

Mr. A. R. Codd gave a lecture on the protection and maintenance of snow sampling equipment in which he gave recommendations for the care, repair, and waxing of the tubes and scales. The wax Mr. Codd recommended is the old standby, paraffin.

The evening sessions were, I believe, most enjoyable. These sessions were attended by nearly everyone at Alta. The lectures usually consisted of slides or films. M. M. Atwater gave a slide lecture on avalanche characteristics and then showed the film "Avalanche Rescue." The film "Avalanches to Order" was scheduled, but instead the film "Snow Ranger" by Sverre Engen was shown. Mr. Engen also had another film called "Champs at Play" which showed many Olympic and National Ski Champions skiing at Alta and various other resorts. Both of these films were produced by Mr. Engen and were excellent in all ways. Dee Molenaar gave a slide talk entitled "An Attempt on K-2 by the Third American Karakoram Expedition." Mr. Francis Millner and Mr. John Clinch, Representatives of the Snowy Mountain Hydroelectric Authority of Australia, presented two films produced by their company entitled "Harvesting the Snow" and "Conservation of Soil in the Snowy."

Routine snow survey work made up the bulk of the remaining indoor sessions except the outstanding sessions presented by G. M. Hawkins, Civilian Instructor on Survival, U. S. Air Force. Mr. Hawkins presented in a very clear fashion "Survival," "Search and Rescue" and "Safety and Treatment of Casualties." He also presented an army training film on survival. A lecture on the "Physics of Snow Cover" by E. R. LaChapelle, U. S. Forest Service Snow Ranger at Alta, and a paper entitled "Fifty Years of Snow Surveying" by George D. Clyde were also presented.

All in all the conference was very successful and the training received by the men will show up in the continued safety record of snow surveys and accurate results of the field work.

SNOW HYDROLOGY SUMMARY REPORT

by
Oliver Johnson^{1/}

The Corps of Engineers, U. S. Army, has long recognized the need for basic knowledge in the field of snow hydrology to insure adequate and economical design of major water control projects, for efficient operation of dams and maximum utilization of reservoir storage, and for meeting its responsibilities in connection with flood emergencies. Twelve years ago the Corps embarked on a cooperative research program with the Weather Bureau and other Federal agencies in order to meet the stated objectives. Most of you here today are fairly well acquainted with the scope of this program, so I will not dwell on that now. I would like to take this opportunity, however, to call your attention to the summary report, entitled "Snow Hydrology", to be completed in the next few months, which summarizes the investigations and is written with the view of being a reference work on theoretical and applied snow hydrology. In order to acquaint you with the material contained in the report, I would like to present a brief resume of the report, chapter by chapter.

Chapter 1, "Introduction," lists the purpose and scope of the report, includes a statement of the problem, and reviews briefly the activities of the Cooperative Snow Investigations.

Chapter 2, "Snow Laboratory Data," provides information on the field observational program of the Cooperative Snow Investigations and includes detailed descriptions of the three laboratory areas, methods of observation of hydrometeorologic elements, a general description of quality of data, brief descriptions of regular and special observations, and information on the publication of basic data.

Chapter 3, "Precipitation and the Accumulation of Snow," discusses the interrelationship between precipitation and snowfall; meteorological and terrain features affecting precipitation; the problem of measurement of precipitation, snowfall, and snow accumulation; factors affecting the accuracy of point precipitation and snow accumulation measurements; and methods of determining basin precipitation and snow accumulation from point measurements.

Chapter 4, "The Water Balance in Areas of Snow Accumulation," discusses the factors affecting the water balance, including rainfall, snowfall, snow accumulation, interception, snowmelt, soil moisture recharge, transpiration, ground water storage, and runoff. It includes a presentation of monthly values of each component of the water balance for the period of record for each snow laboratory.

Chapter 5, "Melting of the Snowpack," is a complete theoretical discussion of the physical processes of heat transfer to the snowpack; it shows how these processes are affected by conditions of the atmosphere and the environment, and includes mathematical expressions for relating snowmelt to meteorologic variables.

Chapter 6, "Snowmelt Indexes," presents methods of application of the principles of snowmelt presented in chapter 5 to basin areas, through use of thermal budget indexes. Reliability of indexes of snowmelt for each of the

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laboratories and for a project-sized basin are shown. Also, simplified general equations for estimating snowmelt on basins of varying forest cover are presented.

Chapter 7, "Areal Snow Cover," discusses snow cover accretion and depletion, methods of observing the areal extent of snow cover, and how to estimate snow cover depletion from related hydrometeorological data. Examples of snow cover depletion on laboratory and project-sized basins are shown.

Chapter 8, "Effect of the Snowpack Condition on Runoff," includes a brief description of the metamorphism of the snowpack, as related to snow hydrology, and presents descriptive material on the change in snowpack characteristics from observations at the snow laboratories. The condition of the snowpack is related to its ability to store and transmit liquid water. Methods are shown for evaluating storage and time delay to runoff from the effect of the snowpack, and an illustrative example provides sample computations for such evaluation on a basin area.

Chapter 9, "Reconstitution of Streamflow Hydrographs," shows methods of combining snowmelt and rainfall with all factors affecting runoff, for the purpose of synthesizing streamflow hydrographs on project-sized basins. Reconstitutions of snowmelt and rain-on-snow hydrographs are illustrated, and both unit hydrograph and storage routing methods for evaluating time delay to runoff are shown.

Chapter 10, "Design Flood Determinations," describes application of snow hydrology principles set forth in previous chapters to project design floods.

Chapter 11, "Seasonal Runoff Forecasting," discusses methods of deriving seasonal runoff forecasting procedures, with emphasis on the logical selection of runoff parameters on the basis of the water balance technique described in chapter 4.

Chapter 12, "Reservoir Regulation," deals with the application of snow hydrology to problems of reservoir regulation, with regard to establishing both long-term operating schedules and short-term regulation of flows at the projects.

The report will contain 437 pages, 21 tables and 72 engineering plate drawings. It will be available for distribution shortly after the first of July, 1956, and will be given general free distribution to government agencies, universities, and scientific organizations. Individuals may obtain copies upon request by paying the cost of reproduction, which will be approximately \$5.00. Requests should be directed to the Division Engineer, North Pacific Division, U. S. Army Corps of Engineers, 210 Custom House, Portland 9, Oregon.