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EXPERIENCE WITH NUCLEONIC SNOW GAUGE

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ABSTRACT

Nucleonic Snow Gauge has been used for the first time in India for measurement of water equivalent of snow cover at a snow course in BEAS Basin. The gauge consists of CS-137 sources, NaI(Tl) detectors and gamma ray counting instruments. The gauge has an RS-232 interface for data transmission to Central Station via Vhf link and remote control facility. The paper discusses experimental setup of Nucleonic Snow Gauge and presents formula for computation of water equivalent from gamma ray counts. Paper also discusses integration of Nucleonic Snow Gauge with Automatic Weather Stations as a water equivalent sensor. A comparison of Nucleonic Snow Gauge data with limited manual measurements has been made.

INTRODUCTION

Attempts have been made in may countries since 1950 to determine the water equivalent of snow cover by measuring attenuation of intensity of gamma radiation. Earlier attempts have been restricted to performance evaluation of prototypes of nucleonic Snow Gauges. On satisfactory performance many countries established networks of nucleonic Snow Gauges. Tele-transmission of data was also done through satellite communication or Vhf communication with radio repeaters. Earlier gauges utilised Geiger - Muller counter which is not very accurate. Scintilator detector with photomultiplier tube replaced Geiger - Muller counter because of its better sensitivity.

Snow and Avalanche Study Establishment, is working on collection of Snow and Meteorological data from inaccessible high altitude snow bound areas. Automatic Weather Stations has been employed for collection of data. But AWS available commercially have only conventional meteorological sensors. Attempts have been made to develop suitable snow sensors for incorporating in the AWS. Nucleonic Snow Gauge, Snow Pillow and Electrically heated tipping bucket rain gauge have been tested for measurement of water equivalent of snow cover. Heated tipping rain gauges consume lot of power as such these are unsuitable for use at remote locations. In remote stations both Nucleonic Snow Gauge and Snow Pillows are being used for measurement of water equivalent of snow cover.

In this paper our observation regarding suitability of Nucleonic Snow Gauge for measurement of water equivalent of snow cover are presented.

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EXPERIMENTAL STUDIES

Scintillation Detectors (NaI(Tl))and instrumentation for counting γ-rays was procured from M/S Nucleonics Aps, DENMARK. The instrumentation has got a small processor which computes average, max, min of 10 readings and prints out on a DC printer. Two radioactive CS-137 sources each of 45 mci strength were procured from Bhabha Atomic Research Centre, Bombay.

Water equivalent of Snow Cover is measured by determining the attenuation of gamma rays in passing through the snow cover. The CS-137 sources in lead collimator are placed in a concrete block flushed with ground. The gamma rays are allowed to pass only in the upward vertical direction. The NaI(Tl) probes are mounted on a rigid stand one meter above the maximum snow height expected, and is accurately positioned in the centre of collimated beam of γ - rays.

Out of two probes, one acts as a reference probe to account for decay of the source. The reference probe is kept under a tin shed and remains free of snow. The other probe is kept in open and measures attenuation of gamma rays caused by the snow cover. The instrumentation which counts numbers of gamma rays incident on both the probes is kept 100 meters away inside a shelter. The instrumentation operates on 12 VDC. The gauge can be operated mannually or through remote control. The instrument counts number of gamma rays for 10 intervals of 1 min each. It selects maximum, minimum of 10 values and computes average of remaining 8 values and prints out maximum, minimum, average alongwith actual values. In remote mode only average count rate is transmitted to control station. The gauge is shown schematically in Fig.1.

The gauge was installed at a Snow Course in BEAS Basin in 1984. The gauge did not function in 1984-85 winter because the gauge instrumentation developed some defect. The instrumentation was repaired in 1985 summer and the gauge operated satisfactorily in 1985-86 winter.

The equation governing the attenuation of gamma radiation in passing through any material is given as :-

$$I = I_o \, e^{-\mu x} \qquad \text{---- (1)}$$

where

I = Transmitted radiation intensity.

I_o = Incident radiation intensity.

μ = Absorption Coefficient for the material.

x = Thickness of the material.

The gauge was calibrated by measuring attenuation of gamma radiation in passing through water. Since the attenuation of gamma rays is independent of phase of material the absorption coefficient for water (μ=0.04603 Cm^{-1}) obtained by calibration was used for calculation of water equivalent of snow cover. A sample calculation is shown below:-

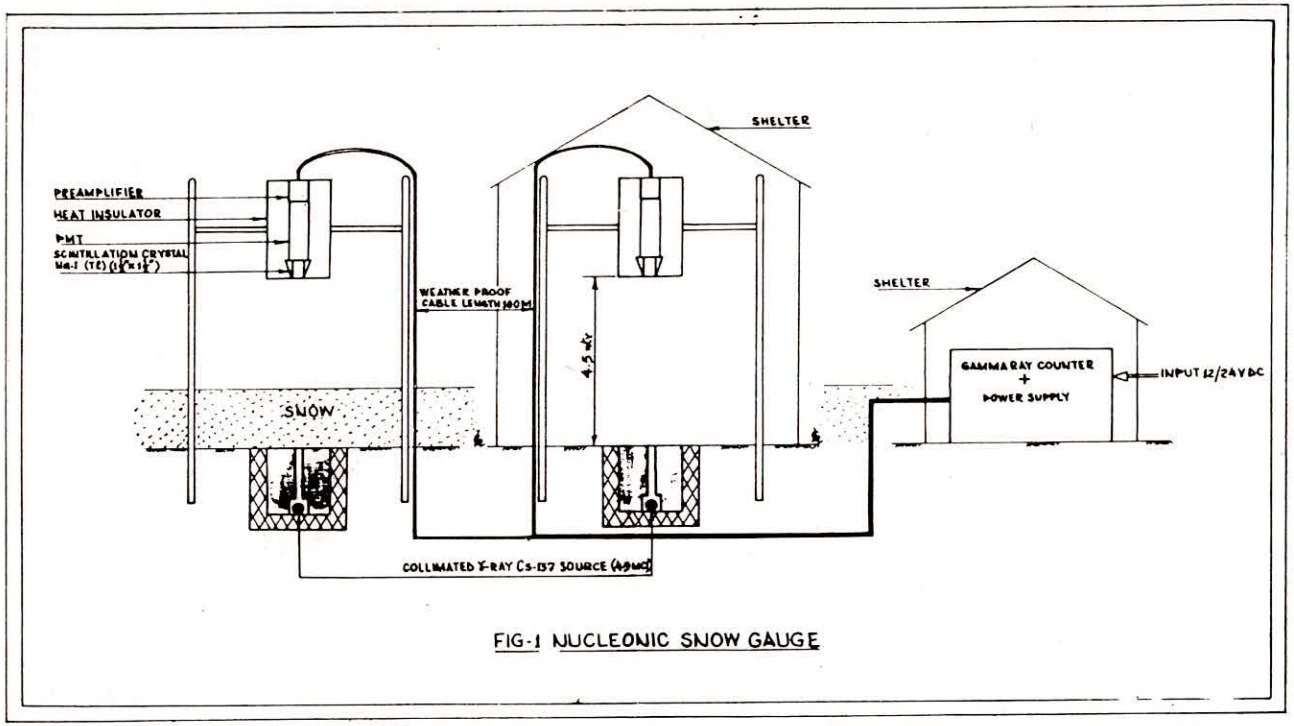

FIG-1 NUCLEONIC SNOW GAUGE

Date 22 Jan 87

I_o = Counts without Snow = 96488 CPM

I = Counts with snow = 23831 CPM

μ = 0.04603 Cm^{-1} for H_2O

From eqn (1) $X = \frac{1}{\mu} \log \frac{I_o}{I}$

$$= \frac{1}{0.04603} \log \frac{96488}{23841} = 30.38 \text{ cm}$$

Mannual measurement of water equivalent was also made in the snow course at the same time for checking the accuracy of nucleonic snow gauge. The results of nucleonic snow gauge and manual measurement are plotted in Fig.2. From limited data it is found that NSG value differ by 5 - 10% from manual values. The experiments are being continued and after analysis of 1987-88 winter data conclusion can be made regarding accuracy of the nucleonic snow gauge. It have been observed abroad (1) that water equivalent of snow cover can be measured by nucleonic snow gauge with 2-5% accuracy. The 5% accuracy is good enough for hydrological studies.

INTEGRATION WITH DATA ACQUISITION SYSTEM (AWS/DCP)

The gauge has been designed for both manual and remote operation. In remote mode the gauge can be switched on by sending a radio signal (12 V pulse for 10 to 30 sec duration) and it switches off automatically after taking reading and transmitting the result to Central Station. The gauge consumes 36 watt on 12 VDC. Because of its high power consumption gauge is read only once in a day while other sensors are read 3 hourly. The gauge can be integrated with existing data acquisition system in order to receive the data at the Central Station alongwith rest of snow-met data. The existing system is based on a RCA C-MOS Microprocessor CDP - 1802 and has facility to accept output from 16 analog and 4 digital sensors. The nucleonic snow gauge output is fed to a analog channel of AWS. The AWS are generally supplied with few free channels for incorporation of additional sensors. We do not forsee any difficulty in incorporating the gauge with DCP's.

CONCLUSION

Thus the nucleonic snow gauge can be used as water equivalent sensor with Automatic Weather Station or DCP. Further studies are being planned to ascertain its accuracy and compare its performance with water equivalent sensors eg snow pillow pillow, precipitation gauge.

BIBLIOGRAPHY

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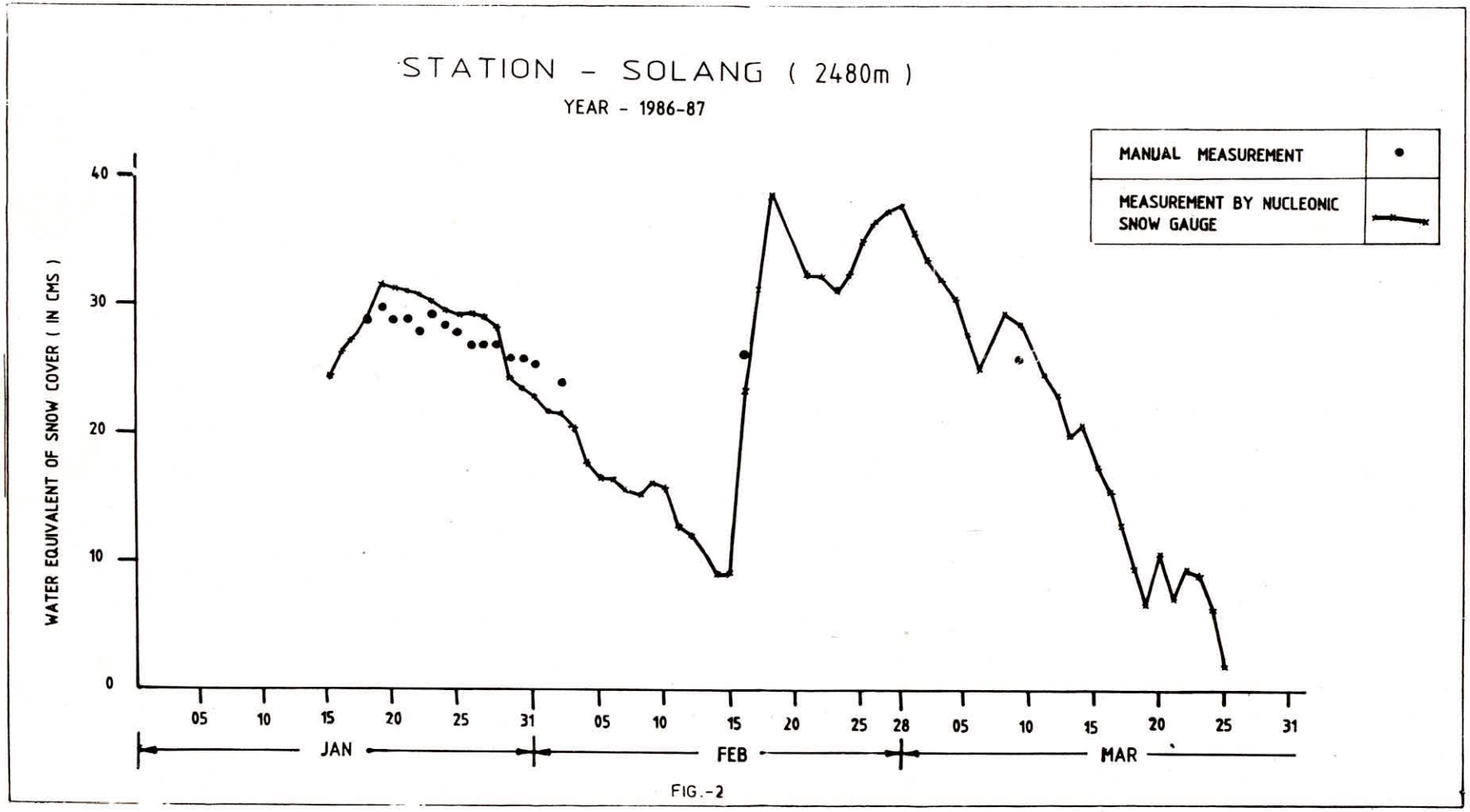
STATION - SOLANG (2480m)
YEAR - 1986-87
MANUAL MEASUREMENT
MEASUREMENT BY NUCLEONIC SNOW GAUGE
WATER EQUIVALENT OF SNOW COVER (IN CMS)
40
30
20
10
0
05
10
15
20
25
31
05
10
15
20
25
28
05
10
15
20
25
31
JAN
FEB
MAR

FIG.-2