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NATIONAL RESEARCH COUNCIL OF CANADA

DIVISION OF BUILDING RESEARCH

No.

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TECHNICAL NOTE

PREPARED BY D. W. Boyd\*

CHECKED BY

APPROVED BY NBH

DATE August 1966

PREPARED FOR Inquiry and record purposes

SUBJECT DESIGN TEMPERATURES FOR 100 SELECTED CANADIAN MUNICIPALITIES

This Technical Note describes the sources and methods of deriving the January and July design temperatures and other weather data submitted to the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) in May 1966 for publication in the 1967 edition of their Guide and Data Book. The values submitted are listed in Table I.

In the 1965 edition of the ASHRAE Guide and Data Book the winter table included 62 Canadian stations, which was approximately the number requested by ASHRAE. The summer table was limited to 33 Canadian stations for lack of further data. In January 1966 the Editor agreed that summer and winter design data for 100 Canadian stations should be included in the 1967 edition of the ASHRAE Guide and Data Book.

A list of 100 stations was prepared with some advice from colleagues in the Meteorological Branch and the Division of Building Research. Population was used as the primary criterion in selecting

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\* D. W. Boyd is a member of the staff of the Meteorological Branch of the Department of Transport seconded to work full time as Climatologist with the Division of Building Research. This note therefore represents a joint contribution from this Division, and from the Meteorological Branch.

stations, but the choice was frequently influenced by previous lists, geographical coverage and availability of weather records.

The 33 stations in the table of summer climatic conditions in the 1965 edition of the Guide were all included. Of the 62 stations in the winter table three were deleted because of their small populations: Knob Lake is an airport and weather station but not a post office, and the adjacent town of Schefferville has a population of only 3178; Mont Joli (pop. 6178) was replaced by Rimouski (pop. 17,739); Norman Wells has a population of 183. The additional 41 stations were all selected from the list of 186 urban municipalities in the 1961 edition of Climatic Information for Building Design in Canada.

To distribute the stations in proportion to the population would, it was thought, result in too many stations in the Lower Lakes and St. Lawrence Valley regions and too few in the Atlantic Provinces and the Prairies. The number of locations in each province was, therefore, chosen to be very nearly proportional to the square root of the province's population, except in the Northwest Territories where more locations were included because of the large area. This method of selection permitted the inclusion of relatively small places in the Atlantic Provinces (Chatham, pop. 7109, Kentville, pop. 4612, Summerside, pop. 8611 and Stephenville, pop. 6043) and in the Prairies (McMurray, pop. 1186, Jasper, pop. 2360 and Estevan, pop. 7728). In Ontario and Quebec the additional stations all have populations over 20,000 except for Kenora (10,904), Owen Sound (17,421) and Rimouski (17,739). Over 30 urban municipalities with populations over 20,000 were omitted because of their proximity to cities on the list.

The columns in the main table are the same as the columns in the two tables in Chapters 26 and 27 in the 1965 Guide. It was suggested later that the latitude and longitude should be tabulated so these had to be listed separately. Almost all the elevations, latitudes and longitudes are the values listed in the machine-tabulated Climatological Station Catalogue with amendments up to April 1966. They refer to the location of the weather observing station, which is seldom in the centre of a city. If a station has been at two or more locations, then its location during most of the period 1951 to 1960 was listed. A few elevations were estimated from large-scale maps and a few latitudes and longitudes were obtained from lists in the Atlas of Canada.

The letters in the third column indicate as nearly as possible the source of the weather observations used to obtain design temperatures. AP indicates that the observations at an airport were used to compute either the January design temperatures or the July design temperatures

or both. CO indicates that the observations at some station in or very near the urban area were used to compute either January or July values or both. These stations include a few experimental farms, a government office, a college, a public utility and private individuals. An asterisk indicates that both the January and July design temperatures were obtained by interpolation on a map of Canada.

January design temperatures on both the 99 and 97 1/2 percentage bases were obtained from machine tabulations of hourly temperatures for the years 1951 to 1960 for 118 weather stations. Our list of 100 stations includes 53 of these stations for which January values have been computed. Values for the remaining 47 stations were interpolated from maps on which all available values had been plotted.

The average annual minimum temperature is usually about the same as, or a few degrees lower than, the January 99 per cent design temperature. To compare them it is important that the two values be computed from the same period of years. Most of the average annual minima are observed values for the ten-year period 1951 to 1960. In 5 cases where there was some doubt about the periods being the same the values were adjusted slightly, and in 7 cases where no data were available the values were estimated.

The wind speeds during extremely cold weather are classified in the ASHRAE Guide on the basis of the frequency with which they exceed 7 mph. The classes are:

VL:	Very Light:	exceeds 7 mph less than 30 per cent of time
L:	Light	: exceeds 7 mph 30 to 49 per cent of time
M:	Moderate	: exceeds 7 mph 50 to 74 per cent of time
H:	High	: exceeds 7 mph 75 per cent or more of time

The classifications for 59 stations were available from the 1965 ASHRAE Guide. The other 41 had to be estimated. The average wind speed for the three months of December, January and February was computed from the monthly values in Climatic Summaries Volume II (Revised) 1959, for 174 stations and plotted on a map (Figure 1). Average wind speeds for other stations could then be estimated by interpolation from the map. Both average wind speeds

and letter classifications were available for 52 stations and from these a relationship was obtained between average speeds and classes. There was some overlapping of classes as one might expect. The results were:

- VL: mean winter speeds up to 7.9 mph
- L: mean winter speeds 8.0 to 9.4 mph
- M: mean winter speeds 9.5 to 12.9 mph
- H: mean winter speeds 13.0 mph and up.

These results were used to assign classes to 9 computed average speeds and 32 average speeds estimated from the map.

Most of the summer design temperatures for Canada published in recent years have been based on the distributions of dry- and wet-bulb temperatures for 33 stations published in Canadian Meteorological Memoirs No. 5. Design temperatures for these 33 stations based on the four-month period from June to September were published in the 1963 and 1965 Guides, but no values were available for the other 67 stations. Both dry- and wet-bulb design temperatures based on the single month, July, were already available for the 2 1/2 per cent level for all of the 100 stations, and also for the 1 and 5 per cent levels for the 33 stations. To estimate the rest of the required values, four maps were prepared based on the differences between the 2 1/2 per cent values and each of the 1 and 5 per cent values for both dry- and wet-bulb July design temperatures for the 33 stations. The maps were used to estimate differences for the remaining 67 stations.

The differences between the 1 per cent and 2 1/2 per cent and between the 2 1/2 per cent and the 5 per cent dry-bulb design temperatures are about 3 F deg on the average whether the values are based on one or four months. All the July dry-bulb values, however, are about 3 deg higher than the corresponding summer values based on four months. The differences between the percentage levels for wet-bulb design temperatures are all about 2 deg and the July wet-bulb values are about 1 deg higher than the corresponding four-month values.

The July daily ranges are the differences between the July mean daily maximum and the July mean daily minimum, based on the available observations during the period 1931 to 1960 as tabulated in a series of pamphlets on temperature normals issued by the Climatology Division and numbered CDS #1 and #5-62, #6 to #9-64 and #1 to #3-65. Ranges were estimated for 13 stations for which mean temperatures were not tabulated.

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TABLE I

DESIGN TEMPERATURES FOR ASHRAE GUIDE, 1967

Prov.	Station		Lat. N		Long. W		Elev. ft	Aver. Ann. Min.	Jan Design Temp.		Winter Wind Speed	July Design Dry Bulb			July Design Wet Bulb			
			o	'	o	'			99%	97%		1%	2 1/2%	5%	1%	2 1/2%	5%	
Alta.	Calgary	AP	51	06	114	01	3540	-30	-29	-25	M	87	85	82	26	66	64	63
	Edmonton	AP	53	34	113	31	2219	-30	-29	-26	VL	86	83	80	23	69	67	65
	Grande Prairie	AP	55	11	118	53	2190	-44	-43	-37	VL	84	81	78	23	66	64	63
	Jasper	CO	52	53	118	04	3480	-38	-32	-28	VL	87	84	81	28	66	64	63
	Lethbridge	AP	49	38	112	48	3018	-31	-31	-24	M	91	88	85	28	68	66	64
	McMurray	AP	56	39	111	13	1216	-44	-42	-39	VL	87	84	81	28	69	67	65
	Medicine Hat	AP	50	01	110	43	2365	-33	-30	-26	M	96	93	90	28	72	69	67
	Red Deer	AP	52	11	113	54	2965	-38	-33	-28	VL	88	86	83	25	67	65	64
B. C.	Dawson Creek	*	55	47	120	14	2200	-47	-40	-35	L	84	81	78	25	66	64	63
	Fort Nelson	AP	58	50	122	35	1230	-43	-44	-41	VL	87	84	81	23	66	64	63
	Kamloops	CO	50	41	120	28	1150	-15	-16	-10	VL	97	94	91	31	71	69	68
	Nanaimo	CO	49	10	123	57	100	16	17	20	VL	81	78	75	20	66	64	62
	New Westminster	CO	49	13	122	54	50	12	15	19	VL	86	84	82	20	68	66	65
	Penticton	AP	49	28	119	36	1121	0	-1	3	L	94	91	88	31	71	69	68
	Prince George	AP	53	53	122	41	2218	-38	-37	-31	VL	85	82	79	26	68	65	63
	Prince Rupert	CO	54	17	130	23	170	9	11	15	L	73	71	69	13	62	60	59
	Trail	*	49	08	117	44	1400	-3	-2	3	VL	94	91	88	30	70	68	67
	Vancouver	AP	49	11	123	10	16	13	15	19	L	80	78	76	17	68	66	65
	Victoria	CO	48	25	123	19	228	20	20	23	M	80	76	72	16	64	62	60
Man.	Brandon	CO	49	52	99	59	1200	-36	-29	-26	M	90	87	84	26	75	73	71
	Churchill	AP	58	45	94	04	115	-43	-40	-38	H	79	75	72	18	68	66	63
	Dauphin	AP	51	06	100	03	999	-35	-29	-26	M	89	86	83	24	74	72	70
	Flin Flon	CO	54	46	101	51	1098	-38	-40	-36	L	85	81	78	19	71	69	67
	Portage la Prairie	AP	49	54	98	16	867	-28	-25	-22	M	90	87	84	22	75	74	72
	The Pas	AP	53	58	101	06	894	-41	-35	-32	M	85	81	78	20	73	71	69
	Winnipeg	AP	49	54	97	14	786	-31	-28	-25	M	90	87	84	23	75	74	72

TABLE I (Continued)

Prov.	Station		Lat. N		Long. W		Elev. Ft.	Aver. Ann. Min.	Jan. Design Temp		Winter Wind Speed	July Design Dry Bulb			July Daily Range	July Design Wet Bulb		
			°	'	°	'			99%	97½%		1%	2½%	5%		1%	2½%	5%
N. B.	Campbellton	CO	48	00	66	40	25	-20	-18	-14	L	87	84	81	20	74	71	69
	Chatham	AP	47	01	65	27	112	-17	-15	-10	M	90	87	84	22	74	71	69
	Edmundston	CO	47	22	68	20	500	-29	-20	-16	M	84	81	78	21	75	72	70
	Fredericton	AP	45	52	66	32	74	-19	-16	-10	L	89	86	83	23	73	70	68
	Moncton	AP	46	07	64	41	248	-16	-12	-7	H	88	85	82	21	74	71	69
	Saint John	AP	45	19	65	53	352	-15	-12	-7	M	81	79	77	18	71	68	66
Nfld.	Corner Brook	CO	48	58	57	57	40	-9	-10	-5	H	84	81	79	18	69	68	66
	Gander	AP	48	57	54	34	482	-5	-5	-1	H	85	82	79	20	69	68	66
	Goose Bay	AP	53	19	60	25	144	-28	-27	-25	M	86	81	77	18	69	67	65
	St. John's	AP	47	37	52	45	463	1	2	6	H	79	77	75	17	69	68	66
	Stephenville	*	48	32	58	33	44	-4	-6	-1	H	79	76	74	13	69	68	66
N. W. T.	Fort Smith	AP	60	01	111	58	665	-51	-49	-46	VL	85	83	80	25	67	65	64
	Frobisher Bay	AP	63	45	68	33	68	-45	-45	-42	H	63	59	56	14	---	---	---
	Inuvik	*	68	21	133	44	75	-54	-50	-48	VL	80	77	75	23	63	61	60
	Resolute	AP	74	43	94	59	209	-52	-49	-47	M	54	51	49	10	---	---	---
	Yellowknife	AP	62	28	114	27	682	-51	-49	-47	VL	78	76	74	17	65	63	62
N. S.	Amherst	*	45	50	64	12	63	-15	-10	-5	H	85	82	79	21	72	70	68
	Halifax	AP	44	38	63	30	136	-4	0	4	H	83	80	77	16	69	68	67
	Kentville	CO	45	04	64	29	50	-8	-4	0	M	86	83	80	23	72	70	69
	New Glasgow	*	45	37	62	37	317	-16	-10	-5	H	84	81	79	21	72	70	68
	Sydney	AP	46	10	60	03	197	-3	0	5	H	84	82	80	20	72	70	68
	Truro	CO	45	22	63	18	77	-17	-12	-7	M	84	81	79	22	72	70	69
	Yarmouth	AP	43	50	66	05	136	2	5	9	H	76	73	71	15	69	68	67

TABLE I (Continued)

Prov.	Station		Lat. N ° ' "	Long. W ° ' "	Elev. ft	Aver. Ann. Min.	Jan Design Temp			Winter Wind Speed.	July Design Dry Bulb			July Daily Range	July Design Wet Bulb		
							99%	97% <sup>2</sup>	95%		1%	2% <sup>2</sup>	5%		1%	2% <sup>2</sup>	5%
Ont.	Belleville	CO	44 09	77 24	250	-15	-11	-7	M	89	86	84	21	77	75	73	
	Chatham	CO	42 23	82 12	600	-1	3	6	M	92	90	88	20	77	75	74	
	Cornwall	*	45 03	74 46	210	-22	-14	-9	M	89	86	84	23	77	75	74	
	Fort William	AP	48 22	89 19	644	-31	-27	-23	L	86	83	80	23	72	70	68	
	Hamilton	*	43 16	79 54	303	-2	0	3	M	91	88	86	21	77	75	73	
	Kapuskasing	AP	49 25	82 28	752	-37	-31	-28	M	87	84	81	23	73	71	69	
	Kenora	AP	49 48	94 22	1345	-33	-31	-28	M	86	83	80	20	75	73	71	
	Kingston	CO	44 16	76 30	300	-16	-10	-7	M	85	82	80	20	77	75	73	
	Kitchener	*	43 27	80 31	1125	-11	-3	1	M	88	85	83	24	76	75	74	
	London	AP	43 02	81 09	912	-9	-1	3	M	90	88	86	22	76	75	74	
	North Bay	AP	46 22	79 25	1210	-27	-21	-17	M	87	84	82	18	71	70	69	
	Oshawa	*	43 54	78 52	370	-11	-5	-2	M	90	87	85	21	77	75	73	
	Ottawa	AP	45 19	75 40	339	-21	-17	-13	M	90	87	84	21	75	74	73	
	Owen Sound	*	44 34	80 55	597	-9	-5	-1	M	87	84	82	21	74	72	71	
	Peterborough	CO	44 20	78 19	648	-20	-13	-9	M	90	87	85	22	76	74	73	
	St. Catharines	CO	43 11	79 14	325	1	2	5	M	91	88	86	20	77	75	73	
	Sarnia	*	42 58	82 22	625	-6	2	6	M	92	90	88	19	76	74	73	
	Sault Ste. Marie	CO	46 32	84 30	675	-21	-20	-15	M	88	85	83	22	72	70	68	
	Sudbury	*	46 29	80 59	850	-25	-20	-15	VL	89	86	84	25	72	70	69	
	Timmins	CO	48 30	81 20	1100	-37	-33	-28	M	90	87	84	24	73	71	69	
Toronto	AP	43 41	79 38	578	-10	-3	1	M	90	87	85	22	77	75	73		
Windsor	AP	42 16	82 58	637	-1	4	7	M	92	90	88	20	77	75	74		
P. E. I.	Charlottetown	AP	46 17	63 08	186	-11	-6	-3	H	84	81	79	16	72	70	68	
	Summerside	AP	46 26	63 50	78	-10	-8	-3	H	84	81	79	16	72	70	68	

TABLE I (Continued)

Prov.	Station		Lat. N	Long. W	Elev. Ft.	Aver. Ann. Min.	Jan Design Temp		Winter Wind Speed	July Design Dry Bulb			July Daily Range	July Design Wet Bulb		
							99%	97%		1%	2 1/2%	5%		1%	2 1/2%	5%
Que.	Bagotville	*	48 20	71 00	536	-35	-26	-22	VL	88	84	81	20	72	71	69
	Chicoutimi	CO	48 25	71 05	150	-31	-24	-20	VL	87	83	80	20	72	71	69
	Drummondville	CO	45 53	72 29	270	-26	-18	-13	M	88	85	82	22	76	74	72
	Granby	*	45 23	72 42	550	-23	-17	-12	L	87	84	82	21	76	74	72
	Hull	*	45 26	75 43	200	-21	-17	-13	M	90	87	84	21	75	74	73
	Mégantic	AP	45 35	70 52	1362	-27	-20	-16	M	84	81	78	19	75	73	71
	Montréal	AP	45 28	73 45	98	-20	-16	-10	M	88	86	84	18	76	74	73
	Québec	AP	46 48	71 23	245	-25	-19	-13	M	86	82	79	21	75	73	71
	Rimouski	*	48 27	68 32	117	-18	-16	-12	H	78	74	71	18	71	69	68
	St. Jean	*	45 18	73 16	129	-21	-15	-10	M	87	85	83	20	76	74	73
	St. Jérôme	*	45 48	74 01	310	-30	-18	-13	L	87	84	82	23	76	74	73
	Sept Îles	AP	50 13	66 16	190	-29	-27	-22	L	80	78	75	17	66	64	63
	Shawinigan	*	46 34	72 43	306	-27	-20	-15	L	88	85	83	21	76	74	72
	Sherbrooke	CO	45 24	71 54	595	-25	-18	-13	L	87	84	81	20	75	73	71
	Thetford Mines	*	46 04	71 19	1020	-25	-19	-14	M	86	83	80	22	75	73	71
	Trois Rivières	CO	46 21	72 35	200	-30	-18	-13	M	88	85	82	23	76	74	72
Val d'Or	AP	48 03	77 47	1108	-37	-31	-27	L	88	85	82	22	72	71	69	
Valleyfield	*	45 16	74 06	150	-20	-14	-9	M	87	85	83	21	76	74	73	
Sask.	Estevan	AP	49 04	103 00	1884	-32	-30	-25	M	93	89	86	25	75	73	71
	Moose Jaw	AP	50 20	105 33	1857	-33	-32	-27	M	93	89	86	27	73	71	69
	North Battleford	AP	52 46	108 15	1796	-33	-33	-29	L	90	86	83	25	71	69	67
	Prince Albert	AP	53 13	105 41	1414	-45	-41	-35	VL	88	84	81	25	72	70	68
	Regina	AP	50 26	104 40	1884	-38	-34	-29	M	92	88	85	27	73	71	69
	Saskatoon	AP	52 10	106 41	1645	-37	-34	-30	M	90	86	83	25	71	69	67
	Swift Current	AP	50 17	107 41	2677	-31	-29	-25	M	93	89	86	24	72	70	68
	Yorkton	AP	51 16	102 28	1653	-38	-33	-28	M	89	85	82	23	74	72	70
Yuk.	Whitehorse	AP	60 43	135 04	2289	-45	-45	-42	VL	78	75	72	22	62	60	59

