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Electric Vehicle Infrastructure Standardization

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One of the most frequently asked questions that a third party safety organization is asked centers on "What standard applies to EV infrastructure products?" This paper will outline the various standardization activities for charging infrastructure for both conductive and wireless power transfer technologies. Included is a discussion on the development status, expected publication schedules, and technology covered for various UL, SAE, and IEC standards centered on electric vehicle charging. Further, the paper will discuss the certification aspects of these standards, such as where the standards are applicable and how certification is handled, within various global locations.

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1. Introduction

The concept of electric vehicles, and electric vehicle charging, has been around for over 100 years, with the first electric vehicles dating back to the 1800's. Over the years, the technology has experienced highs and lows, eventually losing ground to internal combustion vehicles in the 1920's. However, after a brief resurgence in the 1990's, electric vehicles appear to be here to stay. Since 2008, there has been an increase in the interest around electric vehicles. This drives the need for infrastructure to recharge the on board battery in these vehicles, and in turn, creates a need for safety standards that can address the recharging aspect of electric vehicles.

Although electric vehicle infrastructure standards existed in 2008, most of them were outdated or unprepared to handle the technological advances since the 1990's. Due to this, the developing and/or revising of existing standards into a more up-to-date and useable form became the main focus of infrastructure safety standards. This standards work was instrumental in supporting electric vehicle infrastructure in the marketplace and increasing installations of electric vehicle infrastructure such that the use of electric vehicles was supported moving forward. That first wave of standards development was an attempt to catch up to where technology was in 2008, but during the time to complete that "catch up," there were further advances in the technology. Additional standards development was needed; and from 2008 there has been a large amount of standards development activity. Additionally, further advances in technology and a drive for faster charging have created the need for additional standardization work to cover technologies that were not contemplated in previous years. All of this change, revision, updating, and innovation leads to a need to determine what is required today and what will be required tomorrow for electric vehicle infrastructure. Understanding this will assist manufacturers of infrastructure equipment in preparing for the future.

This paper will address the standards involved with electric vehicle recharging infrastructure, which standards cover which types of products, where each of these standards is currently positioned in the development process, what future publication dates are expected, and a high level look at the certification options associated with these standards.

Included in this paper is a discussion concerning conductive charging standards, including efforts around high power charging and actively cooled charging; and it includes a discussion concerning the status of wireless power transfer standards. Additionally, the paper will include discussions for the electric vehicle connectors and electric vehicle cables that are used to provide the conductive connection to the vehicle.

In some cases, the standards included in the discussion may be under a revision phase at the time of this writing. As this paper is intended to cover the standards as a whole, and is not intended to be a deep technical discussion of the requirements in the standards, it would not be prudent to discuss any potential changes in these standards prior to those proposed changes becoming finalized. Therefore, this paper will not address the details concerned with any ongoing revision process or any proposed changes in these standards, and will simply focus on the standards as a whole.

2. Conductive Charging

Conductive charging can be accomplished by delivering AC power to a vehicle with an on board charger or by delivering DC power to a vehicle for directly charging the battery (no on board charger needed). In some cases, the vehicle may contain both an AC and DC connection, and in such cases, the on board charger is used as necessary.

AC delivery is done through what will be called an AC Charging Station. DC delivery is done through what will be called a DC Charging Station. DC Charging Stations were previously referred to as quick chargers, but as technology advanced, this designation had changed to include lightning chargers, super chargers, hyper chargers, and the like. However, there is also lower power DC charging options being considered, and therefore the term DC Charging Station has been adopted. Although terminology may be different depending on region or product, for the purposes of this discussion we can use this terminology to distinguish between the two as the two separate types are covered by different standards.

AC Charging Stations and DC Charging Stations, although different internally and perhaps using different communication protocols, all have to be provided with a means to connect conductively to the vehicle. This is done through an output cable and an EV connector. Standards covering these products are also included in the discussion.

Lastly, internal to the AC Charging Stations and DC Charging Stations is a system of protection, designated and treated differently by different standards, that is provided to protect the user when recharging the electric vehicle. The standards associated with this protection system are also included in the discussion.

In an attempt to summarize this information in the clearest possible manner, we will address the discussion based on the type of equipment involved and divide the discussion between North American standards and European (IEC or IEC/EN) standards. We will not go into all standards that exist, such as SII standards in Israel or GB/T standards in China, as this would be cumbersome and impossible to write up in a concise manner. However, this should set a ground work for moving forward with future plans.

2.1 AC Charge Stations

First, we should explain a little about AC Charge Stations. There are essentially 3 types of charge stations that are widely in use, but they are designated differently around the globe. In North America, there is the Portable EV Cord Set which is a portable device intended to stay with the vehicle and be used with any convenient receptacle. In the IEC document, this is referred to as a Mode 2 cable assembly. Second, in North America there is a fastened in place charge station which is a device that can be moved, but is not intended to be moved often. It typically is cord and plug connected and “hung on a hook” in a residential or commercial garage for use with electric vehicles that are parked in the vicinity. In the IEC document, this is a mode 2 charge station. The last device in North America is a fixed charge station, which is typically a public access charge station that is permanently fixed in one location and is hard wired. In the IEC document, this is designated as a Mode 3 charge station. The designations are not all that important to the discussion with the exception of the portable EV cord set / Mode 2 cable assembly as will be discussed below.

The standards associated with AC Charge Stations are harmonized in North America. This includes ANSI/UL 2594 in the US, CSA C22.2 No. 280 in Canada, and NMX-J-677-ANCE in Mexico. Each of these standards covers an identical scope including equipment for conductive charging of an EV, with a source voltage of 600 V ac or less, 60 Hz, and intended to provide AC power to an EV with an on board charger. All three equipment designations as described above are included in this document.

The second edition of this tri-national standard was published December 21, 2016. For North American harmonization, the process falls under the Council for Harmonization of Electrotechnical Standards of the Nations in the Americas (CANENA). A new CANENA process to start the next edition of the standard would be expected to start either later this year or early next year depending on the need for updates.

In the EU and other countries that accept IEC based standards, IEC 61851-1:2010 and IEC 61851-22:2001 were used to cover AC Charge Stations. These two standards were intended to be used in conjunction with one another to provide general requirements (part 1) and specific requirements for AC Charging Stations (part 22). However, as of February 1, 2017, the new edition of part 1 was published. This document is IEC 61851-1:2017. This document incorporates all of the requirements from part 22, and now AC Charge Stations are covered by IEC 61851-1:2017 only. However, there is a significant change in the equipment covered. The new edition of IEC 61851-1:2017 will cover Mode 2 charge stations and mode 3 charge stations (and the general requirements for Mode 4 – or DC – Charge stations), but the mode 2 cable assembly was removed from the scope and placed into a new standard, IEC 62752. This document is discussed below.

The IEC 62752 standard was published on March 1, 2016. There is a long history behind this document that is not necessarily part of this discussion. However, it should be noted that the IEC 61851 series which is under the scope of Technical Committee (TC) 69 – Electric Vehicles and Charging Infrastructure – did not develop IEC 62752. That standard was developed by TC 23E – Circuit Breakers and Similar Equipment for Household Use – based on the concept that the protection system needed in a portable device requires that the entire device be covered by the protection system standard. Due to this, IEC 61851-1:2017 will no longer be used to cover mode 2 cable assemblies and has relinquished that product from the scope of the IEC 61851 series. The scope of IEC 62752 covers mode 2 cable assemblies that are rated 250 V ac, single phase, or 480 V three phase, and no more than 32 A.

Once IEC 62752 was published, all work was completed. However, a maintenance revision cycle was to be started shortly to draft and publish an amendment to IEC 62752. The amendment is being used to further expand the scope of IEC 62752 by claiming another product from IEC 61851 series. This amendment will attempt to move Mode 2 Charge Stations to IEC 62752 and subsequently that product would need to be removed from IEC 61851-1:2017. Publication of that amendment is not expected until the first half of 2018.

2.2 DC Charge Stations

As was done for AC Charging Stations, we should briefly discuss the equipment designations associated with DC Charging Stations. In North America, the designation quick charger or charger is used. In the IEC standard, the designation Mode 4 charger or DC Charge Station is used. There is no further breakdown in the designations as there are for AC Charging Stations. All devices are expected to be high power, fixed in place and permanently connected devices and therefore only one designation is used. In the future, this may change, as work is currently underway to address lower power DC Charge Stations and cord and plug connected DC Charge Stations.

Unlike AC Charging Stations, the standards associated with DC Charging Stations in the US and Canada are not harmonized, and Mexico has no specific standard for DC Charging Stations that is known today. In the US, ANSI/UL 2202 is used. In Canada, CSA C22.2 No. 107.1 is used. These two standards are very similar overall, but they are not exactly the same. The scope of both documents cover DC Charging Stations connected to an input voltage of 600 V or less, and providing DC power to electric vehicles. ANSI/UL 2202 was published on October 2, 2009 (with a revision in 2012) and CSA C22.2 No. 107.1 was reaffirmed on January 1, 2016. Neither of these documents is currently undergoing any official revision in relation to EV chargers. However, CSA has announced a plan to harmonize to the IEC standard (discussed below), and discontinue the use of CSA C22.2 No. 107.1. This has prompted discussions concerning a North American harmonization effort through CANENA. However, the details around that effort are far from developed, and the actual plan and standard to be used for harmonization is not yet decided. In the meantime, the use of 1000 V dc output DC Charging Stations and actively cooled DC Charging Stations (more on these later) has created the need for updates to be these documents. This is unofficially begun as the technology is just in the beginning phases and no final designs have been reviewed. Requirements will be officially developed once the nature of these systems is better understood.

In the EU and other countries that accept IEC based standards, IEC 61851-1:2010 and IEC 61851-23:2014 were used to cover the electrical aspects of DC Charge Stations, and IEC 61851-24:2014 covers the communication aspects of DC Charge Stations. The part 1 standard and the part 23 standard are intended to be used in conjunction with one another to provide general requirements (part 1) and specific requirements for DC

Charging Stations (part 23). The scope of these standards cover equipment for charging electric road vehicles by providing dc power to the vehicle, with an input voltage up to 1000 V ac or 1500 V dc, with an output voltage of 1500 V dc maximum.

A maintenance cycle for IEC 61851-23:2014 was begun in mid-2015. Publication of a new edition of the standard will be the result of this maintenance phase. The expected publication date is unknown at this time, but would not be expected prior to the end of 2017. This maintenance phase will update and clarify requirements for the part 23, and will begin the development of high power charging at 1000 V dc maximum and actively cooled charging.

The communication protocol covered under IEC 61851-24 is used in conjunction with the DC charger requirements, but is a stand-alone standard covering the communications protocol. This part 24 is also included in the current maintenance cycle described for the part 23 standard above.

It should be noted, there is additional work that has started globally for high power conductive charging (buses and trucks) and overhead conductive charging using a pantograph connection system that is in process. However, these efforts are not yet complete and are not included in this discussion.

Further, there is an effort for charging of vehicles (types still being defined) that are protected by double insulation and charged from a lower voltage source, such as bicycles, scooters, etc. This falls under IEC 61851-3 series but is not included in this paper as these efforts are not yet complete.

2.3 New Technologies

2.3.1 DC Charge Stations for 1000 V dc

There is a push for higher power charging by increasing the voltage but leaving the current the same. This will allow output cables to the vehicle to maintain their original size based on ampacity of the conductors, but allow a higher rate of power transfer to the vehicle. Although this seems to be a small change, standards were previously set to the limit of 600 V in North America and 690 V in the EU for both EV connectors and Vehicle Cables. This creates the need for standards revision to increase the scope limits to 1000 V for these components. As standards revisions take time, the revision effort is underway but not yet complete in both North America and in the EU. Once complete, DC Charging Stations with up to 1000 V dc output will find their way into the market place and allow for a decrease in the charge times for vehicles.

2.3.2 DC Charge Stations with active cooling

Similarly to 1000 V DC Charging Stations, there is some interest in providing for actively cooled, or thermally managed, DC Charging Stations. These devices would use liquid or air cooling in the system to cool the output vehicle cable and the EV connector during use such that a smaller, more manageable cable can be used with a higher current limit. Essentially, a conductor suitable for 100 A may have 200 A or higher passing through it, but the cooling system would keep temperatures low enough within the cable and connector such that this higher current is not an issue. Obviously, none of the standards in existence today have anticipated this technology and as such revision processes are underway to address this innovation in charging. In order to make this work, the DC Charging Station, the output cable, and the EV Connector all need to work together as a system, and therefore a coordinated effort is needed to address changes that will adequately address the concerns and mitigate the risks across all three standards. The schedule is aggressive, but there are hopes to have published requirements for this technology before the end of the year.

2.4 EV Cable

In North America, there are specific requirements that exist for the output cable of AC Charging Station and DC Charging Stations. The cable must be one of six EV cable types, EV, EVJ, EVE, EVJE, EVT, or EVJT, that are available today. These cable types may expand in the future, or installation codes may be revised to address alternatives, but that work is not part of this discussion. In the IEC documents, there is no such cable designation that can be pointed to in the requirements. There is some guidance for cables, but there are no designations that exist today.

In the North America, the standards associated with EV cable (output cable to the vehicle) are harmonized. This includes ANSI/UL 62 in the US, CSA C22.2 No. 49 in Canada, and NMX-J-436-ANCE in Mexico. This tri-national standard covers cabling in general, including EV cable, rated a maximum of 600 V. The standard focuses on construction of the cable and does not address ampacity as part of the cable rating. The ampacity is left to the end product use for evaluation.

The tri-national standard was published on March 14, 2014. The next revision cycle is underway in the CANENA process, but the expected publication date is unknown. One of the discussion topics in this revision cycle concerns removing EV cables from the current harmonized document and moving them to a separate, stand-alone document for EV cables only. The idea would be to harmonize this new standard between the US, Canada and Mexico, but include additional EV cable technology such as 1000 V cable, actively cooled cables, and so on. There are no real details around this to report yet, but it is being discussed at the CANENA harmonization meetings.

In the EU and other countries that accept IEC based standards, the cable requirements are handled a little differently. In IEC 61851-1:2017 standard, the requirements for output cables currently state that the cable "shall be suitable for the application" which leaves the cable requirements open. There are some minor requirements such as dielectric strength and mechanical stability, but for the most part any cable that can comply can be used. Further, there is a note that states IEC 62893 is currently under development to address cables. IEC 62893 is currently under development within TC20 and is expected to be published in 2018. It is understood in general that this document may potentially address 1000 V cable and actively cooled cables as well.

2.5 EV Connectors

The standards associated with EV connectors are harmonized in North America. This includes ANSI/UL 2251 in the US, CSA C22.2 No. 282 in Canada, and NMX-J-678-ANCE in Mexico. This tri-nationally harmonized standard covers connectors rated a maximum of 600 V AC or DC, and up to 800 A.

This tri-national standard was published February 22, 2013, but is currently in the last stage of a revision cycle. The next edition of the standard is expected to publish by the end of the third quarter of 2017.

Also in North America, there is a document from the Society of Automotive Engineers (SAE) that covers the EV connector configuration and associated design parameters. This document is SAE J1772. This document can be used by automakers but is not mandatory. The design in this document has become the unofficially agreed upon configuration for AC conductive charging in North America and also includes a DC connector design that co-exists with CHAdeMO configurations from Japan. The SAE J1772 configurations are also called out in the IEC 62196 series discussed next. The tri-nationally harmonized standard for safety described above does not require this configuration to be used as the safety standard must remain open to alternative designs. EV connectors following the SAE J1772 configuration and design are covered by the tri-nationally harmonized document, but SAE J1772 is not used directly for certification.

It should be noted that in order to DC Charge Stations to provide up to 1000 V dc to a vehicle or for actively cooling to be employed, the EV connector must be able to be used within these parameters as well. Work has started to draft requirements for 1000 V dc ratings and actively cooled connectors. However, in order to add these to the standards in North America, a CANENA process is needed to process the changes. This cannot start until the current CANENA process is complete.

In the EU and other countries that accept IEC based standards, IEC 62196 series is used to cover EV connectors. There are two different types of connectors, an AC connector and a DC connector. IEC 62196-1:2014 and IEC 62196-2:2016 are intended to be used in conjunction with one another to provide general requirements (part 1) and specific requirements for AC connectors (part 2). IEC 62196-1:2014 and IEC 62196-3:2014 are intended to be used in conjunction with one another to provide general requirements (part 1) and specific requirements for DC connectors (part 3). The ratings of connectors covered by this standard are based on the ratings provided by manufacturers dependent upon the standardized configuration as detailed in the standard sheets of the applicable IEC 62196 part. This does not correlate to the documented scope ratings. For example, part 1 states connectors rated 690 V ac, 250 A, but the part 2 will state 480 V ac, 63 A three phase, or 70 A single phase. As can be seen, the scope is not identical between the parts, and the part 2 scope for AC connectors and the part 3 scope for DC connectors are the actual scope limits regardless of the wording in part 1. This is due to the fact that the standardized configurations in the part 2 and part 3 documents are identified with a specific rating limit, and the part 2 and part 3 document scopes are based on the limits assigned in the standards sheets.

All three documents are beginning a maintenance phase as of February of 2017. Any expected publication date would be in 2018 at the earliest.

It should be noted, similar to the North American standards discussed above, there is an effort to develop requirements for 1000 V dc EV connectors and actively cooled connectors. This effort is being undertaken within the IEC 62196 series of standards with the new designation IEC 62196-3-1 being developed for thermal management aspects of EV connectors. This is just underway and no publication date is known.

Further, there is an effort for charging of vehicles (types still being defined) that are protected by double insulation and charged from a lower voltage source, such as bicycles, scooters, etc. The connector to the vehicle falls under IEC 62196-4, but is not included in this paper as these efforts are not yet complete.

2.6 Protection Systems

This topic requires some additional explanation. In North America, the installation codes will indicate that a system of protection is required to protect the user from contact with high voltages or hazardous energy when the power is being transferred to the vehicle. In short, there should be no hazard to the user if they touch the vehicle during charging. This in turn drives requirements in the tri-nationally harmonized standards for AC

Charge Stations and DC Charge Stations, such that all products must be provided with a system or personnel protection to protect the user from a hazard while using the equipment. The protection system is designed to monitor not only the AC or DC Charge Station, but also the vehicle frame from either the presence of hazardous voltage or current, or loss of isolation. In North America, the standard that governs the requirements for these systems of protection is also tri-Nationally harmonized. This includes ANSI/UL 2231-1 and ANSI/UL 2231-2 for the US, CSA C22.2 No. 282.1 and CSA C22.2 No. 281.2 for Canada, and NMX-J-668/1-ANCE and NMX-J-668/2-ANCE for Mexico. In all cases, the part 1 covers general requirements and the part 2 covers particular requirements for the system used. A system of protection in accordance with this standard consists of devices and constructional features that provide protection against electric shock when used as a system.

Both parts of this standard were published on September 7, 2012 with updates published on August 26, 2016. Further updates will occur in the next CANENA cycle for these documents. However, no official start date of that process is set as of the writing of this paper.

In the EU and other countries that are accepting IEC based standards, the IEC 61851 series of documents will provide guidance for the protection system by reference to other IEC standards for residual current devices (RCD's). Additionally, IEC 60364-7-722 covers installation concerns for AC and DC Charge Stations and requires that all products be provided with an RCD, but the RCD can be located in the distribution panel in the building installation or in the product.

IEC 61851-1:2017 states that if an RCD is provided in the AC or DC charge station, it shall comply with IEC 61008-1, IEC 61009-1, IEC 60947-2, or IEC 62423. However, DC fault currents on charge stations shall be considered, and the standard will then reference IEC 62955 which is under development. Lastly, as stated earlier, all portable Mode 2 cable assemblies will be covered under IEC 62752 and that standard is referenced for Mode 2 protection.

Essentially, the IEC requirements for the protection are a little more varied and possibly not as well defined as the protection system required in North America. The variability of the applicable standards allows for the manufacturer of the charge station to have options.

3. Wireless Power Transfer

Wireless power transfer refers to a transfer of power from an off board source to the electric vehicle using no conductive connection between the source and the electric vehicle. The method of energy transfer can vary based on the type of technology involved. There has been some progress using a few different technologies, but the main focus of the industry has been on magnetic resonance charging. This technology allows for transfer of power over a significant air gap between the ground based coil and the vehicle based coil. In essence, the technology claims that the driver simply parks the vehicle over the ground coil and walks away and charging will start. There are a number of things that need to be addressed in using this technology and much of that is being worked out in the standards development processes that are currently ongoing. As such, there is no complete set of requirements that exists in published form as of today. The below discussion will provide some explanation around the standards that are in progress and where they are in their respective processes, along with future timeline plans. It should be noted that all of this is subject to change based on progress in the industry, technology changes, and other factors. However, it does provide some guidance as to where this is at this point in time.

First, a wireless power transfer system consists of an off board component and an on board component. In some cases, standards may only intend to cover the vehicle side, in some cases just the off board side, and in some cases both sides. The scope of a given document will indicate what is covered.

There are three documents that are currently in development for these systems. In the US there is UL 2750 and SAE J2954. In Europe, there is the IEC 61980 series. There are other standards involved dealing with communication and other aspects, but they are not part of this discussion. Our discussion will concentrate on the three indicated standards and where they are in the process.

3.1 North America

There are two documents that are in development in North America. This includes UL 2750 and SAE J2954. These two documents are being developed in conjunction with one another in an attempt to eliminate contradictions, gaps, or duplicate efforts between the two documents. In order to discuss the documents, we also need to look at how they are expected to work together.

SAE J2954 includes requirements for the design of the wireless power transfer system based on magnetic resonance power transfer. It also covers interoperability of the system such that any vehicle can use any wireless charger that is available. Operational parameters such as efficiency are also included. However, it does not contain requirements concerning safety of the off board equipment.

UL 2750 is a safety standard. Typically, the standard is developed based on a given product or system. In this case, most OEMs and most manufacturers have an agreement to follow the SAE J2954 design in North America in order to drive interoperability and make the technology seamless to the user. Due to this, the UL 2750 document has been patterned after the design covered by SAE J2954. It should be noted that this is not the only system that can be covered by UL 2750. If a system that does not follow SAE J2954 was to be made available, UL 2750 would intend to cover that system as well with any additional requirements that are needed based on differences to the SAE J2954 design. This is possible as the SAE J2954 design is not required to be used and the UL document must remain open to changes in the design. With this in mind, the standards can be discussed in more detail.

UL 2750 is intended to cover the off board power source and the off board coil of a wireless power transfer system as a minimum. The on board components can be covered for safety if the system involved is to be evaluated in that manner, but it is not required by current documents. The concept is that a system designed to SAE J2954 would be interoperable with the vehicle side and the two halves could be evaluated using reference coils defined in SAE J2954. The UL 2750 standard will cover the safety aspects – fire, shock, and injury - associated with the product – as part of its scope. If a system does not correspond to the SAE J2954 design, then the UL 2750 document may need to expand its scope to include the vehicle control in order to verify safety.

As stated, both of these documents are in the development stage. UL 2750 will be finalized and published when the first certification for a complete system is authorized. There is no way to finalize the document without a final design, whether it follows SAE J2954 or not, as some aspects of the design are not dictated by the SAE document and are therefore unknown at this time. The SAE J2954 document is currently published as a technical report to be used as a guideline to design systems. The intent is to collect data from these commonly designed systems, and then use that data to move the SAE J2954 document to the next stage later. That next stage is currently underway with an anticipated publication date of the SAE standard by the end of this year.

3.2 Europe

The IEC 61980 series is in development as well. It is intended to consist of three parts. Part 1 is general requirements, part 2 is communication, and part 3 is specific requirements for magnetic resonance transfer systems. The part 1 was published on July 1, 2015, but is currently being revised. The general requirements in this part 1 cannot be used on their own to completely cover a system. The part 2 and part 3 documents have not been published and are still in the development stage.

Overall, the IEC documents are similar to the UL and SAE documents. This is based on the fact that the parties involved are participating in all of the development processes so many of the same discussions have been held in the North American process and the IEC process.

Eventually, once published, the standards will fall under the ELVH category of the CB Scheme and the certification path in the EU will be defined. Outside of the EU has yet to be defined as most countries are awaiting the outcome of the development process to form an opinion.

At some point in the future, when these standards are published, certification options will need to be determined. All of this has yet to be decided, although some particulars are expected, such as the IEC version will be used as a basis for the IEC/EN document, which in turn will become part of the CB Scheme. However, exact details are not yet known.

4. CERTIFICATION

Certification, by definition, is different in North America than it is in the EU and other parts of the globe. These differences are far more than standards based, and involve things such as governmental regulations, responsible parties, installation codes, certification marks, and other issues. A brief description of the main differences may prove helpful.

Certification in the US and Canada is based on a third party organization, such as UL, to provide a test report and authorization to use that organization’s certification mark on the product. In the case of AC and DC Charging Stations, the National Electrical Code in the US will state that all products should be certified by a third party organization. Similar statements exist in the Canadian Electrical Code. Installations are subjected to inspection, and the authority having jurisdiction (AHJ) in that location will make a determination on acceptability of the installation. In short, the device cannot be made operational until the AHJ approves the installation. A certification mark on the product is one way to assist the AHJ in making that approval decision. The authorization to use an organization’s mark also comes with some responsibility of due diligence by the third party organization. That is the reason that very strict rules and policies are in place regarding certification, and accredited Nationally Recognized Testing Laboratories (NRTL’s) will require that specific requirements are used, and that all documented policies, regulations, and rules are adhered to during the certification process. Further, reliability and consistency in safety critical parts used in the device is also required, which leads to programs such as the UL Recognized Component program.

This is a bit different than certification in the EU, where the manufacturer is the responsible party and the third party organization is essentially only providing technical details to allow the manufacturer to declare compliance with given directives. There is still a need to follow rules and policies, there is still a need to have reliability and consistency in the components used, and so on. However, the main difference here is that the third party organization is not authorizing the use of a certification mark. The manufacturer is utilizing the CE mark based on their declaration of having met the requirements applicable to their product. This changes how the process of certification is performed.

A third type of certification would involve countries that are outside the programs described above. For example, China and Israel, to name two, are countries that have their own standards. These may be similar to IEC standards, but the local standard is required and compliance to the IEC requirements is not sufficient in most cases. In some cases, testing may need to be done within the country involved, or only approved organizations within the country can provide the needed certification.

Each of these different types of certification will lead to a different plan to obtain that certification. In some cases, even when the requirements are the same, the process may not be or additional requirements must be met. This is not always easy to navigate. However, there has been progress and the global map for certification is taking shape as countries and governments catch up with standards development activities and decisions are made.

So, based on this explanation, certification breaks down as follows:

US and Canada – Certification is authorized by a third party organization that is accredited to certify to the applicable standards. The UL and CSA standards mentioned above would be used for the given equipment as indicated. Compliance with the UL and CSA standards does not mean that compliance with the IEC standard, or any other standard, is proven.

Mexico – Although Mexico is harmonized in most cases for the EV standards indicated above, there is an extra step needed to make these standards mandatory in Mexico. The standards mentioned are indicated and designated as “NMX” standards. The “NMX” standards are voluntary in Mexico. Only a NOM standard is mandatory. In some cases, the NOM standard will reference an NMX standard for compliance. In those cases, the NMX standard becomes mandatory due to the reference in a mandatory NOM document. In the case of the NMX standards mentioned above, work is underway to add them to the NOM document, and thereby they will eventually become mandatory. For now, they are only considered voluntary standards. In order to import an AC or DC Charge Station to Mexico, the required document, which could be NOM 001 or NOM 003 based on the design, is to be used. Additionally, the NOM Certificate can only be authorized by a Mexican based lab, although some NRTL’s, such as UL, have agreements through local offices in order to assist in obtaining these certificates.

EU – In the EU, the CB scheme applies. All participating countries in CB category ELVH (electric vehicle) that have indicated that they are Recognizing CB reports are bound by rules of the scheme to accept a CB report for certification purposes. In short, a CB report showing compliance with the IEC/EN version of the standard addresses compliance of the device for the low voltage directive. There may be other directives that apply, such as the EMC directive, etc., but this one element is addressed. One can review the list of counties participating in the CB Scheme for ELVH on the IECEE website.

Other Countries – Other countries may accept a CB report as an option; or in some cases they may not. If the CB Reports are acceptable, they may still need to be translated into the native language of the target country. If the CB reports are not accepted, testing may be required to be completed on the countries native soil. Governmental regulations may prevent outside organizations from participating in the certification scheme within that particular country, so only local organizations can provide the mark. Countries may require a physical local office to be responsible for the product when it is sold in the country, meaning a manufacturer has to have a local presence to import. In some countries, a North American certification mark may be acceptable. All of this is dependent on the country and their given rules, which are not always readily available or easy to find. It would be impossible to outline every country and their regulatory needs and rules pertaining to the certification of AC or DC Charge Stations. However, UL can provide guidance as needed to individual manufacturers if they have specific needs for market access globally.

It should be noted, as standards are revised, new standards are developed, and technology advances, the certification needs in a given country may change as well. This topic is very dynamic, and it is difficult to maintain up to the minute accurate information. Knowing where the product is to be sold prior to starting the certification process is important and should be communicated to the third party organization providing the service.

5. CONCLUSION

As can be seen, there is a lot of activity concerning the standardization of this equipment. So much of the work is in progress and so many things are changing and advancing that the development work is far from over. Even in cases where the current revision process is almost complete, there is already a list of topics for the next revision process. In essence, standards development is never complete unless the technology is obsolete, and in the case of electric vehicles this is far from the truth.

Also, as the standards develop and change over time, how certification is handled may also change. Unlike typical electrical devices, we have implemented a connection to a device - the vehicle – that has never before been part of the electric safety landscape. How do these parts work together? Which part should control a given aspect of operation? How does one protect the other in case of hazards? All of these questions are being addressed and opinions are across the board. It proves to be an exciting few years as these standards develop into stable standards addressing a technology that is not changing on a daily basis. We will wait and see what the future brings.

Author

Joe graduated from the Milwaukee School of Engineering with a BS in electrical engineering. He is a Distinguished Member of the Technical Staff of UL LLC and has been at UL LLC for 22 years, the last 14 as principal engineer for automotive technologies. Joe is involved in many standardization committees for EV standards at the UL, IEC, and SAE levels. Joe acts as Chair and Technical Advisor to the USTAG for TC 69 covering EV charging and is also a member of Code Making Panel 12 covering Article 625 for EV Supply Equipment.