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SIPRE CONFERENCE REPORT 3

MINUTES OF SNOW COMPACTION CONFERENCE

4 - 5 SEPTEMBER, 1952

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SNOW, ICE, AND PERMAFROST
RESEARCH ESTABLISHMENT
CORPS OF ENGINEERS, U.S. ARMY

SEPTEMBER 1952

41

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SECURITY INFORMATION

MINUTES OF SIPRE SNOW COMPACTION CONFERENCE

4 - 5 SEPTEMBER 1952

Snow, Ice & Permafrost Research Establishment
1215 Washington Avenue
Wilmette, Illinois

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SECURITY INFORMATION

TABLE OF CONTENTS

List of conferees.

Minutes of the conference.

Appendix A. Agenda of conference.

Appendix B. Minimum program of measurements to be made on snow in relation to snow compaction work.

Appendix C. Snow compaction measurements to be made if adequate personnel and equipment are available.

Appendix D. Instructions for use of Rammsonde.

Appendix E. Meteorological observations to be made at test sites.

Appendix F. Simplified field classification of natural snow type for engineering purposes.

Appendix G. DED snow compaction school.

Appendix H. Graph forms for recording data.

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SECURITY INFORMATION
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SIPRE Conference on Snow Compaction

4 - 5 September 1952

LIST OF CONFEREES

Canada

Canadian Army, Directorate of Engineering Development (DED)

Major A. Taylor
Captain I. Smith

Royal Canadian Air Force

Wing Commander J. D. Shannon

Defence Research Board

Mr. J. Gifford Thompson

United States

U. S. Army, Engineer Research & Development Laboratories (ERDL)

Mr. George B. Schoolcraft
Mr. Paul A. Beigbeder
Mr. R. D. Kase

U. S. Navy, Bureau of Yards and Docks

Lt. Roland D. Hill
Mr. D. C. Hilton

U. S. Air Force Proving Ground Command, Eglin Field

Captain M. O. Colby

SIPRE

Dr. Henri Bader
Mr. J. A. Bender
Mr. T. R. Butkovich
Mr. M. Diamond
Dr. R. W. Gerdel
Mr. B. L. Hansen
Dr. U. Nakaya
Dr. A. L. Washburn

TIME: 4 - 5 September 1952

PLACE: SIPRE Headquarters Building, 1215 Washington Avenue, Wilmette, Illinois

4 September 1952

1. Introduction:

The conference was opened at 10:00 A.M. by Dr. Washburn, who introduced the conferees and welcomed the visitors to SIPRE. He outlined the objective of the conference as being the development of scientific procedures for the cooperative snow compaction program between Canada and the United States.

2. Background:

Mr. Kase gave an account of the historical background of the snow compaction program starting with the work done during 1947 at Fort Churchill and continuing through the past winter's work. He stated that from the Corps of Engineers' viewpoint it is hoped to develop equipment and procedures to provide roads capable of carrying standard ordnance vehicles and airfields which will carry 70,000 pound dual-wheel loads.

Major Taylor pointed out that this year's program was divided between two types of stations. The main base at Kapuskasing will be a development and construction station. The other field stations are primarily to test and evaluate the methods which were developed during 1951-52, and to see if the same processes will be just as successful at other geographic locations and under other climatic conditions. The field stations besides Kapuskasing are:

1. Fort Nelson on the Alaskan Highway - to be operated by the Directorate of Engineering Development (DED).

2. Goose Bay, Labrador - to be operated by the Royal Canadian Air Force (RCAF).

3. Fort Churchill - to be operated by the Engineer Research and Development Laboratories (ERDL).

4. Houghton, Michigan - to be operated by ERDL.

5. Alert Weather Station, Ellesmere Island - to be operated by the U. S. Navy.

6. Thule, Greenland - to be operated by ERDL.

3. Scientific Instrumentation - Types and Procedures:

Dr. Bader led a discussion on the measurements and instrumentation to be used in relation to the scientific phases of the snow compaction work. The final decisions reached are attach to the minutes in the following appendices:

Appendix B - Minimum program of measurements to be made on snow in relation to snow compaction work.

Appendix C - Snow compaction measurements to be made if adequate personnel and equipment are available.

Appendix D - Instructions for use of Rammsonde.

Dr. Bader suggested that no formal program be adopted for measuring free moisture content of snow in the field since there is at present no field method for precise determination.

Various other tests such as the CBR test and the plate-bearing test were discussed but no formal procedures advanced since it was agreed that they should be considered as operational problems.

4. Scientific Instrumentation - Meteorologic Requirements:
Mr. Diamond led the discussion on the recommended meteorologic measurements to be made. The final agreements reached are attached to the minutes as:

Appendix E - Meteorological observations to be made at test sites.

5. Scientific Instrumentation - Data Sheets:
The information desired by SIPRE was outlined by Dr. Bader and a general discussion followed. It seemed desirable for SIPRE to design data sheets to record the scientific information required, and for the Engineer Research and Development Laboratories to design a card for the technical data required by ERDL. The data sheets designed by SIPRE (Appendices B and D are:

a. Snow data sheet - BR3-F6

b. Hardness data sheet - BR3-F4

c. Meteorological data sheet - BR3-F7.

6. Scientific Instrumentation - Availability of Instruments:
It was agreed that the type of instruments and the responsible agency to procure them for the stations would be as follows:

a. Yardsticks - to be procured by ERDL.

b. Weston dial thermometers, Model 2261, range -100° to +100°F. - each organization to be responsible for procuring their own.

c. Punch for making a hole in hard snow for the thermometer, 1/8" by 8" - to be procured by SIPRE.

d. Cups with concentric lines and magnifying lenses for identifying snow type - to be procured by SIPRE.

e. Sampling tubes and balance - each organization to be responsible for procuring their own. However, SIPRE will probably be able to furnish sampling tubes with a 500 cc capacity if needed. The Welch triple beam balance, Model No. 4050, capacity of 1610 grams, was recommended by SIPRE.

f. Ice augers - to be procured by ERDL.

g. Rammsonde - to be procured by ERDL.

With reference to obtaining meteorological instruments, it was decided that ERDL would check with the U. S. Weather Bureau regarding the possibility of borrowing necessary instruments and that Major Taylor would check with the Canadian Department of Transport. If difficulties develop in obtaining the instruments, SIPRE might be able to assist.

7. Snow Classification:

The proposed field classification of snow was introduced by Dr. Bader and discussed by the conferees. The approved classification is attached to the minutes as:

Appendix F - Simplified field classification of natural snow type for engineering purposes.

8. Snow Sampling:

Dr. Bader pointed out some of the precautions to be taken in procuring snow samples. These suggestions are incorporated in Appendix B.

9. Discussion of Compaction vs. Consolidation:

Various members were asked for their definition of "compaction" and "consolidation" with reference to the processing of snow. No single definition was agreed on, although it was pointed out that the term "snow compaction" is generally understood to designate the process by which a snow area has been artificially treated to raise its bearing capacity. Dr. Washburn suggested that precise definition of these terms as applied to snow might be an appropriate agenda item for the next snow compaction conference.

10. School Instruction:

Major Taylor explained the reasons for a snow compaction school and outlined the proposed instruction courses. The syllabus with the agency responsible for each course is attached as:

Appendix G - DED Snow Compaction School.

It was noted that the time allotted for each course was to be considered as tentative until the lecturer was able to make out his lesson plan. It was agreed that the DED would be responsible for the overall coordination of the school. Dr. Bader was asked to develop the courses assigned to SIPRE.

11. Handling of reports data:

During the discussion on the handling of report data, it became apparent that it would be necessary to determine exactly what information the various agencies desired. It was suggested that the field stations would forward copies of the data taken, including their weekly hygrothermograph charts, to a central headquarters (probably at Ottawa, Canada). Arrangements also would be made to obtain hourly synoptic data from nearest standard weather stations. Any information that SIPRE desired could then be procured from the central headquarters as needed.

Dr. Bader suggested that the data could be presented in a briefer and more useable form if they were graphed. Two such suggested graphs are attached to the minutes as:

Appendix H - Graph forms for recording data.

A directive on the handling of data and preparation of reports is to be prepared by ERDL and DED for the snow compaction school.

12. Research Participation:

SIPRE commitments to the snow compaction program are summarized as follows. SIPRE will:

a. Participate in the instruction program for the snow compaction school, this program to be developed by Dr. Bader.

b. Make a total of about three visits of up to a week each to the program. These visits will include Kapuskasing and possibly one or two field stations.

c. Prepare punch rods for the thermometers and forward them to Mr. Kase for distribution.

d. Procure cups with concentric lines for measuring snow particle size, and forward them to Mr. Kase for distribution.

e. Procure magnifying lenses and forward them to Mr. Kase for distribution.

f. Investigate the possibility of determining free moisture content of snow in the field.

g. Prepare instructions for the use of the Ramsonde and forward 60 copies to Major Taylor.

h. Prepare a simplified field classification of natural snow and forward 60 copies to Major Taylor.

i. Prepare a listing of recommended measurements to be made on snow and a listing of recommended accompanying meteorological data to be procured in relation to the snow compaction program. These recommendations will represent the scientific information that SIPRE is interested in obtaining. Sixty copies of these listings will be forwarded to Major Taylor.

j. Revise and publish, upon approval from higher authority, the treatise Snow compaction by Major Taylor and forward a minimum of 60 copies to Major Taylor.

k. Prepare the style of sheets and graphs for the recording of data.

l. Prepare the minutes of the conference.

APPENDIX A

Appendix A

AGENDA

SIPRE CONFERENCE

SCIENTIFIC ASPECTS OF SNOW COMPACTION

THURSDAY - FRIDAY - 4 - 5 SEPTEMBER 1952

Thursday, 4 September

1. 1000 - Introduction
2. 1015 - Background
3. 1030 - Scientific instrumentation
   a. Types
      1. Temperature
      2. Density
      3. Hardness, stability, bearing capacity
      4. Crystal form and size
      5. Free moisture
4. 1200 - Lunch
5. 1400 - Scientific instrumentation (continued)
   b. Meteorologic requirements
   c. Procedures
   d. Data sheets
   e. Availability of instruments

AGENDA

SIPRE CONFERENCE

SCIENTIFIC ASPECTS OF SNOW COMPACTION

THURSDAY - FRIDAY - 4 - 5 SEPTEMBER 1952

Friday, 5 September

6. 0900 - Snow classification

7. 0930 - Snow sampling

8. 1000 - School instruction

9. 1030 - Handling of report data

   a. Technical

   b. Scientific

10. 1100 - Research participation

    a. DED

    b. ERDL

    c. BuDocks

    d. SIPRE

11. 1200 - Adjournment.

APPENDIX B

SNOW, ICE AND PERMAFROST RESEARCH ESTABLISHMENT

APPENDIX B

Minimum program of measurements
to be made on snow in relation
to snow compaction work

I. Procedure.

Not more than one hour before snow processing a hole is dug through the snow to the ground, with a vertical face on the south side (facing north). The following measurements are then made:

1. Sequence and thickness of visually distinguishable snow layers.

2. Determination of snow types, according to simplified snow classification (see attached classification sheet).

3. Temperature. Thermometers are inserted horizontally 1/2" below snow surface, at the layer boundaries, and at the base of the snow cover. If a snow layer is more than about 4" thick, one or more thermometers are also inserted inside the layer so that they are not more than 4" apart. Thermometers are read without extracting after five minutes. The snow surface immediately above the thermometers should be shaded while making temperature measurements to eliminate the effect of radiation on the thermometers. If snow layers are separated by a hard crust, measure temperature below crust.

4. Density. Sampling tubes are inserted horizontally in the middle of each layer. If a layer is thicker than three but less than five sampling tubes diameters, take two samples (near top and bottom of layer). If a

layer is thicker than five tube diameters, take three samples (top, middle, and bottom). If the layers are very thin, two or more can be included in one sample. Hard crusts should not be included in samples. If the entire snow cover is very thin, the tubes may be inserted vertically to obtain the sample.

5. Hardness. Take a Rammsonde hardness profile from snow surface to ground one foot from the vertical snow face (see attached sheet for instructions).

6. Age Hardening. Not more than one hour after processing (record time of end of processing and of subsequent tests), dig a pit in the processed area and make profile measurements as described under items 1 to 5. Then take temperature - and Rammsonde profiles at hourly intervals until the rate of increase of hardness slows sufficiently to warrant lengthening the interval between measurements. Fill snow back into pit after temperatures have been measured and dig new pit for new measurements, the new pit to be not closer to the old pits than four times the snow depth.

NOTE: If measurements have to be curtailed it should be considered that temperature is the most significant item.

II. Instruments.

1. Sequence and thickness of snow layers. Yardsticks graduated in inches and half inches. Measure positions of boundary layers to nearest half inch from the ground up and record in column 3, Snow Data Sheet SIPRE BR3-F6. If the pit does not reach to the bottom of the snow cover, measure from the snow surface down and note this in column 12 of Snow Data Sheet.

2. Determination of snow type. Lens and cup with concentric circles one millimeter apart for estimating grain size. The appropriate snow type for each layer is recorded in Columns 4, 5, 6, Snow Data Sheet. Columns 7 and 8 will be used to record photographic data.

3. Temperature. Weston dial thermometers with 8" x 1/8" stems, graduated in intervals of 2°F. Read to nearest 1°F. In order to avoid damaging thermometers by pushing them into hard snow, a 1/8" steel rod protruding 8" from a handle should be used to punch a hole. Check the ice point of thermometers before first use and at weekly intervals. Each station should have one dozen thermometers. Height of each thermometer above ground and temperature should be recorded in columns 1 and 2, Snow Data Sheet.

4. Density. Sampling tubes (one dozen per station) should sample a snow volume of not less than 200 ccs, and have a diameter of not less than 2". Sampling and weighing should be sufficiently accurate to yield two significant figures of density value. For snow too soft to bear the weight of inserted sampling tubes, use a tube with handle. Alternatively, the sampling tube is inserted vertically down to a plate pushed under the light snow. In this case the thickness of the layer must be measured accurately to determine volume of snow sampled. When the snow is too hard for sampling tubes, drill out a core with an ice auger. The height at which each density sample is obtained and the density should be recorded in columns 9 and 10, Snow Data Sheet. Column 11 of Snow Data Sheet may be used for recording number of sample tubes.

5. and 6. Hardness. Use the Rammsonde and record on the hardness data sheet, SIPRE-BR3-F4 (also see attached instruction sheet).

SNOW DATA SHEET

Station _____ Date _____ Time _____

_____ Observer _____

Present wind (circle one) Compacted Snow Depth, Inches _____

calm light moderate strong New Snow Crystal (circle one)

Present sky conditions (circle one) Plate Stellar Column Needle Graupel

clear partly cloudy cloudy Density Tube I.D., Inches _____

PROFILE

(all heights (ht.) in inches above ground)

1 TEMPERATURE	2	3	4	5	6	7	8	9	10	11	12
		LAYERS						DENSITY			
ht.	°F	ht. of boundary	snow type					ht. of center of tube	Density		
			F-D	K	W						
		0 -									
		-									
		-									
		-									
		-									
		-									
		-									
		-									
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		-									

Hardness Data Sheet

Station _____ Date _____ Time _____

Observer _____

$$R = \frac{P.n.h}{\Delta x} + q \cdot Q + P$$

R = Hardness Number
h = height of fall, cm
Q = Weight of one tube
P = Weight of hammer, kg
Δx = penetration per "n" blows, cm
x = accumulated penetration, cm
n = Number of blows
q = number of tube lengths

(All values are in kilograms and centimeters)

q	P	n	h	x	Δx	R	Remarks

APPENDIX C

SNOW, ICE AND PERMAFROST RESEARCH ESTABLISHMENT

APPENDIX C

Snow compaction measurements to be made if adequate personnel and equipment are available

1. Measurement of change of density in processed snow during age hardening. Immediately after processing, push a yardstick vertically to bottom of processed layer and leave it there. Smoothen snow surface near stick and place a reference marker on it (for instance, a tin can top). Read processed snow depth as accurately as possible at appropriate intervals and calculate density change, which is proportional to the amount of settling. Determine mean density of processed snow by coring with ice auger near yardstick at the end of test.

2. Hardness. Determine hardness with Canadian type spring gage, vertically on the surface and horizontally in the middle of each layer. If layers are thicker than 6" measure near top and bottom. Take mean of five readings at each level (add readings, multiply by 2 and divide by 10).

3. Correlation of measured hardness and vehicle performance. If the effort can be made it is suggested that several instruments be used at the main station in order to determine which one will yield the best correlation with actual vehicle tests.

The range of measurement of bearing capacity by light, medium and heavy test trucks may perhaps be extended by unequal loading of rear axles and by use of different types of tires. When tires make a groove without breaking through, the depth of groove should be noted and the actual load per square inch calculated.

APPENDIX D

SNOW, ICE AND PERMAFROST RESEARCH ESTABLISHMENT

APPENDIX D

Instructions for use of Rammsonde (Kegelsonde)

1. Insert hammer guide in top of first section (which has cone point).

2. Let sonde hang vertically over snow surface by holding near top end and gently lower until cone point touches snow surface.

3. Let go, but immediately grab sonde again to prevent falling over. (From here on provide constant side guidance by hand until sonde stands vertically by itself).

4. Read penetration.

5. Slip hammer on hammer guide until it touches shoulder with no pressure.

6. Release hammer.

7. Read penetration.

8. Start hammering by raising hammer on guide to desired height and letting it drop onto shoulder.

9. Read penetration after each hammer blow or (if very small) after a series of counted blows, all from the same height of drop.

10. When sonde is close to total immersion in snow, remove guide with hammer, attach one length of tubing and insert guide and hammer in top of the new length. If this causes additional penetration, take a reading; otherwise proceed as in section 8 above.

11. Computation and graphical presentation of hardness is made as shown on attached sheets.

Form 1

Recording and Computing
Ramm Hardness Number

$$R = \frac{P.n.h}{\Delta x} + q \cdot Q + P$$

R = Hardness Number
h = height of fall cm
Q = Weight of one tube

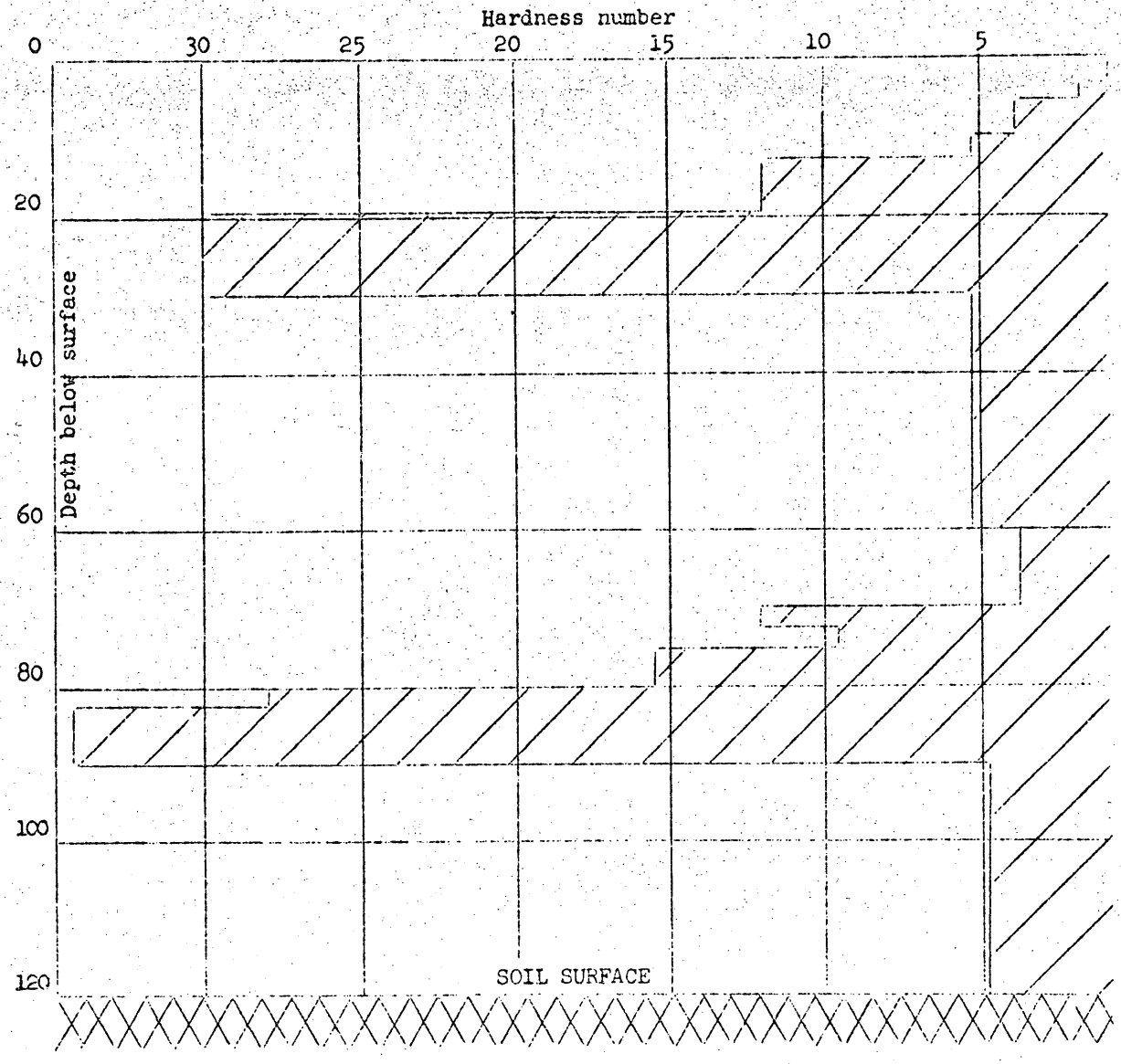
P = Weight of hammer
Δx = penetration per "n" blows
x = accumulated penetration

n = Number of blows
q = number of tube lengths

(All values are in kilograms and centimeters)

q	P	n	h	x	Δx	R	Remarks
1	-	-	-	3	3	1.0	Operation #3, Reading #4
1	1	0	0	5	2	2.0	Operation #6, Reading #7
1	1	1	10	10	5	4.0	Operation #8, Reading #9
1	1	1	10	13	3	5.3	etc
1	1	1	10	14	1	12	
1	1	1	50	19	5	12	
1	1	5	50	30	11	25	
1	1	2	50	60	30	5.3	Break through on 2d blow
1	1	1	20	70	10	4.0	
1	1	1	20	72	2	12	
2	1	0	0	72	0	-	Second tube added
2	1	1	20	75	3	9.7	
2	1	1	50	80	5	13	
2	1	1	50	82	2	28	
2	1	5	50	90	8	34.2	
2	1	1	50	120	30	4.7	Break through on 1st blow
2	1	2	50	121			Reached ground, indicated by limited penetration.

Ramm Profile of Snow Cover
Plotted from Form 1



APPENDIX E

SNOW, ICE AND PERMAFROST RESEARCH ESTABLISHMENT

APPENDIX E

Meteorological observations to be made at test sites

1. The instruments to be used in making meteorological observations at the compaction site will be a maximum thermometer, minimum thermometer, hygrothermograph, and anemometer.

2. The maximum thermometer, minimum thermometer and hygrothermograph will be located within a standard meteorological instrument shelter (cotton region type) and the anemometer will be attached to and supported above the shelter on a suitable bracket as shown on attached diagram.

3. The hygrothermograph measures temperature and humidity continuously and records this data on a chart which will cover a period of seven days. The scale range is from 0-100% relative humidity and -30 to +70°F. The hygrothermograph chart should be changed once each week on the same day.

4. The maximum and minimum thermometers should be read and set each morning at about 0800. The time of occurrence of the maximum and minimum temperature can be obtained by reference to the temperatures record on the hygrothermograph chart for the 24 hours prior to the time of reading the thermometers. If the hygrothermograph fails to operate during this period it can be assumed that the minimum temperature occurred on the day of reading and the maximum temperature on the previous day. The temperatures should be recorded on the meteorological data sheet (SIPRE BR3-F7).

5. The anemometer that is attached to the instrument shelter contains a dial which shows the accumulated miles of wind travel. The dial should be read each morning at about 0800 and the reading recorded

on the meteorological data sheet (SIPRE-BR3-F7) in the "Anemometer Reading" column. The 24 hour wind travel for a day is then obtained by subtracting the previous day's reading from the current day's reading and the value entered in the "24 hour wind travel" column for the previous day. The value is entered for the previous day because 16 of the 24 hours occurred on that day.

6. The prevailing sky and wind conditions at the time that measurements of a snow profile are made should be noted on the snow data sheet, SIPRE-BR3-F6. The following criteria can be used to describe sky conditions and wind:

Clear: less than 3/10 of the sky covered by clouds

Partly cloudy: 3/10 to 8/10 of the sky covered by clouds

Cloudy: more than 8/10 of the sky covered by clouds

Calm wind: smoke rises vertically

Light wind: wind extends light flag

Moderate wind: raises loose paper, whistling heard in telegraph wires

Strong wind: inconvenience felt when walking against the wind.

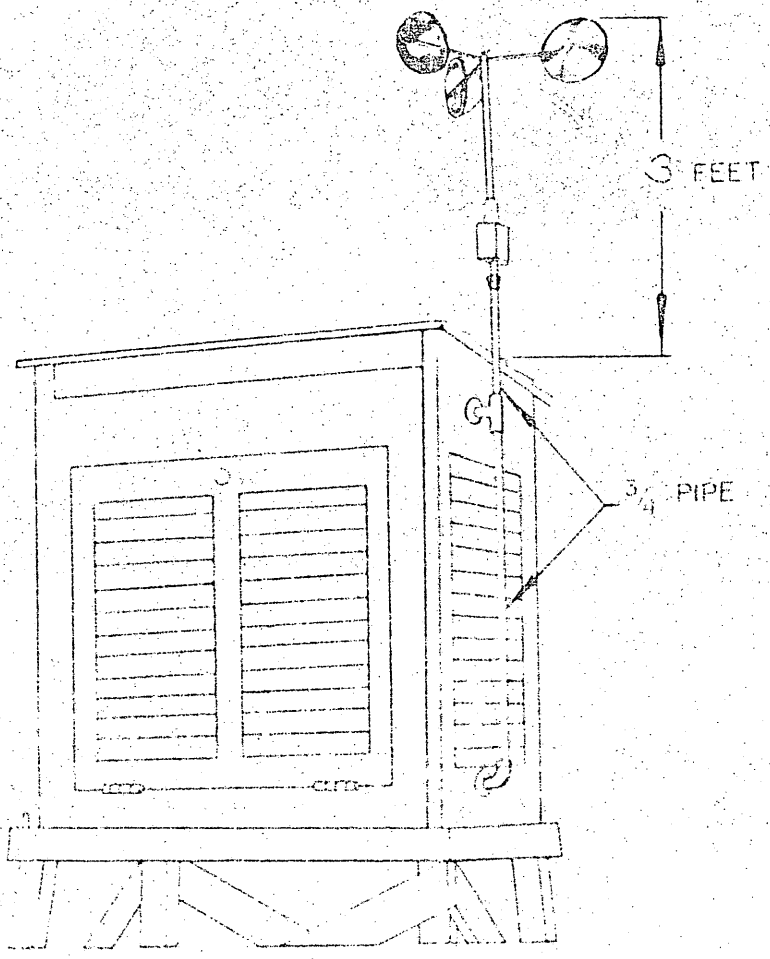
7. Hourly meteorological data such as cloud conditions, air temperature, dewpoint, wind direction and velocity will be obtained from records of an official weather station in the vicinity of the test site and used to supplement and check meteorologic data obtained at the test site. The hourly synoptic data obtained at nearby weather station during the test period should be reproduced and made available for use in analysis of data.

Meteorological Data Sheet

Station _____ Observer _____

Date	Maximum Temperature °F.	Minimum Temperature °F.	Time	Anemometer Reading	24 Hr. Wind Travel

Anemometer Installation on Instrument Shelter



APPENDIX F

Simplified Field Classification of
Natural Snow Type for Engineering Purposes

Snow, Ice and Permafrost Research Establishment
1215 Washington Avenue
Wilmette, Illinois
September 1952

APPENDIX F

Grain nature

1. New snow.
   (original crystal form is recognizable). Fa
2. Old snow, granular, fine-grained.
   (mean diameter is less than approximately 2 mm - like table salt). Db
3. Old snow, granular, coarse-grained.
   (mean diameter is larger than approximately 2 mm - like coarse sand). Dd
4. Depth hoar (cup-shaped crystals 3 to 10 mm). De

Hardness (use gloves)

1. Soft. (4 fingers)* Ka
2. Medium hard. (1 finger)* Kc
3. Hard. (pencil)* Kd
4. Very hard. (knife)* Ke

*The object indicated, but not the foregoing one, can be pushed into the snow without considerable effort.

Wetness (use gloves)

1. Dry. (cannot make a snowball). Wa
2. Moist. (does not obviously contain liquid water, but snowball can be made). Wc
3. Wet. (obviously contains liquid water). Wd
4. Slushy. (water can be pressed out). We

Examples: New snow, dry and medium hard. FaKcWa

Fine-grained, moist and hard snow. DbKdWc

This field classification is intended only for description of natural snow type without the use of instruments. It does not, in itself, classify snow profiles, surface conditions, etc. However, the classification may be used in connection with such descriptions. For instance, in describing a snow profile, the thickness of visually distinguishable snow layers and their sequence in the snow layer are measured and the snow type of each layer may be described according to this classification.

The classification is based on Draft of an international snow classification, International Union of Geodesy and Geophysics, Commission on Snow and Ice, Bruxelles, 1951.

Notes:

1. Because the field classification is intended to define snow type without use of instruments, density is not included; however, it should be measured if instruments are available.

2. When a thermometer is available, it is desirable to make a sufficient number of temperature measurements along a vertical line in the snow cover to enable the drawing of the temperature curve from ground to snow surface.

3. The code symbols are those of the proposed International Snow Classification. F means the form of the grain, D the size (dimension), K the cohesion (Kohaesion) and W the wetness. Any property is classified into five degrees of a, b, c, d and e, according to the order of magnitude or the state of metamorphism.

4. In the case of new snow it is desirable to note the original crystal form, such as stellar, plate, needle or granular, the last including all kinds of crystals which appear as granules to the naked eye. Drifted snow of granular form must be considered as fine-grained old snow, even if it is freshly deposited.

APPENDIX G

RESTRICTED

Appendix G

DED SNOW COMPACTION SCHOOL

OTTAWA, ONT. AND GOOSE BAY OR KAPUSKASING

OBJECT

1. To organize a theoretical and practical course on snow mechanics as applied to snow compaction including the theory and practice of instrumentation, its relationship to traffic testing; standardization of recorded data; its analysis and graphical evaluation; description and demonstration of snow compacting equipment; and an outline of the 1952-53 program.

GENERAL

2. It is anticipated that this course will last about one week in early December 1952.

3. The general arrangement of the course will be as follows:

D-1	Ottawa	Lectures
D-2	Ottawa	Lectures
D-3	Travel	Ottawa to Goose Bay or Kapuskasing
D-4	Goose Bay or Kapuskasing - Field work	
D-5	Goose Bay or Kapuskasing - Field work	

4. It is anticipated that the course will involve a total of about 25 students and instructors. Participating agencies will advise DED of nominations by 1 October 1952 to permit accommodation and transportation arrangements being made.

RESTRICTED

SYLLABUS

5. The proposed syllabus for the course with the agency responsible for each course is as follows:

D1 and D2

Course No.	Course	Resp. Agency	Time
1.	History of the Snow Compaction Project	DED	1 hr.
2.	Snow Properties	SIPRE	2 hr.
3.	Instrumentation	SIPRE	2 hr.
4.	Description of Snow Compaction Equipment	DED	2 hr.
5.	Test Procedure-Instruments-Traffic	ERDL	2 hr.
6.	Recording of Data	ERDL	1 hr.
7.	Snow Compaction Practice	DED	1 hr.
8.	1952-53 Program	DED ERDL Bu Docks	1 hr.

D4 and D5

9.	Demonstration of Equipment (a.m.)	DED	
10.	Demonstration of Instruments (p.m.)	SIPRE	
11.	Traffic Testing (a.m.)	ERDL	
12.	Exercise with Use of Instruments and the Recording of Data (p.m.)	ERDL and SIPRE	

Outline of Courses

1. History of Snow Compaction Project. An outline of the problem of northern transportation; background of European material; field projects 1947-52, outlining progressively objects and results.

2. Snow Properties. The formation of snow flakes; environmental factors; types of snow flakes; snow cover and natural influences active on it; metamorphism of snow; bonding of crystals; analogy between metamorphism and the compaction of snow; definition.

3. Instrumentation. Characteristics of snow; - density, grain size, temperature, free moisture, hardness. Description and theory of instruments used for measuring these characterisitics. Deficiencies and future development.

4. Description of Snow Compaction Equipment. Development of equipment; - rollers, harrows, powered mixers, pre-compactors, heat treatment.

5. Test Procedure.

a. Instruments. Use of instruments, precaution in their use, interpretation of results, care of instruments. Standard procedure.

b. Traffic Testing. Military characteristics required, vehicles used, effects of tires, standardized observation and description of results.

6. Recording of Data. Standard procedure to be used in recording all data; typical data sheets; instruction on purpose behind each standardized form, and method of use.

7. Snow Compaction Practice. Description of the purpose, use and limitation of each piece of equipment; standard procedure developed to date;

existing operational deficiencies of equipment.

8. 1952-53 Program. Outline by each agency concerned of the program proposed for the forthcoming winter.

a. DED - Development and Construction Sites

b. ERDL - Development and Construction Sites

c. Bu Docks - Construction Site

9. Demonstration of Equipment. The use of harrows, rollers, pulvimixers, drags and rollers in the field.

10. Demonstration of Instruments. Demonstration of use of instruments in the field for measuring density, hardness, temperature (including thermal gradients), moisture content, etc. together with the method of identifying grain size and type in the field.

11. Traffic Testing. Demonstration of the use and effects of various vehicles in the field for traffic testing; method of observing and describing results; effects of tire types, grades, etc.

12. Practical Instrumentation. The use of instruments by students, reading and recording data, etc.

Misc.

It is suggested that the course begin on a Wednesday, and that transportation by air to Goose Bay or Kapuskasing be arrainged for the following Monday, which gives some flexibility towards extending the initial lecture period at Ottawa if necessary.

Winter clothing will be provided by each agency.

Equipment required for the field tests will be tractors, snow compacting equipment, a number of sets of snow testing equipment and a P/A system.

At the Ottawa conference room (to be located in detail later) there will be a blackboard, slide projector (3-1/4 x 4-1/4 unless other wise requested), and a 16 mm motion picture projector with sound, (with an operator).

It is suggested that lecturers provide DED with a précis of their lectures by 15 October 1952.

APPENDIX H

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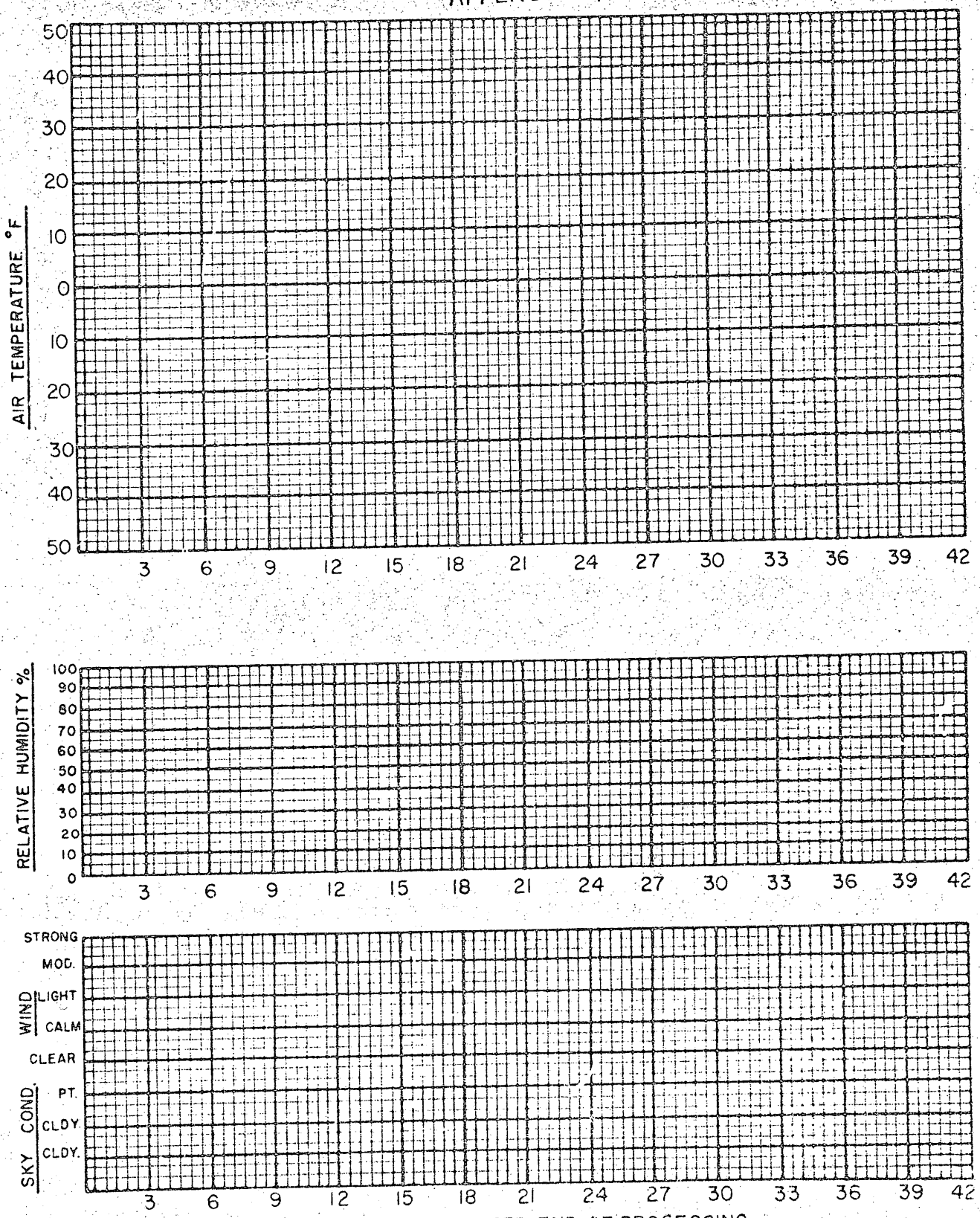

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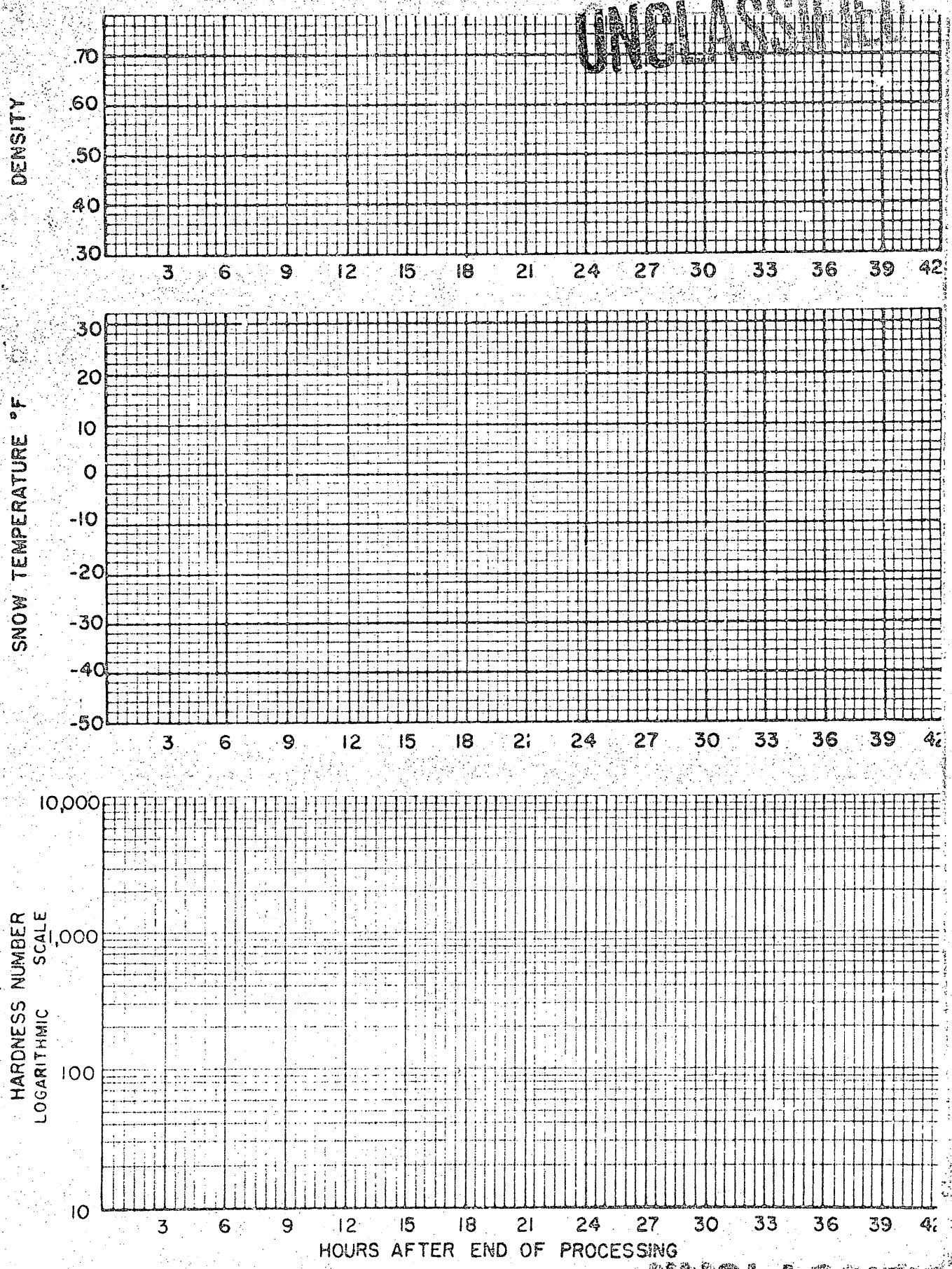

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