEPTEMBER 25 1974
WEATHER ZONES 14 15 16 18 19
SUNNY AND WARM TODAY. INCREASING SOUTHERLY WINDS TODAY REACHING SOUTHERLY 15 TONIGHT WITH FRONT. A FEW SHOWERS THIS AFTERNOON AND EVENING WITH FRONT. WINDS BECOMING NORTHWESTERLY 20 AND GUSTY TONIGHT. FIVE DAY FORECAST INDICATES COOLING TREND WILL CONTINUE WITH MORE SHOWERS BY THE WEEKEND.

| | FCST TMP | FCST RH | FCST WND | PROB PCPN |
|---|---|---|---|---|
| HUDTA CP | 16 | 55 | SW10 | 40 |
| ALEAZA | 18 | 53 | W10 | 30 |
| VALEMOUNT RS | 20 | 52 | SE 8 | 20 |
| HORSEFLY RS | 21 | 43 | S 8 | 10 |
| BLUE RVR AP | 22 | 42 | SW 7 | 20 |

END

Smoke Management Forecast

FORECAST FOR SLASH BURNING AND SMOKE CONTROL FOR THE VANCOUVER FOREST DISTRICT FOR TODAY ISSUED AT 10 A.M. Monday AUGUST 19, 1974.
HIGH PRESSURE AREA WHICH WAS OVER COAST PAST WEEKS IS RETREATING SLOWLY OFFSHORE TO PRODUCE GOOD ONSHORE FLOW OF MOIST AIR.
ZONE 4. CLOUDY. A FEW SHOWERS OR DRIZZLE THIS MORNING WITH SUNNY PERIODS THIS AFTERNOON. WINDS INCREASING TO WESTERLY 25 THIS AFTERNOON
ZONES 1 5 2 AND 3. MAINLY CLOUDY. HIGH HUMIDITIES. WINDS INCREASING TO WESTERLY 20 THIS AFTERNOON.
OUTLOOK. REPORTS INDICATE HIGH PRESSURE AREA WILL CONTINUE TO RETREAT OFFSHORE AND GIVES INCREASING PROBABILITY OF RAIN LATER THIS WEEK.

FORECAST FOR SMOKE CONTROL

LOWER MAINLAND
MIXING HT 4 THSD VENTILATION INDEX 75
2THSD WND SW10 5THSD WND W15 10 THSD WND NW25
OUTLOOK.. HIGH HUMIDITIES. UPPER WINDS WESTERLY.

SOUTHERN VANCOUVER ISLAND
MIXING HT 3 THSD VENTILATION INDEX 55
2THSD WND W7 5THSD WND NW15 10 THSD WND NW25
OUTLOOK.. WESTERLY WINDS HIGH HUMIDITIES.

NORTHERN VANCOUVER ISLAND
MIXING HT 1000 FT VENTILATION INDEX 28
2THSD WND S5 5THSD WND SW5 10THSD WND NW15
OUTLOOK.. CHANCE OF SHOWERS AFTER MIDWEEK. WEST WINDS.
FIRE WEATHER FORECAST UNIT VANCOUVER

APPENDIX "C"

## GOVERNMENT OF CANADA STATIONS RECEIVING FIRE WEATHER FORECASTS

Fire weather forecasts issued by the Fire Weather Forecast Unit may be obtained by telephone from the following Ministry of Transport and Atmospheric Environment Service offices.

| South Coast Forecast Region | Telephone |
|---|---|
| Vancouver Fire Weather Forecast Unit | 273-2370 |
| Victoria Weather Office | 656-3377 |
| Alert Bay Marine Radio Station | 974-5413 |
| Nanaimo Aeradio Station | 245-4032 |
| Tofino Marine/Aeradio Station | 725-3384 |
| Comox Marine/Aeradio Station | 339-3613 |
| Abbotsford Aeradio Station | 859-5385 |
| Port Hardy Weather Office | 949-6559 |
| Hope Weather Station | 869-5765 |
| Port Alberni Weather Station | 724-1333 |
| **North Coast Forecast Region** | |
| Sandspit Marine/Aeradio Station | 637-5311 |
| Prince Rupert Marine/Aeradio Station | 624-2053 |
| Terrace Weather Office | 635-3224 |
| **Omineca Forecast Region** | |
| Smithers Aeradio Station | 847-2035 |
| Burns Lake Weather Station | 692-7023 |
| **Interior Plateau Forecast Region** | |
| Williams Lake Aeradio Station | 989-4415 |
| **Southeastern B.C. Forecast Region** | |
| Castlegar Weather Office | 365-3131 |
| Revelstoke Weather Station | 837-4164 |
| Cranbrook Aeradio Station | 426-6312 |
| **Northwestern B.C. Forecast Region** | |
| Whitehorse Weather Office | Area Code 403,668-2203 |
| Watson Lake Aeradio Station | Area Code 403,537-2201 |
| Teslin Aeradio Station | Whitehorse Operator, 3461 |
| **East Rockies Forecast Region** | |
| Fort Nelson Weather Office | Area Code 403, 774-6461 |
| Fort St. John Weather Office | Area Code 403, 785-4304 |
| Grande Prairie Weather Station | Area Code 403, 532-2642 |

Prince George - Quesnel Lakes Forecast Region

| | |
|---|---|
| Prince George Weather Office | 963-9300 |
| Quesnel Aeradio Station | 992-6722 |
| Blue River Weather Station | 673-8315 |
| Mackenzie Weather Station | 997-6234 |

Southern Interior Forecast Region

| | |
|---|---|
| Kamloops Weather Office | 376-2160 |
| Penticton Weather Office | 492-0539 |
| Princeton Aeradio Station | 295-3913 |
| Lytton Weather Station | 455-2236 |
| Kelowna Weather Office | 765-6598 |

APPENDIX "D"

## Temperature Conversion

To convert to degrees Celsius from Fahrenheit, use the formula

$$C = 5/9 (F-32)$$

Where C, F are temperatures in Celsius and Fahrenheit respectively.

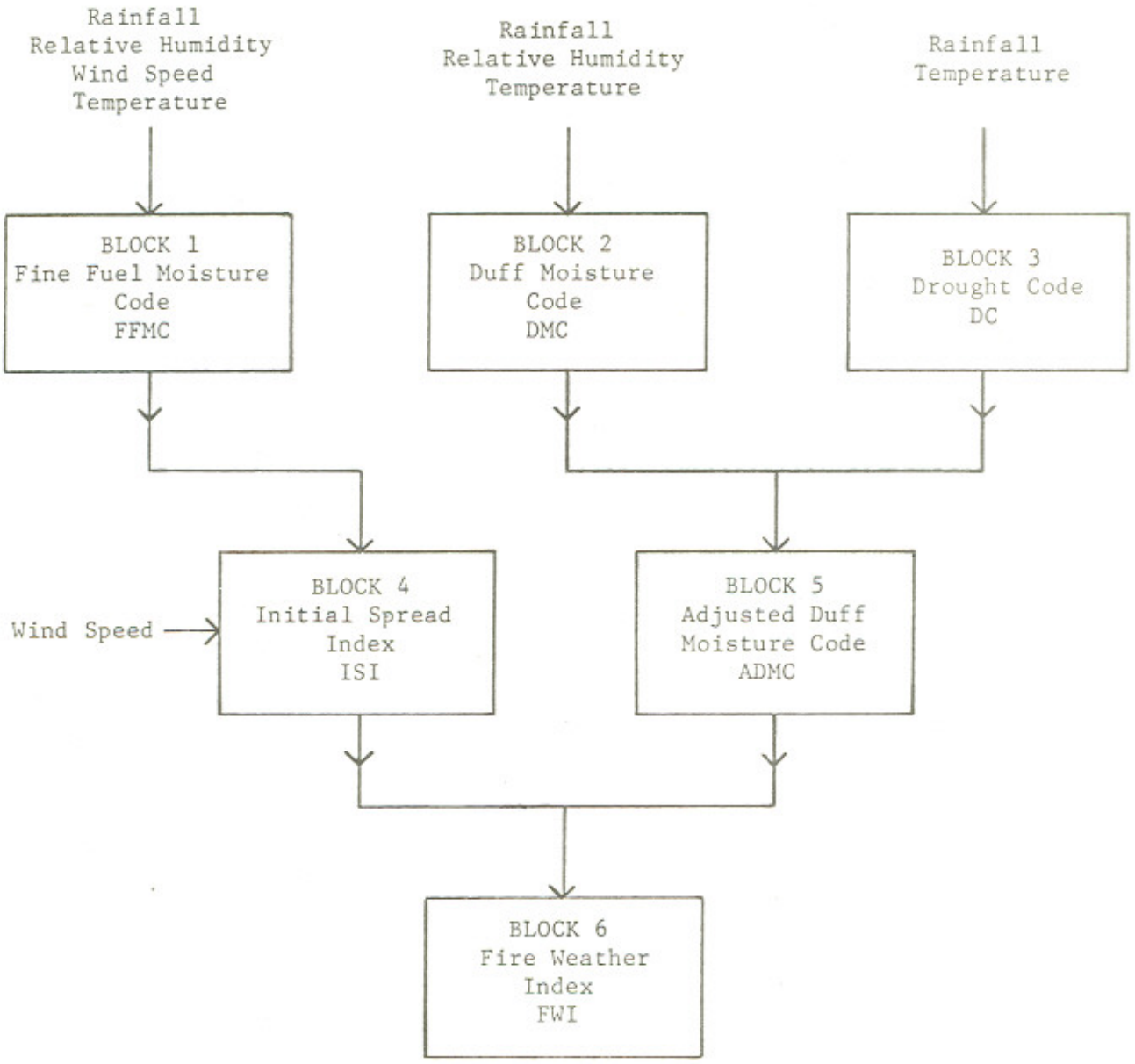
The following table may also be used:

| Fahrenheit | Celsius | Fahrenheit | Celsius |
|---|---|---|---|
| 100 | 38 | 40 | 4 |
| 95 | 35 | 35 | 2 |
| 90 | 32 | 32 | 0 |
| 85 | 29 | 30 | - 1 |
| 80 | 27 | 25 | - 4 |
| 75 | 24 | 20 | - 7 |
| 70 | 21 | 15 | - 9 |
| 65 | 18 | 10 | -12 |
| 60 | 16 | 5 | -15 |
| 55 | 13 | 0 | -18 |
| 50 | 10 | | |
| 45 | 7 | | |

## Distance and speed Conversions

1 kilometre (km) = 1000 metres (m) = 0.62miles
1 metre (m) = 100 centimetres (cm) = 3.28 feet = 1.09 yard
1 centimetre (cm) = 10 millimetres = 0.39 inches
1 millimetre (mm) = .039 inches
1 kilometer /hour (km/h) = 0.62 miles per hour = 0.54 knots

APPENDIX "E"




Block Diagram of Forest Fire Weather Index, (Anon., 1)