

CHAPTER 2 – TEMPERATURE RANGE STUDY

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2.1—BACKGROUND AND OBJECTIVE OF RESEARCH

Temperature range is one of the major parameters that is considered when calculating the temperature induced stresses and movements in bridge design. It is important that these stresses and movements be accurately predicted. Underestimation of the temperature range may lead to cracking and reduce the service life of bridges. Overestimation of the temperature range will require excessive movement capacity in the bearings and expansion joints, thereby increasing the cost of bridge construction.

The current AASHTO Specifications include only two temperature ranges, one for "moderate climate" and the other for "cold climate". This may not necessarily reflect the actual temperature conditions in Louisiana; therefore, a study of actual temperature conditions is necessary to provide more accurate design information.

The objective of this research is to find the actual temperature range to be used in the design of concrete and steel bridges. The research is based on the historic temperature records from 2000 to 2012 in different areas of the state. Temperature data is summarized and recommended modification to the AASHTO Specifications is given in the following sections.

2.2—HISTORIC TEMPERATURE RECORD

Temperature records from 2000 to 2012 are shown in Table 2.2-1. The source of historic temperature information is Louisiana Office of State Climatology (<http://www.losc.lsu.edu/cgi-bin/newsmoonthly.py>).

Table 2.2-1: Historic Temperature Record in Louisiana (2000 to 2012)

Year	Location	Max/Min Temperature, °F											
		Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
2000	Northwest	80/20	82/21	87/30	87/33	94/50	95/52	103/61	110/63	111/40	94/33	87/26	71/20
	North-central	80/21	84/21	89/31	89/32	98/48	96/51	105/59	109/60	111/41	98/32	87/22	72/15
	Northeast	81/20	84/21	85/29	88/36	96/49	95/53	106/60	108/64	104/44	93/34	87/26	74/19
	West-central	81/20	84/21	88/30	90/31	96/50	96/55	105/59	107/60	110/42	94/33	87/21	75/19
	Central	81/12	83/21	87/29	90/32	98/50	99/53	104/59	109/60	110/42	96/35	87/25	77/18
	East-Central	81/21	86/21	90/28	88/30	98/50	100/55	105/60	107/62	105/47	92/35	86/25	77/18
	Southwest	82/24	83/24	86/34	88/33	96/52	95/57	101/58	108/62	109/45	93/40	86/28	81/22
	South-central	81/26	83/27	85/37	88/35	95/56	96/60	100/65	104/65	103/47	91/40	85/27	76/22
	Southeast	82/25	86/19	87/38	88/39	98/57	98/59	104/65	103/61	103/52	92/44	90/29	80/20
2001	Northwest	72/13	79/20	79/30	89/37	92/47	95/61	102/65	100/64	94/43	89/32	84/25	80/23
	North-central	79/10	81/21	79/28	89/34	92/49	95/58	100/64	99/64	95/41	88/30	85/25	78/23
	Northeast	75/14	84/23	79/31	90/37	93/51	96/59	100/60	99/61	94/42	89/32	86/24	79/26
	West-central	75/14	81/24	80/30	89/33	98/45	97/58	101/64	101/65	95/44	89/32	83/25	79/22
	Central	75/15	90/22	80/28	94/33	96/49	96/56	99/38	100/62	95/42	88/31	85/26	81/23
	East-Central	76/19	84/25	79/31	89/36	94/45	96/59	97/62	95/67	92/46	88/31	84/29	82/22
	Southwest	75/19	82/27	80/33	89/37	93/45	95/58	97/65	99/68	94/48	87/35	85/31	79/24
	South-central	75/20	85/27	81/34	92/41	94/50	97/61	96/69	98/66	95/47	88/34	85/32	82/25
	Southeast	80/13	86/31	84/34	92/40	95/48	98/64	98/58	98/63	94/51	92/39	86/41	85/20

Table 2.2-1 (continued): Historic Temperature Record in Louisiana (2000 to 2012)

Year	Location	Max/Min Temperature, °F											
		Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
2002	Northwest	80/15	80/18	83/15	93/37	94/44	95/59	98/68	100/65	99/54	97/41	85/27	76/25
	North-central	81/14	83/16	85/14	92/35	93/42	97/55	100/64	100/63	101/57	93/41	86/20	77/23
	Northeast	82/18	83/20	86/17	93/38	94/44	97/58	99/67	98/64	98/58	92/41	87/26	78/24
	West-central	83/15	81/17	86/14	93/37	95/42	97/54	101/63	101/63	99/56	92/41	86/27	77/27
	Central	84/16	84/18	86/17	92/37	95/40	98/58	100/67	99/63	100/53	95/42	90/28	80/24
	East-Central	84/17	83/20	87/20	90/38	95/43	96/60	97/68	96/65	97/63	91/40	84/29	77/27
	Southwest	82/19	80/23	87/20	89/45	93/48	96/62	97/70	99/67	97/61	91/33	84/31	76/28
	South-central	83/18	83/21	86/24	89/41	92/47	95/62	96/67	97/63	96/60	92/42	84/28	77/26
	Southeast	86/23	83/28	89/22	91/46	94/52	98/66	99/70	98/69	96/65	92/49	86/35	82/27
2003	Northwest	79/18	79/28	79/31	89/33	98/53	98/62	100/68	101/66	96/50	91/42	86/25	80/22
	North-central	79/11	74/26	81/29	90/31	95/51	98/60	98/62	101/66	93/44	91/39	89/25	73/22
	Northeast	75/15	77/25	80/27	90/34	95/53	96/59	97/60	100/65	95/44	91/36	88/22	75/21
	West-central	79/18	76/27	81/30	92/29	98/47	98/57	98/65	100/64	94/44	91/34	94/23	76/22
	Central	79/16	78/27	82/30	100/28	96/50	98/59	98/65	102/66	96/46	94/37	88/23	84/23
	East-Central	76/17	78/29	84/29	89/34	93/0	95/60	95/68	96/62	94/47	92/43	89/25	78/24
	Southwest	76/21	76/31	80/36	89/34	94/54	94/61	98/62	99/66	93/51	89/41	87/28	80/28
	South-central	76/20	78/31	81/34	89/32	94/56	95/67	97/67	99/67	94/51	90/44	87/29	79/27
	Southeast	77/22	80/33	85/35	87/35	93/59	95/67	96/68	96/68	94/53	89/43	86/29	78/29
2004	Northwest	77/17	76/22	86/27	87/30	91/48	95/64	98/63	100/56	98/54	90/43	86/34	83/19
	North-central	76/18	77/22	88/33	89/35	92/44	95/61	99/61	96/52	98/52	91/39	86/32	75/17
	Northeast	79/19	75/23	87/33	89/36	94/45	96/58	100/62	99/51	95/52	94/41	89/34	76/19
	West-central	78/18	78/23	87/32	89/32	93/44	95/64	98/61	97/52	100/52	92/42	88/33	77/19
	Central	91/18	77/24	87/33	89/35	93/43	95/56	101/63	101/51	102/50	94/41	89/34	79/17
	East-Central	80/19	76/26	86/33	88/35	92/41	96/60	99/59	97/50	100/51	95/24	86/34	79/23
	Southwest	79/20	76/29	85/37	87/35	91/49	95/64	99/61	98/54	99/57	95/46	88/37	79/21
	South-central	79/24	77/30	85/39	87/40	92/48	94/67	98/67	98/56	100/56	95/46	91/38	80/22
	Southeast	81/26	78/32	86/38	91/43	93/47	98/64	99/70	99/58	98/62	93/48	89/39	80/25
2005	Northwest	77/24	83/29	87/30	88/33	96/40	101/59	101/64	104/65	104/54	92/33	86/27	84/17
	North-central	78/20	81/27	87/30	87/37	96/40	98/52	102/64	105/65	104/50	94/29	88/23	83/19
	Northeast	78/21	79/29	84/31	87/38	97/40	98/50	100/60	104/62	102/51	93/29	89/10	82/18
	West-central	79/22	80/28	85/30	87/35	97/37	99/57	101/61	101/62	103/55	92/30	90/25	81/20
	Central	82/22	83/29	85/30	89/36	100/40	100/56	101/66	102/65	106/52	94/30	88/25	82/22
	East-Central	80/23	86/29	88/30	87/37	96/44	97/61	100/67	99/68	99/62	93/33	89/27	81/25
	Southwest	79/26	81/29	86/30	87/42	99/44	99/64	100/68	100/49	101/61	93/38	87/31	80/28
	South-central	81/25	82/35	85/36	87/44	98/49	98/66	101/69	99/68	99/64	93/37	89/30	82/27
	Southeast	80/29	82/37	87/36	88/44	96/51	99/68	100/69	99/68	98/68	91/36	89/33	81/31

Table 2.2-1 (continued): Historic Temperature Record in Louisiana (2000 to 2012)

Year	Location	Max/Min Temperature, °F											
		Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
2006	Northwest	80/27	78/22	89/30	94/40	94/47	96/57	106/64	105/61	99/47	96/35	86/25	78/18
	North-central	79/22	76/20	88/27	94/34	94/44	97/54	103/60	105/58	99/42	95/31	84/23	81/15
	Northeast	79/22	78/23	90/31	96/38	94/48	98/55	102/59	104/62	95/42	98/34	84/23	82/16
	West-central	79/24	78/21	88/28	94/37	93/44	95/56	101/63	107/58	96/46	95/33	85/24	81/16
	Central	81/26	81/23	90/28	94/37	94/46	98/56	101/60	103/57	96/46	96/35	86/22	82/17
	East-Central	83/22	83/23	87/30	93/40	95/47	100/57	100/67	101/66	96/50	97/38	84/28	82/22
	Southwest	81/31	79/27	85/34	92/45	93/50	99/61	99/65	101/65	95/51	94/45	84/30	83/23
	South-central	85/29	81/25	85/32	93/42	92/51	102/60	99/66	101/65	93/55	95/43	84/21	83/23
2007	Northwest	81/28	82/29	83/36	92/38	95/54	100/42	98/70	98/67	95/56	93/43	87/31	82/27
	Northwest	80/21	82/19	86/26	89/36	93/49	97/63	96/63	109/67	96/57	94/37	86/28	82/23
	North-central	77/18	82/20	87/22	88/33	93/46	96/60	96/61	105/68	98/54	94/38	84/27	83/23
	Northeast	77/21	82/19	87/25	88/33	92/44	98/58	97/51	103/65	96/53	93/38	84/24	83/20
	West-central	78/20	83/20	85/23	89/32	91/45	96/60	96/61	102/68	98/56	92/35	86/28	82/22
	Central	78/19	82/23	86/24	90/34	99/44	98/61	97/51	107/50	96/53	94/32	85/28	86/23
	East-Central	79/21	82/25	87/27	88/34	92/48	97/62	95/65	104/68	95/56	91/41	83/29	85/24
	Southwest	77/27	80/25	84/30	89/16	93/50	96/64	97/65	103/69	96/62	95/41	85/33	82/28
2008	South-central	80/27	83/24	85/19	89/36	93/51	96/62	95/64	103/69	96/59	92/40	84/33	83/25
	Southwest	80/29	83/27	85/32	91/39	93/53	97/64	97/68	107/71	95/60	91/44	85/33	83/29
	Northwest	79/19	80/24	87/30	87/34	95/44	97/63	106/61	107/66	94/51	87/30	80/23	83/22
	North-central	78/16	80/25	87/27	91/30	94/43	96/60	104/60	105/65	96/48	88/27	81/25	86/21
	Northeast	77/15	80/27	87/27	91/31	94/41	98/58	104/59	103/61	94/48	88/28	83/23	80/23
	West-central	78/19	80/25	88/29	89/31	95/40	96/60	105/58	106/65	94/49	88/28	82/27	77/23
	Central	82/17	82/26	88/-4	90/29	96/45	98/61	105/59	104/64	95/1	91/29	85/26	81/24
	East-Central	81/17	83/27	88/29	90/31	95/46	97/62	100/61	97/64	94/52	89/31	82/25	83/24
2009	Southwest	78/22	82/31	90/32	89/36	94/51	96/64	99/64	101/58	95/54	91/34	85/31	82/27
	South-central	80/23	81/31	86/30	90/33	92/47	96/62	98/67	97/69	93/54	90/30	81/30	82/25
	Southwest	80/25	82/34	84/33	89/37	93/53	97/64	99/68	97/69	114/56	90/34	83/32	81/30
	Northwest	81/19	83/24	87/25	91/33	90/47	103/59	105/65	96/61	97/52	92/39	81/30	70/20
	North-central	81/18	83/24	84/25	90/30	92/47	105/54	102/60	97/56	96/48	92/36	79/28	76/19
	Northeast	78/21	84/22	84/26	90/33	90/50	102/56	102/59	97/55	94/50	91/36	80/24	76/20
	West-central	79/19	84/21	85/23	91/27	92/46	103/55	105/62	98/58	94/49	94/36	80/27	76/19
	Central	79/20	85/25	86/19	91/28	92/45	106/53	107/61	99/57	97/49	97/35	90/27	79/23
East-Central	81/22	83/24	85/28	87/33	91/51	103/57	102/64	96/60	94/52	93/38	83/28	75/25	
2010	Southwest	79/25	80/29	83/30	88/35	89/47	103/59	101/67	98/59	94/55	93/40	81/32	77/25
	South-central	79/24	81/28	85/30	86/36	92/50	102/56	100/53	97/59	94/55	93/39	80/30	77/27
2011	Southwest	80/26	92/28	83/33	87/39	92/48	103/63	100/65	99/65	93/59	97/43	85/33	78/30
	South-central	80/26	92/28	83/33	87/39	92/48	103/63	100/65	99/65	93/59	97/43	85/33	78/30

Table 2.2-1 (continued): Historic Temperature Record in Louisiana (2000 to 2012)

Year	Location	Max/Min Temperature, °F											
		Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
2010	Northwest	76/12	70/23	80/27	85/38	96/50	104/69	100/72	105/59	101/50	99/33	84/28	82/19
	North-central	74/11	68/21	81/25	86/35	95/47	102/65	102/71	106/57	102/46	95/29	84/26	82/15
	Northeast	76/15	72/23	79/26	86/36	95/46	100/68	102/69	106/62	101/47	94/29	87/24	84/13
	West-central	76/11	72/20	82/24	87/34	96/47	102/66	102/67	105/64	99/47	93/32	84/24	80/16
	Central	79/11	74/20	82/17	88/28	97/50	101/66	104/69	105/63	99/46	94/32	85/27	80/17
	East-Central	79/15	72/25	81/28	88/40	95/55	99/67	98/68	103/67	97/50	94/33	84/29	78/18
	Southwest	79/17	75/26	82/29	89/41	97/55	100/68	99/70	101/58	99/54	92/36	84/26	79/23
	South-central	82/17	72/20	80/31	89/40	95/55	98/69	99/70	101/69	96/53	91/36	82/30	77/23
	Southeast	79/21	75/30	82/32	87/37	96/55	97/70	98/69	103/71	97/45	93/41	98/32	85/24
2011	Northwest	77/19	82/15	88/31	92/36	97/43	105/61	108/69	112/69	107/47	92/32	84/30	70/23
	North-central	79/16	85/14	88/28	92/32	96/39	104/56	104/66	107/63	103/44	95/28	87/24	81/20
	Northeast	79/16	87/17	88/32	91/39	95/39	103/64	103/66	105/61	102/45	91/27	85/25	80/21
	West-central	76/16	81/14	87/28	91/32	96/37	103/63	102/68	108/64	102/45	90/30	83/25	79/20
	Central	76/18	85/19	86/19	93/32	98/42	107/66	102/66	109/51	102/44	90/30	84/27	79/23
	East-Central	72/19	87/20	86/33	89/39	96/41	103/64	100/68	101/55	97/51	89/31	89/27	80/24
	Southwest	74/20	82/18	85/36	92/39	96/44	103/67	101/68	112/68	101/51	90/35	84/32	80/25
	South-central	77/18	83/23	87/38	89/39	94/45	103/65	100/68	102/68	97/41	90/36	84/32	81/28
	Southeast	77/25	84/12	89/16	90/43	96/52	101/61	100/64	100/72	95/56	94/42	89/30	86/33
2012	Northwest	80/21	87/24	85/32	87/42	95/50	103/59	103/71	101/61	103/53	88/34	90/29	80/22
	North-central	81/16	89/21	86/28	87/41	96/49	104/59	106/69	103/56	100/50	86/31	85/25	80/19
	Northeast	79/21	87/22	88/33	89/39	96/51	101/56	103/67	99/56	98/40	91/23	87/20	82/20
	West-central	80/17	84/22	85/28	87/40	95/53	102/56	99/64	100/56	98/47	87/29	87/26	81/20
	Central	93/23	84/2	88/16	89/22	95/51	104/56	102/67	99/62	100/47	89/31	87/27	82/20
	East-Central	81/22	81/25	85/35	89/40	96/54	101/56	97/60	96/65	96/54	88/32	84/28	80/27
	Southwest	79/27	82/28	86/37	88/45	94/58	101/61	98/62	98/62	97/53	88/35	86/30	82/27
	South-central	80/28	83/29	85/37	89/45	94/53	101/59	98/67	96/68	97/56	88/35	86/33	82/28
	Southeast	81/25	83/30	87/38	88/45	97/42	102/60	100/70	97/67	94/62	90/36	84/32	80/30

2.3—SUMMARY AND RECOMMENDATIONS

The minimum and maximum measured temperature and calculated temperature ranges in each region of Louisiana are summarized in Tables 2.3-1 to 2.3-3.

Table 2.3-1: Summary of Minimum Temperature, °F

Area	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Avg
Northwest	20	13	15	18	17	17	18	19	19	19	12	15	21	17
North-central	15	10	14	11	17	19	15	18	16	18	11	14	16	15
Northeast	19	14	17	15	19	18	16	19	15	20	13	16	20	17
West-central	19	14	14	18	18	20	16	20	19	19	11	14	17	17
Central	12	15	16	16	17	22	17	19	-4	20	11	18	2	14
East-Central	18	19	17	0	19	23	22	21	17	22	15	19	22	18
Southwest	22	19	19	21	20	26	23	25	22	25	17	18	27	22
South-central	22	20	18	20	22	25	23	24	23	24	17	18	28	22
Southeast	20	13	22	22	25	29	27	27	24	26	21	12	25	23

Average of all areas: 18

Table 2.3-2: Summary of Maximum Temperature, °F

Area	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Avg
Northwest	111	102	100	101	100	104	106	109	107	105	105	112	103	105
North-central	111	100	101	101	99	105	105	105	105	105	106	107	106	104
Northeast	108	100	99	100	100	104	104	103	104	102	106	105	103	103
West-central	110	101	101	100	100	103	107	102	106	105	105	108	102	104
Central	110	100	100	102	102	106	103	107	105	107	105	109	104	105
East-Central	107	97	97	96	100	100	101	104	100	103	103	103	101	101
Southwest	109	99	99	99	99	101	101	103	101	103	101	112	101	102
South-central	104	98	97	99	100	101	101	103	98	102	101	103	101	101
Southeast	104	98	99	96	99	100	100	107	114	103	103	101	102	102

Average of all areas: 103

Table 2.3-3: Summary of Temperature Range, °F

Area	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Avg
Northwest	91	89	85	83	83	87	88	90	88	86	93	97	82	88
North-central	96	90	87	90	82	86	90	87	89	87	95	93	90	89
Northeast	89	86	82	85	81	86	88	84	89	82	93	89	83	86
West-central	91	87	87	82	82	83	91	82	87	86	94	94	85	87
Central	98	85	84	86	85	84	86	88	109	87	94	91	102	91
East-Central	89	78	80	96	81	77	79	83	83	81	88	84	79	83
Southwest	87	80	80	78	79	75	78	78	79	78	84	94	74	80
South-central	82	78	79	79	78	76	78	79	75	78	84	85	73	79
Southeast	84	85	77	74	74	71	73	80	90	77	82	89	77	79

Average of all areas: 85

Based on the above findings, Table 2.3-4 is recommended to replace Table A3.12.2.1-1 in *AASHTO LRFD Bridge Design Specifications*. The design values for steel bridges are based on Louisiana historical practice. The base construction temperature is assumed to be 68°F.

Table 2.3-4: Recommended Temperature Ranges

Material	Temperature Range	Rise	Fall	Minimum Temperature	Maximum Temperature
Concrete Girder Bridges	85°F	35°F	50°F	18°F	103°F
Steel Girder Bridges	120°F	52°F	68°F	0°F	120°F