A TEN-YEAR PERSPECTIVE FOR THE PREPARATION AND DELIVERY OF A BATTERY TECHNICIAN TRAINING CURRICULUM BASED ON IEEE P1657 IN THEORY AND PRACTICE

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Introduction

In December 2009, **IEEE 1657** ***RECOMMENDED PRACTICE FOR PERSONNEL QUALIFICATIONS FOR INSTALLATION AND MAINTENANCE OF STATIONARY BATTERIES*** was published. As presented in the paper preceding this, **DEVELOPING A TRAINING CURRICULUM BASED ON IEEE P1657** ***RECOMMENDED PRACTICE FOR PERSONNEL QUALIFICATIONS FOR INSTALLATION AND MAINTENANCE OF STATIONARY BATTERIES,*** a curriculum was prepared and offered to those interested in formal training on Stationary Batteries based on the guidelines in IEEE 1657.

The instruction curriculum presented, outlines several areas considered essential to the success of the certification training. The training program is intended as an integrated approach and should be combined with a number of years of practical experience. The three areas addressed in the curriculum include:

Formal Training

The candidates should have technical backgrounds in Math and Circuits and practical experience in the execution of Stationary Battery Maintenance and Installation. The plan was to complete the formal instruction and material review for each Level pursued in two (and no more than three) days for each Level. This proved to be an overly ambitious training schedule.

Self-Study

Independent self-study is an essential part of the candidates' training curriculum. The ***Schaum's Outline of Basic Circuit Analysis*** used as part of the program, provide examples and problems for the Math and Circuits material. Specially prepared training manuals, addressing battery and ancillary information for each Level, are also distributed to candidates. The ***Handbook of Batteries*** is recommended and can also be used as a reference in self-study. The distribution of this material allows several weeks of self-directed reading and problem solving prior to the formal class and tests. Candidates are strongly encouraged to work together in the self-study program. Current copies of the IEEE Battery Standards, IEEE 450 and IEEE 1188 are made available to all technicians.

On the Job Training

Observing and notating a candidate's proficiency in the completion of tasks associated with the technical level they are pursuing, often presents recordkeeping challenges to both the candidate and the supervisor. To assist each technician in cataloging their experience, and to provide an historical record, candidates are provided with a personal logbook. The logbook allows the candidate to record the project information, date and personal responsibilities reflecting their tasks and signature by a recognized technical supervisor who holds a Level 3 or equivalent level of qualifications.

Lessons Learned

Over a six-year period, the training programs were scheduled and delivered several times each calendar year. Not all attendees were strictly technicians. Some attendees included supervisor- and manager-level individuals. A number of organizations established their in-house battery management programs based on the foundational training they received. Follow-up and tracking proved difficult.

The training program described and implemented, provided several key lessons learned. The training program experiences and outcomes suggested several adjustments to the earlier curriculum methodology:

Observation: The training program includes subject matter that extends beyond the traditionally held Battery Tutorial. The training plan is intended to complete the formal instruction and material review in two (and no more than three) days. This proved to be an overly ambitious training schedule. Not all candidates were able to complete the Math and Circuits portions of the curriculum without the benefit of additional review of the subject matter. Adjustments were made to the training schedule to accommodate those who required refresher time.

Recommended Program Modification: Formal training incorporates both traditional classroom instruction and class participation via Web Conferencing that allows the instructor contact with candidates in remote office locations. Several areas, including Safety Training, Math and Electric Circuits are best presented as separate subjects or courses. The completion and grading that is associated with each of these subject areas should be tracked and reported to the organization overseeing the battery technician training.

Observation: Implementation of the training program should provide an opportunity for the candidate to succeed. Preparation for training classes, including subject matter review, is essential to the success of the program. Preparation prior to contact hours was inconsistent.

Recommended Program Modification: Establishing pre-class assignments, as mandatory tasks, helps ensure that each attendee is prepared.

Observation: Establishing the candidate eligibility requirements for the training program should recognize the diversity in candidates experience and the practical considerations in conducting formal classes and demonstrating practical skills for the tasks described in IEEE 1657. Participants in classes included both managers and technicians.

Recommended Program Modification: Those class attendees who did not meet the eligibility requirements can still attend with the understanding that their participation is to gain an understanding of batteries and the practices required to ensure proper maintenance and testing. Though their

attendance is recorded, until they meet the eligibility requirements for the technical level, they could not move forward to the next level.

Observation: Follow-on assessment for trainee-retained knowledge was left to the instructor as part of the continuation of prescribed training classes. Empirical data indicates that trainee's recollection of the earlier instruction and given information was generally less than is desired as part of the overall technical progression. Research information suggests that class attendees often retain only a small portion of the total material covered.

Recommended Program Modification: The direction in training and education today is towards utilizing a variety of skills to keep formal class engagements more engrossing while a trend in the use of internet and web-based learning is ever more popular. Short topic-focused videos are often only a few minutes in length, recognizing the recent trend in shorter viewer attention span to technical learning. The training program should incorporate a variety of tools including blended learning, shorter formal contact instruction, online training and the introduction of micro-learning.

Observation: Tracking the candidates' skills, should be formalized and provide a transferable means for them to retain their record of experience. Record keeping proved to be unreliable.

Recommended Program Modification: A learning management system (LMS) should be established to document technical qualifications and training. The system could extend to serve as both a record of past accomplishments but also as a tool to identify necessary retraining as required. The LMS could be made available to interested parties within and outside of the organization.

Repackaging the Training Curriculum

In 2016, the author joined a prominent data center provider, Switch, to help lead their Critical Systems team. Given the involvement with the IEEE Battery Standards process and personal experience with teaching to the recommendations in IEEE 1657, the battery program was gently modified using the lessons learned from the earlier efforts.

Switch is unique and an excellent example of establishing and maximizing in-house training for all their Critical Systems technicians. Switch employees are required to complete a 90-day on-boarding training program as well as participation in a formal Tech Leveling program during their service. This proves to be just the right environment for integrating the IEEE 1657 program. The Technical Level, or more commonly, the Tech Level, is a school leaving qualification offered by educational bodies in the United Kingdom. The terminology is specific to technical or vocational training and serves as a perfect description of the Switch program.

Training Material Organization and Delivery

Drawing from the earlier classroom experience in attempting to deliver the breadth and diversity of information, the fundamental challenge was to streamline the formal course content and focus on presenting information that is specific to stationary batteries. The basics in math and circuits was rearranged into a separate series of class and teaching methods.
Technical training includes a progressive series of electrical fundamentals closely aligned with the IEEE 1657 prescribed knowledge for each battery tech level.

A series of safety training is provided to technicians and includes both OSHA and NFPA materials. Battery tech Level 0 was added to these safety training programs for all those who would be exposed to stationary batteries as part of their responsibilities. All Critical Systems technical personnel are required to take this course.

Battery training is a focused effort. The scope of information and material is presented in separate two (2) to four (4) hour formal class meetings.

Training class schedules present the material in separate sessions, separated by several weeks. Typically, the first session will address Safety. The second and subsequent sessions addresses battery related material and ancillary information. All technicians require annual safety training. Those who are engaged in the battery maintenance efforts are required to review specific battery safety related to working on or around stationary batteries.

Blended learning is being explored as a means of delivering training. Blended learning defines the way e-learning is being combined with traditional classroom methods and independent study to create a new, hybrid teaching methodology.

Technician Readiness and Training Records

All training is managed via an LMS. The LMS provides an instructor with a way to create and deliver content, monitor student participation, and assess student performance. The LMS creates an online learning environment in which employees can maintain and access training. The LMS also offers management a method to track potential improvements in the effectiveness of technical skills based on course history. Technical training includes prescribed courses for each individual based on their responsibilities as well as a variety of courses intended for those who seek to broaden their knowledge. Battery technicians are assigned the courses they must complete.
Features available to a technician and their supervisors include:

- View the calendar for upcoming training courses
- Technician can request the training
- Supervisor can assign the training to those they manage
- Technician can view their transcript
- Lists all of the training they've been assigned and completed
- Tells them when recertification is required (Arc flash, CPR, etc.)
- Access their qualifications (building transfers, power on/failovers, etc.) and see the status of each (% complete)
- Supervisors and above can view/run reports to which technicians have access (administration can create custom reports and share them in the LMS, which provides a copy of the report the technician can view/run at any time).
- Supervisors and above can view the transcripts of their direct reports for purposes of training and mentoring.

Class Assignments and Preparation

The training program is closely coordinated to work schedules and technicians are made aware of upcoming classes and associated study assignments via the LMS and emails. Training is a high priority for all staff members. Technical materials are maintained in electronic format and are available to leaners

via computer and handheld devices. Technicians are advised to notify the training administration of any conflicts and a need to reschedule. Instructors and staff managers are mindful in assessing class attendees on their preparedness for class.

Practical Application and Demonstration

A well designed On-the-Job (OJT) training program is followed both during the 90-day on boarding process and as an integral part of the long-term training efforts. The program is well planned and resourced, staff managers with competent coaching and mentor skills are available. There are criteria for performance standards for all technical activities from Uninterruptible Power System (UPS) to Switchgear operations.

The task/skill levels offered in IEEE 1657, Annex F, have been utilized in the creation of proficiency objectives for the various levels a battery technician should master. The tables of this annex spell out which tasks and skills normally apply to which type of technician. Technicians do not necessarily have to learn all the skills needed by an installation technician, and vice versa. Once the skill level has been mastered and demonstrated by a technician, a supervisor will sign off on the technical accomplishment. The completion of the projected goals for each technician is then recorded in the LMS.

Micro-Learning

Through the course of work activities, there are occasions when a discovery offers a learning opportunity to those involved at that moment and to the larger group who can benefit from what is identified and action taken. Micro-learning has been adopted as a method of sharing such information with others. Micro-learning is a holistic approach for skill-based learning/education that deals with relatively small learning units. It involves short-term-focused strategies especially designed for skill-based understanding/learning/education. In short, the concept is to address a specific item and provide information in a targeted time-limited method.

An example is finding a pallet of VRLA batteries in a storage/staging area of the facility. There are no warning signs posted, no reasonable safeties provided against unwanted handling and is not consistent with agreed methods for handling batteries. In this example, those responsible for placing the batteries in this location, and without proper identification, are tasked with preparing a short fifteen-minute slideshow demonstrating the proper handling methods for a battery. The effort undertaken to review the proper handling methods and preparation of the slideshow for review by senior personnel has several benefits. The training opportunity is not lost, the personnel responsible are challenged to answer for how the batteries were staged, they are motivated to review the recommended practices, they share the information in the form of a slideshow and the slideshow is them made available to others.

Conclusion

The earlier efforts to administer a Battery Technician Certification Training course experienced a number of challenges to the overall success in meeting the guidelines of IEEE 1657. Ensuring that candidates absorbed the information provided and that they practical application of that knowledge and required skills proved to be difficult to assure in a reasonable fashion.

The traditional one or two-day seminar on stationary batteries continues as the foundation in disseminating a basic understanding of the technology. The necessity to provide formal training to those who are tasked with managing a stationary battery system demands an extended training program designed for an extended period of time.

The program described very closely mirrors the three primary categories noted in the creation of the curriculum over ten years ago including *Formal*, *Self-Study* and *On-the-Job* training. The addition of an effective method of recording and managing the progress of education and training is an aspect in the effective management of such programs accomplished over a period of years.
The progression of an individual from an entry/novice level to mastering their skills demands such an effort as described. The program should include multiple opportunities for formal class as well as practical application of what they have learned.

The challenge is to establish both methods and means to enact such a training plan that is transferrable to all organizations responsible for the installation and maintenance of stationary batteries. The program described in this paper represents one method. The rapid expansion of stored energy and renewable resources in support of a variety of applications demands that those in responsible charge have the skills required to meet those challenges.

References

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