Meeting Notes
IEEE VTS Traction Power Substation Standards Sub-Committee Meeting
October 2nd and October 3rd, 2018
at WMATA Board Room 600 5th Street, NW Washington, DC 20001

INTRODUCTION

The Traction Power Substations Standards Subcommittee (TPSSC) is in its sixteenth year of operation since it was formed in 2002. The TPSSC is working on developing new standards, recommended practices, and guides; coordinating with other organizations such as APTA and AREMA and within IEEE; providing up-to-date information on professional activities of interest to the electrified rail and transit industry; and soliciting recommendations, ideas and suggestions that would improve industry practices. The TPSSC is a subcommittee of the Rail Transportation Standards Committee (RTSC) within the IEEE Vehicular Technology Society (VTS). The TPSSC meets bi-annually at various transit properties in the United States and Canada. The TPSSC consist of electrified transit and railway industry leaders in the public and private sectors dedicated to writing national consensus standards, recommended practices, and guides which will govern manufacturing, supply, installation, testing, commissioning, and operation of traction power substation equipment.

PURPOSE

The purpose of this meeting was to update the TPSSC membership on status of TPSSC activities including Working Groups (WG) and Task Forces (TF), to share the progress of their work, to conduct working sessions, and to outline future plans for continuing their work on standards, recommended practices and guides.

The following are brief notes of October 2 and 3, 2018 meeting

- Mr. Gary Touryan called the meeting to order
- Mr. John Thomas, Director of Design and Construction welcomed all participants to WMATA. Mr. Gary Touryan thanked Mr. Thomas for WMATA’s management continuous support of TPSSC volunteer work and mentioned that this is a second meeting at WMATA the first was in June 2007.
- Mr. Ben Ghorban, Director of Power System Engineering, presented the overview of the WMATA traction power system and the ongoing and future major infrastructure projects. In addition, he briefed the attendees with the details of the second day site visits to the new modern OCC at CTF building, and a traction power substation on Silver Line.
- Introductions
- The meeting participants recognized the many new and long-term meal sponsors: Myers Power Products, SYSTRA, Virginia Transformer, Hawker Siddeley Switchgear, Powell Electrical Systems, Mott MacDonald, Niagara Transformer, Secheron, General Electric, and ICS.
- Mr. Touryan presented the VTS Board Report:
  - IEEE has over 400,000 members. VTS is one of the smallest groups within IEEE with 4,200 members
• VTS board consists of 15 elected members. Historically RTSC is able to have two board members representing land transportation.
• Board members are elected for three year term. All IEEE members will receive an envelope with a ballot, or email invitation. This year our candidate is David Thurston for VTS board member.
• Mr. Paul Forquer will forward the email invitation to ballot to all TPSSC members to make sure, that we elect our candidate.
• TPSSC gets a budget from VTS to support travel expenses for agency members.
  ▪ RTSC (Rail Transportation Standards Committee) has 10-15 members in charge of sub-committees, including TPSSC and OCS
• The next OCS meeting is October 24th and 25th in Pittsburgh

Mr. Ethan Kim, chair of APTA power and signals technical forum presented APTA report:
• This past summer annual rail conference was held in Denver, CO
• The goals of the conference are to discuss new technologies in the industry, promote new adaptations of technology, maintenance standards, and promote research proposals

Mr. Steve Bezner, who is the chair of traction power group, gave the following update on the research proposals:
  ▪ The TCRP – Transit Cooperative Research Program holds meetings and creates problem statements for research; for example D16 and D17 are relevant to corrosion
  ▪ A panel was recently held to evaluate 100 problem statements that were submitted before the APTA conference
  ▪ Once selected, the problem statements go out to bid
• Mr. Kim suggested that one of the challenges is that many of the topics lack empirical data to support some of the concepts and best practices that are discussed and that if anyone has data, ideas or thoughts we should get together and develop some problem statements
• TRCP has 3 representatives who have influence over which research proposals are selected
• The APTA also develops maintenance standards including RT004 Traction Electrification Inspection Maintenance and Testing, RT005 Traction electrification and corrosion control equipment inspection and maintenance, RT006 inspection distribution maintenance

• Next meeting location and date
  ▪ Fall meeting, Spring meeting
  ▪ Spring meeting – New Orleans, San Francisco/Oakland, or Miami
  ▪ Request to agencies to host, average participation 80 to 120

Mr. Benjamin Stell, the first one who was able to go through the process, with co-chair Mr. Bezner, gave the following overview on balloting:
• Balloting – formal process by which we approve the standards. Etiquette for balloting – be familiar with the standard. You need to be in the ballot group and there is a window for you to review and comment. The working group chair should send out a reminder. If you don’t have 75% of the group voting it doesn’t count.
You should work out issues before the ballot. If you check that you must comply with comments, it will hold up the ballot process and slow it down.

- Minutes of the Last meeting were approved.
- WMATA Facility Site Visits details:
  - 12:40 PM to 2:40PM by Bus
  - A – Tour of OCC at CTF BLDG
  - B – Tour of Traction Power Substation on Silver Line
- Guidelines for IEEE WG Meetings
  - Mr. Paul Forquer went over PatCom information prior to starting the WG/TF session
  - Mr. Touryan gave an overview of the rules of the working group
    - no business or cost discussions
    - if anyone says anything inappropriate please speak up

### WG and TF UPDATES

#### 1653.1 – 2016 – IEEE Standard for Traction Power Transformers for Substation Application up to 1500 Volts dc Nominal Output

- Ethan Kim is the chair of WG 1653.1. Reza Hessabi has volunteered to be a vice chair for this working group.
- Ethan polled the group to see what a reasonable timeline might be to develop a new document for renewal and suggested 5 years, pointing out we have 10 years but do not need to wait
- Reza added he believes we should not wait another 10 years – for example updates to transformer protection. Most agreed 5 years is feasible and that it normally takes 1.5 years. The conclusion of the poll was that 5 years should be the maximum and 3-5 years should be the target for updating the document
- The following items were discussed:
  - Ping test requirements and snubber circuits
    - Comment - Not necessarily adding it in the standard but adding an appendix that if you have a problem you can do this type of test
    - Comment - if this is recommended practice or guide it is different. We shouldn’t have anything in a standard where we do not clearly define what to do
    - Comment - It would be helpful for the agencies to provide specifics on test if required by their specification
  - Snubber circuits, and guidelines for below 23kV utility voltage
  - Peak power and transformer size required RMS values.
  - Sizing the rectifier on a different basis as the rectifier transformer / decoupling them, and impacts it will have on the standards
    - Comment – do we need to apply the 1.65 factor to the rectifier that we apply to the transformer
  - Surge protection, proposed adding winding over temperature and add more additional for oil-filled. Winding temperature is common between dry type and oil filled right now in the standard.
    - Comment - Have a pressure relay, send an alarm without tripping the substation transformer liquid level protection with two-stage temperature
detection for protecting against damage that may result from low level of liquid events

- Comment - How much can a transformer withstand high impulse values or thermal insulation values – is it a manufacturer thing or does this restrike need to be addressed separately from the transformer itself with snubber?
- Comment - a test for cutoff frequencies of the filter instead of the ping test since it is non-destructive testing. Follow up comment - it is also field dependent on the cable length

- Ethan requested if you have knowledge of the ping test or experience with transformer capabilities please participate in the working group

**Working Group has monthly conference calls the first Thursday of each month.**

All interested in taking part in this Working Group contact [ekim@ltk.com](mailto:ekim@ltk.com)

**1653.2 – 2009 – IEEE Standard for Uncontrolled Traction Power Rectifiers for Substation Application up to 1500 Volts dc Nominal Output**

Mr. Stell, the chair of the WG, provided the following update on the status of 1653.2.

- An overview of the changes since the previous meeting was provided by going through the track-changes in the document (the document is available on iMeet).
- The following major changes were highlighted:
  - EIA 282 is no longer valid (replaced by JEDEC JESD 282)
  - The definition for closely coupled was added – A rectifier transformer with a coupling factor >.75
  - The Recommended Practice and Design Guide (Annex) has been completely re-written
  - The standard service ratings are now light traction, heavy traction, extended heavy traction (3 hours), extra heavy traction, and custom
  - The language for rectifier unit tests has been modified slightly for clarity.
- The following items were discussed:
  - Clarification is required if the standard service rating diagrams are of average or RMS current.
  - Rectifier unit test; Most agencies want the test performed, but should we be doing this by calculations instead? The test may include a rated current test and a short circuit test, the parameters for which should be defined by the specifier This standard needs to go for balloting next year

All interested in taking part in this Working Group contact [Benjamin.stell@stvinc.com](mailto:Benjamin.stell@stvinc.com)


Mr. David Heatherington provided the following update on the status of 1653.3:

- The names of the working group members need to be updated in the document
- The following definitions were discussed:
  - Bunching - can add in some more description or a second sentence
  - Diode grounded – definition added
Negative grounding device / voltage limiting device - definition is needed
Validation / Verification – check the formulas inside the software, check if the data entered is correct

- Question - are hand calculations acceptable for software validation?
- It was suggested that validation through grandfather rights, or historical success may be considered
- Comment - check into wording for guide because IEEE may require a change from “must”. Softer words such as “should” are more appropriate for guides
- Question – is model defined anywhere? Discussion of software validation vs data validation vs model validation
- Question – what is intention of the last paragraph in validation of software? decision to delete “simulation for new systems that have not been built cannot be validated and the user is relying on the software being validated”
- Added in a bit about forced reduction performance in Background and legacy modeling approaches. When voltage reaches the minimum voltage level the motoring power is reduced to zero (forced performance reduction). The software should accurately model these interactions
- Delete available power and change to power drawn by
- Question - does effect energy consumption if you have reduced performance?
  - Yes it takes into account the reduced performance, but if the train is slightly in the wrong position; in terms of substations it is not a big issue, but if you are looking at the train meeting the timetable its not taking that into account and this is the issue
- There were comments about operations:
  - London underground pays 1 million pounds per second that you can make the train run quicker
  - From an agency perspective, we would like more of a robust system
- Comment – guide to establish a common language – there was no real understanding of the minimum parameters to run a model, just an explanation
- Regenerative braking discussion of when to include and not include it in the model, and conditions impacting the consideration of regenerative braking
  - Comment – you want the worst-case scenario for your substations and assume regen braking is not there
  - Comment – what if regen braking equipment fails or breaks and is no longer in operation
  - Comment – if we are going to design the system based on regen working, we should say that
  - Comment – regen as a probable power source, depends if there is load nearby to receive it, consider running one with and one without
  - Comment- see regen as a benefit but not as an initial design of the system, which should not dictate the sizing or spacing of the substation
Cost effectiveness of designing without regenerative braking is a concern. 25% oversized

- Determine regenerative braking modeling requirements (whether we should take it into account or not) based on agency specific needs and system configuration
- Comment – jumper cables and crossbonds in the system should be included in the calculations; 25% of total system energy from regenerative braking seems unrealistic for some systems
- Overview of train current vs line voltage graph
- Voltages from running rails to ground computation should be performed during analysis
- Discussion of how to describe that less than 5% of the difference in rail voltage when the rail to round resistance varies, as modeled with independent traction power modeling software

All interested in taking part in this Working Group contact david.hetherington@mottmac.com


Mr. Gerzeny, TPSSC liaison to the PES WG, provided the following update on the status of C37.14.

- There was a discussion of breaker types and usages
- A more thorough breaker type definitions is needed
- Some breaker types are undefined in the ratings tables in Annex C, and some uses of breakers are not defined or used– for example what ratings apply to a tie breaker
- The definitions are confusing – for example, is a rectifier breaker a high-speed breaker, semi-high speed, general purpose, and should the current ratings be based on the direction?
- Annex C – other breaker ratings with delayed trip or non-trip direction
- Single line diagrams were distributed and a table describing breaker types and properties
- There was a discussion of ratings and breaker withstand timings

All interested in taking part in this Task Force contact brian.gerzeny@powellind.com

Smart Substations – Traction Power Substation Automation

Mr. Halford, the vice chair of the TF provided the following update:

- The existing IEEE PES group and substation automation and security and communications have a lot of substation practices that are meant for utilities but may be used for traction power.
- We decided to make a working group for the standard and adopt some of the IEEE PES Power System Communications & Cybersecurity
- Discussion of whether we should make it a white paper, best practices or a standard
Comment – if you turn it into a white paper it gets lost, it would be difficult to turn it into a standard, a guide may be the best approach

- Discussion of DMP standard
  - Goal to be generic and not to limit
- Standard needs more ac power inputs. It is very dc focused
- There was a question about what automated functions are addressed
- Is there still a desire to still have a system protection recommended practice guide?

All interested in taking part in this Task Force please contact steven.halford@ge.com

P1653.5 Recommended Practice for Controlled Rectifiers for Traction Power Substation Applications

Mr. Vitaly Gelman, the chair of the WG, provided the following update on the status of P1653.5

- The latest version of the document was just sent out this morning October 2\textsuperscript{nd}
- There are currently 15 participants in the group
- The following edits were made to the document:
  - dc traction power substations instead of system
  - added two publication in the references related to conductive interference – referenced in 5.2 dealing with capacitive filter
  - removed a definition that is not in the standard
  - clarified regression testing to make it distinguishable from the parameter changes
  - added definition of firmware (permanent software programmed into a device read-only memory)
- without filters the instantaneous voltage will exceed the train parameters, in other words we need energy storage. Capacitors are the most cost effective with lower losses and do not introduce noise
- status of technology we have now unless someday we get inexpensive superconductors that can operate at room temperature
- communication failures in RCR reverse bridge may cause high fault currents. They should be verified during design testing
- 20% (to be confirmed) in total energy running the same trains with reversible rectifiers in a simulation for propulsion

All interested in taking part in this Working Group contact vgelman@vgcontrols.com

iMeet Central – TPSSC Presentation

Mr. Elbarawy provided the following update/presentation on iMeet:

- Discussion of iMeet, what it is and its benefits
- Working groups can contribute to discussions and see each other’s comments, collaborate
- iMeet status and table showing each working group status: work space created, chair/vice chair signed up, WG members invited, WG members start using it
• recommended that all the working group discussions happen on iMeet, in one place where it is recorded, not through email

TPSSC Website

Mr. Bezner provided the following update on the status of the TPSSC Website:
• Chairs and vice chairs should update their information for the working group and send it to Steve Bezner for inclusion on the website (each working group has its own page)
• Website includes meeting locations, and the working group contacts
• Grouper.ieee.org/groups/railtransit/tps/index.htm
• Rail transportation standards committee is the parent and we are part of it
• In addition to OCS and traction power, we are working on another subcommittee for rail cars and CBTC/signals

P1884 Guide for Stray Current/Corrosion Mitigation for dc Rail Transit Systems

Mr. Wilson, the vice chair of the WG, provided the following update on the status of P1884:
• The standard is in draft form and covers design, rail isolation, grounding, substation spacing
• Mr. Wilson walked us through the guide to show the progress and thanked Dimitrij Greco for his inputs:
  o Definitions, acronyms, and references to other standards
  o Defined corrosion
• The purpose of this guide is to:
  o provide a concise guide for a design framework, maintenance requirements for the mitigation of stray currents on new and existing dc rail transit systems
  o Consolidate all the stray current information into one document for agency use
• There was a discussion of drainage systems
• There was a general discussion:
  o Comment – layout a simple outline of each document, current and future so that we can harmonize documents (definitions for example between documents)
  o Comment – if we are out of bounds with corrosion since it is not really part of substations – should we redefine ourselves as the substation standards committee
  o Comment - APTA is maintenance focused and AREMA are guidelines, not standards
  o The advantage we have is that we are recognized by IEEE as an entity that can issue standards
  o Rail is not the only thing included in calculations but also the structure impacted by it. this is encompassed in the considerations for corrosion

All interested in taking part in this Working Group contact RJWilson1@wmata.com
Mr. Kim, the chair of the WG, provided the following update on the status of 1653.6:

- The standard was published in 2013
- Paul Forquer is the vice chair
- A brief update on the history and timeline of the standard is as follows:
  - Started in 2019 – PAR for systems grounding in traction power applications
  - 2013 document was published for trial use, submitted PAR in 2017 to convert to full use document
  - Since the document was published in 2013 we had several years before we had to renew – talked about schedules, objectives
  - Talked about a new edited document by the end of this year
- Working group updates:
  - Regular meetings will be held on the first Thursday of every month at 8AM PT
  - 1653.1 is at 9:30 PT
- New proposed schedule:
  - Fall 2019 – finalize draft, apply for new par
  - Spring 2020 – submit for new draft
  - Fall 2020 – RevCom review
- Updates
- Introduction – systems grounding and enclosure grounding diagram
- Metallic wireways – when and where they can be used
- Protection – transfer trip now recommended, using multiple zones for multiple rectifiers and switchgear
- Other discussion topics
  - Background -need to refine language
  - Do we want to add more field testing relay and SCADA output information
  - Application edits, use of HR or LR in different environments including Humid environments
- Systems grounding diagram – to show where grounding systems fit in the overall system and how it is interconnected. Diagram does not go into detail of what should be done on any of the elements except for the enclosure grounding portion, but describes the elements in the diagram
- Discussion in Vancouver was to add wayside elements in the diagram, but decision was made that it is outside of the scope
  - Approaches for system grounding overview
    - Deliberately grounding one pole of the power supply
    - Insulation both poles of the power supply to the extent practicable from earth
    - Grounding one pole of the power supply through a diode
    - Having no consideration for grounding or insulating the power supply
Equalizing the potential between the workshop floor and facilities and the rail vehicles being serviced is not recommended for new construction in areas other than workshops. The insulation of both poles of the dc power supply from earth is recommended for new construction.

Resistance to remote earth is not our issue, system grounding needs to be addressed somewhere but not here.

Whole discussion originated because we cannot get into a good discussion of equipment grounding without defining if the system is or is not grounded.

Systems grounding diagram intends to define the scope of the document and show the other systems that are not part of the document.

Comment – when you don’t point out that grounding is at a single point, you run into all kinds of issues.

Question of system grounding in traction power systems is probably worthy of a document on its own. The scope of this document is how to ground the equipment or pieces of equipment within the substation.

Recommended practice describes 5 and 6 in the systems grounding diagram.

“modern practice” language to be added for clarification of a-d.

Working group has monthly conference calls the first Thursday of each month.

All interested in taking part in this Working Group contact ekim@ltk.com

P2720 Rail Potential Management Guide for Direct Current Traction Electrification Systems

Mr. Stell, the chair of the WG, gave a presentation and provided the following update and overview of contents:

- Added relevant definitions, body voltage, earth, etc.
- “Ground” in IEEE Std. 80 is a connection to earth where in the NEC, “ground” is earth. “Earth” used in place of “ground” to avoid confusion.
- Step and touch voltages are defined per EN 50122-1.
- The surface below the train platform which reduces the voltage across your body is not included in the EN 50122-1 tables, so the diagram/equivalent circuit is provided.
- Another equivalent circuit for “impedances to touch voltage circuit” from IEEE-80 is provided.
- IEEE-80 provides a method to calculate step and touch potential, EN 50122-1 does not.
- Platform de-icing materials section added, as well as a section addressing rail potential at station platforms with platform edge doors/screens.
- The following items were discussed:
  - Isolation zone around platform screen doors
  - Update to table 6-1, originally from the modeling standard. Agency rail potential criteria updated for Chicago Transit Authority (CTA)
    - Other agencies to please send their rail potential criteria to Benjamin Stell.
o To reduce rail potential, bond the impedance bonds to other cables/structures along the right-of-way (CTA practice)

o Injuries from rail potential and possible inclusion of history of incidents / lessons learned
  ▪ Anything metallic should be out of reach, and as trains get longer the voltage on the rails increases, this will become more of an issue
  ▪ If there is a possibility of a metal getting above a certain voltage, a spark gap or thyristor is installed (“Voltage limiting device” per EN 50122-1)

o European standards don’t address step voltage since touch voltages are much more dangerous
  ▪ Honolulu system will be the first North American rail transit system to use EN-50122-1 type of system grounding – can use it as a test case
  ▪ Future effort – further analysis of impact of NGD on rail potentials throughout the traction power system via load flow simulation

o There can be problems with half failed surge arresters, for example a rail voltage monitor picking up the issue and opening breakers for no apparent reason

All interested in taking part in this Working Group contact Benjamin.stell@stvinc.com

Housekeeping Items and Closing Remarks

Mr. Touryan provided the following information and closing remarks:

- Some agenda items are not going to be addressed because the individuals are not present
- A working group is needed for primary power distribution and control centers in passenger rail car maintenance facilities (to address items such as a stinger in a shop) Lowell Goudge wrote a first draft and we need more participation
- A guide for wayside energy storage systems is available
- Testing standard – need more volunteers on the testing 1653.4 was issued in 2011, hindsight it should be recommended practice not a standard
- Reminder to vote for David Thurston
- Thank you to Ben Ghorban and all the WMATA people for hosting
- The survey for IEEE should be returned to where it was sent from (not to Paul)

Adjourn the second day of the meeting

Prior to adjourning Mr. Touryan thanked WMATA for hosting the meeting the second time, and Mr. Ben Ghorban and his staff for organizing and taking care of every detail to make the meeting successful and most of all for sharing their traction power system engineering knowledge, and operations and maintenance experience.

Mr. Touryan also thanked Mr. Forquer for getting approval from IEEE for 12 Professional Development Hours for participating in Working Groups for Traction Power Substations Standards.

CONCLUSION
We had a very successful working meeting with over 110 participants with a balanced representation from the transit and rail agencies, manufacturers, and consulting engineering community. These gave all participants a platform to exchange the best practices in our industry.

TPSSC thanks all meal sponsors for their continuous support