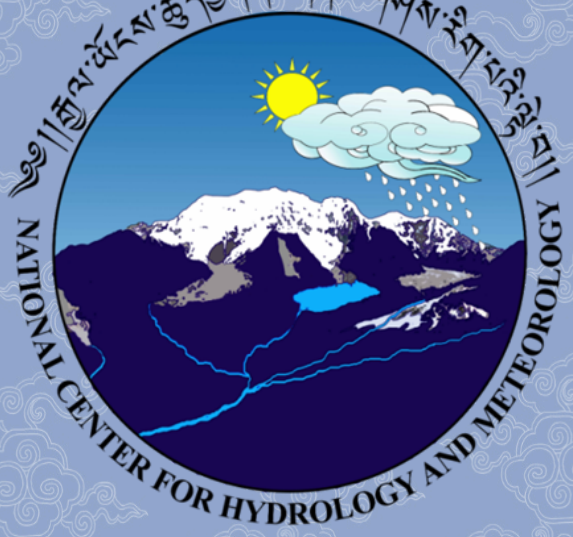


Competency-Based Framework (CBF) for Meteorology/Hydrology Technicians

2025

National Centre for Hydrology and Meteorology (NCHM)

Royal Government of Bhutan

Table of Contents

List of Figures

List of Tables

1. Background

1.1 National Center for Hydrology and Meteorology (NCHM)

The National Centre for Hydrology and Meteorology (NCHM) is the Central government agency in Bhutan for comprehending climate, weather, glaciers, and water resources. To facilitate informed decision-making about natural hazards, water resources management, and climate change adaptation in Bhutan, it was established in 2016 and provides critical data and services related to Hydro-meteorology. The National Centre for Hydrology and Meteorology (NCHM) functions as an autonomous scientific and technical agency under the Royal Government of Bhutan. Understanding the behaviour of the atmosphere, particularly its interactions with the cryosphere and water bodies, as well as researching the nation's weather, climate, and water resource distribution, are its main responsibilities.

Its primary responsibility is to comprehend the behaviors of the atmosphere, including its interaction with the cryosphere and water bodies, as well as to study the weather, climate, and distribution of water resources across the country. Recognized as the nodal agency, NCHM plays a crucial role in generating information and providing products and services related to weather, climate, cryosphere, and water resources in Bhutan. The Centre was established in January 2016, following the endorsement of the Organization Development (RCSC 2014) recommendations, approved by the Cabinet during its 92nd Lhyengye Zhungtsog (LZ) Meeting on December 11, 2015. The Center formally separated from the Ministry of Economic Affairs on February 1, 2017, and became an independent technical agency. The additional responsibility is to meet national and international standards while preserving society's safety and socioeconomic well-being. As the country's official contact point with prestigious international scientific bodies like the Intergovernmental Panel on Climate Change (IPCC) and the World Meteorological Organization (WMO), the Center is essential in promoting cooperation and knowledge sharing. The Center follows the WMO's requirements to guarantee effective service delivery. More than 70% of staff are working as technicians in the center and the Competency-Based Framework of Hydrology & Meteorology Technicians is very important for building their competency.

1.2 Vision, Missions, and Core Values of the Center

1.2.1 Vision

Centre of excellence in Hydrology, Meteorology, and Cryosphere Science and Services.

1.2.2 Mission

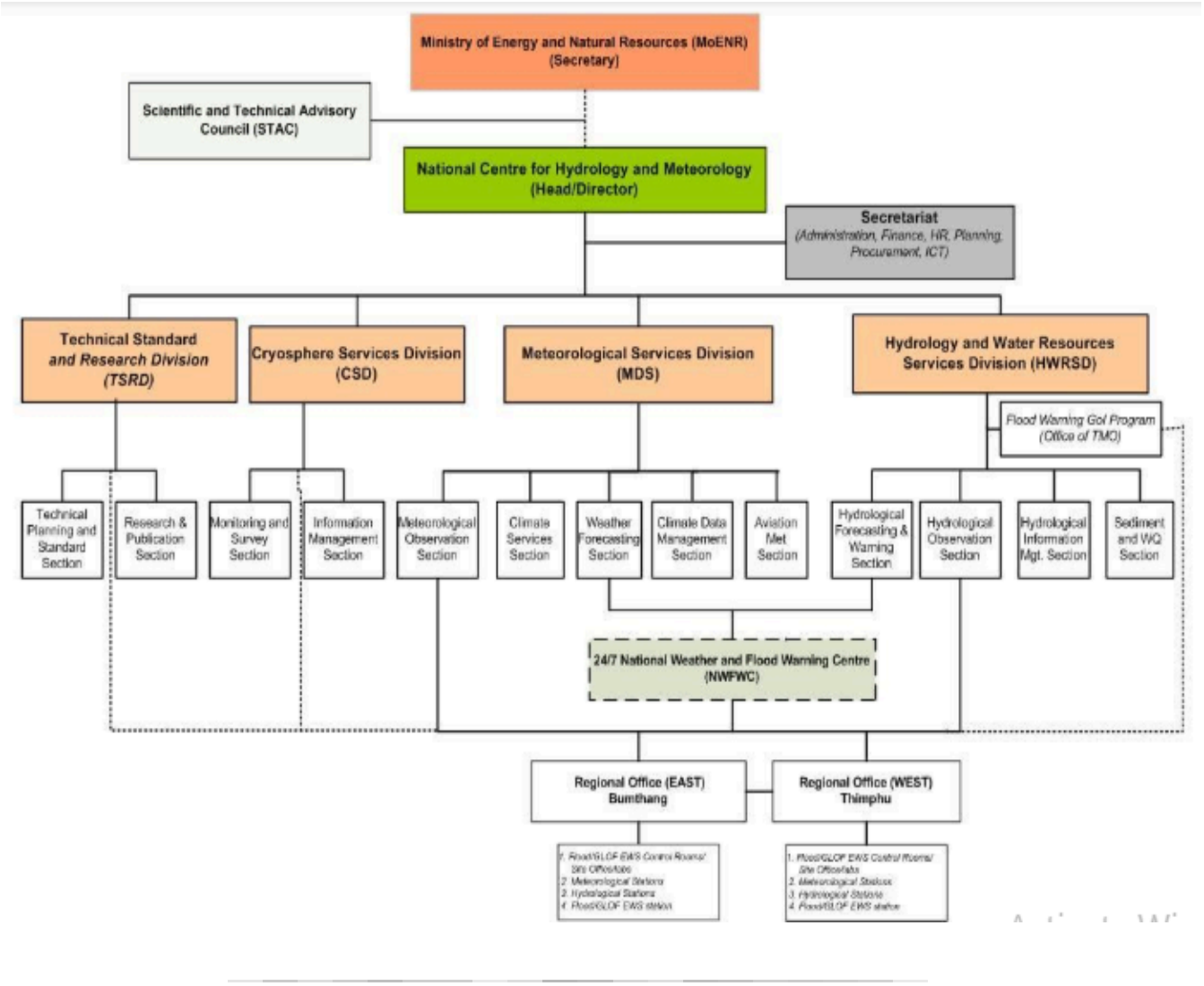
Monitoring and understanding of hydrology, weather, climate, and cryosphere, for timely provision of information and services to protect lives and property and support national needs for ecologically balanced sustainable development and provide quality, accurate, reliable, usable, location-specific, and timely services to reduce risks and to optimize benefit in the following areas:

- Create value and enhance societal benefits from hydro met resources for Sustainable development;
- Protect life, livelihood, and development infrastructure from hydro met hazards.
- Safeguard the environment
- Ensure continuity of hydro met monitoring and observations • Promote endogenous capacity building
- Meet international commitments and contribute to international cooperation 1.3.3 Core values
- Commitment and loyalty in the delivery of products and services Integrity;
- Professionalism in support of science, research, objectivity, impartiality, and excellence; ● Mutual respect, cultural sensitivity, and non-discrimination.

1.2.3 Goals

- Improve result-based decision support service for weather incidents and events that threaten lives and livelihoods;
- Enhance climate services to understand and adapt to climate-related risks;
- Develop capacity to provide integrated and coupled monitoring, detection and forecast services to support assessment and management of water resources and hydrometeorological hazards;
- Build competence to provide sector-relevant information for socio-economic development, and support the development of integrated environmental services to foster healthy communities and ecosystems;
- Sustain a highly skilled professional workforce equipped with training, tools, and infrastructure to fulfill the mission.

1.3 Organizational Structure



1.4 Mandates and Functions of NCHM

The Centre is mandated to provide scientific and technical services in hydrology, water resources, meteorology, climatology, and cryosphere to ensure the safety, and socioeconomic well-being of society and to support national and international needs.

The following are the main functions of the Center:

a. Establish and operate a National Observation network and telemetry system for weather, climate, cryosphere, hydrology, and water resources.
b. Maintain a national database (repository) of hydrology, meteorology, cryosphere, and related environmental data and information;

c. Provide Public Weather Services (PWS), climate services, agro-meteorology, climate projection, and aviation meteorological services.
d. Provide hydrological forecasting (flow and flood), and water resource assessment. Assessment and mapping of hydro-meteorological and GLOF hazards, and provide Early Warning Services;
e. Study and monitoring of snow, glaciers, and glacial lakes and assess associated risks for mitigation and adaptation;
f. Promote and research cryosphere, meteorology (weather and climate), hydrology and water resources;
g. Enhance human resources development and professional capacity in the field of hydrometeorology and cryosphere services;
h. Promote and facilitate standardisation of hydro-met instruments, methods of observation and recording;
i. Establish collaboration and linkage with national, regional, and international organisations in the cryosphere, meteorology (weather and climate), hydrology, and water resources.

1.5 Capacity development requirements at NCHM

Employees who have received proper training can only provide the finest quality services. Forecasts have become more accurate and the quality of hydro-met services has improved as a result of scientific and technological advancements. The RGoB prioritizes capacity development through education and training to keep up with evolving science and technology so that hydro-met service providers can respond appropriately to the increased demand for hydro-met information in the face of adverse hydro-met impacts on various socio-economic sectors in priority to:

a. Ensure staff undergo continuous professional development in line with the national and international standards
a. Provide basic Hydro-met Operational training for Hydro-met Technicians,
b. Ensure that NCHM has sufficient staff equipped with the necessary skills, knowledge, and competencies, which are continuously refreshed
c. Develop Competency Frameworks for the operation of hydro-met observation and instrumentation, delivery of public weather services, aviation meteorological services, flood forecasting and early warning services, and other related services;

d. Ensure that national and international standards are maintained per WMO and ICAO requirements when developing curricula through any training and competency programs;
e. Coordinate and conduct basic hydro-met operational training for monitoring, observation, and collection of data;
f. Establish training facilities in line with the current International Operating Standards, Practices, and Procedures (WMO Manual No. 1083);
g. Foster collaboration with relevant Colleges/Universities and training institutions in the fields of meteorology, hydrology, cryosphere science, etc.

NCHM must place a strong emphasis on using a comprehensive and integrated approach to professional development, and technical training to create the competencies and capabilities of NCHM staff. The knowledge and skills of the workforce that go into producing a result for the NCHM are referred to as workforce capabilities. The term "competence" describes the capacity to carry out particular duties. Enhancing the capacity of employees, the center, and society at large to function, sustain, and self-renew, solve issues, and sustainably accomplish their own goals. The training program will comprise various activities such as hands-on, on-the-job training, job exchanges or attachments, higher education programs, seminars, short courses, workshops, conferences, self-training, and do-it-yourself projects. Additionally, NCHM shall run an in-house training and staff development center for tailored, specialist courses in data observation and collection practices from time to time.

2. Competency-Based Framework for Hydro/Met Technicians/observers

2.1 Introduction

The Competency-Based Framework (CBF) outlines the knowledge, skills, and abilities (KSAs) required for Hydrology & Meteorology Technicians working at the National Center for Hydrology and Meteorology (NCHM), Bhutan. It aims to ensure all technicians possess the necessary competencies to effectively contribute to NCHM's mission of providing accurate and timely hydrological and meteorological data collection and observation services. The framework will ensure that the mobilisation and utilization of the HRD budget are in line with the organization's overall vision, goal, and mandate by guiding the capacity development of public servants at various competence levels with their job responsibilities.

The Competency-based Framework (CBF) development process is a more structured, targeted, and in-depth approach to the capacity development initiative. It will assist agencies in envisioning critical skill requirements to enhance various human resource functions, particularly the capacity of hydro-met technicians. There is no CBF for the technicians working under the NCHM, the Center has been following World Meteorological Organization (WMO) Technical regulations and guidelines and competency framework document as a guide for human resources development and ensuring standards. The developed Competency-Based Framework will enhance the capabilities and efficiency of the Hydro/Met technicians while discharging duties.

2.2 Purpose

The CBF outlines the competencies for Hydro/Met Technicians to demonstrate professional competence and provide the best possible services. Develop and implement competency-based training and assessment programs based upon the World Meteorological Organization (WMO) competency frameworks established in the Technical Regulations, Volume I (WMO-No.49).

2.3 Aim

Create a pool of Hydrology and Meteorology Technicians who are knowledgeable, skilled, and competent in providing the best possible data observation and collection services.

2.4 Objectives

- Ensure alignment of Roles and skills/competence
- Ensure that investments in HR Development are strategically focused on Time, Resources, and Quality.
- Facilitate the transfer of knowledge and experience to enable organizational compliance with WMO requirements

2.5 Structure

The Competency-Based Framework (CBF) for Hydro-met Technicians at the National Center for Hydrology and Meteorology (NCHM) is structured into six sections, described as follows:

2.5.1 Defining key roles and responsibilities

2.5.1.1 Identification of Key Role

To accomplish the present and long-term objectives of the National Center of Hydrology and Meteorology, a well-organized competency and positive attitudes of technicians are desired. The Hydro/met Technicians are supposed to fulfill the following three primary roles and responsibilities of a hydro-met technician as enumerated in ***(Table 1).***

a) Meteorology Technicians/Observer
b) Hydrology Technician/Observer

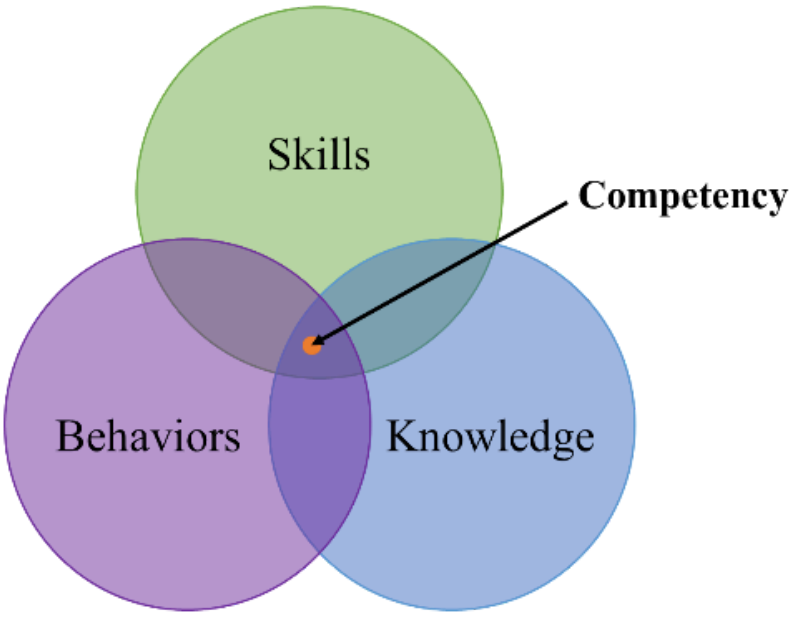
Table 1 Description of Role Profile

Sl. No	Key Roles	Description
a)	Meteorology Technicians/Observers	● Operate and maintain surface weather stations and other equipment used to collect weather data (temperature, precipitation, wind speed, direction, pressure) ● Observe and share the timely record of weather data and communicate with the weather forecaster at Headquarters ● Perform basic data analysis and quality checks at observation sites.
b)	Hydrology Technicians/Observers	● Operate, maintain, and minor troubleshoot the equipment of hydrological monitoring stations ● Observe and share the timely record of hydrological data and communicate with the control room at Headquarters ● Perform basic data quality check and analysis at the site ● Collect and analyze the sediment data

c)	Common role	• Install, maintain, and repair weather and hydrological instruments • Perform preventative maintenance, and minor troubleshooting, and ensure the equipment is functional • Calibrate hydro-met instruments to maintain accuracy and reliability of data collection.

2.5.2 Defining the Competency

Academic qualifications and competencies differ substantially from one another. Qualifications are defined as the minimal core knowledge, typically obtained through education, needed to enter a profession as per Technical Regulations, Volume I (WMO-No.49). whereas, competency is defined as the knowledge, abilities, and behaviors required to perform a job obligation ***(Figure 2).*** Throughout a person's career, they must continue receiving job-specific education and training to become competent in certain areas. The term "Competency Framework" is a general term that refers to all the information related to a competency standard or requirement, such as the background knowledge and skills, performance criteria or components, and competency description.



Defining job competencies and the corresponding requirements for education and training for employees performing tasks of hydro-met technicians is crucial. Every job responsibility must be fulfilled based on various kinds of knowledge and skills as well as personal characteristics or behaviors. The development of the CBF for hydro-met technicians is divided into three specific categories to tailor it to the Bhutanese context while ensuring compliance with international standards as depicted in ***(Figure 3).***

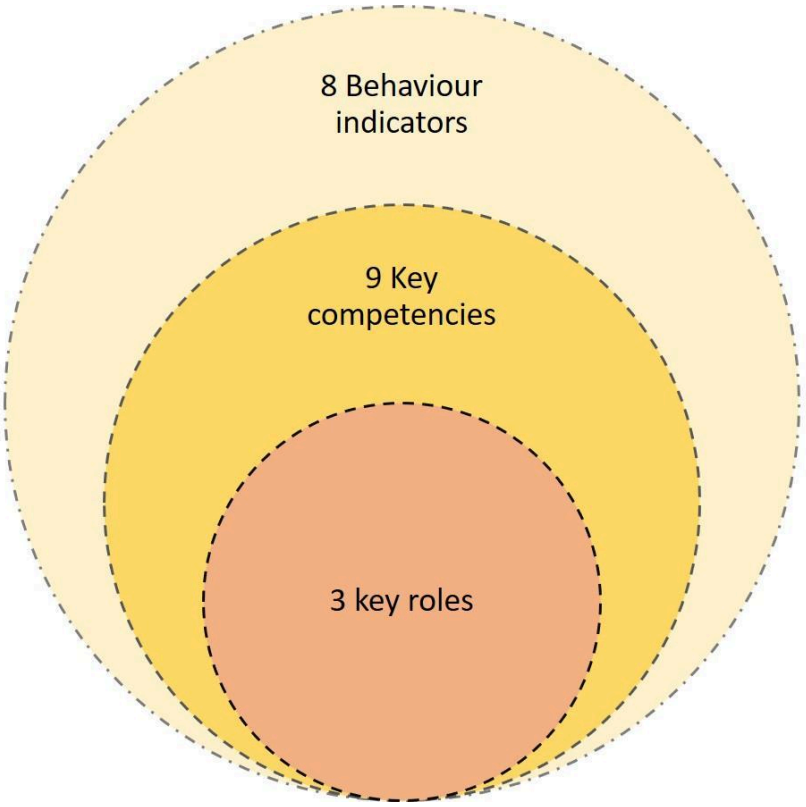


Figure 3 Structure of hydro-met technician roles, competency, and behaviour indicators

A wide range of qualified employees, including meteorologists, climatologists, hydrologists, meteorological instrument technicians, and meteorological technicians, may provide the center's hydrological and meteorological observations function. In addition, the function can be accomplished with the help of other individuals/sectors who are not directly within the NCHM, like farmers, local government, private individuals, research centers, universities, schools, and health staff in health facilities. Collaborative efforts are crucial for enhancing the center's hydro-met data collection and observation processes, as well as raising awareness to foster ownership of the anticipated impacts of hydro-meteorological extreme events.

2.5.3 Identification of Key Competencies

A key competency is an apparent behavior that indicates the presence of a specific competency. Generally, competencies are categorised into core competencies, leadership competencies, and technical or functional competencies. The framework identifies nine key competencies to work as Hydro-met Technicians of the NCHM presented in ***(Table 2).*** These competencies are essential for ensuring that individuals meet the required standards of performance and contribute effectively to organizational goals. Each competency is designed to align with both the organization's strategic objectives and the demands of the key roles identified in the section *(2.5.1)*. Developing key competencies will address gaps in skill requirements and ensure uniformity in data collection and observation methods. This approach will standardize practices across the organization, enhancing overall data quality and reliability. Additionally, it will help create a more consistent and capable workforce, better equipped to meet organizational and industry standards.

Table 2 Key Competencies

Sl. No	Key Role	Competency area	Key Competencies
a)	Meteorology Technicians/ Observers	Domain expertise	1. Monitor the meteorological situation 2. Perform a weather observation 3. Monitor and operate the performance of weather monitoring instruments and systems
b)	Hydrology Technicians/ Observers	Domain expertise	4. Monitor the hydrological situation 5. Monitor and operate the performance of hydrological monitoring instruments and systems 6. Perform measurement and observation methods
c)	Common role	Data collection, Instrumentation, maintenance, and calibration	7. Install, maintain, and repair instruments and communications systems 8. Calibrate, and check instrument performances on-site and in the Lab. 9. Maintain the quality of observational information & data

2.5.4 Description of key competency and performance

To understand each key competency outlined in ***(Table 2),*** further details are provided in the following sections. These elaborations offer in-depth insights into the specific skills and behaviors associated with each competency, facilitating clearer comprehension and application within the organizational context.

1. **Monitor the meteorological situation**

Evaluate the weather conditions to identify any current or emerging factors that may be affecting, or are expected to affect, the designated area of responsibility throughout the entire observation period. This assessment involves examining various meteorological parameters and trends to provide a comprehensive understanding of the atmospheric conditions and their potential implications.

a) Assess the evolving local meteorological situation.
b) Understand the potential influence of the evolving meteorological situation on subsequent observations
c) Identify meteorological symptoms that may lead to the onset of significant weather.

2. Perform a weather observation

Adhere to the prescribed protocols when conducting surface observations of meteorological phenomena and variables, as well as any notable alterations. This entails establishing procedures precisely to ensure accuracy and consistency in data collection, thus facilitating reliable analysis and forecasting of weather patterns.

a) Observe and accurately record

-Precipitation; Atmospheric pressure; Temperature; Humidity; Wind; Cloud; Present and past weather; Sunshine duration; Evaporation and Soil temperature

b) Archive and transmit surface observations data and information

3. Monitor and operate the performance of weather monitoring instruments and systems

Ensure the proper functioning and efficiency of weather instruments by conducting regular monitoring to verify their performance. This includes routine checks and maintenance to guarantee the accuracy and reliability of meteorological data collected, crucial for informed decision-making and forecasting activities.

a) Clean and maintain the instrument and associated parts

b) perform regular minor troubleshooting of equipment at the site

4. Monitor the hydrological situation

Analyze hydrological conditions to evaluate any evolving circumstances that are affecting or expected to affect the designated area of responsibility throughout the entire observation period. This involves assessing various hydrological parameters and trends to gain insights into the current and potential future impacts on water resources, infrastructure, and surrounding environments.

a) Assess the evolving local hydrological situation.
b) Understand the potential influence of the evolving weather and flooding situation on subsequent observations
c) Identify erratic weather events that may lead to significant flooding situations.

5. Monitor and operate the performance of hydrological monitoring instruments and systems

Monitor and manage the functionality of hydrological monitoring instruments and systems to ensure optimal performance. This entails ongoing observation and operation to maintain the accuracy and reliability of data collection, vital for effective water resource management and hazard mitigation efforts.

c) Clean and maintain the instrument and associated parts
d) Perform regular minor troubleshooting of equipment at the site

6. Perform measurement and observation methods

Methodical techniques to measure water levels and discharge of a river/stream with accuracy. The procedures involve collecting data and tracking changes in water levels and discharge rates over time using specific tools and procedures.

a) Record accurate gauge readings
b) Carry out discharge measurements as per the requirement
c) perform data quality checks, archive, and transmit the data

7. Install, maintain, and repair instruments and communications systems

Undertake the installation, repair, and minor troubleshooting of hydro-meteorological observation instruments/equipment and communication systems. This involves deploying, maintaining, and addressing technical issues to ensure the proper functioning and reliability of these critical systems, essential for accurate data collection and dissemination.

a) keep proper inventory of instruments issued
b) install the instrument and test for proper operation
c) Repair and maintain the instrument for accurate recording

8. Calibrate, and check instrument performances on-site and in the lab

Adhere to established calibration protocols when performing calibrations, ensuring precision and accuracy throughout the process. This includes meticulously following procedures for handling items, conducting calibration tests, and updating calibration certificates to maintain compliance with quality standards and regulatory requirements.

a) Execute routine calibrations on a day-to-day basis by standard calibration procedures;
b) Compute the calibration uncertainty in conformity with the SOPs;
c) Prepare a draft of the calibration certificate (not including approval or issuance);
d) Conduct intermediate checks of working standards in the calibration laboratory;

9. Maintain the quality of observational information & data

Quality management procedures established by the NCHM headquarters need to be employed to uphold the accuracy and reliability of information and data observations. These procedures encompass systematic approaches to data collection, validation, and verification, ensuring adherence to quality standards and facilitating informed decision-making processes.

a) Record timely and accurate data
b) Apply the data quality checking procedures
c) Archive and transmit correct information

2.5.5 Identification of Behavioural Indicators

The Behavior Indicator defines competencies based on different proficiency levels. It depicts a range of desirable and noticeable motives, characteristics, and actions when performing the task. It provides a guide for the evaluation of performance reviews of employees. The behaviors (attitudes) like responsibility, treating others with ethics, and dedication to excellence are crucial in delivering assigned tasks. With proficiency levels, employees will be able to identify the skills expected in a particular career path, allowing them to improve their competency in achieving the goals.

1. Demonstrates strong technical knowledge and can update with current hydro met science and technologies
2. Applies the technical expertise to fulfill job responsibilities.
3. Determines issues and provides improvements to ensure systems operate smoothly
4. Examine the observation logs to deliver effective services.

5. Ensures quality Data for efficient use
6. Demonstrates effective management of resources for achieving efficient use
7. Demonstrates the capacity to collaborate with others to complete a task and accomplish the intended outcome.
8. Exhibit outstanding interpersonal skills to complete the given task.

2.6 Knowledge and skill requirements

Successfully fulfilling any job responsibility relies on a combination of skills, knowledge, and personal attributes. Core knowledge, acquired through formal education and ongoing learning, provides the foundation for scenario analysis and skill application. Alongside specific skills and knowledge requirements for hydro-meteorological technicians, certain prerequisite qualifications are necessary. These qualifications serve as benchmarks for competency and proficiency in key areas of the role. In addition to formal education, continuous training and professional development play a crucial role in staying abreast of advancements in the field of hydro-meteorology. Practical experience gained through internships, fieldwork, or specialized training programs, further enhances competency and adaptability in diverse work environments. Moreover, possessing strong communication, problem-solving, and teamwork skills is essential for effectively collaborating with colleagues and stakeholders, as well as addressing complex challenges in the hydro-meteorological domain. The following list of skills and knowledge forms the basis for mandatory continuous training interventions aimed at enhancing the competencies of hydrometeorological technicians in Bhutan. These interventions not only ensure alignment with WMO standards but also facilitate adaptation to evolving new practices and technological advancements.

- Understanding of general meteorology, hydrology, climate, and cryosphere science including physical, dynamic, synoptic, and mesoscale hydro-meteorology, climatology, hydro-met instruments, and observational techniques;
- Identifying clouds and other meteors with the use of the International Cloud Atlas or manual guidelines
- Hydro-meteorological factors influencing the development of notable weather change leading to flood disasters
- Policies and guidelines for monitoring hydro-meteorological events including standard operating procedures (SOPs).

- On-site instrumentation and systems (including software) & handling instruments with care
- Accuracy requirements for measurements of surface observation
- Understanding in detail of hydro-meteorological instruments and methods of observation
- The basics of metrology and uncertainty computation, including knowledge of SI, measurement standards and traceability, measurement uncertainty and errors, and calculation of uncertainty using prescribed methods for proper instrument calibrations
- The basics of meteorological instrumentation, including an understanding of the working principles of common meteorological instruments and their characteristics and accuracy requirements for measurements

2.7. Implementation of Competency-Based Framework

The execution of CBF interventions like HR Capacity development must align with the compulsory programs outlined in the separate training need assessment and the manual in compliance with the ***"Capacity Development for Climate Services: Guidelines for National Meteorological and Hydrological Services (WMO-No. 1247)"***. These mandatory training interventions encompass '**Category 1-Basic Course (WMO-No.1247)**' to address behavior indicators. However, prioritization for implementation should be guided by the following criteria:

a. Annual prioritization,
b. Criticality need of the intervention area,
c. Rationalization of participant selection, and
d. Availability of resource allocation.

The initiation and oversight of implementation should be led by the relevant divisions in close collaboration with the HR section of the Center, specifically tailored for hydrology and meteorology technicians at the National Center for Hydrology and Meteorology, Bhutan.

3. Recommendations

The following recommendations are suggested to ensure the effective and efficient implementation of the Competency-Based Framework (CBF) for Hydro/Meteorological Officers:

- Periodically review and update the CBF to incorporate the evolving needs of the organization and roles of Technicians.

- Develop and implement comprehensive training programs tailored to the specific competencies outlined in the CBF. These programs should cover both theoretical knowledge and practical skills necessary for technicians to excel in their roles.
- Establish a robust system for ongoing monitoring and evaluation of technicians' performance against the competency standards outlined in the CBF. Regular assessments will help identify areas for improvement and ensure adherence to established benchmarks.
- Recommend the Government to support budget allocation for capacity-building initiatives as per CBF recommendations, leveraging support from the Government of India (GoI), and other donor agencies.
- Encourage management to endorse all capacity-building programs based on relevance, priority, frequency, and organizational needs.
- Cultivate a culture of continuous improvement within the organization by encouraging feedback, innovation, and knowledge sharing. Create mechanisms for technicians to provide input on the effectiveness of the CBF and opportunities for enhancement, thereby fostering a dynamic and adaptive learning environment

4. Conclusion

In conclusion, the National Center for Hydrology and Meteorology (NCHM) stands as a pivotal institution in Bhutan, dedicated to the comprehensive understanding and management of the nation's climate, weather, glaciers, and water resources. Established in 2016, NCHM has swiftly evolved into an autonomous scientific and technical agency, instrumental in providing critical hydro-meteorological data and services that aid in informed decision-making for natural hazard management, water resource optimization, and climate change adaptation. Through its comprehensive approach to monitoring and understanding the atmosphere, cryosphere, and water bodies, NCHM ensures the safety and socioeconomic well-being of society. With its vision of becoming a ‘Center of Excellence’, NCHM focuses on advancing hydrology, meteorology, and cryosphere sciences, while upholding its core values of integrity, professionalism, and mutual respect. The development of a Competency-Based Framework (CBF) for Hydro/Met Technicians underscores NCHM's commitment to maintaining high standards of service delivery and capacity building, aligning with international standards set by organizations like the World Meteorological Organization (WMO). Through continuous capacity development and strategic collaborations, NCHM not only safeguards Bhutan’s environment and socioeconomic well-being but also contributes significantly to global scientific communities and international cooperation.

5. References

1. Competency-Based Framework (CBF) for Hydrology Officer and Meteorology Officer 2021(https://www.nchm.gov.bt/attachment/ckfinder/userfiles/files/Hydro-Met%20Officer_CBF_Endorsed_with_cover(1).pdf)
2. Guide to Competency (WMO-No. 1205), 2018 edition (https://library.wmo.int/doc_num.php?explnum_id=4237)
3. Compendium of WMO Competency Frameworks (WMO-No. 1209), 2019 edition (https://library.wmo.int/doc_num.php?explnum_id=10075
4. Capacity Development for Climate Services: Guidelines for National Meteorological and Hydrological Services (WMO-No. 1247), 2020 edition. (https://library.wmo.int/doc_num.php?explnum_id=10272)
5. Technical Regulations Basic Documents No. 2 Volume I – General Meteorological Standards and Recommended Practices (WMO No-49), Edition 2019 updated 2021 (https://library.wmo.int/doc_num.php?explnum_id=10844)
6. Technical Regulations Basic Documents No. 2 Volume II – Meteorological Service for International Air Navigation (WMO No- 49), Edition 2019 updated 2021 (https://library.wmo.int/doc_num.php?explnum_id=10733)
7. Technical Regulations Basic Documents No. 2 Volume III – Hydrology, (WMO No-49), Edition 2006. (https://library.wmo.int/doc_num.php?explnum_id=4564)
8. Annex 3 to the Convention on International Civil Aviation (ICAO)-Meteorological Service for International Air Navigation, Seventeenth edition 2010 (https://www.icao.int/airnavigation/IMP/Documents/Annex%203%20-%2075.pdf)
9. National Centre for Hydrology and Meteorology (Organisation Structure, Mandates and Functions)(https://www.nchm.gov.bt/attachment/ckfinder/userfiles/files/Revised%20structure_mandate_functions%202022%20Final.pdf)