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THE DISCOMFORT INDEX AT TORONTO

The Discomfort Index is a new term that is being used in the United States to indicate the degree of discomfort caused by various combinations of temperature and air moisture. The attached data sheets contain various means and extremes of the Discomfort Index as calculated from weather observations taken at Toronto City over the past several years.

The Discomfort Index is obtained by using the following formula -

$$DI = 0.4 (Td + Tw) + 15$$

that is to four-tenths of the sum of the dry and wet bulb temperatures add 15. The resulting value is not a temperature but it is an index which closely approximates the Effective Temperature, a concept used for 35 years by air conditioning engineers. It is generally accepted that the use of the effective temperature is t he best method of representing temperature and humidity in measuring comfort from an air conditioning standpoint. However, these values are difficult to obtain from available meteorological data and so the development of the Discomfort Index which closely approximates the numerical value of the Effective Temperature, may prove to be a valuable contribution to engineers concerned with air conditioning or to any ordinary individual concerned with comfort in the summer.

Monthly values of the Discomfort Index at Toronto are shown for the period June to September from 1936 to 1958. The average values were obtained by using monthly values of dry and wet bulb temperatures averaged over the 24 hours of each day. During the past 10 years June has averaged an index of 65, July 69, August 68, and September 62. Since 1936 the most uncomfortable month was July 1955 when the index averaged 72.

On an hourly basis the indices at 3.00 p.m. average the highest - June 69, July 73, August 72, and September 66. During July 1955, the index was 76 at 1.00 p.m., 76 at 3.00 p.m. and 75 at 5.00 p.m. However, the highest individual hourly index that month was only 81 compared to a record high of 88 on July 10, 1936 at 5.00 p.m. Other extreme values since 1936 have been 85 at 3.00 and 4.00 p.m. on August 25, 1948 and again at 2.00 p.m. September 2, 1953. In 1958 the highest value was 81 on July 2 at 3 and 4.00 p.m. The maximum Discomfort Index yet computed in the United States is 92 which has occurred at Yuma, Arizona.

A provisional survey of the duration of high Discomfort Index values shows that last year, in 1958, the day with the greatest discomfort - July 2 had an index of over 80 for 4 hours from 3.00 to 6.00 p.m. In comparison, on August 1, 1955 the value remained over 80 for 9 hours from 11.00 a.m. to 7.00 p.m. One of the longest periods of extreme discomfort was on July 10, 1936 when the index reached 81 at 10.00 a.m., peaked 88 at 5.00 p.m. and had only decreased to 81 at midnight - a total of 14 consecutive hours with the index over 80.

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MKT:dmp
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NOTE: All times used are Eastern Daylight Saving Time.

DISCOMFORT INDEX

(A) Average Monthly Values

	June	July	August	September
1936	65	70	67	63
1937	66	70	71	61
1938	66	70	71	61
1939	65	70	70	63
1940	63	69	68	61
1941	67	69	66	63
1942	65	67	67	62
1943	67	69	67	60
1944	65	69	69	62
1945	63	67	67	63
1946	63	68	65	62
1947	64	68	71	63
1948	65	69	68	64
1949	69	71	70	60
1950	64	67	67	61
1951	65	69	67	62
1952	65	71	68	63
1953	65	69	68	63
1954	65	67	66	62
1955	66	72	71	62
1956	65	67	67	59
1957	66	68	66	62
1958	61	68	67	62
10 Year Average 1949-1958	65	69	68	62
Highest	69	72	71	64
Year	1949	1955	1955*	1948

*and earlier years.

(B) Average Hourly Values - 1949-1958

	1 PM	3 PM	5 PM
June	68.5	69.4	68.5
July	72.4	72.9	72.2
August	71.1	71.9	70.8
September	65.0	65.6	64.8

(C) Hourly values during months with high Discomfort Indices - 1949-1958

		1 PM	3 PM	5 PM
July	1955	76	76	75
August	1955	74	74	73
July	1952	74	75	74
June	1949	73	74	73
July	1949	74	75	74
August	1949	74	75	73
For comparison				
July	1958	71	72	71
August	1958	71	71	70

(D) Some extreme hourly values of Discomfort Indices

Date	Hour	Temperature Dry Bulb	Temperature Wet Bulb	Relative Humidity	Discomfort Index	Consecutive Hours With Discomfort Index over 80
July 8, 1936	4 PM	105	78	29%	88	Noon - 10 PM
July 9, 1936	4 PM	105	77	28%	88	Noon - 10 PM
July 10, 1936	5 PM	105	77	28%	88	10 AM - 11 PM
July 11, 1936	5 PM	97	78	42%	85	11 AM - 11 PM
July 12, 1936	5 PM	94	75	41%	83	10 AM - 7 PM
July 13, 1936	7 PM	102	79	36%	87	Noon - 11 PM
Aug 25, 1948	4 PM	101	75	29%	85	11 AM - 8 PM
Sept 2, 1953	3 PM	99	76	34%	85	10 AM - 8 PM
Extremes in most recent 5 years						
1954 Aug 24	4 PM	87	77	63%	81	4 PM - 5 PM
1955 Aug 1	4 PM	98	75	34%	84	11 AM - 7 PM
1956 June 13	3 PM	94	73	36%	82	Noon - 6 PM
1957 June 18	2 PM	92	79	57%	83	1 PM - 4 PM
1958 July 2	3 PM	89	76	28%	81	3 PM - 6 PM

- All times are Eastern Daylight Saving Time -

DISCOMFORT INDEX REFERENCES

Papers are all by E.C. Thom, Office of Climatology, U.S. Weather Bureau, Washington 25, D.C., U.S.A.

1959	"The Discomfort Index"	-	Weatherwise, 12:2:57-60, April 1959.
1958	"Cooling Degree-Days"	-	Manuscript of a paper given at 2nd National Conference on Applied Meteorology, Ann Arbor, Mich., September 1958.
1958	"Cooling Degree-Days"	-	Air Conditioning, Heating and Ventilating, p. 66-72, July 1958.
1957	"A New Concept for Cooling Degree-Days"	-	Air Conditioning, Heating and Ventilating, 8 p., June 1957.
1957	"Cooling Degree-Days"	-	Weekly Weather and Crop Bulletin, 44:12:7-8, March 25, 1957.
1956	"Measuring the Need for Air Conditioning"	-	Air Conditioning, Heating and Ventilating, 6 p., August 1956.

Also see (1) Handbook of Air Conditioning, Heating and Ventilating. Section on summer design temperatures and cooling degree-days, p. 1-135 to 1-154.

(2) ASHAE GUIDE - Annual issues, Chapter on Physiological Principles - Effective temperature index and comfort zones.

DEFINITION

EFFECTIVE TEMPERATURE:

An arbritrary index which combines into a single value the effect of temperature, humidity and air movement on the sensation of warmth or cold felt by the human body. The numerical value is that of the temperature of still saturated air which would induce an identical sensation.