Protocols for the Measurement of Snow Water Equivalent with a Snow Pillow

Protocols for the Measurement of Snow Water Equivalent with a Snow Pillow

Prepared by:

Alberta Environment and Parks

2018

Web Site: http://environmentalmonitoring.alberta.ca/resources/standards-and-protocols/

Disclaimer: The use of specific product or trade names in the text does not indicate an endorsement by Alberta Environment and Parks.

Document Status: This document will be periodically updated as new field protocols are developed or in some cases, the procedures may be updated with new information and science. Each individual protocol includes the date of release to allow updated versions to be identified in the future.

Comments, questions or suggestions regarding the content of this document may be directed to:

Jon Pedlar
Environmental Monitoring and Science Division
Alberta Environment and Parks
Deerfoot Square Building, Main Floor
2938 – 11 Street NE
Calgary, Alberta T2E 7L7
Phone: (403) 369-0050
Email: Jon.Pedlar@gov.ab.ca

Additional copies of this document may be obtained by contacting:

Information Centre
Alberta Environment and Parks
Main Floor, Oxbridge Place
9820 – 106 Street
Edmonton, Alberta T5K 2J6
Phone: (780) 427-2700
Fax: (780) 422-4086
Email: env.infocent@gov.ab.ca

TABLE OF CONTENTS

PAGES

LIST OF FIGURES

1.0 INTRODUCTION

The purpose of this document is to provide information regarding the methodology and technology to be used to measure snow water equivalent using a snow pillow. The goal is to ensure that data collected is accurate and consistent from station to station as well as conforming to World Meteorological Organization (WMO) standards as much as is possible (World Meteorological Organization 2012).

The nature and location of Alberta Environment and Parks (AEP) weather stations mean that strict adherence to WMO standards is not always possible. In these cases, discrepancies should be noted and technicians will have to make decisions on how to best address any issues.

No official formal standard operating procedure (SOP) for the measurement of snow water equivalent using a snow pillow has been written by the Government of Alberta. Most knowledge has been passed on through demonstration, collaboration, and mentorship.

2.0 MEASUREMENT OF SNOW WATER EQUIVALENT USING A SNOW PILLOW

2.1 Definition

Snow water equivalent (SWE) is the amount of water contained in the snow pack. It can be thought of as the depth of water that would result if the snow pack was instantly melted.

A snow pillow is a large flexible bladder filled with an antifreeze solution (Figure 1). This bladder is connected to a standpipe (Figure 2), the level of which changes as snow accumulates on the pillow and displaces the antifreeze inside. The level of the standpipe is monitored using a float on a wire connected to a shaft encoder. The instrument shelter also contains other electronics: a Data Collection Platform (DCP), 12-volt wet cell batteries for powering the electronic equipment, and regulators for the externally mounted solar panel for recharging the batteries. The DCP includes a transmitter to send the recorded data by satellite. The level can also be measured by a pressure transducer connected inline instead of a standpipe.

Figure 1. Sample Photo of a Completed Snow Pillow Installation: (A) Snow Pillow Covered by Prison Grade Chain Link (B) Shut-Off Valve (C) Two-Way Ball Valve。

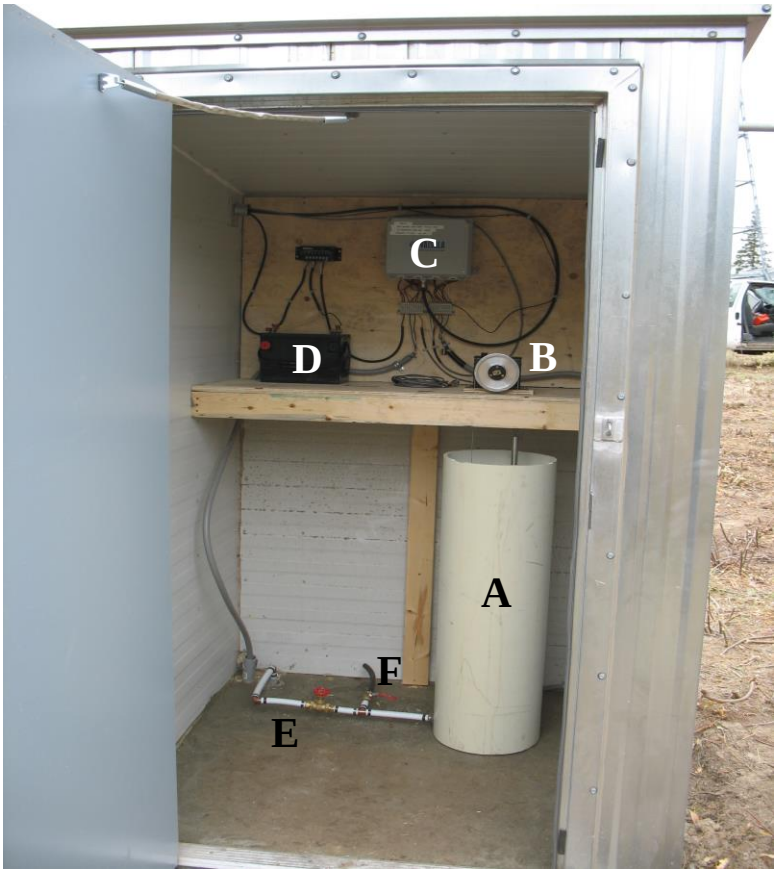

Figure 2. Inside of Instrument Shelter for Snow Pillow: (A) Standpipe (B) Shaft Encoder (C) Data Collection Platform (D) 12-Volt Wet Cell Batteries (E) Main Line Connected to Snow Pillow (F) Sampling Valve for Specific Gravity.

2.2 Units

The basic unit of measurement for SWE is millimeters (mm). It is a measurement of depth.

2.3 Sensor Specifications

A snow pillow can accurately measure SWE by either measuring the changes in the head of the stilling well or changes in pressure in the line coming from the pillow.

To measure changes in the stilling well a digital shaft encoder is used. The encoder is attached to a pulley and float which move as the head in the well changes. The encoder measures the changes in movement and sends these values to the DCP. It is important to ensure that the slope programmed into the encoder matches with the diameter of the pulley used to give the correct output units.

2.4 Site Selection

The site should be selected with the goal of it being a representative location of the surrounding area. Care should be taken to avoid areas affected by wind scouring or snow drifting. The pillow should be located such that the pillow will be on level ground but the general area is well drained to prevent water from collecting on the pillow during melt. Ideally, the pillow should be protected from wind and located far enough from larger objects such as trees and buildings to prevent them from having a significant influence on the measurement where the pillow is situated.

It is important to remember that the stilling well or pressure transducer will need to be located down grade from the pillow. This is necessary so that the sensor location has a positive head when there is no load on the pillow.

2.5 Installation

The pillow should be installed such that it is level with the surrounding terrain (Figure 1). This usually means excavating the area the pillow will occupy, which is typically 0.5 – 1 foot (depth) by 10 feet (diameter). Before laying the pillow in the excavated area, it should be filled with sand or similar material to ensure that the pillow will lay flat and nothing sharp will be protruding into it. A geotextile fabric could also be used between the ground and the pillow for protection.

The pillow will need to be plumbed to a shelter where the measuring sensor will be housed (Figure 2). The line should be buried and must run slightly down grade from the pillow such that the stilling well will have a positive head. A second line will need to be taken from the main line inside the shelter. This line should be open ended and made of flexible clear tubing. It will be used to take manual readings on a staff gauge and will be used to verify the sensor readings.

The pillow will need to be filled with an antifreeze solution. Previous pillows have been filled with an approximate 1:1 methanol-to-water ratio, which gives a freezing point of around - 50 °C. It is important that a sample of the solution is taken from the filled pillow and the specific gravity (acceptable range: 0.92 – 0.96 g/cm^3) of the solution is measured. This value is used to correct the raw SWE value as the antifreeze solution will have a lower specific gravity than water. Transmission fluid (2 L) is poured directly on top of the content inside the standpipe, and it is used as a protective layer at the top of the stilling well and manometer tube to prevent the antifreeze solution from evaporating.

A suitable amount of antifreeze will need to be brought in to fill the pillow. This volume should be determined ahead of time by calculating the volume of the pillow and how full the pillow will need to be. It is generally around six to seven 55 gallon drums. Once the pillow is filled, it is critical to get all of the air out of the pillow and the lines using a vacuum pump (see Section 2.7).

The pillow should not have any gaps around the edge. These should be filled with sand or other suitable material. The pillow will need to be protected from animals (Figure 1) as they can sometimes be attracted to the antifreeze solutions inside. A combination of roofing paper, thin aluminium, and prison grade chain link (standard netting size of approx. 2 inches by 2 inches) can be used to cover the pillow without interfering with its operation.

2.6 Data Logging

Data will be logged once per hour on the last minute of the hour.

2.7 Field Checks and Calibrations

Appropriately deployed snow pillows will often last for 20 to 25 years. They are only replaced if punctured or damaged. Snow pillows can be checked by comparing the manometer reading to the sensor readings throughout the winter. This only assures that the sensor is accurately reading the head of the snow pillow, but not that the snow pillow is measuring accurately.

Measurements can carefully be made by the snow tube from the top of the pillow and these measurements can be compared to the actual snow pillow reading. It is important that the technician tries to avoid stepping on or damaging the pillow with the snow tube.

The “no snow” or “zero” value should be recorded every year before the winter. A second “no snow” value should be recorded when the pillow is clear of snow in the spring. A sample of the snow pillow antifreeze solution should be taken once every three years. The specific gravity of the sample should then be measured and the results recorded and sent into data management.

The snow pillow should be checked annually for gases collecting in the pillow, due to gases coming out of solution from the antifreeze. Gas collecting in the pillow will lead to less accurate readings often beyond acceptable tolerance. This is particularly a potential problem in newly installed pillows. Newly installed pillows

should be vacuumed from the valve located at the centre of the pillow using a pump. This procedure should be repeated each of the next three years. After this period the technician will be observing the pillow, looking for any performance concerns that indicate that further gas evacuation is warranted.

Equipment required to vacuum a pillow are: vacuum pump, power source (generator) for the pump, 3/4 inch of polyvinyl chloride (PVC) tube line to connect the pump to the pillow, breakaway or two-way ball valve installed between the pillow and the line to the pump. A ladder or something similar should be used to bridge the pillow and ensure that no extra weight is on the pillow when hooking up and vacuuming the air.

To vacuum the pillow, open the pillow nozzle and connect the valve while it is in the closed position. Then elevate the valve by tying a rope or strap around the valve and pull gently upwards, making it the highest point on the pillow and tie the rope to the ladder. Then go around the outside of the pillow tapping the edges and low spots to free up any entrained gases so they move to area around the valve. The vacuum pump can now be connected to the valve attached to the pillow nozzle. Once connected, open the two way valve and run the pump until all of the gas is evacuated and the pump starts to draw fluid. Close the valve at the pillow then turn off the pump, disconnect the system from the pillow and close the nozzle on the pillow.

3.0 ACKNOWLEDGEMENTS

The preparation of this document was made possible through the cooperation and efforts of Alberta Environment and Parks Environmental Monitoring and Science Division staff and the Meteorological Working Group.

4.0 REFERENCES

- World Meteorological Organization (2012). *Guide to Meteorological Instruments and Methods of Observation (2008 Edition, Updated in 2010).* Available at: https://library.wmo.int/pmb_ged/wmo_8_en-2012.pdf (Accessed: 8 June 2018)