

DEVELOPING A TRAINING CURRICULUM BASED ON IEEE P1657: RECOMMENDED PRACTICE FOR PERSONNEL QUALIFICATIONS FOR INSTALLATION AND MAINTENANCE OF STATIONARY BATTERIES

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INTRODUCTION

The IEEE PES Stationary Battery Standards Committee recognizes that specific training on battery system installation and maintenance is necessary. The subcommittee also recognizes that existing training of battery maintenance and installation technicians is generally non-existent, or at the least, non-standard. With those thoughts in mind, the IEEE PES Stationary Battery Committee is presently preparing a guide for training to specify the types of knowledge a battery installation or maintenance technician must possess in order to safely and effectively work on lead-acid and nickel-cadmium batteries. The document will define the areas of recommended knowledge for installers and maintainers of stationary batteries and related systems to the extent that they affect the battery. The purpose of the IEEE document is to provide an outline of the necessary items that should be covered by those developing training programs for stationary battery installation and maintenance personnel. At this time, the document is an unapproved draft of a proposed IEEE Standard. As such, this document is subject to change.

There are companies who have now, or who are prepared to undertake a training program as described in the IEEE guide. This paper will present a summary of the scope of the IEEE P1657 document and relate one company's efforts over a two year period to prepare and present a formal training curriculum based strongly on the IEEE recommended practice. Among the topics discussed, the paper shall include reflections on the following items of consideration:

- selecting qualified training and administration personnel
- organization of required training content and information
- selection of training and reference materials
- establishment of the criteria for the level of technical experience required for Skill Levels 1 through 3
- approaching *Specialized Knowledge* in the curriculum
- implementation of the formal training sessions
- tracking candidates practical experience
- dissemination and comprehension of technical information by candidates

ACKNOWLEDGING THE PROPOSED STANDARD AND MAKING A COMMITMENT TO PROCEED

As a member of the working group preparing P1657 since June 2003, the author understands the scope of the document and holds an appreciation of the challenges that undertaking a formal training program, in keeping with the IEEE guide, presented to a training authority. At the same time this document began to take form, the battery service company for which the author provides technical oversight was in the process of reviewing the agenda used to educate their battery technicians. The author elected to pursue a distinctly more formal approach to their existing training program and in 2005 decided to undertake an overhaul of the existing battery technician training curriculum to more closely meet the guidelines presented in P1657 as they began to crystallize. The belief that the guide provides a comprehensive outline of the skills that are required by a well rounded technician was the primary factor in the decision to closely follow the IEEE document in creating the training curriculum. As P1657 has evolved over the past 2 ½ years, so too has the curriculum described in this paper.

SELECTING QUALIFIED TRAINING AND ADMINISTRATION PERSONNEL

The scope of P1657 extends beyond the traditionally held approach to battery technician training that focuses primarily on the battery. The guideline directs the instructor to include Safety, Math, and Electric Circuits subject matter in the training program as well as to develop an understanding within the pupil of the ancillary information that is considered essential to the battery industry.

Organization of the task items that are presented in P1657 for Levels 1, 2, 3 and Specialized Knowledge (SK), which includes formal classroom, hands-on instruction and practical experience, provides the following list of categories:

- Safety
- Math
- Electric Circuits
- Codes and Standards
- Technical Literature
- Documentation and Data Management
- Tools and Installation
- Battery Basics, Increased or Advanced Knowledge
- Maintenance and Inspection

Preparation of a curriculum that incorporates such a diversity of technical subjects requires a broad knowledge of several disciplines in addition to that which is specific to batteries. It was deemed necessary that an appropriate level of safety, engineering and technical skills were required to develop and administer the training program. The challenge was to identify an individual or individuals that could be dedicated to developing the program. The developer must have knowledge of most, if not all, of the areas identified in P1657 and ideally have experience in technical training and teaching math and the sciences. A qualified candidate was selected to compile the training syllabus that has 30 years experience in teaching science and educational administration. The author provides the program oversight and technical content for battery related information used in the curriculum.

DEVELOPING THE TRAINING CURRICULUM

Organization of Training Content

The organization of the training program content is sufficiently addressed in P1657 that the program development has proven to be relatively self-directed. The IEEE guide provides assignments to the associate training level for each task or item discussed in the document.

5.8 Working Clearances, Egress Paths, and Task Lighting

Working clearances are covered by NFPA 70 (the National Electrical Code) in Article 110.26. The clearances are dependent on voltage and physical size of the equipment. Arc flash protection distances are referenced in the NEC for the higher voltages, but calculations are defined in NFPA 70E. **(L3)**

Minimum egress aisle widths are defined by OSHA in CFR 29, Part 1910.36 [B16] and local codes. **(L2)**

Train the technician to inspect their work areas for egress paths and lighting, trip hazards, tools that could fall, removable flammable materials (such as packing material), and general cleanliness. **(L1)**

Adequate task lighting may be the responsibility of the battery technician. The technician may bring in portable lighting (this might include non-metallic flashlights) to ensure a safe work environment. **(L1)**

Document Excerpt 1

Additionally, there are summary tables provided in the Annex section of the document that organizes the training items and tasks by technical level and directs the reader to the sections that apply to each type of technician.

F.2 Summary of Training Items for Level 1 Technicians

Table F.1 — Safety Curriculum for Level 1 Technicians

| Training Item | Installer | Maintenance Tech | Section Reference |
|---|-----------|------------------|--------------------------------|
| avoid standing water &/or clean it up, + general cleaning | ✓ | ✓ | 5.1, 5.8, 9.1.3.2, and 9.3.1.1 |
| remove trip hazards, and ensure aisles are big enough | ✓ | ✓ | 5.1 and 8.1.7 |
| keep tops (or front near terminals) clear of metal objects | ✓ | ✓ | 5.1 |
| no smoking or flames near batteries | ✓ | ✓ | 5.1 |
| Ground battery racks/stands | ✓ | | 5.1 |
| Proper fire extinguishers for battery fires | ✓ | ✓ | 5.1 |
| insulate other metal in vicinity of bus & terminals | ✓ | ✓ | 5.2, 5.4.1, and 9.2.5.2 |
| types of PPE clothing (including footwear), and care of it | ✓ | ✓ | 5.2, 9.2.5.2 |
| dust masks for protection if needed | ✓ | ✓ | 5.2 |
| using an insulated rescue hook | ✓ | ✓ | 5.2 |
| replacing eyewash bottles | | ✓ | 5.2 |
| use of and inspection of acid-resistant & insulating gloves | ✓ | ✓ | 5.2 |
| maintaining clean tools and hands | ✓ | ✓ | 5.2 and 9.1.3.2 |
| face shields and eye protection | ✓ | ✓ | 5.2, and 9.2.5.2 |
| acid splash aprons | ✓ | ✓ | 5.2, and 9.2.5.2 |
| non-conductive ladder use | ✓ | ✓ | 5.4.1, and 9.2.5.2 |
| no metallic jewelry, belt buckles, etc. | ✓ | ✓ | 5.4.1, and 9.2.5.2 |

Document Excerpt 2

Using the assignments provided in P1657, the prescribed training items and tasks were reorganized by the program developer into three separate documents ordered as Level 1, 2 and 3 Manuals. Since the task items in the IEEE document are presented in a brief sentence format, it is necessary for the training program developer to research each and to provide expanded information or other detailed reference.

Selection of Training Material

The selection of the proper training material is vital to the success of any curriculum. It is recognized that a review of Mathematics and Electric Circuits is required in this training program prior to completing tests and quizzes to verify the pupils' comprehension of the material. The majority of the candidates hold technical backgrounds or formal technical school education. Text and workbook material is limited to theory fundamentals and problem solving. The Schaum's Outlines provide the study guides for the Math and Circuit items required in Levels 1, 2 and 3 as well as a Basic Electricity text prepared by The Bureau of Naval Personnel. Safety related training material was compiled from several sources and is included in Safety Manuals prepared for each skill level. Since text books and reference material specific to the required material for batteries is limited, the Level Manuals and a specially compiled Battery Technician Handbook is provided to each candidate.

Establishing the Training Criteria

P1657 Guidelines

Establishing the training programs' criteria for a candidate to be eligible for and achieve a desired level of competence starts with a review of the guidelines as set forth in P1657. The IEEE recommendations are not specific but offer expectations that include the following:

“Level 1 battery technicians should know basic safety and additional core skills”. Implicitly the IEEE working group recognizes that this training should begin as close as practical to the first day of engagement in the duties associated with battery maintenance and installation. The expectation is that the technicians' duties as a Level 1 are limited to a support role to Level 2 and 3 qualified personnel and though the technician will work around the battery, they will have limited if any physical contact with the battery system.

“Level 2 battery technicians should know battery basics, including the basics of maintenance and installation. Level 2 technicians should have on-the-job training (OJT) as a Level 1 (generally at least 6 months) or previous experience (verified by observation by a Level 3 technician or qualified trainer) before becoming a Level 2”. The expectation for a Level 2 technician is to complete a minimum of 6 months practical experience as a Level 1 and that such experience be validated by a Level 3 or equivalently experienced authority.

“Level 3 battery technicians should be able to perform work independently, except for those areas requiring specialized knowledge. Level 3 technicians should generally have at least one year of OJT as a Level 2 before becoming a Level 3, or previous equivalent experience (verified by observation by an experienced Level 3 technician or qualified trainer)”.

The expectation for a Level 3 technician is to complete a minimum of 1 year practical experience as a Level 2 and that such practice is validated by a Level 3 or equivalently experienced authority.

Specialized Knowledge (SK) *“Items in the text that are application specific are denoted in the text by an “(SK)” designation. The instructor can pick and choose which, if any, of these subjects are covered in the curricula, depending on the needs of the audience”*. The expectation under this special category is that these items that are industry specific, so the general battery technician does not need training on them.

In Practice

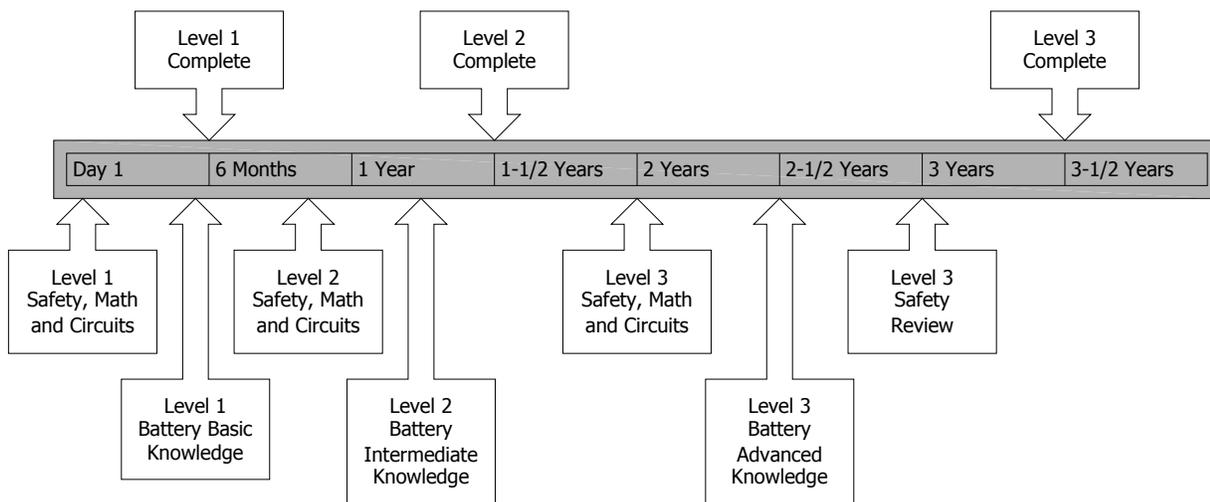
The development of the training program recognizes the three technician skill levels as the foundation for the curriculum. Additionally, the training program includes regularly scheduled Safety Training over and above the guidelines of P1657 as well as periodic reviews and quizzes.

Specialized Knowledge will be prepared in a manner that reflects battery application or industry specific skills as well as unique expertise that is not relevant to the general battery technicians' responsibilities. Application specific certificates of training shall be issued for Uninterruptible Power Supply, Telecommunications, Switchgear, Nuclear, etc.

Early efforts to strictly adhere to the P1657 candidate eligibility guidelines presented several challenges to formalizing the curriculums accepted criteria. As noted below, the difficulties encountered in completing the formal and practical training items and tasks required a less aggressive time line than the prescribed schedule suggested in P1657. To ensure that adequate time is provided to each candidate to comprehend the expectations in knowledge and experience, to complete the necessary reading and coursework problem solving, and to witness each candidate's practical skills, a modified training schedule and candidate criteria was adopted by the training program developers.

The following represents the adopted certification timeline for contact hours and testing:

Adopted Certification Timeline for Contact Hours and Testing



IMPLEMENTING THE TRAINING PROGRAM

Implementation of the training program requires establishing three separate but interrelated avenues to successfully complete the curriculum for each training level. These include the following:

Formal Training

Recognizing that the selected candidates have both technical backgrounds in Math and Circuits and practical experience in the execution of Stationary Battery Maintenance and Installation, the initial plan was 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.

Subsequent training schedules present the material in two separate class sessions, separated by several weeks. Each session is scheduled over multiple days lasting two to three days each. Typically the first session will address Safety, Math and Circuits. The second session addresses battery related material and ancillary information.

Formal training incorporates both traditional classroom instruction and class participation via Web Conferencing that allows the instructor contact with candidates in remote office locations.

Self Study

Independent self study is an essential part of the candidates training curriculum. The Schaum's Outlines 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 as is the Handbook which can be used as reference. 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 are available to all technicians.

On the Job Training

Observing and recording a candidate's proficiency in their completion of tasks associated with the technical level they are pursuing presents challenges to both the candidate and the supervisor. To assist each technician in cataloging their experience and to provide an historical record, each candidate is provided with a personal log book. The log book allows the candidate to record the project information, date and personal responsibilities reflecting their tasks and signature by an a recognized technical supervisor who holds a Level 3 or equivalent level of qualifications. The log book was chosen over electronic records understanding that a technician may changes employers but wish to retain their record of experience.

LESSONS LEARNED

Development of the training program described above holds several lessons to those planning a similar course:

- The training program includes subject matter that extends beyond the traditionally held Battery Tutorial. The program developer should be selected for their knowledge and experience with the majority if not all material.
- Selection of training material should include a collection of texts and workbooks that the candidate will find both practical and easy to use.
- Implementation of the training program should provide an opportunity for the candidate to succeed. Preparation and subject matter review is essential to this success.
- 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 P1657.
- Tracking a candidates skills should be formalized and provide a transferable means for them to retain their record of experience

SUMMARY

IEEE P1657 provides a clearly defined and comprehensive guide for the technical skills required by a well rounded battery technician. The development of a battery technician training program is greatly simplified using P1657 as the roadmap for its preparation.

Though the initial investment in time can be significant, the return realized through the increase in technician knowledge will prove the worth of such expenditure.

As candidates advance through Level 3 and Special Knowledge it will be the leaders in the battery industry today who will be called upon to help support these training programs. Ultimately the industry should establish a governing board to oversee the certification training programs, help ensure that standards are maintained and establish the requirements necessary to uphold the high standards set by IEEE P1657.

REFERENCES

IEEE P1657 Recommended Practice for Personnel Qualifications for Installation and Maintenance of Stationary Lead-Acid and Nickel-Cadmium Batteries