Facility Rating Methodology and Communication

For

Associated Electric Cooperative, Inc.

Effective Date: November 14, 2017

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Approved by the G&T Operations Committee on 11/7/2017

NOTE: WHEN REVISING THIS PROCEDURE ENSURE LATEST REVISION IS UPLOADED TO THE PUBLIC OASIS SITE.

Revision No.	Revision History	Date Revised
0	Original Issue	12/14/2005
1	Added signature page, revision history page, generator rating information and a section on communicating the use of the document.	03/09/2007
2	Added section and table for rigid bus ratings. Also removed the section associated with generator rating. This is included in the ratings methodology procedure for generators.	11/01/2007
3	Removed the reference to generators in the "Purpose" section.	06/18/2008
4	Added section on high temperature conductors within the Overhead conductor section II.1.	12/12/2008
5	Added section on ratings for 6 inch bus in table in the appendix.	02/25/2009
6	Revised transformer section for thermal overload to refer to C57.92 and added series reactors to the procedures.	06/05/2009
7	Added IEEE standard references for equipment ratings associated with transformers, switches, circuit breakers, and reactive devices.	06/26/2009
8	Provided minor changes to provide more precise clarification on data added more clarity associated with FAC-009 Communication and revised Appendix A	01/22/2010
9	Provided editorial change on the cover sheet date and clarification in the purpose section.	03/24/2010
10	Revised description of short term rating application	04/30/2010
11	Added the clarification associated with operating transmission element to NESC requirements	01/16/2012
12	Clarified that Methodology applies to entire AECI system footprint. Added line to CT's that formula would be used unless Mfg. data to contrary. Other minor editorial cleanup (spacing, etc.)	04/04/2012
13	Changed title; Refined limited element language; Added clarifying language for ratings being continuous for PRC-023.	12/14/2012

	Added "terminal equipment" language per CAN – 0018; Clarified ratings duration.	
14	Updated switch rating IEEE standard reference C37.37-1979 to1996; Clarified that AECI will calculate switch loadability factor from C37.37-1996, Added ambient temperature for switch ratings	10/04/2013
15	Temperature adjusted and short-term limit detail added. Updated appendix F. Added disclaimer to purpose.	06/09/2014
16	Added jumpers and rigid bus conductors to Appendix F. Clarified circuit breaker rating detail in Section II.6.	09/15/2014
17	Corrected spring/fall switch ratings to reflect 87F rather than 86F ambient. Correction made in narrative paragraph and in Appendix E tables.	09/23/2016
18	Added statement in section III stating the MANTIS database serves as the source of limits for EMS and RTCA.	02/15/2017
19	Reformatted Appendix A Conductor Ratings table; Corrected 1431, ACSR 45/7 ratings	04/27/2017
20	Added jumper ratings to conductor table in Appendix A	10/11/2017
21	Clarified that relay ratings calculations are based upon 1.0 p.u. voltage.	11/1/2017

AECI's Facility Rating Methodology And Communication.

Contents

I. Purpose / Introduction

The purpose of this document is to ensure that Facility Ratings used in the reliable planning and operation of AECI's Bulk Electric System (BES) are determined based on technically sound principles.

This rating criteria applies to transmission circuits on AECI's and its member owner's transmission system (referred to collectively as the AECI system) operated at 69kV and above, beginning at the high side terminals of generator step-up transformers, and specifies how to develop the maximum rating of each element of a transmission circuit. Although AECI and its member owner's choose to apply the methodology within this document to sub-BES elements, this in no way increases the scope of NERC Standards beyond what is stated in the applicability of each Standard.

This rating criteria specifically addresses overhead conductors, power transformers, switches, wave traps, current transformers, circuit breakers, relays and protective equipment, and series and shunt reactive elements. Where appropriate normal, emergency, short term emergency, and seasonal ratings are developed. Short term emergency ratings and response actions may be developed on a case by case basis. This allows flexibility in the operating horizon and time, post-contingency, for the System Operator to take remedial action such as re-dispatch of generation or switching to reduce the element loading to within the continuous emergency rating.

This discussion also extends the overhead conductor section to include bus conductors.

A summary page of rating for equipment used in transmission other than conductors is provided in Appendix F.

I.1 Limiting Factor

The overall rating of a transmission circuit will be established by the most limiting series connected device within that circuit. Series connected devices may include, but not be limited to, overhead conductors, switches, wave traps, current transformers, circuit breakers, relays and protective equipment (including primary fuses), and/or reactive devices. In the case of a transmission circuit that interconnects with another utility, AECI shall coordinate the overall rating of that circuit with the utility involved. The overall transmission circuit rating shall be the lower of either AECI's equipment rating or the equipment rating of the interconnecting utility.

I.2 Ratings Duration

Unless otherwise stated, (e.g. short-term) the ratings calculated using AECI's methodology detailed in this Facility Rating Methodology and Communication document are to be considered as continuous ratings.

II. Facility Rating Methodology

II.1 Overhead Conductors

AECI's rating criteria for overhead conductors is based on IEEE std 738-1993, IEEE Standard for Calculating the Current-Temperature Relationship of Bare Overhead Conductors. AECI will use the BASIC program provided with IEEE std 738-1993, which requires input of the variables discussed below. A table of conductor sizes and their ratings used by AECI for Transmission Planning studies, at two representative temperatures, as based on this criteria can be found in Appendix A. For real-time operations, ratings will be calculated using current ambient temperatures observed on the AECI system.

Example of Drake – 795 ACSR Conductor, Operated at 161 kV, 75C.

Ambient Temperature	104F	95F	86F	77F	68F	50F	32F
Continuous Rating (MVA)	193.8	213.9	231.9	248.6	263.9	291.8	316.7

Conductor Temperature

All transmission lines are designed such that an acceptable ground clearance is maintained at a certain design temperature according to the construction standards at the time. AECI, and its members', lines are designed to conform to RUS standards. Historically RUS required clearances have been more restrictive than those required by NESC, which allows the conductor to operate at a higher temperature than originally designed for, and still comply with NESC standards. However, operation of these lines shall be based on NESC requirements. If a field check determines a line can be operated at a specific temperature then that temperature will be used to determine the normal and emergency rating for the line.

Conductors used within a substation for bus work, where the conductor is under tension, will be rated the same as overhead transmission line conductors using a maximum conductor temperature of 100°C unless specific design information to the contrary is available. Conductors used for jumpers, or other short untensioned spans where mechanical strength is not a concern, will be rated at a conductor temperature of 140°C.

Wire manufacturers have begun producing a new class of high-temperature, low sag conductor that can operate at temperatures up to 250°C. AECI has begun using these conductors on select transmission lines. The rating for these line sections will be based on the specific conductor temperature that the line design for that specific application is based on. The ampacities for these conductors will be entered into the database on a case-by-case basis based on the conductor manufacturer's design data and good engineering judgment. The overall transmission circuit rating will be based on the most limiting element as discussed in Section I.1 above.

Conductor Properties

Resistance/Diameter - The conductor properties of *resistance* and *diameter* will be obtained from the *EPRI Transmission Line Reference Book 345kV and Above*. For those conductors not listed in the EPRI book, an appropriate reference will be used.

Radiation Constants - The two radiative properties of conductors are solar absorptivity and infrared emissivity. With certain aspects of a line not known, selection of these two variables can be highly subjective.

The *Solar Absorptivity* coefficient represents the fraction of incident solar radiant energy that is absorbed by the conductor surface. The solar absorptivity coefficient varies between about 0.2 to about 0.9, with higher values indicating that more solar energy is being absorbed by the conductor. As a conductor ages, the solar absorptivity, or the amount of solar energy absorbed by the conductor increases, which decreases the MVA rating of the conductor.

The *Infrared Emissivity* coefficient represents the ratio of radiant energy emitted by the conductor surface to the infrared radiant energy emitted by a blackbody at the same temperature, and can vary between about 0.2 to about 0.9. As a conductor ages, the infrared emissivity, or ability of the conductor to radiate heat energy to its surroundings increases, which increases the MVA rating of the conductor.
According to IEEE Std. 738-1993 the absorptivity generally stays higher than the emissivity over the life of a conductor.

To eliminate the need to update conductor ratings annually, and to provide a conservative value for conductor ratings, AECI has chosen to use 0.9 for absorptivity and 0.85 for emissivity for all conductors.

<u>Geographic Location</u>

Elevation - *Elevation* of a conductor above sea level is another variable used in the calculation of conductor capacity. The elevation of a conductor affects the amount of solar energy absorbed and the amount of energy given off to the air around it. The results of a sensitivity analysis (Appendix B, Table B1) show this effect is small compared to many of the other variables, therefore attempts to acquire elevations for specific transmission lines will not be made. A default elevation of 1000 feet as being a fairly representative elevation for the AECI system footprint will be used for all conductors.

Latitude - The *latitude* of a conductor affects the amount of solar energy absorbed by a transmission line. A default latitude of 38 degrees, the approximate center latitude of the AECI system footprint, will be used for all lines. Table B2 in Appendix B shows the effects of latitude on a conductors' current capacity.

Direction and Local Sun Time - The *direction* of a conductor, classified as either North-South or East-West by the IEEE program, describes the general direction of a transmission line. *Local Sun time* describes the overhead position of the sun. These two variables separately and together effect, but not to a large degree, the amount of solar energy absorbed by the conductor. A direction of North-South is recommended as the default for Associated and member G&T transmission lines. This reduces the effect of Local Sun Time on the conductor's capacity, which is given a default value of 12 noon. Table B2 in Appendix B shows the effects of direction and local sun time on a conductors' current capacity.

Atmosphere - *Atmospheric conditions* also have an effect on the rating of a conductor. The IEEE program options are clear or industrial atmosphere. An industrial atmosphere will increase the rating of a transmission line due to decreased solar absorption. Since the majority of AECI's transmission lines are located in rural areas, clear atmosphere is recommended as the default for AECI and member G&T transmission lines.

Weather Conditions

Ambient Temperature - *Ambient temperature* is an important factor in calculating the capacity of a conductor. Real-time conductor ratings will utilize current ambient temperatures observed on the AECI system.

For Transmission Planning studies the summer *maximum ambient temperature* is calculated by averaging the top 1% of the hourly temperature readings, for June through September, for a five-year period. The winter *maximum ambient temperature* is calculated by averaging the top 1% of the hourly temperature readings, for December through March, for a five-year period. This was done for Columbia, Kansas City, St. Louis and Springfield for the years 1991 through 1995. An *off-peak ambient temperature* was also calculated in this same manner for the combination of the months April, May, October and November. Appendix C lists these averages in tabular form.

The highest calculated ambient air temperature in Appendix C, 99.8°F, was at Kansas City and will be rounded up to 100°F (37.8°C) and used for the summer maximum ambient temperature. The highest calculated ambient air temperature for the winter period at Kansas City is 76.3°F and will be rounded up to 77°F (25°C). For the off-peak period, the highest calculated ambient air temperature at Kansas City is 86.1°F and will be rounded up to 87°F (30.6°C).

Wind Speed - Wind Speed is assumed to be 2 ft/sec in a direction perpendicular to the conductor. This is a generally accepted industry standard.

Short-Term Conductor Ratings

IEEE Std. 738-1993 includes a methodology for calculating transient conductor ratings based on a step change in current, such as what occurs following a contingency. AECI develops its short-term conductor ratings based on this methodology assuming a 70% pre-contingency loading on the conductor followed by a 120% post-contingency loading. The BASIC program within the referenced IEEE Standard is used to calculate the available time until the conductor reaches the conductor temperature that the continuous rating is based on. A table is included in Appendix E showing the times available for typical conductors used on AECI's system. This methodology will be applied to the temperature adjusted ratings in real-time.

Example of Drake – 795 ACSR Conductor, Operated at 161 kV, 75C, 70% pre-load. 8-minute short term limit.

Ambient Temperature	**104F**	**95F**	**86F**	**77F**	**68F**	**50F**	**32F**
Short-Term Rating (MVA)	232.6	256.7	278.3	298.3	316.7	350.2	380.0

Rigid Bus Conductor Ratings

The ampacity of rigid bus bar conductors within substations shall be based on the equations contained in Annex C of IEEE Std. 605-1998. In the case of round pipe type bus conductors Std. 605 equations are consistent with those used for overhead transmission line conductors discussed above and thus their ampacities can be calculated with the same equations. For other bus conductor shapes the equations in Std. 605 shall be used. The equation variables pertaining to weather and geographic location shall be the same as discussed above for overhead transmission conductors. The resistance of the particular bus conductor alloy shall be derived from the equations in C.4.4 of Std. 605. The absorptivity and emissivity constants shall each be assumed to be 0.5 as suggested in Std. 605 as being representative of aluminum conductors after extended outdoor exposure. According to Std. 605 aluminum alloy and copper conductors can be operated at 90° C continuously without appreciable loss of strength and can be operated at 100° C under emergency conditions with some annealing. Based on this AECI shall use 90° C for its normal rating and 100° C for its 2-hour emergency rating. A table is included in Appendix A.

II.2 Power Transformers

AECI's Power Transformer ratings are based on IEEE C57.12.00-1980 and IEEE C57.92-1981. For real-time operations, ratings will utilize current ambient temperatures within the calculation of the power transformer limits. As the IEEE C57.92-1981 ratings table are based upon ambient temperatures, the continuous rating adjusted for real-time ambient conditions will be based upon a conservative application of 100% nameplate pre-loading, normal loss of life, and 24 hours of peak load, with values not to exceed name-plate rating at temperatures above 86F.

Example for 161/69 kV Transformer OFAF, 65C Temp Rise, Name-plate 56 MVA.

Ambient Temperature	104F	95F	86F	77F	68F	50F	32F
Continuous Rating (MVA)	56.0	56.0	56.0	58.0	59.9	63.8	67.8

Power transformers are rated based on average daily temperatures due to their relatively high thermal inertia constants. In a manner similar to the daily maximum temperature selections under the conductor rating sections, Transmission Planning studies apply daily averages for AECI's service area and have been established for three seasons; summer 32° C, spring/fall 25° C, and winter 18° C. AECI has developed a higher winter season rating for its transformers based on ANSI Standard C57.92-1981. As per the capability tables in C57.92 an OA/FOA/FOA transformer, at an average ambient temperature of 18° C, can carry 115% of its maximum nameplate rating for 8 hours with no loss of life. Using the same tables an OA/FA/FA transformer has a 117% capability. For the sake of consistency AECI has adopted the 115% multiplier to establish the winter rating for all transformers.

AECI will use ANSI/IEEE Standard C57.92-1981 Tables 3&5 to determine the short term ratings for transformers. The % loss of life noted within the table shall be "Normal". This table is based upon ambient conditions, which will be utilized in real-time operations. The Short-Term ratings used will not exceed 194% of name-plate.

Example for 161/69 kV Transformer, OFAF 65C Temp Rise, Name-plate 56 MVA, 70% pre-load.

Ambient Temperature	104F	95F	86F	77F	68F	50F	32F
2 Hour Short Term (MVA)	66.6	69.4	71.7	73.9	76.2	80.1	83.4

II.3 Switches

AECI's High-Voltage Switch ratings are based on IEEE C37.30-1971, IEEE C37.32-1972 and IEEE C37.37-1996

Unless specific manufacturer data is available to the contrary, to determine the seasonal allowable continuous current capability of an air switch, AECI will use the manufacturers continuous nameplate rating with appropriate Loadability Factor from

Figure 1 of IEEE C37.37 for both normal and emergency ratings, (using the same ambient temperatures as for Overhead Conductors) unless specific circumstances arise that may require a higher rating to be developed. The IEEE Standards C37.30-1971 and C37.37-1979 will be used as the basis for these higher ratings.

AECI has developed short term, 15 minute, ratings for its disconnect switches based on the most limiting switch part class as identified in the C37.37 loadability guide. Based on C37.30 requirements, the temperature rise of a switch part due to current flow is determined by the square of the current increase:

$(Iactual/Irated)^2$ = Temperature Rise/Rated Temperature Rise

The standard also states that at a constant current, the temperature approaches its steady state value at an exponential rate and suggests 30 minutes as a conservative switch part time constant. In equation form then a short time rating multiplier can be established by:

$(1/RatTempRise*(AvailTempRise/(1-e^{-t/T})+(TempMax-AmbTemp)),^{0.5}$ where
RatTempRise = Switch Part Rated Temperature Rise
AvailTempRise = RatTempRise less actual operating temperature
t = emergency loading time interval desired in minutes
T = switch part time constant (30 minutes)
TempMax= Switch part maximum operating temperature
AmbTemp = ambient temperature

Using these equations AECI has established the 15 minute short term multipliers for summer as 152%, spring/fall as 152%, and winter as 167%. These are also shown in Appendix E.

II.4 <u>Wave Traps</u>

AECI's transmission system has two types of wave traps commonly in use; the older air-core type, covered by ANSI Standard C93.3-1981, Requirements for Power-Line Carrier Line Traps, and a newer epoxy-encapsulated type, which are not covered by an ANSI/IEEE standard. The loadability guidelines provided by Trench Electric will be used for epoxy-encapsulated wave traps.

A graphical representation of the loadability factors is in Appendix D. A wave trap's rating is simply the nameplate rating multiplied by the appropriate loadability factor. The emergency current rating represents a level of current that should be maintained for no longer than four hours per load cycle, with the wave trap loading being at or below the normal current loading for at least two hours before the emergency load cycle occurs.

AECI's normal and emergency rating for air-core wave traps will be based on the '4 Hour Emergency' loadability factors from the graph in Appendix D. For a summer rating based on a 100°F ambient, the factor will be 1.11 and likewise, for a winter rating based on a 77°F ambient, the factor will be 1.14. AECI will use the normal rating loadability factors supplied by Trench Electric, for normal and emergency rating of epoxy encapsulated wave traps. For a summer rating on a 100°F ambient, the factor will be 1.02 and likewise, for a winter rating on a 77°F ambient, the factor will be 1.09. (AECI will consider these ratings as continuous ratings.)

AECI has developed short term, 15 minute, ratings for its wave traps developed with the same curves and loadability information discussed above. From this information AECI has established the 15-minute short term multipliers as follows:

Air core traps
summer--141%, spring/fall--142%, and winter--144%
Epoxy traps
summer—109%, spring/fall—120%, and winter—128%.

These are also shown in Appendix E.

II.5 Current Transformers

The two types of current transformers are the separately mounted type or the bushing type. The basis of this current transformer criterion is ANSI/IEEE C57.13-1978, IEEE Standard Requirements for Instrument Transformers.

Separately mounted CTs will have normal and emergency ratings based on the primary current rating for the ratio being used and the average ambient adjusted Continuous-Thermal-Current rating factor supplied by the specific current transformer manufacturer.

Rating of bushing type CTs is dependent upon the environment within the device they are mounted. Unless specific manufacturer data is available to the contrary, AECI will use the rating formulas below based on a Westinghouse Electric technical paper entitled "Memorandum on Thermal Current Characteristics of Current Transformers Used with Power Circuit Breakers and Power Transformers."

Rating Factor = R.F. = $(I_{pa}/I_{ct})^{1/2}$ CT current rating = R.F. * I_{ct}
or
CT current rating = $(I_{pa} * I_{ct})^{1/2}$
where

I_{pa} = Power apparatus continuous current rating (amps)
I_{ct} = Primary current rating of bushing current transformer ratio used (amps)

The results calculated from this equation should be so limited that the maximum rating factor does not exceed 2.0 and that the continuous current rating of the breaker is not exceeded.

The Westinghouse technical paper referenced above states that short term emergency ratings as permitted by IEEE C37.010, can be applied to bushing CTs. On this basis, AECI will use the short term multipliers developed in the Circuit Breaker section below, for bushing CTs.

II.6 Circuit Breakers

AECI's High-Voltage Circuit Breaker ratings are based on IEEE C37.06-1979 and IEEE C37.010-1979

AECI will use the manufacturer's continuous nameplate rating as the basis for both normal and emergency thermal ratings, for all seasons. IEEE Standard C37.010-1979 allows for higher loadability at ambient temperatures below 86°F. A loadability factor of 1.04 will be used during temperatures of 86°F to 69°F, and 1.07 for temperatures 68°F and below.

AECI has developed short term, 15 minute, thermal ratings for its circuit breakers developed with the same equations utilized above for disconnect switches except, as per C37.010, the temperature rise of breaker parts is proportional to the 1.8 power of the current rise. Using these equations AECI has established the 15 minute short term multipliers for summer as 148%, spring/fall as 151%, and winter as 153%. These are also shown in Appendix E.

II.7 Relays and Protective Equipment

Relays can impose limits on transmission power flow in two ways. First, the current flow through the relay, as determined by the transmission circuit current flow in combination with the current transformer ratio chosen, could exceed the relays' internal thermal capabilities. Secondly, the relay distance setting could initiate an undesired line trip during abnormally high transmission circuit power flows. To address this situation, applicable current transformer ratios chosen, shall be such that any underlying relay's loadability capability is set in accordance with AECI's PRC-023 Transmission Relay Loadability Procedure. (Note: In calculating a relay's rating, a voltage of 1.0 per unit shall be used.)

Primary fuses on AECI's 69 kV and above system are used to protect 69 kV to distribution voltage level transformers. As such they are not "series" devices but rather protect shunt loads. Primary fuses on AECI's system are rated according to the manufacturer's continuous nameplate rating.

II.8 Series and Shunt Reactive Devices.

Series reactors on AECI's system are rated according to the manufacturer's continuous nameplate rating for the summer season. Series reactors, like power transformers, are rated based on average daily temperatures. For spring/fall and winter seasons the multipliers in ANSI C57.99-1965, Table 1, are used to adjust the manufacturer's nameplate rating to the applicable seasonal average daily temperature. See Section II.2 above. Series reactors are specified, designed and applied according to IEEE C57.16-1996.

Short term emergency ratings for series reactors are based on the applicable ANSI C57.99-1965, Table 2 to give normal life expectancy, for the time period desired. Since Table 2 of C57.99 is for summer average daily temperatures, the spring/fall and winter short-term emergency ratings will use the multipliers of Table 1 to adjust the short-term rating to the applicable season.

Shunt reactors are specified, designed and applied according to IEEE C57.21-1981.

Shunt capacitors are specified, designed and applied according to IEEE 1036-1992.

III. Communication of Facility Methodology

This document shall be posted on the AECI Public OASIS domain for review by the Reliability Coordinator, Transmission Operators, Transmission Planners and Planning Authorities that have responsibilities within the AECI BES area. AECI Operations and Planning engineers shall ensure that these methodologies are followed when preparing engineering studies for AECI and its Member-Owner Cooperatives.

AECI maintains a Modeling and Network Transmission Information System (MANTIS) database of transmission system equipment characteristics that includes, among other things, the normal and emergency rating of AECI's, and its member G&T's, transmission equipment developed using this methodology. MANTIS serves as the source of information for AECI EMS and Real-Time Contingency Analysis limits. AECI participates in the annual SERC LTSG load flow databank update and the subsequent MMWG model building effort. AECI's equipment ratings in those models is derived from the AECI Transmission Database.

IV. <u>Handling of Comments from Other Entities</u>

AECI will provide a written response within 45 days to any written comments provided from an RC, TO, TP, or PA associated with this document.

Appendix A: Ratings of Typical Conductors

CONDUCTOR	CONDITION	Amps per Conductor	3-Phase MVA Rating per Conductor at Specified Voltage - Voltages in kV - 34.5	69	138	161	345	500
105.7 (1/0), ACSR 6/1								
	Winter 75C	240	14	29	57	67	143	208
	Winter 100C	291	17	35	70	81	174	252
	Jumpers 140C	348	21	42	83	97	208	301
	Summer 75C	200	12	24	48	56	120	173
	Summer 100C	263	16	31	63	73	157	228
	Jumpers 140C	328	20	39	78	91	196	284
	Off-Peak 75C	223	13	27	53	62	133	193
	Off-Peak 100C	279	17	33	67	78	167	242
	Jumpers 140C	340	20	41	81	95	203	294
105.7 (1/0), Copper								
	Winter 75C	311	19	37	74	87	186	269
	Winter 100C	385	23	46	92	107	230	333
	Jumpers 140C	472	28	56	113	132	282	409
	Summer 75C	260	16	31	62	73	155	225
	Summer 100C	348	21	42	83	97	208	301
	Jumpers 140C	445	27	53	106	124	266	385
	Off-Peak 75C	290	17	35	69	81	173	251
	Off-Peak 100C	369	22	44	88	103	220	320
	Jumpers 140C	460	27	55	110	128	275	398
133 (2/0), ACSR 6/1								
	Winter 75C	274	16	33	65	76	164	237
	Winter 100C	333	20	40	80	93	199	288
	Jumpers 140C	397	24	47	95	111	237	344
	Summer 75C	229	14	27	55	64	137	198
	Summer 100C	301	18	36	72	84	180	261
	Jumpers 140C	375	22	45	90	105	224	325
	Off-Peak 75C	256	15	31	61	71	153	222
	Off-Peak 100C	320	19	38	76	89	191	277
	Jumpers 140C	388	23	46	93	108	232	336

CONDUCTOR	CONDITION	Amps per Conductor	3-Phase MVA Rating per Conductor at Specified Voltage - Voltages in kV - 34.5	69	138	161	345	500
133.1 (2/0), Copper								
	Winter 75C	360	22	43	86	100	215	312
	Winter 100C	447	27	53	107	125	267	387
	Jumpers 140C	549	33	66	131	153	328	475
	Summer 75C	300	18	36	72	84	179	260
	Summer 100C	404	24	48	97	113	241	350
	Jumpers 140C	519	31	62	124	145	310	449
	Off-Peak 75C	335	20	40	80	93	200	290
	Off-Peak 100C	429	26	51	103	120	256	372
	Jumpers 140C	536	32	64	128	149	320	464
167.7 (3/0), ACSR 6/1								
	Winter 75C	314	19	38	75	88	188	272
	Winter 100C	381	23	46	91	106	228	330
	Jumpers 140C	454	27	54	109	127	271	393
	Summer 75C	261	16	31	62	73	156	226
	Summer 100C	344	21	41	82	96	206	298
	Jumpers 140C	429	26	51	103	120	256	372
	Off-Peak 75C	292	17	35	70	81	174	253
	Off-Peak 100C	366	22	44	87	102	219	317
	Jumpers 140C	443	26	53	106	124	265	384
211.3, ACSR 12/7								
	Winter 75C	355	21	42	85	99	212	307
	Winter 100C	424	25	51	101	118	253	367
	Jumpers 140C	494	30	59	118	138	295	428
	Summer 75C	294	18	35	70	82	176	255
	Summer 100C	383	23	46	92	107	229	332
	Jumpers 140C	467	28	56	112	130	279	404
	Off-Peak 75C	330	20	39	79	92	197	286
	Off-Peak 100C	407	24	49	97	113	243	352
	Jumpers 140C	483	29	58	115	135	289	418

CONDUCTOR		Amps	3-Phase MVA Rating per Conductor at Specified Voltage - Voltages in kV -					
	CONDITION	Amps per Conductor	34.5	69	138	161	345	500
211.6 (4/0), ACSR 6/1								
	Winter 75C	358	21	43	86	100	214	310
	Winter 100C	435	26	52	104	121	260	377
	Jumpers 140C	517	31	62	124	144	309	448
	Summer 75C	297	18	35	71	83	177	257
	Summer 100C	393	23	47	94	110	235	340
	Jumpers 140C	488	29	58	117	136	292	423
	Off-Peak 75C	333	20	40	80	93	199	288
	Off-Peak 100C	417	25	50	100	116	249	361
	Jumpers 140C	505	30	60	121	141	302	437
211.6 (4/0), Copper								
	Winter 75C	482	29	58	115	134	288	417
	Winter 100C	603	36	72	144	168	360	522
	Jumpers 140C	7454	445	891	1782	2079	4454	6455
	Summer 75C	400	24	48	96	112	239	346
	Summer 100C	544	33	65	130	152	325	471
	Jumpers 140C	704	42	84	168	196	421	610
	Off-Peak 75C	448	27	54	107	125	268	388
	Off-Peak 100C	578	35	69	138	161	345	501
	Jumpers 140C	728	44	87	174	203	435	630
250 (Type V), Copperweld								
	Winter 75C	519	31	62	124	145	310	449
	Winter 100C	645	39	77	154	180	385	559
	Jumpers 140C	790	47	94	189	220	472	684
	Summer 75C	430	26	51	103	120	257	372
	Summer 100C	583	35	70	139	163	348	505
	Jumpers 140C	746	45	89	178	208	446	646
	Off-Peak 75C	483	29	58	115	135	289	418
	Off-Peak 100C	619	37	74	148	173	370	536
	Jumpers 140C	771	46	92	184	215	461	668

CONDUCTOR		Amps	3-Phase MVA Rating per Conductor at Specified Voltage - Voltages in kV -					
	CONDITION	per Conductor	34.5	69	138	161	345	500
266.8, ACSR 26/7								
	Winter 75C	449	27	54	107	125	268	389
	Winter 100C	563	34	67	135	157	336	488
	Jumpers 140C	696	42	83	166	194	416	603
	Summer 75C	371	22	44	89	103	222	321
	Summer 100C	508	30	61	121	142	304	440
	Jumpers 140C	658	39	79	157	183	393	570
	Off-Peak 75C	417	25	50	100	116	249	361
	Off-Peak 100C	540	32	65	129	151	323	468
	Jumpers 140C	680	41	81	163	190	406	589
266.8, ACSS 26/7								
	Winter 75C	459	27	55	110	128	274	398
	Winter 100C	576	34	69	138	161	344	499
	Jumpers 140C	712	43	85	170	199	425	617
	Summer 75C	380	23	45	91	106	227	329
	Summer 100C	520	31	62	124	145	311	450
	Jumpers 140C	672	40	80	161	187	402	582
	Off-Peak 75C	427	26	51	102	119	255	370
	Off-Peak 100C	552	33	66	132	154	330	478
	Jumpers 140C	695	42	83	166	194	415	602
335.6 (2-3/0), ACSR 2-6/1								
	Winter 75C	503	30	60	120	140	301	436
	Winter 100C	618	37	74	148	172	369	535
	Jumpers 140C	744	44	89	178	207	445	644
	Summer 75C	414	25	49	99	115	247	359
	Summer 100C	557	33	67	133	155	333	482
	Jumpers 140C	703	42	84	168	196	420	609
	Off-Peak 75C	466	28	56	111	130	278	404
	Off-Peak 100C	593	35	71	142	165	354	514
	Jumpers 140C	727	43	87	174	203	434	630

CONDUCTOR		Amps	3-Phase MVA Rating per Conductor at Specified Voltage - Voltages in kV -					
	CONDITION	per Conductor	34.5	69	138	161	345	500
336.4, ACSR/OVAL 20/7								
	Winter 75C	533	32	64	127	149	318	462
	Winter 100C	671	40	80	160	187	401	581
	Jumpers 140C	834	50	100	199	233	498	722
	Summer 75C	439	26	52	105	122	262	380
	Summer 100C	605	36	72	145	169	362	524
	Jumpers 140C	788	47	94	188	220	471	682
	Off-Peak 75C	495	30	59	118	138	296	429
	Off-Peak 100C	644	38	77	154	180	385	558
	Jumpers 140C	814	49	97	195	227	486	705
336.4, ACSR 18/1								
	Winter 75C	513	31	61	123	143	307	444
	Winter 100C	645	39	77	154	180	385	559
	Jumpers 140C	799	48	95	191	223	477	692
	Summer 75C	424	25	51	101	118	253	367
	Summer 100C	582	35	70	139	162	348	504
	Jumpers 140C	755	45	90	180	211	451	654
	Off-Peak 75C	477	29	57	114	133	285	413
	Off-Peak 100C	618	37	74	148	172	369	535
	Jumpers 140C	780	47	93	186	218	466	675
336.4, ACSR 26/7								
	Winter 75C	519	31	62	124	145	310	449
	Winter 100C	653	39	78	156	182	390	566
	Jumpers 140C	810	48	97	194	226	484	701
	Summer 75C	428	26	51	102	119	256	371
	Summer 100C	589	35	70	141	164	352	510
	Jumpers 140C	766	46	92	183	214	458	663
	Off-Peak 75C	482	29	58	115	134	288	417
	Off-Peak 100C	626	37	75	150	175	374	542
	Jumpers 140C	791	47	95	189	221	473	685

CONDUCTOR	CONDITION	Amps per Conductor	3-Phase MVA Rating per Conductor at Specified Voltage - Voltages in kV - 34.5	69	138	161	345	500
336.4, ACSS 26/7								
	Winter 75C	531	32	63	127	148	317	460
	Winter 100C	668	40	80	160	186	399	579
	Jumpers 140C	828	49	99	198	231	495	717
	Summer 75C	439	26	52	105	122	262	380
	Summer 100C	603	36	72	144	168	360	522
	Jumpers 140C	783	47	94	187	218	468	678
	Off-Peak 75C	493	29	59	118	137	295	427
	Off-Peak 100C	641	38	77	153	179	383	555
	Jumpers 140C	809	48	97	193	226	483	701
397.5, ACSR 24/7								
	Winter 75C	577	34	69	138	161	345	500
	Winter 100C	727	43	87	174	203	434	630
	Jumpers 140C	902	54	108	216	252	539	781
	Summer 75C	475	28	57	114	132	284	411
	Summer 100C	655	39	78	157	183	391	567
	Jumpers 140C	853	51	102	204	238	510	739
	Off-Peak 75C	535	32	64	128	149	320	463
	Off-Peak 100C	697	42	83	167	194	416	604
	Jumpers 140C	881	53	105	211	246	526	763
477, ACSR 18/1								
	Winter 75C	639	38	76	153	178	382	553
	Winter 100C	807	48	96	193	225	482	699
	Jumpers 140C	1005	60	120	240	280	601	870
	Summer 75C	526	31	63	126	147	314	456
	Summer 100C	728	44	87	174	203	435	630
	Jumpers 140C	949	57	113	227	265	567	822
	Off-Peak 75C	593	35	71	142	165	354	514
	Off-Peak 100C	774	46	93	185	216	463	670
	Jumpers 140C	981	59	117	234	274	586	850

CONDUCTOR		Amps	3-Phase MVA Rating per Conductor at Specified Voltage - Voltages in kV -					
	CONDITION	per Conductor	34.5	69	138	161	345	500
477, ACSR 26/7								
	Winter 75C	646	39	77	154	180	386	559
	Winter 100C	818	49	98	196	228	489	708
	Jumpers 140C	1020	61	122	244	284	610	883
	Summer 75C	531	32	63	127	148	317	460
	Summer 100C	737	44	88	176	206	440	638
	Jumpers 140C	964	58	115	230	269	576	835
	Off-Peak 75C	600	36	72	143	167	359	520
	Off-Peak 100C	784	47	94	187	219	468	679
	Jumpers 140C	996	60	119	238	278	595	863
556.5, ACSR 26/7								
	Winter 75C	712	43	85	170	199	425	617
	Winter 100C	904	54	108	216	252	540	783
	Jumpers 140C	1129	67	135	270	315	675	978
	Summer 75C	585	35	70	140	163	350	507
	Summer 100C	815	49	97	195	227	487	706
	Jumpers 140C	1067	64	128	255	298	638	924
	Off-Peak 75C	660	39	79	158	184	394	572
	Off-Peak 100C	886	53	106	212	247	529	767
	Jumpers 140C	1103	66	132	264	308	659	955
636, ACSR 18/1								
	Winter 75C	765	46	91	183	213	457	663
	Winter 100C	971	58	116	232	271	580	841
	Jumpers 140C	1214	73	145	290	339	725	1051
	Summer 75C	627	37	75	150	175	375	543
	Summer 100C	875	52	105	209	244	523	758
	Jumpers 140C	1148	69	137	274	320	686	994
	Off-Peak 75C	709	42	85	169	198	424	614
	Off-Peak 100C	931	56	111	223	260	556	806
	Jumpers 140C	1186	71	142	283	331	709	1027
636, ACSR 26/7								
	Winter 75C	775	46	93	185	216	463	671
	Winter 100C	985	59	118	235	275	589	853
	Jumpers 140C	1233	74	147	295	344	737	1068
	Summer 75C	635	38	76	152	177	379	550
	Summer 100C	888	53	106	212	248	531	769
	Jumpers 140C	1165	70	139	278	325	696	1009
	Off-Peak 75C	718	43	86	172	200	429	622
	Off-Peak 100C	944	56	113	226	263	564	818
	Jumpers 140C	1204	72	144	288	336	719	1043

CONDUCTOR	CONDITION	Amps per Conductor	3-Phase MVA Rating per Conductor at Specified Voltage - Voltages in kV - 34.5	69	138	161	345	500
636, AAC 37								
	Winter 75C	759	45	91	181	212	454	657
	Winter 100C	963	58	115	230	269	575	834
	Jumpers 140C	1204	72	144	288	336	719	1043
	Summer 75C	623	37	74	149	174	372	540
	Summer 100C	868	52	104	207	242	519	752
	Jumpers 140C	1138	68	136	272	317	680	986
	Off-Peak 75C	704	42	84	168	196	421	610
	Off-Peak 100C	923	55	110	221	257	552	799
	Jumpers 140C	1176	70	141	281	328	703	1018
795, ACSR 26/7								
	Winter 75C	891	53	106	213	248	532	772
	Winter 100C	1138	68	136	272	317	680	986
	Jumpers 140C	1429	85	171	342	398	854	1238
	Summer 75C	728	44	87	174	203	435	630
	Summer 100C	1025	61	122	245	286	612	888
	Jumpers 140C	1350	81	161	323	376	807	1169
	Off-Peak 75C	825	49	99	197	230	493	714
	Off-Peak 100C	1091	65	130	261	304	652	945
	Jumpers 140C	1396	83	167	334	389	834	1209
795, ACSR 30/19								
	Winter 75C	898	54	107	215	250	537	778
	Winter 100C	1147	69	137	274	320	685	993
	Jumpers 140C	1442	86	172	345	402	862	1249
	Summer 75C	733	44	88	175	204	438	635
	Summer 100C	1033	62	123	247	288	617	895
	Jumpers 140C	1363	81	163	326	380	814	1180
	Off-Peak 75C	831	50	99	199	232	497	720
	Off-Peak 100C	1100	66	131	263	307	657	953
	Jumpers 140C	1408	84	168	337	393	841	1219
795, ACSR 45/7								
	Winter 75C	880	53	105	210	245	526	762
	Winter 100C	1122	67	134	268	313	670	972
	Jumpers 140C	1408	84	168	337	393	841	1219
	Summer 75C	719	43	86	172	201	430	623
	Summer 100C	1011	60	121	242	282	604	876
	Jumpers 140C	1330	79	159	318	371	795	1152
	Off-Peak 75C	815	49	97	195	227	487	706
	Off-Peak 100C	1075	64	128	257	300	642	931
	Jumpers 140C	1375	82	164	329	383	822	1191

CONDUCTOR		Amps per Conductor	3-Phase MVA Rating per Conductor at Specified Voltage - Voltages in kV -					
	CONDITION		34.5	69	138	161	345	500
954, ACSR 24/7								
	Winter 75C	1003	60	120	240	280	599	869
	Winter 100C	1284	77	153	307	358	767	1112
	Jumpers 140C	1617	97	193	387	451	966	1400
	Summer 75C	817	49	98	195	228	488	708
	Summer 100C	1156	69	138	276	322	691	1001
	Jumpers 140C	1529	91	183	365	426	914	1324
	Off-Peak 75C	927	55	111	222	259	554	803
	Off-Peak 100C	1231	74	147	294	343	736	1066
	Jumpers 140C	1580	94	189	378	441	944	1368
954, ACSR 45/7								
	Winter 75C	985	59	118	235	275	589	853
	Winter 100C	1261	75	151	301	352	754	1092
	Jumpers 140C	1587	95	190	379	443	948	1374
	Summer 75C	804	48	96	192	224	480	696
	Summer 100C	1135	68	136	271	317	678	983
	Jumpers 140C	1500	90	179	359	418	896	1299
	Off-Peak 75C	912	54	109	218	254	545	790
	Off-Peak 100C	1209	72	144	289	337	722	1047
	Jumpers 140C	1550	93	185	370	432	926	1342
954, ACSR 54/7								
	Winter 75C	994	59	119	238	277	594	861
	Winter 100C	1272	76	152	304	355	760	1102
	Jumpers 140C	1602	96	191	383	447	957	1387
	Summer 75C	810	48	97	194	226	484	701
	Summer 100C	1146	68	137	274	320	685	992
	Jumpers 140C	1514	90	181	362	422	905	1311
	Off-Peak 75C	919	55	110	220	256	549	796
	Off-Peak 100C	1219	73	146	291	340	728	1056
	Jumpers 140C	1565	94	187	374	436	935	1355
954, ACSR 54/37								
	Winter 75C	1155	69	138	276	322	690	1000
	Winter 100C	1500	90	179	359	418	896	1299
	Jumpers 140C	1910	114	228	457	533	1141	1654
	Summer 75C	930	56	111	222	259	556	805
	Summer 100C	1348	81	161	322	376	806	1167
	Jumpers 140C	1806	108	216	432	504	1079	1564
	Off-Peak 75C	1064	64	127	254	297	636	921
	Off-Peak 100C	1437	86	172	343	401	859	1244
	Jumpers 140C	1866	112	223	446	520	1115	1616

CONDUCTOR		Amps per	3-Phase MVA Rating per Conductor at Specified Voltage - Voltages in kV -					
	CONDITION	Conductor	34.5	69	138	161	345	500
954, AACSR/HS285								
	Winter 75C	961	57	115	230	268	574	832
	Winter 100C	1238	74	148	296	345	740	1072
	Jumpers 140C	1570	94	188	375	438	938	1360
	Summer 75C	783	47	94	187	218	468	678
	Summer 100C	1115	67	133	267	311	666	966
	Jumpers 140C	1484	89	177	355	414	887	1285
	Off-Peak 75C	889	53	106	212	248	531	770
	Off-Peak 100C	1187	71	142	284	331	709	1028
	Jumpers 140C	1533	92	183	366	427	916	1328
1192.5, ACSR 45/7								
	Winter 75C	1131	68	135	270	315	676	979
	Winter 100C	1453	87	174	347	405	868	1258
	Jumpers 140C	1836	110	219	439	512	1097	1590
	Summer 75C	919	55	110	220	256	549	796
	Summer 100C	1308	78	156	313	365	782	1133
	Jumpers 140C	1736	104	207	415	484	1037	1503
	Off-Peak 75C	1045	62	125	250	291	624	905
	Off-Peak 100C	1393	83	166	333	388	832	1206
	Jumpers 140C	1794	107	214	429	500	1072	1554
1192.5, ACSR 54/19								
	Winter 75C	1154	69	138	276	322	690	999
	Winter 100C	1484	89	177	355	414	887	1285
	Jumpers 140C	1875	112	224	448	523	1120	1624
	Summer 75C	973	58	116	233	271	581	843
	Summer 100C	1336	80	160	319	373	798	1157
	Jumpers 140C	1773	106	212	424	494	1059	1535
	Off-Peak 75C	1066	64	127	255	297	637	923
	Off-Peak 100C	1422	85	170	340	397	850	1231
	Jumpers 140C	1832	109	219	438	511	1095	1587
1222, ACCC/TW								
	Winter 75C	1132	68	135	271	316	676	980
	Winter 100C	1449	87	173	346	404	866	1255
	Jumpers 140C	1826	109	218	436	509	1091	1581
	Summer 75C	922	55	110	220	257	551	798
	Summer 100C	1305	78	156	312	364	780	1130
	Jumpers 140C	1726	103	206	413	481	1031	1495
	Off-Peak 75C	1047	63	125	250	292	626	907
	Off-Peak 100C	1389	83	166	332	387	830	1203
	Jumpers 140C	1783	107	213	426	497	1065	1544

CONDUCTOR	CONDITION	Amps per Conductor	3-Phase MVA Rating per Conductor at Specified Voltage - Voltages in kV - 34.5	69	138	161	345	500
1272, ACSR 45/7								
	Winter 75C	1176	70	141	281	328	703	1018
	Winter 100C	1514	90	181	362	422	905	1311
	Jumpers 140C	1915	114	229	458	534	1144	1658
	Summer 75C	955	57	114	228	266	571	827
	Summer 100C	1362	81	163	326	380	814	1180
	Jumpers 140C	1810	108	216	433	505	1082	1568
	Off-Peak 75C	1086	65	130	260	303	649	941
	Off-Peak 100C	1450	87	173	347	404	866	1256
	Jumpers 140C	1870	112	223	447	521	1117	1619
1351.5, ACSS/TW 36/37								
	Winter 75C	1342	80	160	321	374	802	1162
	Winter 100C	1735	104	207	415	484	1037	1503
	Jumpers 140C	2200	131	263	526	613	1315	1905
	Summer 75C	1084	65	130	259	302	648	939
	Summer 100C	1560	93	186	373	435	932	1351
	Jumpers 140C	2080	124	249	497	580	1243	1801
	Off-Peak 75C	1237	74	148	296	345	739	1071
	Off-Peak 100C	1662	99	199	397	463	993	1439
	Jumpers 140C	2149	128	257	514	599	1284	1861
1431, ACSR 45/7								
	Winter 75C	1263	75	151	302	352	755	1094
	Winter 100C	1631	97	195	390	455	975	1412
	Jumpers 140C	2068	124	247	494	577	1236	1791
	Summer 75C	1024	61	122	245	286	612	887
	Summer 100C	1467	88	175	351	409	877	1270
	Jumpers 140C	1955	117	234	467	545	1168	1693
	Off-Peak 75C	1166	70	139	279	325	697	1010
	Off-Peak 100C	1562	93	187	373	436	933	1353
	Jumpers 140C	2020	121	241	483	563	1207	1749
1533.3, ACSS/TW 39/19								
	Winter 75C	1323	79	158	316	369	791	1146
	Winter 100C	1705	102	204	408	475	1019	1477
	Jumpers 140C	2158	129	258	516	602	1290	1869
	Summer 75C	1074	64	128	257	299	642	930
	Summer 100C	1534	92	183	367	428	917	1328
	Jumpers 140C	2040	122	244	488	569	1219	1767
	Off-Peak 75C	1222	73	146	292	341	730	1058
	Off-Peak 100C	1633	98	195	390	455	976	1414
	Jumpers 140C	2108	126	252	504	588	1260	1826

CONDUCTOR		Amps per Conductor	3-Phase MVA Rating per Conductor at Specified Voltage - Voltages in kV -					
	CONDITION		34.5	69	138	161	345	500
1590, ACSR 45/7								
	Winter 75C	1346	80	161	322	375	804	1166
	Winter 100C	1742	104	208	416	486	1041	1509
	Jumpers 140C	2213	132	264	529	617	1322	1917
	Summer 75C	1089	65	130	260	304	651	943
	Summer 100C	1566	94	187	374	437	936	1356
	Jumpers 140C	2092	125	250	500	583	1250	1812
	Off-Peak 75C	1242	74	148	297	346	742	1076
	Off-Peak 100C	1668	100	199	399	465	997	1445
	Jumpers 140C	2162	129	258	517	603	1292	1872
1590, ACSR 54/19								
	Winter 75C	1376	82	164	329	384	822	1192
	Winter 100C	1782	106	213	426	497	1065	1543
	Jumpers 140C	2265	135	271	541	632	1353	1962
	Summer 75C	1113	67	133	266	310	665	964
	Summer 100C	1603	96	192	383	447	958	1388
	Jumpers 140C	2141	128	256	512	597	1279	1854
	Off-Peak 75C	1270	76	152	304	354	759	1100
	Off-Peak 100C	1707	102	204	408	476	1020	1478
	Jumpers 140C	2213	132	264	529	617	1322	1917
2156, ACSR 84/19								
	Winter 75C	1631	97	195	390	455	975	1412
	Winter 100C	2129	127	254	509	594	1272	1844
	Jumpers 140C	2725	163	326	651	760	1628	2360
	Summer 75C	1313	78	157	314	366	785	1137
	Summer 100C	1913	114	229	457	533	1143	1657
	Jumpers 140C	2577	154	308	616	719	1540	2232
	Off-Peak 75C	1503	90	180	359	419	898	1302
	Off-Peak 100C	2039	122	244	487	569	1218	1766
	Jumpers 140C	2663	159	318	637	743	1591	2306

Assumptions

Summer Ambient Temp = 100 F
Winter Ambient Temp = 77 F
Off-Peak Ambient Temp = 87 F
Wind Speed = 2 ft/sec
Coef of Emiss = 0.85
Coef of Absorp = 0.90
Latitude = 38 deg
12 pm Local Sun Time
75 C/100 C Line Design Temps
Elevation = 1000 ft
Clear Atmosphere

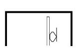
RATINGS OF TYPICAL RIGID BUS CONDUCTORS

Schedule 40 Aluminum Pipe Conductors 6063-T6 Alloy

Std. Pipe Size, In.	Summer Ratings		Spring/Fall Ratings		Winter Ratings	
	Normal	Emerg	Normal	Emerg	Normal	Emerg
2	1409	1563	1546	1684	1602	1734
2 1/2	1877	2084	2028	2218	2136	2315
3	2285	2544	2471	2708	2604	2826
3 1/2	2615	2916	2830	3105	2983	3241
4	2955	3300	3200	3516	3374	3670
5	3683	4125	3992	4396	4212	4591
6	4466	5007	4840	5334	5107	5571

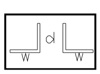
Schedule 80 Aluminum Pipe Conductors 6063-T6 Alloy

Std. Pipe Size, In.	Summer Ratings		Spring/Fall Ratings		Winter Ratings	
	Normal	Emerg	Normal	Emerg	Normal	Emerg
2	1639	1816	1769	1932	1863	2015
2 1/2	2152	2391	2326	2544	2450	2654
3	2648	2948	2864	3139	3018	3276
3 1/2	3049	3400	3299	3620	3478	3779
4	3458	3862	3744	4113	3948	3295
5	4345	4867	4710	5186	4969	5416
6	5382	6034	5833	6428	6155	6714



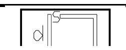
Single Angle Conductors 6061-T6 Alloy

			Summer Ratings		Spring/Fall Ratings		Winter Ratings	
d	w	t	Normal	Emerg	Normal	Emerg	Normal	Emerg
3	3	3/8	2070	2291	2231	2434	2346	2536
4	3	3/8	2366	2619	2548	2780	2678	2896
4	4	3/8	2582	2870	2787	3050	2933	3180
5	3 1/2	3/8	2703	2968	2912	3151	3023	3282
6	4	3/8	3136	3483	3380	3698	3507	3853



Double Angle Back-Back Conductors 6061-T6 Alloy

			Summer Ratings		Spring/Fall Ratings		Winter Ratings	
d	w	t	Normal	Emerg	Normal	Emerg	Normal	Emerg
3	3	3/8	4196	4633	4514	4915	4741	5118
4	3	3/8	4810	5306	5169	5624	5424	5853
4	4	3/8	5245	5810	5649	6167	5936	6424
5	3 1/2	3/8	5504	6022	5915	6382	6208	6642
6	4	3/8	6397	7076	6876	7499	7217	7804



			Double Angle Boxed Conductors 6061-T6 Alloy					
			Summer Ratings		Spring/Fall Ratings		Winter Ratings	
d	w	s	Normal	Emerg	Normal	Emerg	Normal	Emerg
3	3	1	3735	4125	4026	4386	4236	4576
4	3	1	4259	4702	4589	4999	4827	5215
4	4	1	4675	5175	5045	5507	5312	5748
5	3 1/2	1 1/2	4942	5410	5324	5749	5599	5996
6	4	2	5810	6426	6257	6828	6579	7119

<u>Assumptions</u>

Summer amb.=	100 F	Elev.=	1000'	Emiss.=	0.5
Spr/Fall amb.=	87 F	Latitude=	38 deg N.	Absorb.=	0.5
Winter amb.=	77 F	Atmos.=	Clear	Nor. Temp=	90.0 C
Wind Speed =	2ft/sec	Sun time=	12 pm	Emer. Temp=	100.0 C

Appendix B:

795 mcm ACSR Conductor

Table B1 - Elevation Sensitivity Analysis Results

		Winter Amps Norm/Emer	Summer Amps Norm/Emer
Local Sun time = 12pm	**0**	**899/1146**	**735/1032**
Latitude = 38 Deg	**500**	**892/1140**	**728/1026**
East - West line direction	**1000**	**885/1134**	**721/1020**
	1500	**879/1127**	**714/1014**
	2000	**872/1121**	**707/1008**

Table B2 - Latitude, Direction and Local Sun Time Sensitivity Analysis Results

		Winter Amps Latitude (degrees)				Summer Amps Latitude (degrees)			
		37 Norm/Emer	**38 Norm/Emer**	**39 Norm/Emer**	**40 Norm/Emer**	**37 Norm/Emer**	**38 Norm/Emer**	**39 Norm/Emer**	**40 Norm/Emer**
Elevation = 1000ft	**10**	**908/1150**	**908/1150**	**908/1150**	**908/1150**	**748/1038**	**748/1038**	**748/1038**	**748/1038**
East - West line direction	**11**	**891/1137**	**891/1137**	**891/1138**	**891/1138**	**727/1024**	**727/1024**	**728/1025**	**728/1025**
	12	**885/1133**	**885/1134**	**886/1134**	**886/1134**	**721/1020**	**721/1020**	**721/1020**	**721/1020**
	1	**891/1137**	**891/1137**	**891/1138**	**891/1138**	**727/1024**	**727/1024**	**728/1025**	**728/1025**
	2	**908/1150**	**908/1150**	**908/1150**	**908/1150**	**748/1038**	**748/1038**	**748/1038**	**749/1038**

		Winter Amps Latitude (degrees)				Summer Amps Latitude (degrees)			
		37 Norm/Emer	**38 Norm/Emer**	**39 Norm/Emer**	**40 Norm/Emerg**	**37 Norm/Emer**	**38 Norm/Emer**	**39 Norm/Emer**	**40 Norm/Emer**
Elevation = 1000ft	**10**	**892/1138**	**892/1139**	**893/1139**	**894/1140**	**729/1025**	**729/1026**	**730/1026**	**731/1027**
North-South line direction	**11**	**895/1140**	**896/1141**	**896/1141**	**897/1142**	**732/1028**	**733/1028**	**734/1029**	**735/1030**
	12	**891/1137**	**891/1138**	**892/1138**	**893/1139**	**727/1024**	**728/1025**	**729/1026**	**730/1026**
	1	**895/1140**	**896/1141**	**896/1141**	**897/1142**	**732/1028**	**733/1028**	**734/1029**	**735/1030**
	2	**892/1138**	**892/1139**	**893/1139**	**894/1139**	**729/1025**	**729/1026**	**730/1026**	**731/1027**

Summer Ambient Temp = 100 F
Winter Ambient Temp = 77 F
Wind speed = 2 ft/s
Norm cond temp = 75 C

Emerg cond temp =100 C
Clear Atmosphere
Coef of Solar Absorption = 0.9
Coef of Infrared Emissivity = 0.85

Appendix C: Maximum Temperatures

Calculated Maximum Summer Ambient Temperatures

(June through September)

Year	Columbia	Kansas City	Springfield	St. Louis
1991	97.7	99.8	97.4	98.9
1992	91.2	89.8	89.9	94.2
1993	93.0	95.2	94.8	94.8
1994	94.1	94.0	94.1	95.1
1995	95.4	96.1	97.0	97.4
Maximum	97.7	99.8	97.4	98.9

Calculated Maximum Winter Ambient Temperatures

(December through March)

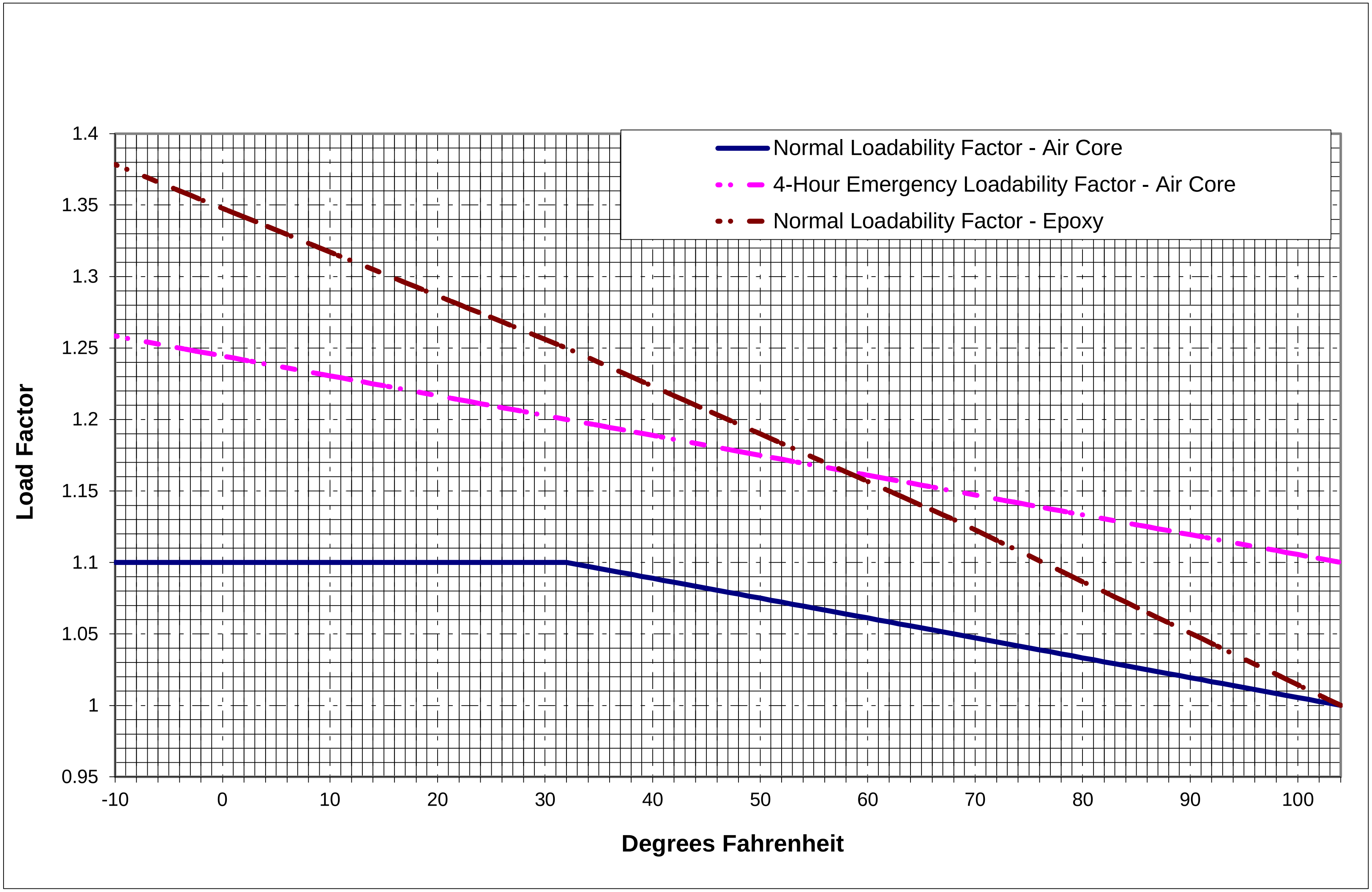
Year	Columbia	Kansas City	Springfield	St. Louis
1991	77.9	75.9	74.9	80.7
1992	74.7	73.1	73.1	74.6
1993	71.5	65.6	72.5	70.1
1994	74.9	75.0	75.1	75.3
1995	75.9	76.3	78.7	76.2
Maximum	77.9	76.3	78.7	80.7

Calculated Maximum Off-Peak Ambient Temperatures

(April, May, October and November)

Year	Columbia	Kansas City	Springfield	St. Louis
1991	86.8	85.6	84.6	90.1
1992	83.1	83.0	82.1	84.8
1993	82.0	82.0	81.0	83.8
1994	83.6	86.1	84.4	85.3
1995	83.1	82.7	84.1	84.5
Maximum	86.8	86.1	84.6	90.1

Appendix D: Wavetrap Loadability Factor vs Ambient Temperature



Appendix E: Short Term Loading Guidelines

Short Term Loading Times for Common AECI Conductors
SEASONAL -- 70% PRECONTINGENCY LOADING FOLLOWED BY 120% POST CONTINGENCY LOADING

Conductor Name	MCM	Type	Stranding	Time in minutes to reach max. conductor temperature		
				Summer	Spring/Fall	Winter
Falcon	1590	ACSR	54/19	12.8	13.1	13.4
Lapwing	1590	ACSR	45/7	12.1	12.4	12.6
Rio Grande	1533.3	ACSS/TW	39/19	17.9	12.1	12.4
River Cross	1351.5	ACSS/TW	36/37	18.5	18.8	19.2
Grackle	1192.5	ACSR	54/19	10.6	11.0	11.2
Cardinal	954	ACSR	54/7	9.2	9.5	9.7
Drake	795	ACSR	26/7	8.4	8.6	8.8
Grosbeak	636	ACSR	26/7	7.2	7.4	7.6
Dove	556.5	ACSR	26/7	6.6	6.8	6.9
Hawk	477	ACSR	26/7	6.0	6.1	6.2

AECI Short Term Load Guide for Disconnect Switches
SEASONAL

	For most limiting case					
AECI Seasons	Max Switch Part Temp	Max Switch Part Temp Rise	Avail Switch Part Temp Rise	Max Ambient Temp	Continuous Rating Factors	15 Minute Rating Factors[2]
Summer	70	30	15.3	40	100%	152%
Spring/Fall	70	30	15.3	30	115%	152%
Winter	70	30	15.3	25	122%	167%

AECI Short Term Load Guide for Power Circuit Breakers
SEASONAL -- 70% PRECONTINGENCY LOADING

	For most limiting case		70% Initial			
AECI Seasons	Limit Break Part Temp	Limit Break Part Temp Rise	Avail Break Part Temp Rise	Max Ambient Temp	Continuous Rating Factors	15 Minute Rating Factors[2]
Summer	150	110	52.1	40	100%	148%
Spring/Fall	150	110	52.1	30	104%	151%
Winter	150	110	52.1	25	107%	153%

Appendix F: Component Rating Summary for AECI and Member G&T Systems

COMPONENT **RATING**

Overhead Conductors

Temperature Adjusted	IEEE 738-1993 applied to Temperature between 104F and 32F
Short Term	120% of temperature adjusted rating for a time period not to exceed time in minutes defined in Appendix E

Jumper Conductors

Temperature Adjusted	IEEE 738-1993 applied to Temperature of 140C

Rigid Bus Conductors

Temperature Adjusted	IEEE 605-1998 using ambient temperatures. Applied to highest nameplate at 90C, normal loss of life.
Short Term	IEEE 605-1998 using ambient temperatures, for 2 hours. Applied to highest nameplate at 100C, normal loss of life.

Power Transformers

Temperature Adjusted	IEEE C57.92-1981 applied to highest nameplate, 24 hours of peak load, normal loss of life, ambient temperature between 86F and 32F. Name-plate used when ambient temperatures are above 86F.
Short Term	IEEE C57.92-1981 tables used to determine the short term ratings . The % loss of life noted within the table shall be “Normal”. This table is based upon ambient temperature between 104F and 32F. The Short-Term ratings used will not exceed 194% of name-plate.

Switches

Temperature Adjusted	IEEE C37.37-1996 using the ambient temperatures.
Short Term	87F and above, 152% for 15 minutes. 86F to 69F, 162% for 15 minutes. 68F and below, 167% for 15 minutes.

Wave Traps - Epoxy Encapsulated

Temperature Adjusted	Above 77F (Nameplate Rating*1.02). 77F and below (Nameplate Rating*1.09)
Short Term	87F and above, 109% for 15 minutes. 86F to 69F, 120% for 15 minutes. 68F and below, 128% for 15 minutes.

Wave Traps - Air-Core

Temperature Adjusted	Above 77F (Nameplate Rating*1.11). 77F and below (Nameplate Rating*1.14)
Short Term	87F and above, 141% for 15 minutes. 86F to 69F, 142% for 15 minutes. 68F and below, 144% for 15 minutes.

Current Transformers

Separately Mounted	Nameplate Rating*CT Specific rating factor. No ambient temperature adjustment.
Bushing Type	87F and above, 148% for 15 minutes. 86F to 69F, 151% for 15 minutes. 68F and below, 153% for 15 minutes.

Circuit Breakers

Temperature Adjusted	87F and above, Manufacturer's Nameplate Rating. 86F to 69F, 104%. 68F and below, 107%.
Short Term	87F and above, 148% for 15 minutes. 86F to 69F, 151% for 15 minutes. 68F and below, 153% for 15 minutes.

Protective Relays

Summer & Winter	Relay Thermal Rating*CT Ratio

Series & Shunt Reactive Devices

Temperature Adjusted	C57.99-1965 Table 1
Short Term	C57.99-1965 Table 2

Primary Fuses

Summer & Winter	Manufacturer's Nameplate Rating