

ICAO CIRCULAR



SEPTEMBER 1949

CIRCULAR 10—AN/8

QUALIFICATIONS OF METEOROLOGICAL PERSONNEL

*Prepared in the Air Navigation Bureau and published by authority
of the Secretary General*

**INTERNATIONAL
CIVIL AVIATION
ORGANIZATION
MONTREAL • CANADA**

This Publication is issued in English, French and Spanish.

Published in Montreal, Canada, by the
International Civil Aviation Organization.

Correspondence concerning publications
should be addressed to the Secretary General
of ICAO, International Aviation Building,
1080 University Street, Montreal, Canada.

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In Canadian or U.S. currency (\$), to In Sterling or Irish currency (s/d), to

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Price: 10 cents (Canadian or U.S. currency) (Montreal)

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INTRODUCTION

With a view to improving the safety of international civil aviation, main and dependent meteorological offices have been established at many international aerodromes by the Contracting States. These offices furnish aeronautical weather information, including forecasts. A knowledge of existing and expected weather conditions en route, such as icing, turbulence and winds aloft, and a knowledge of expected terminal weather at the aircraft's destination, such as ceiling and visibility, is of paramount importance for the safe operation of aviation.

Weather forecasting is not an exact science at the present time. The earth's atmosphere is extremely complex in its reactions to various natural stimuli such as insolation, gravity, dynamic forces and a multitude of localized influences. As yet, the science of meteorology has not been able to measure adequately all the variables that affect the earth's atmosphere, nor has it been able to express the phenomena of the changes in the earth's atmosphere in terms of exact mathematical equations. Consequently, the forecaster must display considerable skill in using the limited, dynamical concepts available, and must supplement these by empirical devices resulting from experience. In order to improve the accuracy of aeronautical weather forecasts, thereby contributing to the safety of air transport operations, Contracting States have assigned specialized personnel to deal with the meteorological aspects of aviation. Some of these States have certain minimum standards establishing the qualifications of such meteorological personnel.

This Circular contains, in re-arranged form, extracts from correspondence concerning meteorological qualifications of forecasters, which have been forwarded to the Secretariat of ICAO. A short introductory paragraph is followed by a few statements concerning the historical background and authority for this Circular. The excerpts that have been forwarded to ICAO are reviewed in Chapter 3. Chapter 3 is divided into twenty sections, one for each Contracting State that submitted information.

Each section is divided into three categories: meteorologists, meteorological assistants, and meteorological observers. Each of these categories is further divided into five paragraphs as follows:

- 1) Requirements;
- 2) Duties;
- 3) Training before responsibility assignment;
- 4) Certificates;
- 5) Training after responsibility assignment.

The last sub-section includes, for example, flight experience, on station training and refresher courses.

Chapter 4 contains a tabulation of the excerpts included in Chapter 3. It is believed that States may profit from reviewing this document. States in process of establishing an aeronautical forecasting service may find the required qualifications reviewed herein useful as a guide in patterning their minimum standards for aeronautical forecasters. States having such a service may wish to compare their minimum requirements with those of other States as a basis for improvement and standardization.

QUALIFICATIONS OF METEOROLOGICAL PERSONNEL

1.- GENERAL CONSIDERATIONS

1.1 The profession of meteorology must be practiced by carefully trained persons if the best service is to be rendered. A high degree of accuracy in aeronautical forecasting is essential for the safe operation of aviation. Therefore, to ensure that meteorological personnel have the necessary skill and ability many governments have set up certain minimum standards of training and experience as prerequisites for aeronautical forecasters.

1.2 Minimum qualifications for meteorologists, assistant meteorologists and observers are also useful for the purposes of establishing and improving international standards.

1.3 The professional meteorologist must combine a sound scientific background with procedures learned from empirical experiences. In modern meteorology, the formal training is usually carried on at the college or university level while the empirical experience is derived from a period of practical training in a forecast centre. Before adequate formal meteorological training was readily available at the universities, meteorologists received their training by apprenticeship as observers, map plotters, map analysts and forecasters-in-training. Either method appears capable of producing competent forecasters. However, the former method is less time-consuming and apparently more efficient. States vary in their academic and practical training requirements for aeronautical meteorologists participating in international civil aviation. This Circular reviews these requirements.

1.4 The replies received from the Contracting States in response to the ICAO Questionnaire indicate that there is considerable variation in the interpretation of terms now in use. For comparison, the following definitions are quoted from the ICAO Specifications for Meteorological Services to International Air Navigation:

a) Meteorologist.- A professional member of a Meteorological Service.

b) Meteorological Service.- A state organization or agency charged with the provision of meteorological information.

c) Meteorological assistant.- A sub-professional or junior technical member of a Meteorological Service.

d) Meteorological observer.- A member of a Meteorological Service designated to make meteorological observations or a person approved by a Meteorological Service for this purpose.

e) Forecaster.- A meteorologist responsible for the provision of forecasts and other current meteorological information.

The terms "dependent forecaster" and "analyst" are not defined in the Specifications. However, the following tentative definitions may assist in interpreting this Circular.

f) Dependent forecaster.- A meteorologist under training, responsible for the provision of forecasts and other current meteorological information under the supervision of a forecaster.

g) Analyst.- A meteorologist responsible for the analysis of charts which indicate the synopsis of prevailing meteorological conditions both at the surface and aloft.

1.5 The meteorological personnel of some States are versed in languages other than their mother tongue. In answer to the questionnaire, a few States indicated that knowledge of certain foreign languages was required of their meteorologists. However, since this question was not included in the questionnaire, the information submitted is not complete and has not been reported in this Circular.

2.- HISTORICAL BACKGROUND AND AUTHORITY FOR CIRCULAR

2.1 The following is quoted from the Resolutions and Recommendations contained on Page 3 of the Final Report of the Met Division - 1st Session, 1945, (Doc 770-Met/82, 12/11/45).

"The Subcommittee on Meteorology recommends that the PICAQ Meteorological Secretariat prepare studies and submit progress reports on standards of adequacy with regard to qualifications of meteorological personnel for international aeronautics."

Note.- On page 169 of the PICAQ Final Report of the Meteorological Division, 2nd Session, 1946, (Doc 2324-Met/146, 30/11/46), "Qualifications of Meteorological Personnel" is listed as a subject for continuing study by PICAQ Met Section.

2.2 At the fourth plenary meeting of the 2nd Session of the Meteorological Division, it was suggested that Member States should be asked to provide details of the qualifications for meteorologists and meteorological observers on which recommendations could be based. Subsequently, a letter containing a questionnaire (Ref. No T 10/18, dated 3 September 1947) was prepared under the direction of the Secretary General and forwarded to Contracting States. The questionnaire requested information concerning the qualifications established for meteorologists, meteorological assistants and meteorological observers. The replies received from the Contracting States are the basis of the main part of this document. A copy of the questionnaire referred to will be found in Appendix A.

2.3 The PEL Division discussed the subject of qualifications for meteorologists at some length during both its First and Second Sessions. The findings and recommendations formulated at these division meetings will be found in the following documents: 1st Session, Doc 1207-PEL/40; 2nd Session, Doc 2667-PEL/110.

2.4 Because of incomplete answers to some of the questions it has been difficult to arrange Chapter 3 in a uniform format. However, it is believed that the form used will facilitate comparisons of the meteorological requirements of various Contracting States.

3.- QUALIFICATIONS OF METEOROLOGICAL PERSONNEL OF VARIOUS CONTRACTING STATES

3.1.- Argentina

3.1.1 Meteorologists.

3.1.1.1 Requirements. A doctor's degree in meteorology, geophysics, mathematics or physics, or some other equivalent university degree such as aeronautical engineering or civil engineering is required. The university course for which the doctor's degree is given includes specialization in general and synoptic meteorology, at the conclusion of which a competitive examination is given.

3.1.1.2 Duties. It is the responsibility of the meteorologist to prepare analyses and forecasts for immediate use and for transmission to the dependent Meteorological Offices as the basis of forecasts issued by these dependent forecast centres.

3.1.1.3 Training before responsibility assignment. After the completion of the university course, the meteorologist is given additional training prior to assignment to duty. This includes synoptic meteorological courses at the Headquarters of the Service. An independent forecaster is given a minimum of one year of experience as a dependent forecaster, and prior to an assignment as an analyst, he is given one year of practical experience under the supervision of the chief forecasters of the Main Meteorological Office or Regional Centre. During the probationary period proficiency is assessed by the Chief Forecaster.

3.1.1.4 Certificates. No certificate of competency is issued at present.

3.1.1.5. Training after responsibility assignment. After assignment to duty there is individualized instruction for personnel showing exceptional ability. Scholarships for further academic training are granted in national and foreign universities. There are no provisions for on-station refresher courses at present. However, such provisions are planned to be provided at a future date. Flight experience is required for all meteorologists. After assignment as a meteorologist, proficiency is determined by technical and individual supervision.

3.1.2 Meteorological assistants.

3.1.2.1 Requirements. A Bachelor of Arts degree with specialization in physics or mathematics is required and in addition they are required to have completed the official meteorological observer's course.

3.1.2.2 Duties. Duties include the supervision of chart work and observation, and the briefing of pilots and tabulation of climatological data. Meteorological assistants do not generally make forecasts, but, occasionally they do prepare them under detailed instruction given by the meteorologist on duty.

3.1.2.3 Training before responsibility assignment. This training includes a specialized practical course given in the Central Forecasting Office.

3.1.2.4 Certificates. No certificate is issued at present.

3.1.2.5 Training after responsibility assignment. This training includes a specialized departmental course.

3.1.3 Meteorological observers.

3.1.3.1 Requirements. A Bachelor of Arts degree or equivalent instruction and official certificate from the National Meteorological Service School for observers are required. Physical examinations are required only for those observers scheduled to be assigned in tropical, high mountainous, or antarctic regions. However, all observers must have generally good health.

3.1.3.2 Duties. Duties include the taking of surface and upper air observations, care of observational instruments, and plotting of charts.

3.1.3.3 Training before responsibility assignment. Before assignment to duty, observers are given an eight month's theoretical and practical course in the National Meteorological Service School for observers.

3.1.3.4 Certificates. Observers are given an official certificate from the National Meteorological Service School for observers.

3.1.3.5 Training after responsibility assignment. Practical experience and on-station training qualifies candidates for promotion from assistant observer to observer and later to station chief. Languages are offered as additional training courses. There is a systematic supervision of all observations made.

3.2.- Belgium

3.2.1 Meteorologists.

3.2.1.1 Requirements. A degree in physical science and mathematics or in civil engineering is required. Each meteorologist must be able to pass the same physical examination as that given to flying personnel.

3.2.1.2. Duties. The Meteorologist must prepare and issue all official forecasts for an area or for specific route.

3.2.1.3 Training before responsibility assignment. Before assignment as a meteorologist, the candidate must undergo training as a map plotter, a coder, an observer and an assistant meteorologist; and must complete the specialized theoretical course in general meteorology, aerology and climatology. A period of one year of training with an experienced meteorologist is also included. Before assignment as a surface and upper air analyst in a particular region, the candidate must acquire at least one year of experience as an independent forecaster. Written and oral tests are given for assessment of proficiency.

3.2.1.4 Certificates. No certificate of competency or formal evidence of proficiency is issued.

3.2.1.5 Training after responsibility assignment. Special courses are given by the Meteorological Department. Weekly seminars are held concerning the newer developments and techniques. Flying experience is included as part of the forecaster's training. The forecasts made by each individual are checked at regular intervals.

3.2.2 Meteorological assistants.

3.2.2.1 Requirements. A diploma in either the ancient or modern humanities is required.

3.2.2.2 Duties. Their duties include the taking of surface and upper air observations such as radiosonde and radiowind observations, plotting surface and upper air charts and thermodynamic diagrams, and the preparation of limited forecasts under the supervision of the meteorologist on duty.

3.2.2.3 Training before responsibility assignment. Before assignment to duty, the meteorological assistants are given practical training in taking observations and plotting maps and theoretical courses of study.

3.2.2.4 Certificates. No certificate is issued.

3.2.2.5 Training after responsibility assignment. After assignment to duty, more advanced courses of study are offered in physical science and meteorology.

3.2.3 Meteorological Observers. The meteorological observers of Belgium are classified as meteorological assistants and their requirements, duties and so forth are described in the preceding paragraph.

3.3.- Canada3.3.1 Meteorologists.

3.3.1.1 Requirements. A B.A., or B.Sc. degree and an M.A. with honours in mathematics, physics or chemistry. The M.A. degree must include specialization in meteorology and is usually obtained at the University of Toronto. The course includes the following subjects:

Differential equations of mathematical physics	(2 hour/week)
Thermodynamics	(1 hour/week)
Hydrodynamics and wave motion	(1 hour/week)
Statistics and climatology	(1 hour/week)
Atmospheric thermodynamics and radiation	(3 hour/week)
Dynamic meteorology	(3 hour/week)
Synoptic meteorology	(2 hour/week)
Meteorological instruments	(1 hour/week)
Practical meteorology	(9 hour/week)
Meteorological seminar	(Fortnightly)

3.3.1.2 Duties. It is the responsibility of the meteorologist to prepare all of the route and area forecasts and to issue terminal forecasts for use by other stations.

3.3.1.3 Training before responsibility assignment. Before assignment to duty, one month of intensive work is given on map analysis and forecasting procedure followed by a variable period of contact training in the field, this period being determined by experience, ability and assignment. Practical meteorological training before an assignment as an analyst, independent forecaster and dependent forecaster depends entirely on the nature and importance of the assignment. Assessment of proficiency is accomplished by the relative standing obtained in the formal course plus evaluation of work by the officer-in-charge while under direct training.

3.3.1.4 Certificates. No certificate is issued.

3.3.1.5 Training after responsibility assignment. There are no routine refresher courses for meteorologists as yet. They have been held at irregular intervals and post war plans include a mobile instruction unit and refresher courses on a routine basis. Meteorologists are required to read technical circulars issued by the Division and to submit reports on weather situations for which they receive a poor verification score.

Assessment of proficiency is accomplished by forecast verification on both accuracy and compliance with established procedures. Familiarization flights on routes for which a forecaster is responsible are encouraged but are not mandatory.

3.3.2 Meteorological assistants.

3.3.2.1 Requirements. A B.A. or B.Sc. degree is required for assistant meteorologists, with specialization in mathematics and physics.

3.3.2.2 Duties. Meteorological assistants act in the capacity of dependent forecasters, depending entirely on the nature and importance of the assignment, but they are not assigned as independent forecasters or analysts.

3.3.2.3 Training before responsibility assignment. Prior to assignment, 3½ months of lectures and laboratory work on meteorology are given, followed by a variable period of contact training in the field.

3.3.2.4 Certificates. No certificate is issued.

3.3.2.5 Training after responsibility assignment. After assignment to duty, the meteorological assistants are issued technical circulars by the Division.

3.3.3 Meteorological observers.

3.3.3.1 Requirements. Elementary School education or its equivalent is required, and a knowledge of touch typing or radio communications is considered desirable. The observers must have a physique that can stand shift work but no test for visual acuity is required.

3.3.3.2 Duties. Duties include plotting weather maps, making surface meteorological observations, pilot balloon observations, transmission of weather messages by teletype or radio, keeping weather reports, preparing weather summaries, and at aeronautical stations other than forecast centres, issuing to pilots meteorological information which has been supplied by the responsible forecast offices.

3.3.3.3 Training before responsibility assignment. At a main meteorological office, approximately six weeks of training is given in observations and map plotting.

3.3.3.4 Certificates. No certificate is issued.

3.3.3.5 Training after responsibility assignment. A barrier examination is given after three years of service.

3.4.- China

3.4.1 Meteorologists.

3.4.1.1 Requirements. A B.Sc. degree in meteorology, physics or geography and three years of practical experience in meteorological work is required.

3.4.1.2 Duties. All forecasting and related duties are the responsibility of the meteorologists.

3.4.1.3 Training before responsibility assignment. Six months of on-the-job training in analysis and forecasting is given jointly by the Central Weather Bureau and the Civil Aeronautics Administration. Before assignment as an official analyst, the meteorologist is given one year of training as a meteorological observer and two years of training as a meteorological assistant. Before assignment as an independent forecaster, the same training is given in addition to regional forecasting. To be assigned as a dependent forecaster, the meteorologist is given one year of training as a meteorological observer and one year of training as a meteorological assistant.

3.4.1.4 Certificates. No certificate is issued.

3.4.1.5 Training after responsibility assignment. After assignment to duty, no further training is provided. However, assessment of proficiency is obtained by forecast verification. Flying training or experience is not required as part of the forecaster's training.

3.4.2 Meteorological assistants.

3.4.2.1 Requirements. Meteorological assistants are required to have a B.Sc. Degree with six months of experience as a meteorological observer.

3.4.2.2 Duties. Duties consist of chart plotting, making upper air soundings, coding and assisting with meteorological briefing. Meteorological assistants do not carry out official forecasting duties.

3.4.2.3 Training before responsibility assignment. Before assignment to duty, courses on the aeronautical weather service are given.

3.4.2.4 Certificates. No certificate is issued.

3.4.2.5 Training after responsibility assignment. After assignment to duty, on-the-job training in analysis and forecasting is offered.

3.4.3 Meteorological observers.

3.4.3.1 Requirements. Meteorological observers must be High School graduates and they must pass physical tests for visual acuity and a good standard of general health.

3.4.3.2 Duties. Duties include making surface weather observations and map plotting.

3.4.3.3 Training before responsibility assignment. Before being assigned to duty, observers are given one year of training in meteorological observations and general meteorology.

3.4.3.4 Certificates. No certificate is issued.

3.4.3.5 Training after responsibility assignment. After assignment to duty, optional on-the-job training is offered in the functions of a meteorological assistant. Work is supervised and observations are checked.

3.5.- Czechoslovakia

3.5.1 Meteorologists.

3.5.1.1 Requirements. Eight half-year terms of university education and successful completion of the State examinations, or a doctor's degree is required.

3.5.1.2 Duties. All routine forecast duties are the responsibility of the meteorologist.

3.5.1.3 Training before responsibility assignment. Before assignment to duty as meteorologists, the candidates are given training in observations and practice as assistant meteorologists. Before assignment as an analyst or an independent forecaster, at least $\frac{1}{2}$ year of training is required. Prior to assignment as a dependent forecaster, at least three months of training are required.

3.5.1.4 Certificates. No certificate is issued.

3.5.1.5 Training after responsibility assignment. Refresher courses are provided for regular forecasters by occasional tests, map discussions and rotation of duties. Re-assigned forecasters are given appropriate practice in analysis and forecasting. Flying training or experience is not included as part of the forecaster's training.

3.5.2 Meteorological assistants.

3.5.2.1 Requirements. The meteorological assistants are required to complete normal basic education as well as the meteorological courses which are offered, and a period of assignment as an observer.

3.5.2.2 Duties. Duties include the supervision of the observational programme, drawing of weather maps and compiling statistics. Meteorological assistants do not carry out forecasting duties.

3.5.2.3 Training before responsibility assignment. Before assignment to duty, a course of training for meteorological assistants and a practice period in the Meteorological Head Office is given.

3.5.2.4 Certificates. No certificate is issued.

3.5.2.5 Training after responsibility assignment. After assignment to duty, additional training courses are offered.

3.5.3 Meteorological observers.

3.5.3.1 Requirements. The observers must have normal basic education and be in good physical condition.

3.5.3.2 Duties. Duties include the taking of surface and upper air observations.

3.5.3.3 Training before responsibility assignment. Before assignment to duty, observers are given observational training at the Meteorological Head Office.

3.5.3.4 Certificates. No certificate is issued.

3.5.3.5 Training after responsibility assignment. After assignment to duty, the observers receive additional courses and practice under supervision at the Head Office as well as being given training in operation and maintenance of the teleprinter. Assessment of skill is accomplished by supervision of the observational programme and correspondence with the observers.

3.6.- Denmark

3.6.1 Meteorologists.

3.6.1.1 Requirements. In Denmark academic qualifications are not mandatory for meteorologists.

3.6.1.2 Duties. It is the duty of the meteorologists to prepare all flight and area forecasts.

3.6.1.3 Training before responsibility assignment. The meteorologist of the Danish Meteorological Aeronautical Service is given a specific specialized training, normally consisting of civil meteorological courses arranged for this purpose by the Danish Meteorological Institute. The training is supplemented by participation in corresponding studies and courses arranged by other Scandinavian Meteorological Institutes. The Administration decides in each case when a meteorologist is considered competent for assignment as an analyst, independent forecaster, or dependent forecaster.

3.6.1.4 Certificates. No certificate is issued.

3.6.1.5 Training after responsibility assignment. Routine refresher courses do not exist. However, forecasters are given the opportunity of making necessary familiarization flights on the air routes for which they regularly forecast.

3.6.2 Meteorological assistants.

3.6.2.1 Requirements. Academic qualifications are not mandatory.

3.6.2.2 Duties. Duties consist of routine office service rather than forecasting and analysis. In some cases, meteorological assistants, when considered competent, assist the forecaster, but do not normally perform forecast duties.

3.6.2.3 Training before responsibility assignment. Meteorological assistants are given a specific meteorological training arranged by the Meteorological Administration of the State.

3.6.2.4 Certificates. No certificate is issued.

3.6.2.5 Training after responsibility assignment. No training of this kind is given.

3.6.3 Meteorological observers.

3.6.3.1 Requirements. No specific educational standard is required.

3.6.3.2 Duties. Duties consist of making and recording surface and upper air weather observations.

3.6.3.3 Training before responsibility assignment. Before assignment to duty, observers receive instruction and training necessary to ensure accurate observations. Such instruction and training is usually given by the staffs of the Meteorological Office of the Copenhagen Airport and of the Danish Meteorological Institute.

3.6.3.4 Certificates. No certificate is issued.

3.6.3.5 Training after responsibility assignment. The accuracy of the observations is continuously checked. However, there is no formal training programme for certified observers.

3.7.- France

3.7.1 Meteorologists.

3.7.1.1 Requirements. A Master of Science or Doctor of Science degree is required. They must have two certificates in mathematics and one in physics. Specialized studies are required in the Superior Schools and Technical Institutes and all meteorologists must pass a special competitive examination.

3.7.1.2 Duties. The meteorologists are required to perform all duties of the forecast service.

3.7.1.3 Training before responsibility assignment. Before assignment to duty, one year of training is given at the Meteorological Studies and Research Institute. Analysts, independent forecasters and dependent

forecasters receive practical operating experience and are given gradual specialization according to qualifications. Assessment of proficiency is achieved by an examination at the conclusion of the training period.

3.7.1.4 Certificates. No certificate is issued.

3.7.1.5 Training after responsibility assignment. Refresher courses are provided for regular forecasters and re-assigned to meteorologists by means of periodical technical information sheets. For a minimum period of two years, newly-assigned meteorologists receive special supervised training. The French Government has an agreement with Air France for the flight training of forecasters. Assessment of proficiency is made at regular intervals by annual reports from station chiefs.

3.7.2 Meteorological assistants.

3.7.2.1 Requirements. Meteorological assistants must pass a special competitive entrance examination. A standard at least as high as that of bachelor of elementary mathematics is required.

3.7.2.2 Duties. The assistants who hold a forecasters brevet prepare meteorological information sheets and brief the pilots. Those not holding the brevet act in the capacity of a chief of an observation station or they do work relating to aeronautical climatology. If the assistant meteorologists satisfactorily pass the final examination of the forecaster's course and are approved for these duties after a minimum probationary period of one year, they are allowed to carry out forecasting duties.

3.7.2.3 Training before responsibility assignment. A theoretical six months' training course is given followed by a practical probationary period of six months in a station network.

3.7.2.4 Certificates. No certificate is issued.

3.7.2.5 Training after responsibility assignment. After assignment to duty, refresher courses are offered which lead to a forecaster's brevet at the conclusion of a practical probationary period.

3.7.3 Meteorological observers.

3.7.3.1 Requirements. The observers are selected by competitive examination with qualification standard at least that of "Brevet élémentaire". A physical examination is also required.

3.7.3.2 Duties. The observers assume the responsibility for the observational and map plotting programme.

3.7.3.3 Training before responsibility assignment. Before assignment to duty, a six months' training course is given followed by a practical probationary period of six months on-station. Assessment of skill is made by a report from the station chief.

3.7.3.4 Certificates. No certificate is issued.

3.7.3.5 Training after responsibility assignment. After assignment to duty, the observers receive refresher courses in the schools at Tours and Montsouris. Assessment of skill is made by an annual report prepared by the station chief. The observations are checked by the superior officers and the daily reports are verified by the climatological centre. In addition to the observational training, a programme of training in communications is being considered.

3.8.- Greece

3.8.1 Meteorologists.

3.8.1.1. Requirements. A diploma in physics or mathematics from the School of Engineering or from the Military Academy is required.

3.8.1.2 Duties. The customary forecasting and analytical duties are the responsibility of the meteorologists.

3.8.1.3 Training before responsibility assignment. Special training is provided by the advanced school of the Meteorological Service.

Prior to assignment as an analyst or an independent forecaster in a new area, the candidate is given eight months of practical training. Assessment of proficiency is determined by personal evaluation.

3.8.1.4 Certificates. A certificate of competency is issued by the Director General upon completion of the meteorological courses.

3.8.1.5 Training after responsibility assignment. After assignment to duty, no further special training is provided. Flying experience is not included as part of the forecaster's training. Assessment of proficiency is determined by forecast verifications.

3.8.2 Meteorological assistants. The requirements and duties for meteorological assistants are the same as those for meteorologists, except that the forecasts are prepared under supervision.

3.8.3 Meteorological observers.

3.8.3.1 Requirements. High school education is required. It is also mandatory that observers be able to pass the examination given by the Military Hygiene Service.

3.8.3.2 Duties. Duties include the taking and recording of observations and the transmission of these observations to other stations.

3.8.3.3. Training before responsibility assignment. The observers are given four months of training at the Observer's School of the Meteorological Service. Written and practical tests concerning observations are given at the completion of the course.

3.8.3.4 Certificates. A certificate of competency is issued to the observers.

3.8.3.5 Training after responsibility assignment. The observers are given training in communications and specialized, practical, on-station training by expert observers. There are regular verifications of the observations.

3.9.- Iceland3.9.1 Meteorologists.

3.9.1.1 Requirements. At least a Bachelor of Arts degree or Bachelor of Science degree in meteorology is required.

3.9.1.2 Duties. Regional and aeronautical forecasting duties are assumed by the meteorologists.

3.9.1.3 Training before responsibility assignment. Before assignment to duty, meteorologists work as meteorological assistants and assistant forecasters under the supervision of independent forecasters until they have acquired the experience necessary for an independent forecaster. Training period is approximately one-half year after the termination of the theoretical education. Experience gained during this training period is considered adequate for a subsequent assignment as an analyst or forecaster.

3.9.1.4 Certificates. No certificate is issued.

3.9.1.5 Training after responsibility assignment. No training of this kind is provided.

3.9.2 Meteorological assistants.

3.9.2.1 Qualifications and duties for meteorological assistants have not as yet been established.

3.9.3 Meteorological observers.

3.9.3.1 Requirements. Observers are required to have completed at least middle class school, which is passed at about the age of seventeen. There are no special physical requirements except that observers must have generally good health.

3.9.3.2 Duties. Duties include the taking and recording of the weather observations.

3.9.3.3 Training before responsibility assignment. At least two months of training is given at the Meteorological Service under the supervision of forecasters and trained assistants.

3.9.3.4 Certificates. No certificate is issued.

3.9.3.5 Training after responsibility assignment. There is no routine supervision of the observers' work as yet and no additional training is offered.

3.9.4 The State Meteorological Service has only very recently taken over the service for aviation and its meteorological standards and facilities should be considered provisional at this time. The staff at Vedurstofan consists of four meteorologists who have had their theoretical training at universities in Norway, France and U.S.A. and are all independent forecasters. Six Icelandic Students are now attending courses in meteorology at the Swedish Meteorological Institute or studying meteorology at the University of Oslo, Norway. As soon as a more adequate staff is obtained the Meteorological Service intends to introduce courses for meteorological assistants, provide for meteorological training and take into consideration the assessment of proficiency of personnel. The preceding report concerning qualifications of meteorological personnel should be considered temporary and subject to revision as further experience and facilities are obtained.

3.10.- India

3.10.1 Meteorologists.

3.10.1.1 Requirements. A first class university degree with physics, mathematics, chemistry or engineering as major subjects is required. First class honours are required in the above subjects. Post collegiate studies in these subjects are considered desirable.

3.10.1.2 Duties. The meteorologists prepare the general and aeronautical forecasts required.

3.10.1.3 Training before responsibility assignment. Training is given with special reference to the weather of India and its neighbourhood, plus practical on-station training. The total training extends to about six months. Prior to an assignment as an analyst, or an independent or dependent forecaster, adequate training in the meteorological conditions peculiar to India is offered. Assessment of proficiency is achieved by written examination.

3.10.1.4 Certificates. No certificate is issued.

3.10.1.5 Training after responsibility assignment. There is no provision for refresher courses for regular meteorologists. Re-assigned forecasters work under the supervision of independent forecasters. Assessment of proficiency is achieved by regular scrutiny of forecasts by the Central Office. Flying experience is not included as part of the forecaster's training.

3.10.2 Meteorological assistants.

3.10.2.1 Requirements. A university degree in science is required, preferably with honours.

3.10.2.2 Duties. The meteorological assistants render technical aid in collating data, prepare charts and diagrams, de-brief pilots, and carry out forecasting duties after sufficient experience in a forecasting unit.

3.10.2.3 Training before responsibility assignment. A six months' training period of theoretical and applied meteorology and experience in the actual work of a forecasting unit are required.

3.10.2.4 Certificates. No certificate is issued.

3.10.2.5 Training after responsibility assignment. After assignment to duty no further formal training is offered.

3.10.3 Meteorological observers.

3.10.3.1 Requirements. A university degree is required for senior observers and matriculation for the remainder. Physical requirements are fixed for Public Service in Civil Departments of the Government of India.

3.10.3.2 Duties. The customary observational programme is the responsibility of the observers.

3.10.3.3 Training before responsibility assignment. Training includes a three months' course in observational work, plotting of charts and elementary meteorology. Assessment of skill is provided for by written tests.

3.10.3.4 Certificates. No certificate is issued.

3.10.3.5 Training after responsibility assignment. After assignment to duty, there is no further formal training. Assessment of skill is provided by scrutiny of observational data at the Central Office.

3.11.- Ireland

3.11.1 Meteorologists.

3.11.1.1 Requirements. The Irish Meteorological Service requires that its meteorologists have a recognized university degree in mechanical, electrical or civil engineering, a degree in meteorology or a degree in which physics, mathematical physics or mathematics was taken as a major subject. First or second class honours are required; if the candidate has not a degree in meteorology, he must have the requisite knowledge of mathematics and physics and the ability to participate in the courses of training.

3.11.1.2 Duties. Duties include all types of forecasting and functions related thereto.

3.11.1.3 Training before responsibility assignment. The candidate is given a two year course covering all aspects of meteorology. Approximately twelve months of on-station training is given prior to an assignment as an independent forecaster and eighteen months training is required in the study of North Atlantic and European weather situations prior to an assignment as an analyst. Assessment of proficiency is achieved by periodical tests.

3.11.1.4 Certificates. No certificate is issued.

3.11.1.5 Training after responsibility assignment. There is no provision for refresher courses or assessment of proficiency and no formal training programme is available. Flying training or experience is not required.

3.11.2 Meteorological assistants.

3.11.2.1 Requirements. Meteorological assistants must have a secondary school leaving certificate with honours in mathematics or physics.

3.11.2.2 Duties. Duties consist of observing, chart plotting and compilation of climatological records. Meteorological assistants do not carry out forecasting duties.

3.11.2.3 Training before responsibility assignment. Before assignment to duty, the candidates receive approximately four months of training.

3.11.2.4 Certificates. No certificate is issued.

3.11.2.5 Training after responsibility assignment. After assignment to duty, the assistants are given one or two months of duplicated duties.

3.11.3 Meteorological observers.

3.11.3.1 Requirements. The observers must have a secondary school education and be sufficiently physically fit to carry out observing duties.

3.11.3.2 Duties. Include the taking and recording of observations.

3.11.3.3 Training before responsibility assignment. The candidates receive two months of specialized training. Assessment of skill is accomplished by tests.

3.11.3.4 Certificates. No certificate is issued.

3.11.3.5 Training after responsibility assignment. No special training is provided after assignment to duty. Assessment of skill is accomplished by periodical tests.

3.12.- Netherlands

3.12.1 Meteorologists.

3.12.1.1 Requirements. The forecasting corps in the Meteorological Service of the Netherlands consist of three groups:

- a) Scientists who are required to complete five to six years of university training and pass "candidaat" and "doctoraal" examinations;
- b) Scientific assistants who are required to complete two to three years of university training and pass a "candidaat" examination;
- c) Technical assistants who are required to pass university entrance examinations.

3.12.1.2 Duties. Duties consist of preparation of general and specific forecasts and the carrying out of research.

3.12.1.3 Training before responsibility assignment. Prior to assignment, meteorologists are given a two years forecaster's course at the Royal Netherlands Meteorological Institute, which comprises physics and mathematics on the university level. A dependent forecaster must have two months of familiarization training in a particular region before assuming forecast duties there and at least one year of practical meteorological training before assuming the duties of an analyst. There is no method for assessment of proficiency.

3.12.1.4 Certificates. No certificate is issued.

3.12.1.5 Training after responsibility assignment. Lectures, refresher courses and studies of special subjects concerning aviation meteorology are part of the general routine. Familiarization flights are made by the forecasters. Assessment of proficiency is accomplished by forecast verification.

3.12.2 Meteorological assistants.

3.12.2.1 Requirements. The meteorological assistants (female) are required to have completed three years of High School and possess a typist licence.

3.12.2.2 Duties. Duties consist of plotting maps, operating teleprinters, editing observations and preparing documents. The meteorological assistants do not carry out forecasting duties.

3.12.2.3 Training before responsibility assignment. The candidates are given a special training course in observing, map plotting and teletyping as well as courses in general meteorology.

3.12.2.4 Certificates. No certificate is issued.

3.12.2.5 Training after responsibility assignment. There is no further formal training.

3.12.3. Meteorological observers.

3.12.3.1 Requirements. The observers are required to have completed three years of high school and pass the same physical examination as all other government personnel. Colour blindness disqualifies an observer.

3.12.3.2 Duties. Duties consist primarily of taking surface observations.

3.12.3.3. Training before responsibility assignment. A special training course in general meteorology and communications is given.

3.12.3.4 Certificates. No certificate is issued.

3.12.3.5 Training after responsibility assignment. Apart from a familiarization period of one month, there is no further training after assignment to duty. Assessment of skill is accomplished by daily control of routine work by the supervisors.

3.13.- Netherlands East Indies

3.13.1 Meteorologists.

3.13.1.1 Requirements. Meteorologists are required to have a certificate from a two years course at the University of Indonesia. Post collegiate studies are required for research associates.

3.13.1.2 Duties. Duties consist of general forecasting and research.

3.13.1.3 Training before responsibility assignment. Before assignment as an analyst or a forecaster, the candidate is given two months of practical training at an aerodrome with emphasis upon tropical meteorology. Assessment of proficiency is achieved by personal evaluation.

3.13.1.4 Certificates. A certificate of competency is issued.

3.13.1.5 Training after responsibility assignment. There is no provision for refresher courses. Flying experience is optional at present but it is planned to make it a requirement in the future. Assessment of proficiency is achieved by forecast verifications.

3.13.2 Meteorological Assistants.

3.13.2.1 Requirements. Meteorological assistants must have a certificate showing the completion of five to six years of secondary school at the "Hogere Burgerschool".

3.13.2.2 Duties. Duties consist of observing and plotting. Meteorological assistants do not make forecasts.

3.13.2.3 Training before responsibility assignment. Five months of specialized training is given to the candidates.

3.13.2.4 Certificates. A certificate of competency is issued.

3.13.2.5 Training after responsibility assignment. No further training is provided.

3.13.3 Meteorological observers.

3.13.3.1 Requirements. The observers must complete the final examinations after three years of secondary school ("Mulo"). There are no special physical requirements.

3.13.3.2 Duties. Duties consist of taking surface weather observations.

3.13.3.3 Training before responsibility assignment. Prior to assignment to duty, observers are given a special three months' course as an apprentice observer. Training in communications is also provided.

3.13.3.4 Certificates. A certificate of competency is issued.

3.13.3.5 Training after responsibility assignment. No further training is provided.

3.14- New Zealand

3.14.1 Meteorologists.

3.14.1.1 Requirements. The Dominion of New Zealand requires that its meteorologists have a minimum academic training of Bachelor of Science

or Bachelor of Arts in physics or mathematics and it is preferred that meteorologists have honours in these subjects. No post-collegiate studies are required.

3.14.1.2 Duties. The meteorologists' duties include the provision of all forecasts required.

3.14.1.3 Training before responsibility assignment. Prior to assignment, the candidate is given training and experience as an observer and then a course of training and practical experience in forecasting. Assessment of proficiency is achieved by personal evaluation. A meteorologist is assigned to a position as analyst, independent forecaster or dependent forecaster in a particular region when he has proven himself capable for such an assignment.

3.14.1.4 Certificates. No certificate is issued.

3.14.1.5 Training after responsibility assignment. There are no formal refresher courses for forecasters at the present time. Provision for refresher courses for meteorologists, who have been re-assigned to forecast duties, is varied according to circumstances. Flying training or experience is not compulsory. Assessment of proficiency is achieved by personal evaluation.

3.14.2 Meteorological assistants.

3.14.2.1 This category is not applicable since the New Zealand Meteorological Service does not employ any personnel of this capacity.

3.14.3 Meteorological observers.

3.14.3.1 Requirements. The minimum educational standard for a meteorological observer is an elementary school certificate, but preferably a high school certificate or a university entrance examination. The normal physical requirements for the New Zealand Public Service must be met.

3.14.3.2 Duties. Duties include the taking and recording of weather observations and the plotting of charts.

3.14.3.3 Training before responsibility assignment. The observer is sent to a training class at the completion of which he is given a series of examinations. Assessment of skill is provided for by written examinations.

3.14.3.4 Certificates. No certificate is issued.

3.14.3.5 Training after responsibility assignment. The observer is given a series of correspondence courses and assessment of skill is provided for by written and practical examinations for purposes of promotion to higher grades.

3.15.- Norway

3.15.1 Meteorologists.

3.15.1.1 Requirements. A Master of Science degree is required with meteorology as the major subject and mathematics, physics and mechanics as the subsidiary subjects.

3.15.1.2 Duties. Duties include the preparation of forecasts and participation in research.

3.15.1.3 Training before responsibility assignment. One year of continuous training in weather analysis and forecasting is given on-station. Prior to an assignment as an analyst or an independent forecaster, a meteorologist must have the training required for a dependent forecaster.

3.15.1.4 Certificates. No certificate is issued.

3.15.1.5 Training after responsibility assignment. Refresher courses are provided for regular forecasters by means of seminars and occasional advanced courses. Flying experience, though not obligatory, is considered desirable and it is encouraged. Re-assigned forecasters work under the supervision of independent forecasters. Assessment of proficiency is accomplished by forecast verifications.

3.15.2 Meteorological assistants.

3.15.2.1 Requirements. Meteorological assistants are required to have a high school education.

3.15.2.2 Duties. Duties consist of plotting and charting meteorological data but not forecasting.

3.15.2.3 Training before responsibility assignment. Three months of training in observations and plotting is given prior to assignment to duty.

3.15.2.4 Certificates. No certificate is issued

3.15.2.5 Training after responsibility assignment. After assignment to duty, additional training is given as necessary.

3.15.3 Meteorological observers.

3.15.3.1 Requirements. Meteorological observers must have a high school education but no physical examination is required.

3.15.3.2 Duties. At aeronautical stations, the observations are made by meteorological assistants. At all other stations, they are made by meteorological observers.

3.15.3.3 Training before responsibility assignment. Instruction is given by a meteorological inspector.

3.15.3.4 Certificates. No certificate is issued.

3.15.3.5 Training after responsibility assignment. No training of this kind is offered. Assessment of skill is achieved by checking the observations at the inspection stations.

3.16.- Portugal

3.16.1 Meteorologists.

3.16.1.1 Requirements. In the Portuguese National Meteorological Service there are three categories of technical personnel and two or more classes in each category. There are four classes of meteorologists: chief, first class, second class and third class. Appointments to each category are made following competitive examinations for the last class in the category. For promotion to the next higher class, a minimum of three years of satisfactory service is required. Meteorologists must have a Bachelor's degree of geophysical sciences. When applicable, other university diplomas may be accepted; for example, a bachelor of physics, mathematics degree or an engineering degree from a technical institute or a military or navy academy.

3.16.1.2 Duties. The duties vary for each class with the more advanced type of research and forecasting assignments allocated to the higher classes.

3.16.1.3 Training before responsibility assignment. Following the university work, candidates are given ten months of theoretical and practical training established by the Service, at the completion of which they must take a competitive entrance examination prior to appointment. Three years of satisfactory service at the Meteorological Centre at Lisbon must be completed prior to assuming the duties of an analyst.

3.16.1.4 Certificates. No certificate is issued.

3.16.1.5 Training after responsibility assignment. Periodical and special refresher courses are provided for permanent and re-assigned meteorologists. However, the service has only been in existence for one year and this programme is not too well established as yet. Flying experience or training is not a specific requirement but the Directorate of the Service has made arrangements with the airlines for free transportation of forecasters on the routes for which they provide forecasts. The meteorologists' proficiency is assessed in the results of their work, verified by the Centre Chief.

3.16.2 Meteorological assistants.

3.16.2.1 Requirements. A university degree is not required, but the candidate must have passed the entrance examination to a Science Faculty or hold a mechanical, electrical or agricultural diploma from a technical school.

3.16.2.2. Duties. His main duties consist of acting as chief of meteorological observing stations and he executes the specialized auxiliary work of the Service. The meteorological assistant does not prepare forecasts and there is no promotion from the observer category to the meteorological category.

3.16.2.3 Training before responsibility assignment. Before assuming duties the assistant is given a preparatory professional course of three months which is established by the Service. He must also pass a competitive entrance examination.

3.16.2.4 Certificates. No certificate is issued.

3.16.2.5 Training after responsibility assignment. After appointment, the assistants are attached to an observatory or meteorological centre before being assigned to a permanent post.

3.16.3 Meteorological observers.

3.16.3.1 Requirements. A general high school course is required or a diploma from a technical secondary school. No physical examination is required at present.

3.16.3.2 Duties. Duties include all of the auxiliary work of the Service such as observations, map plotting and calculations.

3.16.3.3 Training before responsibility assignment. The observer is given a preparatory professional course of three months which is established by the Service. He also must pass a competitive entrance examination.

3.16.3.4 Certificates. No certificate is issued.

3.16.3.5 Training after responsibility assignment. The observer is attached to an observatory before being assigned to a permanent post. Special provisions, established for personal valuation, are made by the Chief of the observatory or centre by verifying the results of the work of his personnel. Communications training is being considered in regard to assignments to isolated or special posts.

3.17.- Sweden

3.17.1 Meteorologists.

3.17.1.1 Requirements. A bachelor's degree in mathematics, physics or meteorology is required. Special honours or post-collegiate studies are not required. In Sweden, there are two categories for forecasters. The first category has at least passed a university examination comparable to a bachelor's degree with meteorology as an essential subject. The second category has a more concentrated education directed toward training as a forecaster throughout the entire programme. After the completion of twelve years of school, at the age of about nineteen years, pupils gifted in mathematics and physics are selected for a special course at the Swedish Meteorological and Hydrological Institute. This course takes two years, including six months of service as chart plotters and meteorological assistants and leads to an examination which, if passed, entitles the candidate to a meteorologist's certificate.

3.17.1.2 Duties. Duties include all routine forecast responsibilities and research.

3.17.1.3 Training before responsibility assignment. Before assignment as a meteorologist, the candidate receives training as an observer and a map plotter and has at least six months training as an assistant meteorologist. One year of training as a dependent analyst is given before assignment as a map analyst.

3.17.1.4 Certificates. No certificate is issued.

3.17.1.5 Training after responsibility assignment. Refresher courses are planned as part of the routine after assignment to duty as a meteorologist. Flying experience is not required but forecasters at aerodromes are allowed to make two familiarization flights every year. No special methods are used for the assessment of proficiency.

3.17.2 Meteorological assistants.

3.17.2.1 Requirements. Information not submitted.

3.17.2.2 Duties. Meteorologist Assistants assist with the observations and prepare special forms. They do not carry out official forecasting duties but, at dependent meteorological offices, they make proposed forecasts which are checked by a main meteorological office before transmission.

3.17.2.3 Training before responsibility assignment. Before assignment to duty, training in observational and chart plotting work is given.

3.17.2.4 Certificates. No certificate is issued.

3.17.2.5 Training after responsibility assignment. After assignment to duty, the assistant's work is supervised and further instruction is given by the meteorologists.

3.17.3 Meteorological observers.

3.17.3.1 Requirements. There are no special educational or physical requirements for the observers.

3.17.3.2 Duties. Duties include the taking of observations and the plotting of weather charts.

3.17.3.3 Training before responsibility assignment. Before assignment to duty, the observers are trained by a meteorologist from the Meteorological Institute.

3.17.3.4 Certificates. No certificate is issued.

3.17.3.5 Training after responsibility assignment. After assignment to duty, the observers are given a short course of one week's duration at the Meteorological Institute. The observations are checked daily by the Meteorological Office to which they are forwarded by telephone.

3.18.- South Africa

3.18.1 Meteorologists.

3.18.1.1 Requirements. A Bachelor of Science degree in mathematics or physics is required. No honours are required.

3.18.1.2 Duties. Duties include preparation of forecasts both general and specific.

3.18.1.3 Training before responsibility assignment. The candidate is given practical training under supervision at Headquarters and at forecast stations. Five years of practical training as a forecaster are prerequisite to an assignment as an analyst. Four years of practical training are required prior to an assignment as an independent forecaster. Dependent forecasters are given a minimum of one year of training.

3.18.1.4 Certificates. No certificate is issued.

3.18.1.5 Training after responsibility assignment. This training consists of on-the-job review of technical manuals. There exists a provision for rotating outstation staff through Headquarters. Assessment of proficiency is achieved by a report of the officer-in-charge of the station. At present, flying training or experience is not included as part of the forecaster's training.

3.18.2 Meteorological assistants.

3.18.2.1 Requirements. The matriculation certificate is required for meteorological assistants.

3.18.2.2 Duties. Duties consist of plotting charts, operating the teleprinter, observing and the issuing of forecasts which have been prepared by the meteorologists, but do not include the preparation of forecasts.

3.18.2.3 Training before responsibility assignment. Practical training is given under supervision at an operational station.

3.18.2.4 Certificates. No certificate is issued.

3.18.2.5 Training after responsibility assignment. There is no provision for such training at present.

3.18.3 Meteorological observers.

3.18.3.1 The information submitted indicates that the meteorological assistants carry out the observational programme. No further information is available.

3.19.- United Kingdom

3.19.1 Meteorologists.

3.19.1.1 Requirements. Members of the staff of the Meteorological Office are appointed in the first instance to the Scientific Civil Service. Forecasting Officers may belong either to the Scientific Officer class or the Experimental Officer Class of the Scientific Civil Service. For appointment as Scientific Officer in the Meteorological Office the basic qualifications required are a first or second class honours degree in mathematics or physics. Competition ensures that only the better candidates are appointed and, though not required, many have done post-graduate work. For appointment in the Experimental Officer class in the Meteorological Office, minimum qualifications equivalent to intermediate Bachelor of Science of a British University are essential with required subjects including physics and mathematics. Many officers in this class are graduates in mathematics or science.

3.19.1.2 Duties. General routine and flight forecasts and participation in research are included as duties of the meteorologists.

3.19.1.3 Training before responsibility assignment. Before taking duty as a dependent forecasting officer three months of training is given at the Training School organized by the Meteorological Office followed by three months of training on a forecasting station. In the United Kingdom, the fundamental analysis of charts is made by officers at the Central Forecasting Office broadcast to all other forecasting units for guidance. The officers responsible for this work in the Central Forecasting Office are graded as Principal Scientific Officers. To reach this grade, ten or more years of practical training in meteorology is generally required. This experience may be gained in other parts of the British Commonwealth as well as in the United Kingdom. Before promotion to an independent forecaster, some years of training as a dependent forecaster is normally required.

3.19.1.4 Certificates. No certificate is issued.

3.19.1.5 Training after responsibility assignment. After assignment to duty, no planned course of instruction is given until the officer qualifies for training as an independent forecaster. Training for duty as an independent forecaster is given by attaching the officer to a unit employing independent forecasters. He then works under instruction from the Officer-in-Charge of the unit for a minimum of two months but the period of attachment depends on the rate of progress made. No provision is made for refresher courses for regular forecasters, but all are supplied with technical memoranda, and other literature on the subject, which they are encouraged to read. Flying training or experience is not required but all Forecasting Officers are encouraged to gain flying experience. For the assessment of proficiency, annual confidential reports are made for all Forecasting Officers by a senior officer.

3.19.2 Meteorological assistants.

3.19.2.1 Requirements. The assistants must possess academic qualifications of education to matriculation standards of a British University with distinction in mathematics or a scientific subject.

3.19.2.2 Duties. Duties consist in making observations and plotting weather charts, but not in the carrying out of any forecasting assignments.

3.19.2.3 Before assignment to duty, the meteorological assistant is given six weeks of training in the Training School of the Meteorological Office, followed by six weeks of training at a forecasting unit.

3.19.2.4 Certificates. No certificate is issued.

3.19.2.5 Training after responsibility assignment. After assignment to duty, no special training is given to the meteorological assistants.

3.19.3 Meteorological observers.

3.19.3.1 The United Kingdom Meteorological Service has not a personnel category classified as meteorological observers. The meteorological observations are taken by the meteorological assistants.

3.20.- United States

3.20.1 Meteorologists.

3.20.1.1 Requirements. The requirements for eligibility for meteorologist position in the U.S. Weather Bureau do not include a positive educational requirement. Experience in the lower grade meteorological positions is the basic factor, with a provision for substitution of education for experience. Because of the recent availability of candidates having sufficient academic training, almost all of those selected at the present time qualify on the basis of education, or education and experience combined rather than by experience alone.

a) P-1 Grade (lowest grade in professional meteorologist series) - Four years of technical or scientific experience, including at least one year in the field of meteorology are required, but a bachelor's degree which includes twenty semester hours of meteorology may be substituted for the experience.

b) P-2 - In addition to the requirements for P-1, the candidate must have one year of professional experience in meteorology involving the use of the concepts and principles of physics, mathematics and meteorology as applied to the scientific and technical problems of meteorology.

c) P-3 - In addition to the requirements for P-1, the candidate must have two years of progressive professional experience in meteorology including one year of moderately difficult research, or scientific meteorological work of comparable character and importance, which was on a level not lower than the work of the P-2 grade.

d) P-4 - In addition to the requirements for P-1, a candidate must have three years of responsible, progressive professional experience in meteorology, including at least one year of difficult and important research, or scientific meteorological work of comparable character and importance, which was on a level not lower than the work of the P-3 grade. This experience must have demonstrated the applicant's initiative, resourcefulness and ability to perform or supervise very difficult and important research on practical work in meteorology.

e) P-5 - In addition to the requirements for P-1, a candidate must have four years of responsible, progressive professional experience in meteorology including one year of very difficult and important research on scientific meteorological work of comparable character and importance, which was on a level not lower than the work of the P-4 grade. The experience must have demonstrated that the applicant possesses initiative, resourcefulness, and an adequate professional knowledge of the principles of meteorology, their applications and either (1) a high degree of technical competence in the original successful solution of complex and difficult problems in meteorology or (2) ability to plan and to supervise very difficult projects in meteorology.

For any grade the required length of experience is not in itself accepted as proof of qualification for a position. The quality, type and scope of the experience must be of such a nature as to demonstrate that the applicant is fully qualified to perform the duties at the level at which he is appointed. Above grade P-5 demonstration of ability is the only additional requirement.

3.20.1.2 Duties. It is the responsibility of the meteorologist to prepare all forecasts and advisories required by aviation and general meteorology. He must participate in research, both dependently and independently.

3.20.1.3 Training before responsibility assignment. Since only well qualified meteorologists are accepted into the service, the U.S. Weather Bureau considers that no special meteorological training is necessary before assignment to duty. However, when large groups are appointed

at one time, refresher courses in map analysis and forecasting are provided in conjunction with an orientation or indoctrination course which is designed to acquaint the new employees with the Weather Bureau's policies and methods of operation. Assignments as surface and upper air senior analyst are based on evidence of ability as revealed by performance in related types of work or in lower grade analyst positions. The selection of independent and dependent forecasting is based on evidence of ability after minimum experience and training requirements for the grade have been met. Before original appointment, inquiries concerning proficiency are made of former employers and references and information are obtained concerning the applicant's standing in university meteorology courses.

3.20.1.4 Certificates. Certificates of competency are not used. The formal notification to the employee concerning the position, and grade to which he is assigned serves as evidence that the Bureau considers him to be qualified and competent to perform the duties of the position.

3.20.1.5 Training after responsibility assignment. After assignment to duty, on-the-job training is continually provided by the supervisors. This is in the form of regularly-scheduled seminars and individual discussions of specific problems. In addition, the U.S. Weather Bureau sends ten employees annually to one of the universities for advanced training in meteorology at government expense. Neither flying training nor flying experience is required of forecasters. However, many of the forecasters have both. Familiarization flights are encouraged. As of December 1946, 88 per cent of the U.S. Weather Bureau personnel had flight experience, totalling more than 265,000 hours and averaging 130 hours per person. An in-service training course on air navigation was made available to forecasters in 1942. For evaluation of forecast personnel after assignment a forecast verification plan is in use and the results are considered together with recommendations from supervisors and officials in charge, based on their intimate knowledge of the employee's skill, ability to work under occasional periods of great stress, interest in a career as a meteorologist, and other factors which indicate overall worth.

No formal refresher courses are provided for regular forecasters. Regularly-scheduled seminars and continuous on-the-job training are the only facilities provided. A meteorologist who is re-assigned to forecast duties is given on-the-job practice and training until his supervisor considers the employee ready to assume full forecasting duties.

3.20.2 Meteorological assistants.

3.20.2.1 Requirements. The academic qualifications of meteorological assistants are described in 1-(a) above under the category P-1. Meteorological assistants are in the P-1 grade and are considered to be in training for higher grade positions.

3.20.2.2 Duties. Meteorological Assistants are assigned to numerous different kinds of work, as assistants, and under the instruction and supervision of higher grade meteorologists. Sometimes they assist in the preparation of forecasts, but a higher grade meteorologist supervises their work and has full responsibility for the final product.

3.20.2.3 Training before responsibility assignment. Assistant meteorologists are required to have university training in meteorology and no further preliminary training is considered necessary prior to assignment.

3.20.2.4 Certificates. No certificate is issued.

3.20.2.5 Training after responsibility assignment. After assignment to duty assistant meteorologists are expected to participate in seminars at their station and receive on-the-job training provided by their supervisors.

3.20.3 Meteorological observers.

3.20.3.1 Requirements. Meteorological Aids, which include observers, computers, and weather data plotters, in order to qualify for the training grade, SP-4, are required to have one year of experience in the field of physical science or in technology in a laboratory, or a high school education including such subjects as mathematics and physical science. Each higher grade SP-5 through SP-8, requires one additional year of experience in making meteorological observations, compilations or plotting weather charts for each grade, in addition to the SP-4 requirements. A physical examination is required. Any physical defect which renders the applicant a hazard to himself or others, or which prevents efficient performance of the duties of the position, disqualifies him for appointment. Distant vision must be at least 20/30 (Shellen) in the better eye.

3.20.3.2 Duties. Duties include taking of observations, plotting of charts, the care of meteorological instruments and the compilation of meteorological records.

3.20.3.3. Training before responsibility assignment. Before assignment to duty, groups of inexperienced observers are given special classroom instruction in observational duties for a period of eight to ten weeks. After this they are sent to a station and remain in trainee status for about a year, during which time they receive continual instruction from the supervisor and are not given full responsibility for observations. If a new inexperienced observer is assigned to a station without the preliminary classroom instruction, its equivalent is given by the supervisor and the employee remains in a trainee status for about a year.

3.20.3.4 Certificates. No certificate is issued.

3.20.3.5 Training after responsibility assignment. After assignment to full observational duties, on-the-job training by the supervisor is continued. In addition to this, periodic visits by a Regional Inspector are made to each station at which time the Inspector gives special instruction as required. Special training programmes are organized from time to time by the Training Section, e.g. ceilometer training. No training other than that required for observational duties is provided by the Weather Bureau. Those observers who are required to operate communication facilities are transferred to the Civil Aeronautics Administration for communication training.

A variety of provisions are made for the assessment of skill. Written and practical tests in observational regulations and procedures are arranged for periodically by Regional Inspectors. Synoptic maps prepared at stations by observers are examined and rated by forecast centres. Observations are checked by designated checking stations, and error letters are sent to the observers responsible. The Supervisor at each station assesses the relative skills of his observers and imparts further training where necessary.

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4.- SUMMARY OF INFORMATION

4.1 In the previous chapter a review was made of the qualifications established for meteorological personnel by twenty different Contracting States. In this chapter these qualifications are arranged in tabular form and summarized to facilitate the rapid extraction of data for comparative purposes.

4.2 The following code is used to classify the various requirements in Table 1:

- 1) Qualifications and training are established and controlled solely by State Meteorological Service;
- 2) Doctor's Degree required;
- 3) Master's Degree required;
- 4) Bachelor's Degree required;
- 5) Some university training, but no degree required;
- 6) Secondary school education required (high school);
- 7) Elementary school education required (8 years);
- 8) No minimum educational requirement specified;
- 9) Experience can be substituted for some of the educational requirements;
- 10) Honours are required;
- 11) Courses in physics and mathematics are required;

- 12) Specialized studies, other than physics and mathematics are required;
- 13) Candidates have to pass a competitive examination;
- 14) Physical examination is required;
- 15) Visual acuity is specified;
- 16) Duties include the preparation of forecasts - independently;
- 17) Duties include the preparation of forecasts under supervision;
- 18) Duties include participation in research;
- 19) Duties include supervisory work;
- 20) Duties include pilot briefing;
- 21) Duties include tabulating climatological data;
- 22) Duties include chart plotting;
- 23) Duties include making observations;
- 24) Before assignment to duty, assessment of proficiency is accomplished by means of personal evaluation;
- 25) Before assignment to duty, assessment of proficiency is accomplished by means of checking of observation or forecast verification;
- 26) Practical training is provided before assignment to duty;
- 27) A certificate of competency or formal evidence of proficiency is issued;
- 28) After assignment to duty, assessment of proficiency is accomplished by means of personal evaluation;
- 29) After assignment to duty, assessment of proficiency is accomplished by means of checking of observations or forecast verifications;
- 30) Familiarization flights are required;

- 31) Familiarization flights are not required, but are encouraged;
- 32) Provision is made for refresher courses;
- 33) Communication training is provided;
- 34) Assignment is intended as a training position for promotion to higher professional grade.

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5.- CONCLUSIONS

5.1 Table 1 of this Circular indicates that there is a wide variation of requirements for meteorological personnel by the various Contracting States. Academic requirements for meteorologists vary from a doctor's degree to no degree at all. For an observer, the requirements vary from a Bachelor's Degree to no specified educational training. However it is clear from the information contained in this paper, that States not having established an extensive meteorological service may have difficulty in providing their personnel with satisfactory "on-the-job training" and that this training can only be carried out successfully within an area served by a highly developed aviation service. A further conclusion which may be drawn from the table is that most States seem to be in agreement that the most satisfactory entrance qualification for meteorologists is a university degree in science or mathematics followed by a further extensive period of familiarization with meteorological procedures and techniques. As an example it may be seen that twelve States out of twenty require that their meteorologist have a Bachelor's Degree and ten States out of seventeen require that their observers have a high school education. States are virtually unanimous in deciding that practical training is necessary before meteorologists assume independent technical responsibilities.

5.2 It is not the purpose of this study to propose minimum standards of requirements for meteorological personnel or to imply that the existing requirements of some States should be more stringent. However, it is believed that this Circular may be useful for reference and comparative purposes. Pending the possible establishment of minimum international standards of meteorological personnel, the information embodied in Paragraph 3 of this Circular may prove to be of value to States establishing or revising their aeronautical meteorological services.

TABLE I
COMPILATION OF DATA SUBMITTED

1. METEOROLOGISTS	REQUIREMENTS										DUTIES							PROFICIENCY				TRAINING														
	State Controlled	Doctor's degree	Master's "	Bachelor's "	Univ. Training, No Degree	High School	Elem. School	No. Min.	Exp. Sub. for educ.	Honours	Phys. and math.	Spec. stud.	Competitive exam.	Physical exam.	Visual acuity spec.	Prep. fests., indep.	" " supervised	Part. in research	Supervisory work	Pilot briefing	Tab. climat. data	Chart plotting	Making obs.	Pers. eval. bef. assign.	Veri. bef. assign.	Training bef. assign.	Cert. issued	Pers. eval. aft. assign.	Veri. aft. assign.	Famil. flts. req.	Famil. flts. encg.	Refresh. courses	Com. train.	Train. Position for prom.		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34		
Argentina	x	x									x	x		x		x	x		x				x		x											
Belgium	x			x							x	x		x		x	x		x					x		x										
Canada	x		x						x		x	x		x		x	x		x					x		x										
China	x			x							x	x		x		x	x		x						x		x									
Czechoslovakia	x			x								x	x		x		x	x		x					x		x									
Denmark	x				x							x				x	x		x						x		x									
France	x	x									x	x	x	x		x	x		x					x		x		x								
Greece	x			x							x	x		x		x	x		x					x		x										
Iceland	x			x								x				x	x		x						x		x									
India	x			x						x	x			x		x	x		x						x		x									
Ireland	x									x	x	x		x		x	x		x						x		x									
Netherlands	x		x								x	x	x	x		x	x		x						x		x									
Netherlands East Indies	x				x							x				x	x		x						x		x									
New Zealand	x			x						x	x			x		x	x		x						x		x									
Norway	x		x								x	x				x	x		x						x		x									
Portugal	x		x								x	x	x			x	x		x						x		x									
Sweden	x			x							x	x				x	x		x						x		x									
Union of South Africa	x			x								x				x	x		x						x		x									
United Kingdom				x						x	x	x	x	x		x	x		x						x		x									
United States				x					x		x	x	x	x		x	x		x						x		x									
Totals	18	2	4	12	2				1	5	16	19	6	12		20		20		20				15	2	20	2	6	9	4	8	7				

TABLE I
 COMPILATION OF DATA SUBMITTED (contd.)

	REQUIREMENTS														DUTIES						PROFICIENCY				TRAINING											
	State Controlled	Doctor's degree	Master's "	Bachelor's "	Univ. Training, No Degree	High School	Elem. School	No. Min.	Exp. Sub. for educ.	Honours	Phys. and math.	Spec. stud.	Competitive exam.	Physical exam.	Visual acuity spec.	Prep. tests., indep.	" supervised	Part. in research	Supervisory work	Pilot briefing	Tab. climat. data	Chart plotting	Making obs.	Pers. eval. bef. assign.	Veri. bef. assign.	Training bef. assign.	Cert. issued	Pers. eval. aft. assign.	Veri. aft. assign.	Famil. flts. req.	Famil. flts. encg.	Refresh. courses	Com. train.	Train. Position for prom.		
2. METEOROLOGICAL ASSISTANTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34		
Argentina	x			x							x			x				x	x	x															x	
Belgium	x				x											x					x	x													x	
Canada	x			x							x					x			x																x	
China	x			x															x			x	x												x	
Czechoslovakia	x				x							x	x						x		x		x												x	
Denmark	x				x															x	x	x	x													
France	x			x							x	x	x			x			x	x	x														x	
Greece	x			x								x	x			x				x	x						x	x							x	
Iceland		Not applicable. See Para. 3.9.2.1																																		
India	x			x										x		x			x	x	x														x	
Ireland	x					x						x	x							x	x	x													x	
Netherlands	x					x						x	x							x	x	x													x	
Netherlands East Indies	x					x							x	x							x	x														
New Zealand		Not applicable. See Para. 3.14.2.1																																		
Norway	x					x														x	x	x													x	
Portugal	x										x		x																							x
Sweden	x	Not submitted																																		
Union of South Africa	x					x															x														x	
United Kingdom											x	x	x						x			x	x													
United States				x					x		x	x	x			x			x	x	x	x													x	
Totals	16			7	2	8			1		6	3	6	11		2	5		7	6	10	11	9				17	2					12	2	7	

TABLE I
COMPILATION OF DATA SUBMITTED (contd.)

	REQUIREMENTS											DUTIES							PROFICIENCY					TRAINING													
	State Controlled	Doctor's degree	Master's "	Bachelor's "	Univ. Training, No Degree	High School	Elemen. School	No. Min.	Exp. Sub. for educ.	Honours	Phys. and math.	Spec. stud.	Competitive exam.	Physical exam.	Visual acuity spec.	Prep. fests., indep.	" " supervised	Part. in research	Supervisory work	Pilot briefing	Tab. climat. data	Chart plotting	Making obs.	Pers. eval. bef. assign.	Veri. bef. assign.	Training bef. assign.	Cert. issued	Pers. eval. aft. assign.	Veri. aft. assign.	Famil. flts. req.	Famil. flts. encg.	Refresh. courses	Com. train.	Train. Position for prom.			
3. METEOROLOGICAL OBSERVERS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34			
Argentina	x			x									x								x	x			x	x	x	x									
Belgium		Not applicable. See Para. 3.2.3.1																																			
Canada	x					x					x		x								x	x				x	x										
China	x					x							x	x	x							x	x			x	x									x	
Czechoslovakia	x					x							x	x								x	x			x	x										
Denmark	x							x														x	x														
France	x												x	x								x	x				x	x									
Greece	x																					x	x														
Iceland	x																					x	x			x	x										
India	x													x								x	x														
Ireland	x													x								x	x														
Netherlands	x												x	x								x	x				x										
Netherlands East Indies	x																					x	x														
New Zealand	x													x								x	x				x	x									
Norway	x																					x	x				x										
Portugal	x																					x	x					x									
Sweden	x																					x	x					x									
Union of South Africa		Not applicable. See Para. 3.18.3.1																																			
United Kingdom		Not applicable. See Para. 3.19.3.1																																			
United States						x					x		x	x	x							x	x			x	x										
Totals	16		1			10	4	2			1	1	5	11	2							17	17			17	3	9	11				10	7	1		

APPENDIX A1.- QUALIFICATIONS ESTABLISHED FOR METEOROLOGISTS

- 1.1 What academic qualifications are required?
 - 1.1.1 Degrees (major subject)
 - 1.1.2 Honours (if required)
 - 1.1.3 Post-graduate studies
 - 1.1.4 Other requirements

- 1.2 What special meteorological training is provided:
 - 1.2.1 Before assignment to duty?
 - 1.2.2 After assignment to duty?

- 1.3 What practical meteorological experience, both general and related to a particular region, is required before assignment as:
 - 1.3.1 Analyst (surface and upper air)?
 - 1.3.2 Independent forecaster?
 - 1.3.3 Dependent forecaster?

- 1.4 Is flying training or flying experience included as part of a forecaster's training or specified as part of his duties? If so, give details.

- 1.5 What methods are used for assessment of proficiency (forecast verification, personal evaluation, etc.):
- 1.5.1 Before assignment?
 - 1.5.2 After assignment?
- 1.6 What provision is made for refresher courses for:
- 1.6.1 Regular forecasters?
 - 1.6.2 Meteorologists who have been re-assigned to forecasting duties?
- 1.7 Are qualifications and training established and controlled solely by the State Meteorological Service?
- 1.8 Is a certificate of competency or other formal evidence of proficiency issued? If so, please enclose a sample form.

2.- QUALIFICATIONS ESTABLISHED FOR METEOROLOGICAL ASSISTANTS

- 2.1 What academic or other qualifications are required?
- 2.2 What are the main duties performed by meteorological assistants in the Aeronautical Meteorological Service?
- 2.3 What special meteorological training is provided:
- 2.3.1 Before assignment to duty?
 - 2.3.2 After assignment to duty?
- 2.4 Do meteorological assistants carry out forecasting duties? If so, what practical meteorological experience is required before assignment?

3.- QUALIFICATIONS ESTABLISHED
FOR METEOROLOGICAL OBSERVERS

3.1 What general educational standard is required?

3.1.1 What physical requirements (e.g., tests for visual acuity) are established?

3.2 What special training is provided:

3.2.1 Before assignment to duty?

3.2.2 After assignment to duty?

3.3 What provision is made for assessment of skill, e.g. by written and practical tests, checking of observation records, arrangements for supervision?

3.4 What other training, in addition to that required for observation duties, is provided (e.g., communications training)?

- END -