WIRE AND CABLE COLD TEMPERATURE RATINGS

INTRODUCTION

Understanding temperature ratings is key to ensuring that cable will withstand the rigors of installation and last its expected lifespan. Many end-users specify the high end of the operating temperature ratings when requesting cable, but fail to specify the low temperature range or understand cable's low temperature limitations.

Extreme cold temperatures can cause cables to become brittle and less flexible. These conditions can lead to difficult installations and even cause damage to cable jackets and insulation. The minimum operating temperature and minimum installation temperature are important to understand and are discussed below.

COLD BEND AND COLD IMPACT TESTING

Cold bend and cold impact testing determine the minimum cold temperature rating (also known as the minimum operating temperature) of cable. These cable tests were designed to see how the entire cable (conductors, insulation, jackets, etc.) performs under cold conditions. UL and CSA have different requirements for the tests, but follow the same basic procedures.

Cold bend testing determines the cable's ability to retain flexibility and plasticity while being bent. The test specimen is placed in a low temperature freezer set to a specified temperature for a number of hours. The cable specimen is then wound at a uniform rate around a mandrel with a diameter determined by the cable's OD. As an example, UL Standard 444 *Communication Cables* requires a nonshielded cable to be conditioned to a temperature of -20°C and be bent around a mandrel eight times the cable's OD. Once the cable is bent, it is removed from the mandrel and set aside for a period of time before inspection for surface damage (cracks, splits, tears, etc.). The cable passes if there is no visual surface damage.

Cold impact testing assesses the cable's ability to resist damage at low temperatures. The procedure consists of a cable specimen and a set of wooden anvils cooled to a low temperature for a period of time. Lengths of cable are then secured to anvils and weights are dropped onto each cable specimen. The cable is then examined for any surface damage. The cable passes the test after several samples are tested and most do not show any damage. As an example, UL Standard 1277 *Tray Cable* requires a one-pound weight be dropped from a height of three feet.

INDUSTRY STANDARDS

Industry standards allow a variety of cold temperature ratings for different cable types. Cold bend testing is required for most UL wire and cable standards. Cold impact testing is optional and is only used to determine if a cable can be marked with a lower temperature rating. CSA standards vary between specifying cold bend, cold impact, or both. It is important to check the applicable standard. Tables 1 and 2 contain the cold bend temperature rating, the cold impact test ratings (if applicable), and the required print legend markings for various UL and CSA standards.

INSTALLATION TEMPERATURES

Installation temperatures are the lowest temperature recommended for cable installation. This temperature is higher than the minimum cold temperature (minimum operating temperature) to compensate for the higher mechanical forces encountered during installation. The minimum installation temperature is determined by increasing the cold temperature rating by 10°C to 20°C; although manufacturers' recommendations may vary. Manufacturers also recommend the following to decrease potential damage during cold weather installations:

- Store cable in a temperature-controlled warehouse for 24 hours immediately before the installation.
- Cables need to be handled with care and not dropped, kinked, or bent roughly.
- Pull cables slowly, use large sheaves and lubes suitable for cold temperatures.

CONCLUSION

Cold temperature installations are difficult and can cause cable stress and damage. Understanding the cables' cold bend and cold impact test results can help installers calculate the installation temperature to ensure a smoother installation.

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	Standard	Standard Cable Types	Required Cold Bend Temperature Rating (°C)	Optional Cold Bend Temperature Ratings (°C)	"Required Cold Impact	Additional Cold Impact Temperature Ratings (°C)	Print Legend Cold Temperature Markings
UL	UL 13 Power-Limited Circuit Cables (3rd Edition, 2010)	CL3P, CL2P, CL3R, CL2R, CL3, CL2, PLTC	-20	-30, -40, -50, -60, -70	-	-	Required for cold bend temperatures lower than -20C
	UL 44 Thermoset Insulated Wire & Cable (18th Edition, 2014)	RHW, RHW-2, RHH, XHH, XHHW, XHHW-2, SIS	-25	-40	-	-40	Required if the cable pass -40C cold bend and impact testing
	UL 62 Flexible Cords and Cable (17th Edition, 2006)	SO, SOO, SOOW, SJ, SJO, SJOO, SJOW, SJOOW, STO, STW, SJTO, SJTOW, SJEO, SJEOW	"All types: -20 "	Any W Type: -40, -50, -60, -70	-	-	Required for "W" type cords when rated –50 °C, –60 °C, or –70 °C
	UL 83 Thermoplastic Insulated Wire & Cable (14th Edition, 2008)	THW, THW-2, THHW, THHN	-25	-40	-	-40	Required if the cable pass -40C cold bend and impact testing
	UL 444 Communication Cables (4th Edition, 2008)	CMP, CMR, CMX, CM	-20	-	CMX outdoor only, -10	-	Not required
	UL 758 Appliance Wiring Methods (3rd Edition, 2014)	UL Styles 1XXX, 2XXX, 3XXX, 4XXX	-10	-20, -30, -40, -50, -60, -70	-	-	Required for cold bend temperatures lower than -10C
	UL 1063 Machine Tool Wires (7th Edition, 2006)	MTW	-25	-40	-	-	Required if the cable pass -40C cold bend testing
	UL 1072 Medium Voltage Cables (4th Edition, 2007)	MV-90, MV-105	-35	-	-	-40	Required if the cable pass -40C cold impact testing
	UL Subject 1276 Welding Cable (1st Edition, 2005)	Welding Cable	-35	-	-	-	Not required
	UL 1277 Tray Cable (5th Edition, 2010)	TC, TC-ER	-25	-	-	-40	Required if the cable pass -40C cold impact testing
	UL 1424 Power-Limited Fire Alarm Circuits (3rd Edition, 2005)	FPLP, FPLR, FPL	-20	-30, -40, -50, -60, -70	-	-	Required for cold bend temperatures lower than -20C
	UL 1425 Non-Power-Limited Fire Alarm Circuits (2nd Edition)	NPLFP, NPLFR, NPLF	-20	-30, -40, -50, -60, -70	-	-	Required for cold bend temperatures lower than -20C
	UL 1569 Metal Clad Cables (3rd Edition, 2009)	MC	-25	-	-	-40	Required if the cable pass -40C cold impact testing

Table 1 UL Cold Temperature Ratings per Cold Bend and Cold Impact Testing

	Standard	Standard Cable Types	Required Cold Bend Temperature Rating (°C)	Optional Cold Bend Temperature Ratings (°C)	"Required Cold Impact	Additional Cold Impact Temperature Ratings (°C)	Print Legend Cold Temperature Markings
CSA	C22.2 No.38 Thermoset-insulated wires and cables (18th Edition, 2014)	RW75, RWU75, R90, RW90, RWU90	-25	-40	-	-40	Required if the cable pass -40C cold bend and impact testing
	C22.2 No. 51 Armoured cables (2009)	AC90, ACWU90, ACG90, ACGWU90	-	-	-25	-40	Required if cable passes cold impact testing
	C22.2 No. 75 Thermoplastic insulated wires and cables (14th Edition, 2008)	TW75, T90, TW, TWU	-25	-40	-	-40	Required if the cable pass -40C cold bend and impact testing
	C22.2 No. 96 Portable power cables (2013)	G, G-BCG, G-GC, PPC, SH, SHC-GC, SHD, SHD-BGC, SHD-PCG, VFD, Type W, etc	-40	-	-40	-	Required if the cable pass -40C or lower cold bend and/or cold impact testing
	C22.2 No. 210 Appliance Wiring Material Products (2005)	AWM I A/B	-15	-20, -30, -40, etc	-	-	Required for cold bend temperatures lower than -15C
	C22.2 No. 214 Communications Cables (4th Edition, 2008)	CMP, CMR, CMX, CMG	-20	-	-10	-	Not Required
	C22.2 No. 230-09 Tray Cables (2009)	TC, TC-ER	-	-	-25	-40	Required if the cable pass -40C cold impact testing
	C22.2 No. 239 Control and Instrumentation Cables (2009)	CIC, ACIC, SW-ACIC	-30	-40	-	-25, -40	Required if the cable passes cold bend or cold impact testing

Table 2 CSA Cold Temperature Ratings per Cold Bend and Cold Impact Testing

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Legal Statement: anixter.com/legalstatement

Anixter Inc. World Headquarters
2301 Patriot Boulevard
Glenview, Illinois 60026
224.521.8000

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